(3) Water Level and Discharge

The observed daily river water level and recorded hourly river water level are tabulated with the following two systems: DB-05 and DB-06 respectively. These systems convert water level to discharge using the discharge rating curve.

If there is a lack of data, the discharge can be estimated using the correlation equation obtained with the system DB-07.

< DB-05: Daily Water Level and Discharge >

DB-05 is a system to make table of daily river water level observed at a hydrometric station, and also to calculate discharge using discharge rating curve obtained with the system DB-03 for DB-04 and make daily discharge table. Those tables are prepared on annual base and by station. Refer to Table-5.6.

Table-5.6(1) DB-05: Daily Water Level in Feet

HF ST.: 1-150 ZAMBEZI PUMP HOUSE YEAR : 1990/91 (WATER LEVEL (f))

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	ANNUAL
1	2.00	1.79	2.49	4.88	20.23	25.20	19.49	13.85	7.27	4.55	2.17	2.38	
2	2.00	1.79	2.53	4.91	20.60	24.70	19.34	13.57	7.13	4.48	2.13	2.38	
3	2.06	1.78	2.57	4.96	21.08	24.33	19.25	13.25	6.98	4.42	2.10	2.36	
4	2.09	1.78	3.02	5.00	21.48	23.83	19.16	13.05	6.88	4.35	2.08	2.31	
5	2.05	1.78	3.08	5.03	21.78	23.38	18.94	12.75	6.68	4.29	2.05	2.28	
6	2.03	1.77	3.10	5.46	22.18	22.90	18.91	12.45	6.55	4.24	2.50	2.28	
7	2.02	1.81	3.18	5.66	22.61	22.51	18.82	12.21	6.44	4.21	2.97	2.25	
8	2.01	1.81	3.23	6.07	22.98	22.10	18.81	11.93	6.34	4.15	2.94	2.25	
9	2.03	1.81	3.28	6.83	23.95	21.70	20.13	11.70	6.26	4.09	2.92	2.23	
10	2.05	1.81	3.32	7.14	25.50	21.32	20.49	11.34	6.18	4.07	2.90	2.22	
11	2.06	1.80	3.41	7.83	26.55	20.90	20.67	11.08	6.12	4.01	2.87	2.00	
12	2.03	1.78	3.56	8.01	26.78	20.41	20.87	10.85	5.98	4.00	2.85	2.00	
13	2.01	1.77	3.64	8.15	27.07	19.73	20.88	10.53	5.90	3.93	2.84	2.02	
14	1.98	1.74	3.76	8.33	27.27	19.36	20.73	10.26	5.82	3.92	2.84	2.00	
15	1.95	1.70	3.80	8.60	27.48	19.28	20.40	10.08	5.74	3.88	2.79	1.98	
16	1.93	1.64	3.87	9.00	27.58	19.20	19.83	9.85	5.67	3.82	2.78	1.97	
17	1.91	1.64	3.97	9.40	27.60	19.28	19.00	9.65	5.54	3.78	2.68	1.96	
18	1.87	1.71	4.09	9.68	27.63	19.41		9.45	5.46	3.73	2.66	1.95	
19	1.83	1.80	4.24	10.10	27.65	19.58		9.26	5.40	3.67	2.65	1.90	
20	1.80	1.83	4.34	10.75	27.93	19.68	17.76	9.05	5.39	3.62	2.63	1.90	
21	1.80	1.76	4.47	11.45	27.85	19.88	17.35	8.86	5.32	3.57	2.62	1.85	
22	1.80	1.78	4.57	12.33	27.50	20.07	17.00	8.65	5.25	3.56	2.60	1.82	
23	1.80	1.83	4.64	13.28	27.23	20.18	16.53	8.49	5.18	3.53	2.59	1.84	
24	1.80	2.12	4.70	13.80	26.83	20.25	16.30	8.32	5.07	3.49	2.58	1.85	
25	1.80	2.14	4.70	14.30	26.57	20.34	16.06	8.14	4.99	3.45	2.58	1.83	
26	1.80	2.25	4.70	14.94	26.33	20.28	15.62	8.03	4.93	3.40	2.51	1.80	MAX.
27	1.80	2.27	4.73	15.60	25.88	20.18	15.14	7.92	4.85	3.36	2.48	1.80	27.93
28	1.80	2.39	4.80	16.37	25.55	20.08	14.81	7.77	4.76	3.33	2.43	1.79	
29	1.79	2.43	4.81	17.08		19.95	14.43	7.67	4.68	3.29	2.40	1.77	MIN.
30	1.77	2.45	4.83	17.90		19.78	14.12	7.52	4.62	3.25	2.39	1.77	1.64
31	1.78		4.85	19.00		19.65		7.38		3.20	2.39		
MEAN	1.92	1.89	3.88	10.06	25.35	20.95	18.24	10.16	5.78	3.83	2.58	2.02	8.89
MAX.	2.09	2.45	4.85	19.00	27.93	25.20	20.88	13.85	7.27	4.55	2.97	2.38	27.93
MIN.	1.77	1.64	2.49	4.88	20.23	19.20	14.12	7.38	4.62	3.20	2.05	1.77	1.64

Table-5.6(2) DB-05: Daily Water Level and Discharge

HM ST.: 1-150 ZAMBEZI PUMP HOUSE YEAR : 1990/91 [WATER LEVEL (m)]

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	ANNUAL
1	0.61	0.55	0.76	1.49	6.17	7.68	5.94	4.22	2.22	1.39	0.66	0.73	
2	0.61	0.55	0.77	1.50	6.28	7.53	5.89	4.14	2.17	1.37	0.65	0.73	
3	0.63	0.54	0.78	1.51	6.43	7.42	5.87	4.04	2.13	1.35	0.64	0.72	
4	0.64	0.54	0.92	1.52	6.55	7.26	5.84	3.98	2.10	1.33	0.63	0.70	
5	0.62	0.54	0.94	1.53	6.64	7.13	5.77	3.89	2.04	1.31	0.62	0.69	
6	0.62	0.54	0.94	1.66	6.76	6.98	5.76	3.79	2.00	1.29	0.76	0.69	
7	0.62	0.55	0.97	1.73	6.89	6.86	5.74	3.72	1.96	1.28	0.91	0.69	
8	0.61	0.55	0.98	1.85	7.00	6.74	5.73	3.64	1.93	1.26	0.90	0.69	
9	0.62	0.55	1.00	2.08	7.30	6.61	6.14	3.57	1.91	1.25	0.89	0.68	
10	0.62	0.55	1.01	2.18	7.77	6.50	6.25	3.46	1.88	1.24	0.88	0.68	
11	0.63	0.55	1.04	2.39	8.09	6.37	6.30	3.38	1.87	1.22	0.87	0.61	
12	0.62	0.54	1.09	2.44	8.16	6.22	6.36	3.31	1.82	1.22	0.87	0.61	
13	0.61	0.54	1.11	2.48	8.25	6.01	6.36	3.21	1.80	1.20	0.87	0.62	
14	0.60	0.53	1.15	2.54	8.31	5.90	6.32	3.13	1.77	1.19	0.87	0.61	
15	0.59	0.52	1.16	2.62	8.38	5.88	6.22	3.07	1.75	1.18	0.85	0.60	
16	0.59	0.50	1.18	2.74	8.41	5.85	6.04	3.00	1.73	1.16	0.85	0.60	
17	0.58	0.50	1.21	2.87	8.41	5.88	5.79	2.94	1.69	1.15	0.82	0.60	
18	0.57	0.52	1.25	2.95	8.42	5.92	5.66	2.88	1.66	1.14	0.81	0.59	
19	0.56	0.55	1.29	3.08	8.43	5.97	5.54	2.82	1.65	1.12	0.81	0.58	
20	0.55	0.56	1.32	3.28	8.51	6.00	5.41	2.76	1.64	1.10	0.80	0.58	
21	0.55	0.54	1.36	3.49	8.49	6.06	5.29	2.70	1.62	1.09	0.80	0.56	
22	0.55	0.54	1.39	3.76	8.38	6.12	5.18	2.64	1.60	1.09	0.79	0.55	
23	0.55	0.56	1.41	4.05	8.30	6.15	5.04	2.59	1.58	1.08	0.79	0.56	
24	0.55	0.65	1.43	4.21	8.18	6.17	4.97	2.54	1.55	1.06	0.79	0.56	
25	0.55	0.65	1.43	4.36	8.10	6.20	4.90	2.48	1.52	1.05	0.79	0.56	
26	0.55	0.69	1.43	4.55	8.03	6.18	4.76	2.45	1.50	1.04	0.77	0.55	
27	0.55	0.69	1.44	4.75	7.89	6.15	4.61	2.41	1.48	1.02	0.76	0.55	
28	0.55	0.73	1.46	4.99	7.79	6.12	4.51	2.37	1.45	1.01	0.74	0.55	
29	0.55	0.74	1.47	5.21		6.08	4.40	2.34	1.43	1.00	0.73	0.54	
30	0.54	0.75	1.47	5.46		6.03	4.30	2.29	1.41	0.99	0.73	0.54	
31	0.54		1.48	5.79		5.99		2.25		0.98	0.73		
MEAN	0.58	0.58	1.18	3.07	7.73	6.39	5.56	3.10	1.76	1.17	0.79	0.62	2.67
MAX.	0.64	0.75	1.48	5.79	8.51	7.68	6.36	4.22	2.22	1.39	0.91	0.73	8.51
MIN.	0.54	0.50	0.76	1.49	6.17	5.85	4.30	2.25	1.41	0.98	0.62	0.54	0.50

QM ST.: 1-150 ZAMBEZI PUMP HOUSE YEAR : 1990/91 [DISCHARGE (m3/sec)]

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	ANNUAL
1	73.6	68.1	87.1	169.6	1347.4	1969.2	1264.9	721.6	279.2	156.6	78.2	84.0	
2	73.6	68.1	88.3	170.8	1389.6	1901.3	1248.4	698.6	272.0	153.9	77.1	84.0	
3	75.2	67.9	89.5	172.8	1445.4	1851.8	1238.7	672.7	264.5	151.6	76.3	83.4	
4	76.0	67.9	103.1	174.4	1492.7	1786.0	1228.9	656.8	259.5	148.9	75.7	82.0	
5	74.9	67.9	105.0	175.7	1528.7	1727.8	1205.2	633.3	249.6	146.7	74.9	81.2	
6	74.4	67.6	105.6	193.7	1577.3	1666.8	1202.0	610.2	243.3	144.8	87.4	81.2	
7	74.1	68.6	108.1	202.4	1630.5	1618.0	1192.4	592.0	238.1	143.7	101.5	80.4	
8	73.9	68.6	109.8	220.8	1676.9	1567.5	1191.3	571.2	233.3	141.5	100.6	80.4	
9	74.4	68.6	111.4	257.0	1801.7	1519.0	1336.1	554.4	229.6	139.3	100.0	79.8	
10	74.9	68.6	112.7	272.6	2010.5	1473.7	1377.0	528.5	225.8	138.6	99.3	79.5	
11	75.2	68.4	115.6	308.8	2158.4	1424.3	1397.7	510.2	223.1	136.4	98.4	73.6	
12	74.4	67.9	120.7	318.7	2191.5	1367.8	1420.8	494.3	216.7	136.1	97.8	73.6	
13	73.9	67.6	123.4	326.4	2233.6	1291.3	1422.0	472.6	213.0	133.5	97.5	74.1	
14	73.1	66.9	127.6	336.6	2262.8	1250.6	1404.6	454.7	209.5	133.2	97.5	73.6	
15	72.3	65.9	129.0	352.0	2293.8	1241.9	1366.7	442.9	205.9	131.8	96.0	73.1	
16	71.7	64.4	131.4	375.6	2308.6	1233.2	1302.4	428.1	202.8	129.7	95.7	72.8	
17	71.2	64.4	135.0	399.9	2311.5	1241.9	1211.7	415.4	197.1	128.3	92.7	72.5	
18	70.2	66.1	139.3	417.3	2316.0	1256.1	1211.7	402.9	193.7	126.5	92.1	72.3	
19	69.2	68.4	144.8	444.2	2318.9	1274.8	1165.9	391.3	191.1	124.4	91.8	71.0	
20	68.4	69.2	148.6	487.5	2360.7	1285.8	1082.1	378.5	190.7	122.7	91.2	71.0	
21	68.4	67.4	153.5	536.4	2348.8	1308.0	1040.9	367.2	187.7	121.0	90.9	69.7	
22	68.4	67.9	157.3	601.1	2296.7	1329.3	1006.3	354.9	184.8	120.7	90.3	68.9	
23	68.4	69.2	160.1	675.1	2257.0	1341.7	960.9	345.7	181.8	119.7	90.0	69.4	
24	68.4	76.8	162.4	717.5	2198.7	1349.6	939.0	336.0	177.3	118.3	89.7	69.7	
25	68.4	77.3	162.4	759.4	2161.2	1359.9	916.4	325.9	174.0	117.0	89.7	69.2	
26	68.4	80.4	162.4	814.8	2126.9	1353.0	875.8	319.8	171.6	115.3	87.7	68.4	
27	68.4	80.9	163.6	874.0	2063.4	1341.7	832.5	313.7	168.4	114.0	86.8	68.4	
28	68.4	84.3	166.4	945.6	2017.4	1330.4	803.4	305.6	164.8	113.0	85.4	68.1	
29	68.1	85.4	166.8	1014.2		1315.8	770.5	300.2	161.6	111.7	84.6	67.6	
30	67.6	86.0	167.6	1096.4		1296.9	744.2	292.3	159.3	110.4	84.3	67.6	
31	67.9		168.4	1211.7		1282.5		284.9		108.8	84.3		
MEAN	71.5	70.9	133.1	484.6	2004.5	1437.4	1145.3	457.3	209.0	130.3	89.9	74.3	515.2
MAX.	76.0	86.0	168.4	1211.7	2360.7	1969.2	1422.0	721.6	279.2	156.6	101.5	84.0	2360.7
MIN.	67.6	64.4	87.1	169.6	1347.4	1233.2	744.2	284.9	159.3	108.8	74.9	67.6	64.4

[Discharge Rating Curve]:Q=25.626*(H+1.085)^2

[Flow Regime (m3/s)]:

Q(95day): 759.4 Q(185day): 162.4 Q(275day): 83.4 Q(355day): 67.6

< DB-06: Hourly Water Level and Discharge >

DB-05 is a system to make a table of hourly river water levels recorded at a hydrometric recording station, and also to calculate discharge using the discharge rating curve obtained with the system DB-03 for DB-04 and make a daily discharge table. These tables are prepared on monthly basis by station. Refer to Table-5.7.

Table-5.7 DB-06: Hourly Water Level and Discharge

HOURLY RIVER WATER LEVEL ST.NO.4-130 SMITH'S BRIDGE APR./1991 [WATER LEVEL m]

HOUR\DATE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
1	5.00	4.92	4.83	4.77	4.73	4.81	4.91	4.84	4.90	4.89	4.90	4.94	4.66	4.65	4.65	4.66	4.66	4.66	4.65	4.66	4.66	4.65	4.65	4.65	4.65	4.66	4.65	4.66	4.66	4.65	
2	5.00	4.92	4.82	4.77	4.73	4.82	4.93	4.84	4.90	4.89	4.90	4.94	4.66	4.65	4.65	4.66	4.66	4.66	4.65	4.66	4.66	4.65	4.65	4.65	4.65	4.66	4.65	4.66	4.66	4.65	
3	5.00	4.92	4.82	4.77	4.73	4.84	4.93	4.84	4.90	4.89	4.90	4.94	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.65	4.66	4.65	4.65	4.66	4.65	4.66	4.66	4.65	
4	4.99	4.91	4.82	4.76	4.73	4.85	4.93	4.84	4.90	4.89	4.90	4.94	4.65	4.66	4.66	4.65	4.66	4.66	4.66	4.66	4.66	4.65	4.66	4.65	4.65	4.65	4.66	4.66	4.66	4.65	
5	4.99	4.90	4.81	4.76	4.73	4.86	4.92	4.84	4.89	4.89	4.90	5.33	4.66	4.65	4.65	4.66	4.66	4.66	4.66	4.66	4.66	4.65	4.65	4.65	4.65	4.65	4.65	4.65	4.66	4.65	
6	4.99	4.90	4.81	4.76	4.73	4.87	4.92	4.84	4.89	4.89	4.91	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.65	4.65	4.65	4.66	4.65	4.66	4.66	4.66	
7	4.99	4.90	4.81	4.75	4.72	4.88	4.91	4.85	4.89	4.89	4.91	4.66	4.65	4.66	4.65	4.66	4.66	4.65	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.65	
8	4.97	4.89	4.80	4.75	4.72	4.89	4.91	4.85	4.89	4.89	4.91	4.66	4.65	4.65	4.65	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.65	4.65	
9	4.91	4.89	4.80	4.75	4.72	4.90	4.90	4.85	4.89	4.89	4.91	4.66	4.65	4.65	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.65	4.65	
10	4.97	4.89	4.80	4.75	4.72	4.91	4.90	4.85	4.90	4.89	4.92	4.66	4.65	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.65	4.66	4.66	4.66	4.66	
11	4.97	4.88	4.80	4.75	4.72	4.92	4.89	4.86	4.89	4.89	4.92	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	
12	4.97	4.88	4.80	4.75	4.72	4.92	4.89	4.86	4.89	4.89	4.92	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	
13	4.97	4.88	4.79	4.75	4.72	4.93	4.89	4.86	4.90	4.89	4.92	4.66	4.65	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	
14	4.97	4.87	4.79	4.75	4.72	4.93	4.87	4.86	4.90	4.89	4.93	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	
15	4.96	4.87	4.79	4.74	4.73	4.94	4.87	4.87	4.89	4.89	4.93	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	
16	4.95	4.87	4.79	4.74	4.73	4.94	4.96	4.88	4.89	4.89	4.93	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	
17	4.95	4.86	4.79	4.74	4.74	4.95	4.88	4.89	4.89	4.89	4.93	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	
18	4.95	4.86	4.78	4.74	4.74	4.95	4.85	4.89	4.89	4.89	4.93	4.65	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	
19	4.95	4.85	4.78	4.74	4.74	4.95	4.85	4.89	4.89	4.89	4.93	4.65	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	
20	4.94	4.85	4.78	4.74	4.75	4.95	4.85	4.90	4.89	4.89	4.91	4.66	4.65	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	
21	4.94	4.84	4.78	4.74	4.76	4.95	4.85	4.90	4.89	4.90	4.94	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.65	4.66	
22	4.93	4.84	4.77	4.74	4.77	4.95	4.85	4.90	4.89	4.90	4.94	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.65	4.66	4.66	
23	4.93	4.83	4.77	4.73	4.79	4.94	4.85	4.90	4.89	4.90	4.94	4.66	4.66	4.66	4.66	4.65	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	
24	4.93	4.83	4.77	4.73	4.80	4.94	4.85	4.90	4.89	4.90	4.94	4.66	4.66	4.66	4.66	4.65	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	
MEAN	4.96	4.88	4.80	4.75	4.74	4.91	4.88	4.87	4.89	4.89	4.92	4.71	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.65	4.66	4.66	4.65	4.66	4.66	4.66	
MAX.	5.00	4.92	4.83	4.77	4.80	4.95	4.94	4.90	4.90	4.90	4.94	5.33	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	
MIN.	4.93	4.83	4.77	4.73	4.72	4.81	4.85	4.84	4.89	4.89	4.90	4.66	4.66	4.66	4.66	4.65	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.65	4.66	4.66	4.66	4.66	

HOURLY RIVER DISCHARGE ST.NO.4-130 SMITH'S BRIDGE APR./1991 Applied Equation :Q = 6.078 * (H + 0.184)^2 [DISCHARGE m3/sec]

HOUR\DATE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
1	169.5	159.5	152.7	149.2	146.8	151.8	159.4	153.6	156.8	156.5	157.0	159.4	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	
2	159.3	159.3	152.5	149.2	146.8	152.5	159.3	153.6	156.8	156.4	157.0	159.4	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	
3	159.1	159.1	152.3	149.0	145.8	153.2	158.9	153.6	156.8	156.4	157.0	159.4	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	
4	162.7	157.5	151.9	148.8	146.8	153.8	158.7	153.6	156.8	156.4	157.2	159.4	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	
5	152.5	157.2	151.8	148.8	145.6	154.5	158.3	153.6	156.8	156.4	157.4	184.9	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	
6	157.3	157.0	151.8	148.6	146.6	155.1	158.1	153.6	155.6	156.4	157.5	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	
7	161.9	156.8	151.4	148.3	146.4	155.7	157.9	153.8	156.4	155.2	157.5	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	
8	161.7	156.4	151.2	148.3	146.4	156.4	157.5	154.0	156.4	156.2	157.5	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	
9	161.5	155.4	151.0	148.3	146.4	156.8	157.2	154.2	156.6	156.2	157.9	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	
10	161.3	156.2	151.0	148.3	146.4	157.5	156.8	154.5	156.8	156.4	158.1	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	
11	161.3	155.9	151.0	148.3	146.4	158.1	156.6	154.7	156.6	156.4	158.3	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	
12	161.3	155.7	150.8	148.3	146.4	158.5	156.2	154.7	156.6	156.4	158.5	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	
13	161.3	155.7	150.6	148.1	146.4	158.9	155.7	154.9	156.8	156.6	158.5	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	
14	161.2	155.5	150.6	147.7	146.6	159.1	155.5	154.9	156.8	156.6	158.9	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	
15	160.8	155.3	150.5	147.5	146.8	159.4	155.1	155.3	156.6	156.6	158.9	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	
16	160.6	155.1	150.1	147.5	146.8	159.6	154.7	155.7	156.6	156.6	158.9	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	
17	160.4	154.7	150.1	147.5	147.2	160.0	154.5	156.2	156.6	156.6	159.1	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	
18	160.4	154.5	149.7	147.3	147.3	160.0	154.2	156.4	156.6	156.6	159.3	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	
19	160.0	154.0	149.5	147.3	147.5	160.0	153.8	156.6	156.6	156.6	159.3	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	
20	159.8	153.8	149.5	147.2	147.9	160.0	153.8	156.8	156.6	156.6	159.4	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	
21	159.4	153.6	149.5	147.2	148.8	160.0	153.8	156.8	156.6	156.6	159.4	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	
22	159.3	153.2	149.4	147.2	149.4	159.8	153.8	157.0	156.6	156.8	159.4	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	
23	158.9	153.1	149.2	147.0	150.1	159.8	153.8	156.8	156.6	156.8	159.4	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	
24	158.7	152.9	149.2	146.8	151.0	159.8	153.8	156.8	156.6	156.8	159.4	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	
MEAN	161.1	155.6	150.7	148.0	147.3	157.5	156.1	155.1	156.6	156.5	158.4	147.3	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	
MAX.	169.5	159.5	152.7	149.2	151.0	160.0	159.4	157.0	156.8	156.8	159.4	184.9	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	
MIN.	158.7	152.9	149.2	146.8	146.4	151.8	153.8	153.6	156.4	156.2	157.0	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	142.8	

< DB-07: Discharge Correlation Analysis >

This system prepares the correlation curve(s) between two stations' discharge. The curve(s) will be used to fill the missing or not-available discharge data in the table obtained with DB-05 or DB-06. The curve is expressed as " Y = aX + b ". Where, X & Y: discharge, a & b: constants. Refer to Table-5.8 and Fig.-5.5.

Table-5.8 DB-07: Discharge Correlation Analysis

NO	YEAR-MONTH	ST:X	ST:Y	X*Y	X^2	Y^2
1	(59/60-10)	260.1	61.0	15865.25	67644.73	3721.00
2	11	280.9	72.1	20251.81	78896.42	5198.41
3	12	349.4	120.8	42210.26	122096.21	14592.64
4	1	587.2	330.0	193774.43	344798.27	108900.00
5	2	1,097.0	996.0	1092582.24	1203343.44	992016.00
308	(88/89-10)	278.6	70.4	19611.58	77603.26	4956.16
309	11	331.1	104.3	34536.66	109645.81	10878.49
310	12	421.9	183.9	77591.11	178016.61	33819.21
311	1	689.8	614.7	423993.65	475764.76	377856.09
312	2	1,135.3	1,354.5	1537739.77	1288865.72	1834670.25
313	8	403.9	168.1	67887.20	163094.90	28257.61
314	9	345.1	115.1	39715.97	119063.79	13248.01
	T O T A L	250293	211126	315849944	299890930	372021945

Y = a + b*X
X = a' + b'*Y (a'=-a/b, b'=1/b)

a=	-499.38835
b=	1.47001
a'=	339.71716
b'=	0.68027
Corelation Coefficient c=	0.97100

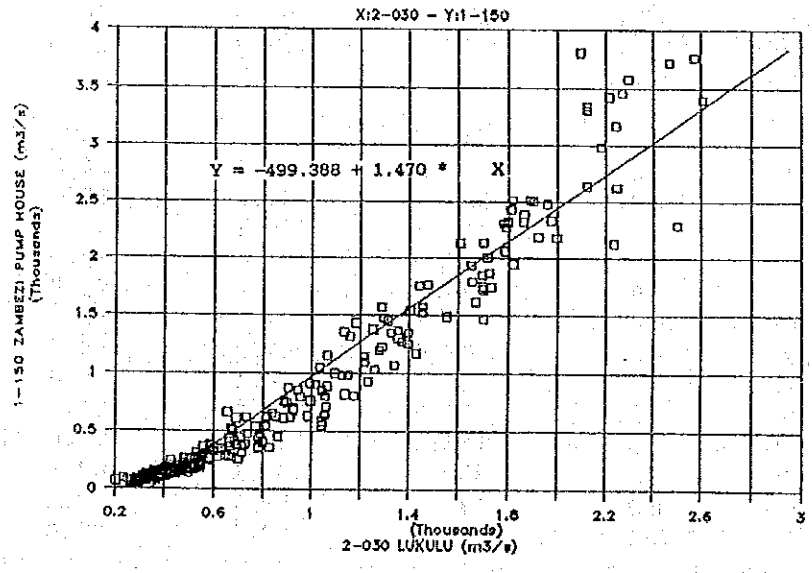


Fig.-5.5 DB-07: Discharge Correlation Curve

(4) Flow Regime

Annual flow regime and long-term flow regime are obtained with the following systems.

< DB-05: Daily Water Level and Discharge >

DB-05, explained above, gives not only the calculated discharge but the annual flow regime showing the following discharge.

1) High Discharge (95-day discharge)
2) Normal Discharge (185-day discharge)
3) Low Discharge (275-day discharge)
4) Drought Discharge (355-day discharge)
5) Annual Mean Discharge

< DB-08: Flow Regime >

This system prepares a table of annual flow regime, showing high discharge (Q95day), normal discharge (Q185day), low discharge (Q275day), drought discharge (Q355day), compiling the data obtained from DB-5. Refer to Table-5.9.

Table-5.9 DB-08: Flow Regime by Station

ST.: 1-150 ZAMBEZI PUMP HOUSE FLOW REGIME (m3/s)

NO	YEAR	Q(95days)	Q(185day)	Q(275day)	Q(355day)	MEAN
1	1959/60	828.9	222.1	102.4	56.2	735.7
2	1960/61	901.5	265.5	125.5	65.9	886.4
3	1961/62	1604.4	363.7	158.5	87.4	1077.4
4	1962/63	2010.5	363.7	139.7	96.3	1119.5
5	1963/64	828.9	270.5	132.5	93.3	573.8
6	1964/65	864.9	217.6	108.8	73.6	663.4
7	1965/66	684.8	245.7	112.0	71.0	607.6
8	1966/67	977.2	204.1	99.3	79.0	657.9
9	1967/68	2617.8	418.6	157.7	71.0	1300.9
10	1968/69	301.2	86.5	35.0	16.2	303.9
			↓			
20	1978/79	1132.4	360.2	170.4	94.2	908.1
21	1979/80	1650.1	350.9	149.3	95.4	889.6
22	1980/81	748.5	215.3	119.7	86.0	572.9
23	1981/82	401.7	174.0	103.1	72.5	338.1
24	1982/83	405.4	188.1	96.9	64.9	280.8
25	1983/84	636.4	121.7	71.2	49.1	469.4
26	1984/85	572.7	198.4	91.2	57.4	453.5
27	1985/86	574.2	152.0	74.4	55.8	490.3
28	1986/87	752.6	292.3	129.0	69.2	571.2
29	1987/88	633.3	155.4	90.6	71.0	439.8
30	1988/89	1153.3	300.2	131.1	68.4	816.4
31	1989/90	393.1	179.8	98.1	78.4	277.7
32	1990/91	759.4	162.4	83.4	67.6	525.7
	MEAN	949.1	248.8	116.8	75.0	665.5

(5) River Flow Analysis

The river flow analysis is obtained with the system DB-09: Analysis of River Flow. This system prepares the annual and monthly tables of river water, using the data obtained from DB-05 and DB-09. Refer to Table-5.10.

Table-5.10 DB-09: River Flow Analysis

AREAS	BASINS	No.	ST.	POINT & STATION NAME	AREA(km2)	79/80	80/81	81/82	82/83	83/84	84/85	85/86	86/87	87/88	88/89	89/90	90/91	MEAN
UPPER ZAMBEZI		(1)		Chalose	73,512	749	483	285	237	395	382	413	481	370	608	234	443	430
"	"	(2)	1-150	St. Zambezi Pump House	87,275	890	573	338	281	469	453	490	571	440	816	278	526	510
"	"	(3)		Zambezi R. Portion	90,353	921	593	350	291	486	469	508	591	455	845	288	544	528
"	"	(4)	1-650	St. Kabompo Boma	42,740	293	240	109	201	124	153	181	243	208	153	140	172	185
"	"	(5)		Kabompo R. Portion	45,029	296	247	118	201	126	157	184	241	207	155	141	175	187
"	"	(6)		Dongwe R. Portion	20,568	28	62	74	1	15	35	26	-17	-6	20	10	27	23
"	"	(7)		Confluence	65,597	325	309	191	201	141	192	210	224	201	176	151	201	210
"	"	(8)	1-950	St. Matopa Pontoon	66,449	326	312	194	201	142	193	211	223	201	177	152	202	211
"	"	(9)		Kabompo R. Portion	72,347	334	329	216	201	146	203	218	218	199	187	154	210	218
"	"	(10)		Confluence	162,700	1255	922	566	492	632	673	726	810	654	1028	442	754	746
"	"	(11)	2-030	St. Lukulu	206,531	1003	795	578	537	594	626	628	708	671	871	514	670	691
"	"	(12)		Zambezi R. Portion	228,076	1031	833	629	645	639	700	674	760	722	896	566	690	734
"	"	(13)	2-250	St. Kalalo	34,621	76	78	32	40	38	51	47	38	65	175	34	39	60
"	"	(14)		Luanginga R. Portion	41,233	85	89	48	43	51	73	61	61	80	183	59	46	73
"	"	(15)		Confluence	269,309	1115	922	677	688	691	773	735	840	802	1080	617	736	806
"	"	(16)	2-400	St. Senanga	278,298	1127	938	699	692	709	804	754	870	823	1090	638	745	824
"	KAFUE	(21)	4-050	St. Baglan Farm	4,999	57	35	21	29	21	30	43	37	26	28	15	21	30
"	"	(22)		Kafue R. Portion	7,730	92	64	46	63	49	75	97	74	55	68	71	69	69
"	"	(23)	4-120	St. Mwambashi	869	8	10	5	6	4	9	13	7	6	6	4	5	7
"	"	(24)	4-130	St. Smith's Bridge	8,599	100	74	50	69	53	84	110	82	61	74	74	74	76
"	"	(25)	4-200	St. Mpatamato	11,655	123	109	58	76	60	121	176	80	78	90	54	79	92
"	"	(26)	4-280	St. Nachiya Ferry	22,920	196	174	90	103	79	178	196	117	114	134	74	106	130
"	"	(27)		Kafue R. Portion	24,582	207	183	95	107	83	185	203	120	118	139	77	109	136
"	"	(28)		Luswishi R. Portion	8,866	58	49	26	20	20	34	38	21	25	27	16	14	29
"	"	(29)		Confluence	33,448	265	233	121	127	103	219	241	141	143	167	93	123	165
"	"	(30)	4-350	St. Chilanga	34,162	270	237	123	129	104	222	244	143	145	169	94	124	167
"	"	(31)	4-450	St. Lubungu	54,442	279	269	128	125	111	212	237	148	139	164	93	114	168
"	"	(32)	4-560	St. Chifumpa Pontoon	21,445	145	125	56	44	51	90	105	74	89	71	54	68	81
"	"	(33)		Luiga R. Portion	24,416	147	135	62	48	55	91	102	72	92	70	57	70	83
"	"	(34)		Confluence	78,858	426	405	190	173	166	303	340	220	231	235	150	184	252
"	"	(35)	4-669	St. Kafue Hook Bridge	95,053	440	461	221	193	190	310	324	209	245	234	163	197	266
LOWER ZAMBEZI		(17)		Livingstone	466,324	1486	1325	791	816	816	898	899	977	936	1468	701	917	1003
"	"	(18)		In (Kariba Dam)	608,634	1772	1972	844	902	919	1312	1240	1053	1233	1828	970	1066	1259
"	"	(18E)		Evaporation	—	285	303	331	305	294	282	247	278	262	260	296	277	285
"	"	(18S)		Storage	—	14	13	-456	-434	-342	57	82	-64	216	510	-382	-118	-75
"	"	(19)		Out (Kariba Dam)	—	1473	1657	969	1031	957	972	911	839	755	1057	1055	906	1049
"	"	(20)		Zambezi R. Portion	612,724	1481	1676	971	1033	970	984	921	841	764	1067	1063	910	1057
"	KAFUE	(36)		In (Itezhi-tezhi Dam)	105,672	466	469	193	171	158	329	319	199	242	242	164	182	261
"	"	(36E)		Evaporation	—	18	19	18	17	14	15	18	18	18	17	17	16	17
"	"	(36S)		Storage	—	3	-2	-33	-24	-48	79	21	-20	0	6	-25	-2	-4
"	"	(37)		Out (Itezhi-tezhi Dam)	—	444	452	208	178	193	236	281	201	224	219	171	168	248
"	"	(38)		In (Kafue Gorge Dam)	151,576	520	661	216	182	178	203	312	214	197	328	213	162	282
"	"	(38E)		Evaporation	—	31	38	35	19	12	25	39	36	31	27	31	24	29
"	"	(38S)		Storage	—	18	1	-10	-5	2	11	2	1	-2	-7	-5	-2	0
"	"	(39)		Out (Kafue Gorge Dam)	—	471	622	191	169	164	168	271	177	168	309	187	140	253
"	"	(40)		Kafue R. Portion	154,882	477	637	192	170	166	178	279	178	175	316	193	144	259
"	ZAMBEZI	(41)		Confluence	767,606	1959	2313	1163	1204	1136	1161	1200	1020	938	1383	1256	1054	1316
"	"	(42)		Zambezi R. Portion	786,686	1997	2399	1170	1215	1150	1217	1246	1030	978	1432	1292	1074	1350
"	LUANGWA	(43)	5-940	St. Luangwa Bridge	143,781	722	563	407	363	342	707	962	469	582	831	1505	373	652
"	"	(44)		Luangwa R. Portion	150,586	756	590	426	380	359	740	1008	492	610	870	1577	390	683
"	ZAMBEZI	(45)		Confluence	937,272	2753	2989	1596	1595	1509	1957	2253	1522	1588	2301	2869	1464	2033

(6) Reservoir Water Balance

The reservoir water balance is obtained with the system DB-10: Analysis of Reservoir Water Balance. This system calculates the monthly reservoir water balance. Refer to Table-5.11.

Table-5.11 DB-10: Reservoir Water Balance

< Annual Reservoir Water Balance >

[RESERVOIR OPERATION] PERIOD: 1979/80 - 1990/91 (12 YEARS) DAM: ITEZHI-TEZHI

Year	W/Level H(m)	Volume V(mcm)	R.Area A(Km2)	Rain R(mm)	P.Evap Eo(mm)	Change/V dV(m3/s)	Inflow QI(m3/s)	A.Evap. E(m3/s)	Outflow Qo(m3/s)	Kafue Qf(m3/s)	H/B QI-Qf (m3/s)
1978/79	1029.17	6026	367								
L1979/80	1029.42	6126	371	859	1620	3.1	466.8	18.0	445.6	441.1	25.6
1980/81	1020.26	6062	369	1013	1620	-2.0	465.8	18.7	449.1	458.5	7.4
1981/82	1026.48	5025	325	496	1620	-32.9	102.3	18.3	206.9	219.3	-26.9
1982/83	1024.22	4275	291	705	1620	-23.8	171.4	16.7	178.5	193.0	-21.6
L1983/84	1018.64	2752	216	533	1620	-48.2	158.6	13.6	193.2	190.2	-31.5
1984/85	1027.06	5230	334	520	1620	78.6	328.8	15.1	235.2	302.1	26.7
1985/86	1028.80	5881	361	523	1620	20.6	318.8	17.6	280.6	322.3	-3.5
1986/87	1027.13	5256	335	644	1620	-19.8	199.3	18.1	201.1	208.8	-9.5
L1987/88	1027.14	5259	335	518	1620	0.1	242.6	17.6	224.9	246.5	-3.9
1988/89	1027.63	5438	343	608	1620	5.7	240.3	17.4	217.2	227.9	12.4
1989/90	1025.82	4797	315	771	1620	-20.3	168.2	17.1	171.4	150.9	17.3
1990/91	1025.60	4723	312	640	1620	-2.4	181.6	16.3	167.6	181.9	-0.3
MEAN(mm & m3/s)				653	1620	-3.4	261.2	17.0	247.6	261.9	-0.7
TOTAL(mm & mcm)						-107	8237	536	7808	8259	-22

< Monthly Reservoir Water Balance >

[RESERVOIR OPERATION] (1) DAM: ITEZHI-TEZHI Year:1979/80

79/80 Month	W/Level H(m)	Volume V(mcm)	R.Area A(Km2)	Rain R(mm)	P.Evap Eo(mm)	Change/V dV(m3/s)	Inflow QI(m3/s)	A.Evap. E(m3/s)	Outflow Qo(m3/s)	Kafue Qf(m3/s)	H/B QI-Qf (m3/s)
SEP	1029.17	6026	367								
OCT	1028.64	5819	359	14	210	-77.3	151.2	28.5	200.0	137.0	14.2
NOV	1028.32	5697	354	202	140	-47.3	175.9	19.2	204.0	161.0	14.9
DEC	1028.78	5873	361	293	140	66.0	631.2	18.7	546.5	366.0	265.2
JAN	1025.18	4583	305	39	120	-481.6	436.7	14.9	903.4	551.0	-114.3
FEB	1025.19	4587	305	200	100	1.3	778.3	12.2	764.8	722.0	56.3
MAR	1025.82	4797	315	103	140	78.6	1035.8	16.2	941.0	961.0	74.8
APR	1027.71	5467	344	6	130	258.6	800.9	16.5	534.8	806.0	3.9
MAY	1028.75	5862	360	0	120	147.2	657.4	15.8	494.4	647.0	10.4
JUN	1029.38	6078	369	0	90	83.3	371.6	12.7	275.8	364.0	7.6
JUL	1029.59	6194	374	6	120	43.3	234.2	16.7	174.2	237.0	-2.8
AUG	1029.56	6182	374	0	140	-4.5	179.6	19.5	164.6	191.0	-11.4
SEP	1029.42	6126	371	2	170	-21.6	132.0	24.4	129.2	145.0	-13.0
MEAN(mm & m3/s)				72	135	3.2	466.8	18.0	445.6	441.1	25.6
TOTAL(mm & mcm)				859	1620	99	14720	588	14052	13911	809

(7) Well Water Level

The observed well water level is filed and analyzed comparing it with the river water level using the following systems.

< DB-11: Well Water Level by Station >

To file daily well water level observed at the observation well, calculate water level elevation in meters and output tables by station. Refer to Table-5.12.

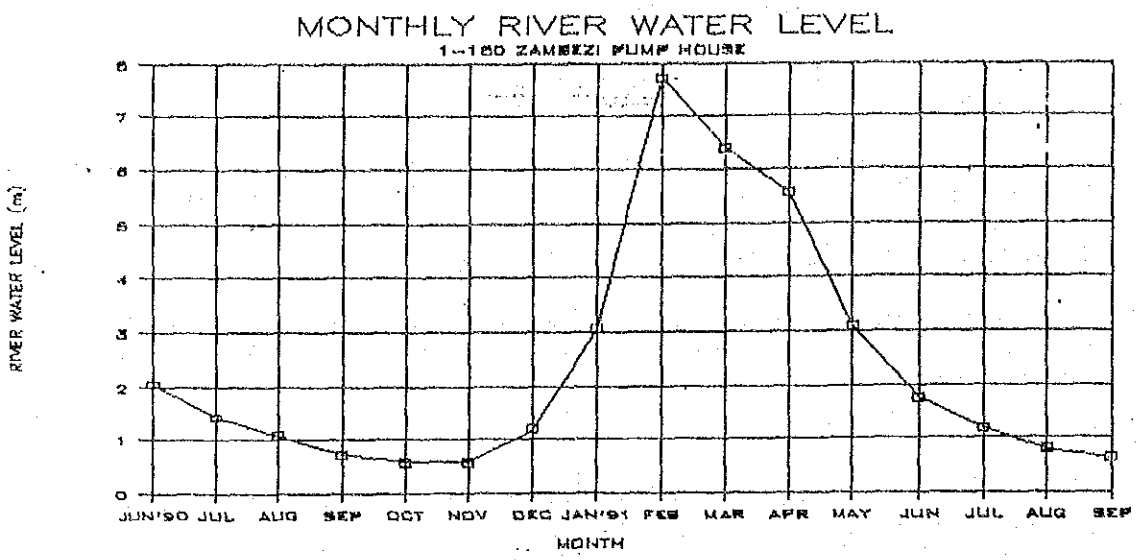
< DB-12: Well Water Level Analysis >

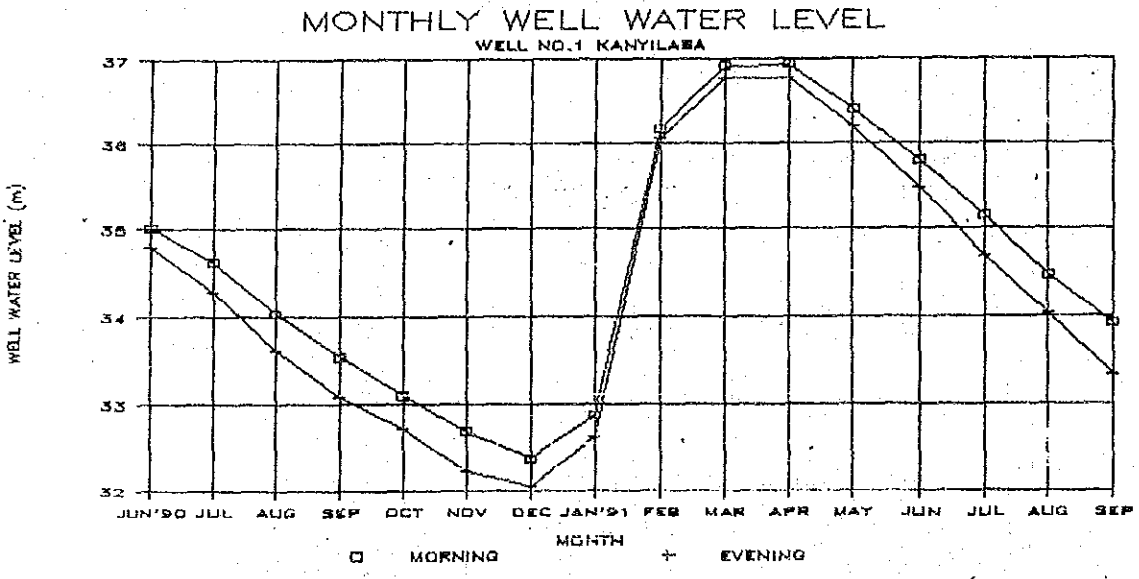
This system analyzes the relationship between the river water level and well water level. Refer to Fig.-5.6.

Table-5.12 DB-11: Well Water Level by Station

WWLe Well No 1990/91 Evening [Water Level (m)]

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	ANNUAL
1	7.23	7.54	7.79	7.17	5.26	5.55	4.52	4.80	5.47				
2	7.14	7.52	7.73	7.18	5.16	5.54	4.53	4.82	5.50				
3	7.19	7.55	7.70	7.14	5.23	5.60	4.55	4.84	5.52				
4	7.16	7.57	7.77	7.14	5.20	5.66	4.54	4.87	5.52				
5	7.18	7.54	7.75	7.10	5.21	5.62	4.57	4.90	5.53				
6	7.21	7.57	7.82	7.06	5.25	5.64	4.61	4.93	5.55				
7	7.23	7.52	7.80	7.11	5.32	5.58	4.64	4.95	5.57				
8	7.26	7.56	7.85	7.02	5.35	5.56	4.54	4.99	5.58				
9	7.26	7.54	7.81	7.00	5.38	5.52	4.49	5.03	5.59				
10	7.24	7.57	7.73	7.02	5.44	5.50	4.45	5.05	5.60				
11	7.30	7.59	7.71	7.07	5.43	5.46	4.43	5.07	5.61				
12	7.26	7.64	7.68	7.00	5.40	5.45	4.37	5.09	5.62				
13	7.21	7.62	7.63	7.10	5.38	5.44	4.35	5.11	5.64				
14	7.33	7.60	7.64	6.99	5.39	5.40	4.37	5.14	5.65				
15	7.30	7.63	7.66	6.90	5.32	5.39	4.36	5.16	5.67				
16	7.32	7.64	7.54	6.92	5.33	5.38	4.38	5.18	5.68				
17	7.28	7.65	7.60	6.89	5.30	5.36	4.39	5.20	5.68				
18	7.31	7.74	7.57	6.91	5.29	5.40	4.42	5.23	5.69				
19	7.36	7.73	7.55	6.70	5.30	5.40	4.44	5.22	5.71				
20	7.38	7.76	7.65	6.52	5.30	5.41	4.45	5.24	5.71				
21	7.34	7.73	7.50	6.44	5.32	5.42	4.47	5.27	5.73				
22	7.44	7.71	7.58	6.45	5.36	5.42	4.53	5.28	5.72				
23	7.50	7.69	7.51	6.43	5.41	5.40	4.54	5.32	5.75				
24	7.42	7.72	7.54	6.40	5.43	5.29	4.56	5.35	5.76				
25	7.40	7.74	7.52	6.44	5.42	5.05	4.58	5.38	5.77				
26	7.47	7.64	7.47	6.29	5.46	4.79	4.61	5.38	5.78				
27	7.43	7.61	7.42	6.21	5.50	4.71	4.68	5.40	5.80				
28	7.50	7.68	7.34	5.69	5.52	4.65	4.71	5.41	5.78				
29	7.48	7.72	7.27	5.45		4.54	4.74	5.43	5.80				
30	7.53	7.77	7.22	5.39		4.58	4.74	5.44	5.81				
31	7.51		7.20	5.27		4.50		5.48					
MEAN	7.33	7.64	7.61	6.66	5.35	5.30	4.52	5.16	5.66				6.14
MAX.	7.53	7.77	7.85	7.18	5.52	5.66	4.74	5.48	5.81				7.85
MIN.	7.14	7.52	7.22	5.27	5.16	4.50	4.35	4.80	5.47				4.35





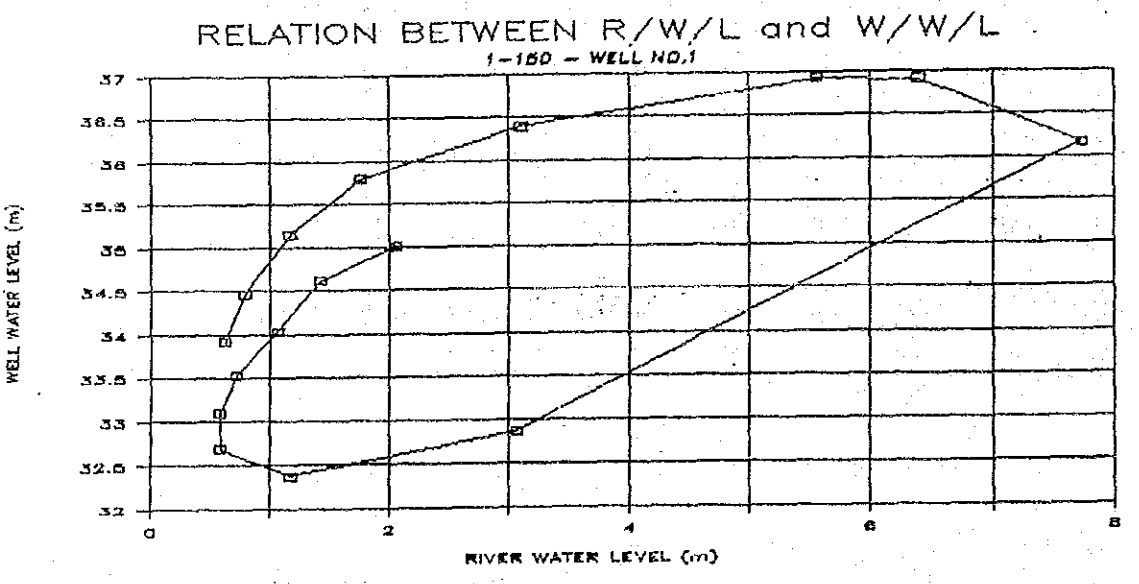


Fig.-5.6 DB-12: Well Water Level Analysis

5.1.3 Data Input Availability

In Zambia, 242 hydrological observation Stations are registered at the DWA.
The Team input the following data onto computer files during the study period.

- Daily River Water Level
- Hourly River Water Level
- Flow Measurement Data
- Discharge Rating Curve Analysis (H/Q Curve)
- River Water Discharge (using H/Q equation)

The available data in diskette form for each river basin is shown as Table-5.13. Details refer to **Supplement-4.7** in **SUPPORTING REPORT**.

Table-5.13 Availability of Data Input

River Basin	Total St. Number	Number of Station of Available Data in Disk				
		D/R/W/L	H/R/W/L	F/M	H/Q	Dis.
Zambezi	64	64	1	7	7	7
Kafue	89	89	5	11	11	11
Luangwa	20	20	0	1	1	1
Chambeshi	27	27	0	0	0	0
Luapula	35	35	0	0	0	0
Tanganyika	7	7	0	0	0	0
TOTAL	242	242	6	19	19	19

[NOTE] D/R/W/L : Daily River Water Level
H/R/W/L : Hourly River Water Level
F/M : Flow Measurement Data
H/Q : H-Q Curve Analysis
Dis. : River Water Discharge

5.2 Discharge Rating Curve

(1) Type of Rating Curve

To know the continuous river discharge at a given point on the river, daily or periodic observation of the river water level is done, because it is very hard to measure discharge continuously. To concert these observed data of water level to discharge, the discharge rating curve is essential. The discharge rating curve , relation curve between discharge:Q and water level:H, is generally chosen from the following equations.

1) Second-degree Curve
   $Q = a \times (H + b)^2$ a, b : Constant

2) n-degree Curve
   $Q = a \times (H + b)^n$ a,b,n : Constant, n = 1.5 -2.5

3) Curve based on Manning Formula
   $Q = A \times V = \{(1/n) \times I^{(1/2)}\} \times A \times R^{(2/3)}$
   A: Discharge area, V: Velocity, n: manning roughness
   I: Water surface slope, R: Hydraulic radius

4) Method based on H-A Curve and H-V Curve
   Q is got from H-A & H-V curve established previously.

(2) Rating Curves Obtained in Study

In this Study, the second degree curve is employed as it is widely used around the world. The discharge rating curve of the selected 19 hydrometric stations for the Study were prepared by either method shown below according to the number of flow measurement data.

1) Method-1: in case of a small amount of measurement data
   By Manning Formula, some rating curves are obtained on the basis of the river cross section, water surface slope and roughness. Comparing these curves with some measurement data, the most appropriate curve is selected. This job is done using Database System DB-03.

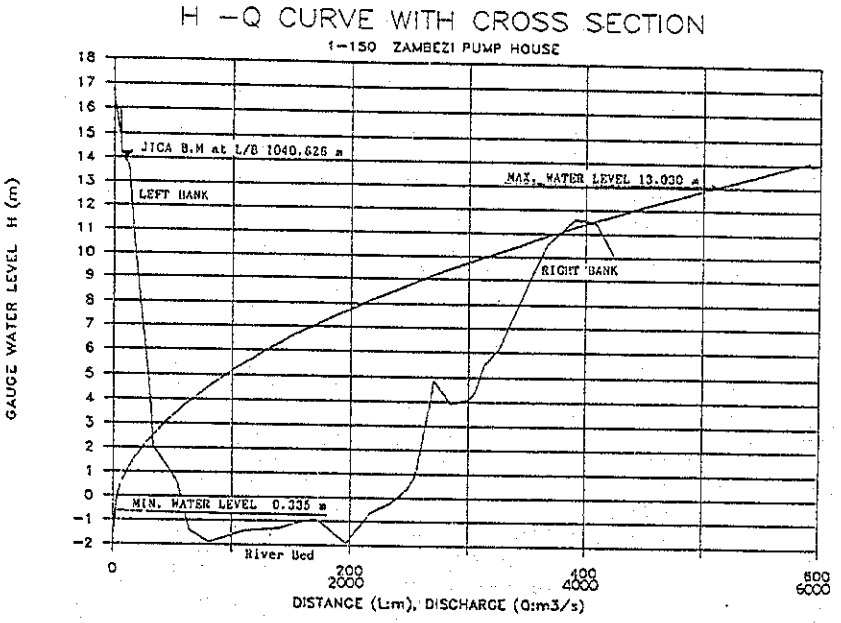
2) Method-2: in case of a large amount of measurement data
   Firstly, water level (H) - square root discharge ($Q^{0.5}$) graph is prepared. Secondly, according to this $H-Q^{0.5}$ curve, the most approximate curve(s) is(are) obtained. In the case data is distributed approximately around a line on $H-Q^{0.5}$ graph, one rating curve is determined. In the case data is distributed around a broken line, plural curves are obtained. This job is done using Database System DB-04.

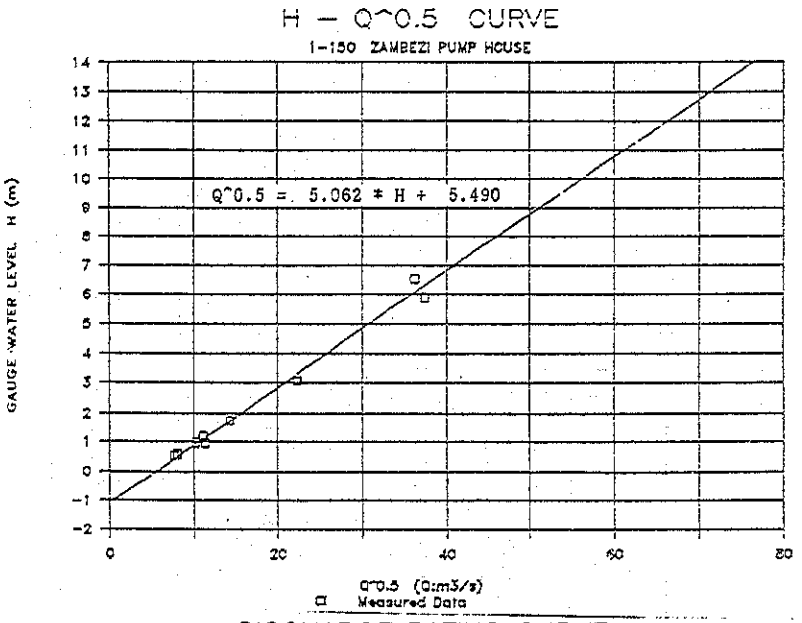
Table-5.14 shows the discharge rating curves thus obtained in this Study.

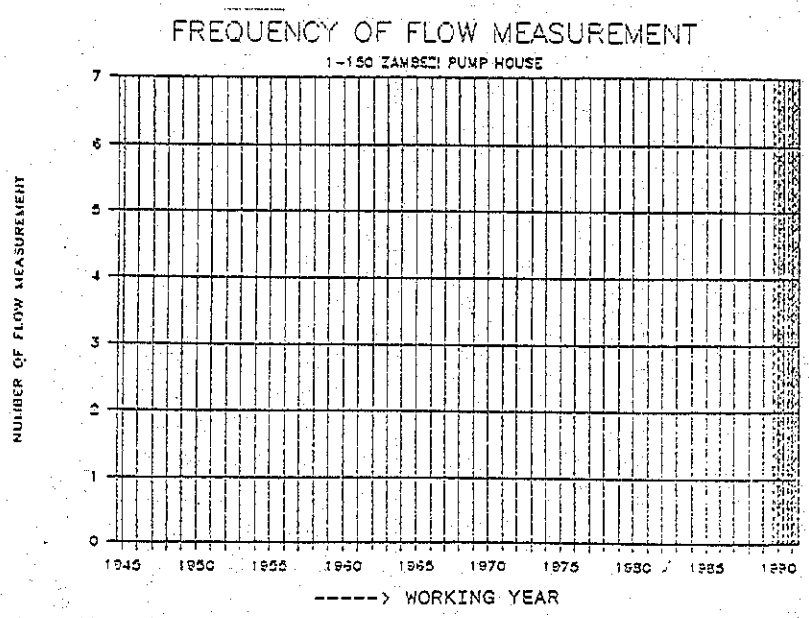
Table-5.14 Equation of Discharge Rating Curve

No.	Hydrometric Station	Discharge Rating Curve
1	1-150 Zambezi P/H	Q=25.626*(H+1.085)^2
2	1-650 Kabompo Boma	Q=66.342*(H-0.715)^2
3	1-950 Watopa Pontoon	Q=29.791*(H-0.262)^2
4	2-030 Lukulu	Q=28.448*(H+2.567)^2
5	2-250 Kalabo	Q= 7.404*(H+0.654)^2 H < 3.179m Q=132.763*(H-2.270)^2 H >= 3.179m
6	2-400 Senanga	Q=50.805*(H+1.747)^2
7	4-050 Raglam Farm	Q= 5.677*(H+0.167)^2
8	4-120 Mwambashi	Q= 6.058*(H-1.262)^2 H < 2.920m Q= 1.989*(H-0.0019^2 H >= 2.920m
9	4-130 Smith's Bridge	Q= 6.078*(H+0.184)^2
10	4-200 Mpatamato	Q= 7.269*(H+0.676)^2
11	4-280 Machiya Ferry	Q=10.964*(H-1.012)^2
12	4-350 Chilenga	Q= 8.771*(H+0.439)^2 H < 5.134m Q=40.036*(H-2.525)^2 H >= 5.134m
13	4-450 Lubungu	Q=31.695*(H-0.476)^2
14	4-560 Chifumpa Pont.	Q=25.326*(H+0.562)^2
15	4-669 Kafue Hook B.	Q=110.511*(H-0.937)^2
16	4-941 Kaleya Dam S.	Q= 1.780*(H-0.115)^2 H < 4.663m Q=32.948*(H-3.603)^2 H >= 4.663m
17	4-958 Uruaff Farm	Q= 8.421*(H-0.009)^2
18	5-030 Exchange Farm	Q= 1.684*(H+0.084)^2 H < 0.720m Q= 9.681*(H-0.386)^2 0.72m<=H<1.64m Q=21.059*(H-0.729)^2 H >= 1.640m
19	5-940 Luangwa Bridge	Q=60.157*(H-1.003)^2

The rating curves shown above are illustrated in Fig.-5.7 to 5.25. The cross section of each station is also shown in the figure.







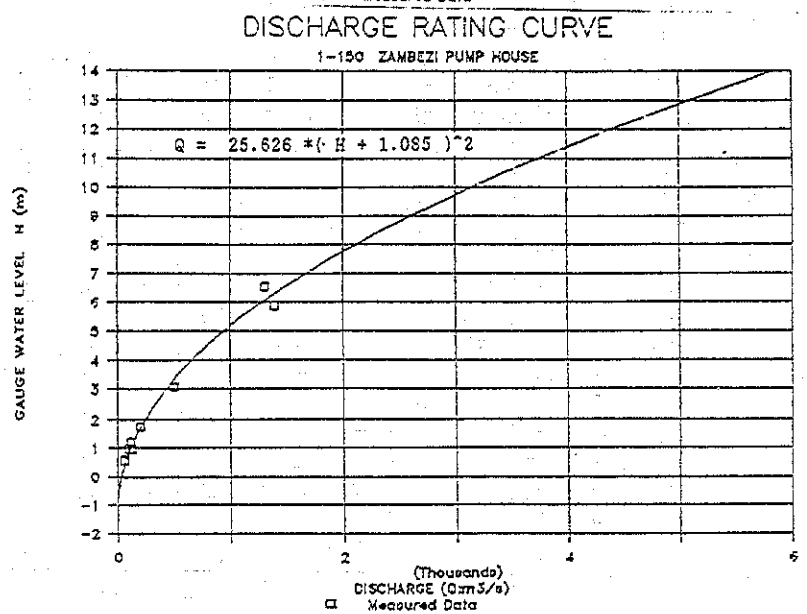
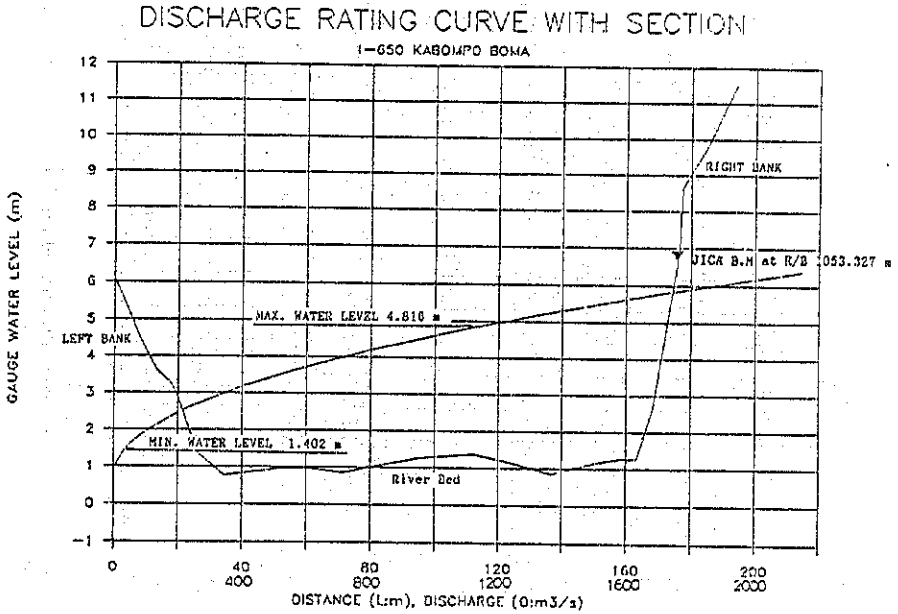
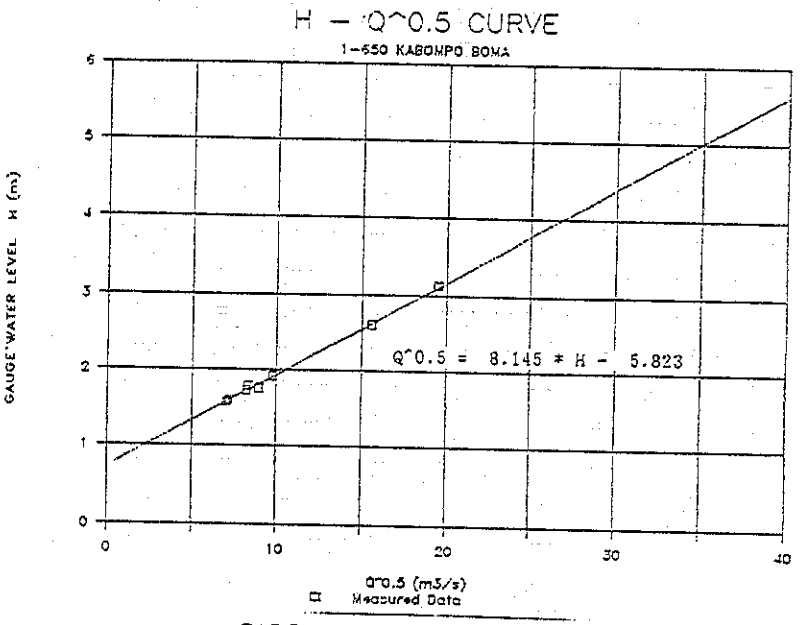
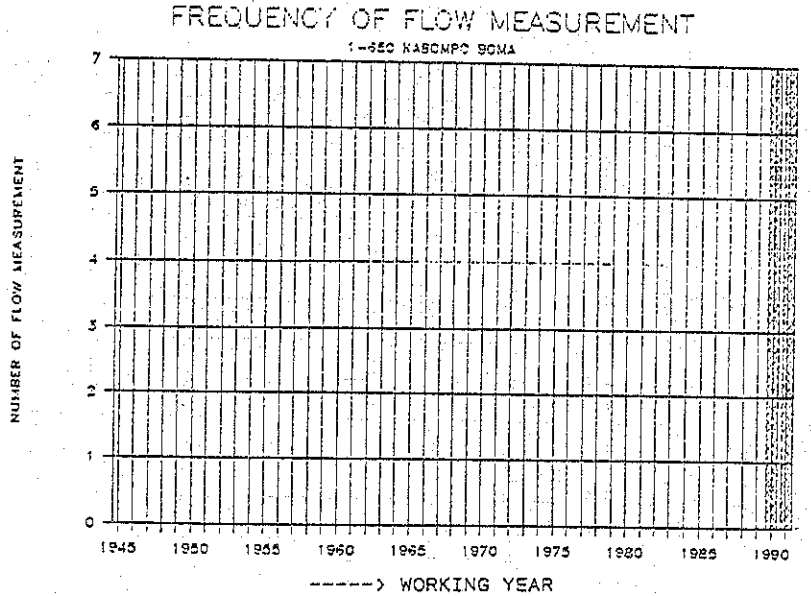


Fig.-5.7 Discharge Rating Curve (1-150 / Zambezi P/H)







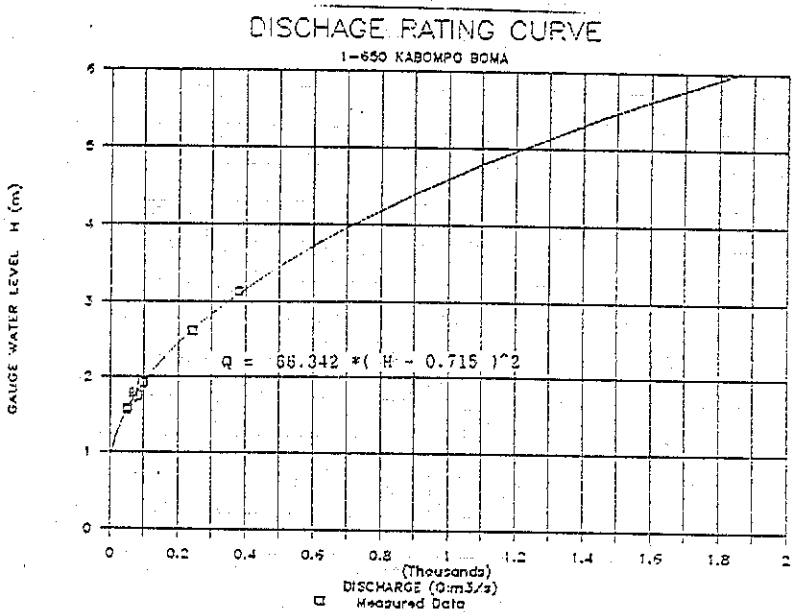
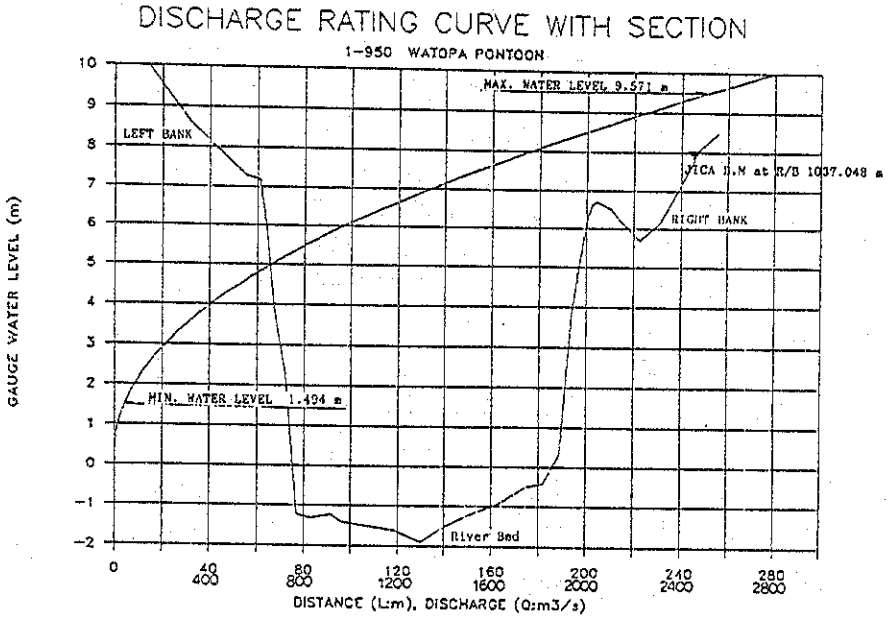
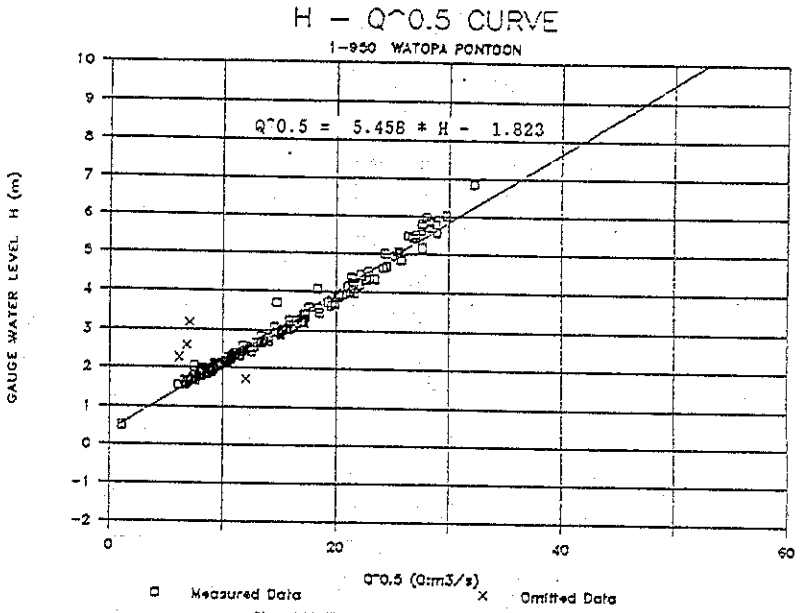
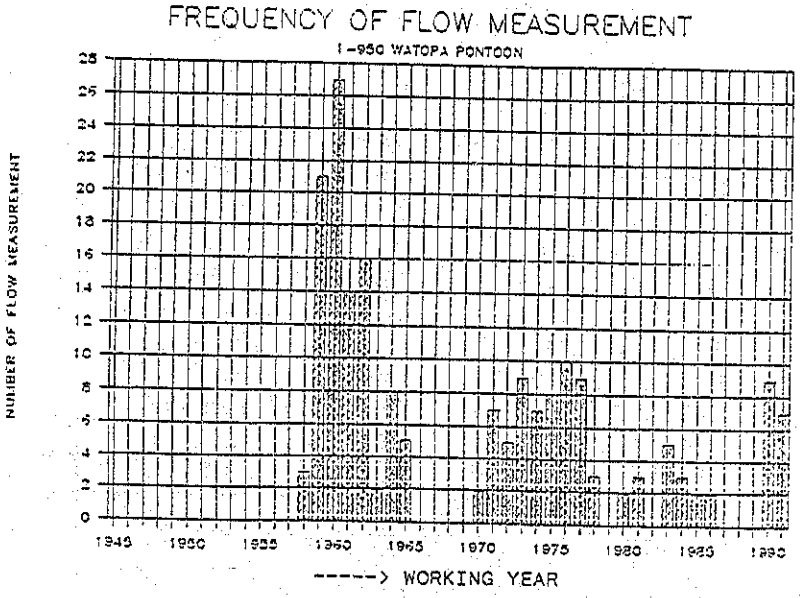


Fig.-5.8 Discharge Rating Curve (1-650 / Kabompo Boma)







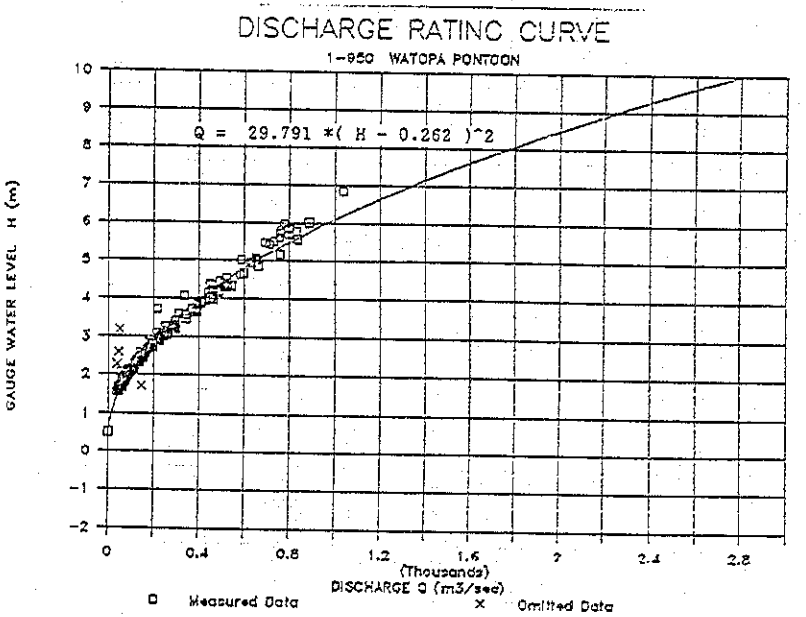
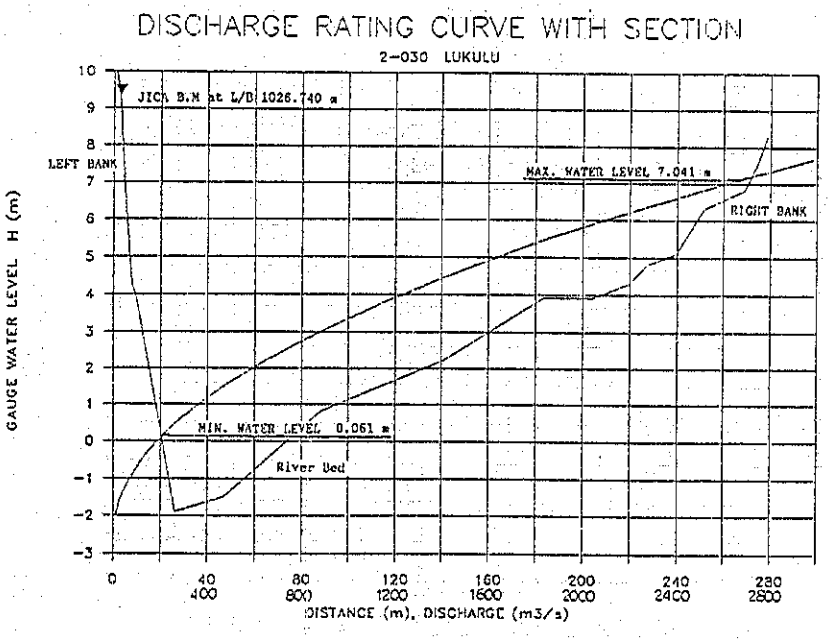
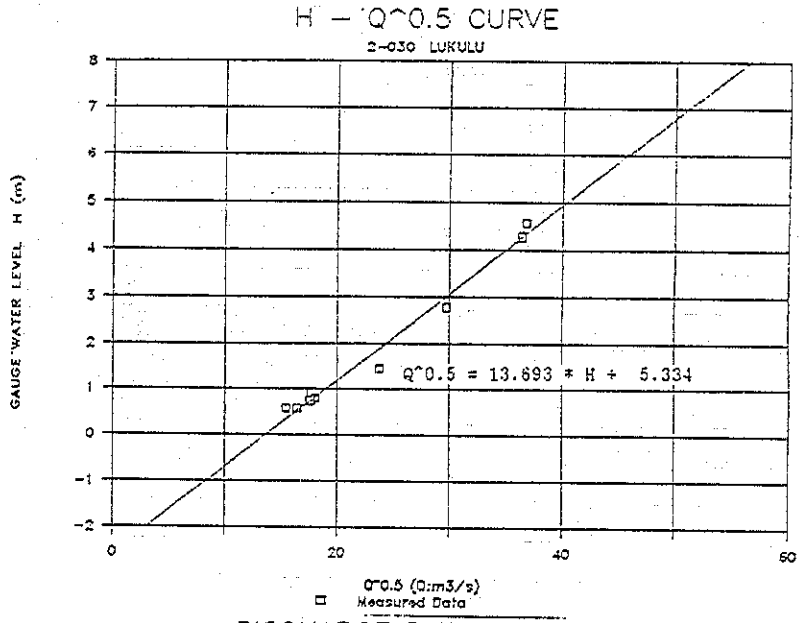
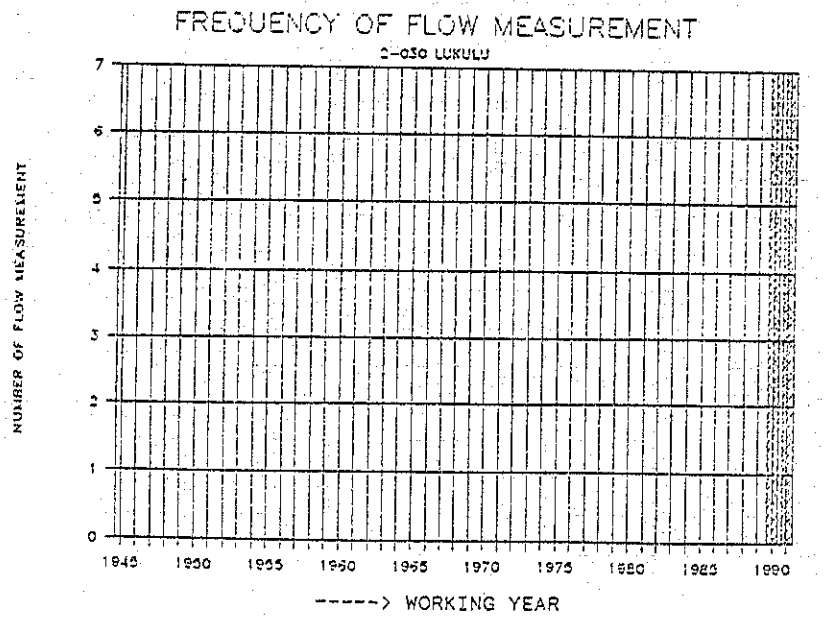


Fig.-5.9 Discharge Rating Curve (1-950 / Watopa Pontoon)







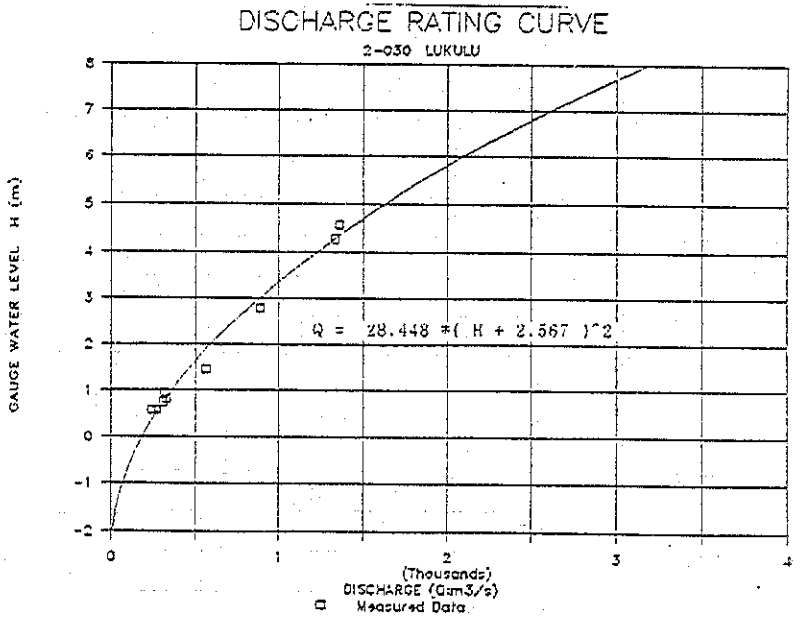
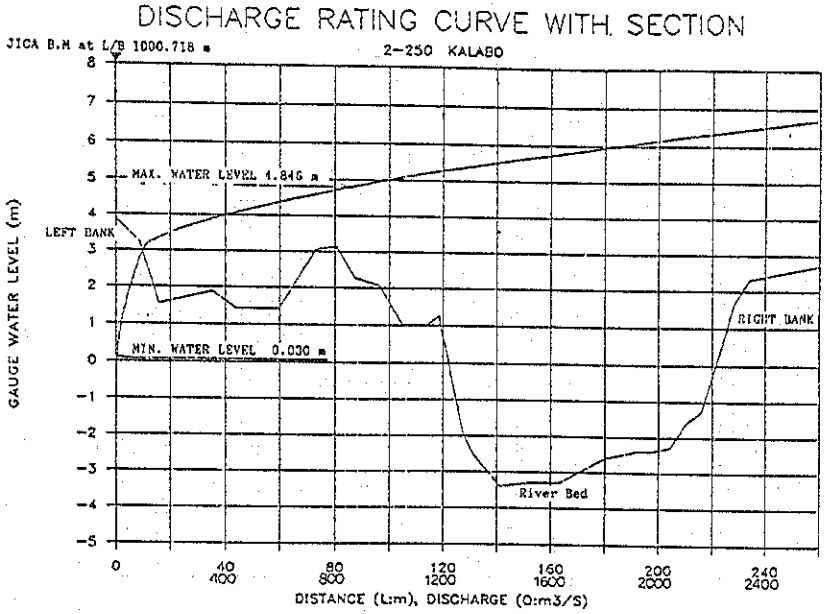
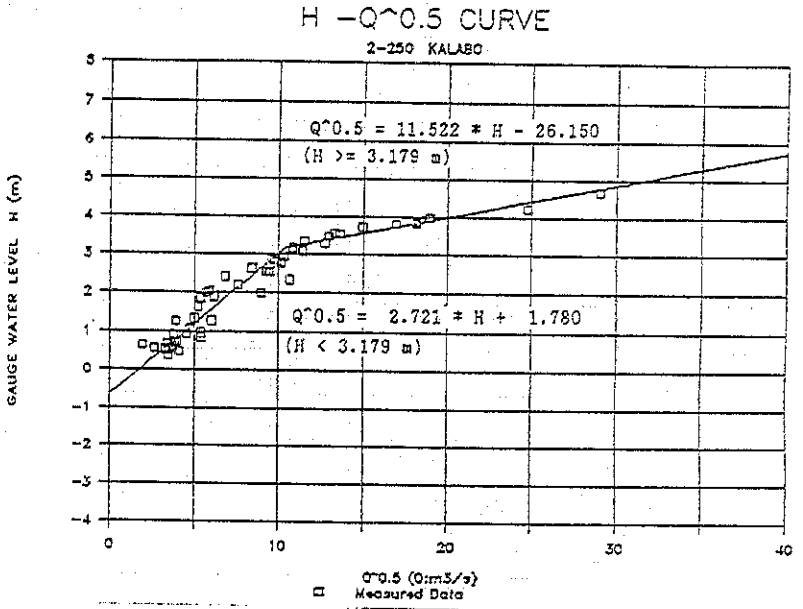
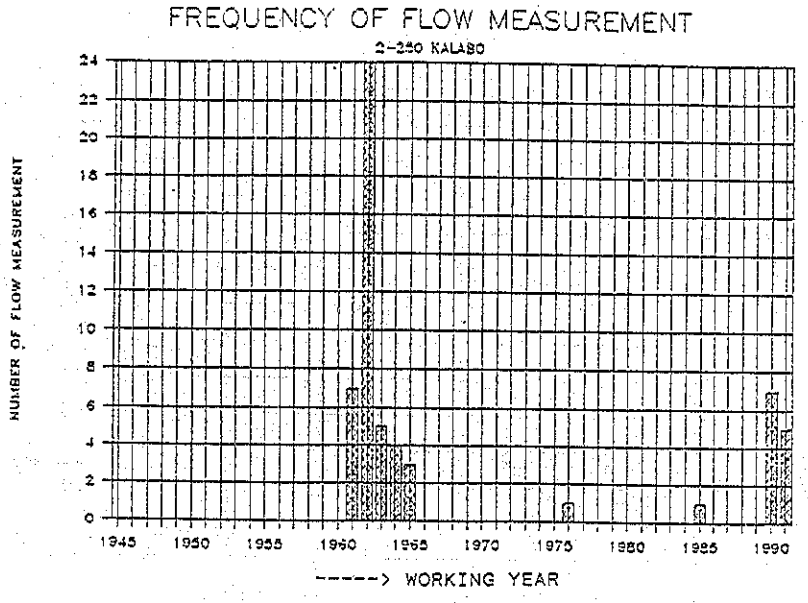


Fig.-5.10 Discharge Rating Curve (2-030 / Lukulu)







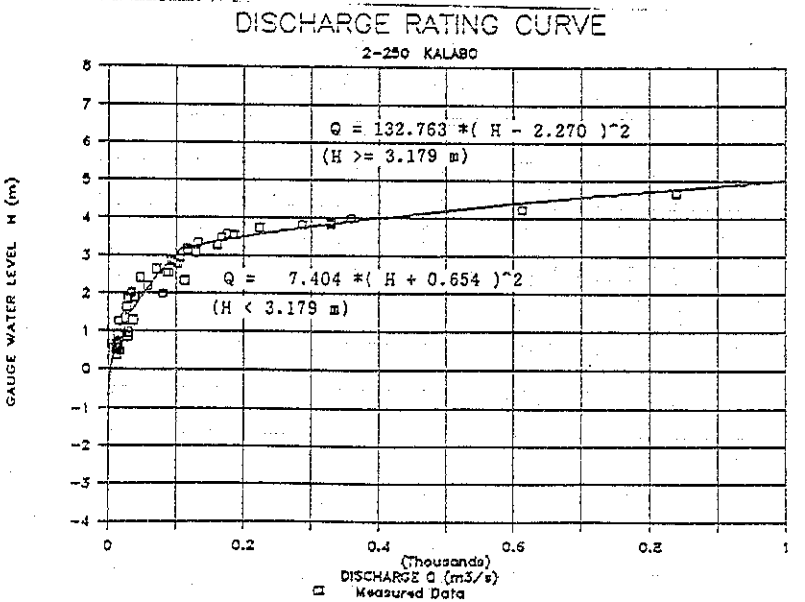
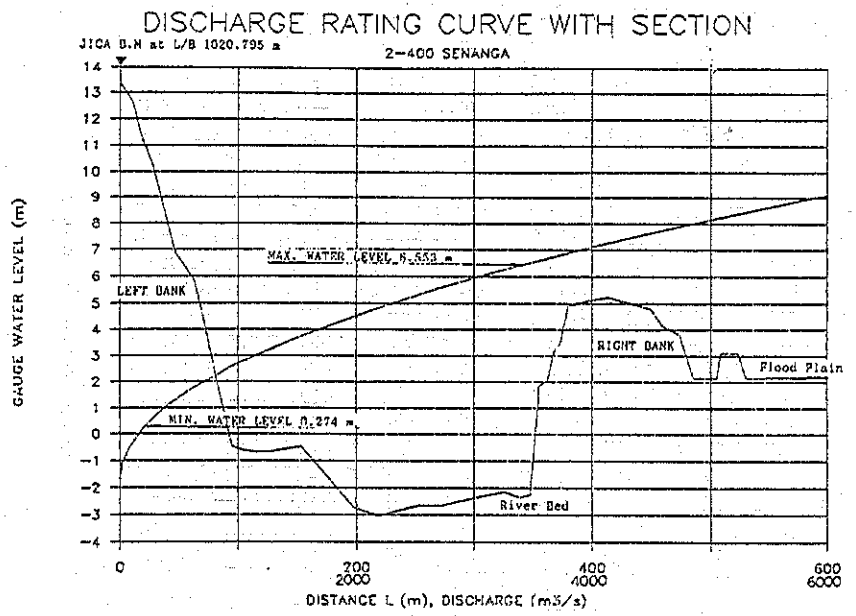
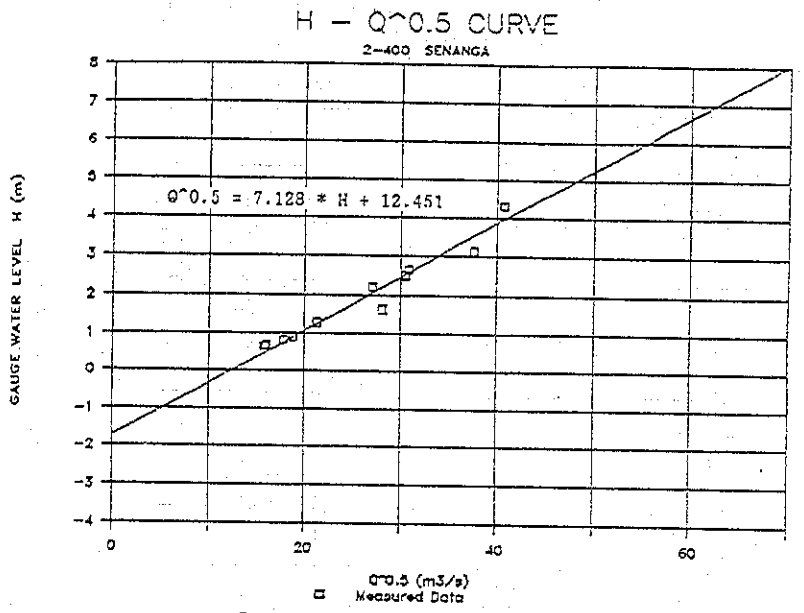
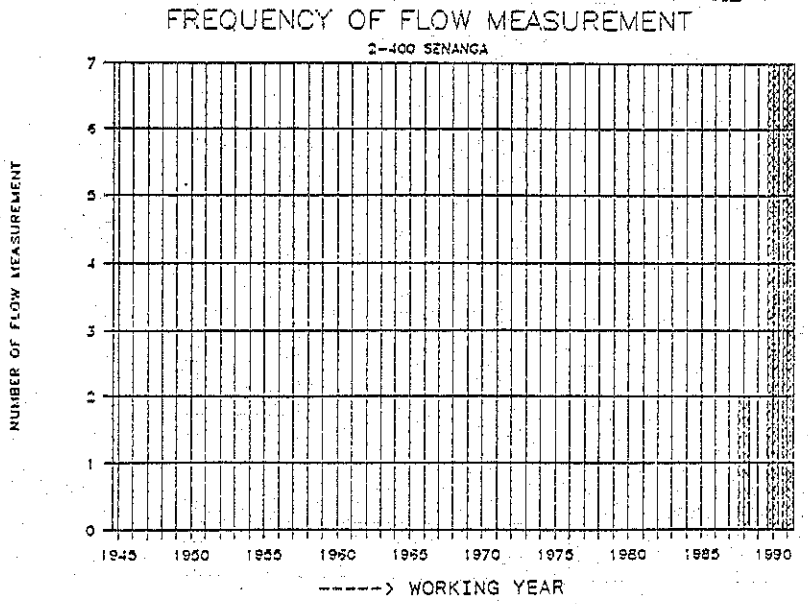


Fig.-5.11 Discharge Rating Curve (2-250 / Kalabo)







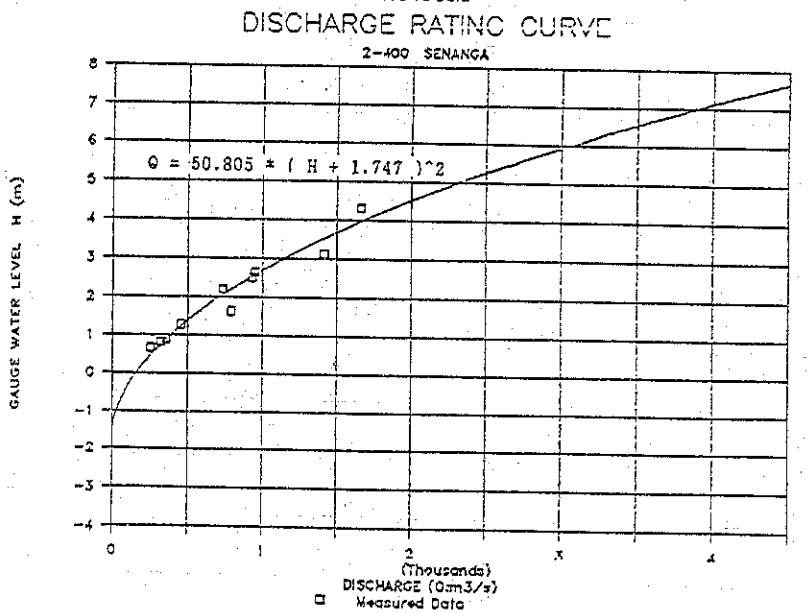
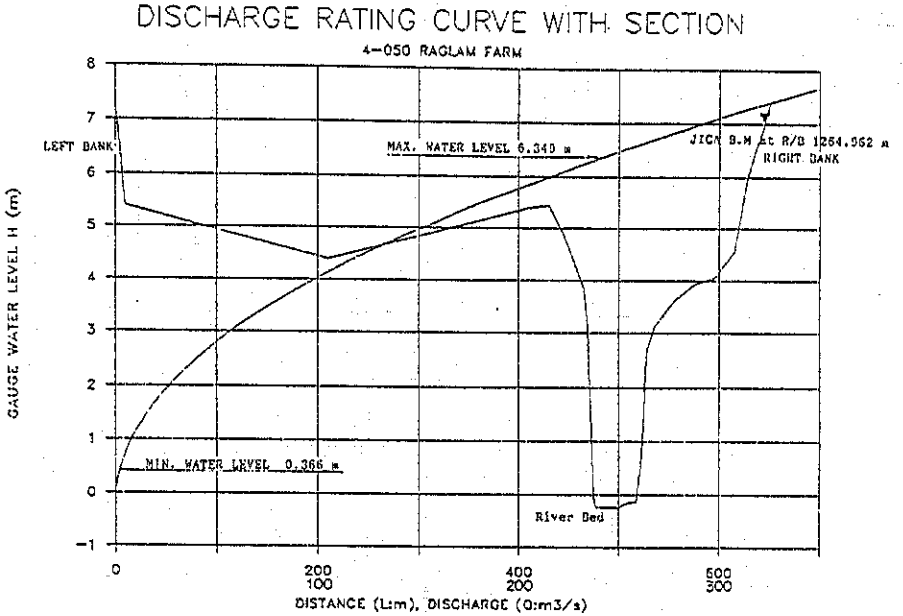
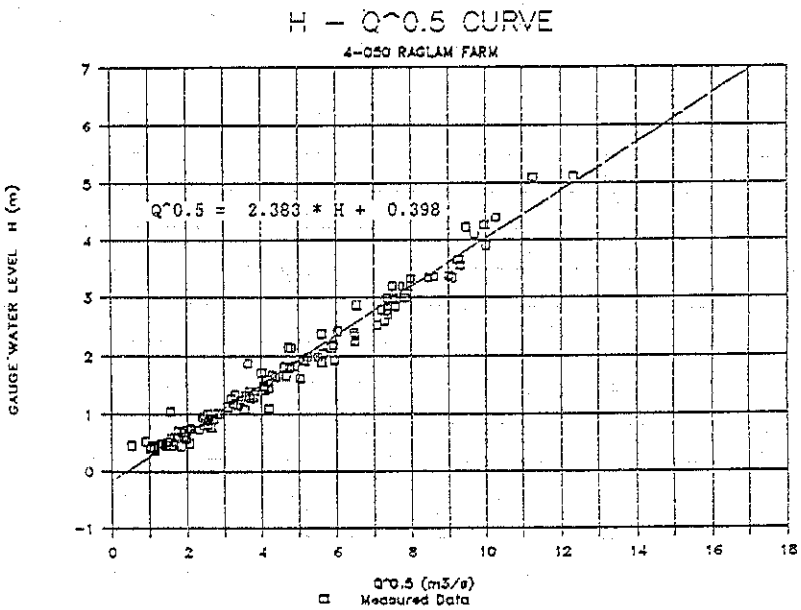
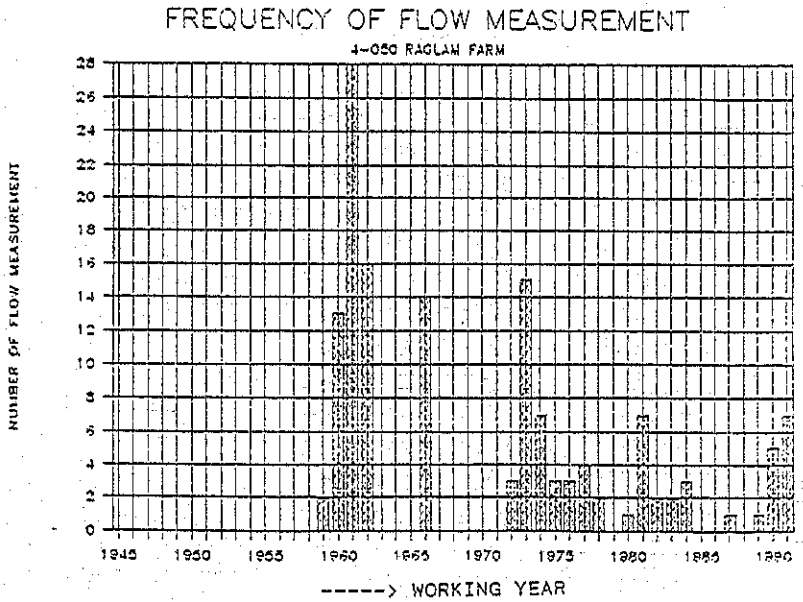


Fig.-5.12 Discharge Rating Curve (2-400 / Senanga)







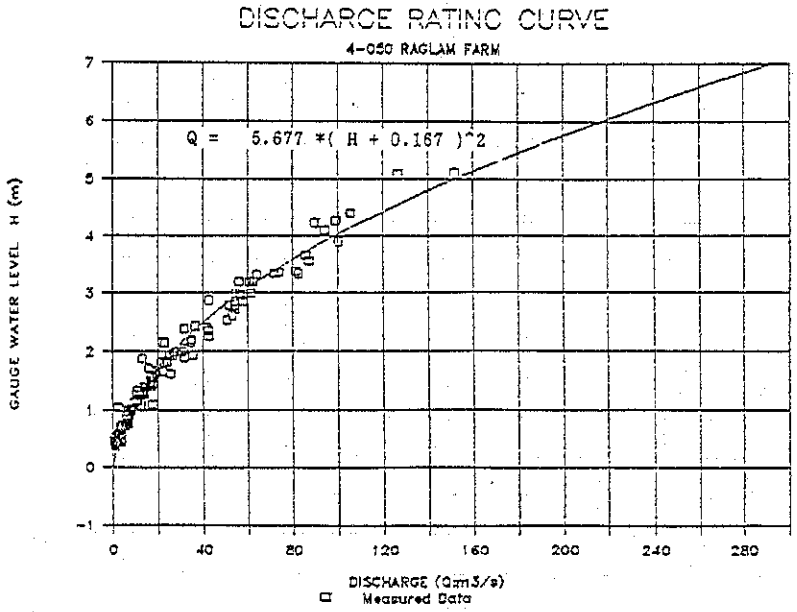
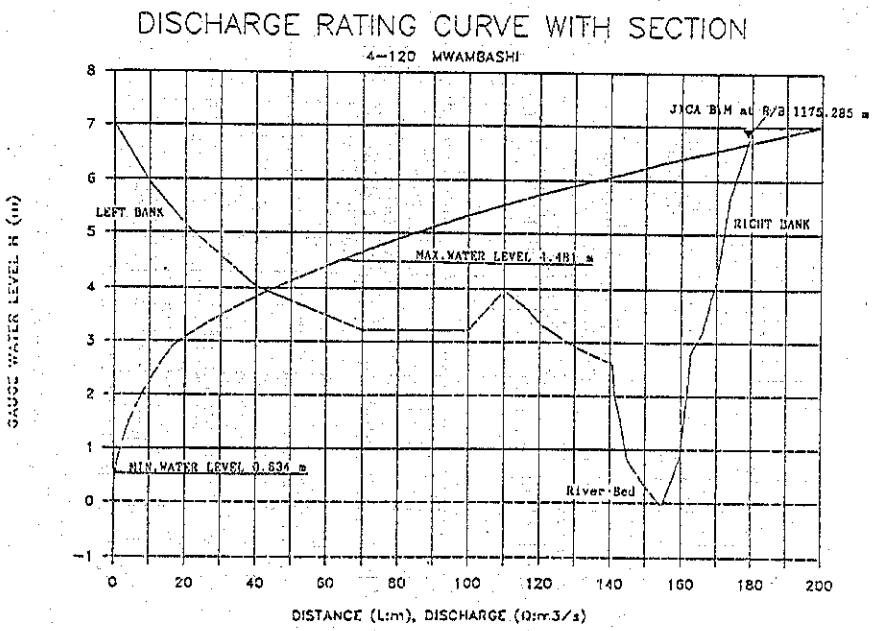
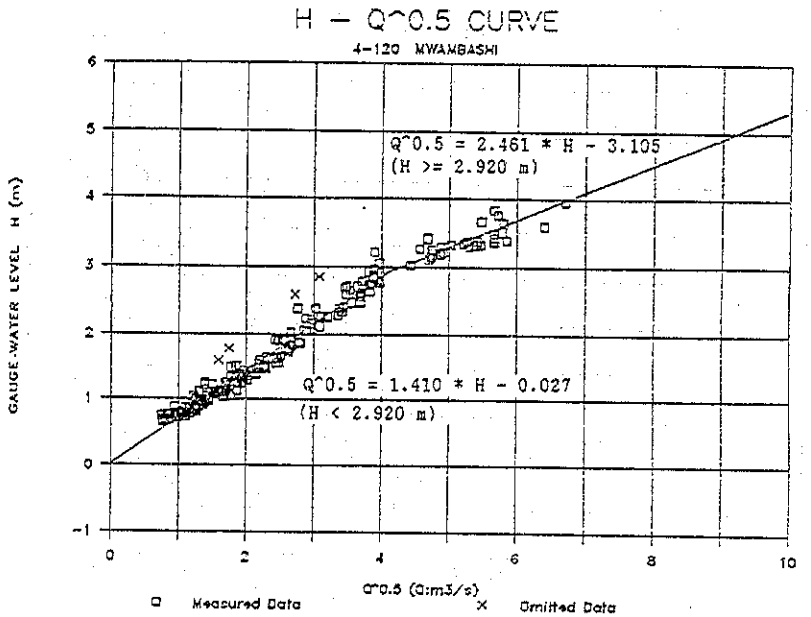
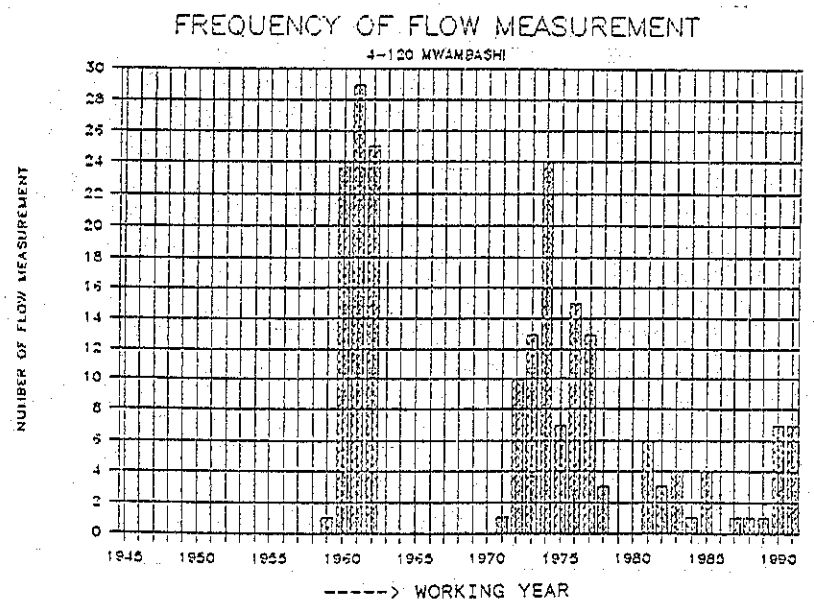


Fig.-5.13 Discharge Rating Curve (4-050 / Raglam Farm)







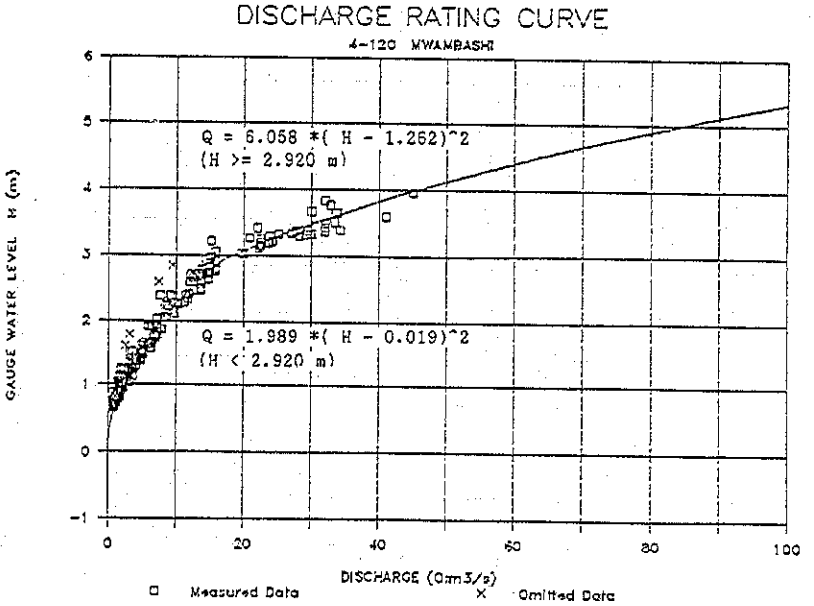
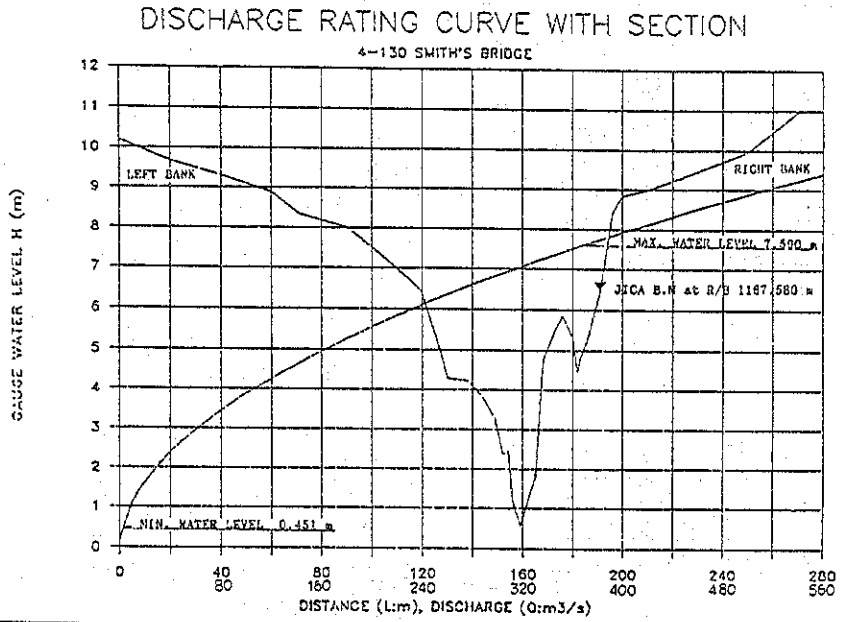
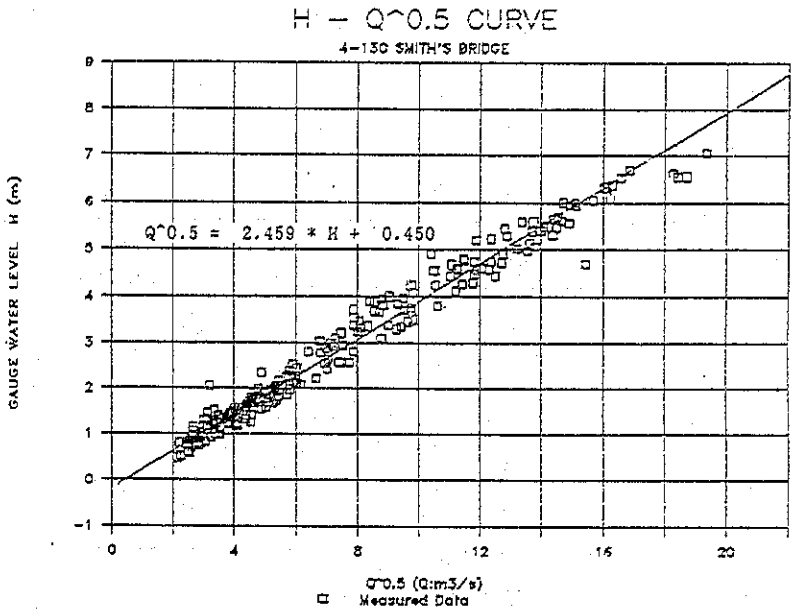
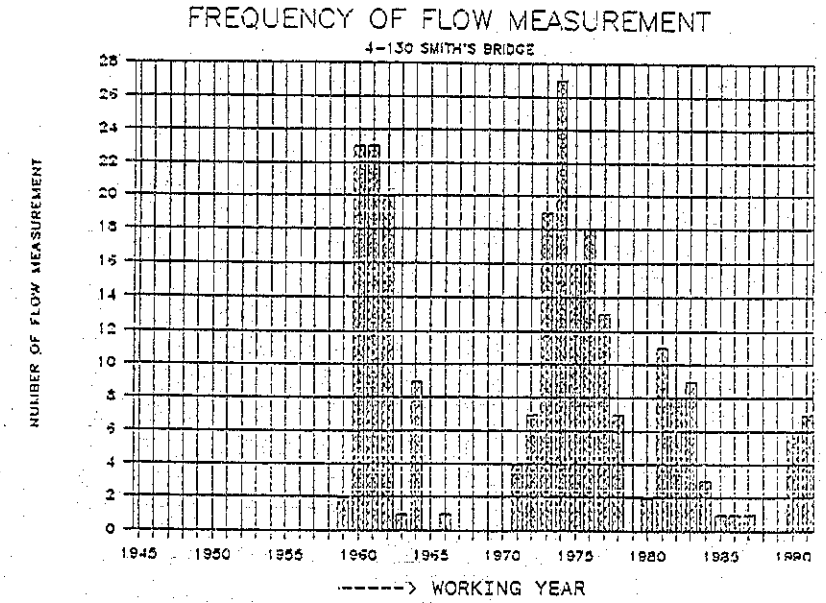


Fig.-5.14 Discharge Rating Curve (4-120 / Mwambashi)







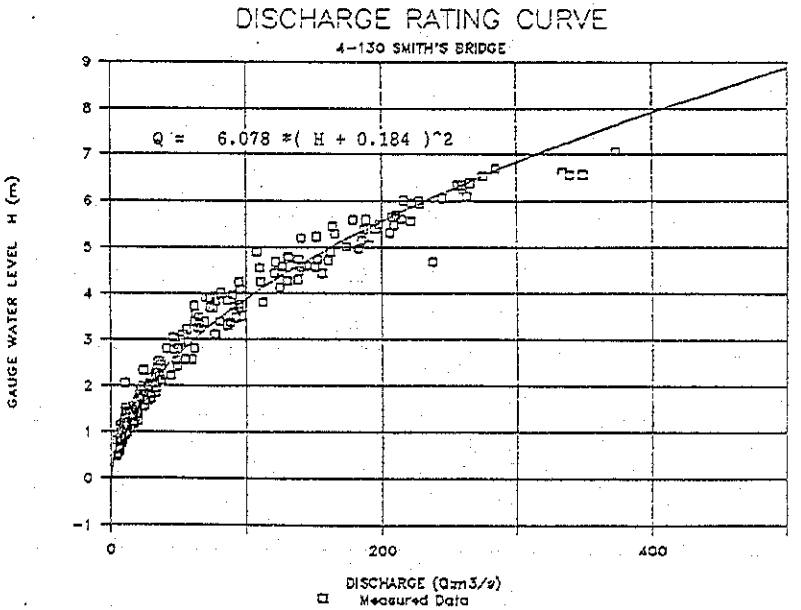
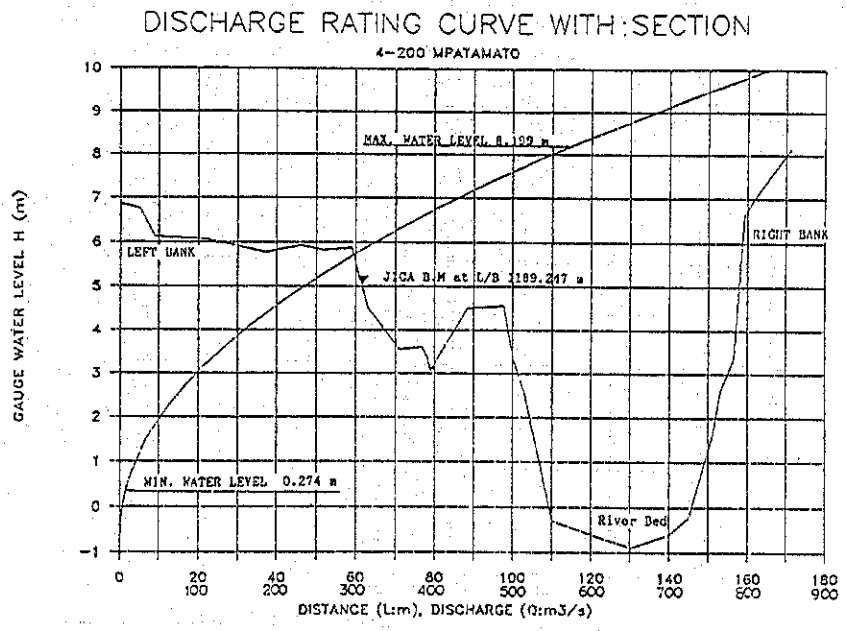
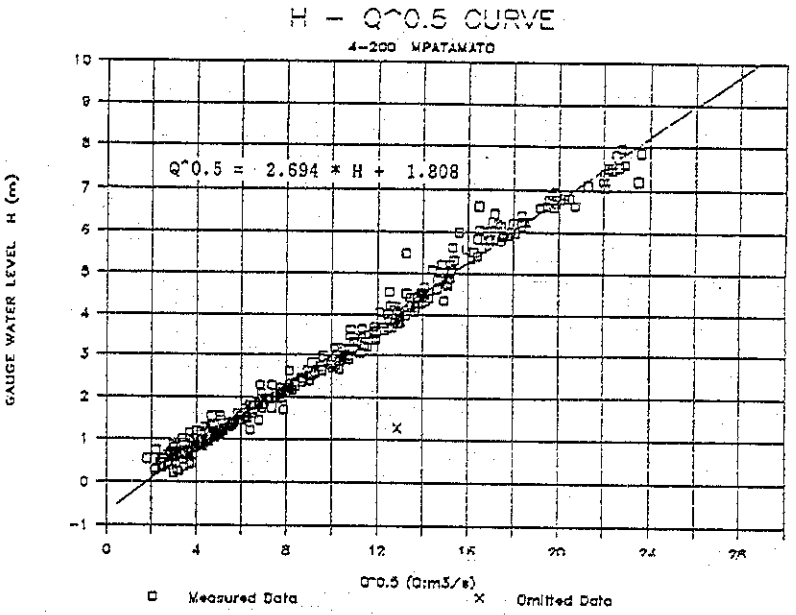
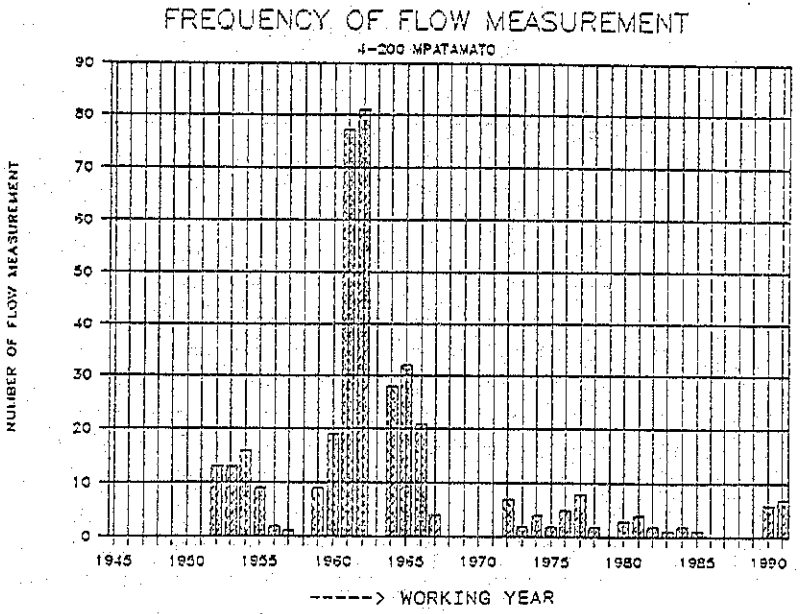


Fig.-5.15 Discharge Rating Curve (4-130 / Smith's Bridge)







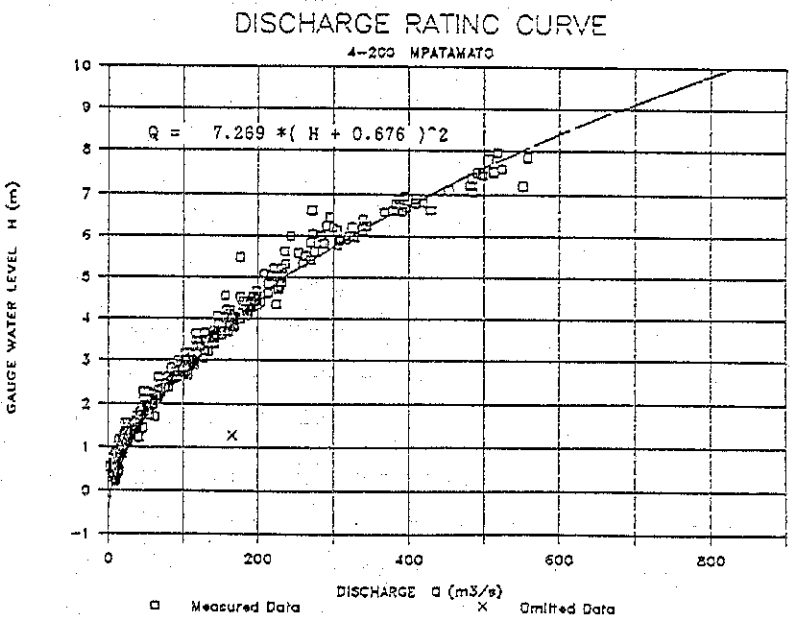
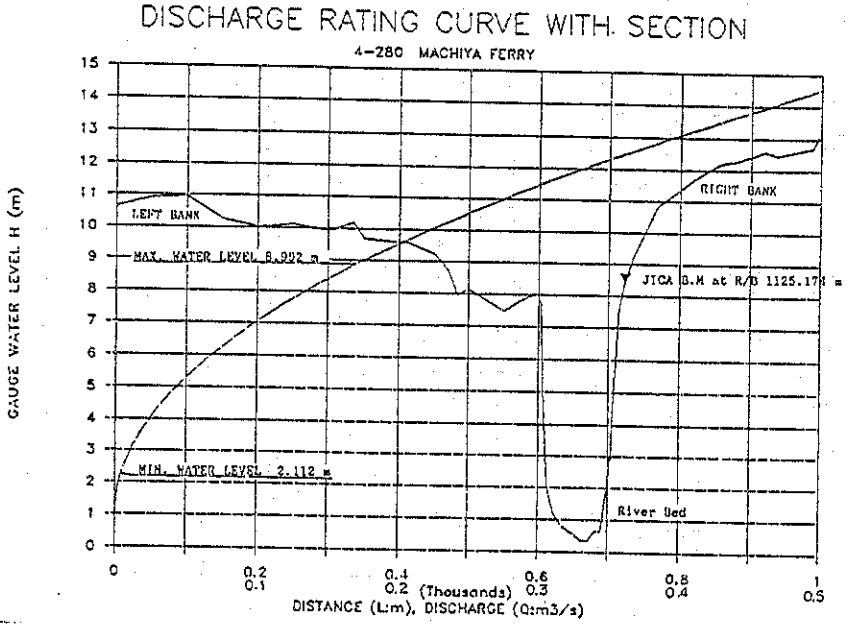
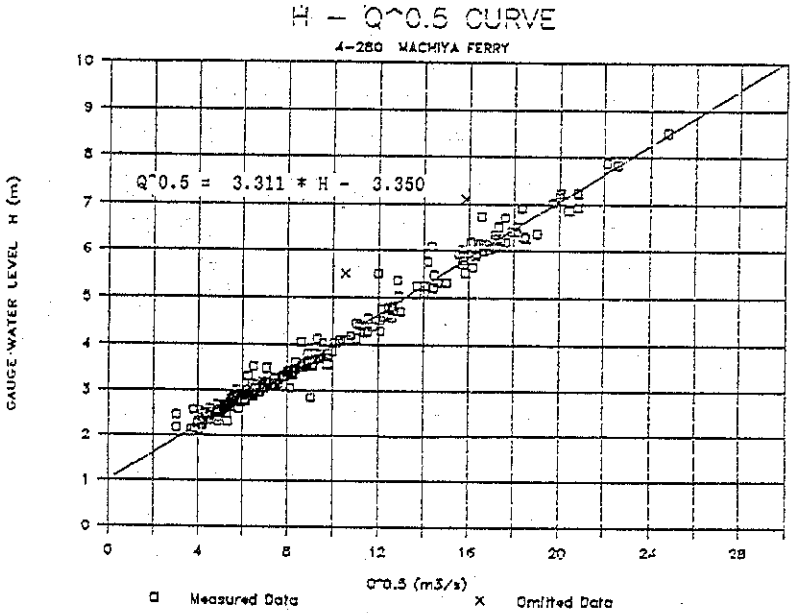
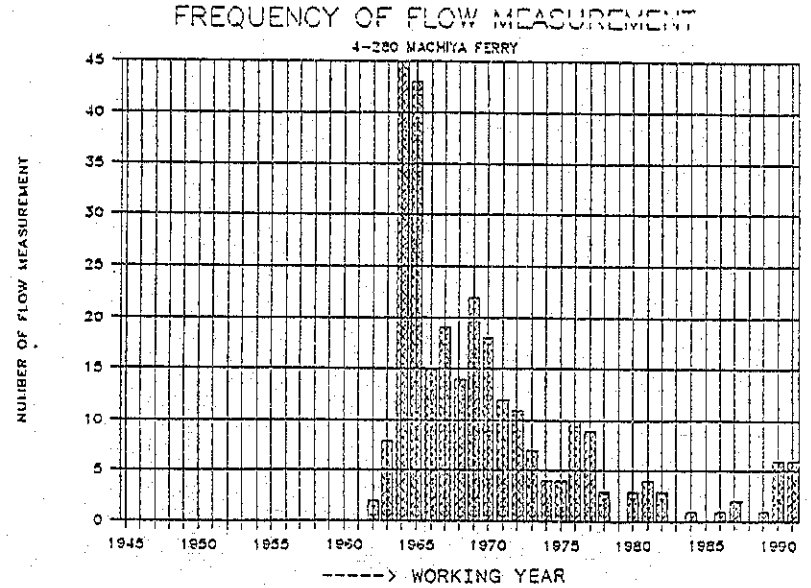


Fig.-5.16 Discharge Rating Curve (4-200 / Mpatamato)







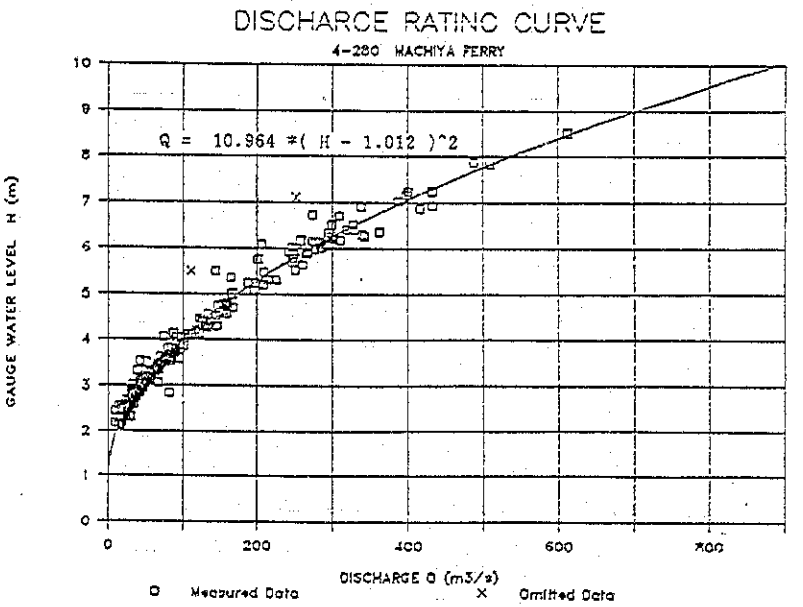
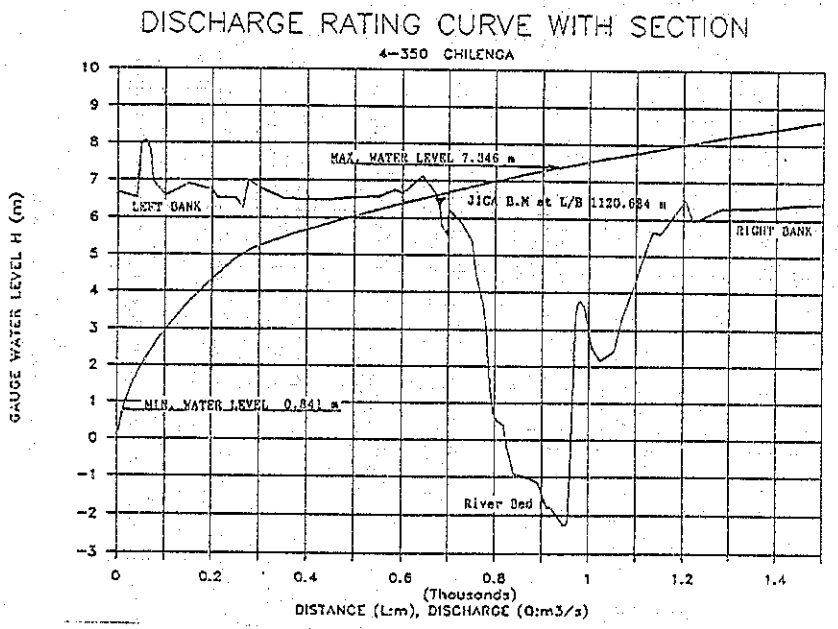
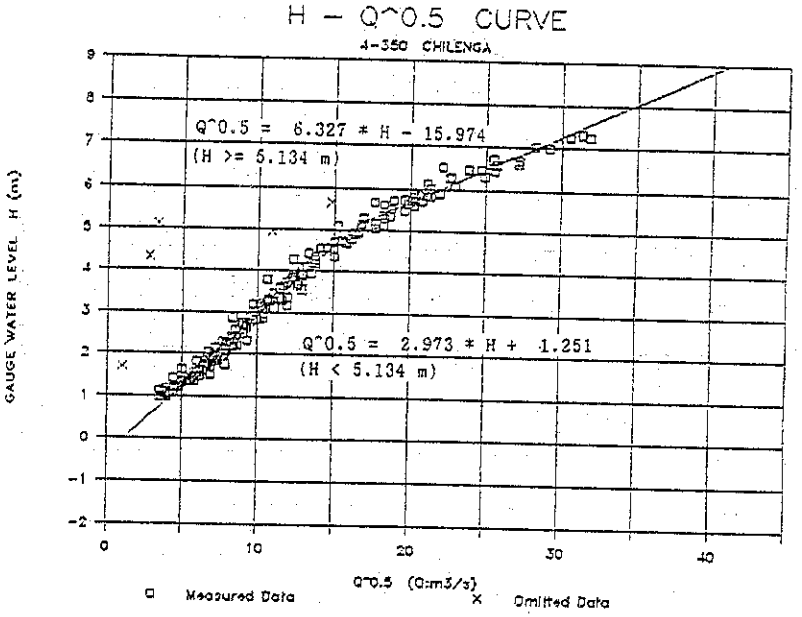
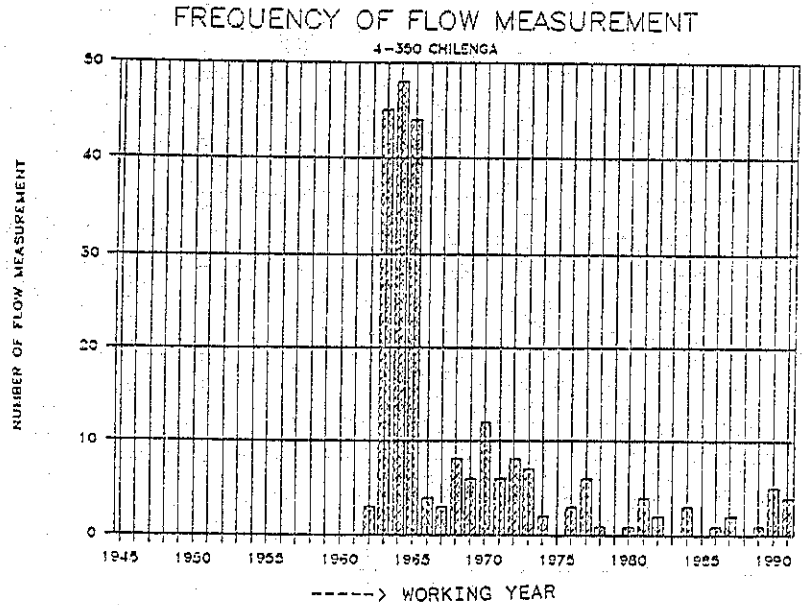


Fig.-5.17 Discharge Rating Curve (4-280 / Machiya Ferry)







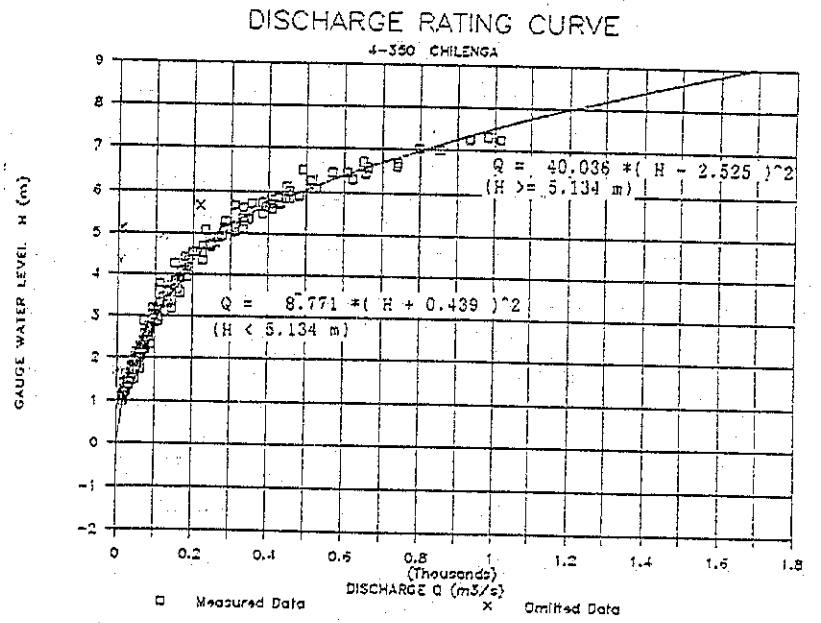
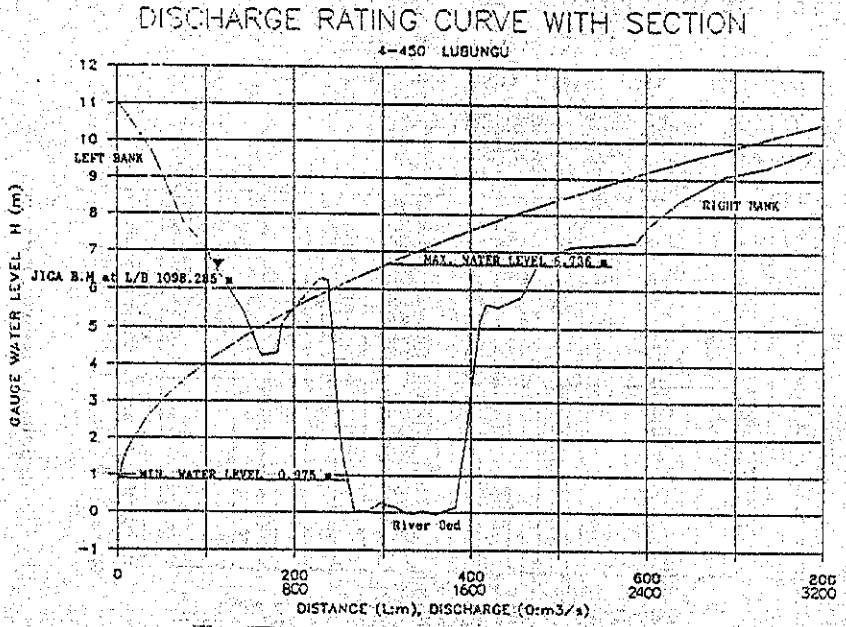
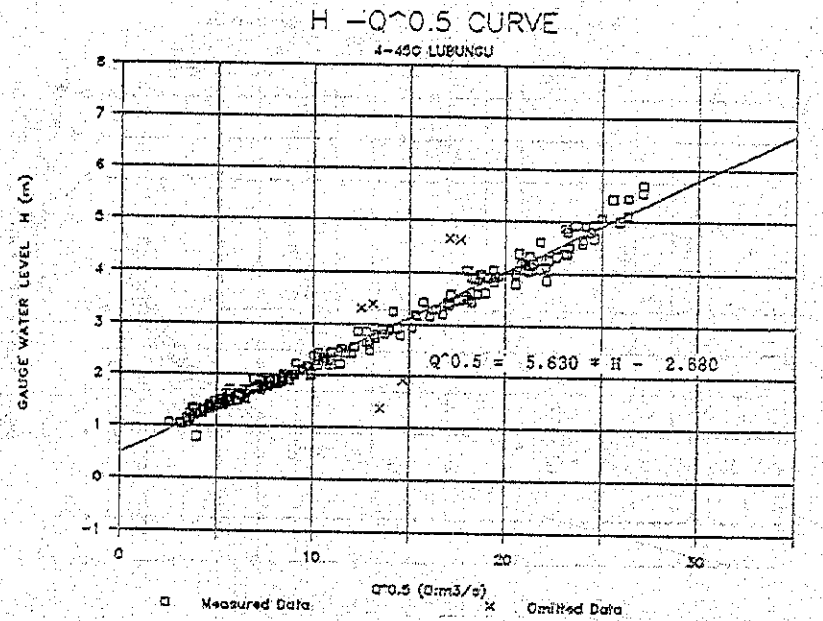
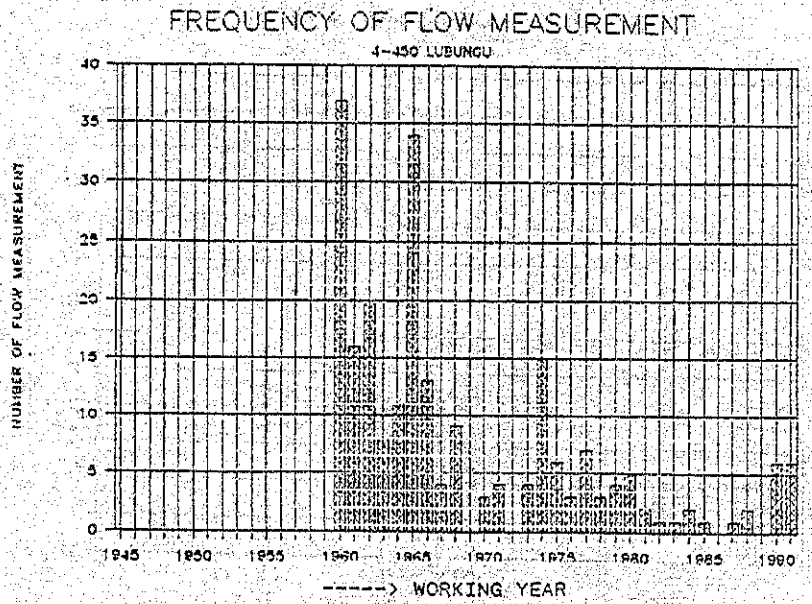


Fig.-5.18 Discharge Rating Curve (4-350 / Chilenga)







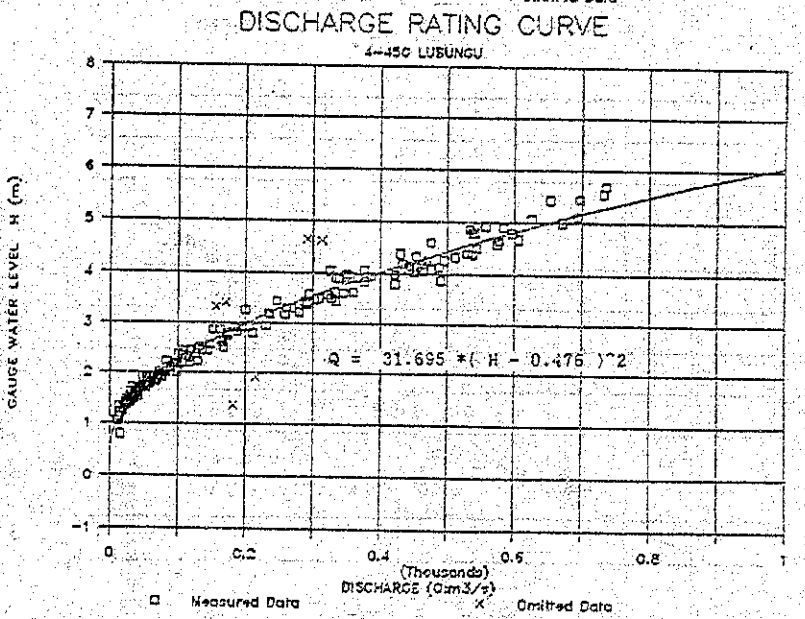
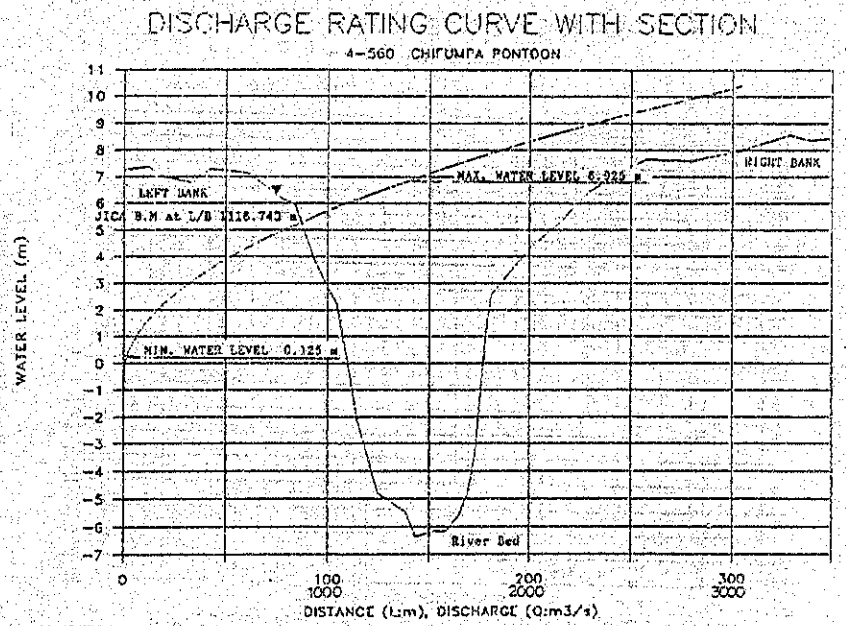
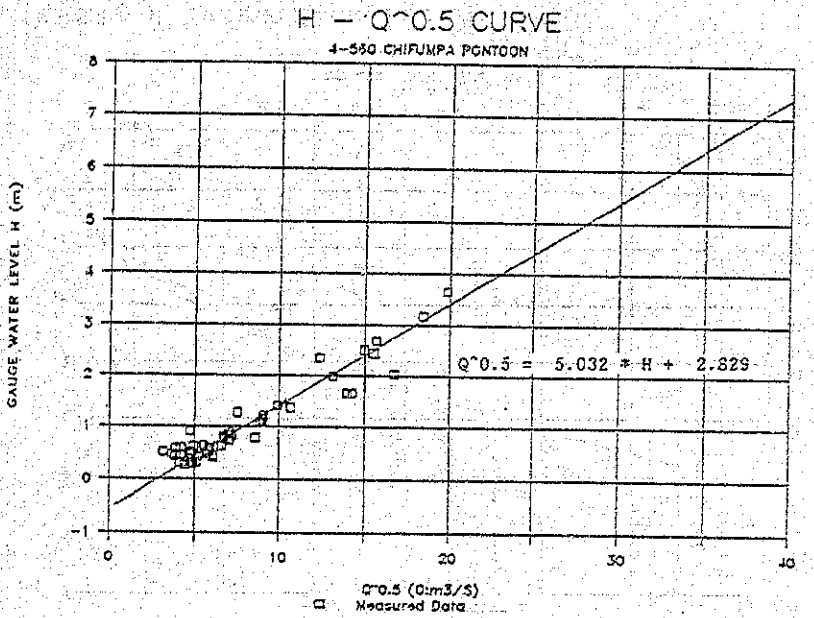
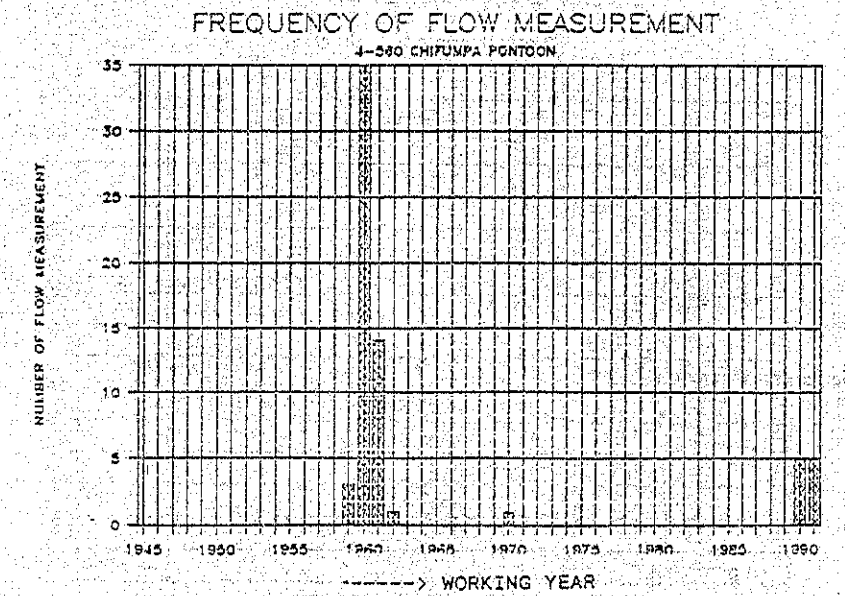


Fig.-5.19 Discharge Rating Curve (4-450 / Lubungu)







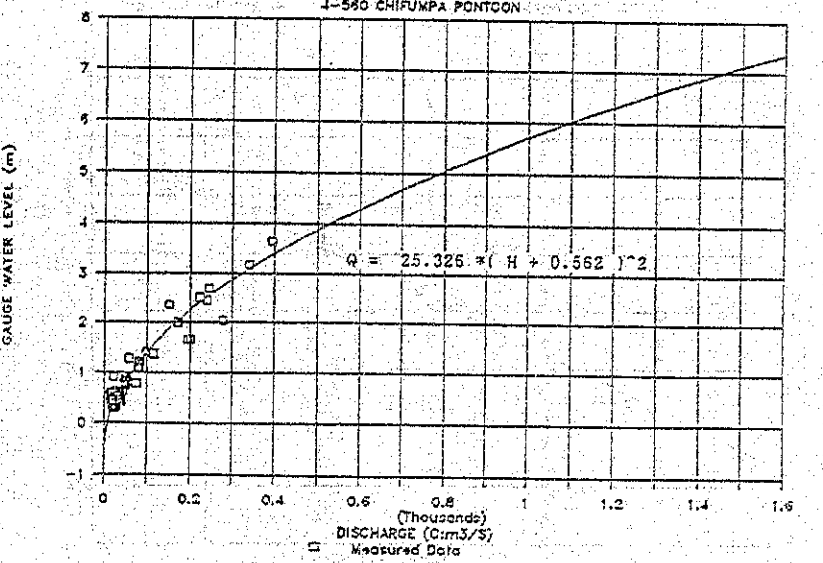
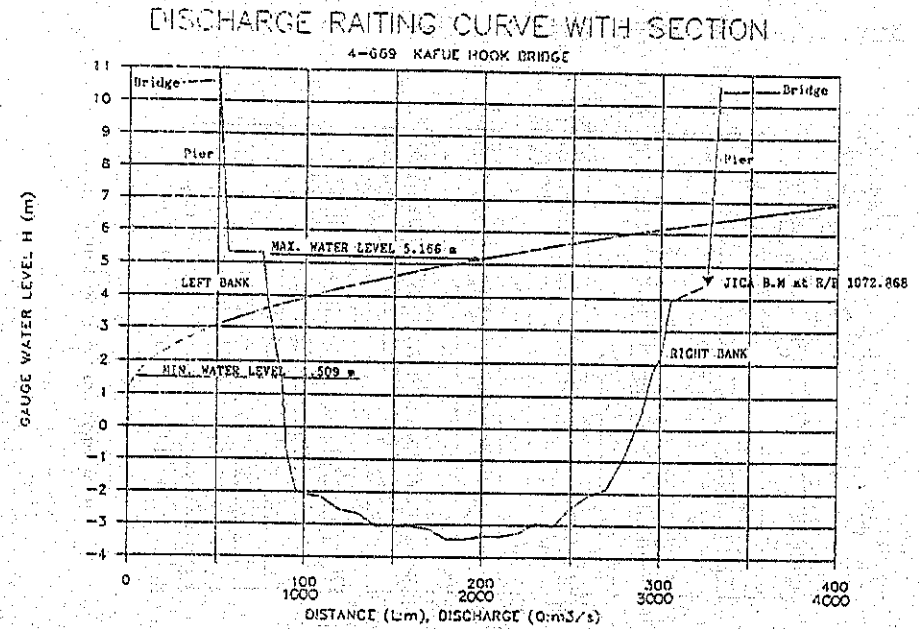
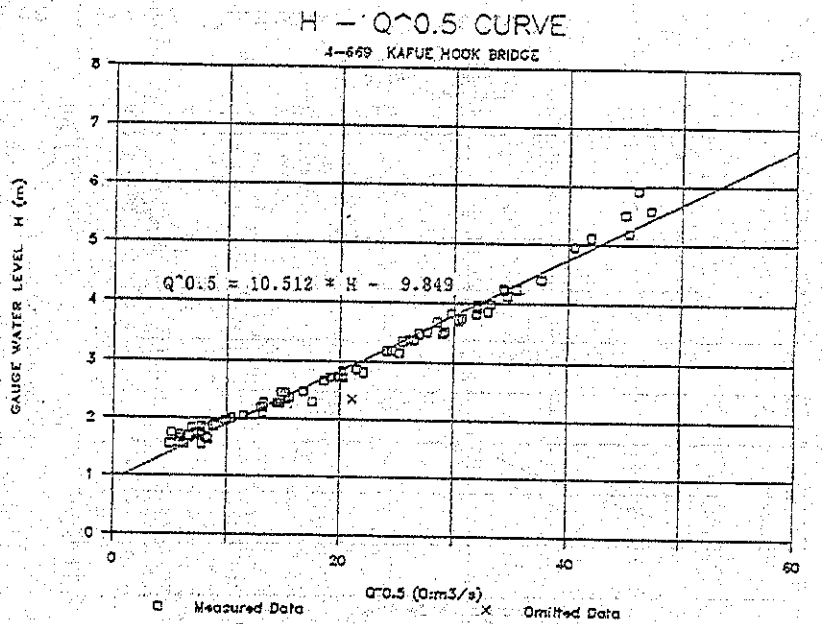
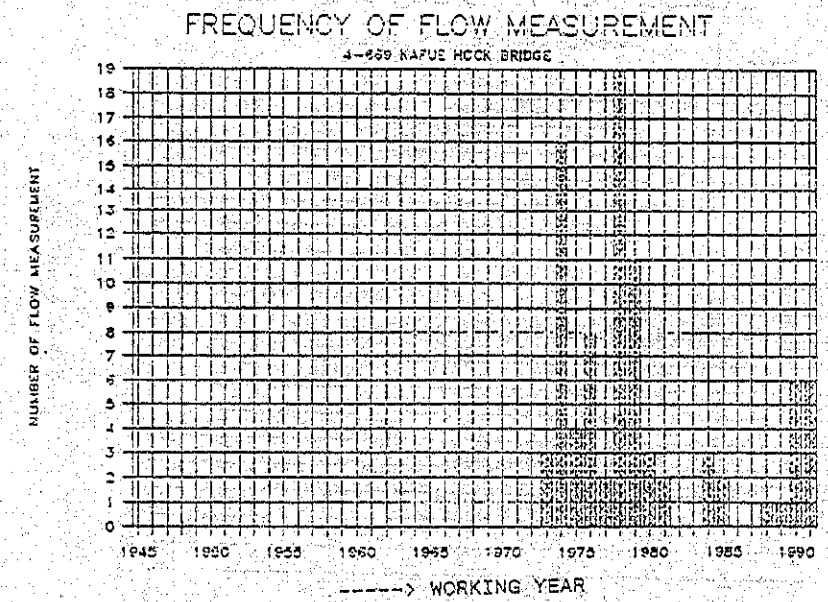


Fig.-5.20 Discharge Rating Curve (4-560 Chifumpa / Pontoon)







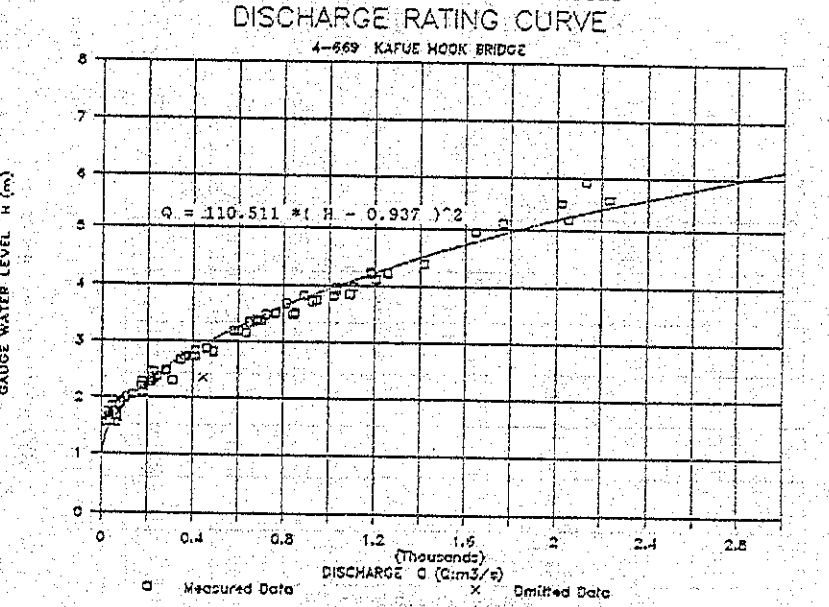
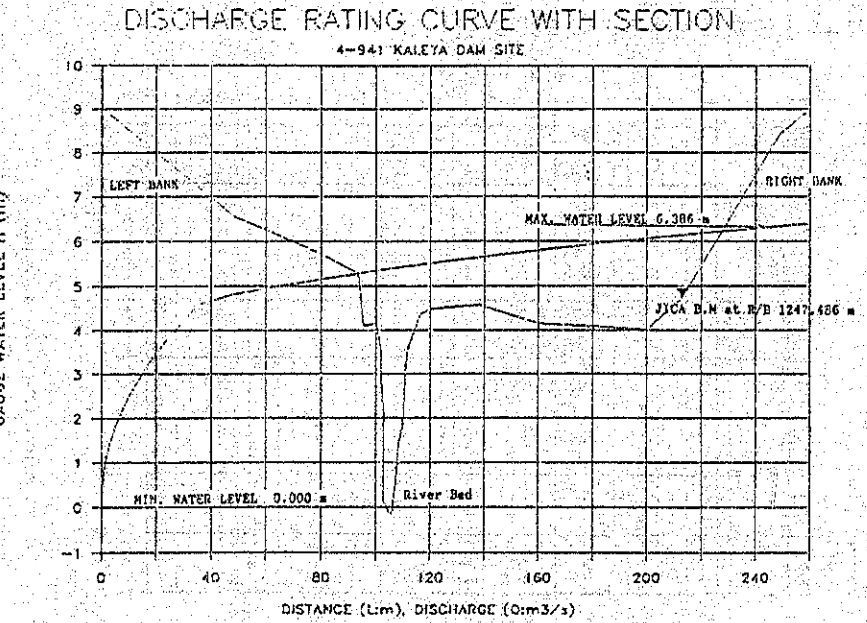
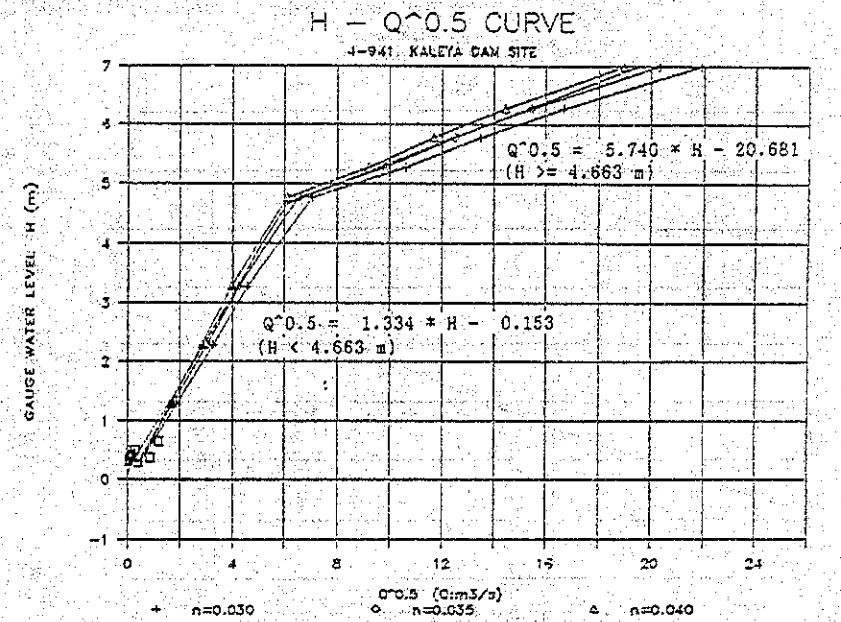
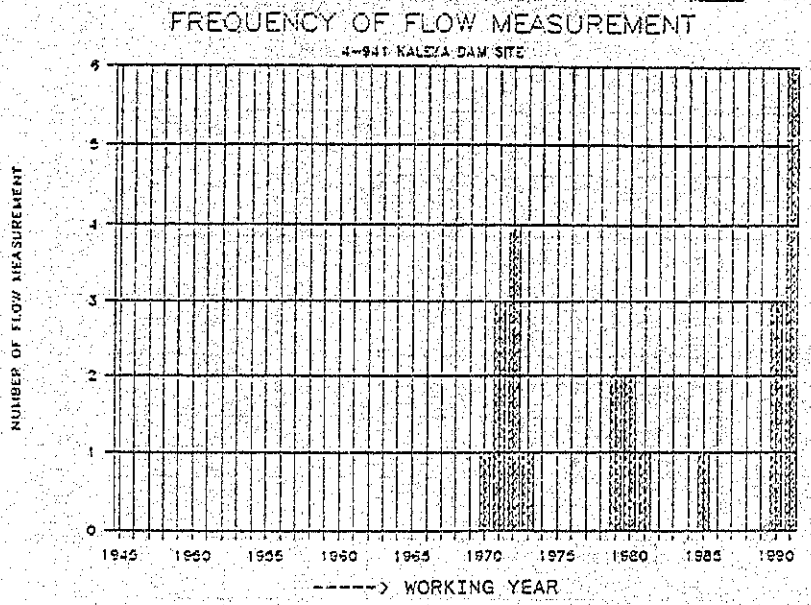


Fig.-5.21 Discharge Rating Curve (4-669 / Kafue Hook Bridge)







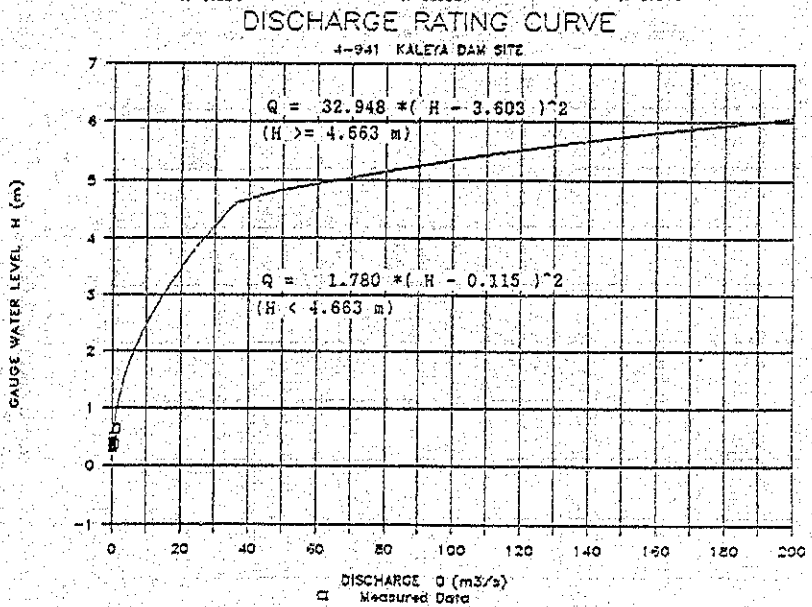
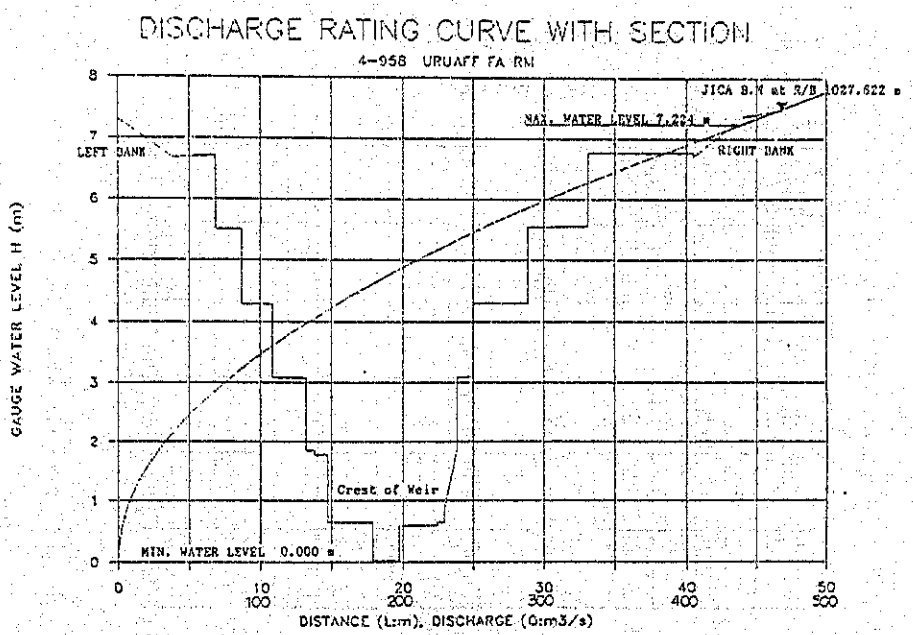
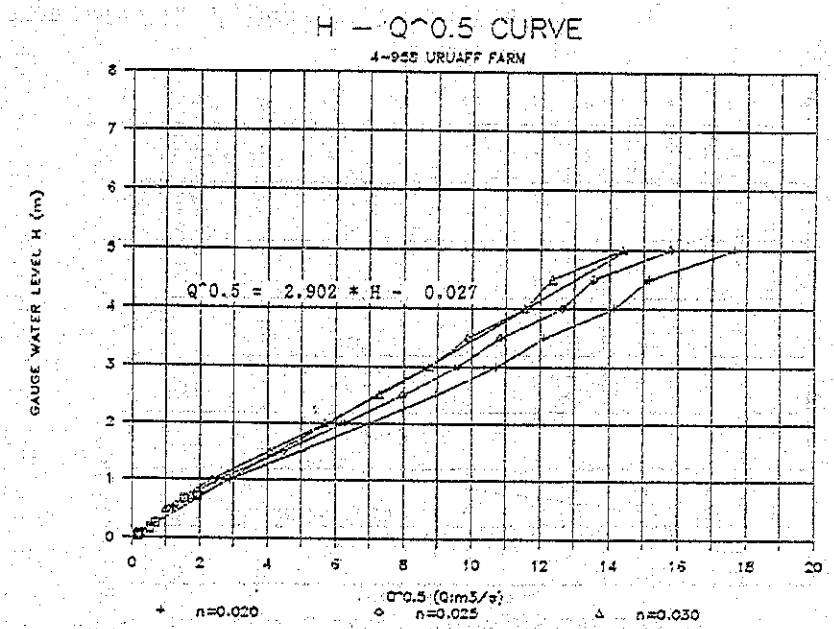
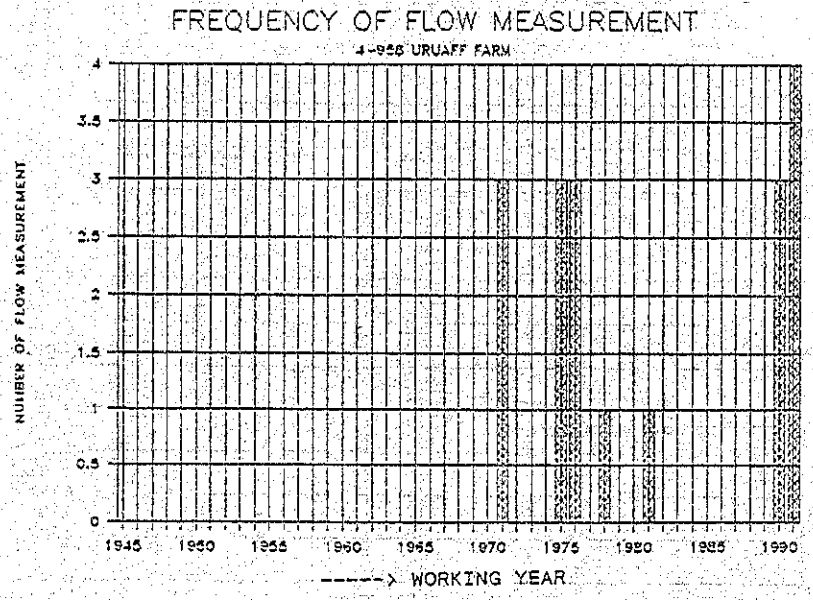


Fig.-5.22 Discharge Rating Curve (4-941 / Kaleya Dam Site)







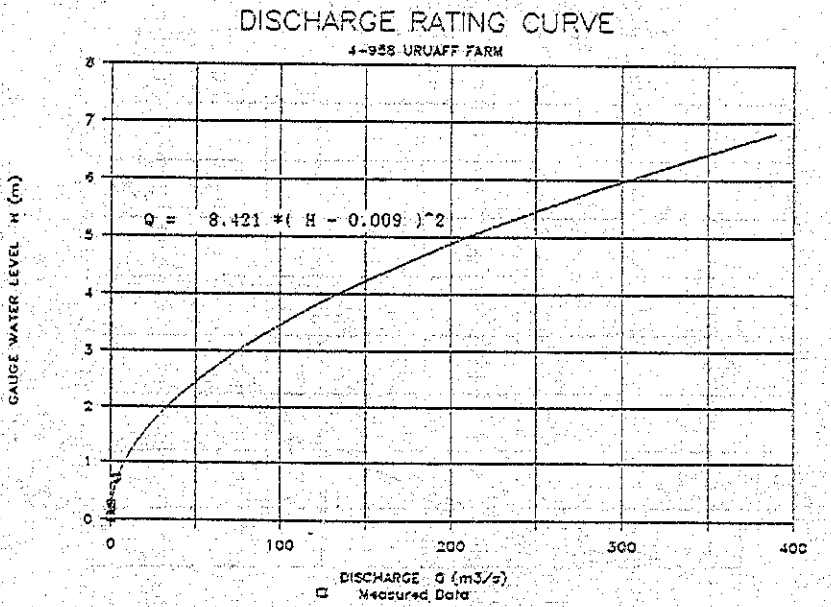
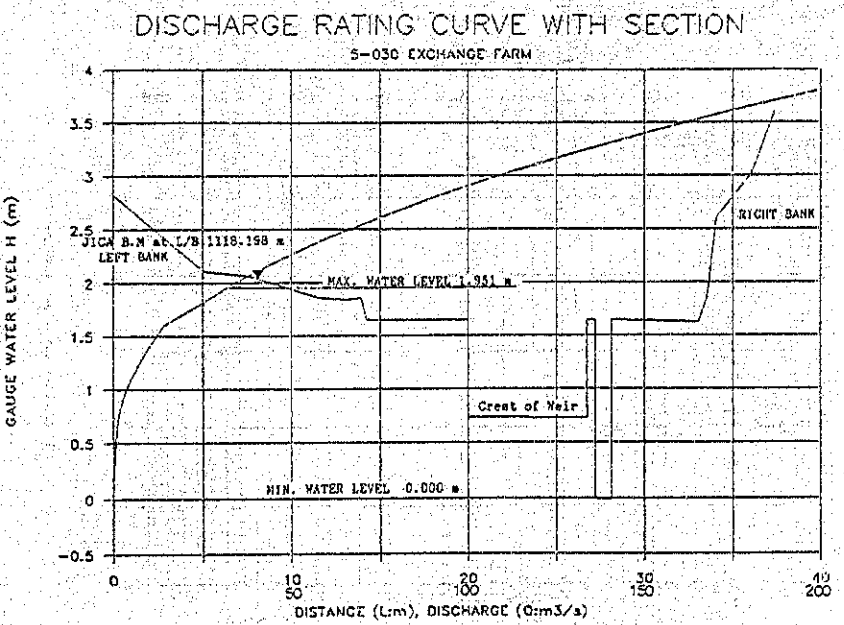
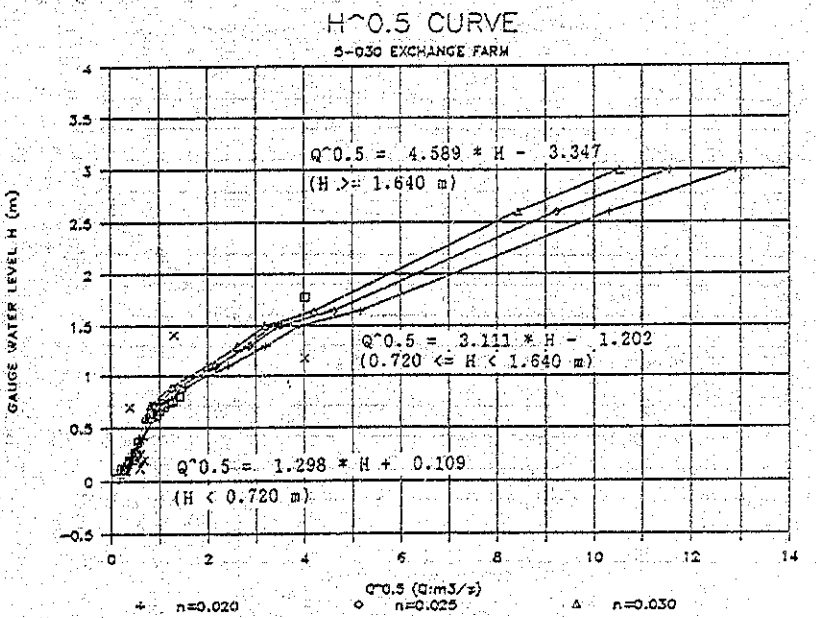
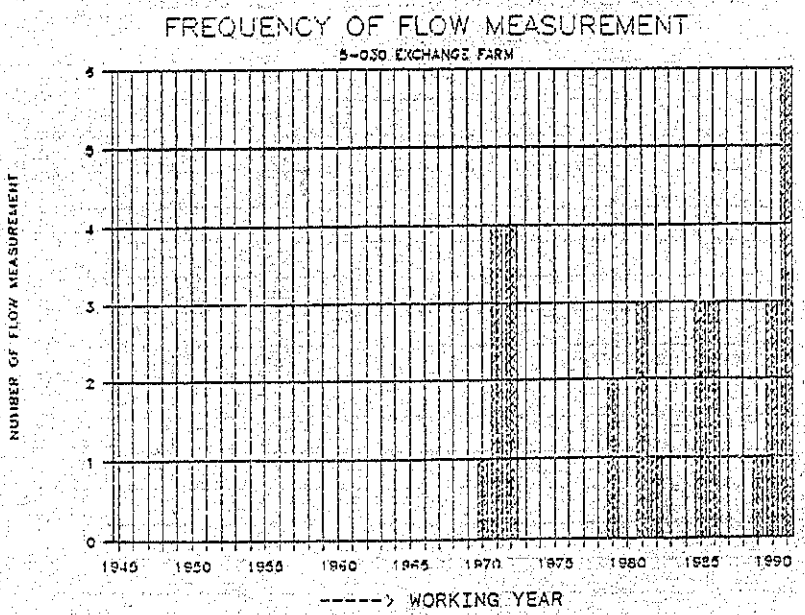


Fig.-5.23 Discharge Rating Curve (4-958 / Uruaff Farm)







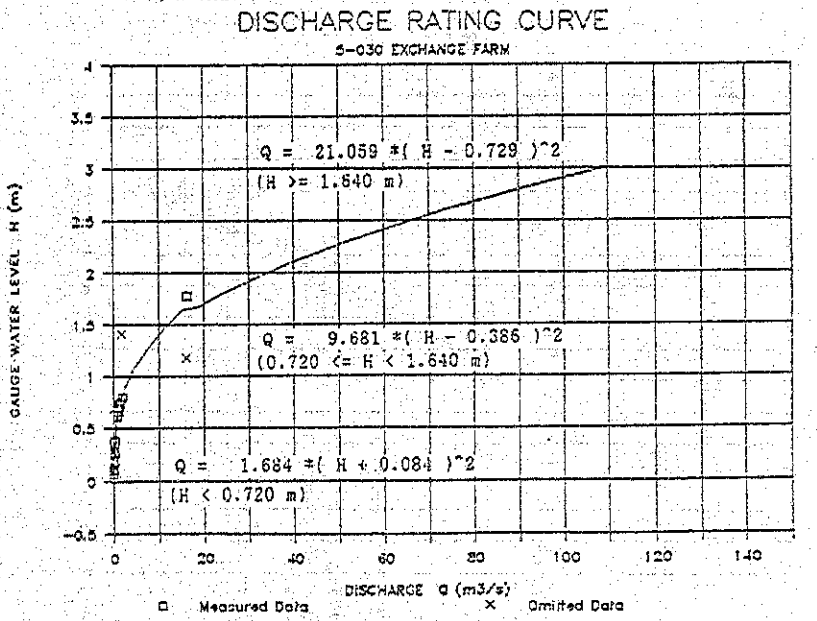
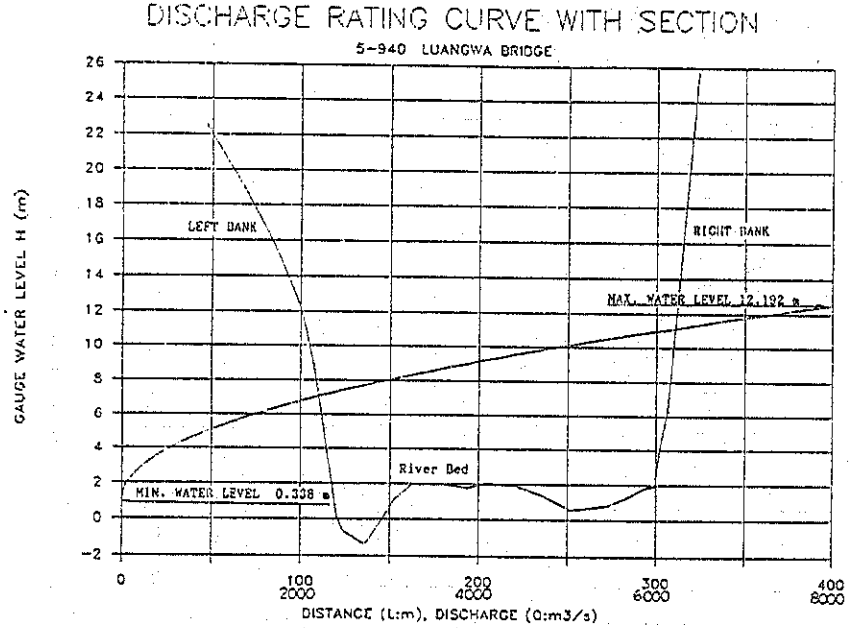
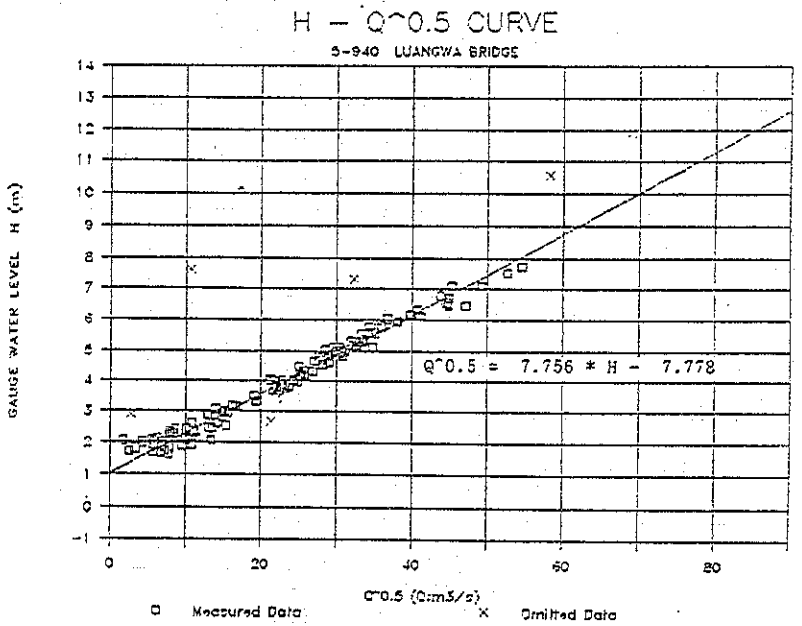
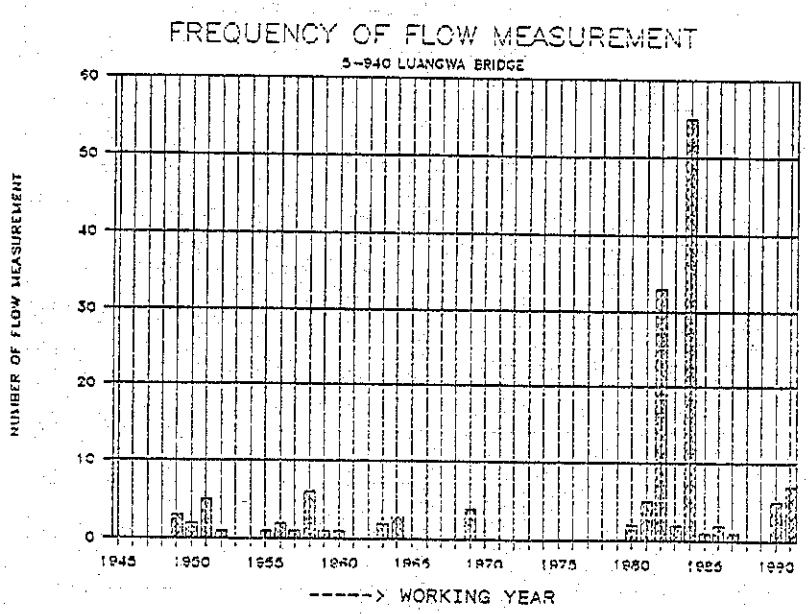


Fig.-5.24 Discharge Rating Curve (5-030 / Exchange Farm)







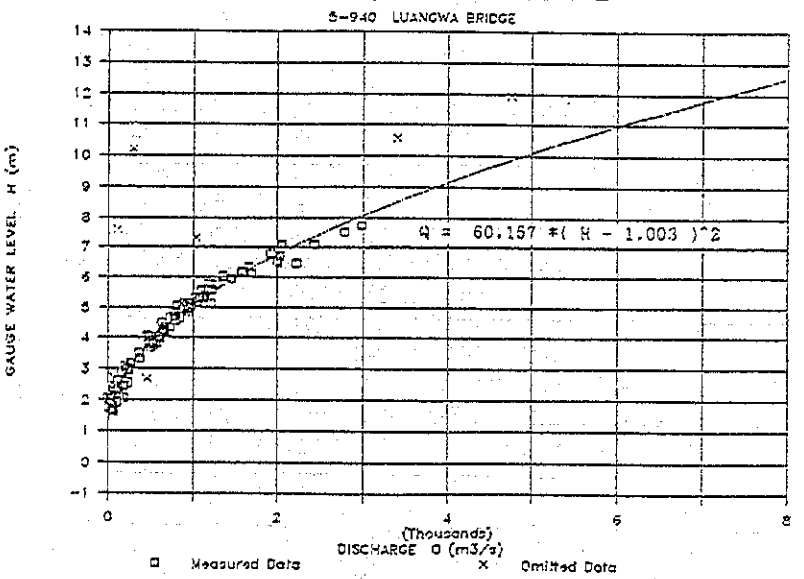


Fig.-5.25 Discharge Rating Curve (5-940 / Luangwa Bridge)

5.3 Reservoir Water Balance

To comprehend the factors of reservoir water balance, the simulation of reservoir water balance was done regarding the existing three (3) main dams: 1) Itezhi-tezhi Dam 2) Kafue Gorge Dam 3) Kariba Dam.

5.3.1 Simulation Model of Reservoir Water Balance

Generally, dam and reservoir balance is expressed by the following equation. Refer to Fig.-5.26.

$$Qo = Qi + dV + R - E + Qgi - Qgo$$

where,

- Qo : Outflow from reservoir
- Qi : Inflow to reservoir
- dV : Change of storage volume
- R : Rainfall to reservoir
- E : Evaporation from reservoir
- Qgi: Groundwater inflow to reservoir
- Qgo: Leakage from reservoir

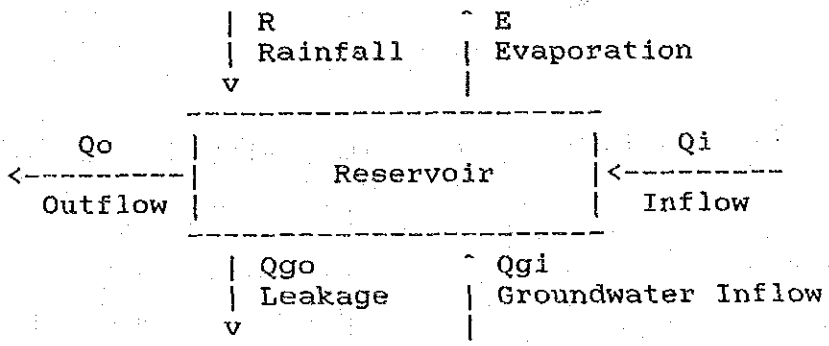


Fig.- 5.26 Reservoir Water Balance

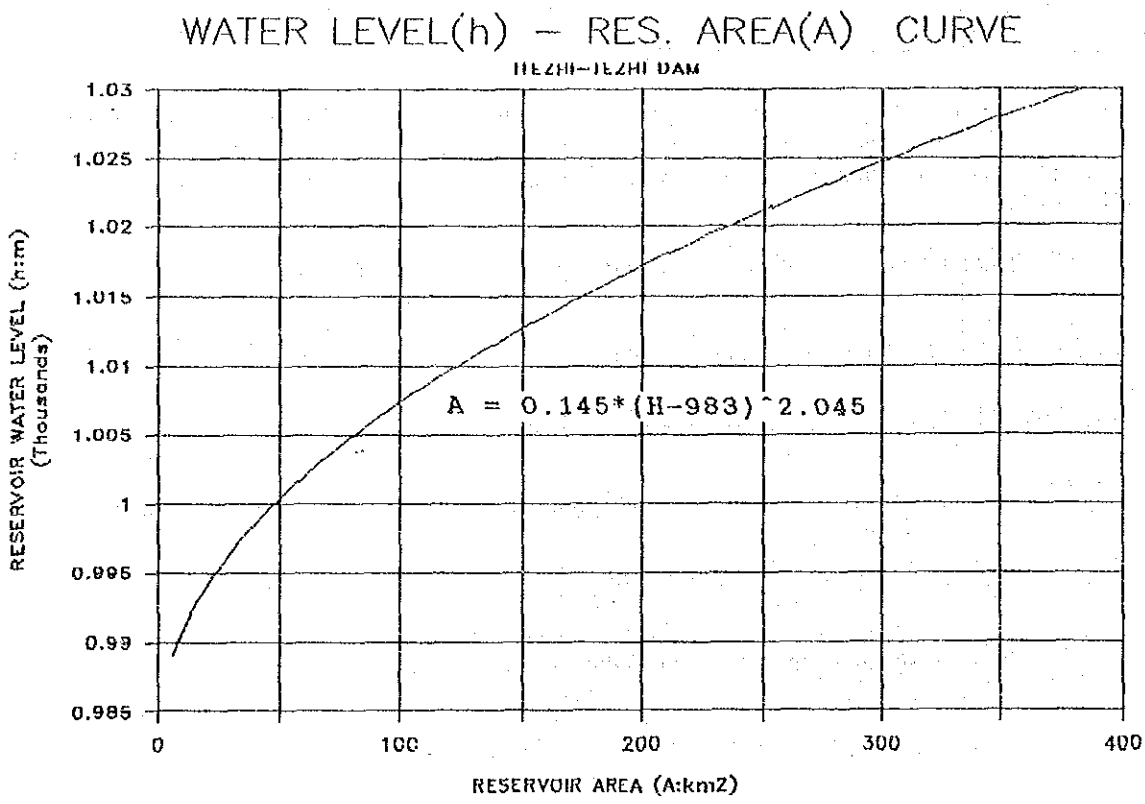
In this Study, two factors : Qgi and Ggo are neglected as these parameters do not affect the balance and the data are not available. The inflow (Qi) is calculated on monthly base as an unknown variable.

< Outflow : Qo >

The outflow from reservoir (Qo) is available as a given variable because the data of outflow through spillway and turbine conduit are recorded daily .

< Change of storage volume : dV >

The change of storage volume (dV) is obtained by 2 water levels (starting water level of calculation period, ending water level of calculation period) and water level (H) - storage volume curve (V). The daily reservoir water level is recorded at each dam. The H-V curves of the reservoirs are given in Fig.-5.27, 28 and 29.



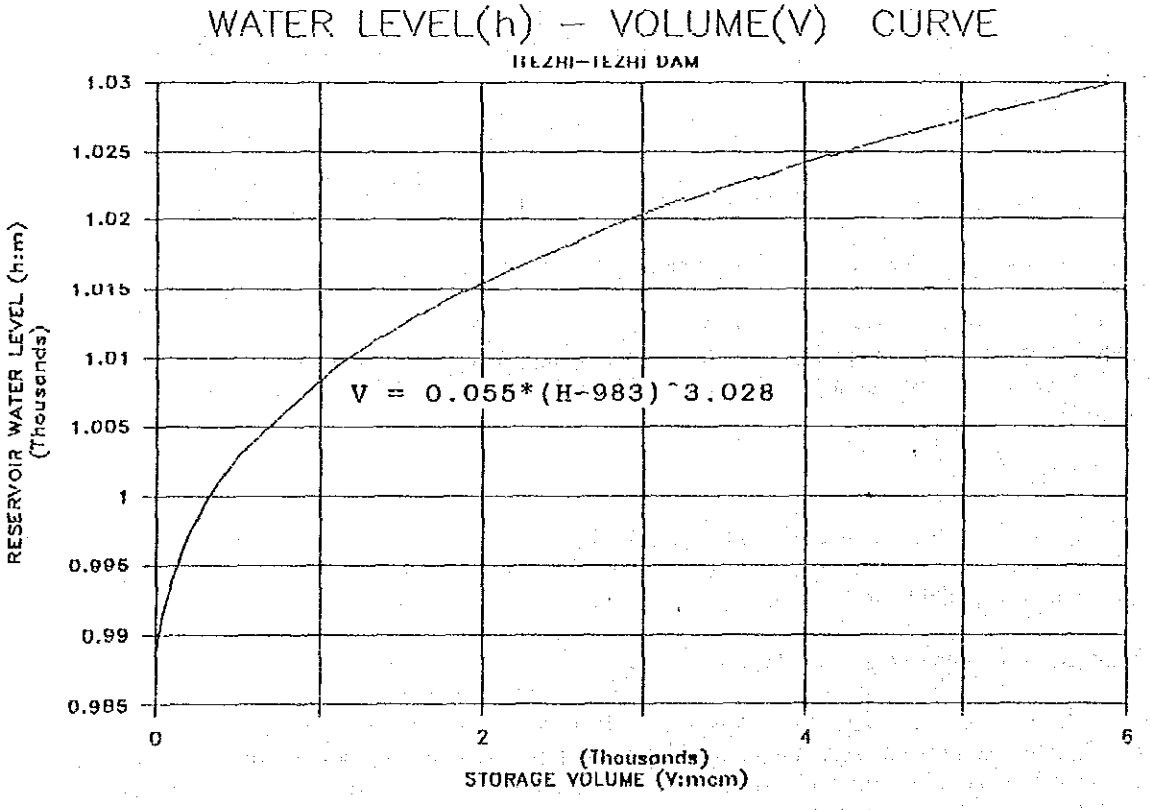
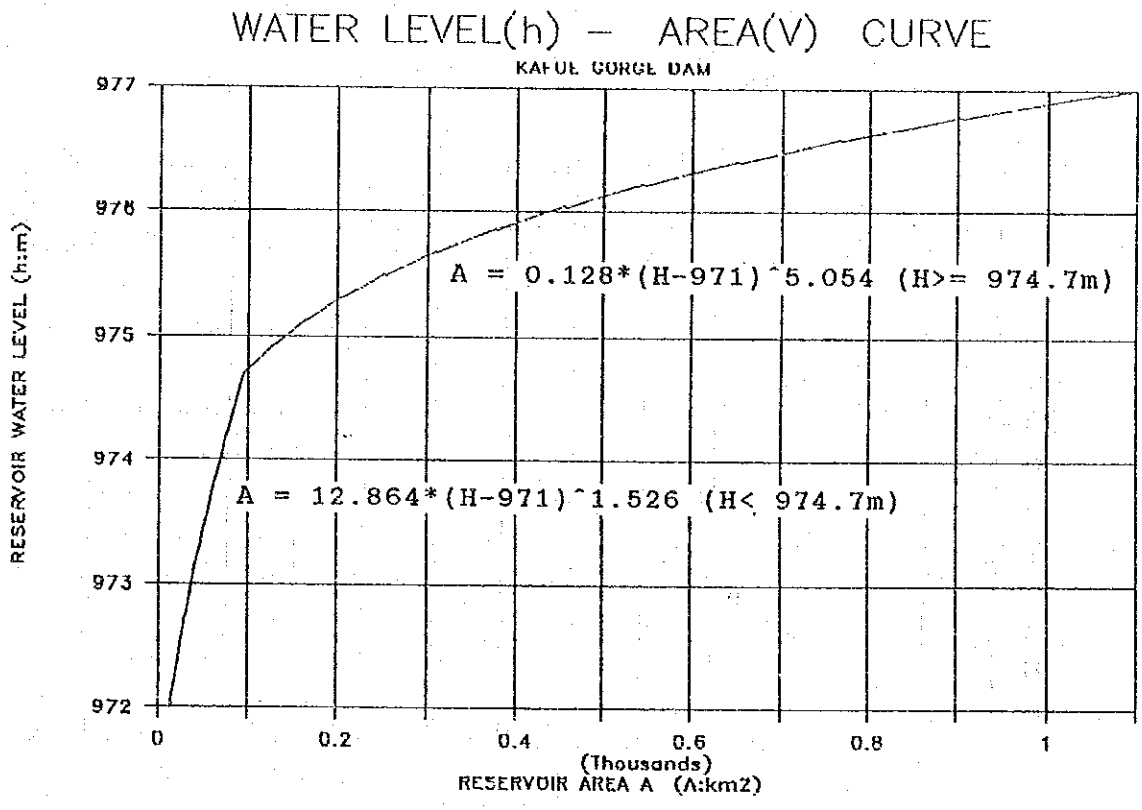


Fig.-5.27 H - V - A Curve (Itezhi-tezhi Dam)



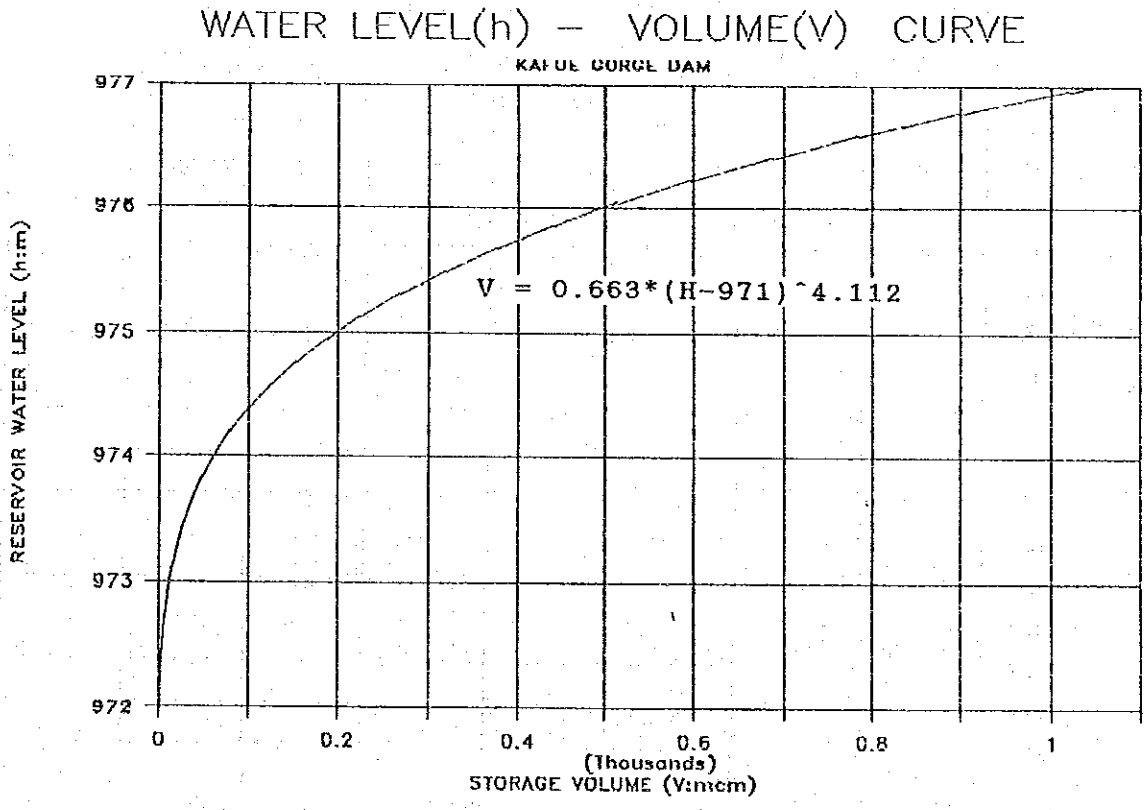
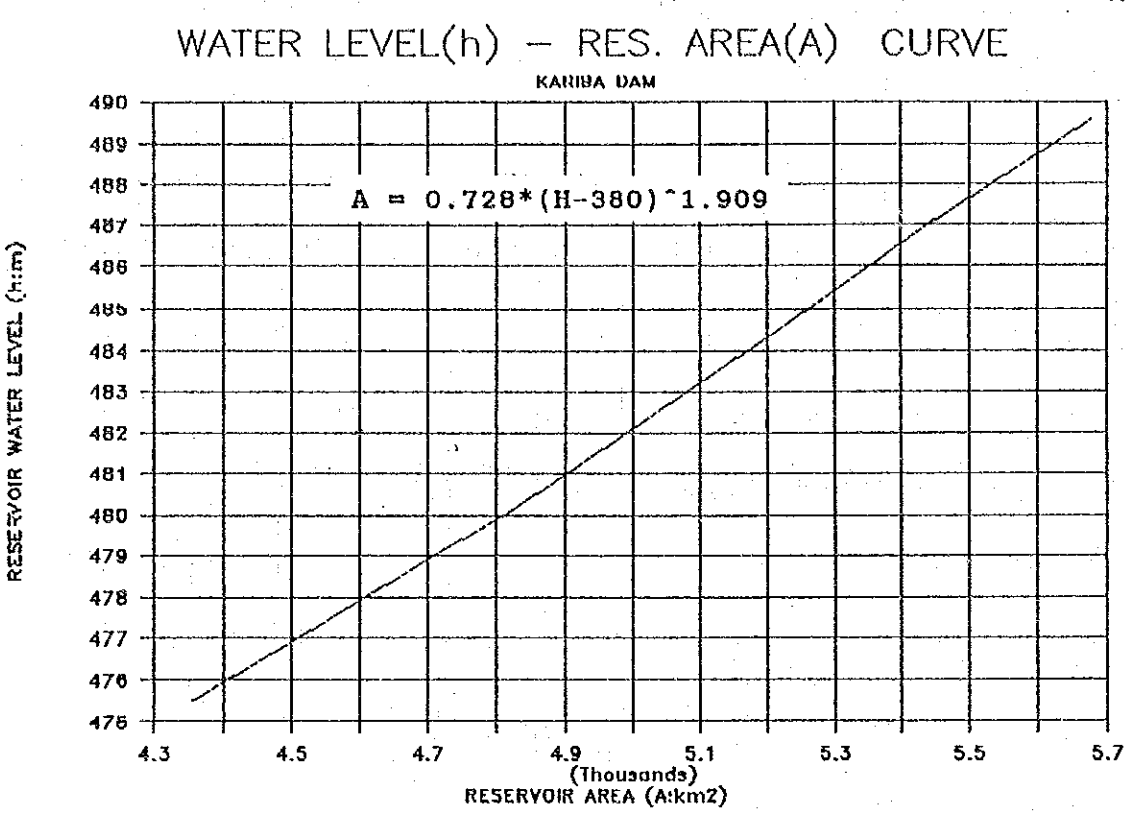


Fig.-5.28 H - V - A Curve (Kafue Gorge Dam)



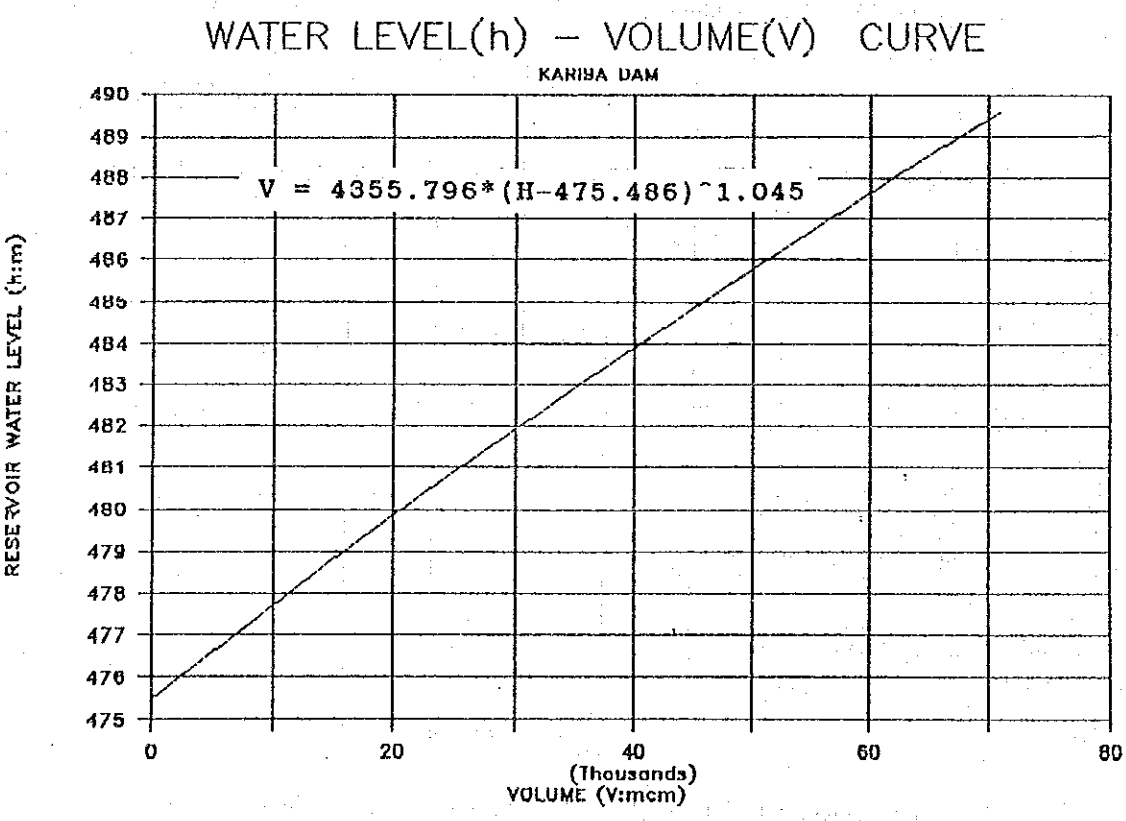


Fig.-5.29 H - V - A Curve (Kariba Dam)

< Rainfall : R and Evaporation : E >

The rainfall amount to the reservoir (R) and evaporation amount from the reservoir (E) are calculated as follows:

$$R = r \times (A1 + A2)/2, \quad E = Eo \times (A1 + A2)/2$$

where,

R : Rainfall to reservoir
E : Evaporation from reservoir
A1: Starting reservoir area of calculation period
A2: Ending reservoir area of calculation period
r : Rainfall height
Eo: Potential free water evaporation height

Data for R, E, r and Eo were obtained as follows:

1) r for Itezhi-tezhi and Kafue Gorge dam is data observed at Namwala and Kafue Polder respectively.
2) Eo for Itezhi-tezhi and Kafue Gorge dam is a value obtained by Penman method (quoted from "SIMULATION OF THE KAFUE GORGE POWER PLANT OPERATION, Draft Final Report, Hydroelectric Hydrological Assistance Project - Phase 1, SADCC 3.0.4)
3) R and E for Kariba dam are data observed at the dam site. In the simulation for Kariba dam, (R+E) is obtained as E.

5.3.2 Simulation Results

The simulation results of reservoir water balance for the 3 main dams are shown in Table-5.15. Refer to Fig.-5.30.

Table-5.15 Summary of Reservoir Water Balance

I t e m s		Itezhitezhi	Kafue Gorge	Kariba
Simulation Period		12ys(1980-91)	12ys(1980-91)	29ys(1963-91)
<Inflow>	(m3/s)	261.2 (100%)	282.1 (100%)	1,620 (100%)
incl.Rainfall	(mcm)	8,237	8,896	51,088
<Outflow>	(m3/s)	247.6 (95%)	252.7 (90%)	1,340 (83%)
	(mcm)	7,808	7,969	42,258
+ Water Power	(m3/s)	-	155.7 (55%)	789 (49%)
+ Spillway	(m3/s)	247.6 (95%)	97.0 (35%)	551 (34%)
<Evaporation>	(m3/s)	17.0 (6%)	28.9 (10%)	279 (17%)
	(mm/day)	4.5	5.1	4.7
<Change of Vol>	(m3/s)	-3.4 (-1%)	0.4 (0.2%)	0.7(0.04%)

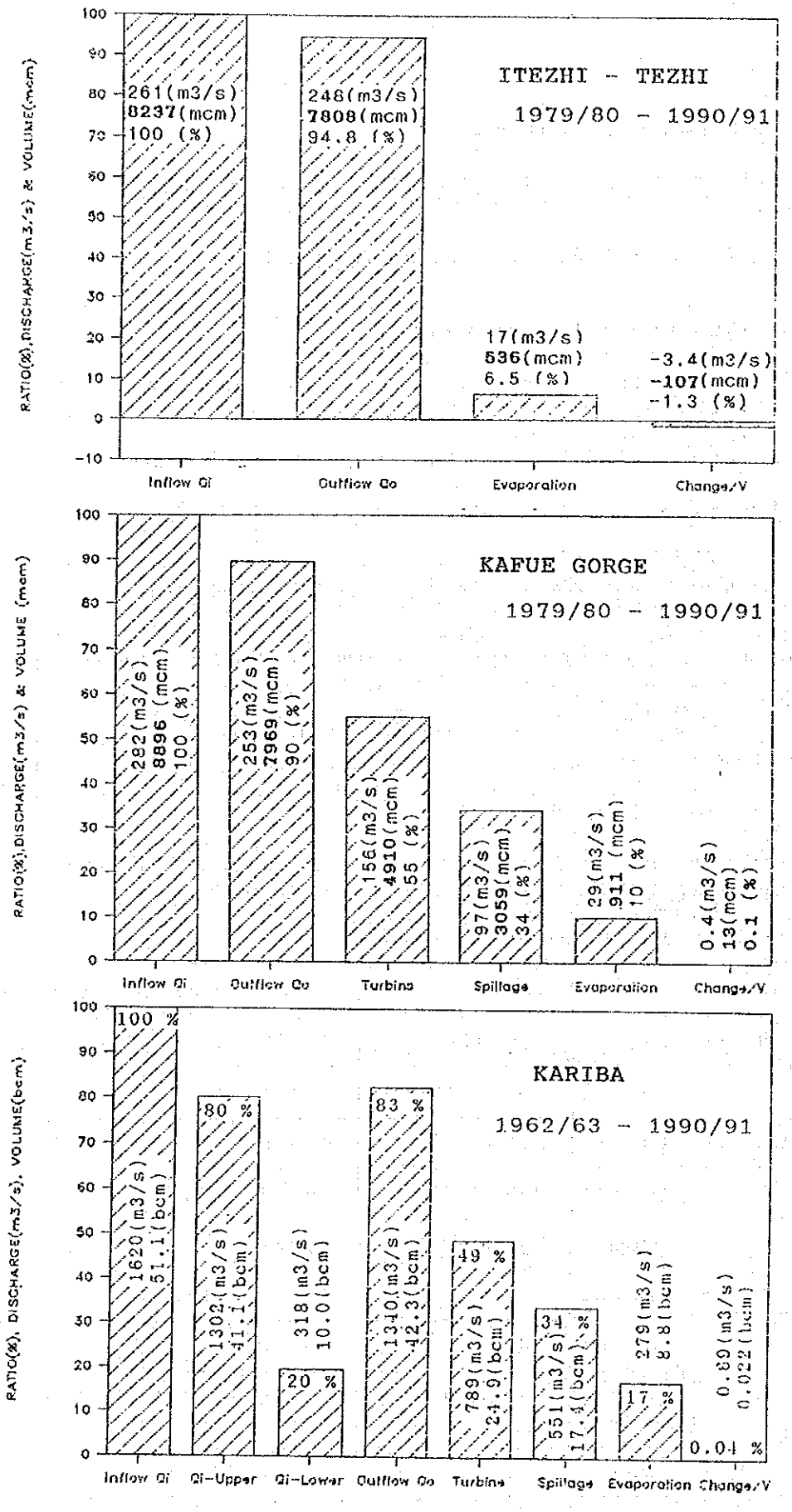


Fig. -5.30 Summary of Reservoir Water Balance

(1) Itezhi-tezhi Dam

The annual reservoir water balance of Itezhi-tezhi Dam is as shown in Table-5.15. Refer to Fig.-5.31. Monthly variation is illustrated in Fig.-5.32.

Table-5.16 Reservoir Operation (Itezhi-tezhi Dam)

Year	Water Level (m)	Storage Volume (mcm)	Change of Volume (m3/s)	Inflow (m3/s)	Evapo-ration (m3/s)	Outflow (m3/s)
1978/79	1029.17	6,026				
1979/80	1029.42	6,126	3.1	466.8	18.0	445.6
1980/81	1029.26	6,062	-2.0	465.8	18.7	449.1
1981/82	1026.48	5,025	-32.9	192.3	18.3	206.9
1982/83	1024.22	4,275	-23.8	171.4	16.7	178.5
1983/84	1018.64	2,752	-48.2	158.6	13.6	193.2
1984/85	1027.06	5,230	78.6	328.8	15.1	235.2
1985/86	1028.80	5,881	20.6	318.8	17.6	280.6
1986/87	1027.13	5,256	-19.8	199.3	18.1	201.1
1987/88	1027.14	5,259	0.1	242.6	17.6	224.9
1988/89	1027.63	5,438	5.7	240.3	17.4	217.2
1989/90	1025.82	4,797	-20.3	168.2	17.1	171.4
1990/91	1025.60	4,723	-2.4	181.6	16.3	167.6
A v e r a g e			-3.4	261.2	17.0	247.6

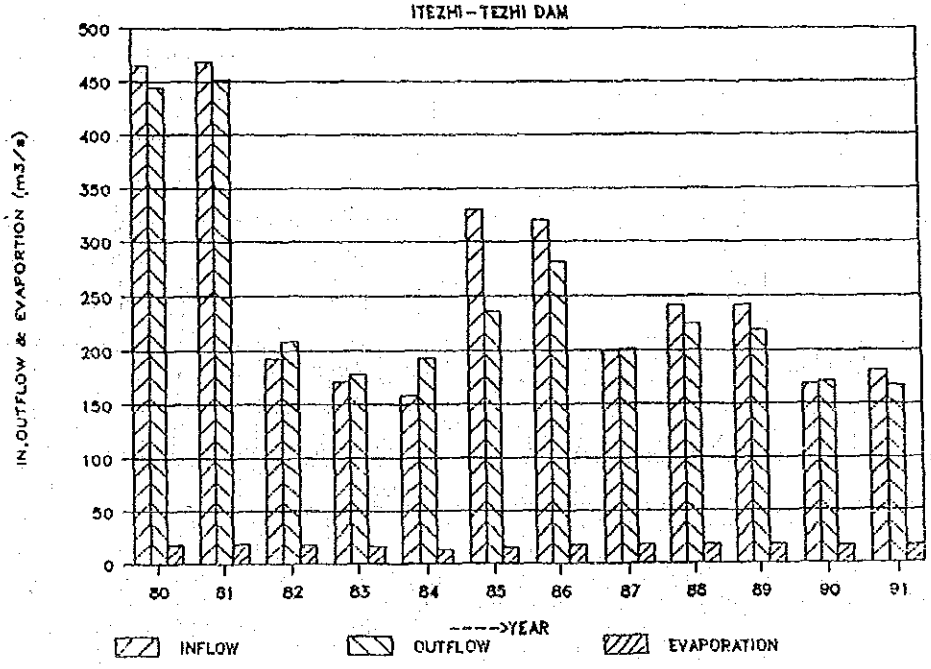
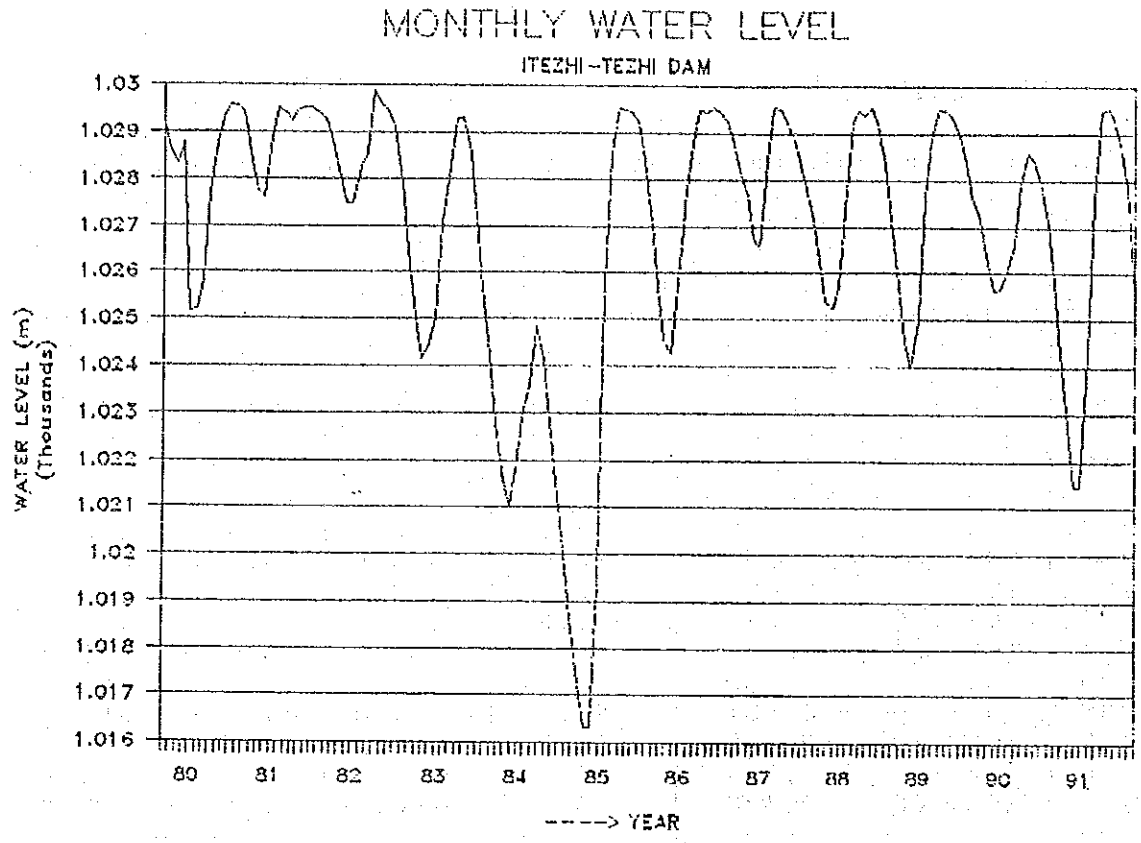


Fig.-5.31 Annual Variation of Itezhi-tezhi Dam



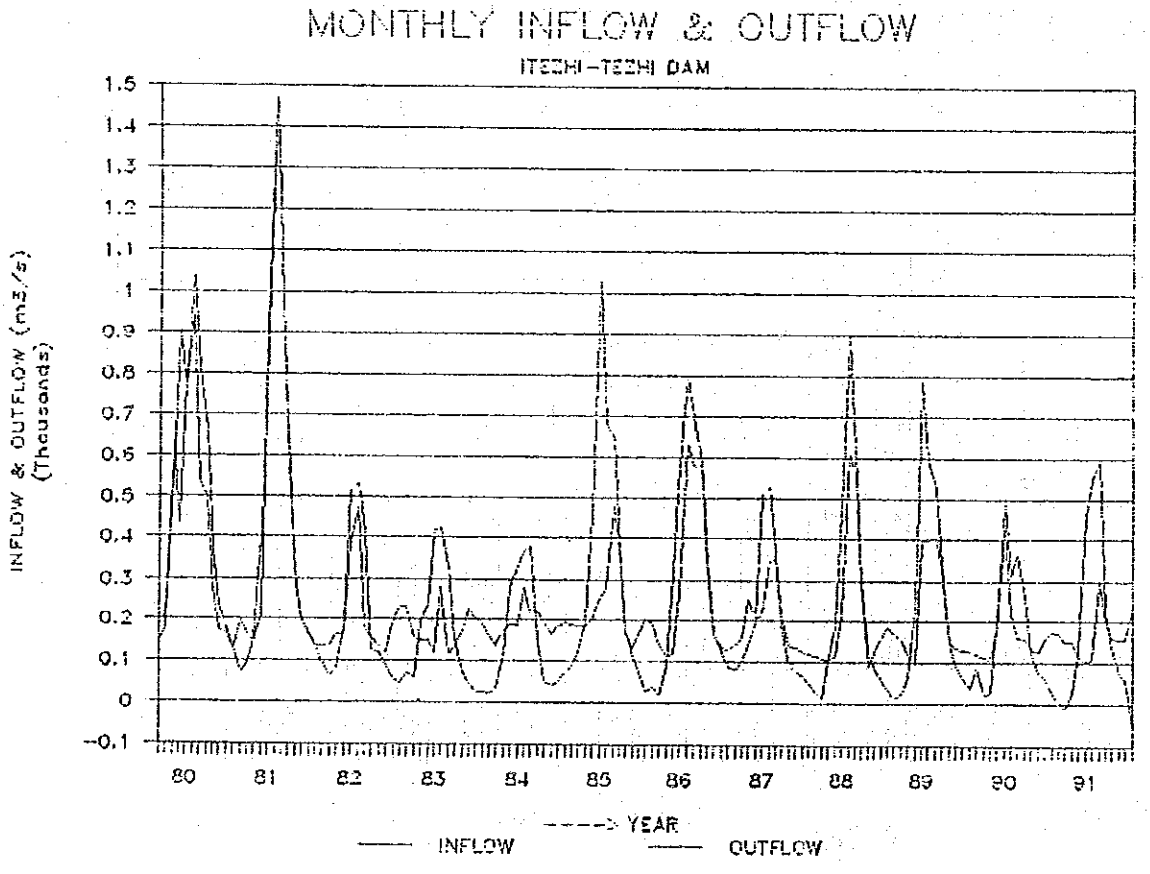


Fig.-5.32 Monthly Variation of Itezhi-tezhi Dam

(2) Kafue Gorge Dam

The annual reservoir water balance of Kafue Gorge Dam is as shown in Table-5.16. Refer to Fig.-5.33. The monthly variation is illustrated in Fig.-5.34.

Table-5.17 Reservoir Operation (Kafue Gorge Dam)

Year	Water Level (m)	Storage Volume (mcm)	Change of Vol (m3/s)	Inflow (m3/s)	Evapo-ration (m3/s)	Outflow (m3/s)		
						Turbi.	Spill.	Total
1978/79	975.10	219						
1979/80	976.58	779	17.7	519.7	31.0	140.3	330.6	470.9
1980/81	976.62	802	0.7	660.2	38.1	161.4	460.0	621.4
1981/82	976.02	504	-9.5	215.8	34.7	182.1	8.4	190.5
1982/83	975.56	340	-5.2	182.0	18.7	168.5	0.0	168.5
1983/84	975.72	392	1.6	177.7	12.2	163.9	0.0	163.9
1984/85	976.48	723	10.5	203.1	24.6	168.0	0.0	168.0
1985/86	976.58	779	1.8	311.8	38.6	178.7	92.7	271.4
1986/87	976.61	797	0.6	213.8	36.4	155.6	21.3	176.9
1987/88	976.52	745	-1.6	197.1	30.7	149.1	18.9	168.0
1988/89	976.10	538	-6.6	326.0	27.1	73.9	231.6	305.5
1989/90	975.84	434	-3.3	214.9	31.1	187.1	0.0	187.1
1990/91	975.70	385	-1.6	162.4	23.8	140.2	0.0	140.2
A v e r a g e			0.4	282.1	28.9	155.7	97.0	252.7

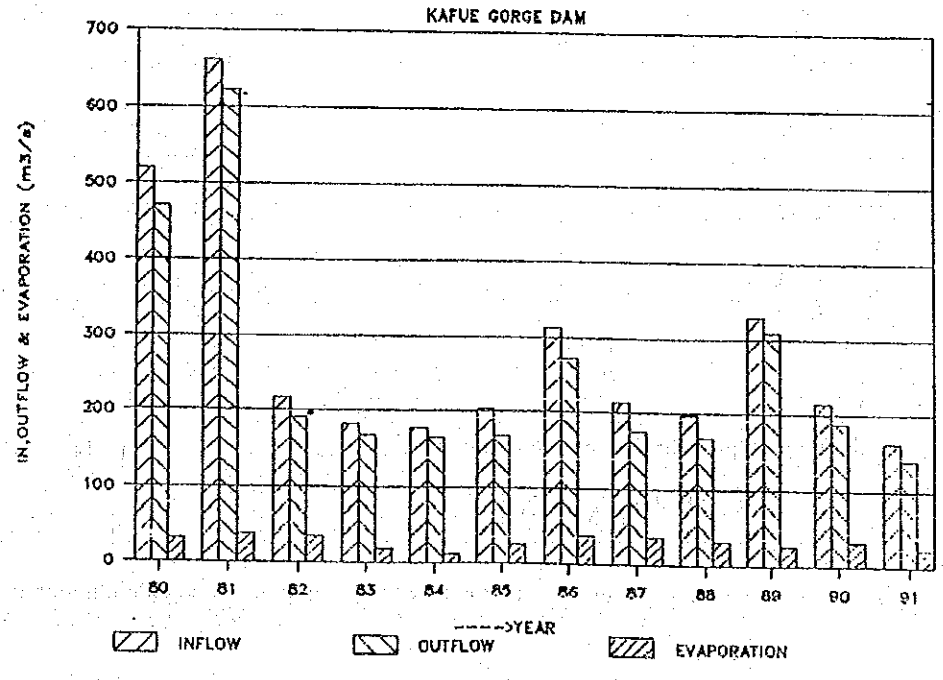
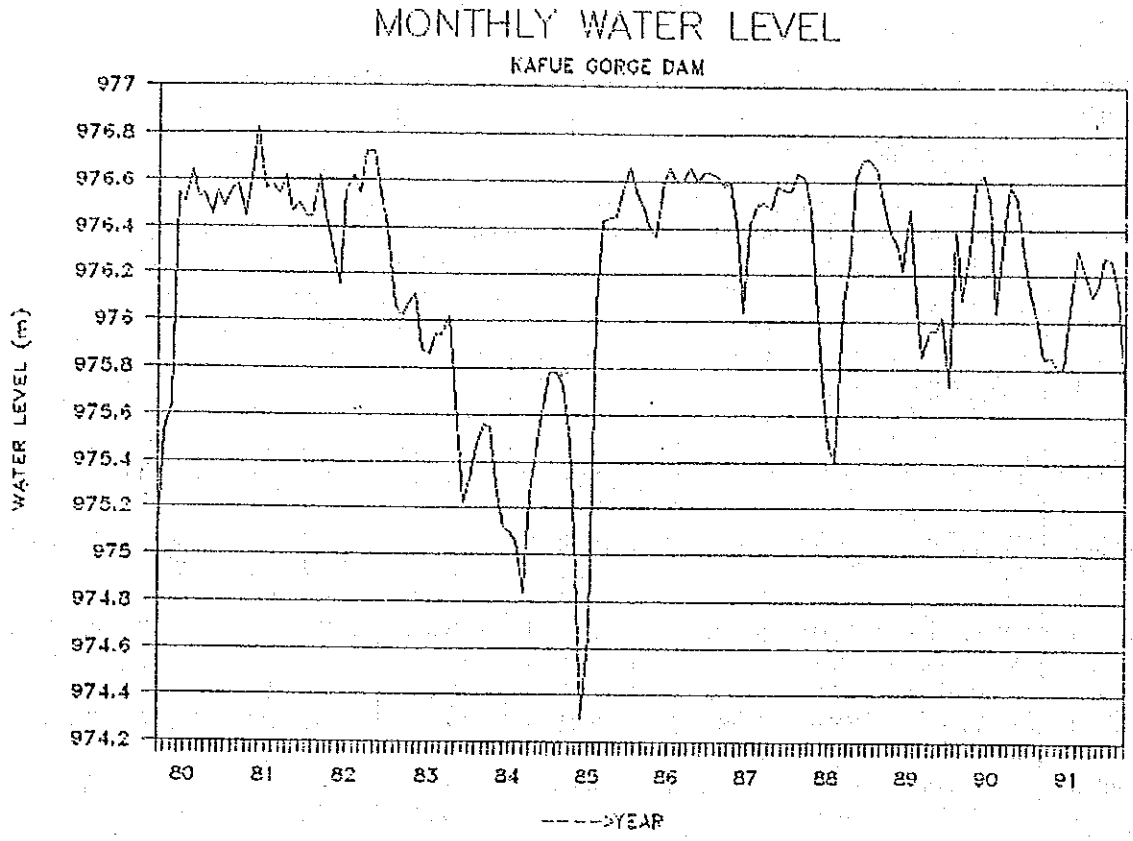


Fig.-5.33 Annual Variation of Kafue Gorge Dam



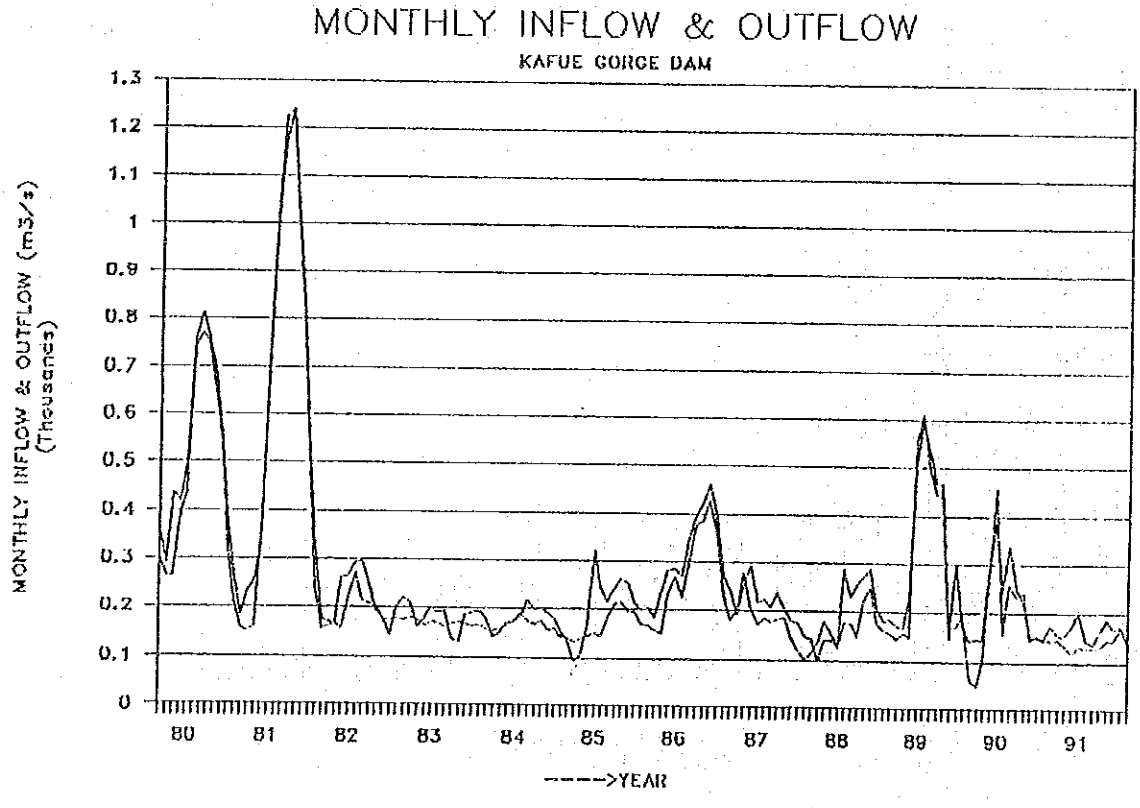


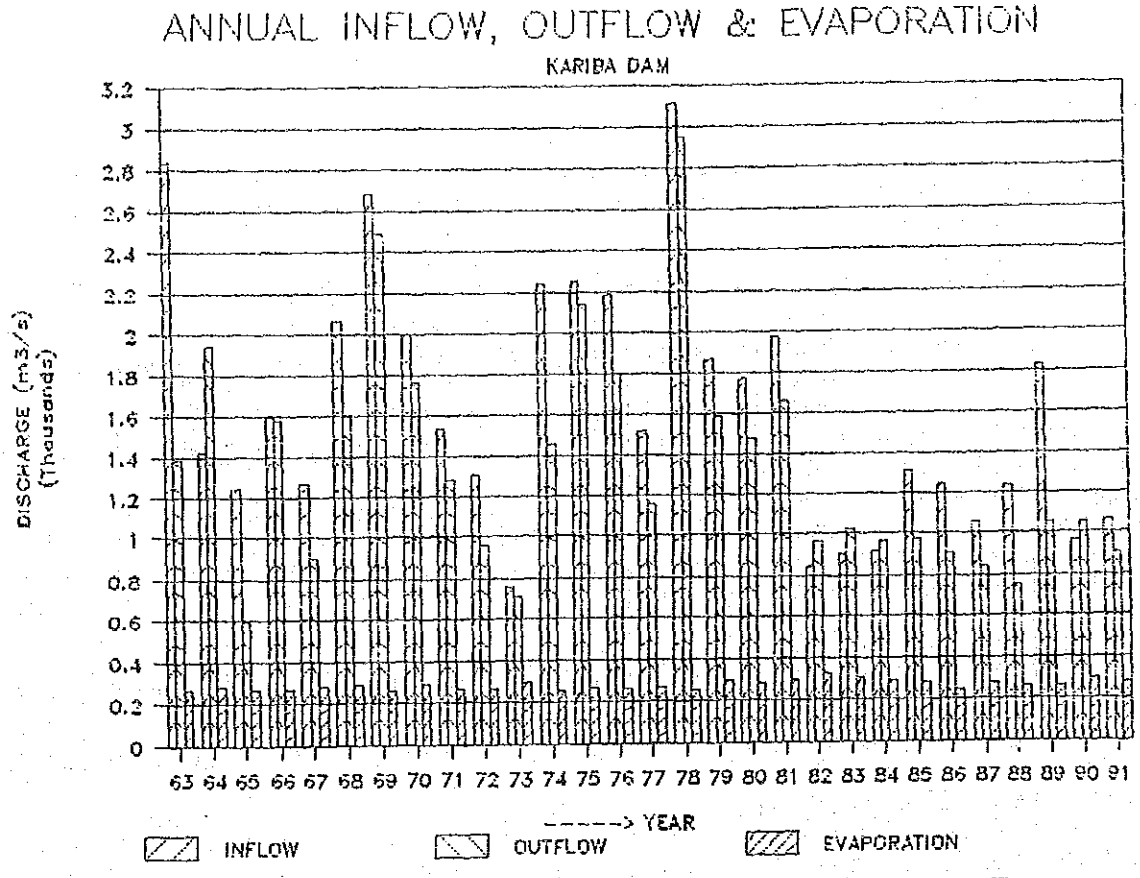
Fig.-5.34 Monthly Variation of Kafue Gorge Dam

(3) Kariba Dam

The annual reservoir water balance of Kariba Dam is as shown in Table-5.18. Refer to Fig.-5.35. The monthly variation is illustrated in Fig.-5.36.

Table-5.18 Reservoir Operation (Kariba Dam)

Year	Water Level (m)	Storage Volume (mcm)	Change of Vol (m3/s)	Inflow (m3/s)	Evapo-ration (m3/s)	Outflow (m3/s) Turbi.	Spill.	Total
1961/62	479.97	20,896						
1962/63	487.44	58,220	1,184	2,835	269	410	973	1,383
1963/64	482.38	32,754	-805	1,420	282	483	1,460	1,943
1964/65	484.78	44,755	381	1,245	272	497	95	592
1965/66	483.18	36,736	-254	1,594	274	517	1,057	1,574
1966/67	483.70	39,335	82	1,267	282	570	333	903
1967/68	484.74	44,554	165	2,064	290	633	976	1,609
1968/69	484.31	42,392	-69	2,684	265	686	1,802	2,488
1969/70	483.99	40,787	-51	1,998	290	699	1,060	1,759
1970/71	483.85	40,086	-22	1,529	274	735	542	1,277
1971/72	484.34	42,543	78	1,301	267	696	260	956
1972/73	482.73	34,494	-255	759	298	716	0	716
1973/74	486.11	51,468	538	2,241	253	701	749	1,450
1974/75	485.12	46,467	-159	2,250	269	711	1,428	2,139
1975/76	485.93	50,557	129	2,183	258	743	1,052	1,795
1976/77	486.53	53,596	96	1,518	269	833	319	1,152
1977/78	485.92	50,507	-98	3,111	257	884	2,068	2,952
1978/79	485.82	50,001	-16	1,863	296	914	670	1,584
1979/80	485.91	50,456	14	1,772	285	994	479	1,473
1980/81	485.99	50,861	13	1,973	303	1,010	647	1,657
1981/82	483.13	36,487	-456	844	331	969	0	969
1982/83	480.36	22,799	-434	902	305	1,031	0	1,031
1983/84	478.12	11,984	-342	919	294	967	0	967
1984/85	478.50	13,797	57	1,312	282	972	0	972
1985/86	479.04	16,390	82	1,240	247	911	0	911
1986/87	478.62	14,371	-64	1,053	278	839	0	839
1987/88	480.03	21,188	216	1,233	262	755	0	755
1988/89	483.29	37,285	510	1,828	260	1,057	0	1,057
1989/90	480.86	25,248	-382	970	296	1,055	0	1,055
1990/91	480.10	21,529	-118	1,066	277	906	0	906
A v e r a g e			1	1,620	279	789	551	1,340



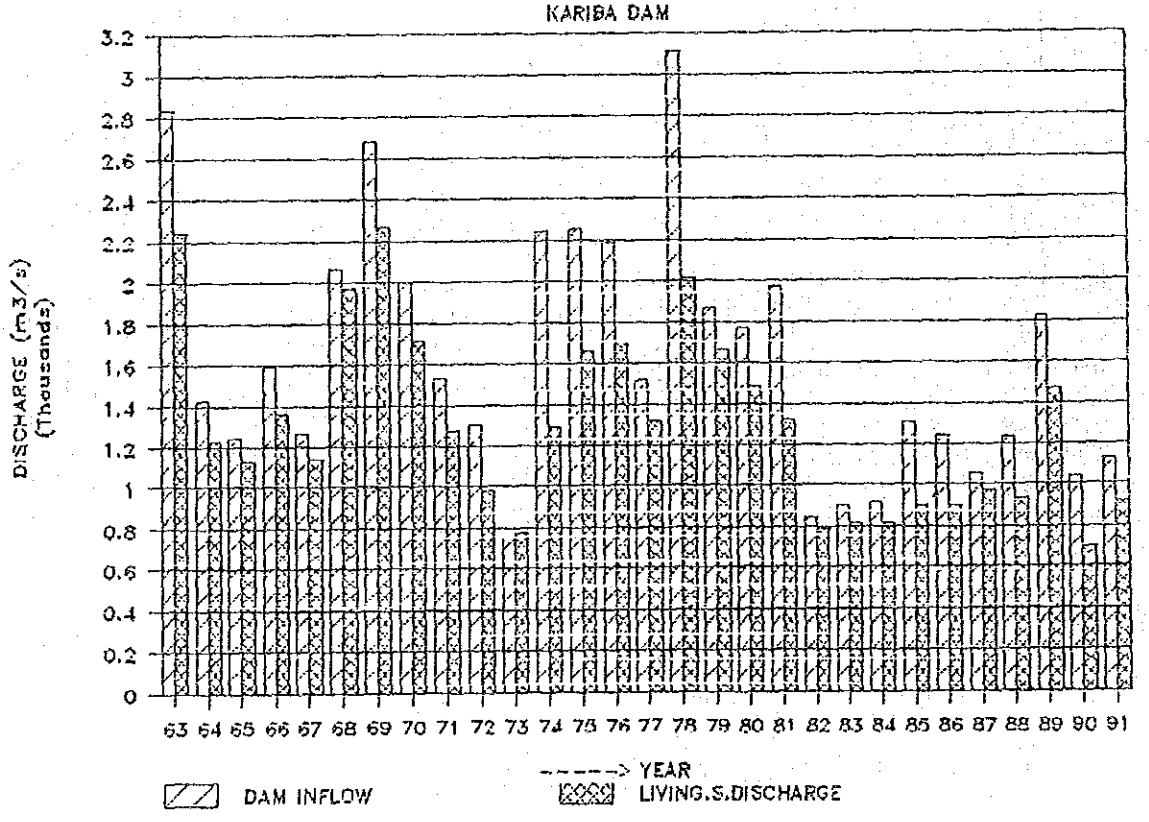
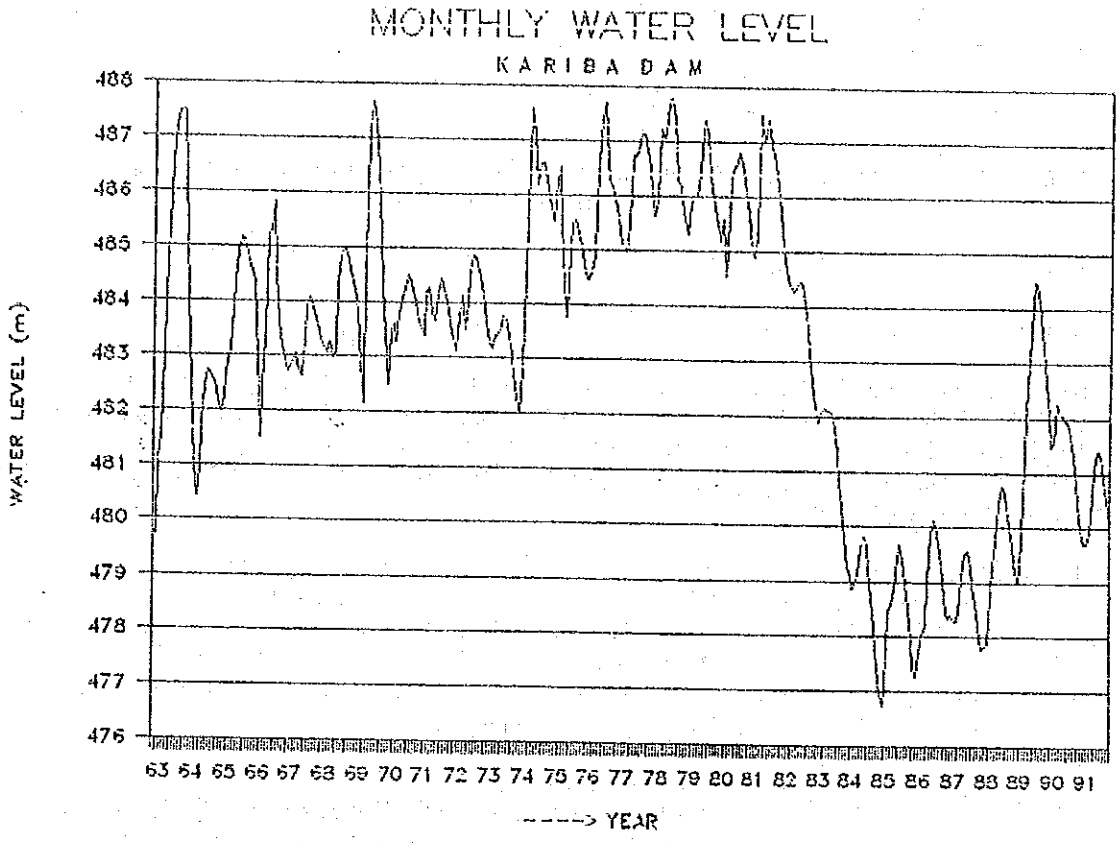


Fig.-5.35 Annual Variation of Kariba Dam



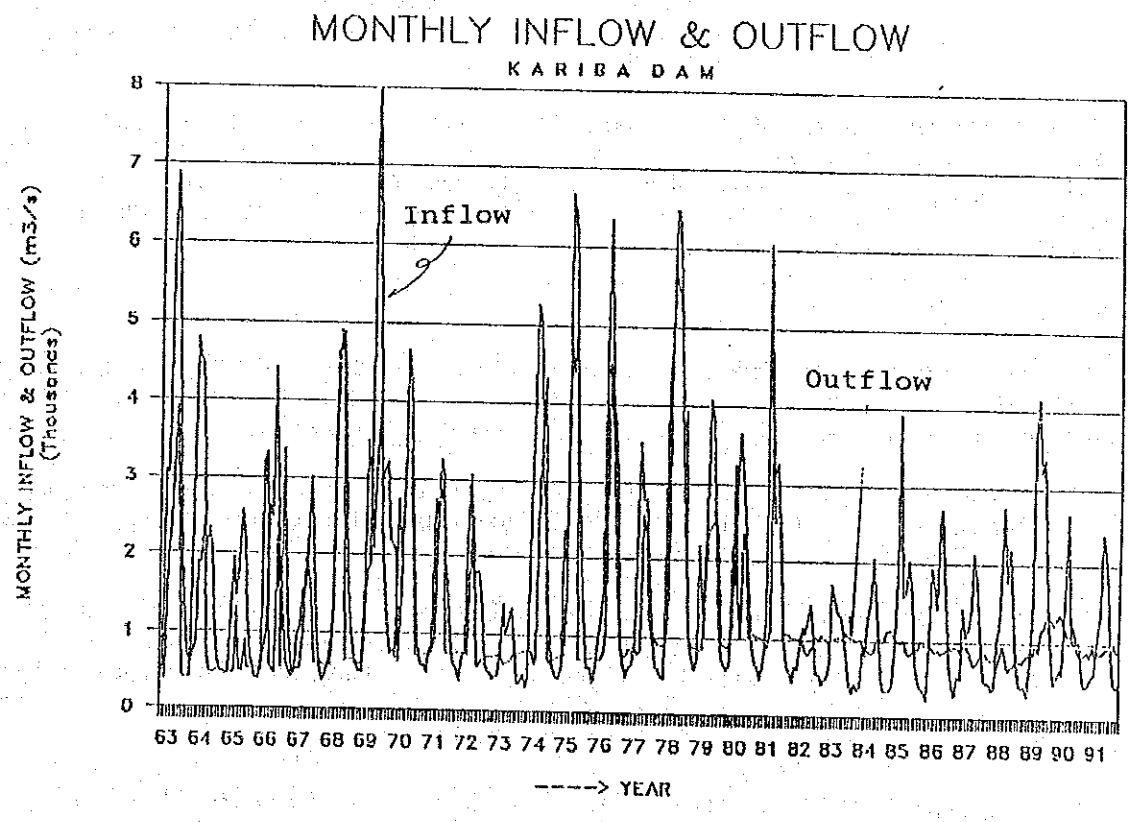


Fig.-5.36 Monthly Variation of Kariba Dam

5.4 River Flow Analysis

5.4.1 River Flow Simulation

The simulation of river flow was done using the Database DB-09 developed in the Study and mentioned in Chapter 5.1.

(1) Simulation Model of River Flow

<Division of Area>

The area for simulation is divided into 34 units (Zambezi River :17 units, Kafue River: 15 units, Luangwa River 2 units) as illustrated in Fig.- 5.37 to analyze the river flow. 45 points are set to obtain discharge. The whole area is divided into the following two (2) areas.

1) Upper Area
   - Zambezi River: St. Senanga (2-400) and upstream area
   - Kafue River : St. Kafue Hook Bridge (4-66) and upstream area
   - Luangwa River: Up to the confluence with Zambezi R.

2) Lower Area
   - Zambezi River: Downstream area from St.Senanga (2-400) and up to the confluence with Luangwa R.
   - Kafue River : Downstream area from St.Kafue Hook Bridge (4-669) and up to the confluence with Zambezi R.

This division was made due to the data availability of each area. The Upper Area has some hydrometric stations and long-term data for more than 30 years. While the Lower Area has no working hydrometric station but three (3) operating dams. Data common to each dam's operation is available from 1979.

< Model for Upper Area >

For Upper Area : (Zambezi River : point 1 -16, Kafue River : point 21 - 35 and Luangwa River : point 43-44), the surface flow simulation is done as follows: Refer to Table-5.15.

1) The discharge at hydrometric station is obtained through Database DB-05 on the basis of the observed water level and the discharge rating curve.

2) The discharge at the other point is calculated in proportion to the catchment area considering the values of discharge at both the hydrometric stations in upper and lower reaches. For example, the discharge at the point 5,6 and 7 can be obtained as follows:

$$Q(5) = Q(4) + \{Q(8)-Q(4)\} \times [\{A(5)-A(4)\}/\{A(8)-A(4)\}]$$
$$Q(6) = \{Q(8)-Q(4)\} \times [A(6)/\{a(8)-A(4)\}]$$
$$Q(7) = Q(5) + Q(6)$$

where,

Q(4), Q(5), Q(6), Q(7), Q(8):
Discharge at point 4, 5, 6, 7, 8
A(4), A(5), A(6), A(8):
Catchment area at point 4, 5, 6, 8

3) Simulation period : 30 years (1959/60 - 1988/89)

< Model for Lower Area >

For Lower Area : (Zambezi River : point 17 - 20, 41 - 42 and 45, Kafue River : point 36 - 40), the surface flow simulation is done as follows: Refer to Table-5.19.

1) The input discharge to the reservoir and output discharge from the reservoir are obtained from the reservoir simulation results through Database DB-10. The extraction from the rservoir (evaporation etc.) and variation of storage volume are also obtained through Database DB-10.

2) The discharge at Livingstone (point 17) observed by ZRA is employed as the Livingstone discharge Q(17).

3) From the difference between Livingstone discharge Q(17) and Kariba dam inflow Q(18) obtained through the simulation, the specific discharge q(m3/s/km2) of unit area AZ-15 is obtained. As shown below, this specific discharge is applied to the calculation of discharge from unit area AZ-16, AZ-17 and AK-15.

$$Q(20) = Q(19) + \{A(20) - A(19)\} \times q(AZ15)$$
$$Q(40) = Q(39) + \{A(40) - A(39)\} \times q(AZ15)$$
$$Q(42) = Q(41) + \{A(42) - A(41)\} \times q(AZ15)$$

where,

Q(20), Q(40), Q(42):
Discharge at point 20, 40, 42
A(19), A(20), A(39), A(40), A(41), A(42):
Catchment area at point 19, 20, 39, 40, 41, 42
q(AZ15):
Specific discharge (m3/s/km2) of unit AZ15

4) The discharge at the point 44 (mouth of Luangwa River) is obtained as follows.

$$Q(44) = Q(43) + \{A(44) - A(43)\} \times q(AL02)$$

where,

Q(43), Q(44): Discharge at point 43, 44
A(43), A(44): Catchment area at point 43, 44
q(AZ15):
Specific discharge (m3/s/km2) of unit AL02

5) Simulation period : 12 years (1979/80 - 1990/91).
For this period, a set of reservoir operation data of the main 3 dams is available.

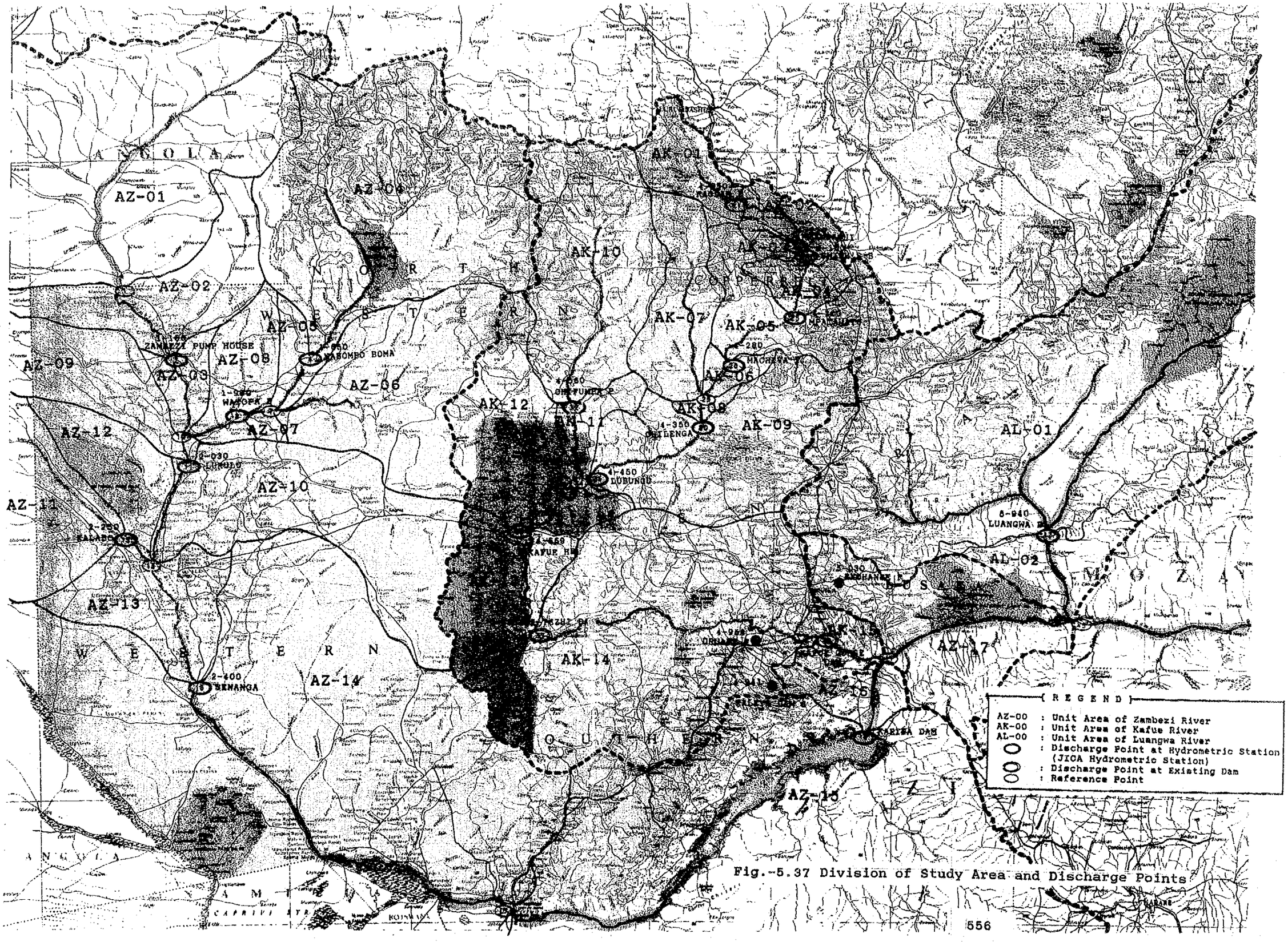


Fig.-5.37 Division of Study Area and Discharge Points

Table- 5.19 Method of Discharge Simulation

No.	Area(km2)	D e s c r i p t i o n	Method to Obtain Discharge Q(x)
1	73,521	Most upstream point of Zambezi main river	Q(1) = Q(2) x (73,512/87,275)
2	82,275	Hydro. St. (1-150 Zambezi Pump House)	Q(2) : Observation Data
3	90,353	Main river portion for Conf.(Zambezi x Kabompo)	Q(3) = Q(2) x (90,353/87,275)
4	42,740	Hydro. St. (1-650 Kabompo Boma)	Q(4) : Observation Data
5	45,029	Kabompo R portion for Conf.(Kabompo x Dongwe)	Q(5) = Q(4) + {Q(8)-Q(4)}x(2,289/23,709)
6	20,568	Area of Dongwe R	Q(6) = {Q(8)-Q(4)}x(20,568/23,709)
7	65,597	Confluence (Kabompo x Dongwe)	Q(7) = Q(5) + Q(6)
8	66,449	Hydro. St. (1-950 Matopa Pontoon)	Q(8) : Observation Data
9	72,347	Kabompo R portion for Conf.(Zambezi x Kabompo)	Q(9) = Q(8) + {Q(8)-Q(4)}x(5,898/23,709)
10	162,700	Confluence (Zambezi x Kabompo)	Q(10) = Q(8) + Q(14)
11	206,531	Hydro. St. (2-030 Lukulu)	Q(11) : Observation Data
12	228,076	Zambezi R portion for Conf.(Zambezi x Luanginga)	Q(12) = Q(11) + (Q(16)-Q(11)-Q(13))x(21,545/37,147)
13	34,621	Hydro. St. (2-250 Kalabo)	Q(13) : Observation Data
14	41,233	Luanginga R portion for Conf.(Zambezi x Luanginga)	Q(14) = Q(13) + (Q(16)-Q(11)-Q(13))x(6,612/37,147)
15	269,309	Confluence (Zambezi x Luanginga)	Q(15) = Q(12) + Q(14)
16	278,298	Hydro. St. (2-400 Senanga)	Q(16) : Observation Data
17	466,324	Livingstone (Victoria Falls)	Q(17) : Observation Data
18	608,634	Catchment area for Kariba Reservoir (In-flow)	Q(18) : Simulation Result
18E		Evaporation	Q(18E): Simulation Result
18S		Storage	Q(18S): Simulation Result
19	608,634	Kariba Dam (Out-flow)	Q(19) : Gate Operation Data
20	612,724	Zambezi R portion for Conf.(Zambezi x Kafue)	Q(20) = Q(19) + 4,090 x {(Q(18)-Q(17))/142,310
21	4,999	Hydro. St. (4-050 Raglan Farm)	Q(21) : Observation Data
22	7,730	Kafue R portion for Conf.(Kafue x Hwambashi)	Q(22) = Q(24) - Q(23)
23	869	Hydro. St. (4-120 Hwambashi)	Q(23) : Observation Data
24	8,599	Hydro. St. (4-130 Smith's Bridge)	Q(24) : Observation Data
25	11,655	Hydro. St. (4-200 Mpatamato)	Q(25) : Observation Data
26	22,920	Hydro. St. (4-280 Machiya Ferry)	Q(26) : Observation Data
27	24,582	Kafue R portion for Conf.(Kafue x Luswishi)	Q(27) = Q(26) + {Q(30)-Q(26)}x(1,662/11,242)
28	8,866	Luswishi R portion for Conf.(Kafue x Luswishi)	Q(28) = {Q(30)-Q(26)}x(8,866/11,242)
29	33,448	Confluence (Kafue x Luswishi)	Q(29) = Q(27) + Q(28)
30	34,162	Hydro. St. (4-350 Chilenga)	Q(30) : Observation Data
31	54,442	Hydro. St. (4-450 Lubungu)	Q(31) : Observation Data
32	21,445	Hydro. St. (4-560 Chifumpa Pontoon)	Q(32) : Observation Data
33	24,416	Lunga R portion for Conf.(Kafue x Lunga)	Q(33) = Q(32) + (Q(35)-Q(31)-Q(32))x(2,971/19,166)
34	78,858	Confluence (Kafue x Lunga)	Q(34) = Q(31) + Q(33)
35	95,053	Hydro. St. (4-669 Kafue Hook Bridge)	Q(35) : Observation Data
36	105,672	Catchment area for Itezhi-tezhi Reservoir (In-flow)	Q(36) : Simulation Result
36E		Evaporation	Q(36E): Simulation Result
36S		Storage	Q(36S): Simulation Result
37	105,672	Itezhi-tezhi Dam (Out-flow)	Q(37) : Gate Operation Data
38	151,576	Catchment area for Kafue Gorge Reservoir (In-flow)	Q(38) : Simulation Result
38E		Evaporation	Q(38E): Simulation Result
38S		Storage	Q(38S): Simulation Result
39	151,576	Kafue Gorge Dam (Out-flow)	Q(39) : Gate Operation Data
40	154,882	Kafue R portion for Conf.(Zambezi x Kafue)	Q(40) = Q(39) + 3,306 x {(Q(18)-Q(17))/142,310
41	767,608	Confluence (Zambezi x Kafue)	Q(41) = Q(20) + Q(40)
42	786,686	Zambezi R portion for Conf.(Zambezi x Luangwa)	Q(42) = Q(41) + 19,080 x {(Q(18)-Q(17))/142,310
43	143,781	Hydro. St. (5-940 Luangwa Bridge)	Q(43) : Observation Data
44	150,586	Luangwa R portion for Conf.(Zambezi x Luangwa)	Q(44) = Q(43) x (150,586/143,781)
45	937,272	Confluence (Zambezi x Luangwa)	Q(45) = Q(42) + Q(44)