CHAPTER - 4

HYDROLOGIC ANALYSIS

<<<<< CHAPTER-4 HYDROLOGIC ANALYSIS >>>>>

C O N T E N T S

LIST OF FIGURES AND TABLES

4 HYDROLOGIC ANALYSIS

4.1 Hydrologic Database

All the hydrologic observation data dealt in this Study will be filed and analyzed with use of the following computer database systems. These systems run with P/C (TOSHIBA, J-3100 series, IBM compatible).

The database systems developed in Study are composed of 1) Filing System : consisting of 5 systems and 2) Analyzing System : consisting of 9 systems as shown in Fig.-4.1. The manual of database system is available in **Supplement-4.1**, and achivement of data input for each database system is listed in **Supplement-4.7**.

[Filing System]

(DB-01): FLOW MEASUREMENT DATA BY MEASUREMENT

To file flow measurement data and calculate discharge area, mean velocity & discharge and output table by measurement.
(See Table-4.1)

(DB-02): FLOW MEASUREMENT DATA BY STATION

To file flow measurement data of each station and output tables by station.
(See Table-4.2)

(DB-05A): DAILY RIVER WATER LEVEL

To file the daily river water level observed at the hydrometric stations and output tables showing water level in feet and meter by station.
(See Table-4.3)

(DB-06A): HOURLY RIVER WATER LEVEL

To file the hourly water level recorded at the hydrometric stations and output tables in feet and meter by station.
(See Table 4-4)

(DB-11): DAILY WELL WATER LEVEL

To file daily well water level observed at the observation well, calculate water level elevation in meters and output tables by station.
(See Table-4.5)

[Analyzing System]

(DB-03): DISCHARGE RATING CURVE METHOD

In case the volume of flow measurement data is small, this system prepares a discharge rating curve using the station's parametric data : cross section, water surface slope and roughness.
(See Table-4.6 and Fig.-4.2)

(DB-04): DISCHARGE RATING CURVE METHOD

In case the amount of flow measurement data is large, this system prepares a discharge rating curve using the data filed in DB-02.
(See Table-4.7 and Fig.-4.3)

(DB-05B): DAILY DISCHARGE

Using the discharge rating curve prepared by DB-03 or DB-04, this system convert the daily river water level filed in DB-05A to daily discharge, and output daily discharge tables.
(See Table-4.8)

(DB-06B): HOURLY DISCHARGE

Using the discharge rating curve prepared by DB-03 or DB-04, this system convert the hourly river water level filed in DB-06A to hourly discharge, and output hourly discharge tables.
(See Table-4.9)

(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 output from DB-05B. The curve is expressed as " Y = aX + b ". Where,
X and Y : discharge, a and b : constants.
(See Table-4.10 and Fig.-4.4)

(DB-08): FLOW REGIME TABLE

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 output in DB-05B.
(See Table-4.11)

(DB-09): RIVER FLOW ANALYSIS

This system prepares the annual and monthly tables of river flow ,using the data obtained from DB-05B and DB-10.
(See Table-4.12 and 4.13)

(DB-10): RESERVOIR WATER BALANCE

This system calculates the monthly reservoir water balance.
(See Table-4.14 and 4.15)

(DB-12): CORRELATION BETWEEN RIVER AND WELL WATER LEVEL

This system analyzed the relationship between the river water level and well water level.
(See Fig.-4.5)

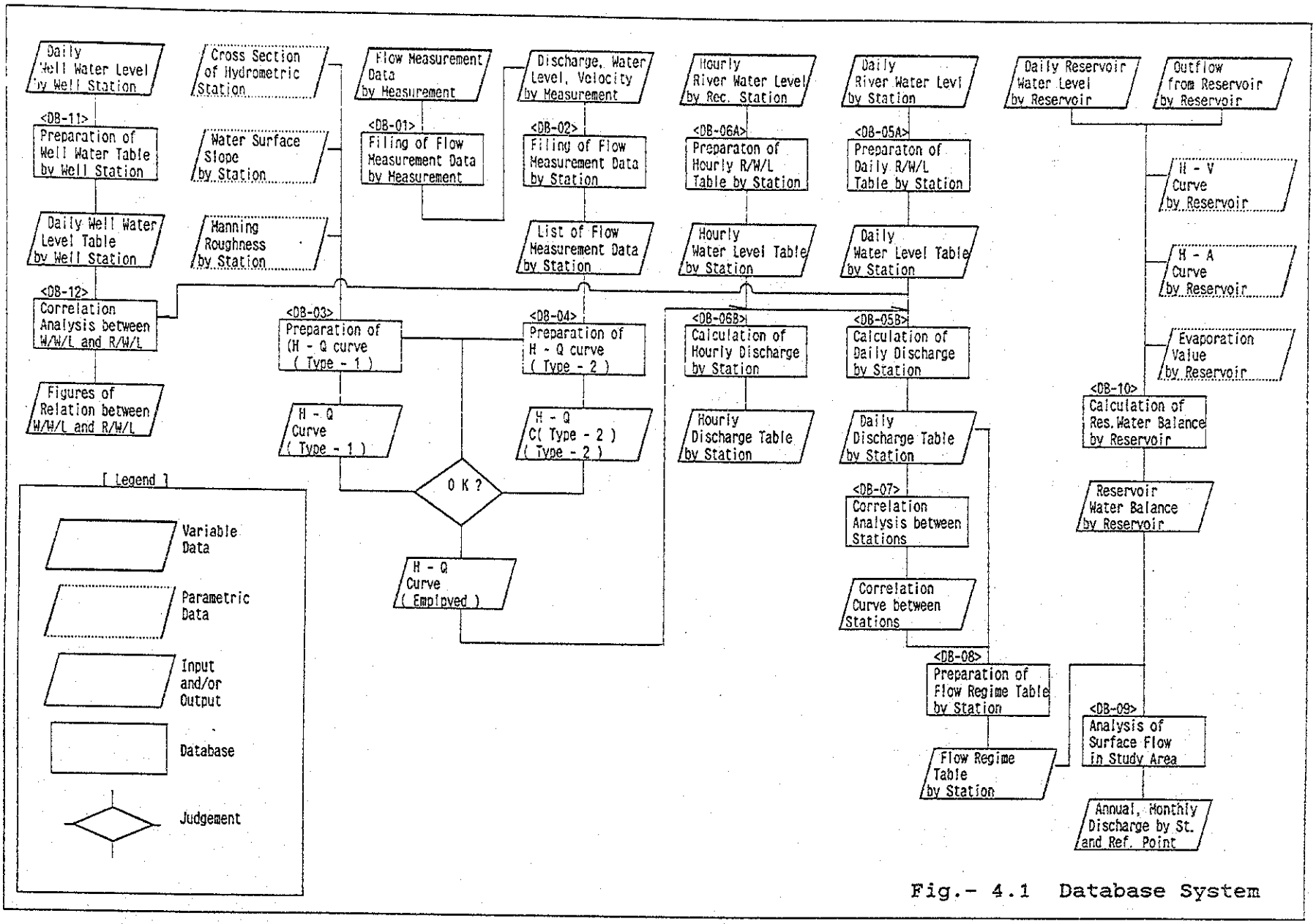


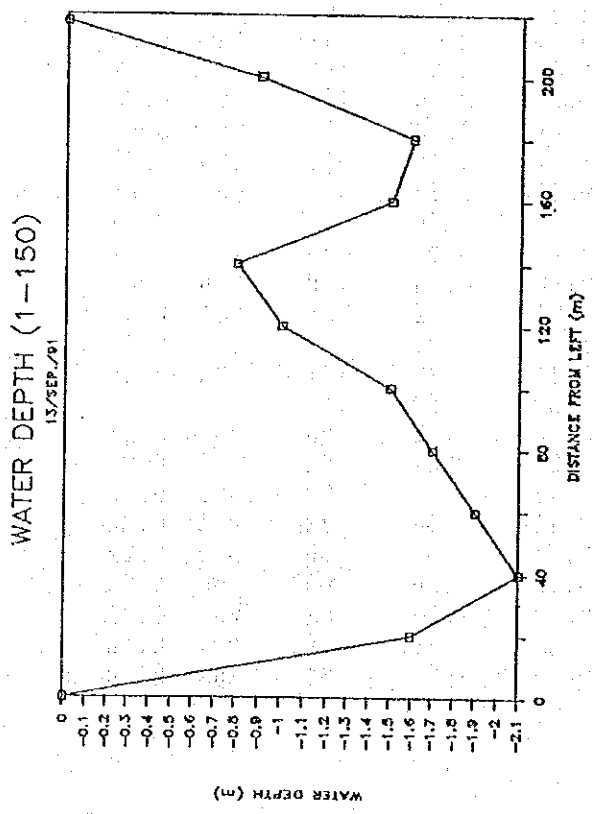
Fig.- 4.1 Database System

Table-4.1 DB-01 : Flow Measurement Data by Measurement

FLOW MEASUREMENT ST. : 1-150 ZAMBEZI PUMP HOUSE 13/SEP./91

ITEMS	NO-L	NO-1	NO-2	NO-3	NO-4	NO-5	NO-6	NO-7	NO-8	NO-9	NO-10	NO-R
WATER DEPTH (m)	0.00	1.60	2.10	1.90	1.70	1.50	1.00	0.80	1.50	1.60	0.90	0.00
SE/WIDTH (m)	0.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	18.00
TOTAL SE/WIDTH(m)	0.00	20.00	40.00	60.00	80.00	100.00	120.00	140.00	160.00	180.00	200.00	218.00
VELOCITY.2-1(f/s)	0.00	0.60	1.20	1.10	1.00	0.90	0.70	0.60	0.40	0.10	0.00	0.00
VELOCITY.2-2(f/s)	0.00	0.60	1.20	1.10	1.00	0.90	0.70	0.60	0.40	0.10	0.00	0.00
MEAN VEL.2 (f/s)	0.00	0.60	1.20	1.10	1.00	0.90	0.70	0.60	0.40	0.10	0.00	0.00
VELOCITY.8-1(f/s)	0.00	0.20	0.90	0.60	0.70	0.60	0.50	0.40	0.05	0.10	0.10	0.00
VELOCITY.8-2(f/s)	0.00	0.20	0.90	0.80	0.70	0.60	0.50	0.40	0.05	0.10	0.05	0.00
MEAN VEL.8 (f/s)	0.00	0.20	0.90	0.70	0.70	0.60	0.50	0.40	0.05	0.10	0.08	0.00
MEAN VEL (f/s)	0.000	0.400	1.050	0.900	0.850	0.750	0.600	0.500	0.225	0.100	0.038	0.000
MEAN VEL (m/s)	0.000	0.122	0.320	0.274	0.259	0.229	0.183	0.152	0.069	0.030	0.011	0.000
L/MEAN DEPTH (m)	0.000	0.800	1.975	1.950	1.750	1.550	1.125	0.850	1.325	1.575	1.075	0.000
L/MEAN WIDTH (m)	0.00	20.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	-
L/SEC. AREA (m2)	0.00	16.00	19.75	19.50	17.50	15.50	11.25	8.50	13.25	15.75	10.75	-
R/MEAN DEPTH (m)	0.000	1.725	2.050	1.850	1.650	1.375	0.950	0.975	1.525	1.425	0.450	-
R/MEAN WIDTH (m)	0.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	18.00	-
R/SEC. AREA (m2)	0.00	17.25	20.50	18.50	16.50	13.75	9.50	9.75	15.25	14.25	8.10	-
S/AREA (m2)	0.00	33.25	40.25	38.00	34.00	29.25	20.75	18.25	28.50	30.00	18.85	-
TOTAL AREA (m2)	0.0	33.3	73.5	111.5	145.5	174.8	195.5	213.8	242.3	272.3	291.1	-
S/DISCHARGE(m3/s)	0.00	4.05	12.88	10.42	8.81	6.69	3.79	2.78	1.95	0.91	0.22	-
TOTAL DIS. (m3/s)	0.00	4.05	16.94	27.36	36.17	42.85	46.65	49.43	51.39	52.30	52.52	-

WATER LEVEL (f) : 2.02 WATER LEVEL (m) : 0.62
TOTAL DISCHARGE (m3/s) : 52.30 MEAN VELOCITY(m/s) : 0.19



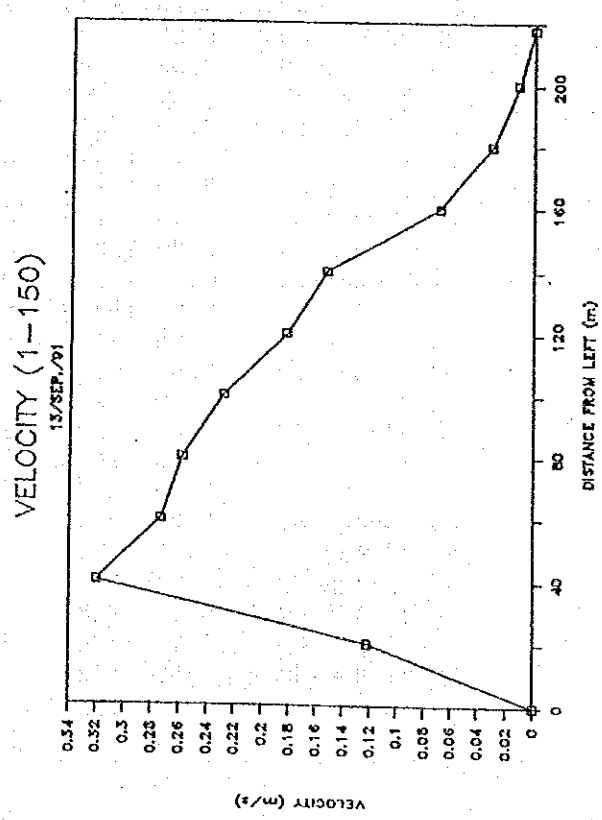


Table-4.2 DB-02 : Flow Measurement Data by Station

LIST OF FLOW MEASUREMENT ST.: 1-950 WATOPA PONTOON

NO.	DATE	------[Feet - Second]----- H (f)	Q (f3/s)	A (f2)	V (f/s)	+++++[Meter - Second]++++ H (m)	Q (m3/s)	A (m2)	V (m/s)
1	26-May-58	6.50	2970	3407	0.87	1.98	84	317	0.27
2	08-Aug-58	5.90	2358	3288	0.72	1.80	67	305	0.22
3	13-Sep-58	5.52	2047	3141	0.65	1.68	58	292	0.20
4	08-Nov-58	6.00	2604	3344	0.76	1.83	74	311	0.23
5	22-Nov-58	6.57	2801	3093	0.91	2.00	79	287	0.28
6	03-Jan-59	9.45	8034	4686	1.71	2.88	227	435	0.52
7	08-Jan-59	10.38	10434	5067	2.06	3.16	295	471	0.63
8	11-Feb-59	12.02	13929	5850	2.38	3.66	394	543	0.73
9	19-Feb-59	12.98	15840	6310	2.51	3.96	449	586	0.77
10	27-Feb-59	14.14	18191	6796	2.68	4.31	515	631	0.82
11	24-Mar-59	14.25	18544	6700	2.77	4.34	525	622	0.84
12	26-Mar-59	13.63	16923	6430	3.83	4.15	479	597	1.17
13	27-Mar-59	13.35	16413	6312	2.60	4.07	465	586	0.79
14	11-Apr-59	10.73	10374	5060	2.05	3.27	294	470	0.62
15	16-Apr-59	10.19	9303	4860	1.91	3.11	263	452	0.58
16	18-Apr-59	9.90	8716	4745	1.84	3.02	247	441	0.56
17	14-May-59	7.63	4720	3875	1.22	2.33	134	360	0.37
18	30-May-59	6.85	3368	3574	0.94	2.09	95	332	0.29
19	19-Jun-59	6.38	2920	3490	0.84	1.94	83	324	0.26
20	30-Jun-59	6.27	2840	3420	0.83	1.91	80	318	0.25
21	10-Jul-59	6.43	2705	3390	0.80	1.96	77	315	0.24
22	22-Jul-59	6.02	2425	3350	0.72	1.83	69	311	0.22
23	25-Jul-59	6.00	2415	3295	0.73	1.83	68	306	0.22
24	29-Sep-59	5.27	1643	3061	0.54	1.61	47	284	0.16
25	15-Oct-59	5.10	1580	3014	0.53	1.55	45	280	0.16
26	17-Oct-59	5.09	1310	2965	0.44	1.55	37	275	0.13
27	20-Nov-59	5.36	1690	3075	0.55	1.63	48	286	0.17
28	28-Nov-59	5.76	2080	3320	0.65	1.76	59	308	0.20
29	20-Dec-59	6.83	3436	3655	0.94	2.08	97	340	0.29
30	22-Jan-60	8.35	5699	4148	1.37	2.55	161	385	0.42
31	27-Jan-60	8.07	5081	4095	1.24	2.46	144	380	0.38
32	16-Feb-60	9.90	8254	4818	1.71	3.02	234	448	0.52
33	24-Feb-60	11.71	12042	5631	2.14	3.57	341	523	0.65
34	29-Feb-60	12.20	13136	5854	2.24	3.72	372	544	0.68
35	09-Mar-60	14.45	18130	6810	2.77	4.40	513	633	0.84
36	18-Mar-60	16.20	22350	8175	2.74	4.94	633	759	0.84
37	31-Mar-60	18.83	26800	9560	2.80	5.74	759	888	0.85
38	22-Apr-60	10.90	10260	5426	1.89	3.32	291	504	0.58
39	29-Apr-60	9.85	8170	4723	1.73	3.00	231	439	0.53
40	12-May-60	8.86	6391	4336	1.47	2.70	181	403	0.45
41	21-May-60	8.20	5222	4073	1.28	2.50	148	378	0.39
42	02-Jul-60	6.80	3185	3588	0.89	2.07	90	333	0.27
43	15-Jul-60	6.60	2952	3482	0.85	2.01	84	323	0.26
44	27-Jul-60	6.40	2536	3320	0.77	1.95	72	308	0.23
45	29-Jul-60	6.36	2548	3402	0.75	1.94	72	316	0.23
46	19-Aug-60	6.10	2295	3228	0.71	1.86	65	300	0.22
47	24-Aug-60	6.05	2322	3232	0.72	1.84	66	300	0.22
48	21-Aug-60	5.90	2181	3199	0.68	1.80	62	297	0.21
49	14-Sep-60	5.70	1951	3133	0.62	1.74	55	291	0.19
50	23-Sep-60	5.57	1827	3064	0.60	1.70	52	285	0.18

Table-4.3 DB-05A : Daily River Water Level

IIF 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	27.56	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

IIM 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	1.79	2.49	4.88	20.23	25.20	19.49	13.85	7.27	4.55	2.17	2.38	
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		2.88	1.66	1.14	0.81	0.59	
19	0.56	0.55	1.29	3.08	8.43	5.97		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	MAX.:
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	25.20
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	MIN.:
30	0.54	0.75	1.47	5.46		6.03	4.30	2.29	1.41	0.99	0.73	0.54	0.50
31	0.54		1.48	5.79		5.99		2.25		0.98	0.73		
M.	.58	0.62	1.24	3.18	8.23	6.95	6.04	3.41	1.93	1.27	0.83	0.67	2.91
MAX.	0.64	1.79	2.49	5.79	20.23	25.20	19.49	13.85	7.27	4.55	2.17	2.38	25.20
MIN.	0.54	0.50	0.77	1.50	6.28	5.85	4.30	2.25	1.41	0.98	0.62	0.54	0.50

Table-4.4 DB-06A : Hourly River Water Level

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

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	16.41	16.15	15.84	15.65	15.52	15.79	16.20	15.89	16.06	16.05	16.07	16.20	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	
2	16.40	16.14	15.83	15.65	15.52	15.83	16.19	15.89	16.06	16.04	16.07	16.20	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	
3	16.39	16.13	15.82	15.64	15.52	15.87	16.17	15.89	16.06	16.04	16.07	16.20	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	
4	16.37	16.10	15.80	15.63	15.52	15.90	16.16	15.89	16.06	16.04	16.08	16.20	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	
5	16.36	16.08	15.79	15.63	15.51	15.94	16.14	15.89	16.05	16.04	16.09	17.49	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	
6	16.35	16.07	15.79	15.62	15.51	15.97	16.13	15.89	16.05	16.04	16.10	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	
7	16.33	16.06	15.77	15.60	15.50	16.00	16.12	15.90	16.04	16.03	16.10	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	
8	16.32	16.04	15.76	15.60	15.50	16.04	16.10	15.91	16.04	16.03	16.10	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	
9	16.31	16.04	15.75	15.60	15.50	16.06	16.08	15.92	16.05	16.03	16.12	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	
10	16.30	16.03	15.75	15.60	15.50	16.10	16.06	15.94	16.06	16.04	16.13	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	
11	16.30	16.01	15.75	15.60	15.50	16.13	16.05	15.95	16.05	16.04	16.14	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	
12	16.30	16.00	15.74	15.60	15.50	16.15	16.03	15.95	16.05	16.04	16.15	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	
13	16.30	16.00	15.73	15.59	15.50	16.17	16.00	15.96	16.06	16.04	16.15	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	
14	16.29	15.99	15.73	15.57	15.50	16.18	15.99	15.96	16.06	16.05	16.17	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	
15	16.27	15.98	15.72	15.56	15.52	16.20	15.97	15.98	16.05	16.05	16.17	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	
16	16.26	15.97	15.70	15.56	15.52	16.21	15.95	16.00	16.05	16.05	16.17	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	
17	16.25	15.95	15.70	15.56	15.54	16.23	15.94	16.03	16.05	16.05	16.18	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	
18	16.25	15.94	15.68	15.55	15.55	16.23	15.92	16.04	16.05	16.05	16.19	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	
19	16.23	15.91	15.67	15.55	15.56	16.23	15.90	16.05	16.05	16.05	16.19	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	
20	16.22	15.90	15.67	15.54	15.58	16.23	15.90	16.06	16.05	16.05	16.20	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	
21	16.20	15.89	15.67	15.54	15.63	16.23	15.90	16.06	16.05	16.05	16.20	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	
22	16.19	15.87	15.66	15.54	15.66	16.23	15.90	16.07	16.05	16.06	16.20	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	
23	16.17	15.86	15.65	15.53	15.70	16.22	15.90	16.06	16.05	16.06	16.20	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	
24	16.16	15.85	15.65	15.52	15.75	16.22	15.90	16.06	16.05	16.06	16.20	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	
MEAN	16.29	16.00	15.73	15.58	15.55	16.10	16.03	15.97	16.05	16.05	16.14	15.54	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	
MAX.	16.41	16.15	15.84	15.65	15.75	16.23	16.20	16.07	16.06	16.06	16.20	17.49	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	
MIN.	16.16	15.85	15.65	15.52	15.50	15.79	15.90	15.89	16.04	16.03	16.07	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30	

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	4.94	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	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	
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	4.66	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	
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	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	
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	4.66	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	
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	4.66	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	
6	4.98	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	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	
7	4.98	4.90	4.81	4.75	4.72	4.88	4.91	4.85	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	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	
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	4.66	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	
9	4.97	4.89	4.80	4.75	4.72	4.90	4.90	4.85	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	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	
10	4.97	4.89	4.80	4.75	4.72	4.91	4.90	4.86	4.90	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	
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	4.88	4.86	4.90	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	
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	4.96	4.87	4.79	4.74	4.73	4.94	4.86	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	4.86	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	4.66	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	
19	4.95	4.85	4.78	4.74	4.74	4.95	4.85	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	
20	4.94	4.85	4.78	4.74	4.75	4.95	4.85	4.90	4.89	4.89	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	4.66	4.66	
21	4.94	4.84	4.78	4.74	4.76	4.95	4.85	4.90	4.89	4.89	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	4.66	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	4.66	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	4.66	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	
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	4.66	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	
MEAN	4.96	4.88	4.80	4.75	4.74	4.91	4.88	4.87	4.89	4.89	4.92	4.74	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	
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	4.66	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	

Table-4.5 DB-11 : Daily Well Water Level

WWLm Well No1 Kanyilaba 1990/91 Morning [Water Level (m)]

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	ANNUAL
1	8.61	9.05	9.37	9.70	7.14	4.97	4.76	5.26	5.82	6.43	7.16	7.73	
2	8.62	9.06	9.39	9.64	7.08	4.94	4.79	5.25	5.86	6.47	7.16	7.75	
3	8.62	9.09	9.39	9.67	7.05	4.94	4.79	5.23	5.88	6.49	7.17	7.77	
4	8.65	9.10	9.41	9.70	7.06	4.95	4.81	5.29	5.86	6.50	7.20	7.80	
5	8.64	9.09	9.43	9.67	7.02	4.95	4.82	5.32	5.89	5.53	7.22	7.81	
6	8.64	9.08	9.41	9.72	6.85	4.95	4.81	5.36	5.93	6.57	7.25	7.82	
7	8.67	9.09	9.45	9.68	6.55	4.96	4.83	5.32	5.95	6.61	7.25	7.81	
8	8.66	9.11	9.46	9.66	6.33	4.97	4.79	5.37	5.94	6.64	7.24	7.86	
9	8.75	9.13	9.47	9.59	6.08	4.99	4.81	5.38	5.96	6.67	7.29	7.87	
10	8.72	9.12	9.47	9.48	6.00	4.98	4.82	5.41	5.98	6.66	7.31	7.89	
11	8.73	9.19	9.47	9.48	5.85	4.98	4.87	5.41	5.96	6.69	7.36	7.91	
12	8.75	9.21	9.51	9.51	5.78	5.01	4.87	5.44	5.94	6.70	7.36	7.93	
13	8.75	9.21	9.50	9.49	5.67	5.00	4.92	5.45	6.00	6.70	7.38	7.91	
14	8.78	9.20	9.52	9.52	5.56	5.02	4.93	5.48	6.07	6.69	7.39	7.96	
15	8.78	9.17	9.53	9.49	5.31	5.04	4.94	5.50	6.09	6.80	7.40	7.98	
16	8.80	9.22	9.56	9.54	5.17	5.02	4.96	5.50	6.12	6.82	7.46	8.00	
17	8.82	9.20	9.52	9.59	5.09	5.04	4.93	5.52	6.13	6.84	7.44	8.00	
18	8.84	9.27	9.40	9.66	5.06	5.05	5.01	5.54	6.13	6.86	7.45	8.02	
19	8.84	9.31	9.57	9.56	5.05	5.03	5.06	5.56	6.16	6.86	7.48	8.05	
20	8.85	9.25	9.55	9.58	4.99	5.09	5.05	5.58	6.19	6.87	7.56	8.07	
21	8.87	9.34	9.53	9.32	4.99	5.07	5.03	5.60	6.22	6.86	7.55	8.08	
22	8.89	9.27	9.56	8.80	4.98	5.12	5.07	5.55	6.24	6.89	7.57	8.10	
23	8.91	9.28	9.57	8.37	4.97	5.09	5.09	5.66	6.25	6.92	7.58	8.11	
24	8.91	9.29	9.57	8.09	5.00	5.13	5.12	5.62	6.28	6.95	7.60	8.13	
25	8.90	9.31	9.65	7.84	4.98	5.10	5.14	5.67	6.33	6.98	7.62	8.15	
26	8.95	9.29	9.64	7.72	4.95	5.11	5.14	5.70	6.36	7.01	7.63	8.17	
27	8.95	9.32	9.68	7.69	4.94	4.92	5.16	5.72	6.39	7.03	7.65	8.21	
28	8.95	9.34	9.66	7.71	4.97	4.82	5.17	5.72	6.41	7.06	7.66	8.24	
29	8.97	9.35	9.66	7.68		4.80	5.21	5.75	6.41	7.08	7.68	8.26	
30	9.00	9.34	9.64	7.57		4.78	5.21	5.78	6.40	7.11	7.70	8.25	
31	9.02		9.67	7.25		4.77		5.80		7.14	7.76		
MEAN	8.80	9.21	9.52	9.03	5.73	4.99	4.96	5.51	6.11	6.76	7.44	7.99	7.18
MAX.	9.02	9.35	9.68	9.72	7.14	5.13	5.21	5.80	6.41	7.14	7.76	8.26	9.72
MIN.	8.61	9.05	9.37	7.25	4.94	4.77	4.76	5.23	5.82	5.53	7.16	7.73	4.76

WWLe Well No1 Kanyilaba 1990/91 Evening [Water Level (m)]

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	ANNUAL
1	8.99	9.50	9.83	9.86	7.50	5.08	4.93	5.45	6.08	6.85	7.63	8.12	
2	8.96	9.57	9.87	9.80	7.29	4.99	4.95	5.39	6.15	6.81	7.61	8.22	
3	9.23	9.48	9.85	9.87	7.31	5.12	4.96	5.52	6.12	6.84	7.67	8.27	
4	9.06	9.54	9.86	9.82	7.21	5.07	4.99	5.51	6.13	6.89	7.71	8.32	
5	8.66	9.65		9.76	7.13	5.05	4.88	5.49	6.17	6.95	7.69	8.25	
6	9.09	9.58		9.86	6.99	5.04	5.01	5.58	6.15	6.91	7.68	8.50	
7	9.13	9.59		9.83	6.60	5.09	5.03	5.57	6.21	6.89	7.73	8.46	
8	8.87	9.56		9.80	6.37	5.06	5.04	5.55	6.19	7.07	7.77	8.50	
9	9.00	9.55		9.78	6.25	5.10	5.03	5.59	6.32	7.10	7.70	8.54	
10	8.97	9.64		9.73	6.03	5.07	5.01	5.57	6.35	7.14	7.69	8.45	
11	9.02	9.65		9.76	6.01	5.18	5.01	5.61	6.33	7.16	7.67	8.51	
12	9.18	9.69		9.87	5.85	5.12	5.02	5.65	6.35	7.19	7.76	8.53	
13	9.16	9.65		9.78	5.73	5.18	5.07	5.61	6.38	7.11	7.79	8.27	
14	9.25	9.67		9.73	5.57	5.14	5.06	5.59	6.37	7.23	7.83	8.40	
15	9.24	9.64		9.75	5.31	5.20	5.12	5.66	6.32	7.26	7.78	8.56	
16	9.25	9.62		9.82	5.13	5.19	5.11	5.70	6.39	7.29	7.81	8.43	
17	9.27	9.77		9.85	5.17	5.21	5.13	5.68	6.41	7.28	7.85	8.54	
18	9.23	9.62		9.71	5.22	5.20	5.17	5.73	6.44	7.22	7.91	8.66	
19	9.28	9.67		9.73	5.14	5.21	5.12	5.81	6.48	7.31	7.84	8.68	
20	9.31	9.87		9.66	5.24	5.27	5.21	5.72	6.41	7.29	7.86	8.70	
21	9.22	9.75		9.35	5.18	5.19	5.19	5.79	6.47	7.33	7.95	8.73	
22	9.29	9.75		9.39	5.19	5.31	5.23	5.82	6.51	7.37	7.93	8.71	
23	9.27	9.67		8.65	5.13	5.25	5.31	5.82	6.60	7.33	7.82	8.82	
24	9.28	9.81		8.40	5.07	5.29	5.24	5.86	6.69	7.39	7.99	8.76	
25	9.33	9.73		8.33	4.99	5.29	5.26	5.87	6.73	7.43	7.97	8.80	
26	9.36	9.78		8.17	5.15	5.23	5.30	5.89	6.76	7.47	8.00	8.77	
27	9.28	9.81		7.89	5.14	5.03	5.31	5.93	6.81	7.47	8.06	8.95	
28	9.41	9.83		8.05	5.11	4.96	5.41	6.00	6.79	7.51	7.99	8.79	
29	9.33	9.75		7.90		4.87	5.42	6.05	6.84	7.49	8.05	8.86	
30	9.39	9.79		7.73		4.93	5.45	6.09	6.88	7.58	8.48	8.89	
31	9.36			7.49		4.95		6.06		7.60	8.54		
MEAN	9.18	9.67	9.85	9.26	5.86	5.12	5.13	5.71	6.43	7.22	7.86	8.57	7.32
MAX.	9.41	9.87	9.87	9.87	7.50	5.31	5.45	6.09	6.88	7.60	8.54	8.95	9.87
MIN.	8.66	9.48	9.83	7.49	4.99	4.87	4.88	5.39	6.08	6.81	7.61	8.12	4.87

Table-4.6 DB-03 : Discharge Rating Curve (Type-1)

4-941 KALEYA DAM SITE <<< H - A - V - Q CALCULATION >>>

n = 0.03000 i = 1/2500

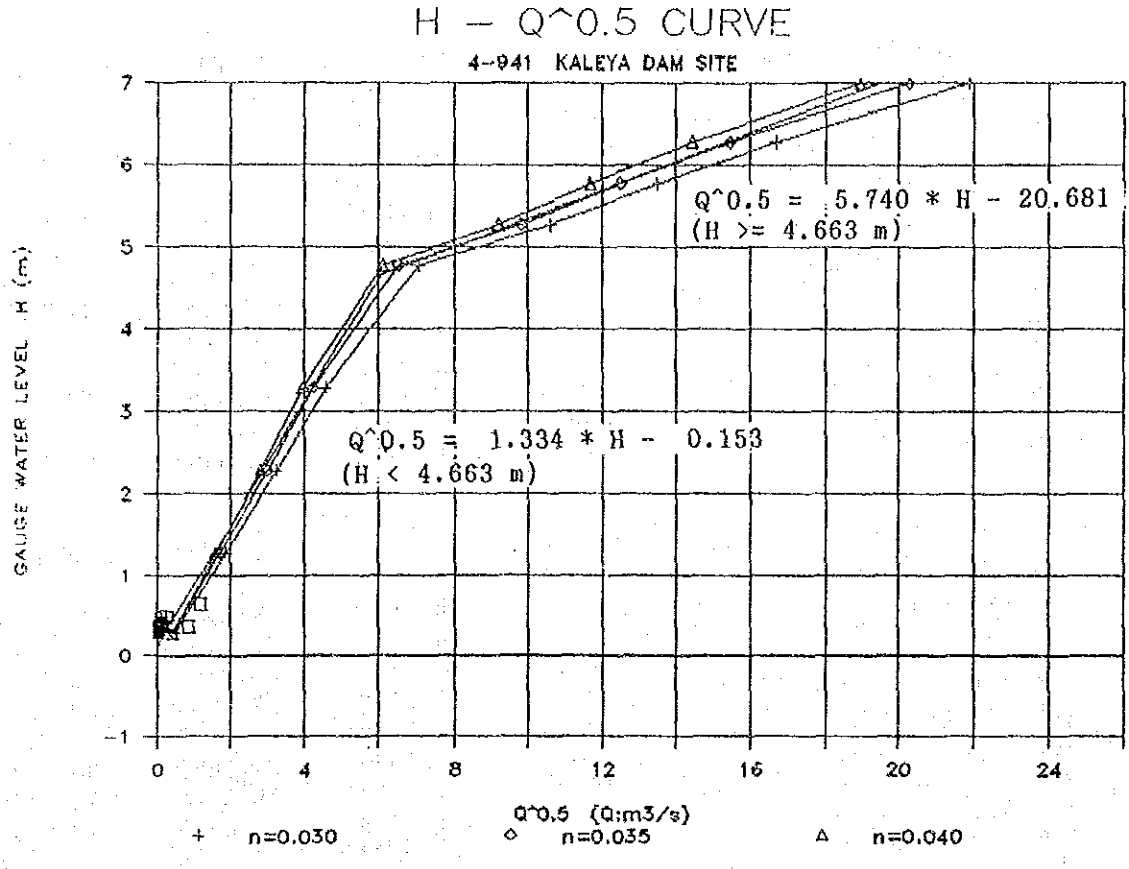
h(m)	H(m)	A(m2)	S(m)	R(m)	V(m/s)	Q(m3/s)	Q^0.5
1,243.00	0.28	0.94	4.06	0.23	0.25	0.24	0.49
1,244.00	1.28	5.76	6.85	0.84	0.59	3.42	1.85
1,245.00	2.28	13.35	10.24	1.30	0.80	10.62	3.26
1,246.00	3.28	22.06	12.94	1.70	0.95	20.99	4.58
1,247.50	4.78	91.30	123.35	0.74	0.55	49.80	7.06
1,248.00	5.28	152.14	129.26	1.18	0.74	113.07	10.63
1,248.50	5.78	215.20	149.61	1.44	0.85	182.82	13.52
1,249.00	6.28	293.57	173.36	1.69	0.95	278.05	16.67
1,249.72	7.00	430.46	199.81	2.15	1.11	478.68	21.88

n = 0.03500 i = 1/2500

h(m)	H(m)	A(m2)	S(m)	R(m)	V(m/s)	Q(m3/s)	Q^0.5
1,243.00	0.28	0.94	4.06	0.23	0.22	0.20	0.45
1,244.00	1.28	5.76	6.85	0.84	0.51	2.93	1.71
1,245.00	2.28	13.35	10.24	1.30	0.68	9.10	3.02
1,246.00	3.28	22.06	12.94	1.70	0.82	17.99	4.24
1,247.50	4.78	91.30	123.35	0.74	0.47	42.69	6.53
1,248.00	5.28	152.14	129.26	1.18	0.64	96.92	9.84
1,248.50	5.78	215.20	149.61	1.44	0.73	156.70	12.52
1,249.00	6.28	293.57	173.36	1.69	0.81	238.33	15.44
1,249.72	7.00	430.46	199.81	2.15	0.95	410.29	20.26

n = 0.04000 i = 1/2500

h(m)	H(m)	A(m2)	S(m)	R(m)	V(m/s)	Q(m3/s)	Q^0.5
1,243.00	0.28	0.94	4.06	0.23	0.19	0.18	0.42
1,244.00	1.28	5.76	6.85	0.84	0.45	2.56	1.60
1,245.00	2.28	13.35	10.24	1.30	0.60	7.97	2.82
1,246.00	3.28	22.06	12.94	1.70	0.71	15.74	3.97
1,247.50	4.78	91.30	123.35	0.74	0.41	37.35	6.11
1,248.00	5.28	152.14	129.26	1.18	0.56	84.80	9.21
1,248.50	5.78	215.20	149.61	1.44	0.64	137.11	11.71
1,249.00	6.28	293.57	173.36	1.69	0.71	208.54	14.44
1,249.72	7.00	430.46	199.81	2.15	0.83	359.01	18.95



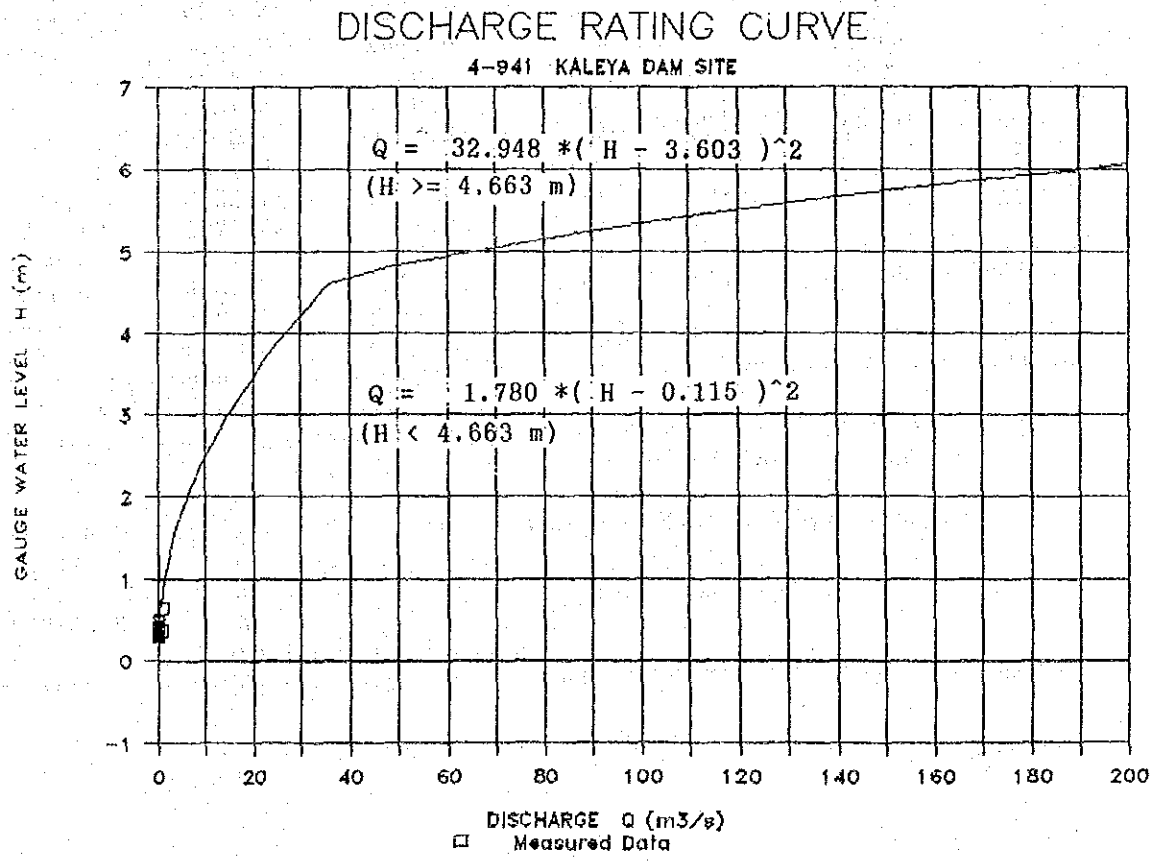


Fig.- 4.2 DB-03 : Discharge Rating Curve (Type-1)

Table-4.7 DB-04 : Discharge Rating Curve (Type-2)

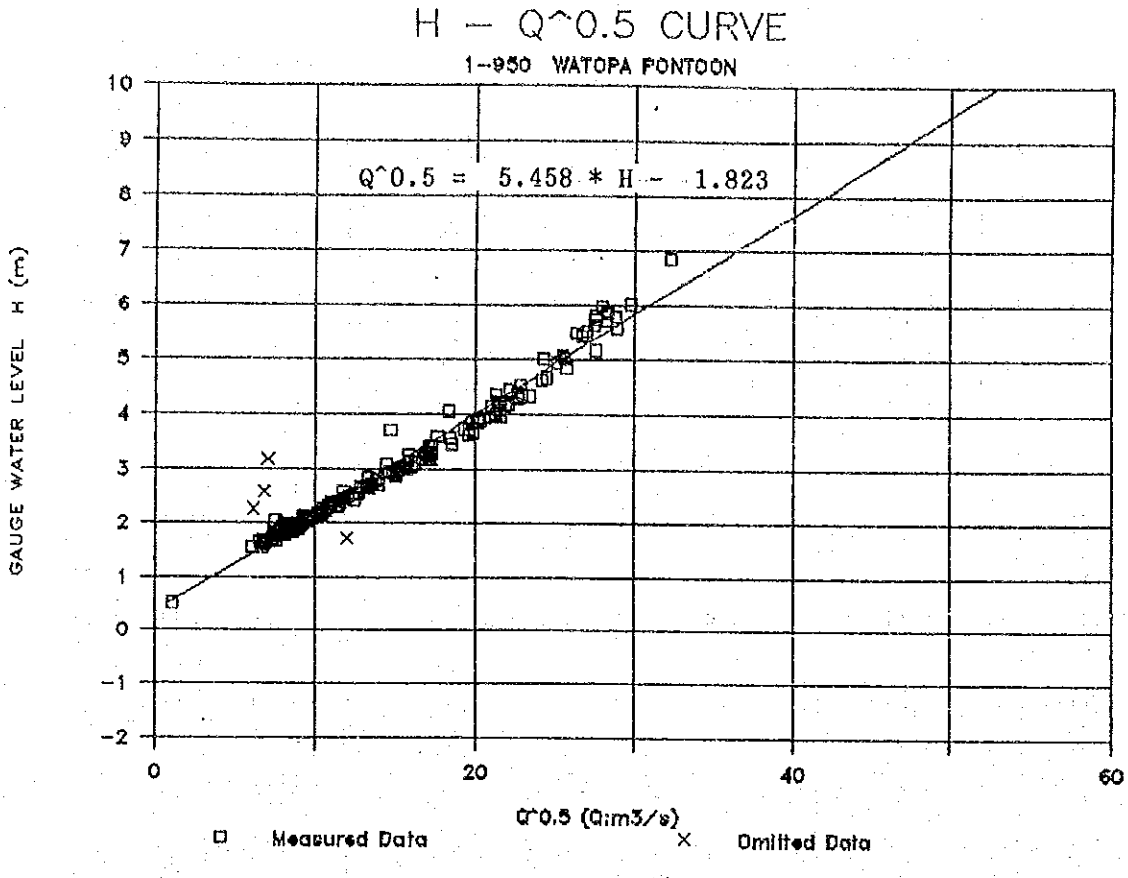
DISCHARGE RATING CURVE STATION: 1-950 WATOPA PONTOON

	NO.	DATE	H(m)	Q(m3/s)	H^2.0	Q^0.5	H*Q^0.5
1	1	58/ 5/26	1.98	84.1	3.9252	9.1707	18.1689
2	2	8/ 8	1.80	66.8	3.2340	8.1714	14.6947
3	3	9/13	1.68	58.0	2.8308	7.6134	12.8096
4	4	11/ 8	1.83	73.7	3.3445	8.5870	15.7040
5	5	11/22	2.00	79.3	4.0102	8.9059	17.8344
6	6	59/ 1/ 3	2.88	227.5	8.2965	15.0830	43.4445
7	7	1/ 8	3.16	295.5	10.0098	17.1889	54.3826
8	8	2/11	3.66	394.4	13.4227	19.8601	72.7615
9	9	2/19	3.96	448.5	15.6523	21.1787	83.7895
10	10	2/27	4.31	515.1	18.5750	22.6961	97.8172
160	162	82/10/22	1.98	73.0	3.9252	8.5441	16.9275
161	163	12/13	2.96	223.0	8.7412	14.9340	44.1532
162	164	83/ 3/21	3.85	393.0	14.7961	19.8252	76.2591
163	165	3/22	3.93	410.1	15.4840	20.2498	79.6825
164	167	84/ 2/26	3.27	286.0	10.7161	16.9124	55.3635
165	168	3/ 2	3.44	298.0	11.7999	17.2637	59.3024
166	170	85/ 3/12	3.92	424.0	15.3643	20.5923	80.7164
167	171	4/23	3.96	466.1	15.7006	21.5886	85.5426
168	172	86/ 8/ 8	2.18	107.0	4.7494	10.3445	22.5440
169	173	9/ 8	1.95	78.0	3.8053	8.8325	17.2297
170	174	89/10/ 6	0.51	1.3	0.2622	1.1396	0.5835
171	175	90/ 2/ 9	3.03	257.3	9.1809	16.0406	48.6029
172	176	3/ 8	3.26	251.3	10.6276	15.8531	51.6810
173	177	5/ 8	3.03	257.3	9.1809	16.0406	48.6029
174	178	6/26	2.13	87.0	4.5369	9.3247	19.8616
175	179	7/29	2.01	65.6	4.0401	8.1019	16.2847
176	180	8/22	1.92	55.3	3.6864	7.4351	14.2753
177	181	9/26	1.71	46.0	2.9241	6.7853	11.6028
178	182	10/25	1.70	49.9	2.8900	7.0626	12.0064
179	183	12/ 6	1.88	66.9	3.5344	8.1786	15.3758
180	184	91/ 1/12	3.08	211.7	9.4864	14.5509	44.8169
181	185	2/ 4	4.29	514.1	18.4041	22.6740	97.2714
OMIT	157	79/11/12	2.27	37.9	5.1564	6.1553	13.9773
OMIT	158	80/ 5/23	3.18	50.0	10.1064	7.0696	22.4747
OMIT	169	6/ 7	2.59	46.4	6.7122	6.8084	17.6393
OMIT	166	4/ 9	1.73	145.0	2.9973	12.0420	20.8479
		T O T A L	548.97	46401	1895.2297	2666.2666	9343.3469

DISCHARGE - RATING CURVE : $Q = a * (H + b)^2$

(where, OMIT : Omitted data)

a' = 5.458147
b' = -1.823601
a = 29.791368
b = -0.261824
Correlation Coefficient 0.981



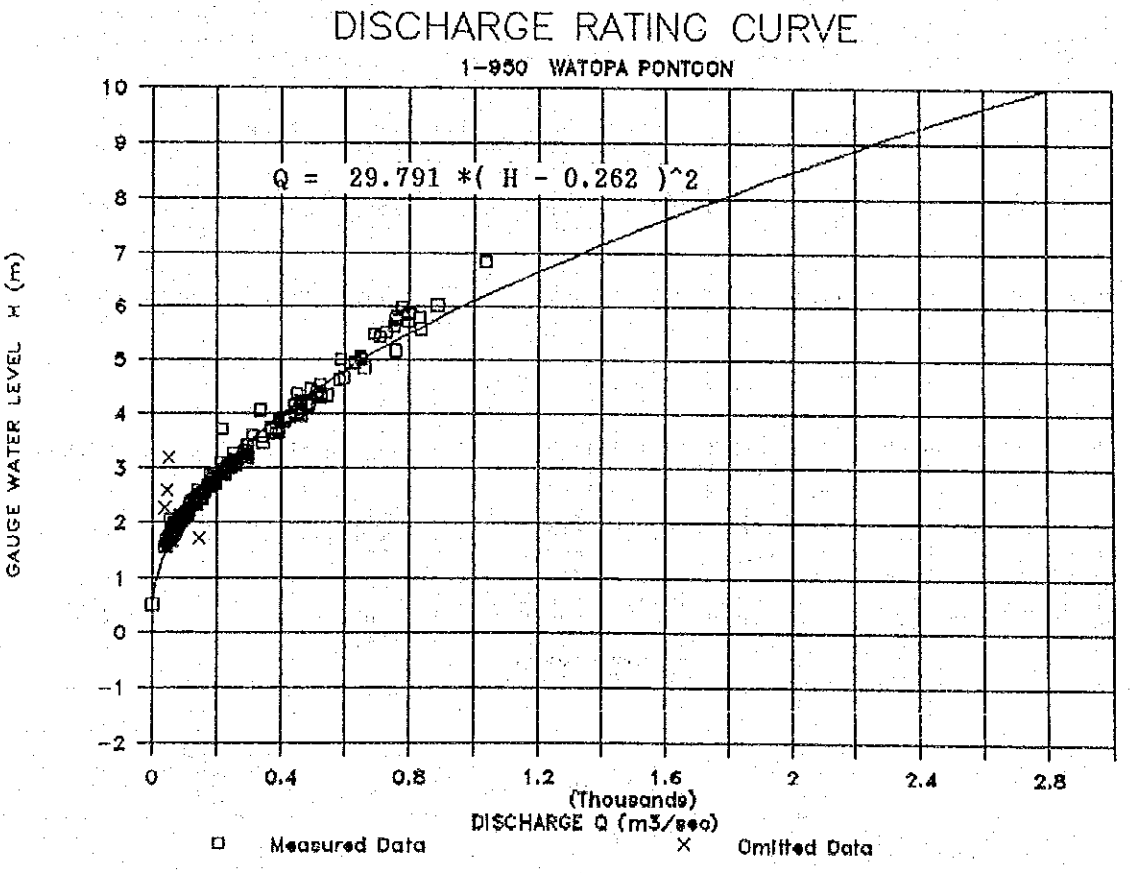


Fig.- 4.3 DB-04 : Discharge Rating Curve (Type-2)

Table-4.8 DB-05B : Daily Discharge

<<< M/[illegible] PROGRAM for DB-05(Normal Year):Daily River W/L & 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

Table-4.9 DB-06B : Hourly 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	4.94	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	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	
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	4.66	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	
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	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	
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	4.66	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	
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	4.66	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	
6	4.98	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	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	
7	4.98	4.90	4.81	4.75	4.72	4.88	4.91	4.85	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	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	
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	4.66	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	
9	4.97	4.89	4.80	4.75	4.72	4.90	4.90	4.85	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	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	
10	4.97	4.89	4.80	4.75	4.72	4.91	4.90	4.86	4.90	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	
11	4.97	4.88	4.80	4.75	4.72	4.92	4.89	4.85	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	4.88	4.86	4.90	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	
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	4.86	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	4.86	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	4.66	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	
19	4.95	4.85	4.78	4.74	4.74	4.95	4.85	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	
20	4.94	4.85	4.78	4.74	4.75	4.95	4.85	4.90	4.89	4.89	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	4.66	4.66	
21	4.94	4.84	4.78	4.74	4.76	4.95	4.85	4.90	4.89	4.89	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	4.66	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	4.66	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	4.66	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	
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	4.66	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	
MEAN	4.96	4.88	4.80	4.75	4.74	4.91	4.88	4.87	4.89	4.89	4.92	4.74	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	
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	4.66	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	

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	163.5	158.5	152.7	149.2	146.8	151.8	159.4	153.6	156.8	156.6	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	163.3	158.3	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	163.1	158.1	152.3	149.0	146.8	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	162.5	157.2	151.8	148.8	146.6	154.5	158.3	153.6	156.6	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	162.3	157.0	151.8	148.6	146.6	155.1	158.1	153.6	156.6	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	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	
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	156.4	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	156.4	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	
14	161.2	155.5	150.6	147.7	146.4	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	159.9	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	160.0	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.	163.5	158.5	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	

Table-4.10 DB-07 : Discharge Correlation Curve

<<< MASTER PROGRAM FOR DB-7:REGRESSION CURVE >>>

MONTHLY DISCHARGE CORELATION BETWEEN STATIONS X and Y
X: NO.04 2-030 LUKULU
Y: NO.01 1-150 ZAMBEZI PUMP HOUSE (DISCHARGE UNIT : m3/s)

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

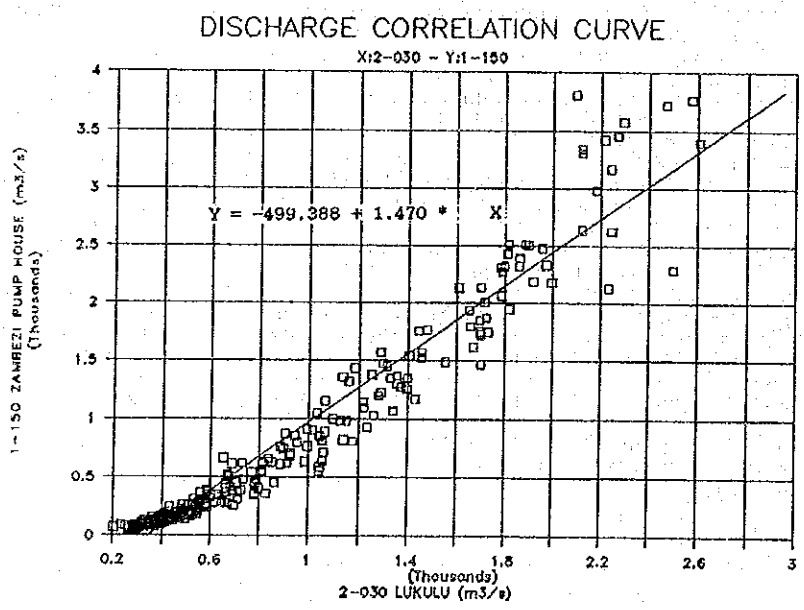


Fig.-4.4 DB-07 : Discharge Correlation Curve

Table-4.11 DB-08 : Flow Regime Table

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	1231.1	381.6	173.6	92.7	1180.3
11	1969/70	1040.9	336.0	175.7	106.5	978.4
12	1970/71	1023.1	304.5	139.7	99.3	705.8
13	1971/72	513.7	241.9	130.4	86.6	422.2
14	1972/73	512.3	196.7	107.8	71.7	412.0
15	1973/74	988.8	208.1	97.8	68.1	578.5
16	1974/75	1495.1	307.2	119.7	68.1	828.0
17	1975/76	1333.8	254.5	115.6	73.3	850.1
18	1976/77	1156.4	281.8	149.3	106.2	695.1
19	1977/78	874.9	322.5	121.7	80.9	865.9
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	978.2	258.0	121.1	77.4	692.9

Table-4.12 DB-09 : Annual Mean Discharge

Annual Mean Discharge (12 Years : 1979/80 - 1990/91)

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	688	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	182	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	205,531	1003	795	578	637	594	626	628	708	671	871	514	670	691
"	"	(12)		Zambezi R. Portion	228,076	1031	833	629	645	639	700	674	780	722	896	566	690	734
"	"	(13)	2-250	St. Kalabo	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	50	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. Raglan 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. Machiya 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. Chilenga	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)	4-550	St. Chifumpa Pontoon	21,445	145	125	56	44	51	90	105	74	89	71	54	68	81
"	"	(33)		Lunga 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	815	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	967	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	308	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

Table-4.13 DB-09 : Monthly Mean Discharge

[Normal Year] : 1990/91 1990/91

AREAS	BASINS	No.	ST.	POINT & STATION NAME	AREA(km2)	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	<MEAN>
UPPER ZAMBEZI		(1)		Cholose	73,512	60	60	112	408	1688	1211	965	385	176	110	76	63	434
"	"	(2)	1-150	St. Zambezi Pump House	87,275	71	71	133	485	2005	1437	1145	457	209	130	90	74	515
"	"	(3)		Zambezi R. Portion	90,353	74	73	138	502	2075	1488	1186	473	216	135	93	77	533
"	"	(4)	1-650	St. Kabompo Boma	42,740	51	46	91	230	415	400	330	147	108	95	84	64	170
"	"	(5)		Kabompo R. Portion	45,029	53	47	91	236	431	401	333	147	111	98	84	65	173
"	"	(6)		Dongwe R. Portion	20,568	11	12	5	55	144	14	24	5	22	22	1	5	26
"	"	(7)		Confluence	65,597	64	59	96	291	575	415	357	153	132	119	85	69	199
"	"	(8)	1-950	St. Watopa Pontoon	66,449	64	60	96	293	580	416	358	153	133	120	85	70	200
"	"	(9)		Kabompo R. Portion	72,347	67	63	97	309	622	420	365	154	139	126	85	71	207
"	"	(10)		Confluence	162,700	141	137	235	810	2697	1908	1551	628	356	261	178	148	740
"	"	(11)	2-030	St. Lukulu	206,531	282	280	361	700	1619	1415	1185	777	498	342	305	273	663
"	"	(12)		Zambezi R. Portion	228,076	283	278	360	579	1311	1247	1422	1132	661	392	332	289	686
"	"	(13)	2-250	St. Kalabo	34,621	11	8	8	11	84	103	87	58	41	28	19	13	39
"	"	(14)		Luanginga R. Portion	41,233	11	7	8	-26	-11	52	159	167	91	43	28	18	46
"	"	(15)		Confluence	269,309	294	285	368	553	1300	1299	1581	1299	752	435	360	307	731
"	"	(16)	2-400	St. Senanga	278,298	294	284	367	502	1171	1229	1680	1447	819	455	371	314	741
"	KAFUE	(21)	4-050	St. Raglan Farm	4,999	2	2	3	14	58	66	58	27	12	7	5	3	21
"	"	(22)		Kafue R. Portion	7,730	6	6	11	76	137	151	122	64	31	20	15	9	54
"	"	(23)	4-120	St. Mwambashi	869	1	1	2	12	15	14	9	4	2	2	2	1	5
"	"	(24)	4-130	St. Smith's Bridge	8,599	7	7	13	87	152	164	131	67	33	22	16	11	59
"	"	(25)	4-200	St. Mpatamato	11,655	11	10	27	144	246	192	144	70	40	27	21	15	78
"	"	(26)	4-280	St. Machiya Ferry	22,920	13	12	26	141	342	262	227	98	52	39	32	26	104
"	"	(27)		Kafue R. Portion	24,582	14	13	26	139	341	273	237	106	55	40	33	26	107
"	"	(28)		Luswishi R. Portion	8,866	5	3	0	-6	-4	59	51	41	14	6	4	0	15
"	"	(29)		Confluence	33,448	19	16	26	134	337	332	288	147	69	46	37	26	121
"	"	(30)	4-350	St. Chilenga	34,162	19	17	26	133	336	337	292	150	70	46	37	26	123
"	"	(31)	4-450	St. Lubungu	54,442	19	18	24	115	290	326	240	142	75	53	38	26	113
"	"	(32)	4-560	St. Chifumpa Pontoon	21,445	23	21	28	89	221	146	103	52	39	34	30	26	67
"	"	(33)		Lunga R. Portion	24,416	23	20	32	102	216	147	110	56	42	35	32	27	69
"	"	(34)		Confluence	78,858	42	38	56	217	506	473	350	197	117	88	70	53	182
"	"	(35)	4-669	St. Kafue Hook Bridge	95,053	41	34	74	286	480	477	391	219	133	90	76	60	195
LOWER ZAMBEZI		(17)		Livingstone	466,324	265	244	341	582	950	1994	2237	1914	1228	570	403	292	917
"	"	(18)		In (Kariba Dam)	608,634	630	673	693	1121	1428	2470	2217	1765	1103	526	475	547	1135
"	"	(18E)		Evaporation	—	577	584	375	268	147	334	335	275	253	257	317	425	347
"	"	(18S)		Storage	—	-768	-885	-490	0	422	1258	947	552	-152	-735	-751	-773	-118
"	"	(19)		Out (Kariba Dam)	—	821	974	808	853	859	878	936	938	1002	1004	909	896	906
"	"	(20)		Zambezi R. Portion	612,724	831	986	818	868	873	892	935	934	998	1003	911	903	913
"	KAFUE	(36)		In (Itezhi-tezhi Dam)	105,672	10	-11	29	123	458	550	596	228	139	74	61	-53	182
"	"	(36E)		Evaporation	—	24	15	14	11	11	17	18	17	13	16	18	22	16
"	"	(36S)		Storage	—	-187	-178	-137	-1	341	423	280	11	-36	-98	-115	-306	-2
"	"	(37)		Out (Itezhi-tezhi Dam)	—	173	152	152	113	106	110	298	201	162	156	157	231	168
"	"	(38)		In (Kafue Gorge Dam)	151,576	172	156	153	172	200	143	136	160	185	167	173	136	162
"	"	(38E)		Evaporation	—	29	20	19	18	22	30	26	22	19	26	28	27	24
"	"	(38S)		Storage	—	3	-7	0	37	47	-16	-19	8	22	-4	-22	-64	-2
"	"	(39)		Out (Kafue Gorge Dam)	—	140	143	134	117	131	129	129	129	144	145	168	174	140
"	"	(40)		Kafue R. Portion	154,882	140	142	138	131	126	130	137	133	147	146	169	175	143
"	ZAMBEZI	(41)		Confluence	767,606	971	1128	956	1000	998	1022	1073	1067	1146	1148	1080	1079	1056
"	"	(42)		Zambezi R. Portion	786,686	1020	1186	1003	1072	1062	1085	1070	1047	1129	1142	1090	1113	1085
"	LUANGWA	(43)	5-940	St. Luangwa Bridge	143,781	46	52	77	981	1139	598	783	298	185	133	114	66	367
"	"	(44)		Luangwa R. Portion	150,586	48	54	81	1028	1193	626	820	312	193	139	119	69	385
"	ZAMBEZI	(45)		Confluence	937,272	1068	1240	1084	2099	2255	1712	1890	1359	1322	1281	1209	1182	1470

Table-4.14 DB-10 : Annual Reservoir Water Balance

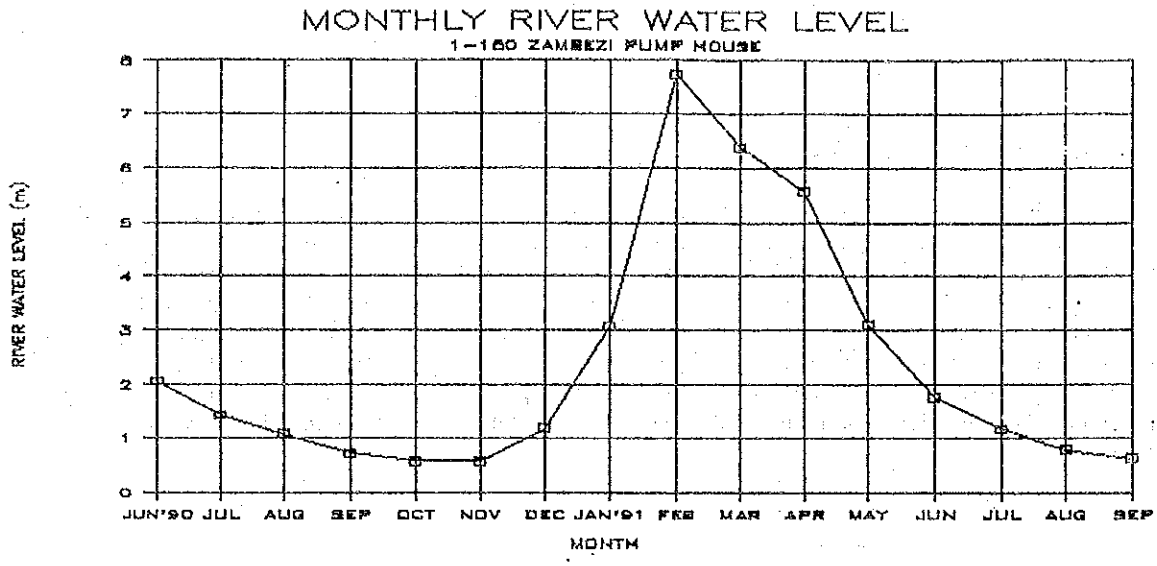
[RESERVIOIR OPERATION] PERIOD: 1979/80 ~ 1990/91 (12 YEARS) DAM: ITEZHI-TEZHI

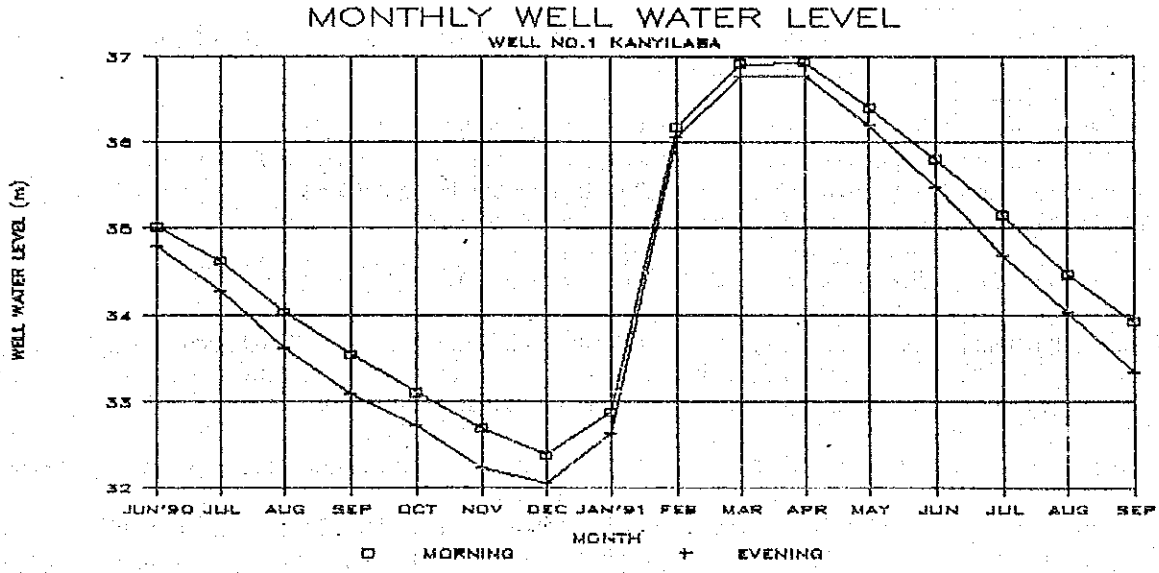
Year	W/Level H(m)	Volume V(mcm)	R.Area A(Km2)	Rain R(mm)	P.Evap Eo(mm)	Change/V dV(m3/s)	Inflow Qi(m3/s)	A.Evap. E(m3/s)	Outflow Qo(m3/s)	Kafue H/B Qf(m3/s)	Qi-Qf (m3/s)
1978/79	1029.17	6026	367								
L1979/80	1020.42	6126	371	859	1620	3.1	466.8	18.0	445.6	441.1	25.6
1980/81	1029.26	6062	369	1013	1620	-2.0	465.8	18.7	449.1	458.5	7.4
1981/82	1026.48	5025	325	496	1620	-32.9	192.3	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

Table-4.15 DB-10 : Monthly Reservoir Water Balance

[RESERVIOIR 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 H/B Qf(m3/s)	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	809.9	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	1029.30	6078	369	0	90	83.3	371.8	12.7	275.8	364.0	7.8
JUL	1029.59	6194	374	0	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)				659	1620	99	14720	568	14052	13911	809





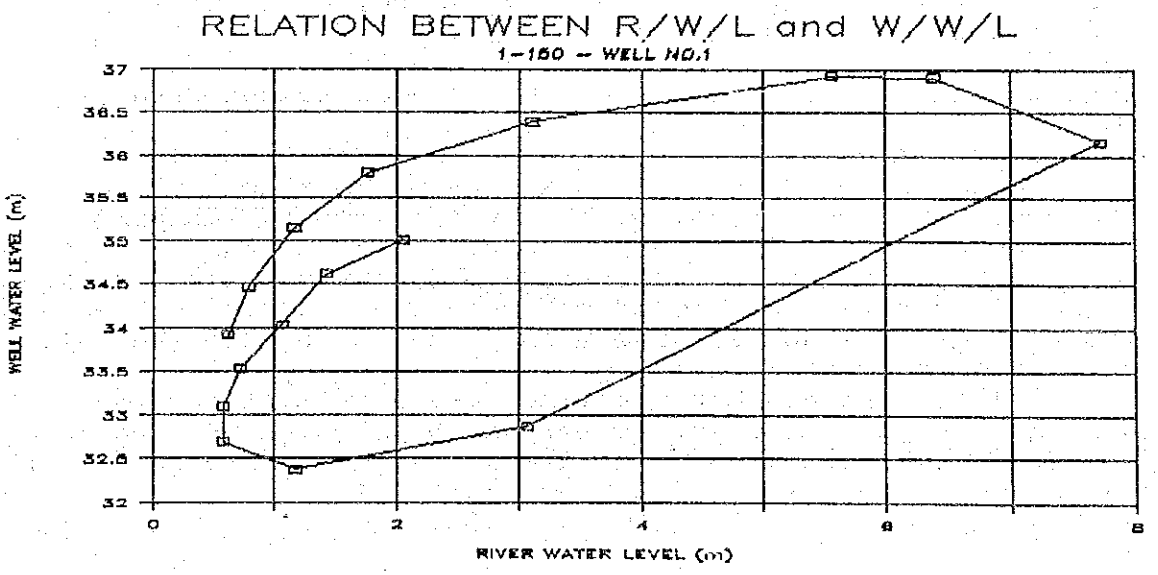


Fig.-4.5 DB-12 : Correlation
between River and well Water Level

4.2 Discharge Rating Curve

To know the continuous river discharge at a given point of 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. In this Study, a second degree curve is employed as it is widely used around the world.

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.

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.

<Method-1>: in case of a small amount of measurement data (DB-03)

By the Manning's 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).

<Method-2>: in case of a large amount of measurement data (DB-04)

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).

In Table-4.16, the discharge rating curves by stations thus obtained are shown. These curves are established on the basis of the existing flow measurement data and new data obtained in this Study. Details are referred to **Supplement-4.2.**

Table-4.16 Discharge Rating Curve

No.	Hydrometric St.	Rating Curve	Range
1	1-150 Zambezi Pump House	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 Q = 132.763 *(H - 2.270)^2	H < 3.179 m H >= 3.179 m
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 Q = 1.989 *(H - 0.019)^2	H < 2.920 m H >= 2.920 m
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 Q = 40.036 *(H - 2.525)^2	H < 5.134 m H >= 5.134 m
13	4-450 Lubungu	Q = 31.695 *(H - 0.476)^2	
14	4-560 Chifumpa pontoon	Q = 25.326 *(H + 0.562)^2	
15	4-669 Kafue Hook Bridge	Q = 110.511 *(H - 0.937)^2	
16	4-941 Kaleya Dam Site	Q = 1.780 *(H - 0.115)^2 Q = 32.948 *(H - 3.603)^2	H < 4.663 m H >= 4.663 m
17	4-958 Uruaff Farm	Q = 8.421 *(H - 0.009)^2	
18	5-030 Exchange Farm	Q = 1.684 *(H + 0.084)^2 Q = 9.681 *(H - 0.386)^2 Q = 21.059 *(H - 0.729)^2	H < 0.720 m 0.720m <= H < 1.640m H >= 1.640 m
19	5-940 Luangwa Bridge	Q = 60.157 *(H - 1.003)^2	

[Note]
RANGE : Applicable range of water level

4.3 Discharge Correlation Analysis

The correlation curve(s) will be used to fill the missing or not-available discharge data in the table output from DB-05B. The correlation curve for variable target station's daily discharge : y versus variable nearest station's daily discharge : x is defined by a straight line which gives the best estimate of y for a given value of x.
The equation of the lines are; $Y = aX + b$

where, a is the regression coefficient of y versus x, b is the regression constant of x versus y.

The correlation coefficient (:f) is used statistical parameter for measuring the degree of association of two linearly dependent variables. It is determined as;

$$f = \frac{\sum Xi\,Yi - (\sum Xi)(\sum Yi)/N}{\sqrt{\{\sum X_i^2 - (\sum Xi)^2/N\}\{\sum Y_i^2 - (\sum Yi)^2/N\}}}$$

The result of discharge correlation analysis by stations is summarized in Table-4.17 as illustrated below (Details refer to **Supplement-4.3**)

Table-4.17 Monthly Discharge correlation Results

No.	Nearest St. X:	Target St. Y:	Correlation Equation Y=	a	+	b	*	X	Coeff. f
0401	Lukulu	Zambezi P/H	Y=	-499.388	+	1.470	*	X	0.971
0302	Watopa	Kabompo B.	Y=	46.512	+	0.652	*	X	0.961
0403	Lukulu	Watopa	Y=	-94.735	+	0.452	*	X	0.919
0304	Watopa	Lukulu	Y=	305.506	+	1.866	*	X	0.919
0405	Lukulu	Kalabo	Y=	-47.705	+	0.151	*	X	0.806
0406	Lukulu	Senanga	Y=	135.448	+	1.054	*	X	0.890
0907	Smith's B.	Raglam F.	Y=	-9.587	+	0.607	*	X	0.958
0908	Smith's B.	Mwambashi	Y=	0.126	+	0.097	*	X	0.922
1009	Mpatamato	Smith's B.	Y=	10.245	+	0.711	*	X	0.930
1110	Machiya F.	Mpatamato	Y=	9.614	+	0.601	*	X	0.967
1011	Mpatamato	Machiya F.	Y=	-4.920	+	1.556	*	X	0.967
1112	Machiya F.	Chilenga	Y=	0.657	+	1.309	*	X	0.980
1213	Chilenga	Lubungu	Y=	11.831	+	0.967	*	X	0.976
1314	Lubungu	Chifumpa P.	Y=	8.263	+	0.471	*	X	0.773
1315	Lubungu	Kafue H/B	Y=	34.396	+	1.519	*	X	0.940
1816	Exchange F.	Kaleya D/S	Y=	0.189	+	0.389	*	X	0.577
1617	Kaleya D/S	Uruaff F.	Y=	-0.353	+	2.282	*	X	0.538
1618	Kaleya D/S	Exchange F.	Y=	-0.036	+	0.855	*	X	0.577
1019	Mpatamato	Luangwa	Y=	-79.628	+	6.559	*	X	0.873

4.4 Reservoir Water Balance

To comprehend the factors of reservoir water balance and evaluate reservoir operation, the simulation of reservoir water balance is done regarding the following 3 main dams existing in Study area.

1) Itezhi-Tezhi Dam and Reservoir
2) Kafue Gorge Dam and Reservoir
3) Kariba Dam and Reservoir

(1) Simulation Model

Generally, dam and reservoir balance is expressed as the following equation. Refer to Fig.-4.6.

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

where,

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

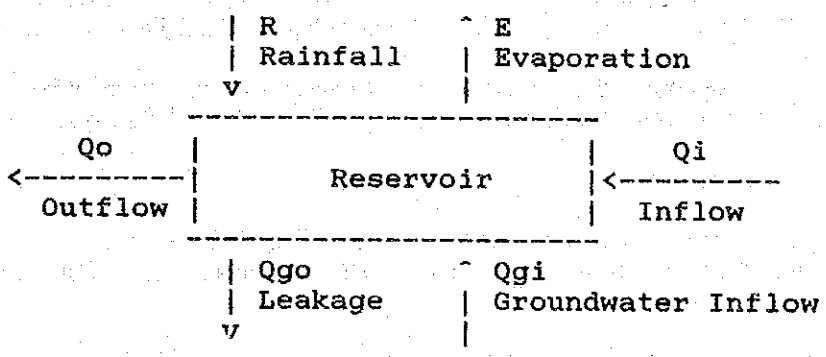


Fig.- 4.6 Reservoir Water Balance

In this Study, two factors : Qgi and Ggo are neglected as these parameters do not greatly affect the balance and the data are not available. The inflow (Qi) is calculated on a monthly basis as an unknown variable. The above equation can be rewritten as follow:

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

< 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 curve of each reservoir is given as shown in **Supplement-4.4**.

< Rainfall : R and Evaporation : E >
The rainfall amount to the reservoir (R) and evaporation amount from 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 the rainfall station Namwala and Kafue Polder respectively.
2) Eo is 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.

(2) Simulation Results

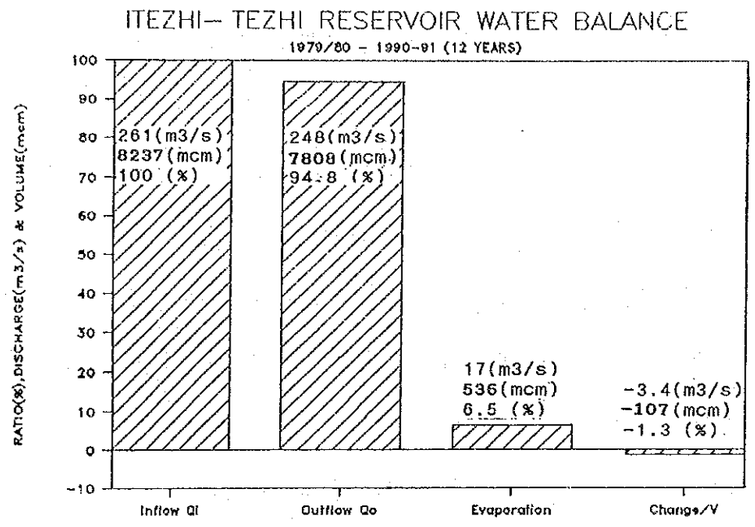
The simulation results of reservoir water balance for the 3 main dams are shown in Table-4.18, Fig.-4.7 as summary. Details are referred to **Supplement-4.4**.

Table-4.18 Summary of Reservoir Water Balance

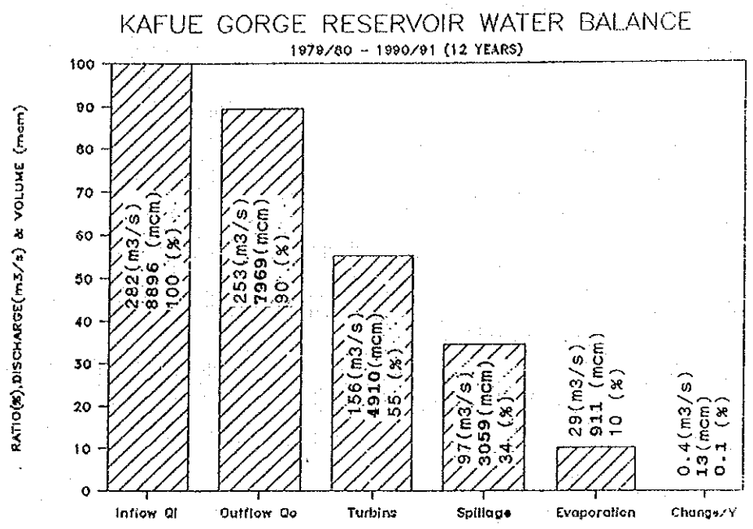
I t e m s		Itezhitezhi	Kafue Gorge	Kariba
Simulation Period		12ys(1980-91)	12ys(1980-91)	29ys(1963-91)
Inflow	(m3/s)	261.2 (100%)	282.1 (100%)	1,620 (100%)
"	(mcm/y)	8,237	8,896	51,088
Outflow	(m3/s)	247.6 (95%)	252.7 (90%)	1,340 (83%)
"	(mcm/y)	7,808	7,969	42,258
- Water Power	(m3/s)	-	155.7 (55%)	789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

[Note] Total inflow is including rainfall.

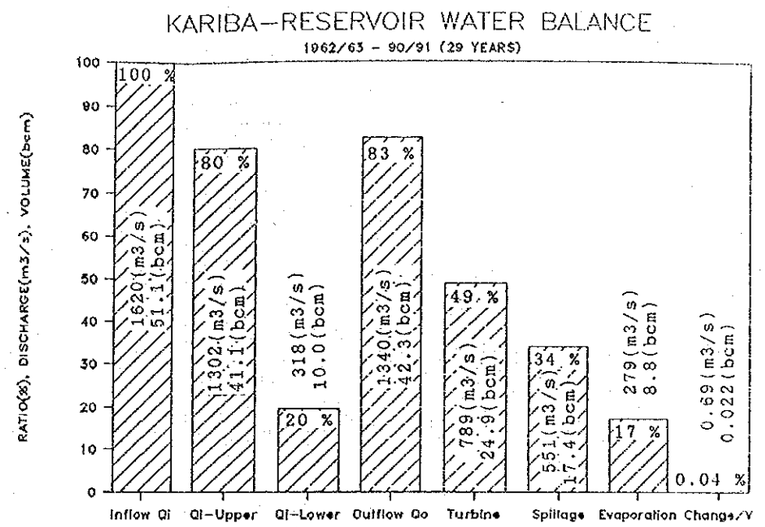
<<< ITEZHI - TEZHI DAM >>>

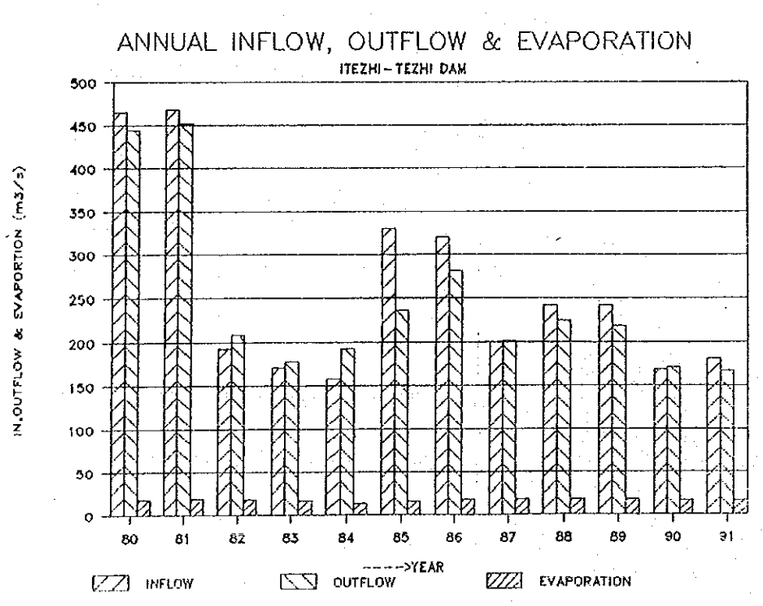


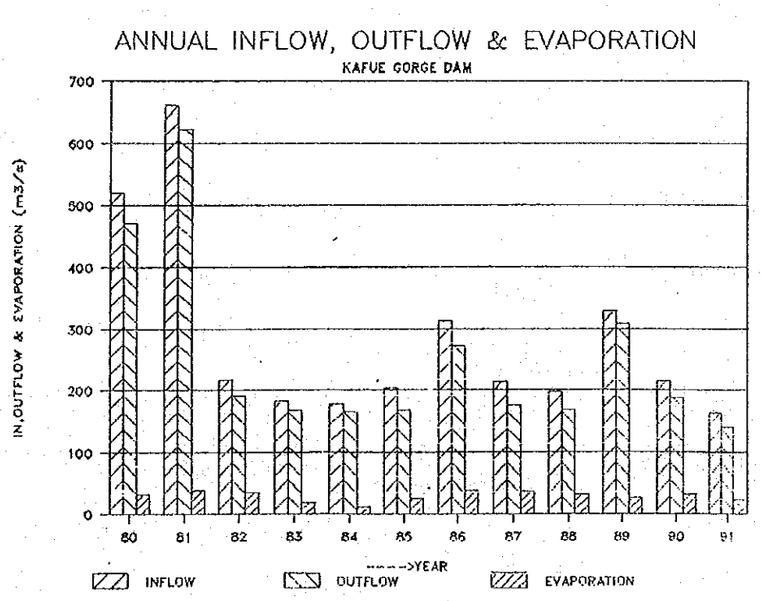
<<< KAFUE GORGE DAM >>>



<<< KARIBA DAM >>>







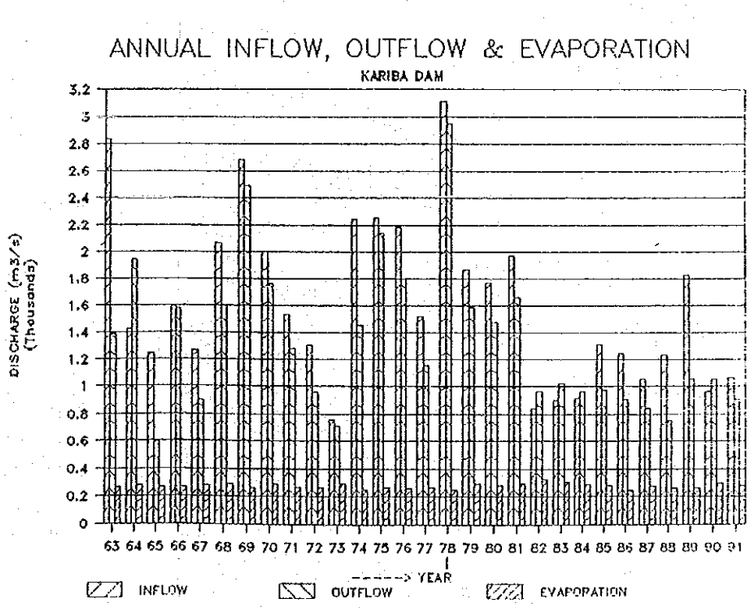


Fig. -4.7 Summary of Reservoir Water Balance

4.5 River Flow Analysis

(1) Simulation Model

<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.- 4.8 and Fig.-4.9 to analyze the river flow balance . 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 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-4.19.

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 : 32 years (1959/60 - 1990/91)

< 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-4.19.

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.

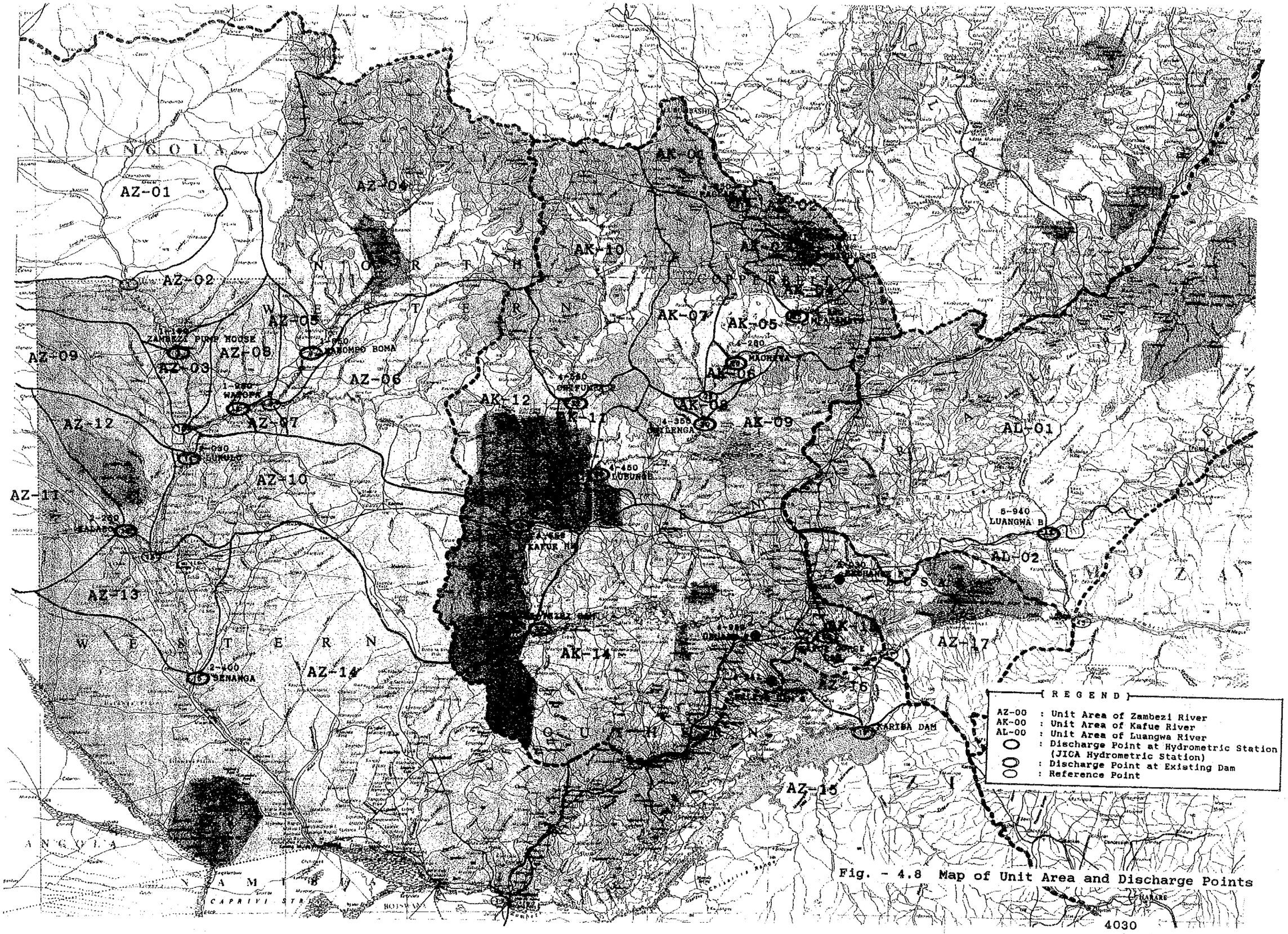


Fig. - 4.8 Map of Unit Area and Discharge Points

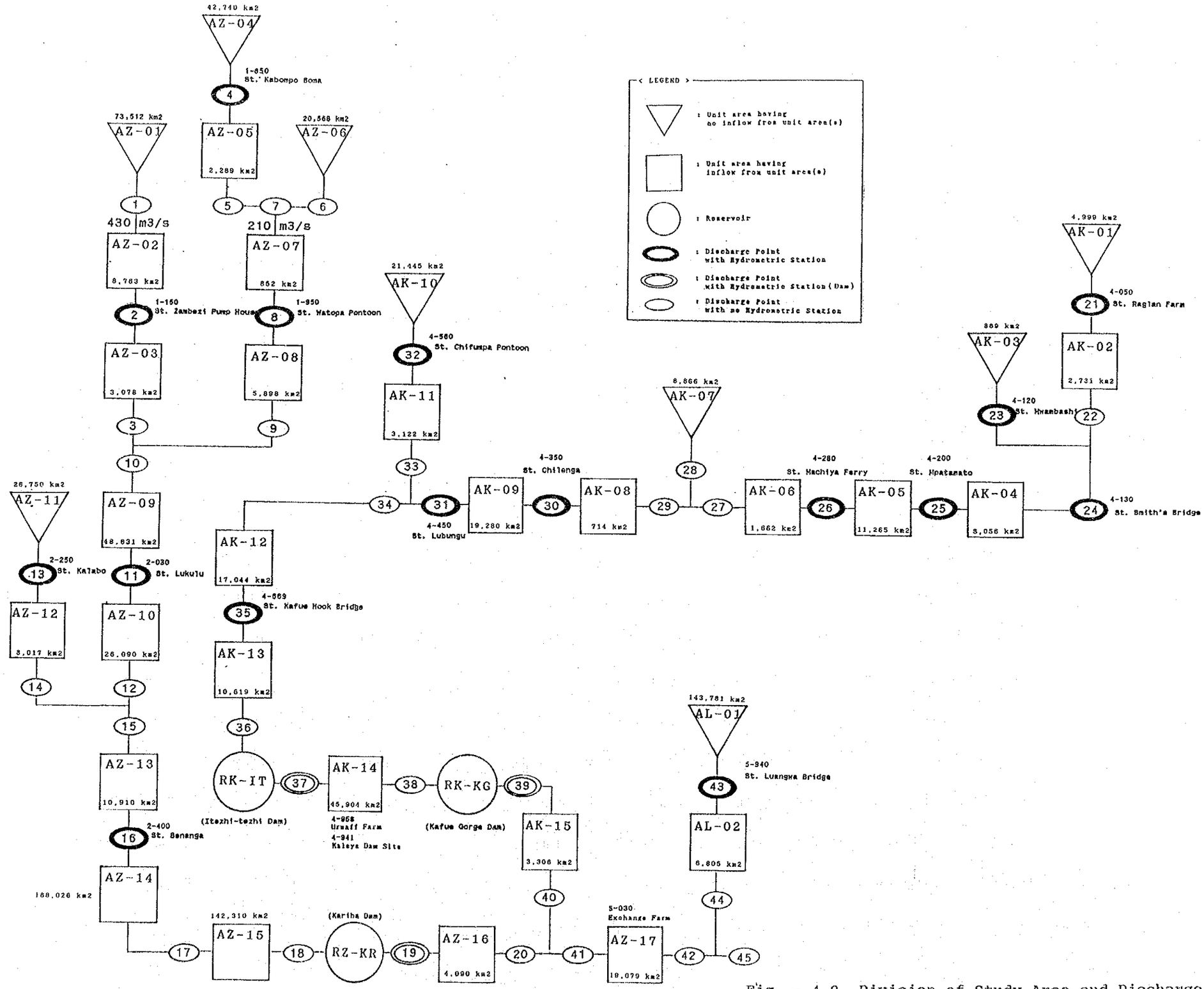


Fig. - 4.9 Division of Study Area and Discharge Points

Table-4.19 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 Watopa 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 Ragtam 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)

(2) Simulation Results

<River Flow for Upper Area>

The summary of river water analysis of the upper area for 32 years (1959/60 - 1990/91) is as follows: (Details are referred to Table-4.20, Fig.-4.10 and **Supplement-4.5**)

		<----Discharge----> (m3/s)	(bcm/yr)
Zambezi Main River Basin			
(point- 2) Zambezi Pump House	(1-150)	: 693	21.9
(point-11) Lukulu	(2-030)	: 808	25.5
(point-16) Senanga	(2-400)	: 986	31.1
Kafue River Basin			
(point-21) Raglam Farm	(4-050)	: 37	1.2
(point-24) Smith's Bridge	(4-130)	: 79	2.5
(point-25) Mpatamato	(4-200)	: 98	3.1
(point-26) Machiya Ferry	(4-280)	: 145	4.6
(point-31) Lubungu	(4-450)	: 199	6.3
(point-35) Kafue Hook Bridge	(4-669)	: 336	10.6
Luangwa River Basin			
(point-43) Luangwa Bridge	(5-949)	: 626	19.7

<River Flow for Whole Area>

The summary of river water analysis of the upper area for the latest 12 years (1979/80 - 1990/91) is as follows: (Details are referred to Table-4.21, Fig.-4.11 and **Supplement-4.5**)

<<<Upper Area>>>		<------Discharge------> (m3/s)	(bcm/yr)
Zambezi Main River Basin			
(point- 2) Zambezi Pump House	(1-150)	: 510	16.1
(point-11) Lukulu	(2-030)	: 691	21.8
(point-16) Senanga	(2-400)	: 824	26.0
Kafue River Basin			
(point-21) Raglam Farm	(4-050)	: 30	0.96
(point-24) Smith's Bridge	(4-130)	: 76	2.4
(point-25) Mpatamato	(4-200)	: 92	2.9
(point-26) Machiya Ferry	(4-280)	: 130	4.1
(point-31) Lubungu	(4-450)	: 168	5.3
(point-35) Kafue Hook Bridge	(4-669)	: 266	8.4
Luangwa River Basin			
(point-43) Luangwa Bridge	(5-949)	: 652	20.6
<<<Lower Area>>>			
(point-17) Livingstone		: 1003	31.6
(point-18) Kariba Inflow		: 1259	39.7
(point-19) Kariba Outflow		: 1049	33.1
(point-36) Itezhi-tezhi Inflow		: 261	8.2
(point-37) Itezhi-tezhi Outflow		: 248	7.8
(point-38) Kafue Gorge Inflow		: 282	8.9
(point-39) Kafue Gorge Outflow		: 253	8.0
(point-41) Confluence(Zambezi x Kafue)		: 1316	41.5
(point-45) Confluence(Zambezi x Luangwa)		: 2033	64.1

Table-4.20 River Flow for Upper Area
Period : 32 Years : (1959/60 - 1990/91)

AREAS	BASINS	No.	ST.	POINT & STATION NAME	AREA(km2)	MEAN DISCHARGE (m3/s)	(bcm/yr)	SPECIFIC DISCHARGE (m3/s/1000 km2
UPPER	ZAMBEZI	(1)		Cholose	73,512	584	18.4	7.94
"	"	(2)	1-150	St. Zambezi Pump House	87,275	693	21.9	7.94
"	"	(3)		Zambezi R. Portion	90,353	718	22.6	7.94
"	"	(4)	1-650	St. Kabompo Boma	42,740	219	6.90	5.12
"	"	(5)		Kabompo R. Portion	45,029	223	7.0	4.96
"	"	(6)		Dongwe R. Portion	20,568	39	1.2	1.92
"	"	(7)		Confluence	65,597	263	8.3	4.00
"	"	(8)	1-950	St. Watopa Pontoon	66,449	264	8.3	3.98
"	"	(9)		Kabompo R. Portion	72,347	275	8.7	3.81
"	"	(10)		Confluence	162,700	993	31.3	6.10
"	"	(11)	2-030	St. Lukulu	206,531	808	25.5	3.91
"	"	(12)		Zambezi R. Portion	228,076	868	27.4	3.81
"	"	(13)	2-250	St. Kalabo	34,621	74	2.3	2.13
"	"	(14)		Luanginga R. Portion	41,233	93	2.92	2.24
"	"	(15)		Confluence	269,309	961	30.3	3.57
"	"	(16)	2-400	St. Senanga	278,298	986	31.1	3.54
"	KAFUE	(21)	4-050	St. Raglan Farm	4,999	37	1.2	7.33
"	"	(22)		Kafue R. Portion	7,730	72	2.3	9.27
"	"	(23)	4-120	St. Mwambashi	869	8	0.25	8.99
"	"	(24)	4-130	St. Smith's Bridge	8,599	79	2.5	9.24
"	"	(25)	4-200	St. Mpatamato	11,655	98	3.1	8.40
"	"	(26)	4-280	St. Machiya Ferry	22,920	145	4.6	6.31
"	"	(27)		Kafue R. Portion	24,582	151	4.8	6.15
"	"	(28)		Luswishi R. Portion	8,866	35	1.1	3.97
"	"	(29)		Confluence	33,448	186	5.88	5.57
"	"	(30)	4-350	St. Chilenga	34,162	189	6.0	5.54
"	"	(31)	4-450	St. Lubungu	54,442	199	6.3	3.66
"	"	(32)	4-560	St. Chifumpa Pontoon	21,445	99	3.1	4.63
"	"	(33)		Lunga R. Portion	24,416	105	3.3	4.30
"	"	(34)		Confluence	78,858	304	9.6	3.86
"	"	(35)	4-669	St. Kafue Hook Bridge	95,053	336	10.6	3.54
"	LUANGWA	(43)	5-940	St. Luangwa Bridge	143,781	626	19.7	4.36
"	"	(44)		Luangwa R. Portion	150,586	656	20.7	4.36

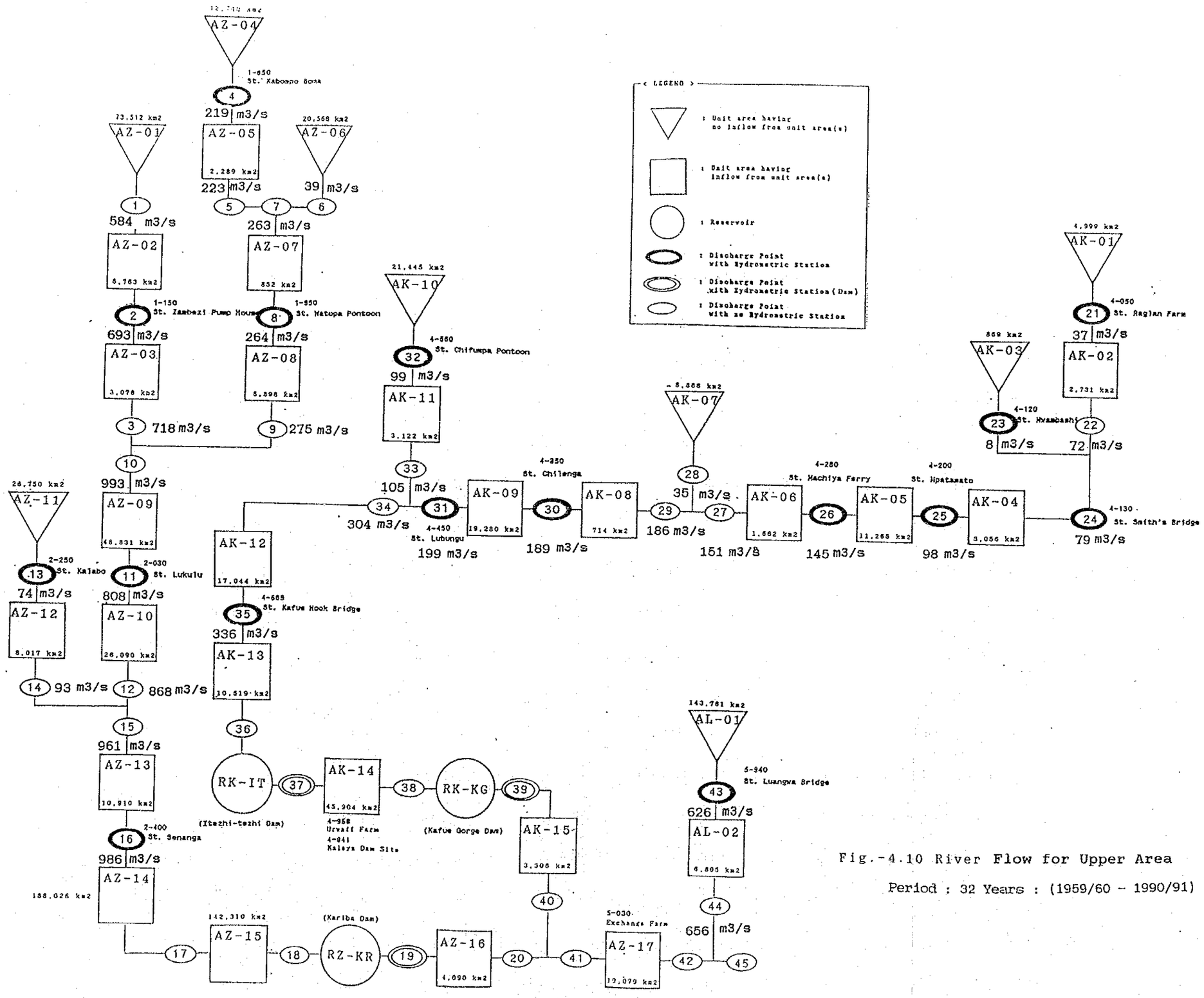


Fig.-4.10 River Flow for Upper Area

Period : 32 Years : (1959/60 - 1990/91)

Table-4.21 River Flow for Whole Area
Period : 12 Years : (1979/80 - 1990/91)

AREAS	BASINS	No.	ST.	POINT & STATION NAME	AREA(km2)	MEAN DISCHARGE (m3/s)	MEAN DISCHARGE (bcm/yr)	SPECIFIC DISCHARGE (m3/s/1000 km2)
UPPER	ZAMBEZI	(1)		Cholose	73,512	430	13.6	5.85
"	"	(2)	1-150	St. Zambezi Pump House	87,275	510	16.1	5.85
"	"	(3)		Zambezi R. Portion	90,353	528	16.7	5.85
"	"	(4)	1-650	St. Kabompo Boma	42,740	185	5.8	4.32
"	"	(5)		Kabompo R. Portion	45,029	187	5.9	4.16
"	"	(6)		Dongwe R. Portion	20,568	23	0.72	1.11
"	"	(7)		Confluence	65,597	210	6.6	3.20
"	"	(8)	1-950	St. Watopa Pontoon	66,449	211	6.7	3.18
"	"	(9)		Kabompo R. Portion	72,347	218	6.9	3.01
"	"	(10)		Confluence	162,700	746	23.5	4.59
"	"	(11)	2-030	St. Lukulu	206,531	691	21.8	3.35
"	"	(12)		Zambezi R. Portion	228,076	734	23.1	3.22
"	"	(13)	2-250	St. Kalabo	34,621	60	1.9	1.72
"	"	(14)		Luanginga R. Portion	41,233	73	2.3	1.76
"	"	(15)		Confluence	269,309	806	25.4	2.99
"	"	(16)	2-400	St. Senanga	278,298	824	26.0	2.96
"	KAFUE	(21)	4-050	St. Raglan Farm	4,999	30	0.96	6.08
"	"	(22)		Kafue R. Portion	7,730	69	2.2	8.88
"	"	(23)	4-120	St. Mwambashi	869	7	0.22	7.99
"	"	(24)	4-130	St. Smith's Bridge	8,599	76	2.4	8.79
"	"	(25)	4-200	St. Mpatamato	11,655	92	2.9	7.90
"	"	(26)	4-280	St. Machiya Ferry	22,920	130	4.1	5.68
"	"	(27)		Kafue R. Portion	24,582	136	4.3	5.52
"	"	(28)		Luswishi R. Portion	8,866	29	0.92	3.28
"	"	(29)		Confluence	33,448	165	5.2	4.92
"	"	(30)	4-350	St. Chilenga	34,162	167	5.3	4.89
"	"	(31)	4-450	St. Lubungu	54,442	168	5.3	3.09
"	"	(32)	4-560	St. Chifumpa Pontoon	21,445	81	2.6	3.77
"	"	(33)		Lunga R. Portion	24,416	83	2.6	3.42
"	"	(34)		Confluence	78,858	252	7.9	3.19
"	"	(35)	4-669	St. Kafue Hook Bridge	95,053	266	8.4	2.79
LOWER	ZAMBEZI	(17)		Livingstone	466,324	1003	31.6	2.15
"	"	(18)		In (Kariba Dam)	608,634	1259	39.7	2.07
"	"	(18E)		Evaporation	---	285	9.0	-
"	"	(18S)		Storage	---	-75	-2.4	-
"	"	(19)		Out (Kariba Dam)	---	1049	33.1	1.72
"	"	(20)		Zambezi R. Portion	612,724	1057	33.3	1.72
"	KAFUE	(36)		In (Itezhi-tezhi Dam)	105,672	261	8.2	2.47
"	"	(36E)		Evaporation	---	17	0.54	-
"	"	(36S)		Storage	---	-4	-0.12	-
"	"	(37)		Out (Itezhi-tezhi Dam)	---	248	7.8	2.35
"	"	(38)		In (Kafue Gorge Dam)	151,576	282	8.9	1.86
"	"	(38E)		Evaporation	---	29	0.91	-
"	"	(38S)		Storage	---	0	0.01	-
"	"	(39)		Out (Kafue Gorge Dam)	---	253	8.0	1.67
"	"	(40)		Kafue R. Portion	154,882	259	8.2	1.67
"	ZAMBEZI	(41)		Confluence	767,606	1316	41.5	1.71
"	"	(42)		Zambezi R. Portion	786,686	1350	42.6	1.72
"	LUANGWA	(43)	5-940	St. Luangwa Bridge	143,781	652	20.6	4.54
"	"	(44)		Luangwa R. Portion	150,586	683	21.5	4.54
"	ZAMBEZI	(45)		Confluence	937,272	2033	64.1	2.17

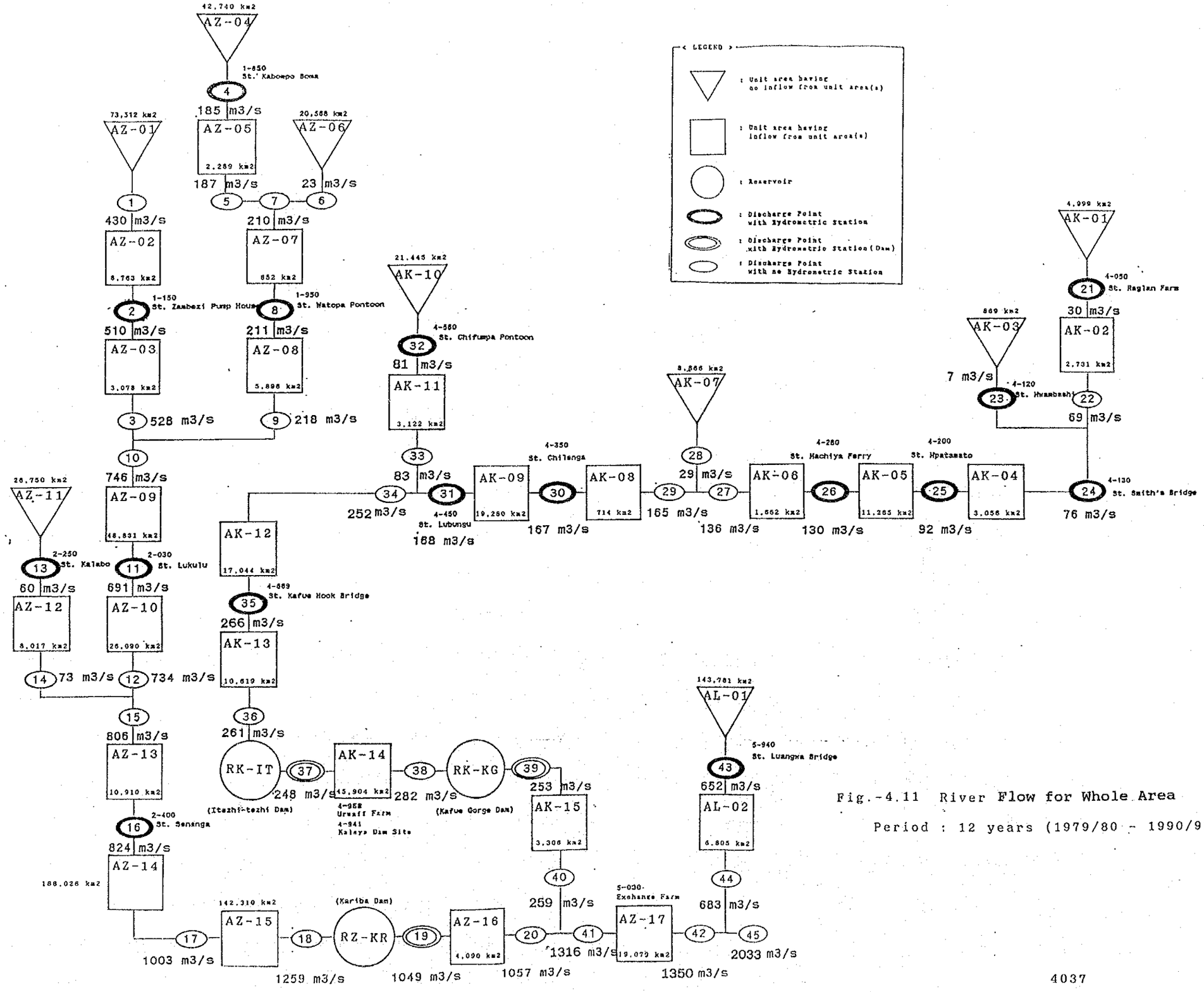


Fig.-4.11 River Flow for Whole Area

Period : 12 years (1979/80 - 1990/91)

4.6 Characteristics of River Flow

(1) Monthly Discharge

Using the simulation results mentioned in Section 4.4, the average monthly flow patterns for the 32 years periods is given as Table-4.22.

Table-4.22 Average Monthly Flow Pattern at Hydrometric Station

(Simulation Period : 32years, 1959/60- 90/91) (Unit:m3/s)

St.Nos.	St. Names	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	ANNUAL
1	1-150 Zambezi P/H	84.7	106.3	240.2	707.7	1474.3	2161.4	1955.3	806.0	338.8	205.0	139.7	100.5	693.3
2	1-650 Kabompo Bore	74.2	94.0	175.6	257.4	377.2	497.0	460.3	223.7	153.1	125.7	103.9	82.8	218.7
3	1-950 Watopa Pontoon	78.5	98.3	184.4	311.0	502.6	691.6	590.9	244.9	151.2	125.0	104.7	86.8	264.2
4	2-030 Lukulu	333.8	369.8	532.8	899.6	1342.0	1749.3	1646.5	985.7	609.2	470.7	399.4	351.9	807.6
5	2-250 Kalabo	11.8	10.1	14.2	45.7	134.2	229.4	190.5	99.6	64.2	43.2	26.8	16.7	73.9
6	2-400 Senanga	357.2	387.0	523.8	798.3	1231.7	1803.1	2086.0	1777.4	1195.5	739.0	522.4	411.8	986.1
7	4-050 Raglan Farm	3.4	4.3	14.0	37.1	75.6	107.3	99.4	48.4	21.6	13.4	9.4	5.8	36.6
8	4-120 Mwanbashi	1.6	2.3	6.1	11.8	17.7	21.0	13.6	6.8	4.4	3.6	2.8	2.0	7.8
9	4-130 Smith's Bridge	15.0	19.0	48.5	110.6	172.5	200.1	162.3	92.1	53.9	36.4	27.0	18.9	79.7
10	4-200 Mpatamato	18.1	23.3	60.9	134.9	225.2	255.9	197.7	102.0	60.4	41.7	31.7	23.4	97.9
11	4-280 Machiya Ferry	24.6	29.5	76.8	189.5	319.7	385.6	321.3	164.2	84.6	59.4	45.7	33.5	144.5
12	4-350 Chilenga	29.4	34.6	83.7	216.3	379.1	509.0	454.6	261.2	122.4	79.7	58.8	41.3	189.2
13	4-450 Lubungu	35.9	37.8	85.3	216.7	378.0	498.1	472.6	309.4	148.1	90.2	66.8	51.3	199.2
14	4-560 Chifunpa Pon.	25.6	29.5	64.5	119.2	209.2	262.1	200.4	91.5	57.9	46.6	39.5	31.3	98.1
15	4-669 Kafue Hook B.	80.1	83.8	162.1	365.0	638.9	805.7	752.7	475.6	262.0	170.3	133.9	104.8	336.2
16	4-941 Kaleya D/S	0.14	0.19	0.36	0.40	0.47	0.26	0.20	0.18	0.18	0.18	0.17	0.16	0.2
17	4-958 Urusff Farm	0.16	0.24	0.50	0.66	1.10	0.32	0.23	0.10	0.10	0.09	0.10	0.11	0.3
18	5-030 Exchange Farm	0.04	0.09	0.30	0.41	0.81	0.49	0.18	0.09	0.07	0.06	0.05	0.05	0.2
19	5-940 Luangwa Bridge	45.3	53.2	383.8	1238.7	1961.6	1904.2	975.3	404.8	226.4	143.7	105.0	72.3	626.2

(2) Annual Flow Regime

The annual flow regime of each station selected in the Study shows 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

The results of annual flow regime tables and flow regime charts of 1990/91 year are refferd to **Supplement-4.6.**