6.2 LONG TERM SIMULATION

6.2.1 CONDITIONS OF SIMULATION

Under the following conditions, the base flow simulation for a long-term period was carried out, using the model verified in Section 6.1:

① Discharge reference model;

- Rowojedang Intake for Unit M, K. Mujur

- K. Leprak No. 1 Check Dam for Unit R, K. Rejali

- Planned Pronojiwo Dam for Unit G, K. Glidik

② Simulation period;

30 years, from 1953 to 1982

③ Monthly rainfall data used;

- Besuk Sat for Unit M, K. Mujur from 1952 to 1982

- Curah Kobo'an for Unit R, K. Rejali from 1952 to 1982

- Supit Urang for Unit G, K. Glidik from 1952 to 1982 (Data from 1952 to 1969 is estimated by correlation to Curah Kobo'an)

6.2.2 SIMULATION RESULTS

The simulation results of long-term base flow are shown in the following figures and tables.

①	Fig.-5.15	:	Annual Mean Base Flow
②	Fig.-5.16	:	Annual Mean Monthly Base Flow Distribution
③	Fig.-5.17	:	Annual Mean Monthly Base Flow and Rainfall Distribution
④	Fig.-5.18	:	Monthly Distribution of Base Flow and Rainfall
⑤	Table-5.11	:	Characteristics of Simulated Monthly Base Flow
⑥	Table-5.12	:	Computer Output of Long-term Base Flow Simulation

From these figures and tables, the following characteristics of the base flow discharge are summarized:

① Among three points, the highest amounts of mean base flow and specific mean base flow are obtained at the planned Pronojiwo dam site of K. Glidik. The fluctuation coefficient is the smallest at the same site. This means that the area upstream of the point possesses a greater natural reservoir in the Mt. Semeru than the others;

② The periodicity of the monthly base flow is noted although the interval is not one but two or three years;

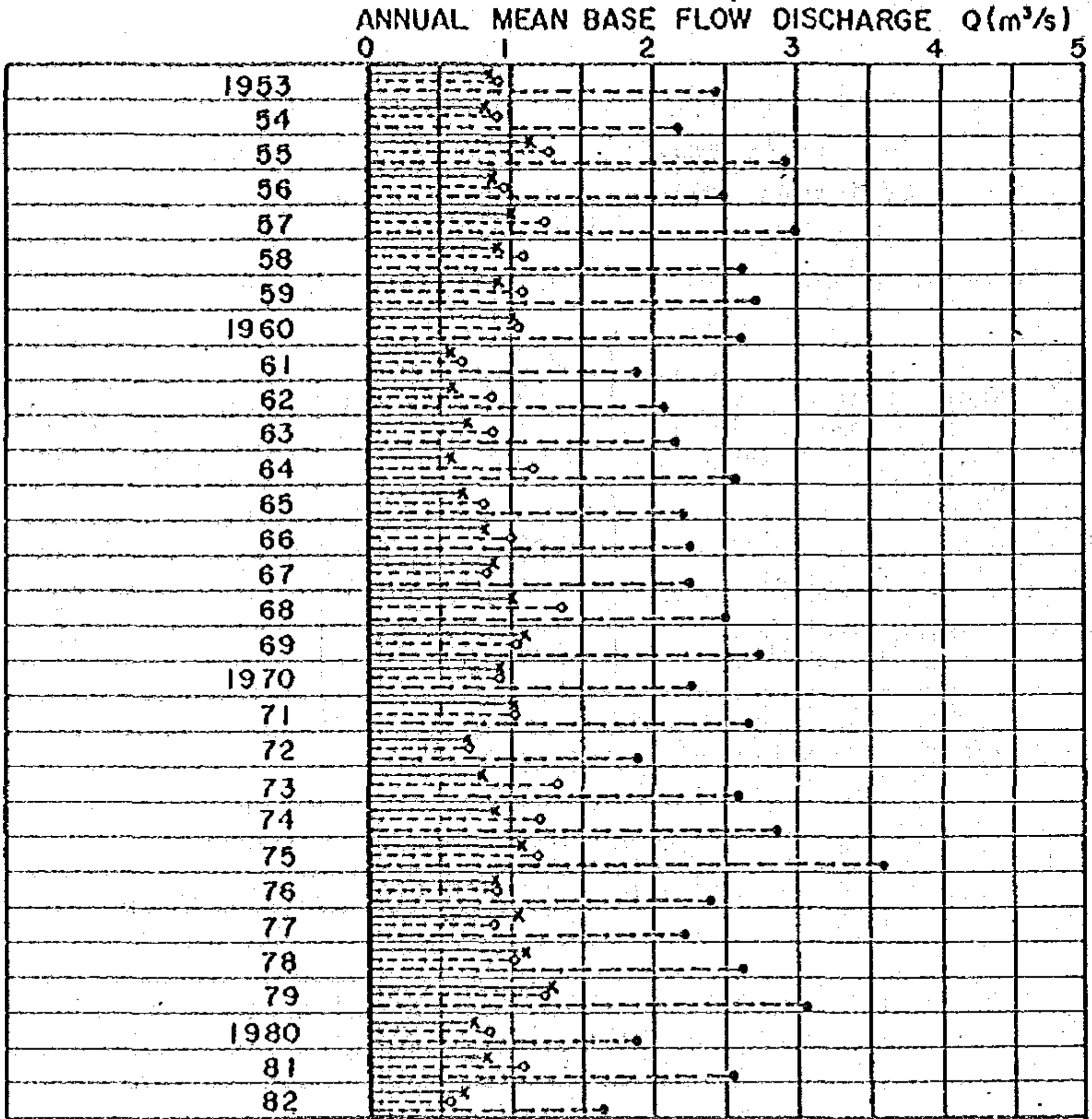
③ The fluctuation of the annual mean monthly base flow is rather leveled due to the reason stated above in ②;

④ The fluctuation of the annual mean base flow can be said to be small judging from its fluctuation coefficient (slightly lower than 20%).

Table-5.11 Characteristics of Simulated Monthly Base Flow

Reference Point \ Items	Q (m^3/s)	σn (m^3/s)	c_f (N.D.)	q ($m^3/s/km^2$)
(M) Intake Rowojedang of K. Mujur	0.898	0.258	0.287	0.013
(R) Leprak No. 1 Check Dam of K. Rejali	0.992	0.309	0.312	0.036
(G) Planned Pronojiwo Dam of K. Glidik	2.648	0.681	0.276	0.045

Notes: Q = Monthly mean base flow
σn = Standard deviation
c_f = Coefficient of fluctuation ($\sigma n/Q$)
q = Specific mean base flow (Q/area)



① K.MUJUR INTAKE ROWOJEDANG	$\bar{Q}$	———x 0.898 m³/s
	σ_n	0.258 m³/s
	Cf	0.287
② K.REJALI K.LERAK CHD NO.1 SITE	$\bar{Q}$	··········o 0.992 m³/s
	σ_n	0.195 m³/s
	Cf	0.196
③ K.GRIDIK PRONOJIWO DAM SITE	$\bar{Q}$	— — — — —• 2.468 m³/s
	σ_n	0.411 m³/s
	Cf	0.167

Fig.-5.15 Annual Mean Base Flow

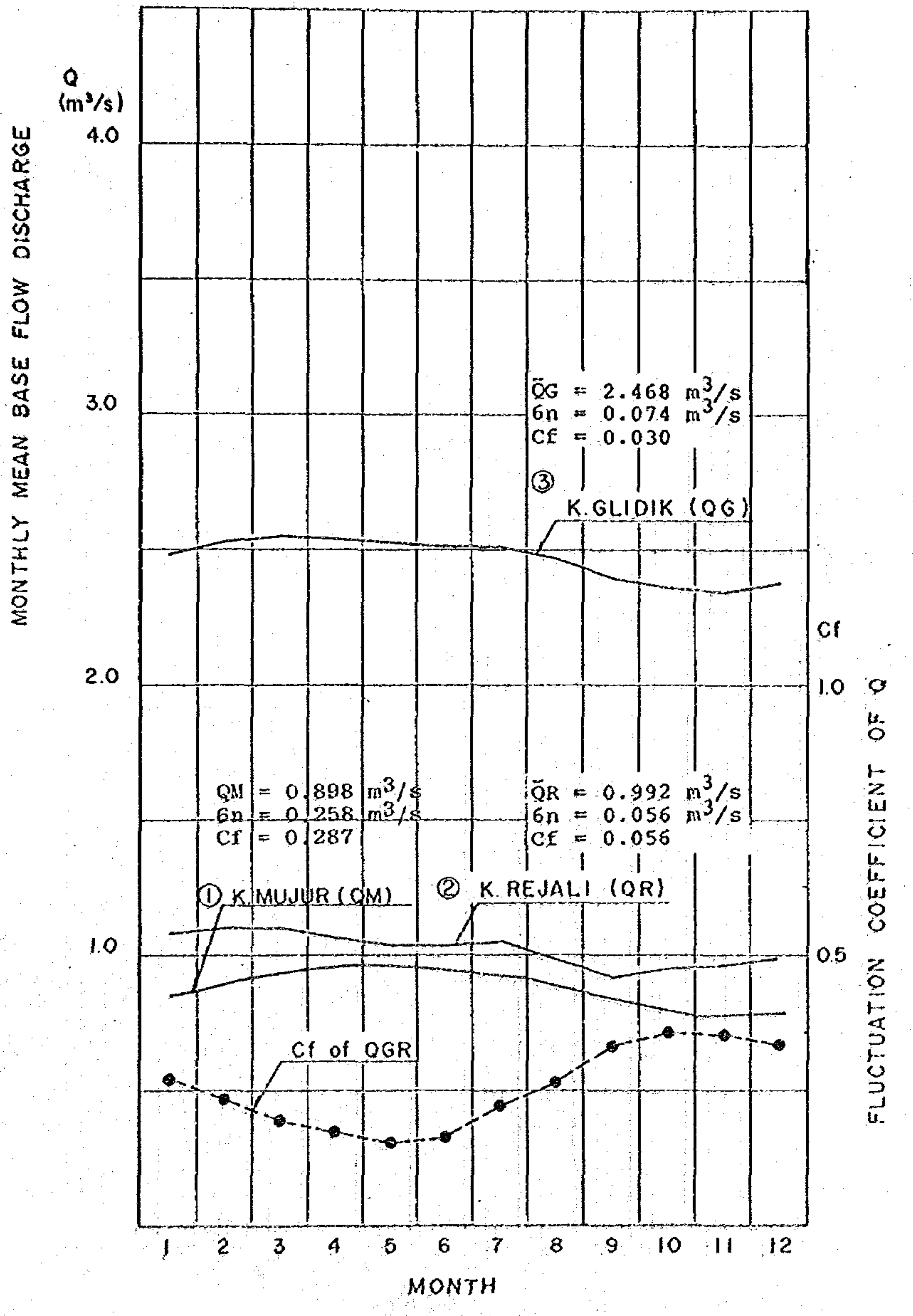


Fig.-5.16 Annual Mean Monthly Base Flow Distribution

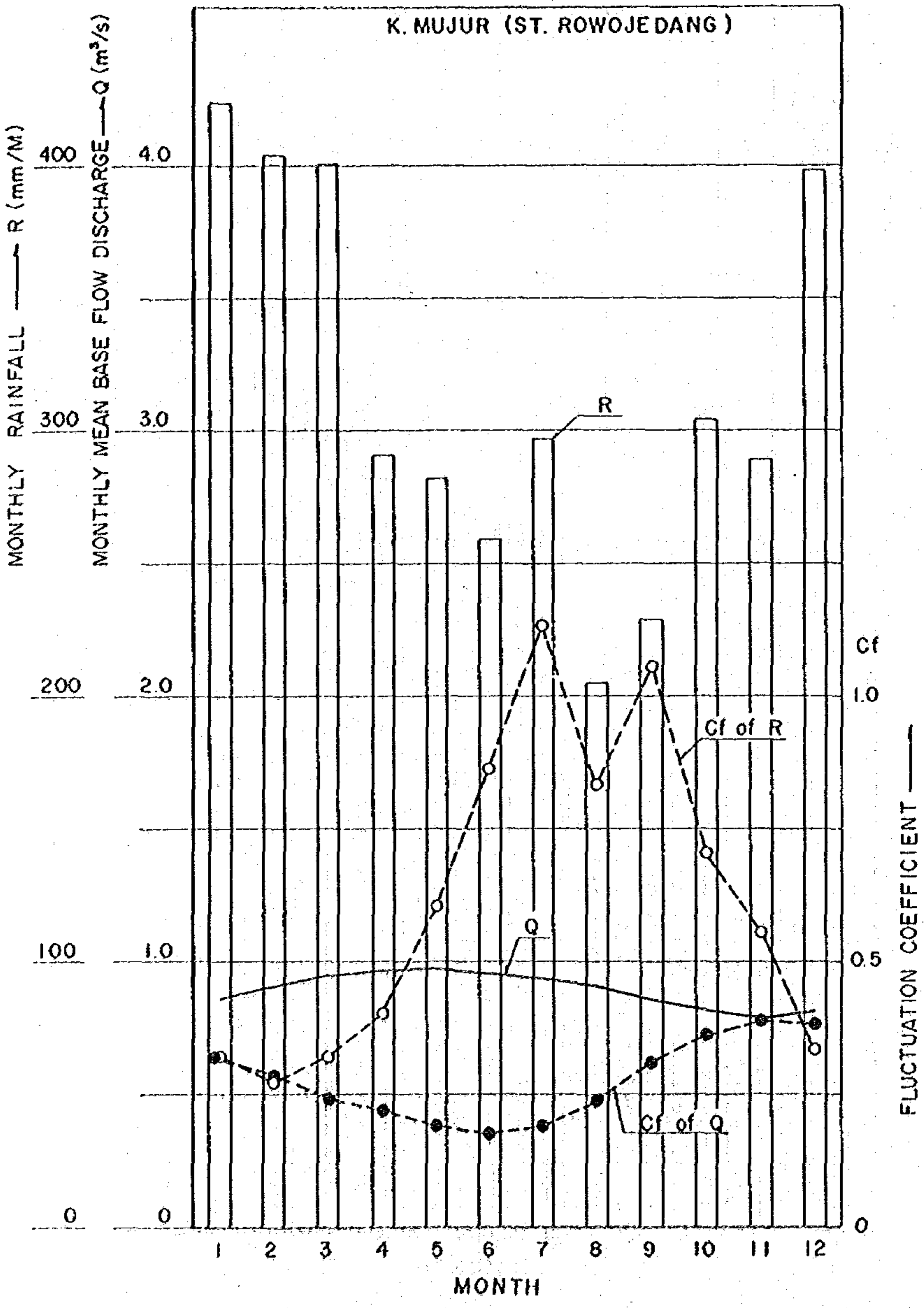


Fig.-5,17(1) Annual Mean Monthly Base Flow and Rainfall Distribution

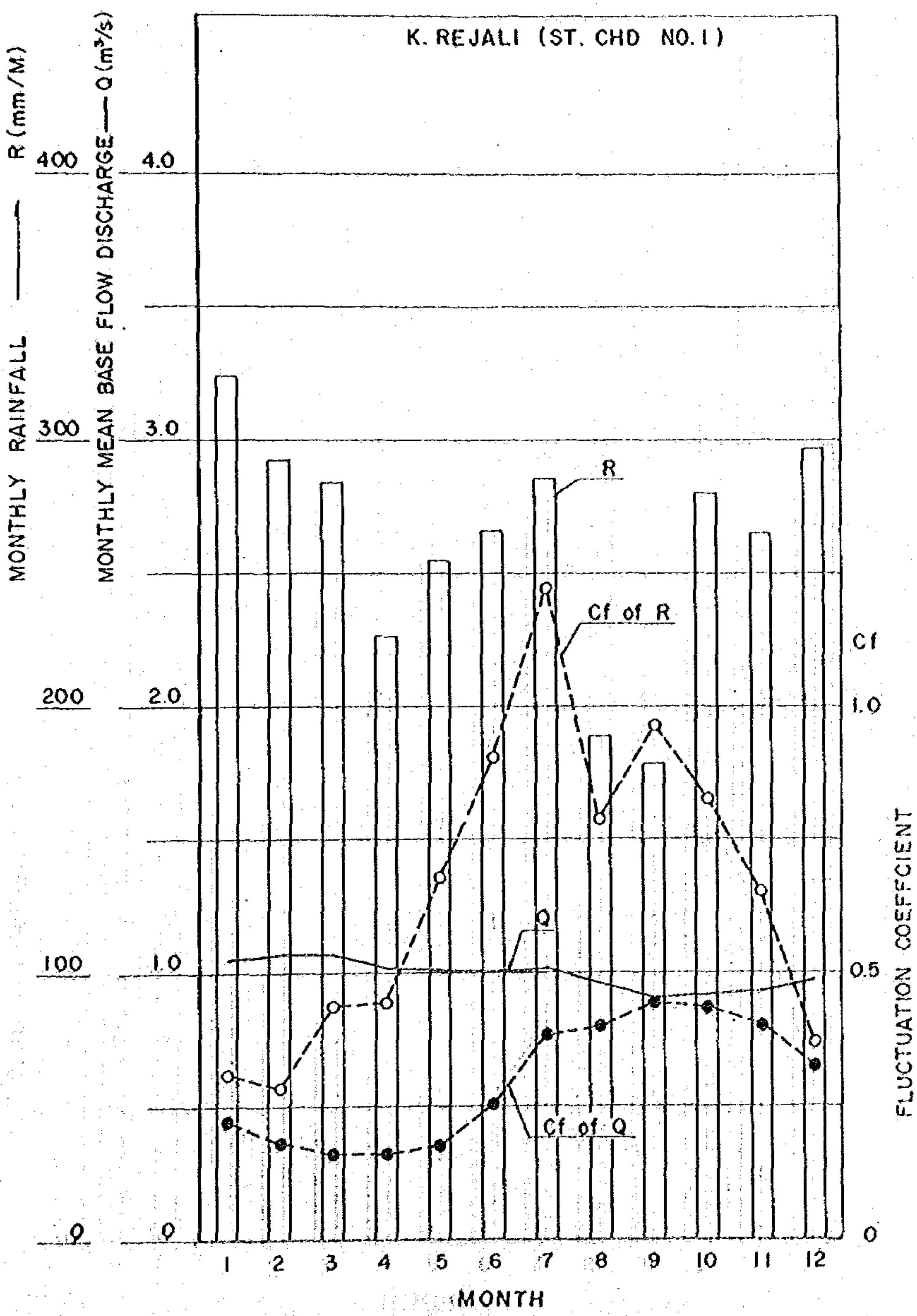


Fig.-5.17(2) Annual Mean Monthly Base Flow and Rainfall Distribution

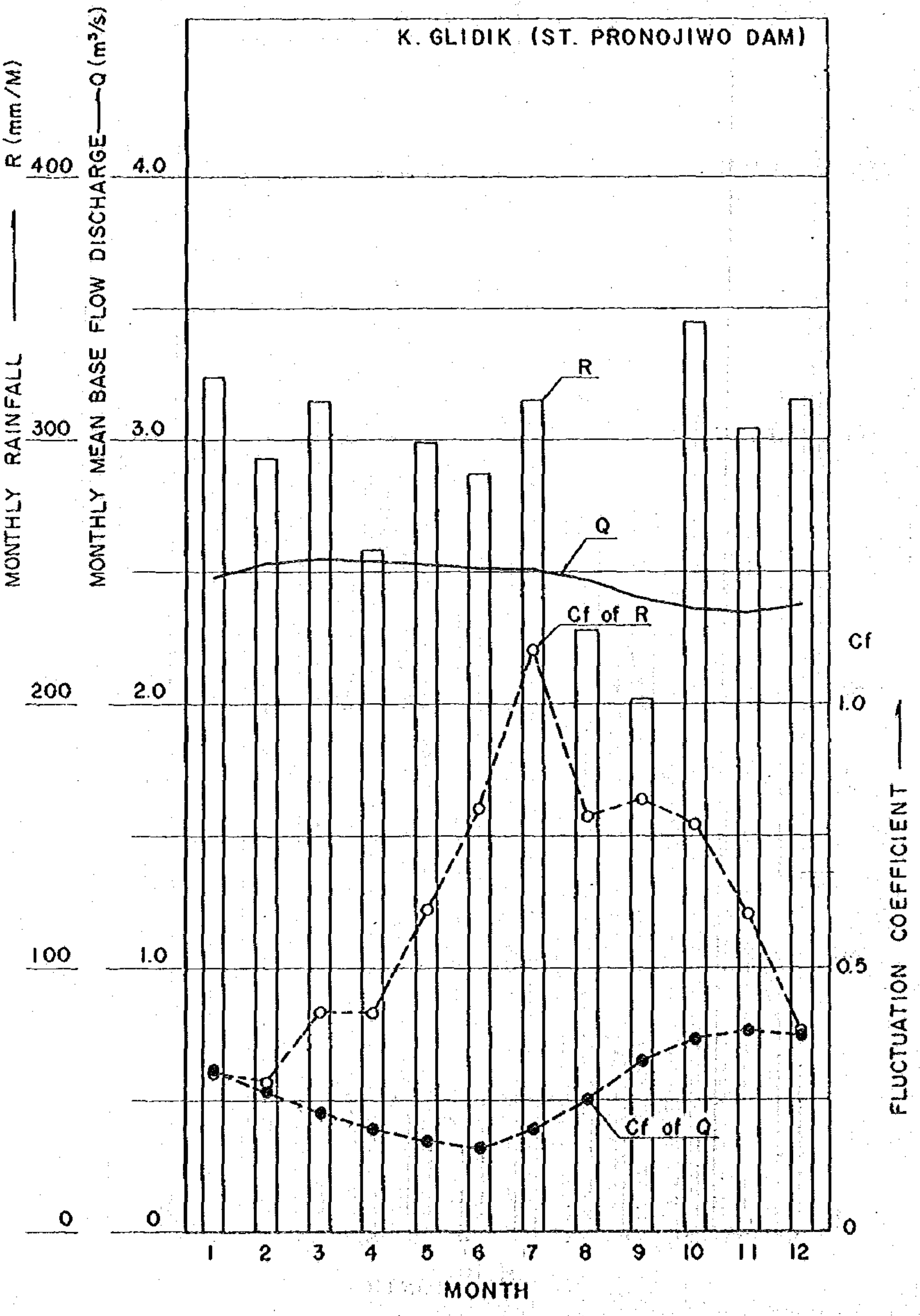


Fig.-5.17(3) Annual Mean Monthly Base Flow and Rainfall Distribution

Table-5.12 M (1) Computer Output of Long-term Base Flow Simulation

********** K.MUJUR (ST. RUWOJEDANG) 1953-1982 ********** RAINFALL (m m)

	1	2	3	4	5	6	7	8	9	10	11	12	TOTAL	MEAN
1953	282.0	383.0	442.0	396.0	346.0	12.0	99.0	119.0	10.0	101.0	205.0	468.0	2863.0	238.6
1954	457.0	372.0	317.0	383.0	251.0	487.0	235.0	348.0	28.0	218.0	384.0	368.0	3848.0	320.7
1955	563.0	344.0	353.0	185.0	195.0	688.0	1262.0	344.0	388.0	593.0	291.0	212.0	5418.0	451.5
1956	126.0	457.0	249.0	93.0	466.0	285.0	410.0	254.0	85.0	301.0	188.0	600.0	3514.0	292.8
1957	348.0	425.0	658.0	243.0	175.0	105.0	1268.0	140.0	59.0	25.0	12.0	478.0	3936.0	328.0
1958	473.0	335.0	382.0	350.0	224.0	655.0	212.0	491.0	112.0	341.0	351.0	466.0	4392.0	366.0
1959	376.0	433.0	168.0	239.0	421.0	317.0	293.0	39.0	334.0	185.0	228.0	636.0	3669.0	305.7
1960	393.0	458.0	430.0	452.0	638.0	531.0	74.0	214.0	284.0	282.0	285.0	232.0	4273.0	356.1
1961	319.0	225.0	183.0	432.0	297.0	42.0	174.0	6.0	2.0	2.0	102.0	213.0	1997.0	166.4
1962	580.0	483.0	311.0	43.0	15.0	163.0	531.0	210.0	12.0	276.0	260.0	435.0	3319.0	276.6
1963	575.0	318.0	518.0	356.0	20.0	79.0	16.0	5.0	0.0	53.0	192.0	278.0	2410.0	200.8
1964	212.0	354.0	464.0	212.0	264.0	154.0	80.0	217.0	293.0	624.0	399.0	149.0	3422.0	285.2
1965	375.0	204.0	490.0	163.0	159.0	60.0	98.0	12.0	101.0	124.0	388.0	347.0	2521.0	210.1
1966	427.0	412.0	477.0	263.0	409.0	66.0	36.0	261.0	385.0	426.0	529.0	412.0	4103.0	341.9
1967	577.0	638.0	291.0	186.0	38.0	116.0	253.0	90.0	54.0	136.0	62.0	639.0	3080.0	256.7
1968	238.0	302.0	390.0	500.0	469.0	399.0	1040.0	300.0	751.0	384.0	301.0	604.0	5678.0	473.2
1969	661.0	493.0	602.0	337.0	129.0	100.0	239.0	117.0	138.0	219.0	176.0	600.0	3811.0	317.6
1970	330.0	415.0	382.0	345.0	437.0	361.0	387.0	91.0	382.0	292.0	398.0	438.0	4258.0	354.8
1971	540.0	534.0	476.0	157.0	430.0	395.0	171.0	87.0	293.0	516.0	291.0	347.0	4237.0	353.1
1972	335.0	197.0	542.0	179.0	278.0	94.0	37.0	30.0	16.0	10.0	223.0	340.0	2281.0	190.1
1973	433.0	228.0	498.0	344.0	449.0	257.0	326.0	127.0	887.0	475.0	247.0	375.0	4646.0	387.2
1974	271.0	504.0	243.0	184.0	201.0	108.0	72.0	730.0	325.0	752.0	504.0	463.0	4357.0	363.1
1975	510.0	430.0	495.0	423.0	176.0	97.0	110.0	354.0	550.0	349.0	305.0	501.0	4300.0	358.3
1976	475.0	344.0	494.0	199.0	21.0	95.0	95.0	70.0	40.0	801.0	748.0	253.0	3635.0	302.9
1977	567.0	565.0	638.0	430.0	249.0	166.0	115.0	82.0	213.0	355.0	108.0	524.0	4012.0	334.3
1978	381.0	381.0	306.0	252.0	597.0	639.0	621.0	456.0	771.0	542.0	298.0	372.0	5616.0	468.0
1979	768.0	553.0	282.0	501.0	362.0	789.0	167.0	470.0	126.0	108.0	421.0	245.0	4792.0	399.3
1980	399.0	450.0	222.0	375.0	143.0	22.0	33.0	264.0	35.0	365.0	223.0	326.0	2857.0	238.1
1981	408.0	343.0	302.0	252.0	516.0	465.0	447.0	209.0	199.0	263.0	544.0	288.0	4214.0	351.2
1982	326.0	561.0	400.0	294.0	100.0	52.0	17.0	28.0	0.0	7.0	8.0	353.0	2146.0	178.8
TOTAL	12725.0	12141.0	12005.0	8748.0	8475.0	7797.0	8918.0	6165.0	6873.0	9125.0	8671.0	11962.0	113605.0	9467.1
MEAN	424.2	404.7	400.2	291.6	282.5	259.9	297.3	205.5	229.1	304.2	289.0	398.7	3786.8	315.6
S.D.	138.5	109.9	128.3	118.2	170.4	223.9	336.3	170.9	241.4	214.0	160.6	133.6	960.0	80.0
Cf	0.326	0.272	0.321	0.405	0.603	0.862	1.131	0.832	1.054	0.704	0.556	0.335	0.254	0.254

Table-5.12 M (2) Computer Output of Long-term Base Flow Simulation

********** K.MUJUR (ST. ROWOJEDANG) 1953-1982 ********** RUNOFF (m^3/s)

	1	2	3	4	5	6	7	8	9	10	11	12	TOTAL	MEAN
1953	1.007	1.046	1.082	1.117	1.137	1.074	0.973	0.834	0.676	0.559	0.490	0.500	10.494	0.874
1954	0.560	0.642	0.719	0.799	0.841	0.916	0.938	0.968	0.918	0.863	0.820	0.801	9.786	0.816
1955	0.856	0.903	0.949	0.943	0.912	0.955	1.159	1.278	1.403	1.473	1.430	1.364	13.625	1.135
1956	1.258	1.183	1.097	0.993	0.930	0.857	0.848	0.849	0.807	0.789	0.754	0.797	11.162	0.930
1957	0.831	0.897	1.005	1.040	1.036	0.984	1.119	1.123	1.136	1.051	0.889	0.803	11.917	0.993
1958	0.787	0.793	0.848	0.890	0.873	0.937	0.938	1.017	1.013	1.005	0.975	0.977	11.053	0.921
1959	0.983	1.021	0.999	0.968	0.952	0.925	0.922	0.867	0.838	0.773	0.730	0.777	10.756	0.896
1960	0.823	0.907	0.986	1.045	1.134	1.222	1.215	1.187	1.113	1.028	0.964	0.900	12.524	1.044
1961	0.861	0.816	0.765	0.761	0.760	0.734	0.715	0.632	0.535	0.438	0.359	0.323	7.701	0.642
1962	0.396	0.501	0.612	0.661	0.650	0.620	0.654	0.671	0.665	0.668	0.637	0.653	7.387	0.616
1963	0.736	0.809	0.928	1.001	0.973	0.911	0.797	0.666	0.541	0.423	0.346	0.325	8.456	0.705
1964	0.331	0.393	0.497	0.577	0.662	0.694	0.679	0.667	0.659	0.724	0.792	0.824	7.498	0.625
1965	0.864	0.846	0.877	0.872	0.855	0.793	0.710	0.590	0.495	0.419	0.425	0.464	8.210	0.684
1966	0.547	0.647	0.763	0.841	0.924	0.917	0.866	0.816	0.782	0.786	0.847	0.905	9.642	0.803
1967	0.997	1.107	1.158	1.170	1.102	0.996	0.895	0.776	0.662	0.569	0.467	0.496	10.396	0.866
1968	0.514	0.584	0.676	0.777	0.876	0.970	1.167	1.255	1.413	1.459	1.448	1.454	12.594	1.050
1969	1.479	1.480	1.520	1.491	1.389	1.249	1.099	0.950	0.828	0.735	0.648	0.664	13.531	1.128
1970	0.682	0.752	0.827	0.890	0.955	1.001	1.038	1.010	1.001	0.956	0.942	0.951	11.006	0.917
1971	1.003	1.066	1.136	1.132	1.142	1.131	1.082	1.007	0.937	0.907	0.880	0.886	12.309	1.026
1972	0.888	0.868	0.907	0.892	0.891	0.851	0.772	0.662	0.543	0.424	0.369	0.368	8.434	0.703
1973	0.428	0.490	0.603	0.694	0.804	0.873	0.928	0.916	1.023	1.077	1.115	1.145	10.097	0.841
1974	1.112	1.108	1.075	1.027	0.966	0.878	0.760	0.774	0.766	0.901	1.018	1.116	11.502	0.959
1975	1.204	1.259	1.304	1.334	1.295	1.197	1.060	0.943	0.909	0.894	0.905	0.946	13.250	1.104
1976	0.983	1.014	1.075	1.075	1.020	0.929	0.798	0.666	0.551	0.595	0.702	0.799	10.207	0.851
1977	0.948	1.062	1.185	1.287	1.322	1.281	1.185	1.033	0.893	0.801	0.712	0.727	12.436	1.036
1978	0.734	0.775	0.819	0.848	0.924	1.030	1.154	1.253	1.383	1.453	1.469	1.452	13.292	1.108
1979	1.479	1.487	1.468	1.454	1.384	1.403	1.340	1.327	1.234	1.122	1.042	0.950	15.691	1.308
1980	0.914	0.927	0.909	0.911	0.873	0.792	0.705	0.644	0.556	0.550	0.533	0.557	8.871	0.739
1981	0.613	0.673	0.752	0.775	0.850	0.919	0.997	1.019	1.006	0.963	0.968	0.951	10.465	0.872
1982	0.961	1.009	1.032	1.041	0.997	0.908	0.788	0.662	0.525	0.403	0.296	0.274	8.896	0.741
TOTAL	25.777	27.066	28.552	29.305	29.431	28.947	28.302	27.063	25.811	24.808	23.973	24.152	323.188	26.933
MEAN	0.859	0.902	0.952	0.977	0.981	0.965	0.943	0.902	0.860	0.827	0.799	0.805	10.773	0.898
S.D.	0.279	0.260	0.236	0.216	0.186	0.173	0.182	0.216	0.269	0.299	0.313	0.309	2.046	0.171
CE	0.325	0.288	0.248	0.220	0.190	0.180	0.193	0.239	0.313	0.361	0.392	0.383	0.190	0.190

Table-5.12 M (3) Computer Output of Long-term Base Flow Simulation

********** K.MUJUR (ST. ROWOJEDANG) 1953-1982 ********** RUNOFF ($10^3 m^3$/day)

	1	2	3	4	5	6	7	8	9	10	11	12	TOTAL	MEAN
1953	87.0	90.4	93.5	96.5	98.2	92.8	84.1	72.1	58.4	48.3	42.3	43.2	906.7	75.6
1954	48.4	55.5	62.1	69.0	72.7	79.2	81.0	83.6	79.3	74.6	70.8	69.2	845.5	70.5
1955	74.0	78.0	82.0	81.5	78.8	82.5	100.1	110.4	121.2	127.3	123.6	117.9	1177.2	98.1
1956	108.7	102.2	94.8	85.8	80.4	74.0	73.2	73.3	69.8	68.1	65.2	68.9	964.4	80.4
1957	71.8	77.5	86.8	89.9	89.5	85.1	96.7	97.1	98.2	90.8	76.8	69.4	1029.6	85.8
1958	68.0	68.5	73.2	76.9	75.5	80.9	81.0	87.9	87.5	86.8	84.3	84.4	955.0	79.6
1959	85.0	88.2	86.3	83.6	82.3	80.0	79.7	74.9	72.4	66.8	63.1	67.1	929.4	77.4
1960	71.1	78.3	85.2	90.3	98.0	105.6	105.0	102.5	96.2	88.8	83.3	77.8	1082.1	90.2
1961	74.4	70.5	66.1	65.8	65.7	63.4	61.8	54.6	46.2	37.9	31.0	27.9	665.4	55.4
1962	34.2	43.2	52.8	57.1	56.2	53.6	56.5	58.0	57.5	57.7	55.0	56.4	638.3	53.2
1963	63.6	69.9	80.1	86.5	84.1	78.7	68.8	57.6	46.7	36.5	29.9	28.1	730.6	60.9
1964	28.6	33.9	42.9	49.9	57.2	59.9	58.7	57.6	56.9	62.6	68.4	71.2	647.8	54.0
1965	74.6	73.1	75.8	75.3	73.8	68.5	61.3	51.0	42.8	36.2	36.7	40.1	709.3	59.1
1966	47.2	55.9	65.9	72.7	79.8	79.2	74.8	70.5	67.5	67.9	73.2	78.2	833.0	69.4
1967	86.1	95.6	100.0	101.1	95.3	86.1	77.3	67.0	57.2	49.2	40.4	42.9	898.2	74.8
1968	44.4	50.4	58.4	67.1	75.7	83.8	100.9	108.5	122.1	126.1	125.1	125.6	1088.1	90.7
1969	127.8	127.9	131.4	128.8	120.0	107.9	94.9	82.0	71.5	63.5	56.0	57.4	1169.1	97.4
1970	58.9	65.0	71.5	76.9	82.5	86.5	89.6	87.2	86.5	82.6	81.4	82.2	950.9	79.2
1971	86.7	92.3	98.2	97.8	98.6	97.7	93.4	87.0	80.9	78.4	76.0	76.5	1063.5	88.6
1972	76.8	75.0	78.4	77.1	77.0	73.5	66.7	57.2	46.9	36.6	31.9	31.8	728.7	60.7
1973	37.0	42.3	52.1	60.0	69.5	75.4	80.2	79.2	88.4	93.1	96.3	99.0	872.4	72.7
1974	96.1	95.7	92.9	88.8	83.5	75.8	65.7	66.9	66.2	77.8	88.0	96.4	993.8	82.8
1975	104.0	108.7	112.6	115.3	111.9	103.5	91.6	81.5	78.5	77.2	78.2	81.8	1144.8	95.4
1976	84.9	87.6	92.9	92.9	88.1	80.3	69.0	57.5	47.6	51.4	60.7	69.0	881.9	73.5
1977	81.9	91.8	102.4	111.2	114.2	110.7	102.3	89.3	77.1	69.2	61.5	62.8	1074.5	89.5
1978	63.4	66.9	70.8	73.2	79.9	89.0	99.7	108.2	119.5	125.5	126.9	125.4	1148.5	95.7
1979	127.7	128.5	126.8	125.6	119.6	121.2	115.8	114.7	106.7	97.0	90.1	82.1	1355.7	113.0
1980	78.9	80.1	78.6	78.7	75.4	68.4	60.9	55.6	48.1	47.5	46.1	48.1	766.5	63.9
1981	53.0	58.2	63.3	66.9	73.5	79.4	86.1	88.0	86.9	83.2	83.6	82.2	904.2	75.4
1982	83.0	87.2	89.2	90.0	86.1	78.4	68.1	57.2	45.4	34.8	25.5	23.7	768.6	64.1
TOTAL	2227.2	2338.5	2466.9	2532.0	2542.8	2501.0	2445.3	2335.2	2230.1	2143.4	2071.3	2086.8	27923.7	2327.0
MEAN	74.2	78.0	82.2	84.4	84.8	83.4	81.5	77.9	74.3	71.4	69.0	69.6	930.8	77.6
S.D.	24.1	22.5	20.4	18.6	16.1	15.0	15.7	18.6	23.2	25.8	27.0	26.7	176.8	14.7
CF	0.325	0.288	0.248	0.221	0.190	0.180	0.193	0.239	0.313	0.361	0.392	0.383	0.190	0.190

Table-5.12 R (1) Computer Output of Long-term Base Flow Simulation

********** K.REJALI (ST. CHD NO.1) 1953-1982 ********** RAINFALL (mm)

	1	2	3	4	5	6	7	8	9	10	11	12	TOTAL	MEAN
1953	205.0	219.0	331.0	227.0	310.0	79.0	57.0	207.0	26.0	129.0	226.0	317.0	2333.0	194.4
1954	389.0	250.0	58.0	346.0	227.0	335.0	237.0	290.0	67.0	80.0	417.0	540.0	3236.0	269.7
1955	279.0	169.0	207.0	72.0	160.0	750.0	888.0	318.0	318.0	453.0	243.0	269.0	4126.0	343.8
1956	148.0	320.0	128.0	64.0	243.0	208.0	418.0	321.0	93.0	242.0	244.0	472.0	2901.0	241.7
1957	189.0	274.0	616.0	251.0	103.0	187.0	1537.0	155.0	111.0	61.0	42.0	399.0	3925.0	327.1
1958	216.0	301.0	337.0	178.0	168.0	603.0	362.0	401.0	96.0	351.0	204.0	313.0	3530.0	294.2
1959	377.0	444.0	194.0	251.0	457.0	254.0	379.0	41.0	224.0	141.0	278.0	310.0	3350.0	279.2
1960	421.0	261.0	508.0	179.0	172.0	664.0	155.0	220.0	83.0	216.0	219.0	121.0	3219.0	268.2
1961	464.0	279.0	201.0	136.0	215.0	13.0	176.0	5.0	44.0	21.0	58.0	216.0	1830.0	152.5
1962	298.0	294.0	241.0	251.0	229.0	292.0	610.0	176.0	35.0	264.0	120.0	410.0	3220.0	268.3
1963	516.0	169.0	454.0	375.0	8.0	89.0	9.0	0.0	24.0	240.0	240.0	376.0	2500.0	208.3
1964	292.0	288.0	452.0	292.0	632.0	139.0	107.0	162.0	445.0	712.0	313.0	163.0	3997.0	333.1
1965	385.0	201.0	275.0	214.0	81.0	173.0	57.0	34.0	66.0	97.0	339.0	178.0	2100.0	175.0
1966	345.0	337.0	392.0	262.0	377.0	165.0	17.0	194.0	161.0	652.0	544.0	377.0	3823.0	318.6
1967	336.0	424.0	141.0	74.0	79.0	38.0	163.0	83.0	107.0	99.0	75.0	463.0	2082.0	173.5
1968	276.0	219.0	342.0	388.0	636.0	242.0	1148.0	346.0	417.0	234.0	140.0	364.0	4752.0	396.0
1969	378.0	385.0	298.0	454.0	77.0	195.0	151.0	142.0	95.0	253.0	156.0	388.0	2972.0	247.7
1970	246.0	215.0	156.0	239.0	372.0	353.0	230.0	75.0	209.0	183.0	458.0	382.0	3118.0	259.8
1971	402.0	304.0	240.0	62.0	448.0	372.0	60.0	72.0	317.0	388.0	311.0	186.0	3162.0	263.5
1972	342.0	235.0	303.0	126.0	206.0	90.0	21.0	17.0	16.0	32.0	261.0	239.0	1888.0	157.3
1973	532.0	333.0	420.0	336.0	489.0	433.0	532.0	135.0	728.0	391.0	228.0	212.0	4769.0	397.4
1974	301.0	426.0	216.0	164.0	148.0	121.0	78.0	616.0	501.0	874.0	353.0	411.0	4209.0	350.7
1975	445.0	251.0	339.0	276.0	204.0	120.0	75.0	313.0	385.0	420.0	244.0	295.0	3367.0	280.6
1976	235.0	302.0	307.0	155.0	44.0	48.0	96.0	65.0	46.0	716.0	904.0	176.0	3094.0	257.8
1977	413.0	257.0	359.0	329.0	65.0	57.0	113.0	34.0	111.0	108.0	90.0	337.0	2273.0	189.4
1978	351.0	351.0	231.0	313.0	467.0	347.0	235.0	203.0	333.0	251.0	193.0	182.0	3457.0	288.1
1979	312.0	499.0	204.0	286.0	337.0	1055.0	171.0	422.0	100.0	58.0	426.0	265.0	4135.0	344.6
1980	324.0	153.0	118.0	220.0	161.0	18.0	32.0	414.0	49.0	641.0	262.0	273.0	2665.0	222.1
1981	208.0	360.0	136.0	127.0	488.0	498.0	469.0	207.0	179.0	109.0	362.0	181.0	3324.0	277.0
1982	117.0	274.0	319.0	173.0	66.0	54.0	17.0	28.0	3.0	9.0	1.0	105.0	1166.0	97.2
TOTAL	9742.0	8794.0	8523.0	6822.0	7669.0	7992.0	8600.0	5696.0	5389.0	8425.0	7951.0	8920.0	94523.0	7876.8
MEAN	324.7	293.1	284.1	227.4	255.6	266.4	286.7	189.9	179.6	280.8	265.0	297.3	3150.8	262.6
S.D.	100.8	83.1	124.8	100.5	173.5	241.2	350.4	149.9	172.8	231.2	172.5	109.8	858.0	71.5
CV	0.311	0.283	0.439	0.442	0.679	0.905	1.222	0.789	0.962	0.823	0.651	0.369	0.272	0.272

Table-5.12 R (2) Computer Output of Long-term Base Flow Simulation

********** K.REJALI (ST. CHD NO.1) 1953-1982 ********** RUNOFF (m^3/s)

	1	2	3	4	5	6	7	8	9	10	11	12	TOTAL	MEAN
1953	1.251	1.158	1.176	1.119	1.141	0.974	0.601	0.766	0.596	0.547	0.595	0.715	10.838	0.903
1954	0.876	0.898	0.761	0.865	0.865	0.957	0.959	0.996	0.847	0.721	0.880	1.118	10.742	0.895
1955	1.126	1.040	0.980	0.817	0.756	1.178	1.657	1.615	1.554	1.576	1.425	1.335	15.060	1.255
1956	1.178	1.182	1.035	0.853	0.831	0.786	0.934	0.994	0.862	0.864	0.866	1.054	11.439	0.953
1957	0.999	1.014	1.293	1.235	1.066	0.979	1.966	1.741	1.497	1.229	0.961	1.045	15.025	1.252
1958	0.991	1.024	1.075	0.985	0.890	1.140	1.188	1.280	1.111	1.150	1.066	1.080	12.981	1.082
1959	1.155	1.267	1.167	1.116	1.227	1.166	1.221	1.006	0.961	0.858	0.881	0.935	12.960	1.080
1960	1.067	1.059	1.237	1.125	1.020	1.323	1.186	1.123	0.953	0.905	0.874	0.774	12.646	1.054
1961	0.967	0.986	0.940	0.848	0.821	0.651	0.645	0.511	0.427	0.341	0.297	0.388	7.820	0.652
1962	0.533	0.661	0.725	0.779	0.804	0.874	1.184	1.109	0.924	0.933	0.821	0.961	10.308	0.859
1963	1.172	1.079	1.214	1.256	1.000	0.845	0.657	0.506	0.404	0.490	0.566	0.735	9.923	0.827
1964	0.814	0.872	1.047	1.075	1.367	1.226	1.069	0.971	1.102	1.436	1.408	1.257	13.643	1.137
1965	1.285	1.158	1.118	1.047	0.690	0.834	0.690	0.547	0.454	0.412	0.580	0.600	9.617	0.801
1966	0.746	0.862	0.999	1.014	1.110	1.025	0.832	0.805	0.756	1.103	1.319	1.363	11.935	0.995
1967	1.353	1.398	1.217	1.015	0.656	0.699	0.667	0.577	0.516	0.460	0.400	0.662	9.821	0.818
1968	0.745	0.776	0.896	1.025	1.328	1.273	1.928	1.652	1.821	1.640	1.391	1.372	16.048	1.337
1969	1.376	1.395	1.336	1.398	1.152	1.030	0.907	0.612	0.709	0.748	0.707	0.850	12.420	1.035
1970	0.865	0.850	0.792	0.808	0.934	1.027	1.011	0.667	0.840	0.797	0.982	1.088	10.858	0.905
1971	1.192	1.197	1.136	0.940	1.078	1.151	0.974	0.627	0.883	0.988	1.025	0.962	12.353	1.029
1972	1.026	0.995	1.024	0.909	0.873	0.761	0.610	0.479	0.367	0.295	0.421	0.517	8.278	0.690
1973	0.829	0.936	1.087	1.143	1.302	1.397	1.550	1.365	1.657	1.636	1.481	1.333	15.716	1.310
1974	1.270	1.327	1.215	1.083	0.954	0.824	0.691	1.005	1.194	1.653	1.627	1.624	14.466	1.206
1975	1.637	1.493	1.456	1.377	1.255	1.080	0.886	0.908	0.994	1.110	1.076	1.078	14.351	1.196
1976	1.031	1.046	1.070	0.976	0.810	0.667	0.561	0.489	0.404	0.866	1.414	1.303	10.656	0.888
1977	1.374	1.291	1.300	1.301	1.099	0.920	0.803	0.639	0.559	0.492	0.440	0.598	10.816	0.901
1978	0.745	0.871	0.883	0.953	1.132	1.189	1.147	1.079	1.116	1.082	1.006	0.931	12.133	1.011
1979	0.970	1.154	1.081	1.078	1.112	1.706	1.527	1.556	1.319	1.071	1.164	1.123	14.860	1.238
1980	1.146	1.028	0.891	0.849	0.767	0.605	0.492	0.699	0.597	0.969	0.989	1.005	10.038	0.836
1981	0.967	1.044	0.943	0.848	1.057	1.240	1.367	1.261	1.132	0.964	1.029	0.957	12.808	1.067
1982	0.850	0.883	0.941	0.873	0.728	0.599	0.469	0.378	0.289	0.221	0.161	0.196	6.588	0.549
TOTAL	31.535	31.943	32.034	30.710	30.227	30.125	30.597	28.761	26.844	27.558	27.853	28.960	357.147	29.761
MEAN	1.051	1.065	1.068	1.024	1.008	1.004	1.020	0.959	0.895	0.919	0.928	0.965	11.905	0.992
S.D.	0.235	0.194	0.173	0.167	0.179	0.254	0.394	0.384	0.398	0.401	0.374	0.316	2.338	0.195
Cf	0.223	0.182	0.162	0.163	0.178	0.253	0.386	0.400	0.445	0.437	0.403	0.327	0.196	0.196

Table-5.12 R (3) Computer Output of Long-term Base Flow Simulation

********** K.REJALI (ST. CHO NO.1) 1953-1982 ********** RUNOFF ($10^3 m^3/day$)

	1	2	3	4	5	6	7	8	9	10	11	12	TOTAL	MEAN
1953	108.1	100.0	101.6	96.7	98.6	84.1	69.2	66.1	51.5	47.3	51.4	61.7	936.4	78.0
1954	75.7	77.6	65.7	74.7	74.7	82.7	82.9	86.0	73.2	62.3	76.0	96.6	928.1	77.3
1955	97.3	69.8	84.7	70.6	65.3	101.8	143.2	139.5	134.2	136.2	123.1	115.4	1301.2	108.4
1956	101.8	102.1	89.4	73.7	71.8	67.9	80.7	85.9	74.5	74.6	74.9	91.1	988.3	82.4
1957	86.3	87.6	111.7	106.7	92.1	84.6	169.8	150.4	129.4	106.2	83.0	90.3	1298.1	108.2
1958	85.6	88.5	92.9	85.1	76.9	98.5	102.6	110.6	96.0	99.4	92.1	93.4	1121.6	93.5
1959	99.8	109.4	100.8	96.4	106.0	100.7	105.5	86.9	83.0	74.2	76.1	80.8	1119.7	93.3
1960	92.2	91.5	106.8	97.2	88.1	114.3	102.5	97.0	82.4	78.2	75.5	66.9	1092.6	91.1
1961	83.6	85.2	81.2	73.3	71.0	56.2	55.6	44.1	36.9	29.5	25.7	33.5	675.7	56.3
1962	46.1	57.1	62.6	67.3	69.5	75.5	102.3	95.8	79.8	80.6	70.9	83.0	890.6	74.2
1963	101.2	93.2	104.9	108.6	86.4	73.0	56.8	43.8	34.9	42.3	48.9	63.5	857.4	71.4
1964	70.3	75.3	90.4	92.8	118.1	105.9	92.3	83.9	95.3	124.1	121.6	108.6	1178.7	98.2
1965	111.0	100.1	96.6	90.5	76.9	72.1	59.6	47.3	39.3	35.6	50.1	51.8	830.9	69.2
1966	64.4	74.5	86.3	87.6	95.9	88.6	71.9	69.6	65.3	95.3	114.0	117.8	1031.2	85.9
1967	116.9	120.7	105.1	87.7	74.1	60.4	57.6	49.8	44.6	39.7	34.6	57.2	848.6	70.7
1968	64.4	67.0	77.4	88.5	114.8	110.0	166.6	160.0	157.3	141.7	120.2	118.5	1386.6	115.5
1969	118.8	120.5	115.5	120.8	99.5	89.0	78.3	70.2	61.2	64.6	61.1	73.5	1073.1	89.4
1970	74.7	73.5	68.4	69.8	80.7	88.7	87.3	74.9	72.6	68.8	84.8	94.0	938.2	78.2
1971	103.0	103.4	98.1	81.2	93.2	99.4	84.1	71.5	76.3	85.4	88.6	83.1	1067.3	88.9
1972	88.7	86.0	88.4	78.6	75.5	65.7	52.7	41.4	31.7	25.5	36.4	44.7	715.2	59.6
1973	71.6	80.9	93.9	98.7	112.5	120.7	134.0	117.9	143.2	141.4	127.9	115.2	1357.9	113.2
1974	109.7	114.6	105.0	93.5	82.4	71.2	59.7	86.8	103.2	142.8	140.6	140.3	1249.9	104.2
1975	141.4	129.0	125.8	119.0	108.5	93.3	76.5	78.5	85.9	95.9	93.0	93.2	1239.9	103.3
1976	89.1	90.4	92.4	84.3	70.0	57.6	50.2	42.2	34.9	74.9	122.1	112.6	920.7	76.7
1977	118.7	111.6	112.3	112.4	94.9	79.5	69.4	55.2	48.3	42.5	38.0	51.7	934.5	77.9
1978	64.3	75.3	76.3	82.3	97.8	102.7	99.1	93.2	96.4	93.5	86.9	80.5	1048.3	87.4
1979	83.8	99.7	93.4	93.1	96.1	147.4	131.9	134.4	114.0	92.5	100.6	97.0	1283.9	107.0
1980	99.0	88.9	77.0	73.4	66.3	52.3	42.5	60.4	51.6	83.7	85.4	86.8	867.3	72.3
1981	83.6	90.2	81.5	73.3	91.3	107.1	118.1	108.9	97.8	83.2	88.9	82.7	1106.6	92.2
1982	73.5	76.3	81.3	75.4	62.9	51.8	40.5	32.7	24.9	19.1	13.9	16.9	569.2	47.4
TOTAL	2724.6	2759.9	2767.7	2653.4	2611.6	2602.8	2643.6	2485.0	2319.5	2381.0	2406.5	2502.1	30857.7	2571.3
MEAN	90.8	92.0	92.3	88.4	87.1	86.8	88.1	82.8	77.3	79.4	80.2	83.4	1028.6	85.7
S.D.	20.3	16.7	14.9	14.5	15.5	22.0	34.0	33.1	34.4	34.7	32.3	27.3	202.0	16.8
CF	0.223	0.182	0.162	0.163	0.178	0.253	0.386	0.400	0.445	0.437	0.403	0.327	0.196	0.196

Table-5.12 G (1) Computer Output of Long-term Base Flow Simulation

##########K.GLIDIK (ST. PRONOJIWO DAM) 1953-1982 ########## RAINFALL (mm)

	1	2	3	4	5	6	7	8	9	10	11	12	TOTAL	MEAN
1953	237.0	250.0	357.0	258.0	337.0	117.0	97.0	259.0	67.0	165.0	257.0	343.0	2724.0	227.0
1954	412.0	280.0	98.0	371.0	258.0	360.0	267.0	318.0	106.0	118.0	438.0	555.0	3581.0	298.4
1955	307.0	203.0	239.0	111.0	194.0	754.0	886.0	344.0	344.0	473.0	273.0	298.0	4426.0	368.8
1956	183.0	346.0	164.0	103.0	273.0	240.0	439.0	347.0	131.0	272.0	274.0	491.0	3263.0	271.9
1957	222.0	303.0	627.0	281.0	140.0	220.0	1502.0	190.0	148.0	100.0	82.0	421.0	4236.0	353.0
1958	248.0	328.0	362.0	211.0	202.0	615.0	386.0	423.0	134.0	376.0	236.0	340.0	3861.0	321.7
1959	400.0	464.0	227.0	281.0	476.0	284.0	402.0	81.0	255.0	176.0	306.0	337.0	3689.0	307.4
1960	442.0	290.0	525.0	212.0	206.0	673.0	190.0	251.0	121.0	248.0	250.0	157.0	3565.0	297.1
1961	483.0	307.0	233.0	173.0	247.0	55.0	210.0	47.0	84.0	62.0	98.0	248.0	2247.0	187.2
1962	325.0	322.0	271.0	281.0	260.0	320.0	622.0	210.0	76.0	293.0	156.0	432.0	3568.0	297.3
1963	532.0	203.0	473.0	398.0	50.0	127.0	51.0	42.0	65.0	270.0	270.0	399.0	2880.0	240.0
1964	320.0	316.0	472.0	320.0	642.0	174.0	144.0	196.0	465.0	718.0	340.0	197.0	4304.0	358.7
1965	408.0	233.0	304.0	246.0	119.0	207.0	97.0	75.0	105.0	135.0	364.0	211.0	2504.0	208.7
1966	370.0	362.0	415.0	291.0	400.0	199.0	59.0	227.0	195.0	661.0	559.0	400.0	4138.0	344.8
1967	361.0	445.0	176.0	113.0	117.0	79.0	197.0	121.0	144.0	136.0	114.0	482.0	2485.0	207.1
1968	304.0	250.0	367.0	411.0	646.0	272.0	1132.0	371.0	438.0	265.0	175.0	388.0	5019.0	418.2
1969	401.0	408.0	325.0	473.0	116.0	228.0	186.0	177.0	133.0	283.0	191.0	411.0	3332.0	277.7
1970	276.0	247.0	191.0	269.0	396.0	378.0	261.0	114.0	241.0	216.0	477.0	405.0	3471.0	289.2
1971	376.0	279.0	363.0	70.0	710.0	404.0	80.0	55.0	341.0	456.0	326.0	281.0	3741.0	311.7
1972	251.0	184.0	436.0	119.0	296.0	88.0	17.0	19.0	13.0	0.0	268.0	251.0	1942.0	161.8
1973	505.0	436.0	508.0	261.0	423.0	400.0	389.0	216.0	216.0	793.0	462.0	243.0	4852.0	404.3
1974	328.0	348.0	171.0	157.0	211.0	45.0	34.0	934.0	425.0	1131.0	416.0	520.0	4720.0	393.3
1975	353.0	334.0	425.0	442.0	460.0	66.0	121.0	277.0	674.0	692.0	383.0	313.0	4540.0	378.3
1976	263.0	300.0	325.0	200.0	12.0	57.0	68.0	133.0	79.0	692.0	976.0	118.0	3223.0	268.6
1977	336.0	110.0	337.0	338.0	142.0	94.0	139.0	49.0	160.0	121.0	53.0	53.0	1932.0	161.0
1978	274.0	237.0	338.0	298.0	523.0	682.0	614.0	452.0	591.0	551.0	226.0	215.0	5001.0	416.7
1979	278.0	382.0	215.0	422.0	404.0	698.0	177.0	269.0	76.0	92.0	482.0	258.0	3753.0	312.7
1980	237.0	198.0	124.0	295.0	179.0	19.0	29.0	378.0	95.0	444.0	335.0	209.0	2542.0	211.8
1981	231.0	231.0	98.0	143.0	471.0	717.0	667.0	295.0	159.0	415.0	381.0	239.0	4047.0	337.2
1982	84.0	197.0	300.0	198.0	61.0	43.0	0.0	17.0	0.0	0.0	0.0	241.0	1147.0	95.6
TOTAL	9747.0	8793.0	9472.0	7746.0	8971.0	8615.0	9463.0	6867.0	6081.0	10354.0	9168.0	9456.0	104733.0	8727.2
MEAN	324.9	293.1	315.7	258.2	299.0	287.2	315.4	228.9	202.7	345.1	305.6	315.2	3491.1	290.9
S.D.	97.1	82.8	131.2	106.8	182.5	229.7	347.3	180.4	166.1	266.3	183.2	119.8	967.7	80.6
CE	0.299	0.283	0.416	0.414	0.610	0.800	1.101	0.788	0.820	0.772	0.600	0.380	0.277	0.277

Table-5.12 G (2) Computer Output of Long-term Base Flow Simulation

**********K.GLIDIK (ST. PRONOJIWO DAM) 1953-1982 ********** RUNOFF (m^3/s)

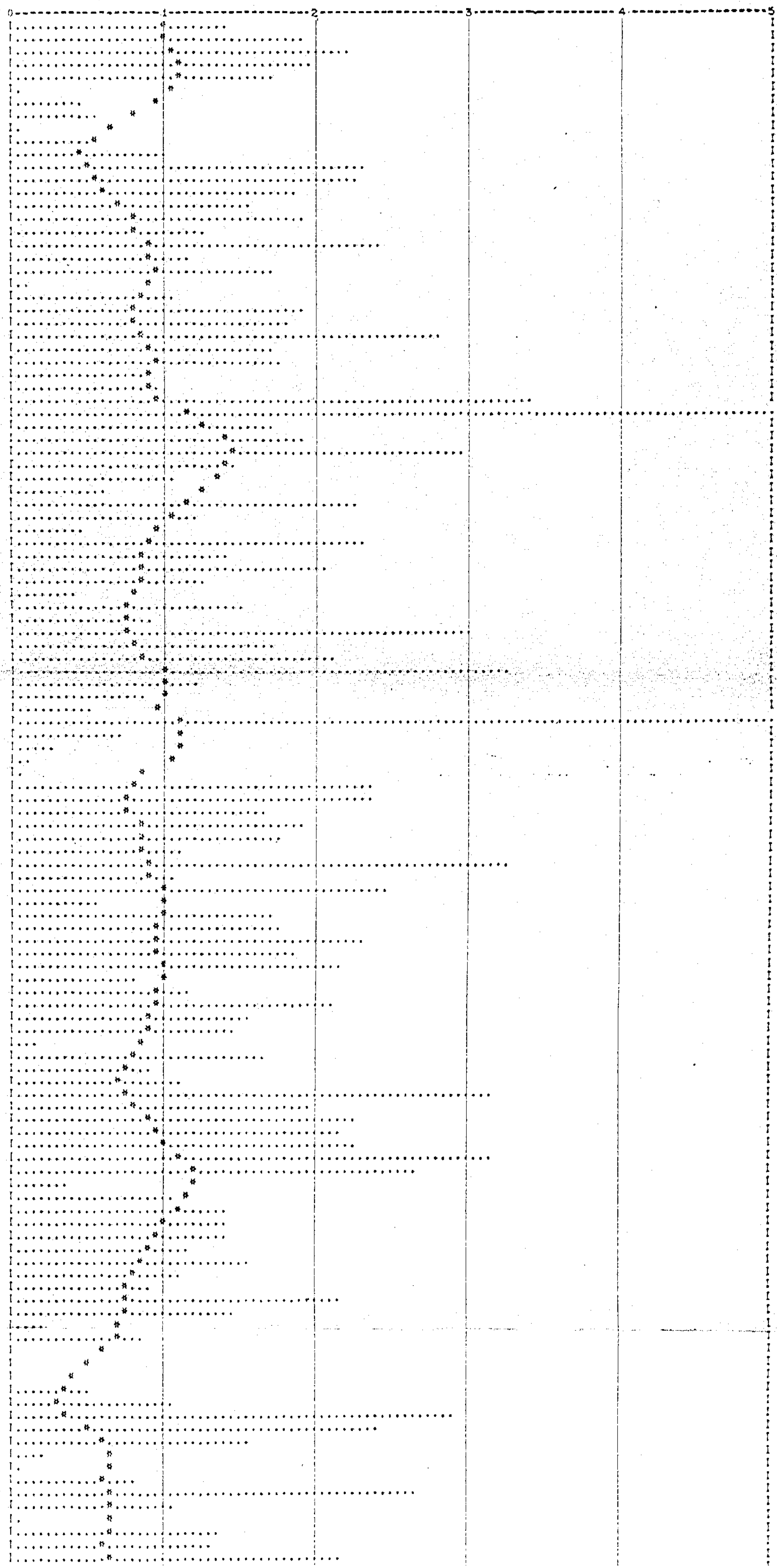
	1	2	3	4	5	6	7	8	9	10	11	12	TOTAL	MEAN
1953	2.959	2.991	2.991	2.940	2.923	2.774	2.537	2.279	1.962	1.746	1.644	1.666	29.413	2.451
1954	1.818	1.972	2.006	2.104	2.131	2.249	2.331	2.415	2.353	2.224	2.176	2.291	26.071	2.173
1955	2.447	2.559	2.557	2.395	2.251	2.400	2.827	3.219	3.523	3.631	3.554	3.487	34.849	2.904
1956	3.317	3.177	2.955	2.666	2.365	2.145	2.130	2.202	2.207	2.222	2.207	2.319	29.934	2.494
1957	2.383	2.485	2.697	2.799	2.804	2.718	3.248	3.468	3.742	3.570	3.173	2.906	35.993	2.999
1958	2.705	2.592	2.581	2.527	2.372	2.433	2.500	2.773	2.841	2.883	2.785	2.748	31.741	2.645
1959	2.747	2.842	2.853	2.845	2.853	2.809	2.884	2.775	2.680	2.479	2.365	2.295	32.427	2.702
1960	2.375	2.436	2.635	2.670	2.668	2.841	2.846	2.898	2.761	2.589	2.406	2.246	31.372	2.614
1961	2.241	2.262	2.304	2.264	2.200	2.021	1.943	1.750	1.578	1.375	1.191	1.114	22.244	1.854
1962	1.174	1.347	1.551	1.748	1.892	2.048	2.351	2.522	2.575	2.549	2.374	2.357	24.487	2.041
1963	2.480	2.537	2.717	2.618	2.719	2.575	2.293	1.982	1.695	1.515	1.423	1.528	26.283	2.190
1964	1.672	1.859	2.118	2.337	2.723	2.878	2.928	2.808	2.753	2.900	3.053	3.115	31.143	2.595
1965	3.134	3.002	2.900	2.789	2.607	2.457	2.212	1.914	1.639	1.428	1.412	1.436	26.930	2.244
1966	1.594	1.785	2.041	2.244	2.476	2.549	2.493	2.390	2.219	2.332	2.549	2.816	27.488	2.291
1967	3.008	3.153	3.103	2.977	2.737	2.430	2.176	1.896	1.661	1.459	1.307	1.387	27.295	2.275
1968	1.517	1.716	1.952	2.181	2.545	2.786	3.421	3.751	4.104	4.117	3.916	3.689	35.695	2.975
1969	3.535	3.418	3.314	3.286	3.053	2.871	2.604	2.402	2.197	2.085	1.946	1.973	32.683	2.724
1970	1.998	2.051	2.061	2.078	2.163	2.298	2.406	2.390	2.333	2.209	2.257	2.360	26.605	2.217
1971	2.537	2.642	2.722	2.595	2.755	2.852	2.884	2.748	2.575	2.478	2.492	2.536	31.817	2.651
1972	2.528	2.454	2.453	2.334	2.314	2.199	2.005	1.709	1.381	1.063	0.958	0.952	22.350	1.862
1973	1.199	1.534	1.965	2.278	2.591	2.811	3.010	3.068	3.021	3.172	3.267	3.342	31.258	2.605
1974	3.333	3.244	3.059	2.864	2.619	2.313	2.007	2.136	2.255	2.969	3.454	3.931	34.184	2.849
1975	4.094	4.126	4.064	4.039	4.002	3.743	3.375	2.936	2.830	2.969	3.205	3.355	42.738	3.562
1976	3.333	3.218	3.098	2.954	2.705	2.397	1.994	1.633	1.335	1.464	1.983	2.355	28.470	2.372
1977	2.737	2.740	2.732	2.734	2.681	2.521	2.318	1.980	1.683	1.427	1.231	1.102	25.885	2.157
1978	1.069	1.089	1.258	1.467	1.818	2.296	2.826	3.274	3.686	3.979	4.044	3.945	30.751	2.563
1979	3.705	3.485	3.229	3.090	2.967	3.102	3.090	3.095	2.873	2.606	2.504	2.404	36.148	3.012
1980	2.369	2.297	2.134	2.010	1.901	1.743	1.582	1.547	1.439	1.580	1.708	1.851	22.161	1.847
1981	1.961	2.008	1.941	1.879	1.957	2.251	2.709	3.036	3.154	3.177	3.150	3.105	30.329	2.527
1982	2.950	2.746	2.543	2.326	2.062	1.784	1.484	1.204	0.929	0.685	0.498	0.485	19.695	1.641
TOTAL	74.922	75.766	76.532	76.240	75.873	75.294	75.414	74.203	71.985	70.881	70.233	71.094	888.439	74.036
MEAN	2.497	2.526	2.551	2.541	2.529	2.510	2.514	2.473	2.399	2.363	2.341	2.370	29.615	2.468
S.D.	0.763	0.677	0.573	0.501	0.434	0.402	0.484	0.614	0.774	0.861	0.889	0.891	4.933	0.411
CE	0.305	0.268	0.225	0.197	0.172	0.160	0.193	0.248	0.323	0.364	0.380	0.376	0.167	0.167

Table-5.12 G (3) Computer Output of Long-term Base Flow Simulation

**********K.GLIDIK (ST. PRUNOJIWO DAM) 1953-1982 ********** RUNOFF ($10^3 m^3/day$)

	1	2	3	4	5	6	7	8	9	10	11	12	TOTAL	MEAN
1953	255.7	258.4	258.4	254.0	252.6	239.7	219.2	196.9	169.5	150.9	142.0	144.0	2541.3	211.8
1954	157.1	170.4	173.3	181.8	184.1	194.3	201.4	208.7	203.3	192.1	188.0	198.0	2252.5	187.7
1955	211.4	221.1	220.9	206.9	194.5	207.4	244.3	278.1	304.4	313.7	307.0	301.3	3010.9	250.9
1956	286.6	274.5	255.3	230.5	206.0	185.3	184.0	190.2	190.7	192.0	190.7	200.3	2586.3	215.5
1957	205.9	214.7	233.0	241.9	242.3	234.9	280.6	299.7	325.3	308.4	274.1	251.0	3109.8	259.2
1958	233.7	223.9	223.0	216.4	205.0	210.2	216.0	239.6	245.5	249.1	240.6	237.5	2742.4	228.5
1959	237.3	245.5	246.5	245.8	246.5	242.7	249.2	239.7	231.5	214.2	204.3	198.3	2801.7	233.5
1960	205.2	210.5	227.7	230.7	230.5	245.5	245.9	250.4	238.6	223.7	207.9	194.1	2710.5	225.9
1961	193.7	195.4	199.0	195.6	190.1	174.6	167.9	151.2	136.4	118.8	102.9	96.2	1921.9	160.2
1962	101.4	116.4	134.0	151.0	163.5	176.9	203.1	217.9	222.5	220.2	205.1	203.7	2115.7	176.3
1963	214.3	219.2	234.7	243.5	234.9	222.5	198.1	171.2	146.5	130.9	123.0	132.0	2270.9	189.2
1964	144.5	160.5	183.0	201.9	235.2	248.6	253.0	242.7	237.9	250.6	263.8	269.2	2690.8	224.2
1965	270.8	259.4	250.5	241.0	225.3	212.3	191.1	165.3	141.6	123.4	122.0	124.1	2326.8	193.9
1966	137.7	154.2	176.3	195.9	213.9	220.2	215.4	206.5	191.8	201.5	220.2	243.3	2375.0	197.9
1967	259.9	272.4	268.1	257.2	236.5	209.9	188.0	163.8	143.5	126.1	112.9	119.8	2358.3	196.5
1968	131.1	148.2	168.7	188.5	219.9	240.7	295.6	324.1	354.6	355.7	338.3	318.7	3084.0	257.0
1969	305.4	295.3	286.4	283.9	263.8	248.1	224.9	207.6	189.6	180.1	168.1	170.5	2823.8	235.3
1970	172.6	177.2	178.1	179.5	186.9	198.5	207.9	206.5	201.6	190.8	195.0	203.9	2298.7	191.6
1971	219.2	228.5	235.2	224.2	238.1	246.4	249.2	257.4	222.5	214.1	215.3	219.1	2748.9	229.1
1972	218.4	212.0	211.9	201.6	199.9	190.0	173.2	147.7	119.4	91.9	82.8	82.3	1931.0	160.9
1973	103.6	132.5	169.7	196.8	223.8	242.9	260.1	265.1	261.0	274.1	282.3	288.8	2700.7	225.1
1974	287.9	280.2	264.3	247.4	226.3	199.9	173.4	184.5	194.8	256.5	298.5	339.6	2953.5	246.1
1975	353.7	356.5	351.1	340.0	345.8	323.4	291.6	253.7	244.5	256.5	276.9	289.8	3692.6	307.7
1976	288.0	278.1	267.7	255.3	233.7	207.1	172.3	141.1	115.3	126.5	171.3	203.5	2459.8	205.0
1977	236.5	236.7	236.0	236.2	231.7	217.8	200.3	171.1	145.4	123.3	106.3	95.2	2236.5	186.4
1978	92.4	94.1	108.7	126.7	157.1	198.4	244.1	282.9	318.5	343.8	349.4	340.9	2656.9	221.4
1979	320.1	301.1	279.0	267.0	256.3	268.0	266.9	267.4	248.2	225.1	216.3	207.7	3123.2	260.3
1980	204.7	198.5	184.3	173.7	164.2	150.6	136.7	133.7	124.3	136.5	147.6	159.9	1914.7	159.6
1981	169.5	173.5	167.7	162.4	169.1	194.5	234.1	262.3	272.5	274.5	272.2	268.3	2620.4	218.4
1982	254.9	237.3	219.7	200.9	178.1	154.2	128.2	104.0	80.2	59.2	43.1	41.9	1701.7	141.8
TOTAL	6473.5	6546.2	6612.4	6587.2	6555.4	6505.4	6515.8	6411.2	6219.5	6124.1	6068.1	6142.5	76761.2	6396.9
MEAN	215.8	218.2	220.4	219.6	218.5	216.8	217.2	213.7	207.3	204.1	202.3	204.8	2558.7	213.2
S.D.	65.9	58.5	49.5	43.3	37.5	34.7	41.8	53.0	66.9	74.4	76.8	77.0	426.2	35.5
Cf	0.305	0.268	0.225	0.197	0.172	0.160	0.193	0.248	0.323	0.364	0.380	0.376	0.167	0.167

	R	Q
1953/ 1	282.0	1.007
2	383.0	1.046
3	442.0	1.082
4	396.0	1.117
5	346.0	1.137
6	12.0	1.074
7	99.0	0.973
8	119.0	0.834
9	10.0	0.676
10	101.0	0.559
11	205.0	0.490
12	468.0	0.500
1954/ 1	457.0	0.560
2	372.0	0.642
3	317.0	0.719
4	383.0	0.799
5	251.0	0.841
6	487.0	0.916
7	235.0	0.938
8	348.0	0.968
9	28.0	0.918
10	218.0	0.863
11	384.0	0.820
12	368.0	0.801
1955/ 1	563.0	0.856
2	344.0	0.903
3	353.0	0.949
4	185.0	0.943
5	195.0	0.912
6	688.0	0.955
7	1262.0	1.159
8	344.0	1.278
9	388.0	1.403
10	593.0	1.473
11	291.0	1.430
12	212.0	1.364
1956/ 1	126.0	1.258
2	457.0	1.183
3	249.0	1.097
4	93.0	0.993
5	466.0	0.930
6	285.0	0.857
7	410.0	0.848
8	254.0	0.849
9	85.0	0.807
10	301.0	0.789
11	188.0	0.754
12	600.0	0.797
1957/ 1	348.0	0.831
2	425.0	0.897
3	658.0	1.005
4	243.0	1.040
5	175.0	1.036
6	105.0	0.984
7	1268.0	1.119
8	140.0	1.123
9	59.0	1.136
10	25.0	1.051
11	12.0	0.889
12	478.0	0.803
1958/ 1	473.0	0.787
2	335.0	0.793
3	382.0	0.848
4	350.0	0.890
5	224.0	0.873
6	655.0	0.937
7	212.0	0.938
8	491.0	1.017
9	112.0	1.013
10	341.0	1.005
11	351.0	0.975
12	466.0	0.977
1959/ 1	376.0	0.983
2	433.0	1.021
3	168.0	0.999
4	239.0	0.968
5	421.0	0.952
6	317.0	0.925
7	293.0	0.922
8	39.0	0.867
9	334.0	0.838
10	185.0	0.773
11	228.0	0.730
12	636.0	0.777
1960/ 1	393.0	0.823
2	458.0	0.907
3	430.0	0.986
4	452.0	1.045
5	638.0	1.134
6	531.0	1.222
7	74.0	1.215
8	214.0	1.187
9	284.0	1.113
10	282.0	1.028
11	285.0	0.964
12	232.0	0.900
1961/ 1	319.0	0.861
2	225.0	0.816
3	183.0	0.765
4	432.0	0.761
5	297.0	0.760
6	42.0	0.734
7	174.0	0.715
8	6.0	0.632
9	2.0	0.535
10	2.0	0.438
11	102.0	0.359
12	213.0	0.323
1962/ 1	580.0	0.396
2	483.0	0.501
3	311.0	0.612
4	43.0	0.661
5	15.0	0.650
6	163.0	0.620
7	531.0	0.654
8	210.0	0.671
9	12.0	0.665
10	276.0	0.668
11	240.0	0.637
12	435.0	0.653



1962/ 1	[illegible]	0.596
2	483.0	0.501
3	311.0	0.612
4	43.0	0.661
5	15.0	0.650
6	165.0	0.620
7	531.0	0.654
8	210.0	0.671
9	12.0	0.665
10	276.0	0.668
11	260.0	0.637
12	435.0	0.653
1963/ 1	575.0	0.736
2	318.0	0.809
3	518.0	0.928
4	356.0	1.001
5	20.0	0.973
6	79.0	0.911
7	16.0	0.797
8	5.0	0.666
9	0.0	0.541
10	53.0	0.423
11	192.0	0.346
12	278.0	0.325
1964/ 1	212.0	0.331
2	354.0	0.393
3	464.0	0.497
4	212.0	0.577
5	264.0	0.662
6	154.0	0.694
7	80.0	0.679
8	217.0	0.667
9	293.0	0.659
10	624.0	0.724
11	399.0	0.792
12	149.0	0.824
1965/ 1	375.0	0.864
2	204.0	0.846
3	490.0	0.877
4	163.0	0.872
5	159.0	0.855
6	60.0	0.793
7	98.0	0.710
8	12.0	0.590
9	101.0	0.495
10	124.0	0.419
11	388.0	0.425
12	347.0	0.464
1966/ 1	427.0	0.547
2	412.0	0.647
3	477.0	0.763
4	263.0	0.841
5	409.0	0.924
6	66.0	0.917
7	36.0	0.866
8	261.0	0.816
9	385.0	0.782
10	426.0	0.786
11	529.0	0.847
12	412.0	0.905
1967/ 1	577.0	0.997
2	638.0	1.107
3	291.0	1.158
4	186.0	1.170
5	38.0	1.102
6	116.0	0.996
7	253.0	0.895
8	90.0	0.776
9	54.0	0.662
10	136.0	0.569
11	62.0	0.467
12	639.0	0.496
1968/ 1	236.0	0.514
2	302.0	0.584
3	390.0	0.676
4	500.0	0.777
5	469.0	0.876
6	399.0	0.970
7	1040.0	1.167
8	300.0	1.255
9	751.0	1.413
10	384.0	1.459
11	301.0	1.448
12	604.0	1.454
1969/ 1	661.0	1.479
2	493.0	1.480
3	602.0	1.520
4	337.0	1.491
5	129.0	1.389
6	100.0	1.249
7	239.0	1.099
8	117.0	0.950
9	138.0	0.828
10	219.0	0.735
11	176.0	0.648
12	600.0	0.664
1970/ 1	330.0	0.682
2	415.0	0.752
3	382.0	0.827
4	345.0	0.890
5	437.0	0.955
6	361.0	1.001
7	387.0	1.038
8	91.0	1.010
9	382.0	1.001
10	292.0	0.956
11	398.0	0.942
12	438.0	0.951
1971/ 1	540.0	1.003
2	534.0	1.068
3	476.0	1.136
4	157.0	1.132
5	430.0	1.142
6	395.0	1.131
7	171.0	1.082
8	87.0	1.007
9	293.0	0.937
10	516.0	0.907
11	291.0	0.880
12	347.0	0.886
1972/ 1	335.0	0.888
2	197.0	0.868
3	542.0	0.907
4	179.0	0.892
5	278.0	0.891
6	94.0	0.851
7	37.0	0.772
8	30.0	0.662
9	16.0	0.543
10	10.0	0.424
11	223.0	0.369
12	340.0	0.368
1973/ 1	433.0	0.428
2	228.0	0.490
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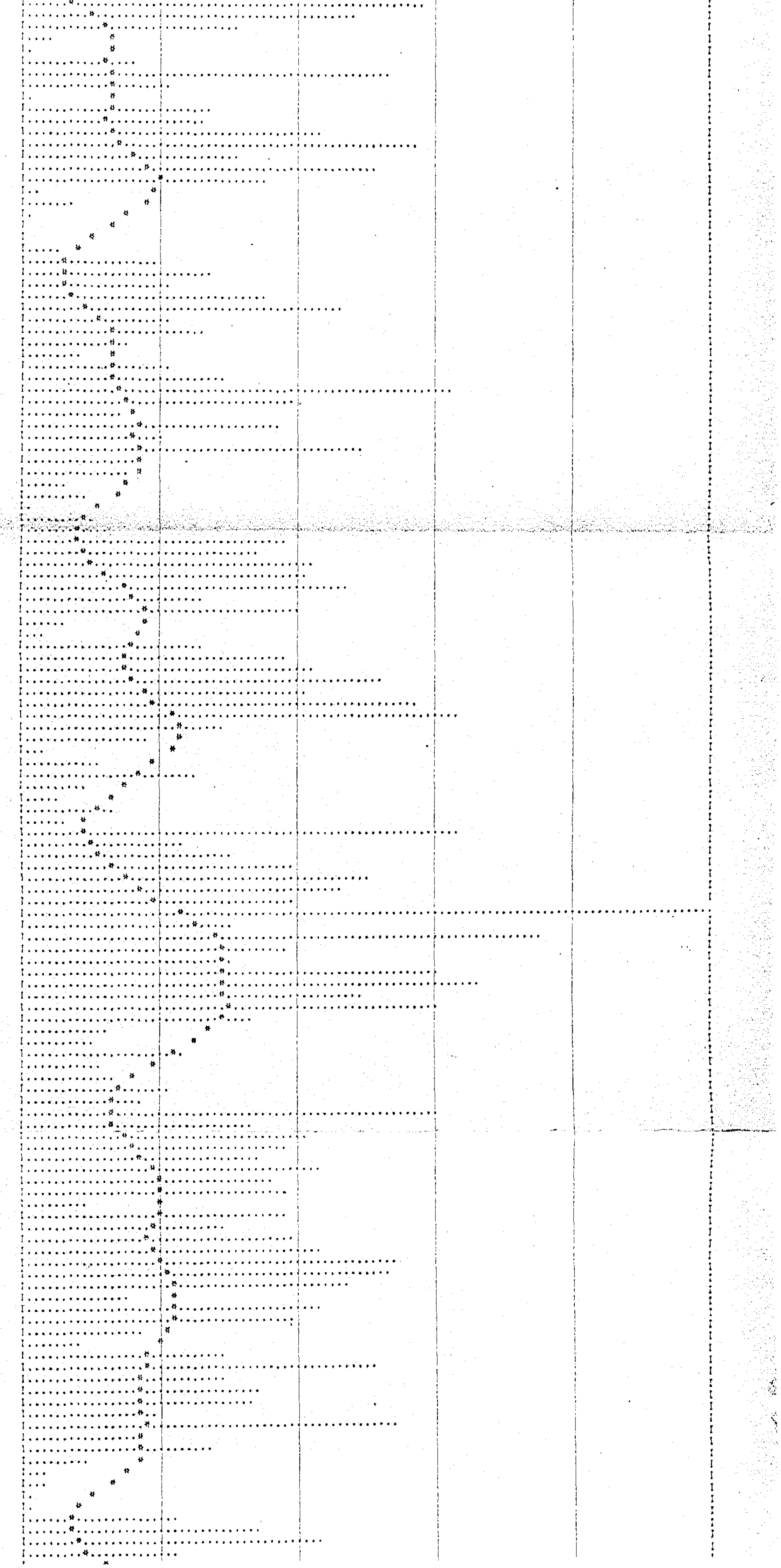


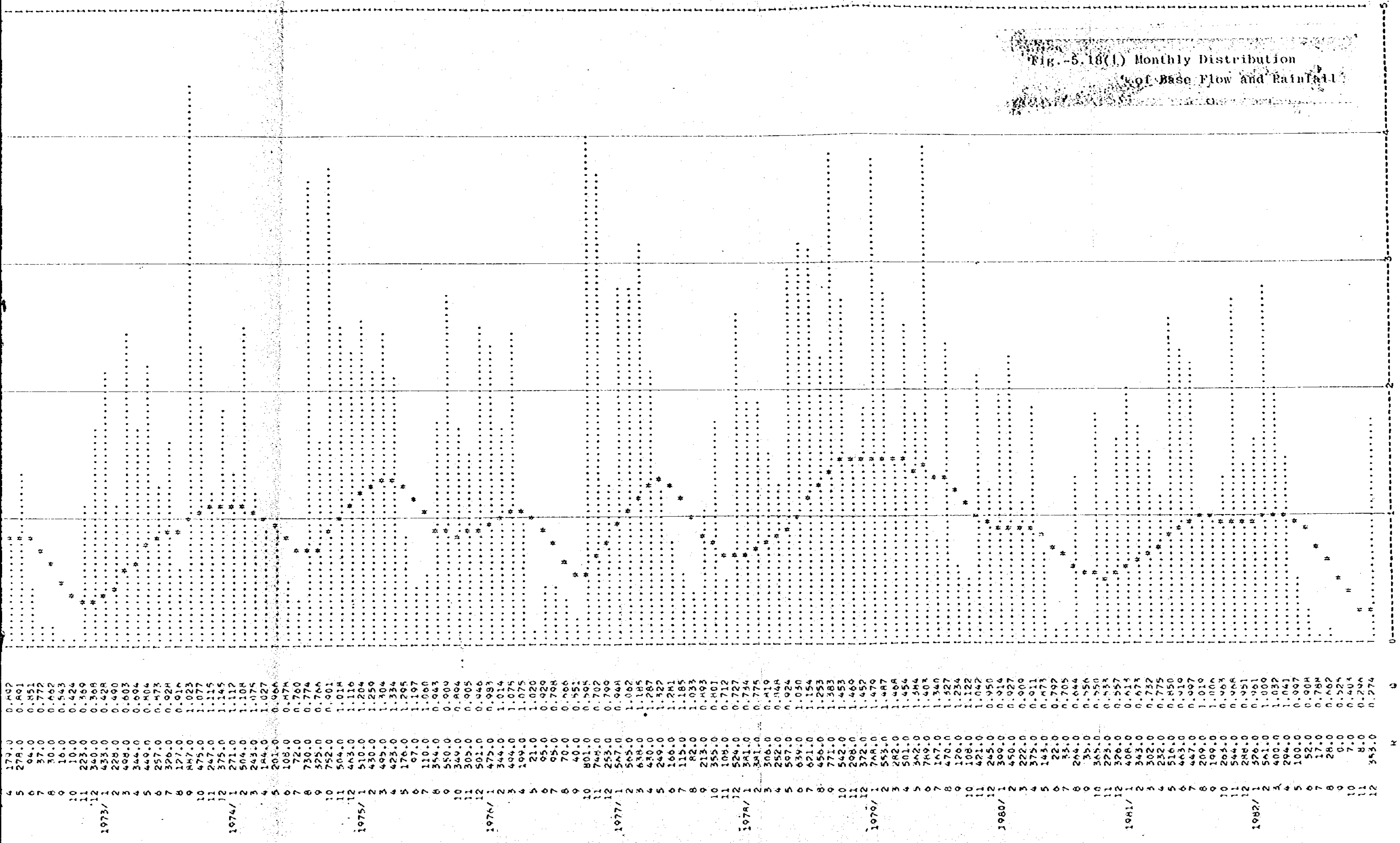
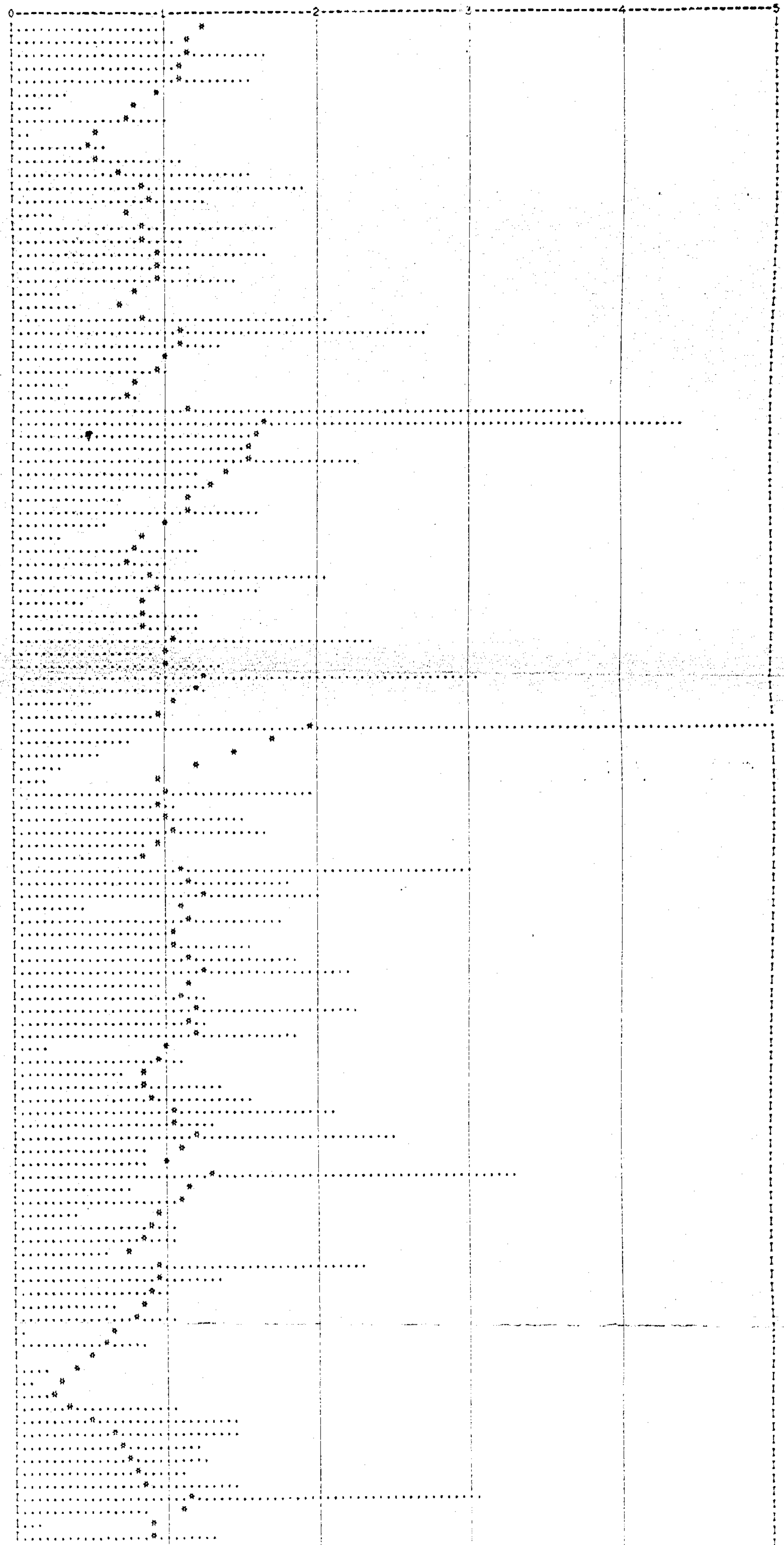


Fig.-5.18(1) Monthly Distribution of Base Flow and Rainfall



		N	R
1953/	1	205.0	1.251
	2	219.0	1.158
	3	331.0	1.176
	4	227.0	1.119
	5	310.0	1.141
	6	79.0	0.974
	7	57.0	0.801
	8	207.0	0.766
	9	26.0	0.596
	10	129.0	0.547
	11	226.0	0.595
	12	317.0	0.715
1954/	1	369.0	0.876
	2	250.0	0.898
	3	58.0	0.761
	4	346.0	0.965
	5	227.0	0.865
	6	335.0	0.957
	7	237.0	0.959
	8	290.0	0.996
	9	67.0	0.847
	10	80.0	0.721
	11	417.0	0.880
	12	540.0	1.118
1955/	1	279.0	1.126
	2	169.0	1.040
	3	207.0	0.980
	4	72.0	0.817
	5	160.0	0.756
	6	750.0	1.178
	7	888.0	1.657
	8	318.0	1.615
	9	318.0	1.554
	10	453.0	1.576
	11	243.0	1.425
	12	269.0	1.335
1956/	1	148.0	1.178
	2	320.0	1.182
	3	126.0	1.035
	4	64.0	0.853
	5	243.0	0.831
	6	206.0	0.786
	7	418.0	0.934
	8	321.0	0.994
	9	95.0	0.862
	10	242.0	0.864
	11	244.0	0.866
	12	472.0	1.054
1957/	1	189.0	0.999
	2	274.0	1.014
	3	616.0	1.293
	4	251.0	1.235
	5	103.0	1.060
	6	187.0	0.979
	7	1537.0	1.966
	8	155.0	1.741
	9	111.0	1.497
	10	61.0	1.229
	11	42.0	0.961
	12	399.0	1.045
1958/	1	216.0	0.991
	2	301.0	1.024
	3	337.0	1.075
	4	178.0	0.985
	5	168.0	0.890
	6	603.0	1.140
	7	362.0	1.188
	8	401.0	1.280
	9	96.0	1.111
	10	351.0	1.150
	11	204.0	1.066
	12	313.0	1.080
1959/	1	377.0	1.155
	2	444.0	1.267
	3	194.0	1.167
	4	251.0	1.116
	5	457.0	1.227
	6	254.0	1.166
	7	379.0	1.221
	8	41.0	1.006
	9	224.0	0.961
	10	141.0	0.858
	11	276.0	0.881
	12	310.0	0.935
1960/	1	421.0	1.067
	2	261.0	1.059
	3	508.0	1.237
	4	179.0	1.125
	5	172.0	1.020
	6	664.0	1.323
	7	155.0	1.186
	8	220.0	1.123
	9	83.0	0.953
	10	216.0	0.905
	11	219.0	0.874
	12	121.0	0.774
1961/	1	464.0	0.967
	2	279.0	0.986
	3	201.0	0.940
	4	138.0	0.848
	5	215.0	0.821
	6	13.0	0.651
	7	176.0	0.643
	8	5.0	0.511
	9	44.0	0.427
	10	21.0	0.341
	11	58.0	0.297
	12	216.0	0.388
1962/	1	296.0	0.535
	2	294.0	0.661
	3	241.0	0.725
	4	251.0	0.779
	5	279.0	0.804
	6	292.0	0.874
	7	610.0	1.184
	8	176.0	1.109
	9	35.0	0.924
	0	264.0	0.933

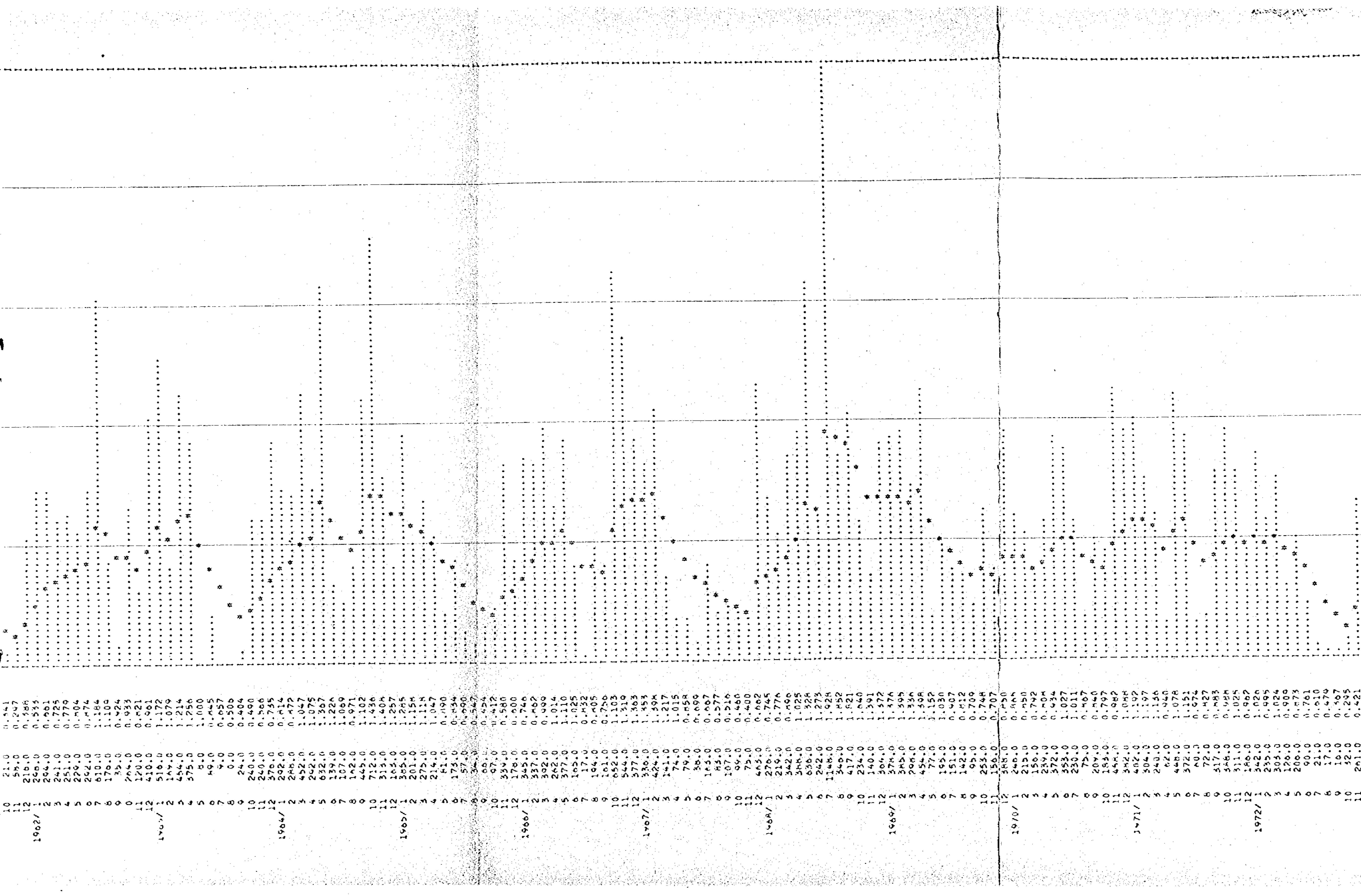
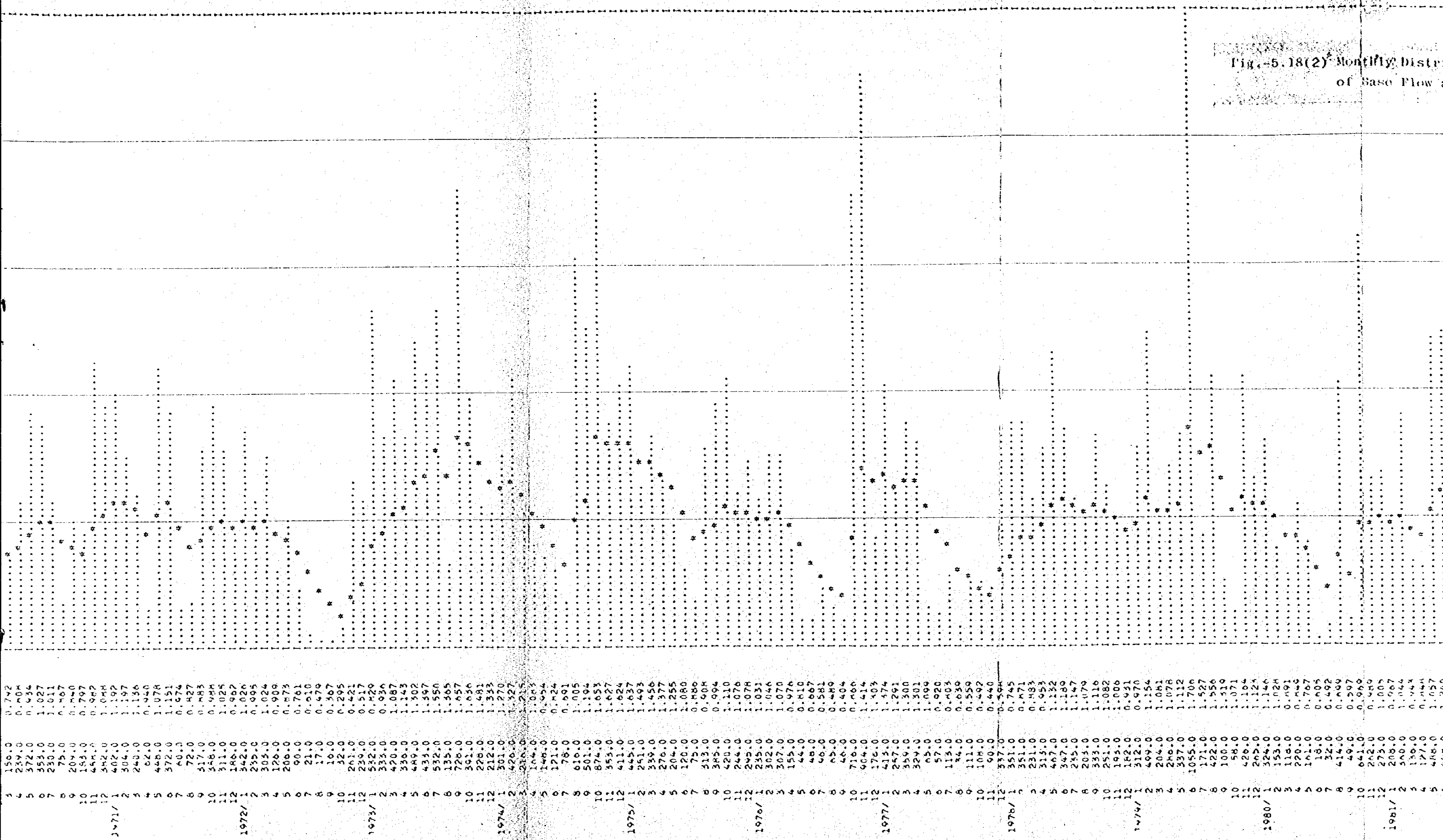


Fig.-5.18(2) Monthly Distr
of Base Flow a



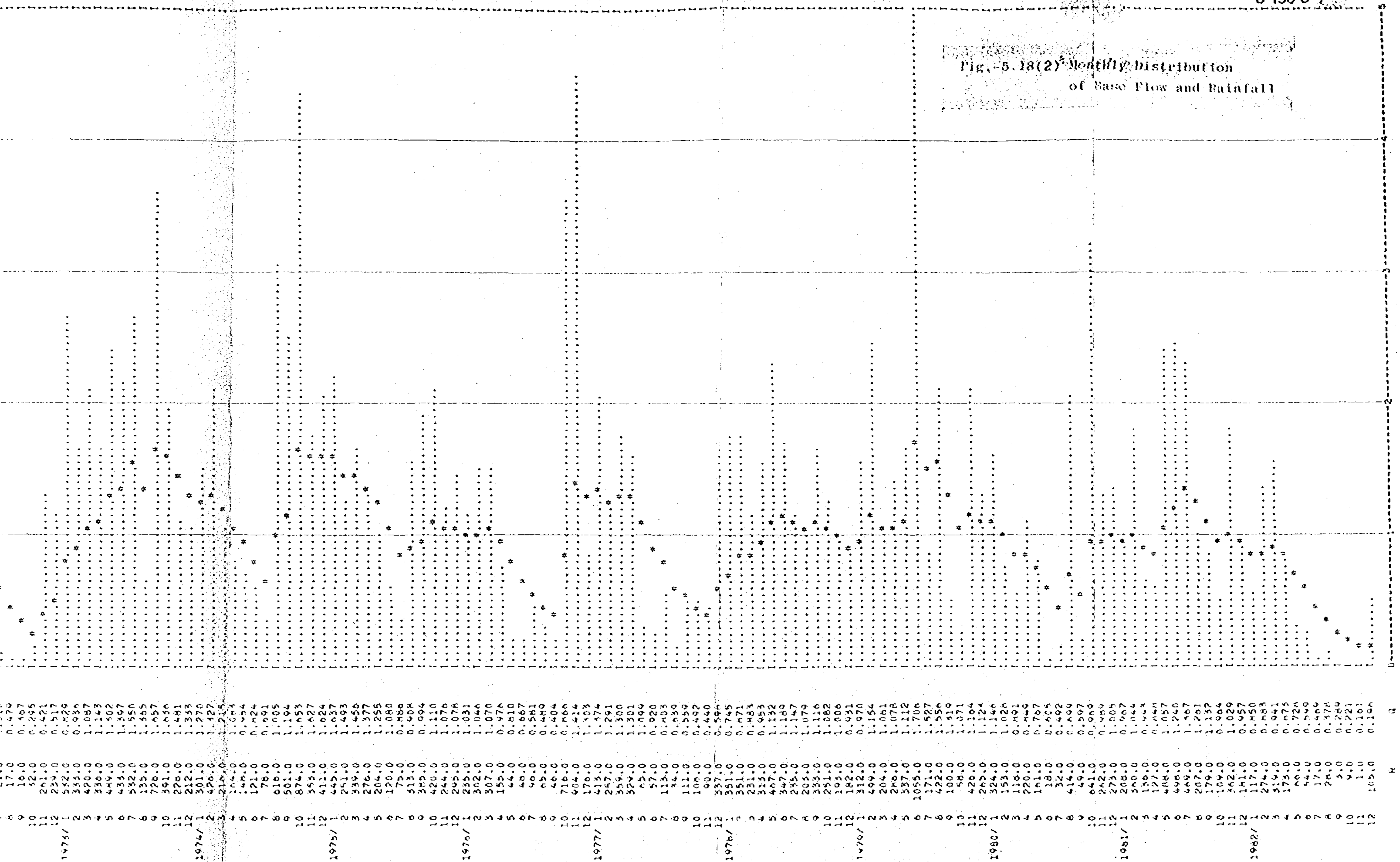
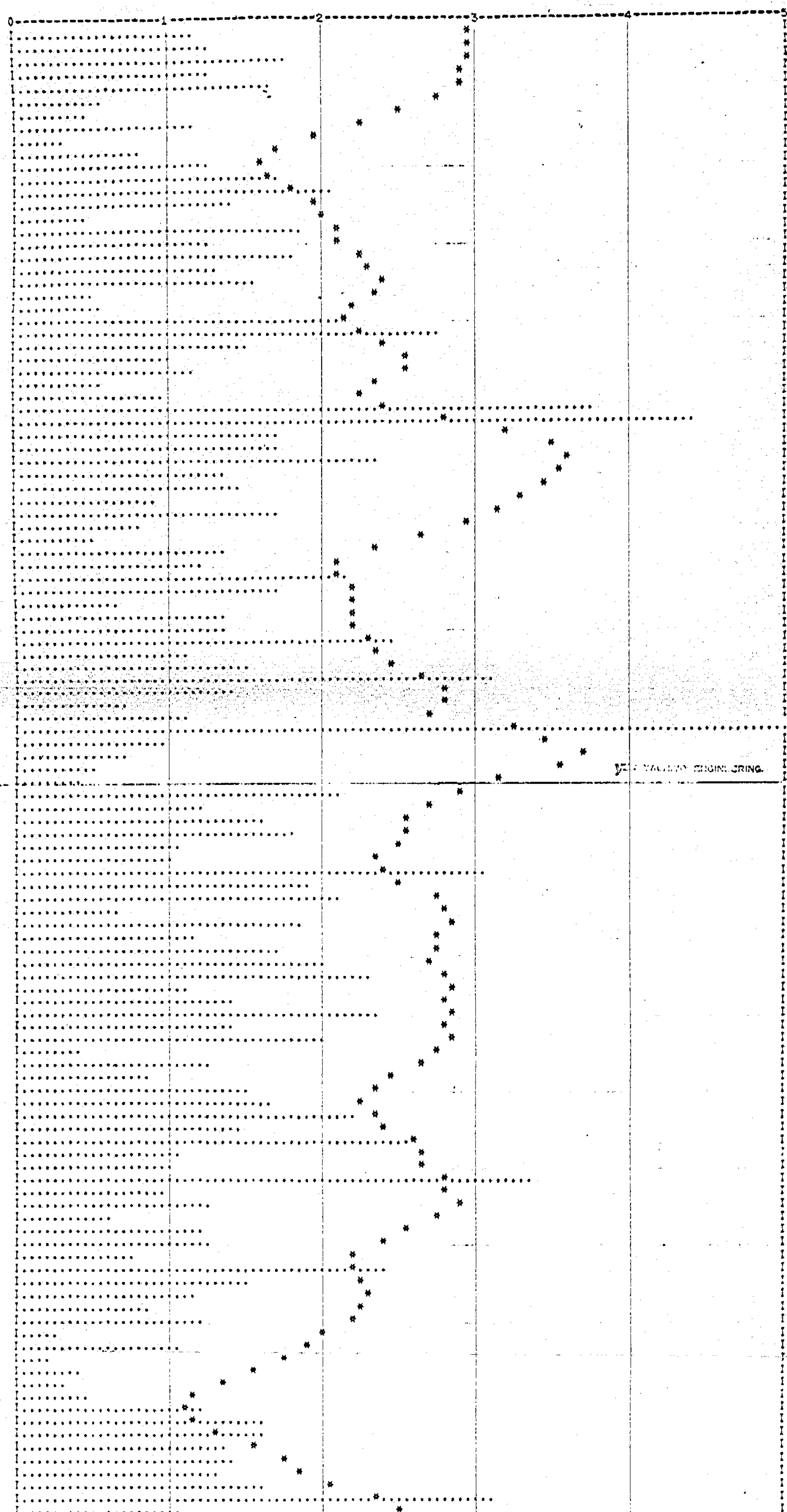
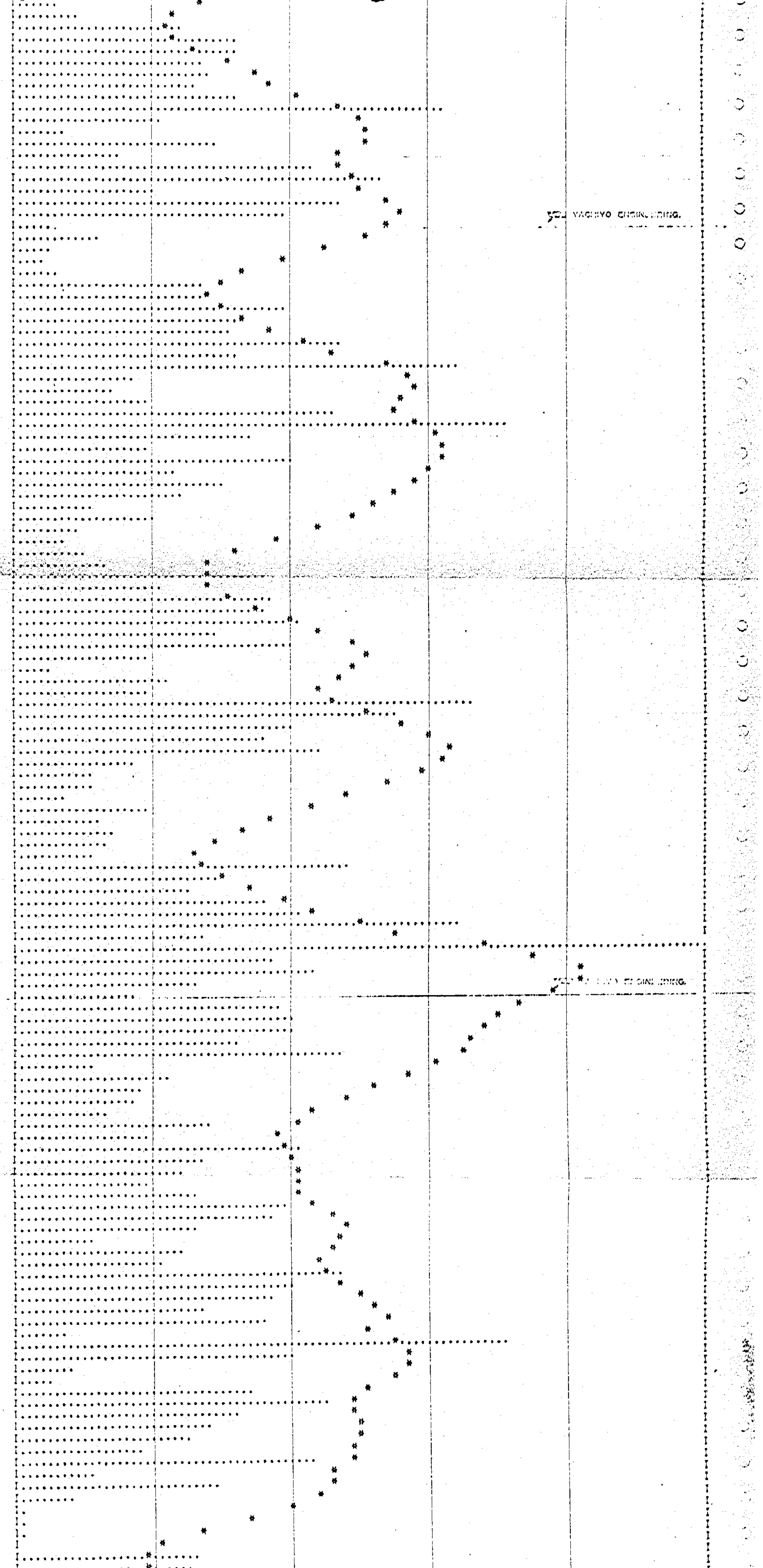


Fig.-5.18(2) Monthly Distribution of Base Flow and Rainfall

	R	Q
1953/ 1	237.0	2.959
2	250.0	2.991
3	357.0	2.991
4	258.0	2.940
5	337.0	2.923
6	117.0	2.774
7	97.0	2.537
8	239.0	2.279
9	67.0	1.962
10	165.0	1.746
11	257.0	1.644
12	343.0	1.666
1954/ 1	412.0	1.818
2	280.0	1.972
3	98.0	2.006
4	371.0	2.104
5	258.0	2.131
6	360.0	2.249
7	267.0	2.331
8	318.0	2.415
9	106.0	2.353
10	118.0	2.224
11	438.0	2.176
12	555.0	2.291
1955/ 1	307.0	2.447
2	203.0	2.559
3	239.0	2.557
4	111.0	2.395
5	194.0	2.251
6	754.0	2.400
7	886.0	2.827
8	344.0	3.219
9	344.0	3.523
10	473.0	3.631
11	273.0	3.554
12	298.0	3.487
1956/ 1	183.0	3.317
2	346.0	3.177
3	164.0	2.955
4	103.0	2.668
5	273.0	2.385
6	240.0	2.145
7	439.0	2.130
8	347.0	2.202
9	131.0	2.207
10	272.0	2.222
11	274.0	2.207
12	491.0	2.319
1957/ 1	222.0	2.383
2	303.0	2.485
3	627.0	2.697
4	281.0	2.799
5	140.0	2.804
6	220.0	2.718
7	1502.0	3.248
8	190.0	3.468
9	148.0	3.742
10	100.0	3.570
11	82.0	3.173
12	421.0	2.906
195[illegible]/ 1	248.0	2.705
2	328.0	2.592
3	362.0	2.581
4	211.0	2.527
5	202.0	2.372
6	615.0	2.433
7	386.0	2.500
8	423.0	2.773
9	134.0	2.841
10	376.0	2.883
11	236.0	2.785
12	340.0	2.748
59/ 1	400.0	2.747
2	464.0	2.842
3	227.0	2.853
4	281.0	2.845
5	476.0	2.853
6	284.0	2.809
7	402.0	2.884
8	81.0	2.775
9	255.0	2.680
10	176.0	2.479
11	306.0	2.365
12	337.0	2.295
1960/ 1	442.0	2.375
2	290.0	2.436
3	525.0	2.635
4	212.0	2.670
5	206.0	2.668
6	673.0	2.841
7	190.0	2.846
8	251.0	2.898
9	121.0	2.761
10	248.0	2.589
11	250.0	2.406
12	157.0	2.246
1961/ 1	483.0	2.241
2	307.0	2.262
3	233.0	2.304
4	173.0	2.264
5	247.0	2.200
6	55.0	2.021
7	210.0	1.943
8	47.0	1.750
9	84.0	1.578
10	62.0	1.375
11	98.0	1.191
12	248.0	1.114
1962/ 1	325.0	1.174
2	322.0	1.347
3	271.0	1.551
4	281.0	1.748
5	260.0	1.892
6	320.0	2.048
7	622.0	2.351
8	210.0	2.522



10	62.0	1.375
11	98.0	1.191
12	248.0	1.114
1962/ 1	325.0	1.174
2	322.0	1.347
3	271.0	1.551
4	281.0	1.748
5	260.0	1.892
6	320.0	2.048
7	622.0	2.351
8	210.0	2.522
9	76.0	2.575
10	293.0	2.549
11	156.0	2.374
12	432.0	2.357
1963/ 1	532.0	2.480
2	203.0	2.537
3	473.0	2.717
4	398.0	2.818
5	50.0	2.719
6	127.0	2.575
7	51.0	2.293
8	42.0	1.982
9	65.0	1.695
10	270.0	1.515
11	270.0	1.423
12	399.0	1.528
1964/ 1	320.0	1.672
2	316.0	1.859
3	472.0	2.118
4	320.0	2.337
5	642.0	2.723
6	174.0	2.878
7	144.0	2.928
8	196.0	2.808
9	465.0	2.753
10	718.0	2.900
11	340.0	3.053
12	197.0	3.115
1965/ 1	408.0	3.134
2	233.0	3.002
3	304.0	2.900
4	246.0	2.789
5	119.0	2.607
6	207.0	2.457
7	97.0	2.212
8	75.0	1.914
9	105.0	1.639
10	135.0	1.428
11	364.0	1.412
12	211.0	1.436
1966/ 1	370.0	1.594
2	362.0	1.785
3	415.0	2.041
4	291.0	2.244
5	400.0	2.476
6	199.0	2.549
7	59.0	2.493
8	227.0	2.390
9	195.0	2.219
10	661.0	2.332
11	559.0	2.549
12	400.0	2.816
1967/ 1	361.0	3.008
2	445.0	3.153
3	176.0	3.103
4	113.0	2.977
5	117.0	2.737
6	79.0	2.430
7	197.0	2.176
8	121.0	1.896
9	144.0	1.661
10	136.0	1.459
11	114.0	1.307
12	482.0	1.387
1968/ 1	304.0	1.517
2	250.0	1.716
3	367.0	1.952
4	411.0	2.181
5	646.0	2.545
6	272.0	2.786
7	1132.0	3.421
8	371.0	3.751
9	438.0	4.104
10	265.0	4.117
11	175.0	3.916
12	388.0	3.689
1969/ 1	401.0	3.535
2	408.0	3.418
3	325.0	3.314
4	473.0	3.286
5	116.0	3.053
6	228.0	2.871
7	186.0	2.604
8	177.0	2.402
9	133.0	2.197
10	283.0	2.085
11	191.0	1.946
12	411.0	1.973
1970/ 1	276.0	1.998
2	247.0	2.051
3	191.0	2.061
4	269.0	2.078
5	396.0	2.163
6	378.0	2.298
7	261.0	2.406
8	114.0	2.390
9	241.0	2.333
10	216.0	2.209
11	477.0	2.257
12	405.0	2.360
1971/ 1	376.0	2.537
2	279.0	2.642
3	363.0	2.722
4	70.0	2.595
5	710.0	2.755
6	404.0	2.852
7	80.0	2.884
8	55.0	2.748
9	341.0	2.575
10	456.0	2.478
11	326.0	2.492
12	281.0	2.536
1972/ 1	251.0	2.528
2	184.0	2.454
3	436.0	2.453
4	119.0	2.334
5	296.0	2.314
6	88.0	2.199
7	17.0	2.005
8	19.0	1.709
9	13.0	1.381
10	0.0	1.063
11	268.0	0.958
12	[illegible]	[illegible]



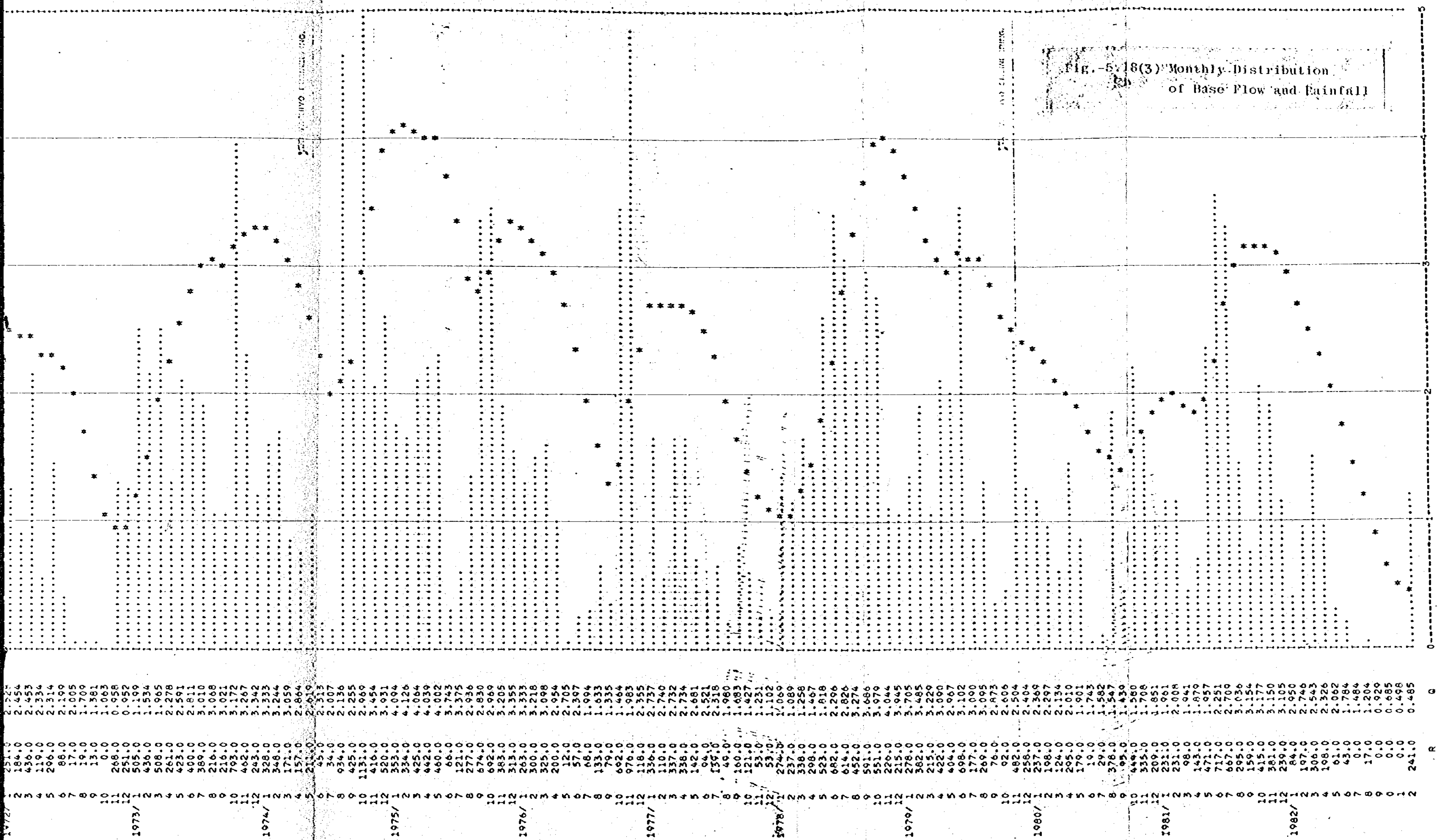


Fig.-5.18(3) Monthly Distribution of Base Flow and Rainfall

APPENDIX

Observed Rainfall & Discharge Data

Table - Observed Rainfall and Discharge Data at Mujur Bridge Station

Month/Year : Feb. /'83
Catchment Area : 125.70 Km²

Date	BENDO	KEDUNG WRINGIN	BEDOR	G. SAWUR	SEMEMU	MUNGGIR	TEMPEH KIDUL	G. LEKER	G. PAKIS	WONOKERTO	KERTOSARI	B. SAT	GANDIPUROS	RANUPANE	R̄	Qp (m³/s)	Observed Time	Remarks
	3	5	7	10	12	20	24	30	31	33	36	37	39	41				
	0.07	0.05	0.01	0.04	0.06	0.09	0.01	0.02	0.30	0.16	0.10	0.07	0.03	0.09				
1	-	-	-	32	-		-		-	18.1	6.3	13.3	9.5		5.0			
2	2	5	-	-	-		-		3.1	2.1	0.1	6.4	-		2.8			
3	-	-	-	-	-		-		23.6	-	7.3	4.6	0.5		11.6			
4	14	6	15	11	10		21		3.8	10.6	3.6	24.5	-		8.4			
5	1	-	6	25	15		1		-	15.6	18.2	29.7	0.7		8.4			
6	12	14	34	6	28		32		66.0	15.4		58.8	21.3		41.0			
7	-	4	-	-	-		-		-	4.4		16.0	0.3		2.7			
8	43	25	4	33	11		10		54.0	31.8		28.1	1.0		25.3			
9	48	8	8	18	-		2		-	50.0		41.7	3.6		13.7			
10	11	2	-	23	23		-		28.8	9.3	25.6	17.8	4.7		20.9			
11	59	15	11	11	30		18		0.4	13.6	3.4	22.9	10.0		12.6			
12	1	20	23	-	25		10		-	15.4	-	32.1	-		8.6			
13	1	-	-	14	-		-		-	10.0	-	1.5	-		1.3			
14	-	-	-	-	-		-		-	-	-	-	13.0		0.4	3.39	10:45 ~ 18:00	START
15	-	-	3	-	-		1		-	-	-	-	-		0		10:30 ~ 18:00	
16	-	3	-	-	-		2		-	-	-	-	-		1.3		13:00 ~ 18:00	
17	1	20	64	4	23		32		-	-	7.0	-	13.6		5.1	4.91	12:30 ~ 20:00	
18	35	11	11	17	25		12		-	14.1	4.4	0.8	-		7.1	4.93	13:00 ~ 18:45	
19	-	-	-	-	-		1		-	16.2	-	-	1.0		1.0		13:00 ~ 18:00	
20	20	9	34	19	20		15			-	25.3	27.1	15.0		11.1			UNRECORDED
21	44	16	15	34	35		22			36.7	64.8	20.1	23.8		35.1	6.55	13:00 ~ 19:30	
22	13	8	-	7	-		-			24.4	14.2	14.3	5.1		16.9	11.73	11:30 ~ 18:15	
23	17	-	-	45	-		-			2.1	1.3	22.1	8.7		7.6	6.55	9:00 ~ 18:00	
24	-	-	-	-	-		-			24.6	-	0.1	-		11.6	4.39	11:45 ~ 18:00	
25	8	-	24	24	-		11			5.0	2.7	8.9	-		5.6		13:00 ~ 18:00	
26		-	-	-	-		-			5.9	0.4	0.3	-		2.9		"	
27	13	-	-	3	-		-			-	6.1	19.5	-		4.5			UNRECORDED
28	8	4	7	20	-		22			77.7	6.2	37.0	-		44.5	3.37	13:00 ~ 18:00	
29																		
30																		
31																		
Total	351.0	173.6	259.0	344.0	245.0		212.0		(180.5)	403.7	(106.8)	435.5	150.7		325.3			

Notes :
1. Space (A) expresses rainfall observation station name.
2. Space (B) shows rainfall observation station number.
3. Space (C) shows Thiessen Coefficient.
4. R̄ means average depth of rainfall over area.
5. Qp means peak flood.

Table – Observed Rainfall and Discharge Data at Mujur Bridge Station

Month/Year : Mar. /'83

Catchment Area : 125.70 km²

Date \ Ⓐ	Bendo	Kedung Wringin	Bedog	G. Sawur	Sememu	Munggik	Tempeh Kidul	G. Lekker	G. Pakis	Wonorenggo	Kertosari	B. Sat	Gandipuro	Ranupane	R̄	Qp (m^3/s)	Observed Time	Remarks
Ⓑ	3	5	7	10	12	20	24	30	31	33	36	37	39	41				
Ⓒ	0.07	0.08	0.01	0.04	0.06	0.04	0.01	0.02	0.30	0.06	0.10	0.09	0.03	0.09				
1	–	–	–	–	–		10			0.5	0.3	2.0	–		0.4	3.79	13:00 ~ 18:00	
2	–	–	11	–	–		21			18.7	–	21.2	–		11.9	3.77	〃	
3	38	5	3	36	22		2			38.7	8.3	58.1	6.4		30.0	3.77	〃	
4	8	–	–	29	–		–			8.2	–	6.7	–		6.2	4.04	〃	
5	–	–	–	–	–		–			16.8	–	11.3	0.4	–	7.7	3.24	〃	
6	1	–	–	6	13		–			15.3	4.9	15.7	24.0	7.0	11.3	4.14	〃	
7	33	–	–	19	–		–			7.5	0.7	7.3	–	10.7	8.2	3.47	〃	
8	22	–	–	10	–		7			7.7	3.0	30.1	9.0	12.1	13.1	3.89	〃	
9	48	5	23	20	24		4			12.3	15.1	26.8	36.3	23.7	38.2	17.88	〃	
10	3	–	–	–	–		–			4.5	2.0	1.7	5.0	1.0	2.4	9.48	14:30 ~ 17:45	
11	16	–	–	3	16		–			7.9	–	33.5	–	–	9.4	7.34	8:00 ~ 9:00 13:00 ~ 18:00	
12	–	17	–	–	–		–			0.6	3.8	2.3	3.0	–	2.4	4.39	13:00 ~ 18:00	
13	25	17	31	41	14		10			40.0	9.1	29.6	9.9	2.3	26.1	22.43	〃	
14	5	5	1	67	–		2			11.6	3.6	8.0	6.7	0.6	9.6	7.62	〃	
15	2	5	15	9	34		22			26.0	5.7	12.6	1.6	–	15.4	7.08	〃	
16	32	3	–	3	–		–			2.9	5.4	26.5	42.9	1.0	9.1	13.01	9:15 ~ 18:00	
17	9	–	–	19	10		–			7.8	–	20.8	0.3	–	7.4	4.02	13:00 ~ 18:00	
18	11	12	4	2	–		1			12.5	–	5.5	–	14.8	8.7	4.36	〃	
19	12	–	–	–	2		2			2.0	–	5.2	–	2.0	2.6	7.62	〃	
20	–	4	–	–	–		3				0.6	0.3	4.5	31.4	15.1	4.87	〃	
21	8	–	–	42	–		1				1.8	30.2	5.3	9.0	10.7	7.68	〃	
22	13	38	19	7	35		2				–	13.3	4.8	9.7	13.1	9.78	〃	
23	6	–	–	4	9		2				13.3	2.3	1.3	11.4	2.6	17.62	〃	
24	–	–	–	–	–		–				–	–	–	–	–	5.40	〃	
25	25	–	–	2	2		–				6.3	55.0	1.5	–	9.8	3.57	〃	
26	–	11	3	–	–		1				1.6	0.5	1.1	–	1.2	2.10	〃	
27	–	–	–	–	–		–				–	–	–	27.7	13.8	2.03	〃	
28	–	39	19	6	9		7				51.2	0.3	18.5	–	9.7	1.89	〃	
29	–	–	–	–	–		–				0.6	–	3.0	–	0.2	2.03	13:00 ~ 15:00	
30	1	35	20	–	–		4				13.7	37.7	–	–	9.4	2.19	13:00 ~ 18:00	
31	2	–	–	9	–		1				0.4	1.5	–	6.8	3.9	3.52	〃	
Total	320.0	176.0	149.0	334.0	190.0		102.0			(291.7)	152.1	465.3	185.0	(176.0)	316.6			

Notes :
1. Space Ⓐ expresses rainfall observation station name.
2. Space Ⓑ shows rainfall observation station number.
3. Space Ⓒ shows Thiessen Coefficient.
4. R̄ means average depth of rainfall over area.
5. Qp means peak flood.

Table - Observed Rainfall and Discharge Data at Mujur Bridge Station

Month/Year : Apr. /'83
Catchment Area : 125.70 km²

Date	Bendo	Kedung Wringin	Bedog	G. Sawur	Sememu	Munggir	Tempeh Kidul	G. Leker	G. Paris	Wonorejo	Kertosari	B. Sat	Candipuro	Ranupane	R̄	Qp (m³/s)	Observed Time	Remarks
(Station No.)	3	5	7	10	12	20	24	30	31	33	36	37	39	41				
(Thiessen Coef.)	0.07	0.08	0.01	0.04	0.06	0.04	0.01	0.02	0.30	0.06	0.10	0.09	0.13	0.09				
1	–	–	–	–	–		–				–	–	–		–	2.85	13:00 ~ 17:00	
2	–	–	–	–	–		2				–	–	–		0.6	2.62	〃	
3	1	–	5	3	–		2				1.0	0.7	0.4		0.8	1.96	〃	
4	11	7	–	28	–		–				5.5	7.1	–		7.1	1.89	〃	
5	6	25	32	6	10		–				0.7	3.5	0.6		5.7	4.20	〃	
6	57	–	–	41	–		–				36.6	2.5	30.8		11.7	2.84	〃	
7	28	31	–	19	–		8		63.2		30.5	31.0	13.0		44.8	17.41	〃	
8	4	1	7	2	–		–		0.6		–	1.0	–		0.9	4.63	〃	
9	1	–	–	3	–		–		1.2		–	0.3	–		0.7	3.52	〃	
10	–	–	7	–	–		9		–		–	4.3	–		0.7	29.41	〃	
11	24	30	56	16	27		61		–		20.0	4.6	11.7		10.5	3.92	〃	
12	54	25	28	21	22		12		–		44.3	38.0	4.5		17.8	3.44	〃	
13	12	27	2	20	26		7		–		7.3	31.1	24.0		11.0	3.32	〃	
14	–	11	3	–	–		1		12.0		0.3	3.3	0.7		7.0		〃	
15	–	–	–	–	7		–		–		–	–	–		0.4		〃	
16	–	–	–	19	–		–		7.7		8.1	13.8	1.8		7.0		〃	
17	–	–	–	15	–		–		–		–	4.0	–		1.1		〃	
18	–	–	–	33	–		–		20.0		–	1.6	–		10.9		〃	
19	–	–	–	12	–		–		62.0		–	6.0	–		30.4		〃	
20	–	6	–	11	–		–		0.5	2.7	1.3	0.7	4.0		1.6		〃	
21	–	13	8	–	7		6		–	–	6.0	–	0.6		2.2	2.03	〃	
22	–	7	1	9	–		3		7.0	15.2	–	3.8	0.4		5.4	1.96	〃	
23	2	15	–	–	12		2		0.9	1.0	1.0	2.0	18.0		3.4	1.96	〃	
24	–	–	–	–	–		–		1.5	–	–	–	–		0.6	1.77	〃	
25	7	–	–	17	–		–		7.5	9.6	9.0	24.0	–		8.8	1.96	〃	
26	3	4	3	2	–		3		–	5.0	3.3	3.2	2.0		1.7	1.89	〃	
27	7	2	–	–	7		1		47.0	6.0	–	17.1	0.9		22.9	1.84	〃	
28	–	–	–	–	–		–		2.9	38.0	–	3.8	–		3.9	1.94	〃	
29	9	14	–	22	–		58		–	–	4.5	24.3	–		6.1		〃	
30	12	–	–	2	–		–		–	65.8	–	9.8	–		6.1	4.07	〃	
31																		
T.C	238.0	218.0	152.0	301.0	120.0		175.0		(239.0)	(137.1)	177.6	243.7	113.1		232.7			

Notes :
1. Space Ⓐ expresses rainfall observation station name.
2. Space Ⓑ shows rainfall observation station number.
3. Space Ⓒ shows Thiessen Coefficient.
4. R̄ means average depth of rainfall over area.
5. Qp means peak flood.

Table - Observed Rainfall and Discharge Data at Mujur Bridge Station

Month/Year : May / '83
Catchment Area : 125.70 km²

Date (A)	BENDO	KEDUNG WRINGIN	BEDOG	G. SAWUR	SEMEMU	MUNGGIR	TEMPEH K. DUL	G. LEKER	G. PAKIS	WONOREJO	KERTOSARI	B. SAT	CANDIPURO	RANUPANE	R̄	Qp (m^3/s)	Observed Time	Remarks
(B)	3	5	7	10	12	20	24	30	31	33	36	37	39	41				
(C)	0.07	0.08	0.01	0.04	0.06	0.04	0.01	0.02	0.30	0.06	0.10	0.09	0.03	0.09				
1	18	40	44	50	32		33			37.8	15.0	22.7	48.6		33.8	24.15	13:00 ~ 18:00	
2	-	-	-	-	-		-		1.1	-	-	-	-		0.5	9.10	〃	
3	28	24	20	43	38		30		8.9	-	33.5	19.3	27.0		19.4	35.45	15:00 ~ 17:30	
4	5	23	25	3	13		14		-	-	3.5	-	4.0		4.0	7.04	13:00 ~ 18:00	
5	4	2	11	-	-		4		52.0	1.0	3.0	4.4	1.0		16.7	6.57	13:00 ~ 17:00	
6	18	4	-	25	9		28		8.5	78.2	11.0	41.3	9.9		18.2	5.08	13:00 ~ 18:00	
7	17	54	17	14	6		21			25.4	5.7	26.6	9.0		20.9	5.08	〃	
8	-	-	1	-	-		1			2.1	1.5	4.0	1.7		1.8	5.17	〃	
9	-	-	-	13	-		1			24.7	-	6.6	-		13.0	5.08	〃	
10	-	-	-	-	-		-			-	-	-	-		-	5.57	〃	
11	5	2	6	2	-		5			0.6	2.3	9.7	0.5		2.3	4.07	〃	
12	23	3	15	15	-		10			33.6	1.7	34.6	7.3		25.6	4.07	〃	
13	79	3	-	99	-		2			57.4	14.1	57.8	3.5		45.1	24.03	〃	
14	-	-	-	-	-		-		2.3	-	0.4	-	-		1.0	5.38	〃	
15	17	10	-	14	-		2		4.4	2.3	28.2	4.7	58.0		9.9	2.92	〃	
16	-	31	-	33	13		17		40.5	33.2	11.7	56.6	1.5		37.4		〃	
17	11	38	30	5	28		12		3.5	1.6	10.2	1.8	38.2		14.7	14.96	〃	
18	38	-	1	23	19		9		45.1	5.0	-	24.0	-		26.2	13.11	〃	
19	25	3	5	20	-		1		6.7	12.1	3.3	15.4	-		8.7	9.10	〃	
20	9	6	-	29	-		2			12.0	-	85.2	5.0		45.5	9.10	〃	
21	-		-	-	-		-			0.4	26.0	0.6	11.7			8.59	〃	
22	2		28	1	-		-			2.2	0.9	-	-			9.10	〃	
23	11		51	32	37		27			16.6	31.8	8.0	55.3			39.13	〃	
24	18		-	13	32		30			14.5	13.0	15.3	28.6			19.74	〃	
25	202		5	134	44		2			7.9	68.9	141.0	1.0			9.10	〃	
26	10		-	37	13		-			24.7	103.4	118.4	11.4				〃	
27	65		36	79	4		46			86.4	18.5	28.5	16.2				12:00 ~ 18:00	
28	19		98	15	45		72			18.5	13.2	20.9	10.0			9.10	〃	
29	-		-	15	-		-			29.1	1.9	11.5	1.9			4.27	14:00 ~ 18:00	
30	30		-	5	-		1			7.0	12.3	20.8	-				13:00 ~ 18:00	
31	2		-	7	-		-			8.0	-	2.7	-					UNRECORDED
Total	650.0		393.0	771.0	336.0		370.0		(152.7)	772.2	564.7	779.8	355.6					

Notes :
1. Space (A) expresses rainfall observation station name.
2. Space (B) shows rainfall observation station number.
3. Space (C) shows Thiessen Coefficient.
4. R̄ means average depth of rainfall over area.
5. Qp means peak flood.

Table - Observed Raintall and Discharge Data at Mujur Bridge Station

Month/Year : Jun. /'83
Catchment Area : 125.70 km²

Ⓐ Ⓑ Ⓒ Date	Raintall (mm)															Discharge		Remarks
	BENDO	KEDUNG WRINGIN	BEDOG	G. SAWUR	SEMEMU	MUNGGIR	TEMPEN KIDUL	G. LEKER	G. PAKIS	WONOKERTO	KERTOSARI	B. SAT	LANDIPURO	RANUPANE	R̄	Qp (m³/s)	Observed Time	
Ⓑ	3	5	7	10	12	20	24	30	31	33	36	37	39	41				
Ⓒ	0.07	0.08	0.01	0.04	0.06	0.04	0.01	0.02	0.30	0.06	0.10	0.09	0.03	0.09				
1	—		—	—	—		—			—	1.4	—					13:00 ~ 17:40	
2	1		—	—	—		—			—	0.8	—					"	
3	2		—	—	—		—			—	—	—				19.74	"	
4	2		—	—	—		—			—	2.6	1.0				9.10	"	
5	—		—	4	—		—			0.5	5.5	56.0					"	
6	7		—	9	—		—			5.7	12.2	—					"	
7	—		—	—	—		—			0.7	1.9	—					"	
8	27		—	44	—		—			176.0	2.1	179.0					"	
9	45		29	54	22		48				18.1	77.6					"	
10											39.7	44.9					"	
11											—	15.6					"	
12											10.3						"	
13											2.8						"	
14																	"	
15																	"	
16																	"	
17																	"	
18																	"	
19																	"	
20																	"	
21																	"	
22																	"	
23																	"	
24																	"	
25																	"	
26																		
27																		
28																		
29																		
30																		
31																		
[illegible]																		

Notes :
1. Space Ⓐ expresses raintall observation station name.
2. Space Ⓑ shows rainfall observation station number.
3. Space Ⓒ shows Thiessen Coefficient.
4. R̄ means average depth of rainfall over area.
5. Qp means peak flood.

Table - Observed Raintall and Discharge Data at Kloposawit Bridge Station

Month/Year : Feb. / '83
Catchment Area : 82.20 Km²

Date \ (A) (B) (C)	Raintall (mm) BENDO	MUNGGIK	G. LEKER	G. PAKIS	WONOK[illegible]	KERTOSARI	E. SAT	RANUPANE						R̄	Discharge Qp (m³/s)	Observed Time	Remarks
(B)	3	20	30	31	33	36	37	41									
(C)	0.07	0.06	0.04	0.45	0.07	0.04	0.15	0.14									
1	–			–	18.0	6.2	13.3							3.2			
2	2			3.1	2.0	0.2	6.4							3.3			
3	–			23.6	–	7.2	4.6							17.2			
4	14			3.3	10.6	3.6	24.5							7.3			
5	1			–	15.6	18.2	27.7							5.5			
6	12			66.7	15.0		45.3							54.3			
7	–			–	4.4		16.0							2.4			
8	43			54.7	31.8		38.2							46.8			
9	48			–	50.0		41.4							12.4	20.15	13:00 ~ 18:00	START
10	11			78.5	9.7	25.6	17.3							24.7		〃	
11	59			0.7	13.6	3.4	22.7							7.8	11.50	〃	
12	1			–	15.4	–	32.1							5.9		〃	
13	1			–	10.0	–	0.3							0.8	13.03	〃	
14	–			–	–	–	–							–		〃	
15	–			–	–	–	–							–	13.03	〃	
16	–			–	–	–	–							–			UNRECORDED
17	1			–	–	7.0	–							0.4			〃
18	35			–	14.1	4.6	0.8							3.7	12.11	15:00 ~ 18:00	
19	–			–	16.2	–	–							1.1		14:00 ~ 18:00	
20	20				–	25.2	27.1							5.9		〃	
21	44				36.8	14.8	20.3							36.3	26.12	13:00 ~ 18:00	
22	13				24.9	14.3	14.3							22.3	14.35	〃	
23	17				2.0	1.2	22.2							5.6	6.50	〃	
24	–				24.6	–	0.3							18.7	4.94	〃	
25	8				5.0	2.7	8.7							5.6	4.94	〃	
26	–				2.8	0.7	0.3							4.5	4.90	〃	
27	13				–	6.1	19.5							3.7	14.35	〃	
28	8				77.7	6.8	39.0							64.7	8.76	13:00 ~ 19:15	
29																	
30																	
31																	
T.C	351.0			(180.5)	403.9	(196.8)	435.5							364.9			

Notes :
1. Space (A) expresses rainfall observation station name.
2. Space (B) shows rainfall observation station number.
3. Space (C) shows Thiessen Coefficient.
4. R̄ means average depth of rainfall over area.
5. Qp means peak flood.

Table – Observed Raintall and Discharge Data at Kloposawit Bridge Station

Month/Year : Mar. /'83
Catchment Area : 82.20 Km²

Date (Ⓐ / Ⓑ / Ⓒ)	Rainfall (mm): BENDO	MUNGGIR	G. LEKER	G. PAKIS	WONORENGGO	KERTOSARI	B. SAT	RANUPANE							R̄	Discharge: Qp (m³/s)	Observed Time	Remarks
Ⓑ	3	20	30	51	33	36	37	41										
Ⓒ	0.07	0.06	0.04	0.45	0.07	0.04	0.13	0.14										
1	—				0.5	0.3	2.0								0.7	4.94	13:00 ~ 18:00	
2	—				18.3	—	21.2								16.7	13.03	〃	
3	38				38.7	8.3	38.1								37.4	7.17	13:00 ~ 18:30	
4	2				8.2	—	4.9								9.4		〃	
5	—				16.4	—	11.3	—							11.6	4.94	〃	
6	1				16.8	4.9	15.1	7.0							13.6	6.06	13:00 ~ 18:00	
7	33				7.5	0.7	9.3	10.9							9.7		〃	
8	22				7.7	3.2	50.1	12.1							14.6	6.06	〃	
9	48				62.2	15.1	26.8	23.9							49.4	13.67	13:00 ~ 21:00	
10	3				4.5	2.0	1.7	1.0							3.4		13:00 ~ 19:00	
11	16				7.9	—	33.5	—							10.4	9.98	13:00 ~ 20:00	
12	—				0.1	3.8	2.3	—							0.8	4.94	13:00 ~ 18:00	
13	25				60.0	9.1	29.6	2.2							31.1	13.05	13:00 ~ 19:00	
14	5				11.6	3.6	8.0	0.6							8.9		13:00 ~ 18:00	
15	2				26.0	5.7	12.6	—							13.1		〃	
16	57				2.9	5.9	26.8	1.0							9.7	13.03	13:00 ~ 15:45	
17	9				4.8	—	20.2	—							7.8	9.17	13:00 ~ 17:45	
18	11				12.5	—	5.5	14.8							11.3			UNRECORDED
19	12				2.0	—	5.2	2.0							5.0	13.03	14:30 ~ 18:30	
20	—					0.6	0.3	31.4							21.8	13.03	13:00 ~ 19:15	
21	8					1.5	30.2	9.0							12.9	8.45	13:00 ~ 18:15	
22	12					—	13.5	9.7							10.4	7.62	13:00 ~ 19:00	
23	6					13.3	2.8	11.7							9.6	16.03	13:00 ~ 18:30	
24	—					—	—	—							—	4.94	13:00 ~ 13:30	
25	75					6.3	55.0	—							13.0	13.03	13:00 ~ 18:00	
26	—					1.6	0.5	—							0.2		〃	
27	—					—	—	29.8							20.3	6.06	〃	
28	—					51.2	0.3	—							2.1		〃	
29	—					0.6	—	—							0		〃	
30	1					13.9	32.7	—							8.2	8.15	〃	
31	2					0.4	1.5	6.3							5.1		〃	
Total	320.0				(291.7)	146.4	465.8	(174.5)							367.4			

Notes :
1. Space Ⓐ expresses rainfall observation station name.
2. Space Ⓑ shows rainfall observation station number.
3. Space Ⓒ shows Thiessen Coefficient.
4. R̄ means average depth of rainfall over area.
5. Qp means peak flood.

Table - Observed Rainfall and Discharge Data at Kloposawit Bridge Station

Month/Year : Apr. /'83
Catchment Area : 82.20 Km²

Date	BENDO	MUNGGIK	G. LEKER	G. PAKIS	WONOKERTO	KEMSOSARI	B. SAT	RANUPANE	R̄	Qp (m³/s)	Observed Time	Remarks
(station no.)	9	20	30	31	33	36	37	41				
(Thiessen coef.)	0.07	0.06	0.04	0.45	0.01	0.04	0.13	0.14				
1	–					–	–		–		13:00 ~ 18:00	
2	–					–	–		–		"	
3	1					1.0	0.7		0.7		"	
4	11					3.5	9.1		9.2		"	
5	6					0.4	3.5		3.4		"	
6	57					36.6	2.5		9.9	13.03	13:00 ~ 18:45	
7	28			68.2		30.5	31.0		56.4	13.43	13:00 ~ 18:15	
8	4			0.6		–	1.0		0.9		13:00 ~ 18:00	
9	1			1.1		–	0.3		1.0		"	
10	–			–		–	4.3		0.9		"	
11	24			–		20.0	4.6		3.4		"	
12	54			–		46.3	38.0		13.2	16.48	13:00 ~ 19:00	
13	12			–		9.3	31.6		7.5	7.17	13:00 ~ 18:00	
14	–			12.0		0.4	3.9		9.0	5.61	"	
15	–			–		–	–		–		"	
16	–			9.7		8.1	13.4		8.3		"	
17	–			–		–	4.0		0.8		"	
18	–			20.0		–	1.0		14.1	6.00	"	
19	–			62.0		–	6.5		44.0		"	
20	–			0.3	2.8	1.3	0.7		0.7		"	
21	–			–	–	6.0	–		0.2		"	
22	–			7.0	18.2	–	5.8		6.5		"	
23	2			0.9	1.0	1.0	2.0		1.1		"	
24	–			1.5	–	–	–		1.0		"	
25	7			9.5	9.6	9.0	14.0		9.8		"	
26	3			–	3.1	3.8	3.8		1.0		"	
27	7			41.0	4.0	–	17.1		35.4	5.20	"	
28	–			2.0	32.0	–	3.8		5.1		"	
29	9			–	–	4.5	24.8		4.0		"	
30	12			–	65.4	–	9.5		6.7		"	
31												
T.C.	238.0			(239.0)	(137.1)	177.6	243.7		250.2			

Notes :
1. Space Ⓐ expresses rainfall observation station name.
2. Space Ⓑ shows rainfall observation station number.
3. Space Ⓒ shows Thiessen Coefficient.
4. R̄ means average depth of rainfall over area.
5. Qp means peak flood.

Table – Observed Rainfall and Discharge Data at Kloposawit Bridge Station

Month/Year : May/'83
Catchment Area : 72.20 km²

Date	Rainfall (mm) BENDO	MUNGGI K	G. LEKEK	G. PAKIS	WONORENGO	KERTOSARI	B. SAT	RANUPANE	R̄	Discharge Qp (m³/s)	Observed Time	Remarks
②	3	20	50	31	33	36	37	41				
③	0.07	0.06	0.04	0.45	0.07	0.04	0.15	0.14				
1	18				39.8	15.0	22.7		35.1	20.15	13:00 ~ 18:15	
2	–			1.1	–	–	–		0.8		13:00 ~ 18:00	
3	22			8.8	–	38.5	17.3		12.1	9.97	〃	
4	5			–	–	3.5	–		0.5		〃	
5	4			32.0	1.0	3.0	4.4		23.1	11.57	〃	
6	18			8.5	72.0	11.0	41.3		18.4	11.57	13:00 ~ 19:00	
7	19				45.4	6.7	26.6		24.4	13.53	13:00 ~ 18:00	
8	–				2.2	1.5	4.2		2.3	11.57	〃	
9	–				24.7	–	6.6		19.6		〃	
10	–				–	–	–		–		〃	
11	3				0.6	2.3	9.7		2.0		〃	
12	23				33.6	1.7	34.6		31.7		〃	
13	79				57.8	14.1	52.8		56.0	27.7	〃	
14	–			2.3	–	0.0	–		1.6		〃	
15	17			4.4	2.3	28.1	6.7		1.4		〃	
16	–			40.5	33.2	66.4	56.4		40.3	20.46	13:00 ~ 19:00	
17	11			3.5	1.6	60.2	1.8		5.7	11.57	13:00 ~ 18:00	
18	32			45.1	3.0	–	24.0		36.7		〃	
19	25			6.7	12.1	3.3	15.4		9.8	7.54	〃	
20	9				68.0	–	85.2		63.8		〃	
21	–				0.0	26.0	0.6		1.4		〃	
22	2				2.6	0.9	–		1.8		〃	
23	11				16.6	31.3	8.0		15.7	12.22	13:00 ~ 16:00	
24	18				14.5	13.0	15.3		14.8		13:00 ~ 18:00	
25	202				7.9	68.4	141.2		41.2		〃	
26	10				204.7	103.7	118.4		125.8	8.31	〃	
27	65				86.4	18.5	22.5		74.7	11.57	〃	
28	19				18.5	13.2	20.9		18.6		〃	
29	–				29.5	1.4	11.5		24.0		〃	
30	30				7.0	12.3	20.8		10.6		〃	
31	2				2.0	–	2.4		2.0		〃	
T.t	650.0			(152.7)	772.8	544.7	779.8		770.7			

Notes :
1. Space Ⓐ expresses rainfall observation station name.
2. Space Ⓑ shows rainfall observation station number.
3. Space Ⓒ shows Thiessen Coefficient.
4. R̄ means average depth of rainfall over area.
5. Qp means peak flood.

Table - Observed Rainfall and Discharge Data at Kloposewit Bridge Station

Month/Year : Jun. /'83
Catchment Area : 82.20 km²

Date	Rainfall (mm)														R̄	Discharge		Remarks
Ⓐ	BENDO	MUNGGIR	G. LEKER	G. PAKIS	WONORENGGO	KERTOSARI	B. SAT	RANUPANE								Qp (m³/s)	Observed Time	
Ⓑ	3	20	30	31	33	36	37	41										
Ⓒ	0.07	0.06	0.04	0.45	0.07	0.04	0.13	0.14										
1	–				–	1.6	–										13:00 ~ 18:00	
2	1				–	0.8	–										"	
3	2				–	–	–										"	
4	2				–	2.6	1.0										"	
5	–				0.5	5.5	56.0										"	
6	7				5.7	18.2	–										"	
7	–				0.7	1.9	–										"	
8	27				176.0	2.2	129.0										"	
9	45					18.2	77.6										"	
10						39.9	44.9									22.0	"	
11						–	15.6										"	
12						10.6											"	
13						2.8											"	
14																	"	
15																	"	
16																	"	
17																	"	
18																	"	
19																	"	
20																	"	
21																	"	
22																	"	
23																	"	
24																	"	
25																	"	
26																		
27																		
28																		
29																		
30																		
31																		
[illegible]																		

Notes :
1. Space Ⓐ expresses rainfall observation station name.
2. Space Ⓑ shows rainfall observation station number.
3. Space Ⓒ shows Thiessen Coefficient.
4. R̄ means average depth of rainfall over area.
5. Qp means peak flood.

Table - Observed Rainfall and Discharge Data at Check Dam Leprak No.1 Station

Month/Year : Feb. / '83
Catchment Area : 27.60 Km²

Date (Ⓐ / Ⓑ / Ⓒ)	Raintall (mm) G. SAWUR	G. LEKER	G. PAKIS	KAMARA A	WONOKENGO	CURAH KOBO'AN	R̄	Discharge Qp (m³/s)	Observed Time	Remarks
Ⓑ	10	30	31	32	33	38				
Ⓒ	0.02	0.36	0.06	0.18	0.05	0.35				
1	32		-		18.0		7.5			
2	-		3.1		2.0		2.6			
3	-		23.6		-		14.2			
4	11		3.3		10.6		6.2			
5	25		-		15.6		6.9			
6	6		66.0		13.9		45.3			
7	-		-		4.7		1.7			
8	33		54.9		31.8		45.6			
9	18		-		50.0		19.4	17.86	13:00 ~ 18:00	START
10	23		28.3		9.3		21.3	49.57	〃	
11	11		6.9		13.6		5.7	18.58	〃	
12	-		-		15.4		5.7		〃	
13	14		-		10.0		4.1		〃	
14	-		-		-		-		〃	
15	-		-		-		-		〃	
16	-		-	-	-		-		〃	
17	4		-	1.4	-		0.3		〃	
18	17		-	38.5	14.1		12.7	49.59	20:00 ~ 23:15	
19	-		-	-	16.8		1.8		13:00 ~ 18:00	
20	17			-	-		0.4		〃	
21	34			52.4	36.8		46.1		〃	
22	3			15.6	24.7		12.9	49.57	13:00 ~ 20:00	
23	45			2.6	2.0		3.8		13:00 ~ 18:00	
24	-			25.0	26.6		24.5		〃	
25	24			16.2	5.0		12.1	31.13	13:00 ~ 20:15	
26	-			17.6	5.3		12.5	97.46	13:00 ~ 19:45	
27	3			26.7	-		16.2	69.04	13:00 ~ 16:15	
28	20			5.3	77.7		33.1	49.57	15:00 ~ 17:00	
29										
30										
31										
Total	344.0		(180.5)	(201.5)	403.7		372.9			

Notes :
1. Space Ⓐ expresses rainfall observation station name.
2. Space Ⓑ shows rainfall observation station number.
3. Space Ⓒ shows Thiessen Coefficient.
4. R̄ means average depth of rainfall over area.
5. Qp means peak flood.

Table - Observed Rainfall and Discharge Data at Check Dam Leprak No.1 Station

Month/Year : Mar. /'83
Catchment Area : 27.60 km²

Date	G. SAWUK	?. LEKOR	?. PAK-S	KAMAR A	WONORENGGO	CURAH KOBO.AN	R̄	Qp (m³/s)	Observed Time	Remarks
(Station No.)	10	30	31	32	33	38				
(Thiessen Coef.)	0.02	0.36	0.06	0.17	0.03	0.35				
1	—			19.9	0.5		12.1		13:00 ~ 18:00	
2	—			5.2	18.3		10.1		"	
3	36			20.1	33.9		27.5	46.09	13:00 ~ 17:15	
4	29			—	8.1		3.7		13:00 ~ 18:00	
5	—			—	11.9		6.2		"	
6	6			6.1	18.3		10.3	22.77	"	
7	19			37.5	7.5	30.0	33.7		"	
8	10			27.6	7.7	14.5	22.1	22.06	13:00 ~ 18:15	
9	20			25.3	12.3	11.0	21.3	49.57	13:00 ~ 18:00	
10	—			5.6	4.5	4.7	5.1		"	
11	9			—	7.9	2.0	1.7		"	
12	—			0.3	0.6	0.2	0.3		"	
13	41			30.3	40.0	44.5	35.9	64.79	13:00 ~ 19:15	
14	67			5.1	11.6	52.0	22.9	31.13	13:00 ~ 18:00	
15	9			19.7	26.0	9.6	16.3		"	
16	3			24.0	2.9	35.4	26.7	35.02	"	
17	19			43.7	7.3	24.3	35.3	135.66	"	
18	2			3.3	12.5	10.0	5.7		"	
19	—			60.0	2.0	—	36.1	175.00	13:00 ~ 18:15	
20	—			32.3		2.0	20.1	191.20	13:00 ~ 18:45	
21	42			17.3		47.7	29.3	87.[illegible]	13:00 ~ 17:00	
22	7			15.7		5.3	11.6		13:00 ~ 18:00	
23	4					20.7	20.6	39.10	"	
24	—					—	—		"	
25	2					2.5	2.5		"	
26	—					1.0	1.0	34.16	"	
27	—					—	—		"	
28	6					1.4	1.5	37.17	"	
29	—					3.4	3.3	22.77	"	
30	—					0.2	0.7		"	
31	9					11.7	11.7		"	
Total	334.0			(398.3)	(291.7)	(335.6)	434.2			

Notes :
1. Space Ⓐ expresses rainfall observation station name.
2. Space Ⓑ shows rainfall observation station number.
3. Space Ⓒ shows Thiessen Coefficient.
4. R̄ means average depth of rainfall over area.
5. Qp means peak flood.

Table - Observed Raintall and Discharge Data at Check Dam Leprak No.1 Station

Month/Year : Apr. /'83
Catchment Area : 27.60 km²

Date \ Ⓐ	G. SAWUR	G. LEKER	G. PAKIS	KAMARA	WONOREnggo	CURAH KOBO. AN	R̄	Qp (m³/s)	Observed Time	Remarks
Ⓑ	10	30	31	82	33	38				
Ⓒ	0.02	0.36	0.06	0.18	0.03	0.35				
1	–			–		–	–		13:00 ~ 18:00	
2	–					–	–	31.18	〃	
3	3					8.5	8.4		〃	
4	28			44.5		14.6	32.7	39.10	〃	
5	6			45.0		10.9	31.3	60.53	〃	
6	41			4.7		27.4	14.7		〃	
7	19		60.2	15.0		24.8	41.1		〃	
8	2		0.6	4.7		1.6	1.8		〃	
9	3		1.2	37.7		0.6	7.6		〃	
10	–		–	8.7		–	1.5		〃	
11	16		–	4.7		10.5	5.2		〃	
12	21		–	27.5		16.5	22.6		〃	
13	20		–	21.1		12.3	16.0	22.94	〃	
14	–		12.0	2.3		3.0	3.1	92.47	13:00 ~ 19:15	
15	–		–	2.0		0.8	0.4		13:00 ~ 18:00	
16	19		7.7	43.3		15.8	17.4		〃	
17	15		–	29.5		9.5	19.8		〃	
18	33		20.0	–		6.3	11.5	39.10	〃	
19	12		62.0	62.0		20.7	45.3	60.53	〃	
20	11		0.5	21.4	2.3	14.7	14.6	39.10	〃	
21	–		–	4.7	–	2.0	3.7		〃	
22	9		7.0	2.6	53.1	4.5	5.6		〃	
23	–		0.7		1.0	0.7	0.8		〃	
24	–		1.5		–	–	0.7		〃	
25	17		7.5		9.2	18.7	10.3		〃	
26	2		–	6.0	3.1	2.5	4.2		〃	
27	–		42.0	4.5	4.0	0.7	5.7		〃	
28	–		2.9	95.0	58.0	2.5	21.5	53.08	13:00 ~ 18:30	
29	22		–	29.0	–	14.0	41.2	73.63	13:00 ~ 19:15	
30	2		–	–	65.4	–	2.0		13:00 ~ 18:00	
31										
T.C.	301.0		(239.0)	(468.0)	(137.1)	240.6	375.6			

Notes :
1. Space Ⓐ expresses raintall observation station name.
2. Space Ⓑ shows raintall observation station number.
3. Space Ⓒ shows Thiessen Coefficient.
4. R̄ means average depth of raintall over area.
5. Qp means peak flood.

Table - Observed Rainfall and Discharge Data at Check Dam Leprak No.1 Station

Month/Year : May / '83
Catchment Area : 27.60 Km²

Date (A) / (B) / (C)	G. SAWUR	G. LEKER	G. PAKIS	KAMAK A	WONOKENGKO (?)	CURAH KOKOSAN	R̄	Qp (m^3/s)	Observed Time	Remarks
(B)	10	30	31	32	33	58				
(C)	0.02	0.36	0.06	0.18	0.03	0.35				
1	50				39.8	50.6	43.6	522.42	13:00 ~ 21:15	
2	-		1.1		-	0.6	0.7		13:00 ~ 18:00	
3	43		8.8		-	47.0	22.6	53.04	12:00 ~ 18:00	
4	3		-		-	8.9	3.8		13:00 ~ 18:00	
5	-		32.0	6.8	1.0	1.9	6.2		〃	
6	25		8.5	5.8	78.2	11.0	10.3		〃	
7	14			60.8	55.4	31.8	48.7		〃	
8	-			47.4	2.2	1.0	28.7		〃	
9	13			65.0	24.7	1.3	40.5		〃	
10	-			28.8	-	15.9	21.6		〃	
11	2			-	0.6	0.8	0.1	39.10	〃	
12	65			0.1	35.4	2.1	3.5		〃	
13	94			64.1	57.9	42.3	59.1	46.17	〃	
14	-		2.3	44.8	-	55.3	22.4		〃	
15	14		4.4	7.0	2.3	31.9	14.6		〃	
16	33		40.6	55.1	33.2	37.2	41.6	60.63	13:00 ~ 18:45	
17	5		3.5	32.6	1.6	3.7	8.7		13:00 ~ 18:00	
18	23		45.1	13.9	5.0	2.2	11.3			UNRECORDED
19	20		6.7	10.9	12.1	8.1	8.5			〃
20	29			-	68.0	39.6	11.5			〃
21	-			0.5	1.9	-	0.3	46.44	13:00 ~ 18:00	
22	1				1.2	0.6	1.6		〃	
23	32				16.6	41.6	45.7	22.44	〃	
24	13				14.5	12.0	13.6		〃	
25	134				7.9	49.0	64.8		〃	
26	31				204.7	140.8	178.8	289.63	0:15 ~ 6:45	
27	74				86.9	61.1	77.3	39.10	14:00 ~ 18:30	
28	15				18.5	11.6	16.0		14:00 ~ 18:00	
29	15				22.5	21.6	43.9	60.53	〃	
30	5				7.0	6.8	6.9		〃	
31	4				2.0	6.3	5.8		13:00 ~ 18:00	
Total	711.0		(152.9)	(441.7)	772.7	797.8	811.7			

Notes :
1. Space (A) expresses rainfall observation station name.
2. Space (B) shows rainfall observation station number.
3. Space (C) shows Thiessen Coefficient.
4. R̄ means average depth of rainfall over area.
5. Qp means peak flood.

Table - Observed Rainfall and Discharge Data at Check Dam Leprak No1 Station

Month/Year : Jun. /'83
Catchment Area : 27.10 km²

Date	Rainfall (mm)														$\bar{R}$	Discharge		Remarks
①	G.SAWUR	G.LEKER	G.PAKIS	KAMARA A	WONOKENGNO	CURAH KOHOAN										Qp (m³/s)	Observed Time	
②	10	30	31	32	43	38												
③	0.02	0.36	0.06	0.18	0.03	0.35												
1	—				—	—											13:00 ~ 18:00	
2	—				—	2.1											〃	
3	—				—	2.5											〃	
4	—				—	—											〃	
5	4				0.4	4.3											〃	
6	9				5.7	28.3											〃	
7	—				0.7	0.8											〃	
8	44				176.0	56.6											〃	
9	54					25.4										307.19	13:00 ~ 18:00 21:15 ~ 24:00	
10						42.6											13:00 ~ 18:00	
11						12.3											〃	
12																	〃	
13																	〃	
14																	〃	
15																	〃	
16																	〃	
17																	〃	
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28																		
29																		
30																		
31																		
T.C																		

Notes :
1. Space Ⓐ expresses rainfall observation station name.
2. Space Ⓑ shows rainfall observation station number.
3. Space Ⓒ shows Thiessen Coefficient.
4. $\bar{R}$ means average depth of rainfall over area.
5. Qp means peak flood.

Table - Observed Rainfall and Discharge Data at Planned Pronojiwo Dam Station

Month/Year : Feb. /'83
Catchment Area : 54.30 Km²

Date \ Ⓐ	G. LEKER	G. PAKIS	KAMARA A	PRONOJIWO	CURAH KOBO'AN	SUPIT UKANG									R̄	Qp (m³/s)	Observed Time	Remarks
Ⓑ	30	31	32	34	38	42												
Ⓒ	0.01	0.02	0.34	0.16	0.09	0.38												
1		–				28.0									16.7			
2		3.4				11.7									9.6			
3		23.6				10.0									14.1			
4		3.5				20.8									13.1			
5		–				4.0									3.6			
6		66.0				30.2									42.7			
7		–				–									0.4			
8		54.9				32.7									40.8			
9		–				47.0									27.7			
10		28.8				25.8									25.5			
11		0.9				20.7									12.9			
12		–				1.6									2.3			
13		–				11.0									6.8			
14		–				23.4									12.8			
15		–				4.0									2.2	22.0	12:45 ~ 18:00	START
16		–	–			4.8									2.6	28.0	13:00 ~ 18:00	
17		–	1.4			1.0									1.0	3.12	"	
18		–	38.5			–									14.9	19.1	"	
19		–	–			–									1.5	3.57	"	
20			–	25.7		18.8									10.2	3.86	"	
21			52.0	23.5		6.9									26.1	25.0	"	
22			15.6	1.0		–									8.3	3.59	"	
23			2.4	12.8		9.5									6.9	19.4	"	
24			25.0	8.0		2.7									13.5	134.0	"	
25			16.6	24.0		44.3									20.1	17.0	"	
26			11.6	9.0		6.4									10.4	220.5	"	
27			26.9	26.1		5.7									16.8	14.2	"	
28			5.3	44.1		81.0									49.9	14.3	"	
29																		
30																		
31																		
[illegible]		(180.5)	(201.6)	(178.4)		457.4									419.6			

Notes :
1. Space Ⓐ expresses rainfall observation station name.
2. Space Ⓑ shows rainfall observation station number.
3. Space Ⓒ shows Thiessen Coefficient.
4. R̄ means average depth of rainfall over area.
5. Qp means peak flood.

Table - Observed Rainfall and Discharge Data at Planned Pronojiwo Dam Station

Month/Year : Mar. / '73
Catchment Area : 54.30 Km²

Date	G. Lekek	G. Pakis	Kamak A	Pronojiwo	Curah Kobo'an	Supit Urang	R̄	Qp (m³/s)	Observed Time	Remarks
(No.)	30	31	32	34	38	48				
(Coef.)	0.01	0.02	0.36	0.16	0.09	0.38				
1			19.7	–		–	7.4	3.52	13:00 – 17:00	
2			5.2	–		–	3.6	3.52	〃	
3			20.1	–		18.6	18.0	449.4	〃	
4			–	–		0.4	0.9	3.52	〃	
5			–	–		0.7	1.7	19.44	〃	
6			6.1	10.1		0.3	5.5	14.44	〃	
7			37.5	2.4	30.4	–	17.0	34.5	〃	
8			27.6	1.9	14.5	7.6	14.7	3.52	〃	
9			25.4	7.7	11.0	32.3	23.9	16.4	〃	
10			5.6	6.3	4.7	7.0	6.2	19.5	〃	
11			–	–	2.4	–	0.5	3.52	〃	
12			0.3	–	0.2	–	0.1	3.52	〃	
13			30.3	38.7	44.5	28.7	37.7	58.0	〃	
14			5.1	–	52.0	–	6.6	48.0	〃	
15			19.7	31.0	9.6	12.0	18.5	53.4	〃	
16			24.0	7.7	35.4	23.7	22.3	164.4	〃	
17			43.4	1.0	24.3	3.0	19.2	3.52	〃	
18			3.3	–	10.0	16.0	8.2	3.52	〃	
19			60.0	14.3	–	–	24.5	486.0	〃	
20			32.3	0.5	2.0	6.0	14.5	512.0	〃	
21			11.2	9.0	47.7	11.4	16.4	32.19	〃	
22			15.7	3.0	5.5	–	6.8	178.77	〃	
23				–	20.0	1.3	10.1	3.88	〃	
24				–	–	–	–	3.88	〃	
25				19.0	2.5	10.0	8.0	118.44	〃	
26				–	1.0	5.5	2.6	60.9	〃	
27				1.3	–	4.5	1.9	32.47	〃	
28				25.7	1.4	5.0	6.7	178.43	〃	
29				34.9	3.4	1.0	7.5	232.43	〃	
30				30.5	0.2	34.3	18.0	60.9	〃	
31				6.0	11.4	–	6.2	33.17	〃	
T.C.			(398.9)	255.0	(335.0)	229.3	329.4			

Notes :
1. Space Ⓐ expresses rainfall observation station name.
2. Space Ⓑ shows rainfall observation station number.
3. Space Ⓒ shows Thiessen Coefficient.
4. R̄ means average depth of rainfall over area.
5. Qp means peak flood.

Table - Observed Rainfall and Discharge Data at Planned Pronojiwo Dam Station

Month/Year : Apr. /'83
Catchment Area : 54.30 km²

Ⓐ / Ⓑ / Ⓒ / Date	Rainfall (mm) G. LEKER	G. PAKIJ	KAMAR A	PRONOJIWO	CURAH KOBOKAN	SUPIT URANG	$\bar{R}$	Discharge Qp (m^3/s)	Observed Time	Remarks
Ⓑ	30	31	32	34	38	42				
Ⓒ	0.01	0.02	0.34	0.16	0.09	0.38				
1			—	—	—	—	—	3.77	13:00 – 18:00	
2				—	—	0.3	0.2	3.77	"	
3				0.6	8.5	5.3	6.4	38.44	"	
4			44.2	27.8	14.6	43.1	33.4	60.7	"	
5			45.0	31.7	10.9	7.3	25.1	88.46	"	
6			2.9	8.4	27.4	49.6	13.3	74.77	"	
7		68.2	15.0	14.7	24.5	9.4	15.3	49.36	"	
8		0.6	4.7	4.0	1.6	—	2.5	125.66	"	
9		1.2	37.0	2.4	0.6	—	13.3	3.49	"	
10		—	8.2	0.6	—	10.8	7.6	33.49	"	
11		—	4.7	8.0	10.5	16.0	10.0	44.30	"	
12		—	29.5	6.7	16.5	5.0	14.5	3.88	"	
13		—	21.3	9.3	12.3	3.6	11.1	33.41	"	
14		12.0	2.3	4.7	3.0	1.8	2.9	44.43	"	
15		—	2.0	0.1	0.1	15.1	6.5	22.43	"	
16		7.9	43.3	6.3	15.8	3.7	19.1	33.39	"	
17		—	24.5	11.0	9.6	1.2	13.4	55.43	"	
18		20.0	—	2.2	6.3	—	1.5	3.77	"	
19		62.0	62.0	1.0	20.1	65.0	49.7	243.74	"	
20		0.5	21.8	15.8	14.7	33.0	23.9	3.77	"	
21		—	4.7	18.2	2.0	1.0	7.1	55.48	"	
22		7.0	2.6	1.2	4.5	—	1.7	3.77	"	
23		0.9		—	0.7	0.5	0.6	3.88	"	
24		1.5		—	—	1.0	1.8	10.14	"	
25		7.5		1.0	14.3	4.1	5.8	33.49	"	
26		—	6.0	9.1	2.6	4.4	5.9	44.43	"	
27		47.0	4.5	4.3	0.7	3.7	5.1		"	
28		2.2	45.0	3.7	2.5	31.7	28.7	121.59	"	
29		—	29.0	18.0	14.6	—	14.3	142.44	"	
30		—	—	—	—	32.7	12.8			
31										
Total		(289.[illegible])	(468.[illegible])	204.7	240.[illegible]	348.[illegible]	364.5			

Notes :
1. Space Ⓐ expresses rainfall observation station name.
2. Space Ⓑ shows rainfall observation station number.
3. Space Ⓒ shows Thiessen Coefficient.
4. $\bar{R}$ means average depth of rainfall over area.
5. Qp means peak flood.

Table - Observed Raintall and Discharge Data at Planned Pronojiwo Dam Station

Month/Year : May / '83
Catchment Area : 54.30 Km²

Date	G. LEKEK	G. PAKIS	KAMAKA A	PRONOJIWO	DUKAH KOBO'AN	SUPIT URANG	$\bar{R}$	Qp (m³/s)	Observed Time	Remarks
	Raintall (mm)							Discharge		
Ⓑ	30	31	32	34	33	42				
Ⓒ	0.01	0.02	0.34	0.16	0.09	0.38				
1				26.6	50.0	2.0	24.2	2956.90	13:00 ~ 17:00	
2		1.1		—	2.8	44.3	17.3		〃	
3		2.8		21.6	47.0	14.3	16.4	221.37	〃	
4		—		5.5	8.9	9.0	5.1		〃	
5		32.0	6.8	4.0	1.7	62.9	27.9	55.40	〃	
6		2.5	5.8	39.0	11.0	97.0	46.3	421.04	〃	
7			60.3	49.0	31.8	1.4	33.7	532.40	〃	
8			41.4	11.4	1.0	33.8	32.1	102.87	〃	
9			65.0	19.7	1.3	0.7	27.3	67.87	〃	
10			26.8	0.7	15.9	—	11.5		〃	
11			—	—	0.2	55.1	21.0		〃	
12			0.2	91.4	2.1	82.6	38.5	159.96	〃	
13			24.1	50.1	42.3	33.6	38.8	243.67	〃	
14		2.3	44.0	—	55.5	21.2	23.2		〃	
15		4.4	7.0	9.3	31.7	21.2	15.0	71.87	〃	
16		40.5	55.1	4.2	37.2	8.0	27.6	49.30	〃	
17		3.5	32.6	29.8	3.7	14.4	22.1	20.61	〃	
18		45.1	13.7	1.0	2.2	0.2	6.5		〃	
19		6.7	10.7	5.4	8.6	8.4	8.7		〃	
20			—	27.8	37.6	2.5	9.1	49.76	〃	
21			0.8	2.4	—	8.8	4.7	14.30	13:00 ~ 17:00	
22				1.2	0.6	7.8	4.0			UNRECORDED
23				26.3	41.6	0.4	14.3			〃
24				1.0	12.0	36.0	20.3			〃
25				84.0	41.0	95.5	57.1	492.20	16:00 ~ 18:30	
26				51.7	140.9	90.1	130.9		13:00 ~ 18:00	
27				74.7	61.1	15.3	55.2	263.67	〃	
28				94.6	11.6	40.4	31.1	67.87	〃	
29				12.2	71.6	14.0	25.0		〃	
30				26.9	6.3	4.9	9.4	44.41	〃	
31				0.7	6.3	—	1.4			
T.C		(152.7)	(441.7)	680.9	299.8	826.1	820.3			

Notes :
1. Space Ⓐ expresses raintall observation station name.
2. Space Ⓑ shows raintall observation station number.
3. Space Ⓒ shows Thiessen Coefficient.
4. $\bar{R}$ means average depth of raintall over area.
5. Qp means peak flood.

Table — Observed Rainfall and Discharge Data at Planned Pronojiwo Dam Station

Month/Year : Jun. / '83
Catchment Area : 54.30 Km²

Date \ Ⓐ	G. LEKER	G. PAKIS	KAMAR A	PRONOJIWO	CURAH KOBO'AN	SUPIT URANG									R̄	Qp (m³/s)	Observed Time	Remarks
Ⓑ	30	31	32	34	58	42												
Ⓒ	0.01	0.07	0.34	0.16	0.09	0.58												
1				0.6	–	0.6											13:00 – 19:00	
2				–	2.1	–											〃	
3				–	2.5	–											〃	
4				–	–	–											〃	
5				6.6	4.3	21.3										26.44	〃	
6				–	28.3	7.0											〃	
7				–	0.8	0.1											〃	
8				57.4	56.1	33.9											〃	
9				85.7	25.4	67.0										125.26	〃	
10				41.6	42.6	57.8											〃	
11				8.0	12.1	11.4											〃	
12				0.4		2.0											〃	
13				–		–											〃	
14				–		0.1										136.41	〃	
15				0.5		7.0											〃	
16																	〃	
17																	〃	
18																	〃	
19																	〃	
20																	〃	
21																	〃	
22																	〃	
23																	〃	
24																	〃	
25																	〃	
26																		
27																		
28																		
29																		
30																		
31																		
T.C.																		

Notes :
1. Space Ⓐ expresses rainfall observation station name.
2. Space Ⓑ shows rainfall observation station number.
3. Space Ⓒ shows Thiessen Coefficient.
4. R̄ means average depth of rainfall over area.
5. Qp means peak flood.

THE REPUBLIC OF INDONESIA

THE FEASIBILITY STUDY ON THE VOLCANIC DEBRIS CONTROL AND WATER CONSERVATION PROJECT IN THE SOUTHEASTERN SLOPE OF MT. SEMERU

SUPPORTING REPORT (5)

PART - C
GROUND WATER

FEBRUARY, 1984

JAPAN INTERNATIONAL COOPERATION AGENCY

C. GROUNDWATER

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1. INTRODUCTION

1.1 OBJECTIVE

The principal objective of this hydrogeological study is to delineate the groundwater system in the study area. This study results will be contributed to the evaluation of groundwater development potential at the prospective sites, closely related to the project feature of sediment control work.

1.2 BACKGROUND

The study area located in the southeastern slope of Mt. Semeru has abundant rainfall amound in rainy season, but the shortage of irrigation water appears more or less in the certain area during dry season.

Groundwater is recognized as the stable water resource in comparison with surface water, and is expected to the one of solutions to resolve this shortage of irrigation water.

It is necessary that the prospective site will have an adequate groundwater basin structure to store enough capacity of groundwater.

From the viewpoints of topographical and geological conditions, the K. Lengkong basin located in the south of Mt. Semeru will be recognized as the main target of groundwater development potential.

Moreover, the K. Lengkong basin will be included into the first priority project area of K. Rejali.

1.3 STUDY ITEMS

Hydrogeological study consists mainly of geology, groundwater, water quality and these integral interpretations, and also depends on hydrology, water and land use, and so on.

Taking into consideration the above-mentioned study results, this report will be dealt with the following study items;

① Groundwater Level

- Well inventory
- Observation of groundwater level
- Interpretation and consideration

② Water Quality

- Simplified water quality test; pH, T, DO, EC, Turb.
- Chemical analysis; Na, K, Mg, Ca, Cl, SO_4, HCO_3, etc.
- Hydro-geochemical interpretation
- Water quality evaluation for use

③ Hydrogeology of K. Lengkong Basin

- Hydraulic properties; Groundwater table, Permeability, etc.
- Delineation of groundwater system; Aquifer, Basin structure, Groundwater movement, etc.
- Panorama for groundwater development

Flow chart of these field works and studies are as shown in Fig.-1.1.

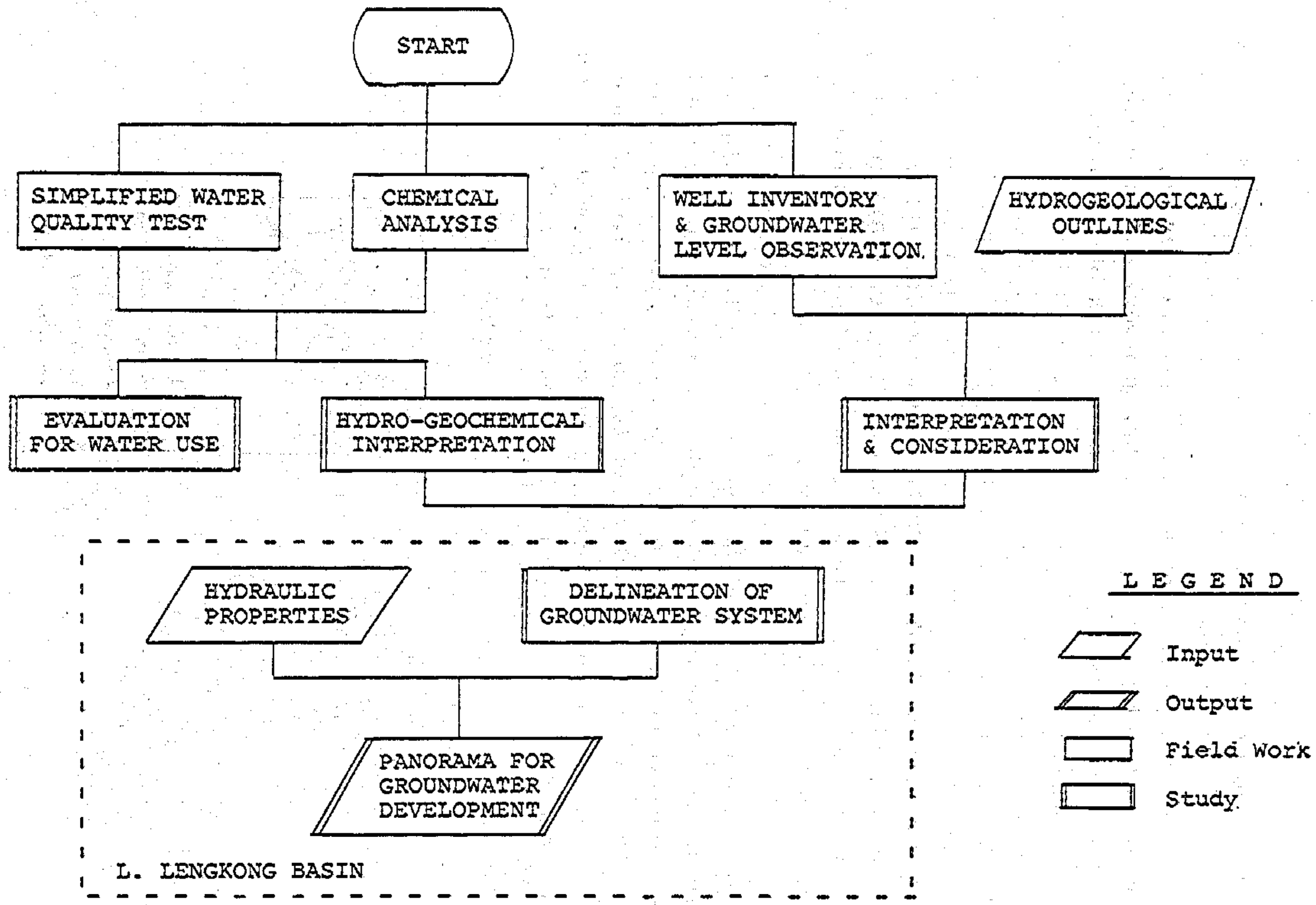


Fig.-1.1 Flow Chart of Groundwater Study

1.4 OUTLINES OF THE STUDY AREA

Before enter the groundwater and water quality studies, we will mention briefly about topography, geology, and land use, because these studies are closely related with our hydrogeological studies.

1.4.1 TOPOGRAPHY

Mt. Semeru is located about 100 km southeast of Surabaya and about 30 km west of Lumajang (long. 113°E, lat. 8°S); the study area covers the southern and southeastern slopes of this mountain with an area of about 730 km^2.

Mt. Semeru, one of the most active volcanoes in Indonesia, is a very young stratovolcano of the Quaternary period and stands at the southern end of a series of volcanoes stretching north and south. This range of volcanoes is generally divided into three topographical units; Tenggat mountains, Jambangan complex volcano and Mt. Semeru, from north to south (Fig.-1.2).

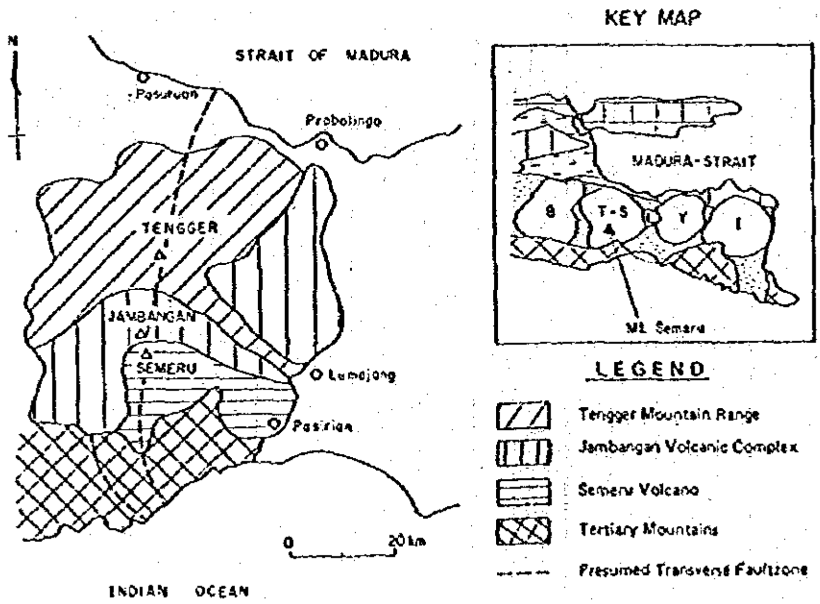


Fig.- 1.2 Schematic Geomorphological Unit Map of Tengger - Semeru Volcanic Row

Mt. Semeru is the youngest of these volcanoes and is being formed on the southern slope of the Jambangan complex volcano, which is the oldest.

On the south of Mt. Semeru, a range of mountains is found, consisting of Tertiary rocks with an elevation of 200 m to 1,000 m. The piedmont of Mt. Semeru develops extensively from east to southeast and reaches as far as Lumajang; however, its development towards the south is interrupted by the Tertiary mountains. The slopes of Mt. Semeru extending towards the north are formed covering a length of 2,600 m over the Jambangan volcano.

(1) Southeastern Slope of Mt. Semeru

The southeastern part of Semeru Volcano, a subject area of the current study, can be divided into the following 3 geomorphological units.

i) Main Part of the Volcanic Cone

Main part of the volcanic cone is over EL. 1,500 m, where volcanic activity of Semeru Volcano directly affects. Pyroclastic flow, ash fall, lapilli, volcanic bomb and lava etc. spewed directly from the crater, are distributed over this area and its inclination is very steep at 27 degree.

ii) Volcanic Fan

The volcanic fan is the slope between EL. 150 and 1,500 m, where Lahar and Ladu disasters mostly concentrate. The volcanic fan is classified, as shown in Table-1.1.

Tablo-1.1 Geomorphological Subunits of Volcanic Fan

Geomorphological Subunits		Deposits	Elevation / Slop
Ladu Fan		lava flow pyroclastic flow Lahar	EL. 800 to 1,500 m
Lahar Fan	Lahar Fan A	Lahar	EL. 250 to 800 m steel sloped fan
	Lahar Fan B	Lahar	EL. 150 to 250 m slow sloped fan

iii) Volcanic Piedmont Periphery

Volcanic piedmont periphery is a very slow sloped flat ground formed outside of the volcanic fan. In this area, exists an overflow deposit comprising sand, subangular pebbles, silt and clay. Further outside of this terrain, the alluvial plain and the coastal plain are formed.

(2) Tertiary Mountains and Hills

In the southwestern part of the study area lie steep mountains of Mature stage of max. EL. 1,000 m consisting of Tertiary volcanic rocks. In the north of these mountains near the boundary between Semeru Volcano and the mountains, a mountain range extends east to west in arcs, which blocks the extension of the foot of Semeru Volcano to the south. The slope of the mountains is very steep and dissected with many small valleys. To the south of Pasirian, two isolated hills consisting of the Tertiary Volcanic breccia stand out in the Volcanic fan.

(3) River Systems

A great number of valleys is conspicuously developed on the southern and southeastern slopes of Mt. Semeru. These valleys can be classified into three river systems flowing into the Indonesian ocean; i.e., K. Mujur, K. Rejali and K. Glidik, as shown in Fig.-1.3.

i) K. Mujur

The main channel of K. Mujur is formed by B. Sat, B. Tunggeng and K. Mujur, in that order. The average incline of the main stream from the mountain top to the river mouth is 1/11, which represents the most moderate gradient of the three rivers.

ii) K. Rejali

The main channel of K. Rejali is formed by B. Kobo'an, K. Leprak, K. Regoyo and K. Rejali, in that order. The main stream from the mountain top to the river mouth runs swiftly at the average inclination of 1/9.2. The river deeply erodes the Tertiary mountains (Kobo'an valley) from EL. 500 m to 600 m, and forms an alluvial fan at its lower reaches once again.

iii) K. Glidik

The main channel of K. Glidik is formed by B. Bang, K. Lengkong and K. Glidik in that order. The average inclination from the mountain top to the river mouth is of 1/9.0, which represents the steepest slope among the three rivers. K. Glidik collects water from valleys on the southern slope of Mt. Semeru and flows down through a valley deeply eroded in the Tertiary mountains.

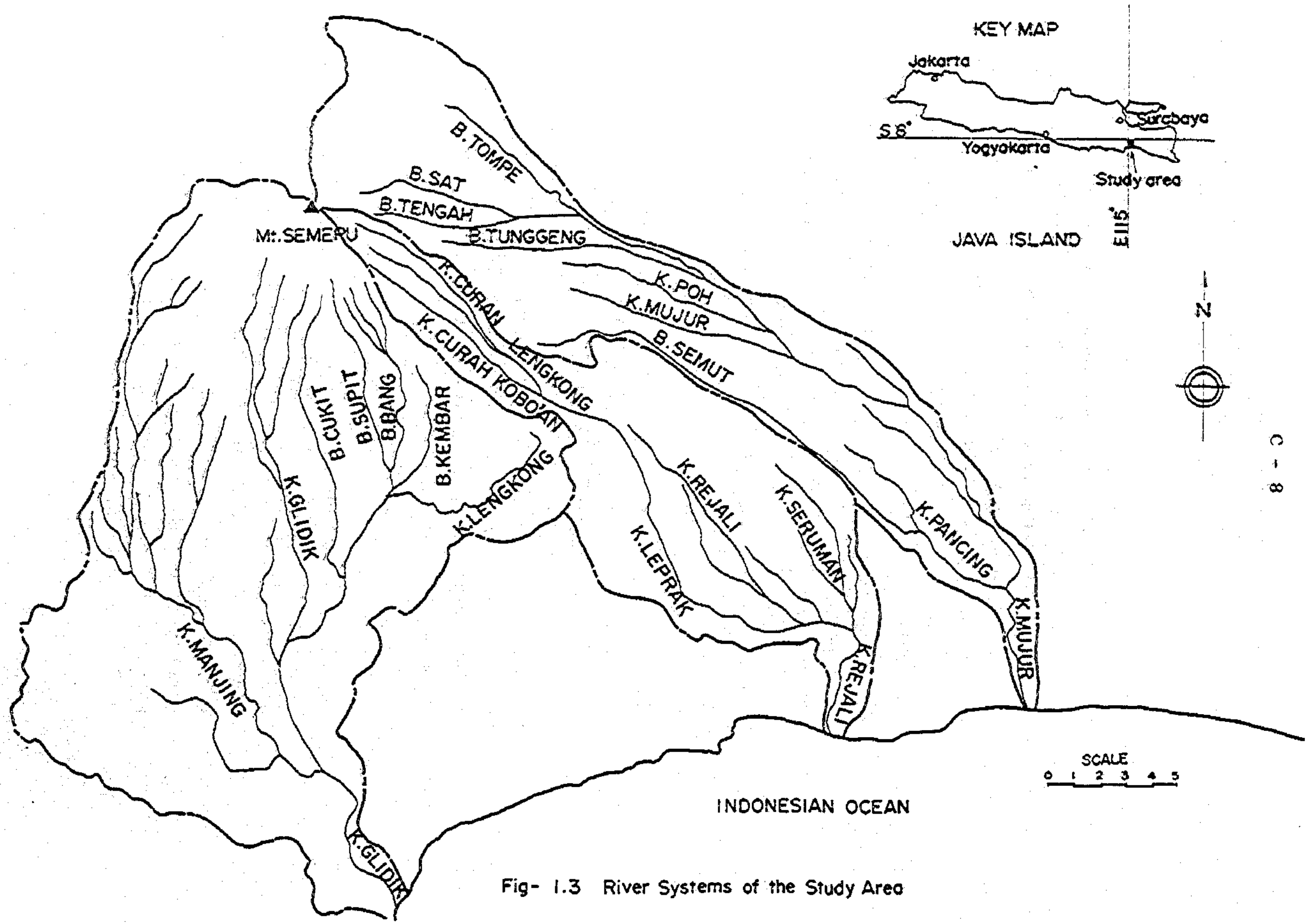


Fig- 1.3 River Systems of the Study Area

1.4.2 GEOLOGY

(1) Lithology and Stratigraphy

The study area covers both Tertiary volcanic rocks and Tertiary limestone distribution area and Quaternary volcanic products distribution area. Geology of the study area is largely divided into Tertiary system of south and Quaternary system of north. Tertiary system and Quaternary system are respectively divided into several layers as shown in Table-1.2 and schematically represented in Fig.-1.4.

i) Tertiary System

Tertiary system of the study area is mostly composed of such volcanic rocks as andesite and tuff breccia distributed in the south of the study area. Mountains consisting of Tertiary system show very steep topography of the mature stage, making a sharp contrast with the smooth slope of Semeru Volcano consisting of Quaternary system.

Tertiary system of the study area is divided into following 5 layers from lower to upper.

- Green Tuff
- Limestone Layer
- Alternation of Andesite/Tuff Breccia
- Tuff
- Volcanic Breccia

As sedimentary rocks, only limestone is distributed in a very narrow sphere near the estuary of K. Glidik.

Table-1.2 Sequence of Strata of the Study Area

Age	Layer		Facies
Holocene	Alluvial Deposits		Sand, round-subangular gravels, silt, clay storatified.
↑	Younger Volcanic Products (From Semeru Volcano)	Primary Volcanic Products	Andesite to basaltic lava, pyroclastic deposits, ash, bomb, lapilli, etc. very loose.
		Younger Lahar Deposits	Loose sand and angular gravels.
		Older Lahar Deposits	Compact sand and angular gravels.
Pleistocene	Older Volcanic Products (From Jambangan Volcanic Complex and Tengger Mountain Range)		Andesitic to basaltic lava, Pyroclastic deposits, ash, bomb, lappilli, Lahar deposits, etc., weathered.
↑	Volcanic Breccia		Volcanic breccia partly intercalated sandy tuff and andesite lava.
	Tuff		Tuff partly intercalated tuff breccia, tufficious mudstone, tufficious sand, andesite lava and pumice layer.
	Alternation of andesite Lava and Volcanic Breccia		Alternation of andesite lava and volcanic breccia.
	Limestone		Chalky linestone, partly calcarenite.
Miocene	Green Tuff		Green tuff, green volcanic breccia, green tuff breccia, propylite, acidic welded tuff, liparite, etc.

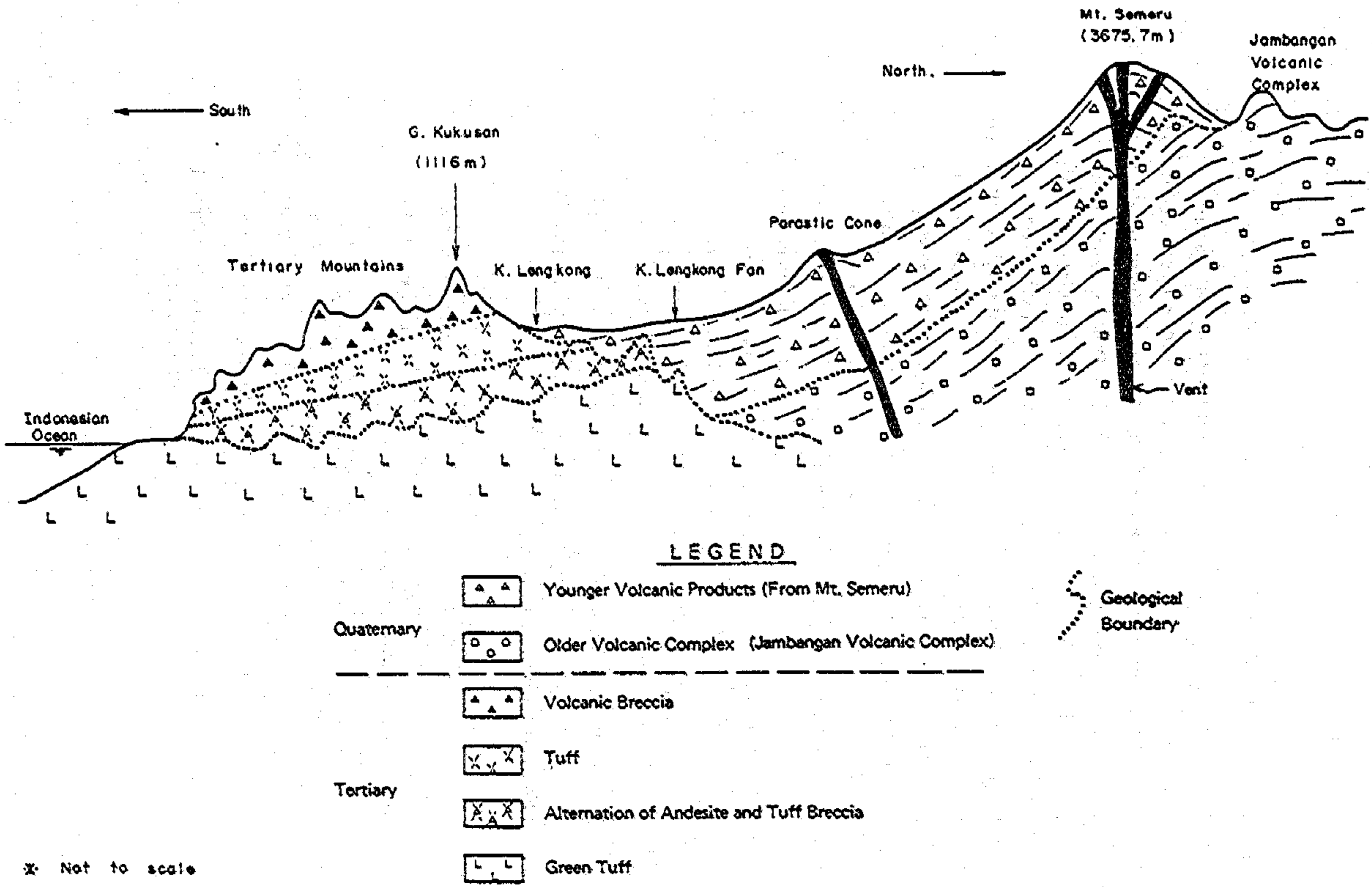


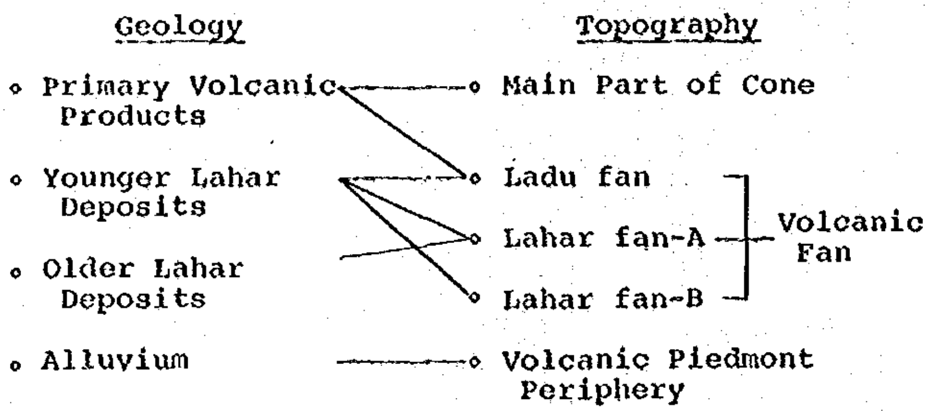
Fig.- 1.4 Schematic Geological Profile of the Study Area

ii) Quaternary System

Quaternary system of the study area is largely classified from lower to upper into older volcanic products of Tengger Mountain Range, Jambangan volcanic complex, younger volcanic products which is presently being supplied from Semeru Volcano and alluvium which is being deposited in the volcanic piedmont periphery. Volcanic products from Semeru Volcano are classified according to their origin, primary volcanic products, younger Lahar deposits and older Lahar deposits.

- Older Volcanic Products
- Younger Volcanic Products
  - Older Lahar deposits
  - Younger Lahar deposits
  - Primary volcanic ejecta
- Alluvium

The distribution of volcanic products from Semeru Volcano and its topography is closely related in the following manner.



(2) Geological Structure

i) Geological Structure of Tertiary System

Green tuff, layers at the bottom of Tertiary system in the study area repeat foldings and are dissected by faults at many places, showing a very complicated geological structure due to the intrusion of granite batholith in the middle Miocene period.

Limestone is only distributed in a very narrow sphere near the estuary of K. Glidik and its bedding plane is generally horizontal with caves developing along the bedding plane.

Alternation of andesite/volcanic breccia, tuff layer and tuff breccia layer, are presumed to be continuously superposed without long hiatas covering discordantly green tuff layer of underneath. Small folds are observed in these layers and they gently slope towards south (toward Indonesian Ocean). Faults are rarely observed in these layers.

ii) Geological Structure of Quaternary System

Older and younger volcanic products of Quaternary period are thickly distributed on a series of large depression zones called Solo Zone. In those volcanic products, folds and faults by crustal movements are not observed, but small folds and faults due to compaction settlement are partially observed.

Although the internal structure of stratovolcano is not generally well known, a schematic profile of Semeru volcano will be presumed as shown in Fig.-1.5. Its bedding plane of volcanic products is considered to be roughly parallel with the present slope of volcano.

On the ring at EL. 1,500 m around Semeru volcano, several parasitic volcanoes are lined up where a circular fault is presumed to exist.

From the macroscopic viewpoint of a series of Tengger - Semeru volcanoes, it is presumed that a large transverse fault zone runs cutting across Java Island along Tengger - Semeru volcanic row extending in N-S direction.

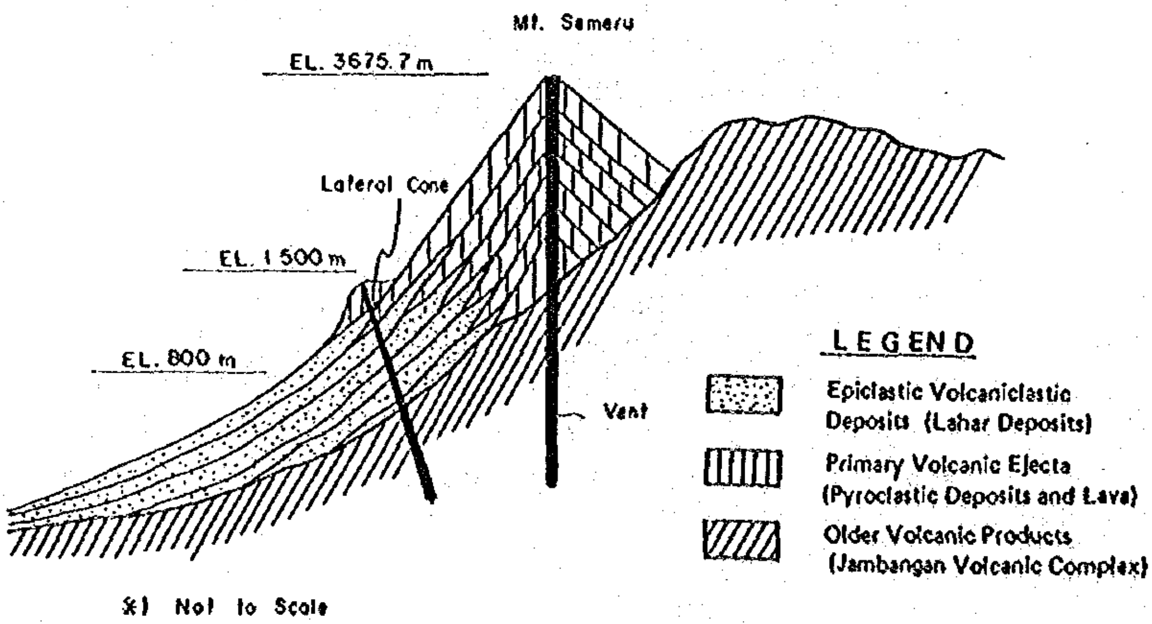


Fig.- 1.5 Schematic Structural Profile of Mt. Semeru

1.4.3 LAND USE

The present conditions of land use inside the study area as agricultural purpose are noticeably compatible with its topographical conditions. Conceptual relationships between topography and land use are given in Table-1.3.

Table - 1.3 Conceptual Relationships of Topography and Land use

Topography			Land use
Main part of volcanic cone	2500m and over		Bare soil
	2500m and under		Forest (natural)
Ladu Fan			Forest (natural/artifical), Dry field (mainly sugarcane), Cloves, Coffee.
Lahar Fan	Steep Slope	B. Sat Fan	Rice paddy (single- and double-harvesting), Dry field
		B. Semut fan	Wasteland, Artifical forest, Rice paddy (single- and double-harvesting) Dry field, Cloves
		K. Rejali fan	Rice paddy (double-harvesting), Wasteland
		K. Lengkong fan	Wasteland
		K. Poh fan (old fan)	Stable rice paddy (double-harvesting), Tobacco, Corn
	Gentle-slope		Rice paddy (double-harvesting); half of B. sat fan, dry field.
Volcanic Periphery			Dry field (considerable area of land where planting during dry season is not possible)
Alluvial plain			Rice paddy (double-harvesting)
Tertiary mountains			Forest (natural/artificial), Coffee, Cloves, Cassava
Old volcanic piedmont	Pronojiwo		Coffee, Dry field
	Left bank of B. Sat and K. Lateng		Coffee, Dry field, Rice paddy (single-harvesting)

2. GROUNDWATER INVESTIGATION

2.1 GENERAL

The in-situ investigation of groundwater level consists of;

- Field reconnaissance
- Continuous observation of groundwater level in long period at 17 wells with installation of automatic water level gauge.
- Regular measurement of water level in borehole in K. Lengkong fan, using potable water level gauge.
- Quasi-simultaneous measurement of groundwater level in K. Lengkong basin, using potable water level gauge.

In this Chapter, the study will be carried out, based on the results of continuous groundwater level observation at 17 wells. This study intends to clarify some characteristics as general hydrogeology of the study area from the interpretation of data, taking account of topography, geology, land use and so on.

The work allocation of groundwater level observation for the Indonesian Government and JICA Team is as follows;

i) Indonesian Government
- Groundwater level observation
- Data arrangement

ii) JICA
- Technical guidance relating to observation method and data arrangement
- Data analysis and its interpretation

Detail study of groundwater will be dealt with in the chapter of "Hydrogeology of K. Lengkong Basin" (§4).