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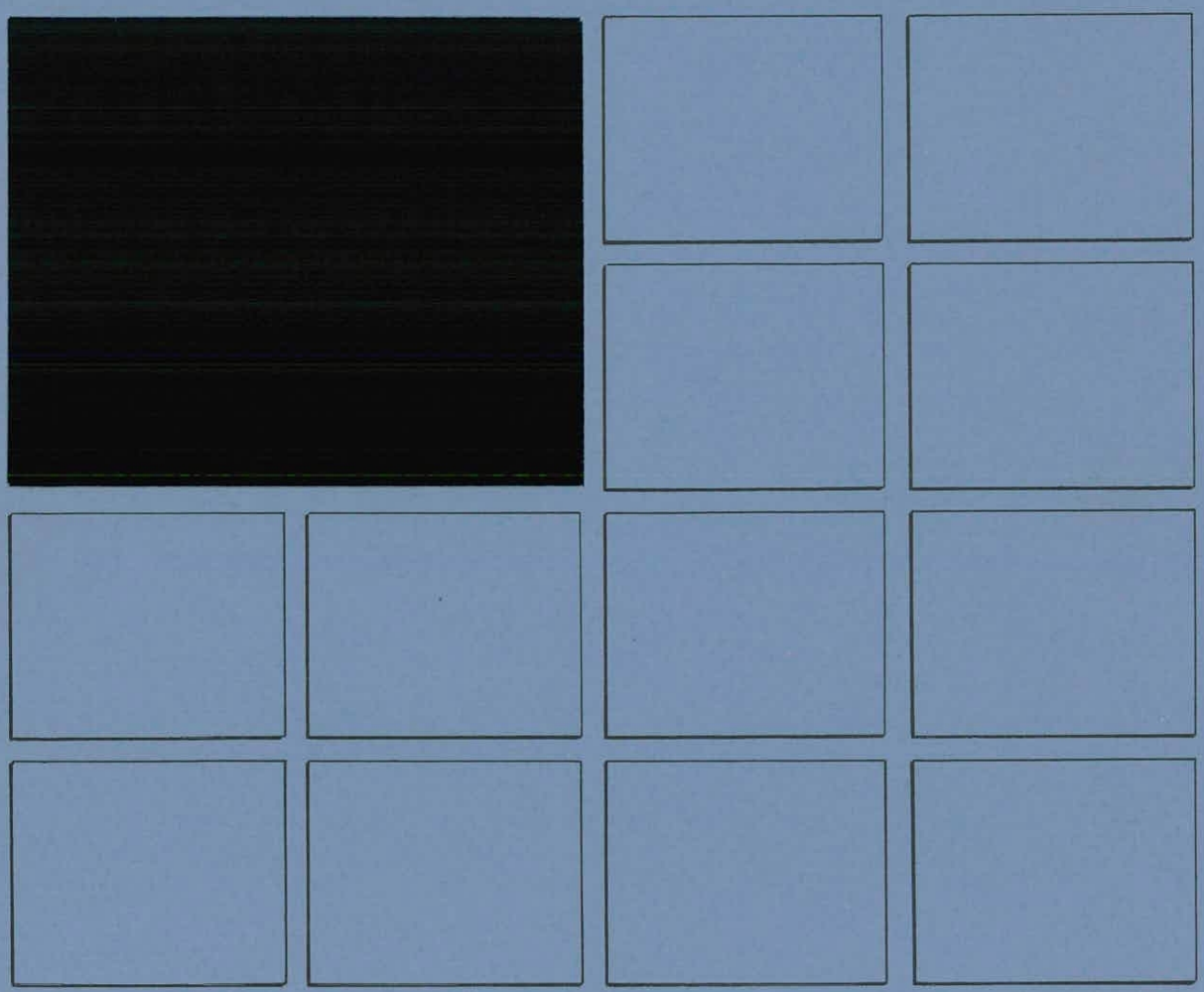

Report prepared for Sir Alexander Gibb & Partners, Reading, by the Institute of Hydrology, Wallingford

HYDROLOGICAL ANALYSES FOR MAHE

SEYCHELLES

February 1988

1. INTRODUCTION

Mahe is the main island of the Seychelles archipelago with capital city Victoria. It has a tropical maritime climate which is affected by the ridge of hills along the centre of the island. The rainy season extends from November to April with a mean annual rainfall varying between 2000 mm at the coast to over 3000 mm on the hills.

Additional water resources are required for the future. This study is intended to review all the available information and compare possible strategies for the future development of water resources.

There were three distinct hydrological sections to the work required; firstly, ten daily volumes are necessary as inputs to the system model of the island, secondly, possible sites for additional storage are to be investigated and, thirdly, information on which to base run-of-river investigations are required.

2. AVAILABLE DATA

Hydrological and meteorological data are published in a series of year books by the Seychelles Water Authority. These provide the most comprehensive sources of information available.

2.1 Rainfall

There is a good spread of rainfall stations throughout Mahe, including some at high altitudes, however most records are not very long. Monthly records are published for over 40 stations together with correlation analyses carried out to enable infilling of intermittent series. The longest continuous record is for Long Pier Victoria where monthly rainfall is available from January 1909 to December 1970.

2.2 Evaporation

Various estimates of open water evaporation have been made over the years, varying from 1670 to 2230 mm. The total of 1760 mm given in the Seychelles Water Authority Yearbook is the most recent estimate available and is believed to be the most reliable. This estimate is from the monthly Penman open water evaporation estimates as shown below.

TABLE 1. PENMAN OPEN WATER EVAPORATION (mm)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
121	125	131	115	161	177	188	193	192	141	111	105	1760

2.3 Runoff

The catchments on Mahe are steep with swift flowing streams. Generally two types of runoff information are available. A series of V-notch weirs were

installed from 1960 providing daily flow information. However, these are often drowned out at high flows, thereby producing a truncated series of flows. In the last ten years, compound broad-crested weirs, equipped with autographic recorders, have superseded some of the V-notch weirs providing daily flow information.

The flow information used in this study has been summarised in Table 2. The daily weir records are reasonably complete for many years but they are often drowned out. The Munro recorded values cover the whole range of flows but the records are rather short and intermittent.

2.4 HYDATA

All the available daily runoff information was entered on the IH surface water, microcomputer database, HYDATA (Institute of Hydrology, 1987). This database provides a readily accessible data archive together with a powerful package of programs covering many of the requirements of an hydrological department.

TABLE 2. SUMMARY OF FLOW RECORDS IN THIS STUDY

Station No.	Name	Availability of records	Comments
10	Le Niol - Recorder	Nov 1978 - Dec 1986	Many gaps
11	- Weir	Apr 1969 - Dec 1962 May 1967 - Dec 1986	All vals < = 381 l/s
30	Mamelles - Recorder	Jan 1984 - Aug 1986	Many gaps
31	- Weir	Aug 1959 - Dec 1962 May 1967 - May 1985	All vals < = 998 l/s
40	Cascade - Recorder	Apr 1975 - Dec 1986	Very intermittent
	- Weir	Oct 1960 - Aug 1966 Jun 1967 - Aug 1973	Some gaps < = 400 l/s
50	Baie Lazare	Aug 1977 - Dec 1986	Good
70	Grand Anse	Apr 1976 - Dec 1986	Many gaps
71	Grand Anse Weir	Sep 1960 - Apr 1966 May 1967 - Jan 1976	Good < = 400 l/s
*1000	Rochon Inflows	Jul 1969 - Dec 1978	Complete synthesised

* Rochon inflows were deduced by Howard Humphreys (1979) from a reservoir water balance.

Short gaps of 5 days or less were infilled in the daily records using a logarithmic interpolation between observed values. This enabled a more complete monthly record to be produced than would otherwise be the case.

3. SYSTEM MODEL FLOWS

The system model is run with a ten-daily time step. Ten-daily volumes are therefore required as inputs to the model at the positions shown in Table 4 for a congruent period of about 20 years.

TABLE 4. SITES FOR TEN-DAILY VOLUMES

SITE	RIVER	AREA ha
Le Niol (Station 10)	Grand St. Louis	162
Rodas intake	Grand St. Louis	94
La Gogue inflows	Anse Etoile	66
Rochon inflows	Rochon	213
Cascade intake	Cascade	330
Cascade at coast road	Cascade	494
Grand Anse upper catchment	Grand Anse	196
Grand Anse lower catchment	Grand Anse	440
Baie Lazare (Station 50)	Baie Lazare	240

A ten-day volume series was produced at each site for the period May 1967 to December 1986. These are provided in Tables AI1 to AI9.

Generally the procedure at each site was to

(a) use any complete daily records collated as ten-day volumes in units of 1000 cubic metres,
(b) synthesise monthly runoff from a simple regression on nearby rainfall records and distribute these as ten-day volumes according to the nearest available ten-day distribution and
(c) for any months still remaining (which numbered only two in each series) the monthly volumes were merely divided by three to provide a continuous series.

Only continuously recorded data were collated as ten-day volumes. Flows recorded over the weirs were used to provide a ten-day distribution for synthesised monthly flows but were not used directly as they are biased by the truncation described in Table 1.

The remainder of this section describes, in detail, the analyses carried out at each site to produce the required series.

3.1 Le Niol Catchment

Daily flow values are available from the Munro recordings at Site 10 as shown in Table 2. A regression was carried out between monthly volumes (in 1000 m^3) for
Site 10 (Q) and monthly rainfall (R) for Le Niol Waterworks to provide a rainfall runoff relationship as follows:

$$Q = 1.1645R + 0.1793 \quad (r^2 = 0.9) \qquad (1)$$

The correlation coefficient r^2 indicates a good fit to the data.

Station 11 flows are spot 0800 hr readings and are only accurate up to 381 l/s after which the weir is drowned out. However, these flows are reasonable for providing a ten-day distribution for dispersion of synthesised monthly flows.

The available Station 10 volumes were infilled using volumes synthesised from Le Niol waterworks rainfall and the distribution from Station 11. There were still a few gaps remaining in the data and it was decided to complete the record using Station 11 flows translated to the Station 10 site using the equation relating monthly flows:

$$St\ 10\ Q = 1.6354\ St\ 11\ Q - 37.03 \quad (r^2 = 0.9) \qquad (2)$$

This produced a complete 10-day volume series from May 1967 to December 1986 representing volumes at gauging site 10.

Ten-day volumes were also required at an additional site in the Grand St. Louis catchment at the Rodas intake. As the catchment of the Rodas site is adjacent to Site 10 and is likely to experience the same meteorological conditions, a series of volumes was produced using a simple catchment area ratio between this and Site 10. The two sets of ten-day volumes for the Grand St. Louis catchment are shown in Tables AI1 and AI2.

3.2 La Gogue inflows

In 1977 Howard Humphreys analysed one year of available Anse Etoile records and produced the relationship

$$Q(\text{Anse Etoile}) = 0.24 * Q(\text{Le Niol}) \qquad (3)$$

This is based on the weir at Station 11. With no further information available it is necessary to use this relationship, together with the relationship connecting Le Niol Stations 10 and 11 to transform Le Niol flows as representative of La Gogue inflows. Thus from equations (2) and (3) we have

$$Q(\text{Anse Etoile}) = 0.1468 * Q\ \text{Station 10} + 5.4343 \qquad (4)$$

These are monthly flows and are then distributed according to the final Le Niol series distribution. The ten-day volumes are shown in Table AI3.

3.3 Rochon inflows

There are no records available of daily flows in the Rochon catchment, however Howard Humphreys (1979) used a water balance of the reservoir to provide a sequence of synthetic inflows from July 1969 to December 1978. These have formed the basis of the record produced for inflows to Rochon reservoir. Lack of time in this study has precluded checking this series or extending it.

Regressions were carried out with Rochon monthly flows and several rainfall stations to determine the best basis for extension. The rainfall records at

Victoria proved to be the most complete and provided a better fit than raingauges in the catchment. Two equations were necessary, one for the early period using the Long Pier Victoria record (LPV) and one for the later using the New Port Victoria record (NPV). The regression equations produced were:

$$\text{Rochon} = 2.1612 * \text{LPV} - 48.5574 \qquad r^2 = 0.72 \qquad (5)$$

for records before 1970, and

$$\text{Rochon} = 0.6713 * \text{NPV} + 35.1573 \qquad r^2 = 0.6 \qquad (6)$$

for extension of records to the present from January 1975. When available, the ten-day distribution in the Mamelles catchment (Site 31) was used to distribute synthetic monthly flows where available. Otherwise the Le Niol (site 11) distribution was used. The two remaining monthly volumes were divided by three to produce ten-day values to provide the complete sequence of volumes shown in Table AI4.

3.4 Cascade catchment

A continuous recorder at Site 40 has enabled the collection of data between 1976 and 1986. These records are rather patchy, becoming more complete in the later part of the record.

There is also a weir at Site 41 which drowns out above 400 l/s. Data are available here from September 1960 to August 1973.

A regression carried out between monthly Station 40 volumes (Q) and monthly Victoria rainfall (R) yielded the equation:

$$Q = 2.3447R + 114.1142 \qquad (r^2 = 0.42) \qquad (7)$$

This was used to infill missing Station 40 flows after first distributing according to Station 41 ten-day values. For the short periods where Station 41 records were also missing, the Le Niol ten-day distribution was used.

This provided the 20-year sequence of volumes shown in Table AI5 for the Cascade Intake site. A further set of ten-day volumes were required for the Cascade at the coast road, which has a catchment area of 494 ha. The volumes for Cascade intake were multiplied by the ratio 494/330 (that is a simple catchment area ratio) to estimate the required flows (Table AI6). If more time were available, the likely effect of reduced catchment rainfall would have been included.

3.5 Grand Anse

Grand Anse flow records are available for Site 70 with existing records from April 1976 to December 1986. Discharges over the weir at Site 71 are available from September 1960 to January 1976 but, as before, the discharges are truncated at 400 l/s.

Station 70 monthly volumes (Q) were calculated and regressed with Victoria monthly rainfall (R) to provide a best fit equation as follows:

$$Q = 2.8832R + 105.272 \qquad (r^2 = 0.69) \qquad (8)$$

The Victoria rainfall record used here is a composite record consisting of LPV records, then an infilled section using translated Val Riche rainfalls and finally NPV recorded values.

The missing Station 70 volumes were then synthesised, using this relationship, and were distributed according to a ten-daily distribution from Station 71. Where flows were not available for Station 71, a ten-day distribution from Le Niol was used.

The ten-day volume series thus constructed (Table AI7) refers to the gauge point Station 70. Ten-day volumes were also required for a catchment upstream of Site 70 with a catchment area of 196 ha. Again the series for this site was obtained by a simple area ratio that is 196/440 multiplied by the Site 70 volumes (Table AI8). The volumes for this upper catchment would be expected to be rather higher than this due to an increase in rainfall with altitude, but with the time limitations on this project, Table AI8 provides the best possible set of volumes.

3.6 Baie Lazare

Finally a ten-day volume series was required for the inflows to the Baie Lazare reservoir site. Although this is some way downstream of gauging station 50 we used the flows from the gauging station as representative of the reservoir site due to the uncertainty in the data.

Records of daily flows are available for site 50 from August 1977 to December 1986. These were collated as ten-day volumes. A previous study (Gibb 1986) showed that the relationship of Baie Lazare flows with Victoria rainfall was statistically no worse than with other rainfall records, therefore a monthly regression was carried out between Baie Lazare volumes (Q) and the composite Victoria monthly rainfall (R) to give:

$$Q = 0.7139R + 34.837 \qquad (r^2 = 0.54) \qquad (9)$$

This equation was used to infill any missing months of data and the monthly volumes were distributed into a ten-day series using information from Cascade and Mamelles in its absence. The final sequence of volumes is shown in Table AI9.

3.7 Discussion

Some of the regression equations used in this section have a rather poor associated coefficient. Transformation of logarithms and square roots were tried in each case but did not improve the goodness of fit. The time available did not permit investigation of more complex models, therefore the linear regressions presented here provided the best fit models.

When modelling a system of water supply for the whole island it is hoped that areas experiencing low rainfall, and hence low flows, could have their resources augmented by other areas. To this end it would seem unfortunate to use one rainfall station (in this case a composite Victoria record) for many of the synthesised system model inputs. In each case local rainfall records were also regressed with flows but the Victoria record provided a better correlation coefficient and a more complete rainfall record.

Mahe is a fairly small island with catchments experiencing similar topographical

and meteorological conditions. Therefore it is unlikely that one part of the island will experience a very different water resources condition from other parts. To illustrate the homogeneity of rainfall conditions, Figure 1 has been constructed. This shows one year of monthly rainfall records from six different stations spread throughout Mahe. There is no evidence to suggest these stations are not influenced by the same weather regime, in fact the only noticeable difference is a lower rainfall in the extreme south during February.

From this figure there is no justification for using short local rainfall records for flow synthesis rather than the long Victoria record.

4. RESERVOIR STORAGE YIELD ANALYSIS

The terms of reference for this study included investigating suitable sites for future storage schemes. The only two suitable catchments identified are Grand Anse and Baie Lazare. The available records suggest that the flow in the Mare aux Cochon catchment is also worth considering but further investigation showed there were no suitable sites available.

4.1 Grand Anse

The site chosen for the Grand Anse reservoir is at the gauging station number 70 with a catchment area of 440 ha. The storage area characteristics of the reservoir are shown in Table 5.

TABLE 5. STORAGE AREA CHARACTERISTICS FOR GRAND ANSE SITE

Elevation (m)	Area (Ha)	Volume ($m^3 \times 10^3$)
95	0	0
100	0.25	6.5
105	0.50	25.5
110	0.94	61.5
115	1.60	125
120	2.57	230
125	3.50	382
130	4.38	579
135	5.80	834
140	7.25	1161
145	8.40	1553
150	10.40	2023
155	11.90	2581
160	14.93	3252

Minimum drawoff level of 100 m

4.4.1 Data series

The information required for storage yield analysis are congruent monthly rainfall, runoff and evaporation series for the reservoir site. Evaporation is a rather conservative variable with little change from year to year thus the mean

Mean Monthly Rainfall for Six Stations in 1980.

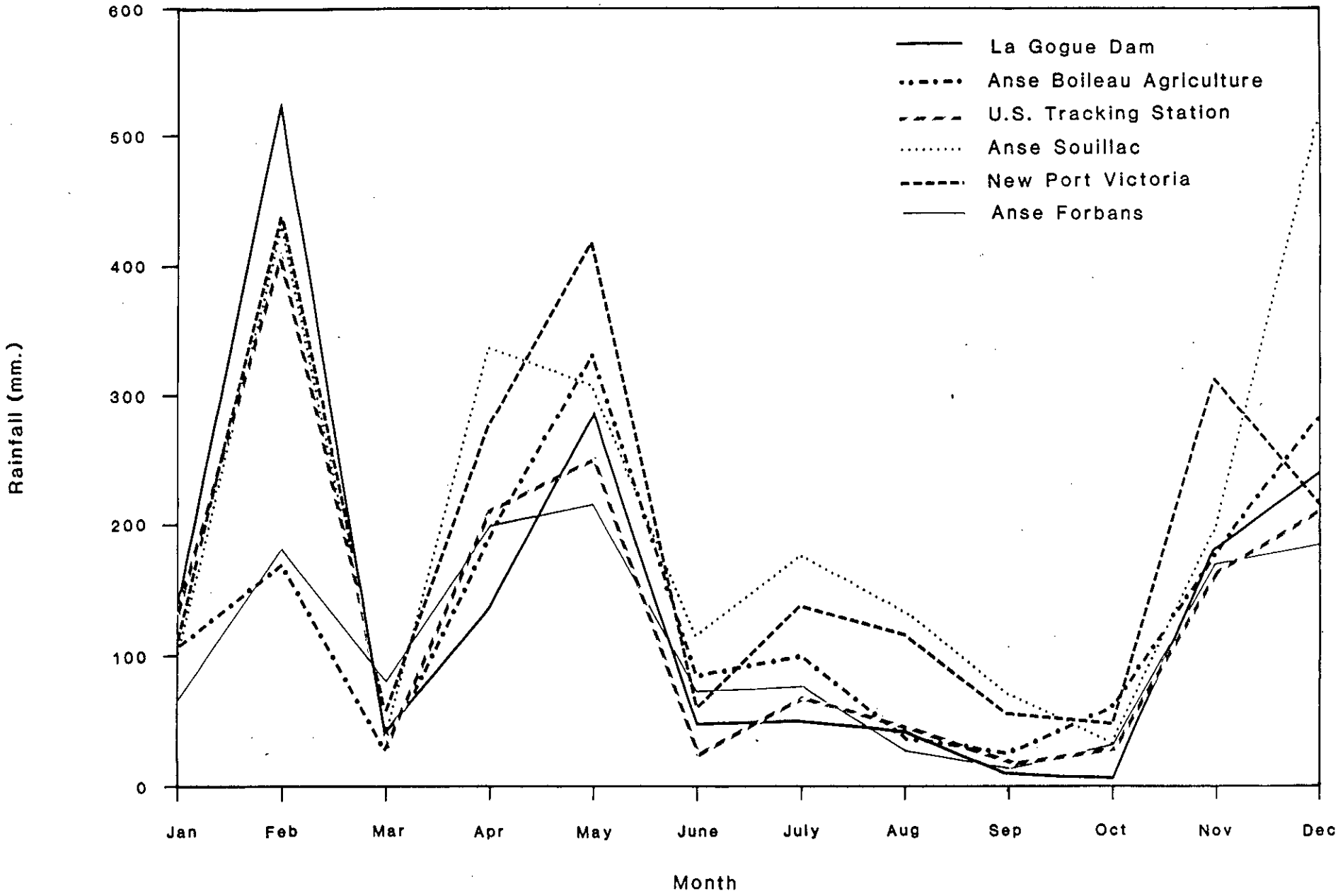

Figure 1

open water values from Table 1 are considered adequate.

The flows were collated as monthly flows and regressed with Victoria rainfall as in Section 3.5. The composite Victoria record provided monthly rainfall from June 1897 to December 1986. Therefore, using the regression Equation (8), monthly Grand Anse inflows were synthesised for this period.

The most appropriate rainfall record for the reservoir site is measured at the Tea Factory. This has records available from 1970 to 1984. These were also regressed with Victoria rainfall to provide the equation

$$R(\text{Tea Factory}) = 1.093R(\text{Victoria}) \quad r^2 = 0.57 \qquad (10)$$

This equation was forced through the origin as it is unrealistic to expect a significant constant term when comparing two rainfall stations in close proximity.
Equation 10 was used to extend the Tea Factory records to cover the period of extended Grand Anse inflows.

Tables 6 and 7 provide a summary of the extended flow and rainfall series from 1900 to 1986 from HYDATA.

4.1.2 Storage yield design procedures

A comprehensive description of the available storage yield design procedures is given in the Baie Lazare Dam report, Gibb (1986). The relevant section has been reproduced here as Appendix II for reference.

Briefly, we have chosen the Deficient volumes and Gould matrix methods to provide two sets of storage yield results and have then calculated the mean of the two to provide a best estimate of the storage yield relationship.

4.1.3 Results

The deficient volumes and Gould matrix methods were used with the 89 years of rainfall and runoff series to provide results for the storage yield relationship for both 20 and 50 year return periods of failure. These failure criteria are based on annual failure counts, that is any failure during the year designates the year as a failure event.

Table 8 provides a summary of the storage yield results and Figure 2 repeats the information in diagrammatic form.

4.2 Baie Lazare

A comprehensive study of the Baie Lazare dam site was carried out by Gibb in 1986. A repeat of the analysis with one extra year of information would produce very little change (if any) in the results. We recommend that the Baie Lazare storage yield results published in 1986 are still valid. In this case results were produced for 90% and 98% reliability which are equivalent to 10 and 50 year return periods respectively.

The final table of results and Figure are reproduced here as Table 9 and Figure 3.

Table 7

Summary of monthly data - rainfall

Station number : 1003 Name : TEA FACTORY

	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Annual Mean
1900/ 1	104.	176.	554.	532.	348.	167.	389.	268.	146.	125.	111.	36.9	247.
1901/ 2	336.	136.	228.	270.	429.	409.	274.	48.9	110.	21.1	25.6	114.	199.
1902/ 3	69.6	239.	302.	406.	497.	420.	406.	186.	190.	56.3	91.4	19.5	240.
1903/ 4	108.	52.5	330.	264.	820.	402.	15.5	110.	5.25	329.	8.85	131.	214.
1904/ 5	198.	78.3	667.	526.	372.	167.	96.3	117.	264.	24.7	17.2	173.	225.
1905/ 6	359.	13.3	157.	700.	572.	246.	353.	391.	140.	123.	74.7	24.5	263.
1906/ 7	26.5	131.	212.	375.	559.	471.	55.2	140.	137.	15.3	100.	37.5	187.
1907/ 8	166.	116.	98.8	392.	84.9	548.	209.	292.	177.	125.	70.0	29.4	191.
1908/ 9	173.	113.	131.	292.	514.	460.	38.6	287.	82.4	39.7	39.7	9.18	180.
1909/10	44.9	156.	290.	250.	362.	179.	294.	303.	211.	35.5	46.1	42.0	185.
1910/11	73.9	0.875	250.	518.	310.	424.	137.	106.	116.	53.8	28.1	22.5	168.
1911/12	194.	194.	393.	165.	741.	519.	88.5	140.	255.	198.	112.	21.1	251.
1912/13	141.	121.	119.	378.	175.	203.	309.	138.	75.2	92.7	134.	65.3	163.
1913/14	6.67	69.4	232.	420.	416.	274.	470.	347.	263.	68.0	29.2	20.9	218.
1914/15	304.	302.	224.	312.	231.	728.	101.	257.	167.	64.4	25.0	99.9	231.
1915/16	544.	254.	302.	415.	259.	199.	193.	257.	224.	119.	156.	13.9	244.
1916/17	13.9	31.4	122.	283.	359.	281.	49.4	269.	12.5	30.3	103.	87.5	136.
1917/18	110.	12.5	193.	335.	671.	187.	64.7	64.9	77.8	26.3	38.3	49.4	153.
1918/19	395.	254.	248.	276.	500.	332.	357.	181.	373.	257.	133.	12.2	276.
1919/20	135.	140.	34.1	352.	906.	165.	349.	21.1	185.	97.2	66.4	24.2	208.
1920/21	178.	140.	219.	422.	439.	371.	132.	238.	213.	33.3	196.	29.4	217.
1921/22	8.85	78.8	218.	447.	148.	49.4	332.	99.1	159.	114.	60.0	45.3	148.
1922/23	130.	275.	52.3	97.2	538.	397.	337.	252.	227.	124.	13.3	121.	213.
1923/24	192.	426.	246.	225.	350.	51.4	420.	452.	137.	95.0	196.	25.3	236.
1924/25	226.	340.	299.	418.	701.	379.	632.	403.	158.	32.2	138.	161.	324.
1925/26	149.	300.	433.	244.	299.	440.	208.	289.	451.	443.	309.	59.5	300.
1926/27	3.94	125.	209.	580.	218.	16.6	44.9	142.	186.	201.	53.3	29.2	152.
1927/28	140.	391.	149.	294.	464.	410.	631.	409.	434.	74.7	86.6	15.3	292.
1928/29	70.3	50.8	284.	800.	366.	345.	409.	157.	105.	18.6	37.7	49.7	225.
1929/30	40.0	90.0	144.	304.	172.	246.	200.	182.	97.4	100.	95.0	51.9	143.
1930/31	241.	58.6	572.	368.	310.	519.	56.1	61.3	272.	113.	67.8	31.7	220.
1931/32	3.94	233.	160.	814.	420.	27.8	336.	25.8	154.	51.9	67.8	45.6	197.
1932/33	115.	351.	166.	300.	590.	34.1	227.	56.1	127.	135.	35.3	23.3	182.
1933/34	304.	60.8	324.	299.	357.	593.	184.	116.	157.	70.5	636.	397.	290.
1934/35	646.	134.	237.	501.	537.	342.	396.	304.	183.	174.	378.	97.2	327.
1935/36	77.0	187.	317.	379.	430.	238.	67.4	179.	365.	134.	137.	364.	240.
1936/37	68.9	143.	451.	396.	523.	267.	80.0	303.	286.	54.7	69.4	9.73	221.
1937/38	259.	189.	250.	291.	193.	160.	95.0	144.	235.	46.3	33.0	17.5	159.
1938/39	102.	302.	462.	364.	558.	193.	122.	127.	190.	15.0	21.1	15.9	207.
1939/40	30.5	84.2	127.	482.	391.	257.	195.	343.	100.	30.5	49.2	125.	185.
1940/41	223.	79.7	46.3	267.	402.	295.	19.7	270.	237.	191.	132.	134.	191.
1941/42	59.7	226.	285.	416.	424.	215.	180.	103.	135.	54.1	57.7	24.2	182.
1942/43	23.1	63.8	128.	385.	239.	43.6	219.	45.3	85.8	9.95	25.3	92.2	115.
1943/44	64.4	199.	81.3	248.	273.	106.	294.	229.	142.	46.1	28.6	64.2	149.
1944/45	65.8	336.	294.	79.7	470.	26.1	342.	229.	134.	178.	83.8	33.9	191.
1945/46	21.6	138.	171.	331.	154.	188.	196.	99.4	250.	111.	114.	65.3	154.
1946/47	243.	193.	239.	314.	133.	99.4	337.	161.	400.	196.	64.7	26.9	201.
1947/48	19.1	61.1	417.	427.	522.	81.9	391.	123.	82.4	45.3	61.9	46.3	191.
1948/49	126.	246.	180.	256.	725.	368.	145.	33.3	109.	107.	60.6	175.	211.
1949/50	55.2	264.	191.	378.	322.	354.	177.	475.	141.	42.5	50.8	126.	214.

Table 7 contd.

Summary of monthly data - rainfall

Station number : 1003 Name : TEA FACTORY

1950/51	161.	155.	269.	307.	415.	308.	265.	196.	55.2	26.1	50.0	142.	195.
1951/52	186.	552.	107.	460.	495.	416.	543.	248.	140.	104.	51.6	104.	284.
1952/53	61.1	70.3	118.	257.	568.	170.	305.	267.	332.	142.	48.0	32.2	198.
1953/54	247.	152.	474.	337.	283.	186.	259.	126.	191.	56.1	69.4	83.0	205.
1954/55	63.3	88.3	86.4	503.	1030.	368.	314.	325.	60.6	26.3	41.1	91.4	250.
1955/56	252.	23.8	100.	420.	216.	360.	408.	239.	50.8	41.4	44.7	66.9	185.
1956/57	113.	96.3	409.	253.	386.	380.	109.	132.	189.	205.	33.3	22.5	192.
1957/58	26.7	476.	154.	499.	201.	664.	114.	142.	289.	295.	126.	24.4	249.
1958/59	31.4	16.9	167.	410.	528.	228.	182.	205.	112.	22.5	19.1	38.9	163.
1959/60	127.	138.	253.	345.	294.	462.	145.	201.	74.4	58.0	76.1	35.9	183.
1960/61	11.9	217.	75.8	403.	766.	542.	565.	278.	6.12	8.09	29.7	311.	267.
1961/62	398.	305.	350.	255.	235.	321.	103.	248.	331.	170.	144.	90.5	244.
1962/63	195.	261.	254.	342.	428.	293.	393.	131.	340.	43.3	111.	299.	258.
1963/64	232.	201.	310.	181.	794.	228.	163.	345.	248.	74.0	223.	101.	259.
1964/65	301.	163.	196.	411.	423.	446.	369.	213.	601.	48.9	121.	108.	283.
1965/66	291.	408.	589.	282.	528.	331.	231.	198.	43.5	76.4	225.	144.	278.
1966/67	74.4	190.	253.	130.	632.	172.	66.4	172.	236.	134.	74.2	160.	192.
1967/68	97.9	134.	281.	676.	441.	395.	613.	35.9	298.	73.8	108.	115.	273.
1968/69	137.	205.	185.	421.	612.	107.	355.	158.	85.0	66.1	25.3	24.6	200.
1969/70	65.7	77.7	213.	358.	177.	239.	188.	117.	278.	171.	116.	125.	177.
1970/71	23.9	194.	211.	268.	194.	134.	196.	181.	57.5	114.	58.6	198.	153.
1971/72	127.	54.0	298.	308.	232.	94.5	199.	187.	153.	130.	33.3	127.	162.
1972/73	326.	447.	370.	116.	311.	256.	489.	172.	353.	146.	71.7	172.	269.
1973/74	103.	57.0	122.	236.	240.	541.	225.	196.	9.00	18.9	58.7	119.	158.
1974/75	225.	551.	385.	455.	636.	392.	199.	162.	52.0	68.6	137.	120.	282.
1975/76	75.6	98.0	201.	422.	523.	553.	125.	172.	25.4	59.0	152.	187.	215.
1976/77	158.	114.	56.7	400.	700.	231.	333.	364.	145.	99.5	120.	84.0	234.
1977/78	55.8	346.	193.	349.	536.	5.80	346.	193.	349.	536.	221.	149.	276.
1978/79	432.	154.	85.7	80.4	42.9	104.	228.	449.	648.	355.	181.	295.	255.
1979/80	302.	40.6	92.8	107.	85.8	38.5	301.	417.	303.	123.	393.	37.9	187.
1980/81	203.	329.	148.	140.	129.	75.1	65.6	223.	158.	252.	193.	285.	184.
1981/82	34.2	347.	114.	104.	53.7	53.6	203.	288.	555.	294.	47.4	298.	201.
1982/83	136.	112.	112.	121.	144.	327.	382.	340.	277.	550.	50.4	253.	232.
1983/84	192.	115.	103.	205.	312.	400.	159.	182.	357.	436.	390.	126.	248.
1984/85	68.1	20.0	92.9	78.5	183.	168.	295.	474.	277.	203.	146.	423.	203.
1985/86	149.	127.	17.8	37.5	455.	170.	341.	91.8	354.	236.	110.	174.	189.
1986/87	223.	84.8	176.	134.	10.4	7.43	128.	93.1	458.	-	-	-	-
1987/88	-	-	-	-	-	-	-	-	-	-	-	-	-
Mean	153.	178.	231.	338.	403.	277.	248.	208.	203.	121.	103.	101.	213.
St.d	124.	125.	132.	151.	207.	165.	147.	110.	133.	113.	99.0	93.6	
CV	0.813	0.704	0.575	0.447	0.513	0.598	0.592	0.528	0.655	0.934	0.960	0.925	

Data flags

Missing - flag "-" Original - no flag

Limit to missing daily data permissible [5]

Printed on 13/11/1987

Table 6

Summary of monthly data - Flow

Station number : 1002 Name : GRAND ANSE

	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Annual Mean
1900/ 1	381.	569.	1566.	1509.	1023.	545.	1130.	813.	491..	436.	399.	203.	757.
1901/ 2	993.	463.	707.	817.	1236.	1183.	828.	234.	395.	161.	173.	406.	630.
1902/ 3	289.	735.	902.	1176.	1415.	1212.	1175.	596.	607.	254.	346.	157.	737.
1903/ 4	391.	244.	976.	802.	2267.	1166.	146.	396.	119..	973.	129.	451.	669.
1904/ 5	627.	312.	1865.	1492.	1087.	547.	359.	414.	802.	170.	151.	563.	700.
1905/ 6	1052.	140.	519.	1950.	1615.	753.	1037.	1138.	475.	429.	302.	170.	799.
1906/ 7	175.	451.	664.	1093.	1579.	1349.	251.	475.	466.	146.	370.	204.	598.
1907/ 8	544.	412.	366.	1139..	329.	1552.	656.	875.	572.	436.	290.	183.	608.
1908/ 9	563.	402.	452.	876.	1460.	1319.	207.	862.	323.	210.	210.	129.	579.
1909/10	224.	518.	871.	765.	1059.	578.	881.	906.	663.	199.	227.	216.	593.
1910/11	300.	108.	764.	1472.	922..	1224.	466.	386.	411.	247.	179.	165.	550.
1911/12	618.	618.	1141.	540.	2060.	1475.	339.	476.	778.	627.	402.	161.	766.
1912/13	477.	425.	419.	1102.	566.	641.	921.	469.	304.	350.	458.	277.	534.
1913/14	123.	288.	716.	1214.	1203.	827.	1344.	1019.	798.	285.	182.	160.	680.
1914/15	907.	902.	695.	929.	714.	2025.	373.	784.	546.	275.	171.	369.	714.
1915/16	1541.	775.	902.	1201.	787.	630.	615.	783.	695.	420.	518.	142.	750.
1916/17	142.	188.	428.	851.	1052.	846.	236.	815.	138.	185.	376.	336.	464.
1917/18	395.	138.	614.	988.	1876.	599.	276.	277.	311.	175.	206.	236.	508.
1918/19	1147.	775.	759.	834.	1425.	980.	1047.	584.	1088.	783.	455.	138.	833.
1919/20	460.	475.	195.	1032.	2495.	541.	1026.	161.	593.	362.	280.	169.	654.
1920/21	576.	473.	682.	1218.	1262.	1084.	453.	734.	666.	193.	622.	183.	677.
1921/22	129.	313.	679.	1285.	496.	236.	980.	367.	525.	405.	264.	225.	495.
1922/23	449.	831..	243.	362.	1525.	1152.	995.	770.	704.	433.	140.	425.	667.
1923/24	613.	1229.	753.	698.	1028.	241.	1214.	1297.	466.	356.	623.	172.	727.
1924/25	701.	1002.	893.	1207.	1954.	1105.	1772.	1168.	523.	190.	470.	529.	961.
1925/26	497.	896.	1246.	748.	894.	1266.	653.	868.	1296.	1273.	920.	262.	898.
1926/27	116.	434.	656.	1635.	679.	149.	224.	481.	597.	635.	246.	182.	506.
1927/28	474.	1137.	498.	881.	1330.	1188.	1769.	1185.	1251.	302.	334.	146.	876.
1928/29	291.	239.	854.	2214.	1071.	1016.	1185.	520.	382.	154.	205.	236.	697.
1929/30	211.	343.	484.	907.	558.	753.	632.	585.	362.	370.	356.	242.	482.
1930/31	741.	260.	1613.	1075.	923.	1473.	253.	267.	823.	403.	284.	189.	685.
1931/32	116.	721.	529.	2251.	1213.	179.	993.	173.	510.	242.	284.	225.	626.
1932/33	409.	1032.	542.	897.	1661.	195.	703.	253.	440.	460.	198.	167.	585.
1933/34	907.	266.	961.	894.	1046.	1669.	591.	410.	519.	291.	1782.	1152.	870.
1934/35	1808.	460.	730.	1427.	1522.	1007.	1150.	907.	587.	565.	1103.	362.	968.
1935/36	308.	600.	942.	1106.	1240.	732.	283.	578.	1067.	459.	467.	1066.	739.
1936/37	287.	483.	1295.	1149.	1483.	808.	316.	905.	860.	249.	288.	131.	687.
1937/38	789.	605.	764.	872.	615.	526.	356.	485.	726.	228.	192.	151.	525.
1938/39	375.	903.	1323.	1065.	1577.	616.	428.	439.	608.	145.	161.	147.	650.
1939/40	186.	327.	439.	1376.	1138.	783.	620.	1010.	370.	186.	235.	436.	593.
1940/41	693.	315.	228.	810.	1165.	883.	157.	816.	731.	610.	452.	458.	608.
1941/42	263.	702.	857.	1201.	1223.	672.	580.	378.	460.	248.	257.	169.	585.
1942/43	166.	274.	443.	1120.	736.	220.	682.	225.	332.	131.	172.	348.	407.
1943/44	275.	629.	320.	761.	824.	384.	881.	709.	481.	227.	181.	275.	497.
1944/45	279.	991.	881.	315.	1346.	174.	1007.	709.	460.	575.	326.	195.	608.
1945/46	162.	470.	556.	979.	510.	601.	622.	367.	766.	398.	405.	277.	510.
1946/47	745.	616.	735.	933.	457.	367.	995.	531.	1160.	623.	276.	176.	636.
1947/48	156.	266.	1206.	1231.	1481.	321.	1136.	430.	323.	225.	268.	228.	609.
1948/49	439.	754.	579.	780.	2018.	1075.	487.	193.	392.	389.	265.	567.	661.
1949/50	251.	802.	610.	1102.	956.	1039.	571.	1357.	478.	217.	239.	438.	669.
1950/51	530.	514.	816.	914.	1199.	917.	803.	622.	251.	174.	237.	479.	620.
1951/52	595.	1562.	386.	1319.	1411.	1202.	1537.	759.	474.	380.	241.	380.	855.
1952/53	266.	291.	416.	783.	1604.	554.	909.	810.	982.	479.	232.	190.	628.

Table 6 contd.

Summary of monthly data - Flow

Station number : 1002 Name : GRAND ANSE

	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Annual Mean
1953/54	756.	507.	1356.	993.	852.	595.	787.	438.	608.	253.	288.	324.	646.
1954/55	272.	338.	333.	1433.	2822.	1075.	933.	963.	265.	175.	214.	346.	765.
1955/56	770.	168.	370.	1212.	674.	1055.	1181.	735.	239.	215.	223.	282.	592.
1956/57	404.	359.	1183.	772.	1122.	1107.	393.	454.	604.	645.	193.	165.	612.
1957/58	176.	1360.	513.	1421.	636.	1858.	405.	481.	868.	885.	437.	170.	761.
1958/59	188.	150.	547.	1186.	1497.	707.	585.	646.	400.	165.	156.	208.	536.
1959/60	441.	469.	772.	1014.	880.	1324.	487.	365.	302.	258.	306.	200.	565.
1960/61	137.	679.	305.	1168.	2126.	1535.	1594.	839.	121.	127.	184.	925.	811.
1961/62	1135.	909.	1029.	777.	725.	951.	376.	759.	978.	554.	485.	344.	749.
1962/63	619.	794.	775.	1007.	1234.	879.	1143.	450.	1001.	219.	398.	893.	786.
1963/64	717.	636.	923.	584.	2200.	707.	535.	1016.	760.	300.	693.	371.	788.
1964/65	899.	534.	621.	1189.	1222.	1283.	1080.	667.	1690.	234.	426.	389.	852.
1965/66	872.	1181.	1658.	849.	1498.	979.	714.	627.	220.	307.	699.	486.	839.
1966/67	302.	605.	772.	448.	1771.	558.	280.	558.	729.	459.	301.	527.	611.
1967/68	364.	458.	846.	1887.	1267.	1146.	1723.	200.	891.	300.	391.	407.	826.
1968/69	467.	646.	592.	1214.	1719.	389.	1041.	523.	330.	280.	172.	170.	632.
1969/70	279.	310.	666.	1051.	710.	554.	676.	376.	563.	340.	311.	316.	513.
1970/71	135.	533.	662.	1063.	1203.	764.	599.	778.	200.	462.	338.	629.	614.
1971/72	345.	183.	775.	863.	1216.	574.	813.	578.	490.	548.	247.	410.	587.
1972/73	415.	1000.	784.	978.	881.	774.	899.	484.	540.	442.	163.	324.	641.
1973/74	202.	281.	224.	655.	980.	809.	559.	378.	587.	163.	189.	327.	446.
1974/75	622.	823.	621.	1005.	1856.	1486.	588.	569.	193.	279.	241.	395.	719.
1975/76	252.	365.	772.	1068.	1332.	1885.	623.	478.	169.	223.	303.	458.	656.
1976/77	524.	357.	190.	1443.	906.	1216.	607.	844.	485.	209.	256.	279.	607.
1977/78	260.	829.	453.	859.	1908.	666.	392.	864.	413.	273.	158.	157.	604.
1978/79	242.	648.	1126.	1621.	1062.	731.	1400.	708.	173.	260.	259.	154.	700.
1979/80	197.	1065.	498.	1160.	437.	1354.	196.	712.	827.	176.	302.	230.	594.
1980/81	154.	187.	578.	708.	763.	597.	887.	511.	741.	198.	238.	257.	485.
1981/82	155.	383.	697.	1760.	740.	204.	520.	539.	271.	221.	285.	353.	514.
1982/83	549.	975.	831.	867.	1546.	466.	454.	735.	613.	381.	533.	560.	712.
1983/84	821.	426.	406.	1174.	875.	1149.	311.	243.	142.	190.	149.	256.	509.
1984/85	275.	1080.	754.	875.	641.	490.	1222.	497.	441.	152.	204.	1305.	665.
1985/86	552.	1005.	347.	1038.	727.	394.	563.	693.	329.	569.	460.	133.	569.
1986/87	125.	443.	351.	1313.	-	-	-	-	-	-	-	-	-
Mean	469.	579.	724.	1080.	1213.	870.	742.	622.	562.	346.	334.	330.	656.
St.d	320.	312.	340.	352.	499.	425.	393.	265.	291.	201.	230.	226.	
CV	0.683	0.538	0.470	0.326	0.411	0.488	0.530	0.426	0.519	0.580	0.687	0.683	

Data flags

Missing - flag "-" Original - no flag Estimate - flag "e" Observer - no flag Chart - flag "c"
Overtop - flag "o" Radio - flag "r" Model - flag "M" - no flag

Limit to missing daily data permissible [5]

Printed on 13/11/1987

TABLE 8 SUMMARY OF STORAGE YIELD RESULTS FOR GRAND ANSE SITE

(a) Return period of failure 20 years

Volume $m^3 \times 10^3$	Yield Def Vols $m^3 \times 10^6$ yr	Yield Gould $m^3 \times 10^6$ yr	Yield Mean $m^3 \times 10^6$ yr
500	3.59	3.53	3.56
1000	4.66	4.58	4.62
1500	5.29	5.18	5.24
2000	5.80	5.69	5.74
2500	6.24	6.09	6.16
3250	6.36	6.50	6.43

(b) Return period of failure 50 years

Volume $m^3 \times 10^3$	Yield Def Vols $m^3 \times 10^6$ yr	Yield Gould $m^3 \times 10^6$ yr	Yield Mean $m^3 \times 10^6$ yr
500	3.43	3.27	3.35
1000	4.29	4.31	4.30
1500	4.88	4.88	4.88
2000	5.45	5.42	5.44
2500	5.77	5.83	5.80
3250	6.07	6.24	6.16

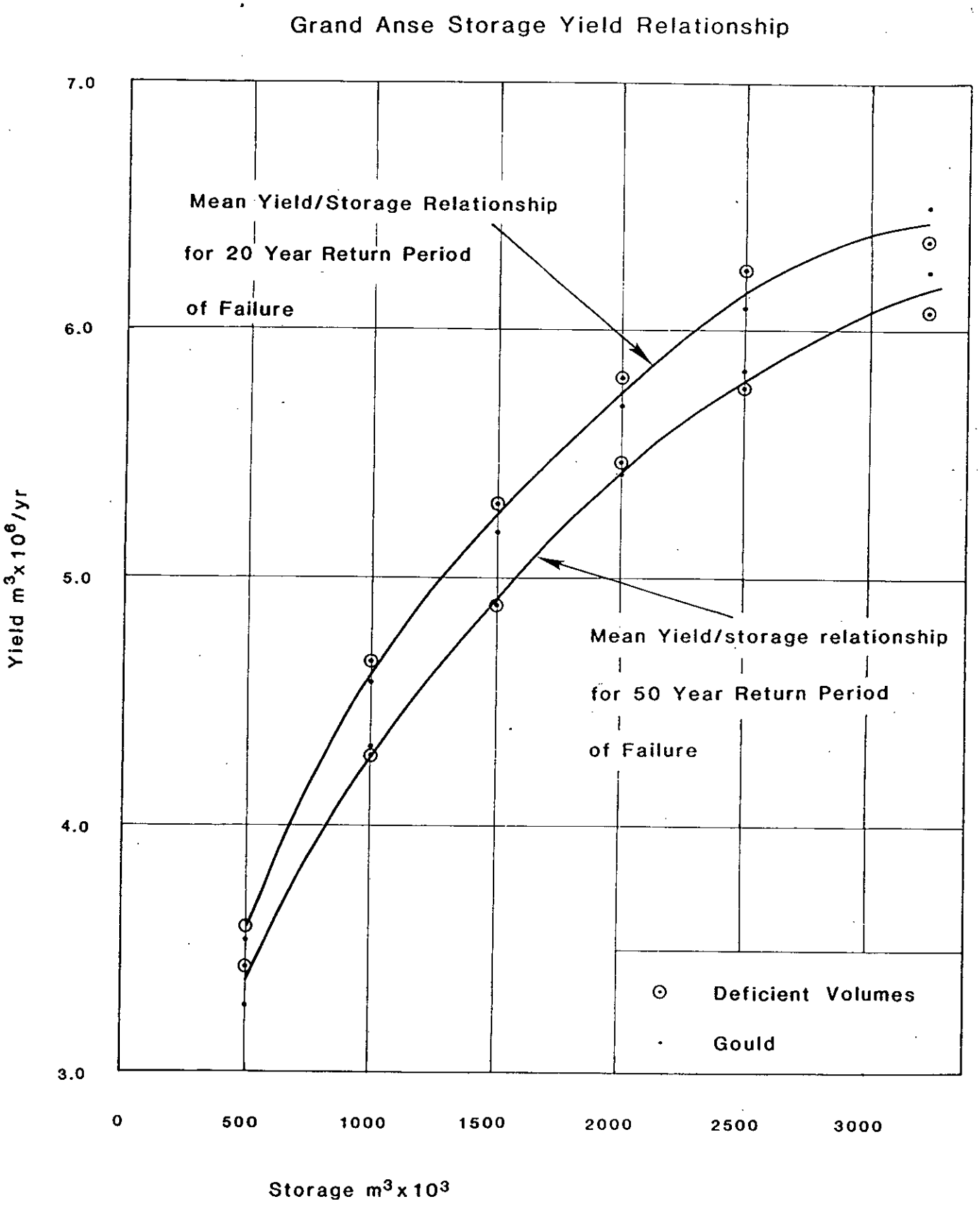
Grand Anse Storage Yield Relationship
7.0
6.0
5.0
4.0
3.0
Yield $m^3 \times 10^6$/yr
Mean Yield/Storage Relationship
for 20 Year Return Period
of Failure
Mean Yield/storage relationship
for 50 Year Return Period
of Failure
Deficient Volumes
Gould
0
500
1000
1500
2000
2500
3000
Storage $m^3 \times 10^3$

Figure 2

TABLE 9 SUMMARY OF STORAGE YIELD RESULTS FOR BAIE LAZARE SITE

(a) Return period of failure 50 years (98% reliability)

RESERVOIR CAPACITY REQUIRED TO MEET DEMAND - (M LITRES)

Annual Demand	Gould Method	Deficient Volumes	Counting Failures	Central Estimate
500	190	220	190	202
700	270	290	280	280
900	380	400	390	390
1100	520	520	520	520
1300	810	860	830	834
1280 (3500 Kl/day)	760	790	750	770

(b) Return period of failure 10 years

RESERVOIR CAPACITY REQUIRED TO MEET DEMAND (M LITRES)

Annual Demand	Gould Method	Deficient Volumes	Counting Failures	Central Estimate
500	160	170	170	166
700	230	230	240	232
900	310	320	320	316
1100	420	420	430	422
1300	590	650	620	620
1500	860	1140	1080	1061
1280	570	600	590	586

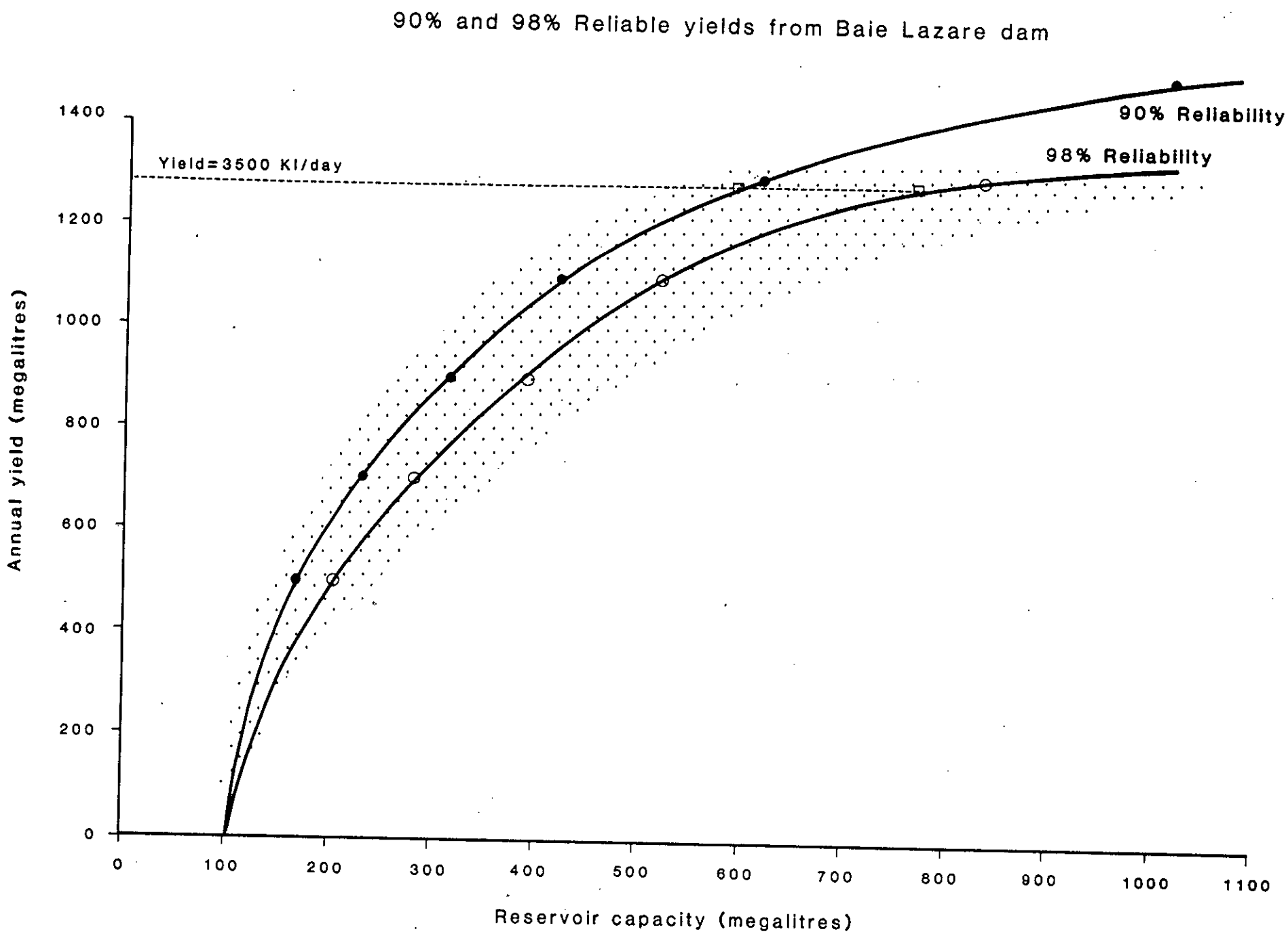
90% and 98% Reliable yields from Baie Lazare dam
Yield=3500 Kl/day
90% Reliability
98% Reliability
Annual yield (megalitres)
Reservoir capacity (megalitres)
0
200
400
600
800
1000
1200
1400
0
100
200
300
400
500
600
700
800
900
1000
1100

Figure 3

5. FLOW DURATION

Run of river schemes as a source of water are to be investigated in this report. To aid the selection of promising sites we have produced one day standardised flow duration curves for each of the gauging sites with continuous records. These are shown in Appendix III.

A flow duration curve (FDC) provides information defining the percentage of time a flow is exceeded. It is ideally suited, therefore, to assess the reliability of a site as a run-of-river scheme. Standardising the curve entails dividing the flows by the mean daily flow at the site. This enables the comparison of the shape of flow duration curves from different sites.

5.1 Regional flow duration curve

Unfortunately the observed flows do not provide information for all the catchments of interest so a regional FDC was attempted, pooling together standardised curves on a regional basis. In fact there was no evidence to separate the curves regionally as they are all remarkably similar, suggesting that one pooled standardised curve is suitable for the whole island.

Figure 4 describes the pooled standardised FDC for the whole of Mahe. All the stations in Appendix III were used except Station 30 (Mamelles) as this was a short biased record which produced a rather different FDC.

The pooled FDC was constructed by taking the mean of the percentage points of each of the curves. The top and bottom limit lines provide an enveloped to the observed data and therefore indicate the possible range of results expected. This curve is applicable to all sites in Mahe (including ungauged sites) and can be used once a suitable value for the mean daily flow is selected.

5.2 Estimating mean daily flow

The estimation of mean daily flow for ungauged catchments is difficult as there are no data for calibration of a model. There are two major environmental factors which influence river flows, namely average annual rainfall and the catchment area. A multiple regression was carried out relating mean daily flow (MDF), for the six catchments used to produce the pooled FDC; to catchment area and average annual rainfall (AAR). The equation produced was:

$$MDF = 0.0597AAR + 47.3AREA - 156 \qquad (r^2 = .91)$$

where MDF has units l/s
AAR mm
and AREA km^2.

Although this equation has a high correlation coefficient it is only based on information from six catchments and they are all of similar size. The large negative constant will cause a negative value of MDF to be predicted for small catchments with low rainfall, for example, a small coastal catchment. Therefore it is wise to restrict the use of the equation to catchments larger than 1.2 ha and with an AAR of greater than 1800 mm.

1-Day Standardised Flow Duration Curve For Mahe

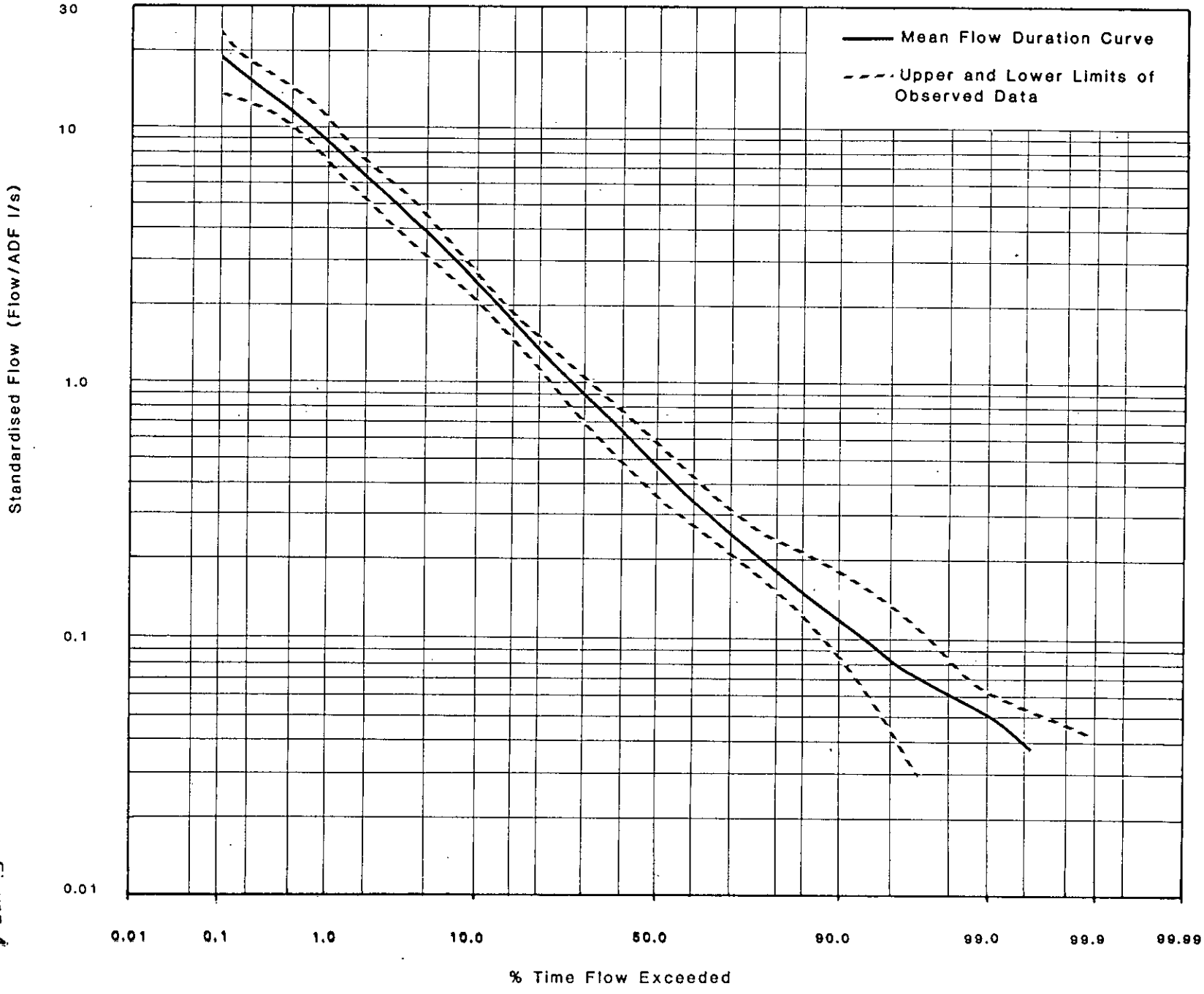

Figure 4

5.3 Summary

By combining the estimation of MDF and the regional FDC it is possible to predict at what level of certainty a required run-of-river abstraction can be maintained for ungauged catchments; bearing in mind the limitations as discussed in 5.2. If, however, a prediction for a small catchment is required, an alternative model for MDF should be sought.

6. COMMENTS

It would seem, from this study, that a computer based analysis and archival system similar to HYDATA could be very useful in the Seychelles. HYDATA, on an IBM compatible machine, would provide all the space and power to store the existing hydrological records for the island, input additional information as it becomes available and carry out many of the hydrological analyses required.

REFERENCES

Institute of Hydrology (1987), 'HYDATA' operation manual - Version 3.0. IH, Wallingford, U.K.

Howard Humphreys & Partners (1979), Further studies in connection with Mahe water supply, Volume 3.

Sir Alexander Gibb & Partners (1986), Baie Lazare Dam.

APPENDIX I

TEN-DAY VOLUMES

Table AI1

Le Niol

YEAR	MONTH	TENDAY VOLUMES		
1967	5	143.5	115.26	98.69
1967	6	79.94	85.68	99.6
1967	7	71.31	48.14	50.17
1967	8	68.15	78.46	154.72
1967	9	88.79	161.59	50.94
1967	10	55.17	94.28	101.22
1967	11	84.79	122.76	249.35
1967	12	270.89	235.01	121.02
1968	1	52.5	191.16	263.55
1968	2	112.97	301.01	96.14
1968	3	159.08	136.65	327.11
1968	4	23.37	9.65	9.19
1968	5	154.58	149.05	108.9
1968	6	32.71	29.86	23.08
1968	7	39.23	61.97	56.31
1968	8	67.2	82.09	70.4
1968	9	43.75	72.06	37.85
1968	10	37.71	110.82	119.6
1968	11	35.67	89.78	146.52
1968	12	140.79	122.78	232.34
1969	1	153.73	276.1	311.57
1969	2	64.29	30.22	38.77
1969	3	150.64	328.1	141.08
1969	4	135.77	135.44	136.31
1969	5	69.2	84.36	32.72
1969	6	27.33	20.84	42.26
1969	7	9.94	24	19.81
1969	8	21.25	29.07	32.07
1969	9	25.01	60.57	21.04
1969	10	23.94	11.94	61.88
1969	11	63.02	135.15	108.15
1969	12	72.04	350.55	130.6
1970	1	138.38	147.23	83.72
1970	2	181.69	86.18	42.88
1970	3	56.09	21.82	63.06
1970	4	90.05	132.06	140.12
1970	5	9.73	7.35	49.94
1970	6	43.14	38.68	73.71
1970	7	39.58	27.41	30.19
1970	8	4.89	7.35	2.73
1970	9	49.66	37.04	33.31
1970	10	13.99	11.05	72.54
1970	11	67.11	115.8	103.96
1970	12	138.5	187.36	116.32
1971	1	280.91	226.16	82.28
1971	2	88.45	95.02	80.29
1971	3	83.39	148.87	73.93
1971	4	124.51	130.96	71.86
1971	5	41.7	46.71	22.79
1971	6	20.67	32.25	24.43
1971	7	31.99	21.07	28.92
1971	8	43.68	175.24	95.11
1971	9	79.19	66.47	35.23
1971	10	19.87	18.24	18.22
1971	11	14.86	38.83	35.48
1971	12	261.65	63.13	80.71
1972	1	114.04	108.42	163.69
1972	2	132.01	42.25	118.21
1972	3	135.32	116.25	96.55
1972	4	46.83	45.57	49.19
1972	5	88.44	84.32	57.01
1972	6	44.16	25.2	26.65
1972	7	18.36	11.93	34.25
1972	8	15.29	18.89	14.38
1972	9	105.87	92.67	123.65
1972	10	88.63	305.09	77.25
1972	11	88.82	120.49	178.54
1972	12	324.51	181.71	265.32
1973	1	60.4	77.85	64.67
1973	2	133.51	78.54	100.33
1973	3	178.12	195.82	109.34
1973	4	87.51	126.21	58.14
1973	5	125.12	113.63	92.42
1973	6	51.35	60.68	64.33
1973	7	138.36	53.59	43.65
1973	8	38.69	41.64	84.17
1973	9	27.51	31.33	15.19
1973	10	56.72	27.42	43.55
1973	11	70.49	41.58	32.5
1973	12	32.85	350.17	103.1

YEAR	MONTH	TENDAY VOLUMES		
1974	1	192.89	225.56	279.74
1974	2	133.87	71.5	200.18
1974	3	79.33	35.31	54.74
1974	4	41.25	15.77	11.98
1974	5	17.45	12.93	14.17
1974	6	17.43	12.83	11.38
1974	7	28.72	71.5	135.66
1974	8	149.01	33.46	14.16
1974	9	114.6	135.57	220
1974	10	73.57	266.54	448.21
1974	11	132.4	197.75	127.45
1974	12	300.16	99.44	268.07
1975	1	351.96	391.22	180.22
1975	2	132.76	125.44	204.29
1975	3	119.91	51.94	35.26
1975	4	109.64	126.97	82.06
1975	5	16.73	12.85	9.37
1975	6	25.8	56.93	44.03
1975	7	29.84	28.95	106.52
1975	8	136.13	71.11	48.67
1975	9	86.21	71.92	35.36
1975	10	21.92	61.56	37.81
1975	11	27.25	178.61	258.96
1975	12	160.91	221.22	304.88
1976	1	218.9	164.67	173.94
1976	2	250.65	334.71	236.27
1976	3	104.97	93.29	69.99
1976	4	47.3	40.64	75.5
1976	5	24.91	16.67	18.34
1976	6	20.36	18.52	84.15
1976	7	99.13	23.84	118.26
1976	8	19.72	94.08	86.91
1976	9	12.77	10.79	125.21
1976	10	73.72	59.16	59.34
1976	11	23.85	17.62	14.73
1976	12	150.03	103.1	281.21
1977	1	162.83	132.55	279.72
1977	2	84.62	149.4	64.15
1977	3	90.36	72.13	44.5
1977	4	111.51	166.2	246.5
1977	5	108.82	61.98	49.13
1977	6	35.42	55.36	30.28
1977	7	33.25	58.23	134.73
1977	8	76.39	33.69	33.8
1977	9	22.73	15.42	22.58
1977	10	16.27	327.73	80.3
1977	11	75.16	90.31	29.06
1977	12	100.04	59.42	328.64
1978	1	224.41	206.23	185.67
1978	2	170.86	53.58	105.87
1978	3	73	45.3	33.5
1978	4	157.56	169.68	249.49
1978	5	145.1	42.13	36.77
1978	6	40.76	32.57	31.54
1978	7	25.8	14.99	58.14
1978	8	36.75	17.46	27.83
1978	9	19.97	45.48	18.11
1978	10	24.09	223.82	152.97
1978	11	64.17	116.84	276.722
1978	12	194.4	269.482	249.005
1979	1	147.537	108.328	185.155
1979	2	168.566	85.372	41.437
1979	3	283.738	155.2	64.299
1979	4	103.749	99.006	51.71
1979	5	36.288	26.516	24.434
1979	6	18.265	34.716	54.207
1979	7	18.377	46.742	31.372
1979	8	75.125	20.529	15.276
1979	9	9.228	10.964	6.696
1979	10	7.681	22.084	126.913
1979	11	101.244	98.928	66.519
1979	12	164.29	146.491	217.85
1980	1	176.913	51.788	57.076
1980	2	130.481	321.97	98.556
1980	3	41.23	22.36	40.332
1980	4	120.286	106.89	72.3
1980	5	84.309	34.845	350.05
1980	6	103.11	52.972	35.424
1980	7	21.064	23.96	69.388
1980	8	17.205	18.118	25.54

Table AI1 contd.

YEAR	MONTH	TENDAY VOLUMES		
1980	9	17.902	12.623	14.291
1980	10	8.631	9.85	12.632
1980	11	61.318	39.537	50.181
1980	12	34.249	62.597	296.153
1981	1	95.092	119.448	153.541
1981	2	225.297	52.505	50.89
1981	3	37.93	111.905	321.667
1981	4	104.06	48.669	27.346
1981	5	156.375	231.647	77.328
1981	6	49.032	43.295	26.914
1981	7	27.13	29.134	49.76
1981	8	62.459	24.123	13.124
1981	9	18.56	9.694	21.816
1981	10	23.363	62.735	17.297
1981	11	156.56	95.662	90.115
1981	12	125.4	125.4	125.4
1982	1	277.43	257.878	51.434
1982	2	39.735	24.149	20.468
1982	3	63.798	21.773	53.758
1982	4	33.134	27.32	40.306
1982	5	19.267	25.94	16.14
1982	6	8.916	10.273	10.619
1982	7	83.57	74.95	17.16
1982	8	34.85	53.24	73.37
1982	9	33.06	134.25	101.53
1982	10	163.26	149.52	92.77
1982	11	46.26	68.64	280.05
1982	12	116.71	291.963	208.656
1983	1	376.4	361.53	269.79
1983	2	98.11	107.47	37.86
1983	3	39.71	77.57	68.28
1983	4	46.59	110.12	103.74
1983	5	107.99	34.97	68.57
1983	6	38.69	33.26	23.57
1983	7	70.22	99.749	77.017
1983	8	135.13	112.76	136.996
1983	9	241.63	256.1	141.07
1983	10	259.546	63.625	15.17
1983	11	30.54	47.183	78.114
1983	12	140.581	197.122	140.348
1984	1	394.416	254.534	83.782
1984	2	340.243	392.429	283.565
1984	3	181.734	95.1	43.969
1984	4	42.58	19.43	20.148
1984	5	13.902	12.286	10.385
1984	6	15.733	22.144	34.681
1984	7	12.917	9.02	40.513
1984	8	45.429	16.347	48.393
1984	9	32.884	25.08	50.691
1984	10	30.508	44.289	159.85
1984	11	65.35	118.688	225.806
1984	12	75.833	103.81	617.155
1985	1	216.276	53.672	190.884
1985	2	196.474	58.173	24.918
1985	3	95.532	296.836	77.008
1985	4	91.014	36.893	145.342
1985	5	193.398	63.573	34.811
1985	6	21.695	18.325	13.401
1985	7	21.807	21.315	34.534
1985	8	18.36	25.151	389.932
1985	9	220.804	85.035	34.413
1985	10	51.805	178.589	105.909
1985	11	62.588	38.163	28.391
1985	12	129.22	262.742	333.331
1986	1	70.157	128.295	245.981
1986	2	50.708	29.22	77.285
1986	3	214.49	76.25	25.514
1986	4	61.681	78.797	81.873
1986	5	69.44	30.75	23.164
1986	6	125.721	174.701	144.564
1986	7	201.744	60.687	48.756
1986	8	56.696	20.123	15.379
1986	9	14.463	9.763	8.467
1986	10	7.716	23.527	15.155
1986	11	18.187	45.567	93.347
1986	12	174.9	361.498	302.754

Table AI2

Rodas Intake

YEAR	MONTH	TEN DAY VOLUMES		
1967	5	83.26	66.87	57.26
1967	6	46.38	49.71	57.79
1967	7	41.37	27.93	29.11
1967	8	39.54	45.52	89.77
1967	9	51.52	93.75	29.56
1967	10	32.01	54.70	58.73
1967	11	49.20	71.23	144.67
1967	12	157.17	136.35	70.22
1968	1	30.46	110.91	152.91
1968	2	65.55	174.65	55.78
1968	3	92.30	79.28	189.79
1968	4	13.56	5.60	5.33
1968	5	89.69	86.48	63.18
1968	6	18.98	17.32	13.39
1968	7	22.76	35.95	32.67
1968	8	38.99	47.63	40.85
1968	9	25.38	41.81	21.96
1968	10	21.88	64.30	69.39
1968	11	20.70	52.09	85.01
1968	12	81.69	71.24	134.80
1969	1	89.19	160.19	180.77
1969	2	37.30	17.53	22.49
1969	3	87.40	190.36	81.85
1969	4	78.77	78.58	79.09
1969	5	40.15	48.95	18.98
1969	6	15.86	12.09	24.52
1969	7	5.77	0.14	11.49
1969	8	12.33	16.87	18.61
1969	9	14.51	35.14	12.21
1969	10	13.89	6.93	35.90
1969	11	36.56	78.41	62.75
1969	12	41.80	203.39	75.77
1970	1	80.29	85.42	48.57
1970	2	105.42	50.00	24.88
1970	3	32.54	12.66	36.59
1970	4	52.25	76.62	81.30
1970	5	5.65	4.26	28.98
1970	6	25.03	22.44	42.77
1970	7	22.96	15.90	17.52
1970	8	2.84	4.26	1.58
1970	9	28.81	21.49	19.33
1970	10	8.12	6.41	42.09
1970	11	38.94	67.19	60.32
1970	12	80.36	108.71	67.49
1971	1	162.98	131.22	47.74
1971	2	51.32	55.13	46.58
1971	3	48.38	86.37	42.89
1971	4	72.24	75.98	41.69
1971	5	24.19	27.10	13.22
1971	6	11.99	18.71	14.17
1971	7	18.56	12.22	16.78
1971	8	25.34	101.67	55.18
1971	9	45.95	38.57	20.44
1971	10	11.53	10.58	10.57
1971	11	8.62	22.53	20.59
1971	12	151.81	36.63	46.83
1972	1	66.17	62.91	94.97
1972	2	76.59	24.51	68.59
1972	3	78.51	67.45	56.02
1972	4	27.17	26.44	28.54
1972	5	51.31	48.92	33.08
1972	6	25.62	14.62	15.46
1972	7	10.65	6.92	19.87
1972	8	8.87	10.96	8.34
1972	9	61.43	53.77	71.74
1972	10	51.42	177.01	44.82
1972	11	51.53	69.91	103.59
1972	12	188.28	105.43	153.94
1973	1	35.04	45.17	37.52
1973	2	77.46	45.57	58.21
1973	3	103.35	113.61	63.44
1973	4	50.77	73.23	33.73
1973	5	72.59	65.93	53.62
1973	6	29.79	35.21	37.32
1973	7	80.28	31.09	25.33
1973	8	22.45	24.16	48.84
1973	9	15.96	18.18	8.81
1973	10	32.91	15.91	25.27
1973	11	40.90	24.12	18.86
1973	12	19.06	203.17	59.82

YEAR	MONTH	TENDAY VOLUMES		
1974	1	111.91	130.87	162.31
1974	2	77.67	41.48	116.14
1974	3	46.03	20.49	31.76
1974	4	23.93	9.15	6.95
1974	5	10.12	7.50	8.22
1974	6	10.11	7.44	6.60
1974	7	16.66	41.48	78.71
1974	8	86.46	19.41	8.22
1974	9	66.49	78.66	1.28
1974	10	42.69	154.65	260.05
1974	11	76.82	114.73	73.95
1974	12	174.15	57.70	155.53
1975	1	204.21	226.99	104.56
1975	2	77.03	72.78	118.53
1975	3	69.57	30.14	20.46
1975	4	63.61	73.67	47.61
1975	5	9.71	7.46	5.44
1975	6	14.97	33.03	25.55
1975	7	17.31	16.80	61.80
1975	8	78.98	41.26	28.24
1975	9	50.02	41.73	20.52
1975	10	12.72	35.72	21.94
1975	11	15.81	103.63	150.25
1975	12	93.36	128.35	176.89
1976	1	127.01	95.54	100.92
1976	2	145.43	194.20	137.08
1976	3	60.90	54.13	40.61
1976	4	27.44	23.58	43.81
1976	5	14.45	9.67	10.64
1976	6	11.81	10.75	48.82
1976	7	57.52	13.83	68.61
1976	8	11.44	54.59	50.43
1976	9	7.41	6.26	72.65
1976	10	42.77	34.32	34.43
1976	11	13.84	10.22	8.55
1976	12	87.05	59.82	163.16
1977	1	94.47	76.91	162.29
1977	2	49.10	86.68	37.22
1977	3	52.43	41.85	25.82
1977	4	64.70	96.43	143.02
1977	5	63.14	35.96	28.51
1977	6	20.55	32.12	17.57
1977	7	19.29	33.79	78.17
1977	8	44.32	19.55	19.61
1977	9	13.19	8.95	13.10
1977	10	9.44	190.15	46.59
1977	11	43.61	52.40	16.86
1977	12	58.04	34.48	190.68
1978	1	130.20	119.65	107.73
1978	2	99.13	31.09	61.43
1978	3	0.42	26.28	19.44
1978	4	91.42	98.45	144.75
1978	5	84.19	24.44	21.33
1978	6	23.65	18.90	18.30
1978	7	14.97	8.70	33.73
1978	8	21.32	10.13	16.15
1978	9	11.57	26.39	10.51
1978	10	13.98	129.86	88.75
1978	11	37.23	67.79	160.55
1978	12	112.79	156.35	144.47
1979	1	85.60	62.85	107.43
1979	2	97.80	49.53	24.04
1979	3	164.62	90.05	37.31
1979	4	60.20	57.44	30.00
1979	5	21.05	15.38	14.18
1979	6	10.60	20.14	31.45
1979	7	10.66	27.12	18.20
1979	8	43.59	11.91	8.86
1979	9	5.35	6.36	3.89
1979	10	4.46	12.81	73.63
1979	11	58.74	57.40	38.59
1979	12	95.32	84.99	126.40
1980	1	102.64	30.05	33.12
1980	2	75.71	186.81	57.18
1980	3	23.92	12.97	23.40
1980	4	69.79	62.02	41.95
1980	5	48.92	20.22	203.10
1980	6	59.82	30.73	20.55
1980	7	12.22	13.90	40.26
1980	8	9.98	10.51	14.82

Table AI2 contd.

YEAR	MONTH	TENDAY VOLUMES		
1980	9	10.39	7.32	8.29
1980	10	5.01	5.71	7.33
1980	11	35.58	22.94	29.12
1980	12	19.87	36.32	171.83
1981	1	55.17	69.30	89.08
1981	2	130.72	30.46	29.53
1981	3	22.01	64.93	186.63
1981	4	60.38	28.24	15.87
1981	5	90.73	134.40	44.87
1981	6	28.45	25.12	15.62
1981	7	15.74	16.90	28.87
1981	8	36.24	14.00	7.61
1981	9	10.77	5.62	12.66
1981	10	13.56	36.40	10.04
1981	11	90.84	55.50	52.28
1981	12	72.76	72.76	72.76
1982	1	160.96	149.62	29.84
1982	2	23.05	14.01	11.88
1982	3	37.02	12.63	31.19
1982	4	19.22	15.85	23.39
1982	5	11.18	15.05	9.36
1982	6	5.17	5.96	6.16
1982	7	48.49	43.49	9.96
1982	8	20.22	30.89	42.57
1982	9	19.18	77.89	58.91
1982	10	94.72	86.75	53.83
1982	11	26.84	39.82	162.49
1982	12	67.72	169.40	121.06
1983	1	218.39	209.76	156.53
1983	2	56.92	62.35	21.97
1983	3	23.04	45.01	39.62
1983	4	27.03	63.89	60.19
1983	5	62.66	20.29	39.78
1983	6	22.45	19.30	13.68
1983	7	40.74	57.87	44.69
1983	8	78.40	65.42	79.49
1983	9	140.19	148.59	81.85
1983	10	150.59	36.92	8.80

YEAR	MONTH	TENDAY VOLUMES		
1983	11	17.72	27.38	45.32
1983	12	81.57	114.37	81.43
1984	1	228.84	147.68	48.61
1984	2	197.41	227.69	164.52
1984	3	105.44	55.18	25.51
1984	4	24.70	11.27	11.69
1984	5	8.07	7.13	6.03
1984	6	9.13	12.85	20.12
1984	7	7.49	5.23	23.51
1984	8	26.36	9.48	28.08
1984	9	19.08	14.55	29.41
1984	10	17.70	25.70	92.74
1984	11	37.92	68.86	131.01
1984	12	44.00	60.23	358.07
1985	1	125.48	31.14	110.75
1985	2	113.99	33.75	14.46
1985	3	55.43	172.22	44.68
1985	4	52.81	21.41	84.33
1985	5	112.21	36.89	20.20
1985	6	12.59	10.63	7.78
1985	7	12.65	12.37	20.04
1985	8	10.65	14.59	226.24
1985	9	128.11	49.34	19.97
1985	10	30.06	103.62	61.45
1985	11	36.31	22.14	16.47
1985	12	74.97	152.44	193.40
1986	1	40.71	74.44	142.72
1986	2	29.42	16.95	44.84
1986	3	124.45	44.24	14.80
1986	4	35.79	45.72	47.50
1986	5	40.29	17.84	13.44
1986	6	72.94	101.36	83.88
1986	7	117.05	35.21	28.29
1986	8	32.90	11.68	8.92
1986	9	8.39	5.66	4.91
1986	10	4.48	13.65	8.79
1986	11	10.55	26.44	54.16
1986	12	101.48	209.74	175.66

Table AI3

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YEAR	MONTH	TENDAY VOLUMES		
1967	5	23.25	18.67	15.99
1967	6	13.37	14.33	16.66
1967	7	12.75	8.61	8.97
1967	8	11.23	12.93	25.50
1967	9	14.64	26.64	8.40
1967	10	9.29	15.88	17.05
1967	11	13.46	19.48	39.57
1967	12	42.11	36.54	18.81
1968	1	8.27	30.11	41.51
1968	2	17.79	47.39	15.14
1968	3	24.74	21.25	50.87
1968	4	6.44	2.66	2.53
1968	5	24.73	23.84	17.42
1968	6	6.88	6.28	4.85
1968	7	7.11	11.24	10.21
1968	8	11.53	14.08	12.08
1968	9	7.97	13.13	6.89
1968	10	6.30	18.51	19.98
1968	11	5.95	14.97	24.44
1968	12	22.21	19.37	36.65
1969	1	23.69	42.56	48.02
1969	2	12.06	5.67	7.27
1969	3	23.43	51.04	21.95
1969	4	21.74	21.69	21.83
1969	5	12.18	14.85	5.76
1969	6	5.65	4.31	8.74
1969	7	3.26	0.08	6.50
1969	8	4.52	6.18	6.82
1969	9	4.95	11.98	4.16
1969	10	4.85	2.42	12.52
1969	11	10.37	22.24	17.80
1969	12	11.28	54.90	20.46
1970	1	22.35	23.78	13.52
1970	2	29.85	14.16	7.04
1970	3	10.40	4.04	11.69
1970	4	14.57	21.37	22.67
1970	5	2.22	1.67	11.38
1970	6	7.84	7.03	13.40
1970	7	8.02	5.56	6.12
1970	8	2.49	3.75	1.39
1970	9	9.54	7.11	6.40
1970	10	2.83	2.24	14.69
1970	11	11.12	19.19	17.23
1970	12	22.03	29.81	18.51
1971	1	43.83	35.29	12.84
1971	2	14.81	15.91	13.44
1971	3	13.72	24.50	12.17
1971	4	20.35	21.40	11.74
1971	5	8.16	9.14	4.46
1971	6	4.49	7.00	5.30
1971	7	6.82	4.49	6.16
1971	8	7.17	28.76	15.61
1971	9	14.00	11.75	6.23
1971	10	4.83	4.44	4.43
1971	11	3.09	8.07	7.37
1971	12	41.92	10.11	12.93
1972	1	18.35	17.44	26.33
1972	2	21.83	6.99	19.55
1972	3	21.98	18.88	15.68
1972	4	8.67	8.44	9.11
1972	5	15.07	14.37	9.72
1972	6	8.98	5.13	5.42
1972	7	4.24	2.76	7.91
1972	8	3.96	4.89	3.72
1972	9	17.33	15.17	20.24
1972	10	14.03	48.31	12.23
1972	11	14.28	19.38	28.71
1972	12	49.92	27.95	40.82
1973	1	10.48	13.51	11.23
1973	2	21.92	12.90	16.47
1973	3	28.15	30.95	17.28
1973	4	14.60	21.05	9.70
1973	5	20.42	18.55	15.08
1973	6	9.12	10.78	11.43
1973	7	23.50	9.10	7.41
1973	8	6.96	7.49	15.14
1973	9	6.06	6.90	3.34
1973	10	10.74	5.19	8.25
1973	11	13.00	7.67	5.99
1973	12	5.19	55.32	16.29

YEAR	MONTH	TENDAY VOLUMES		
1974	1	29.82	34.87	43.24
1974	2	21.45	11.45	32.07
1974	3	14.19	6.32	9.79
1974	4	9.30	3.56	2.70
1974	5	4.69	3.48	3.81
1974	6	4.83	3.56	3.16
1974	7	4.88	12.14	23.04
1974	8	25.99	5.84	2.47
1974	9	19.29	22.82	0.37
1974	10	11.31	40.97	68.89
1974	11	21.01	31.38	20.22
1974	12	46.51	15.41	41.53
1975	1	53.74	59.73	27.52
1975	2	21.05	19.89	32.39
1975	3	20.75	8.99	6.10
1975	4	17.96	20.80	13.45
1975	5	4.79	3.68	2.68
1975	6	4.89	10.80	8.35
1975	7	5.36	5.20	19.14
1975	8	22.87	11.95	8.18
1975	9	15.08	12.58	6.18
1975	10	4.20	11.80	7.24
1975	11	4.32	28.31	41.04
1975	12	24.89	34.22	47.17
1976	1	34.27	25.78	27.23
1976	2	38.45	51.35	36.25
1976	3	17.54	15.58	11.69
1976	4	8.52	7.32	13.59
1976	5	5.92	3.96	4.36
1976	6	3.89	3.54	16.07
1976	7	16.79	4.04	20.02
1976	8	3.43	16.36	15.11
1976	9	2.34	1.98	22.95
1976	10	12.91	10.36	10.39
1976	11	5.81	4.29	3.59
1976	12	23.55	16.18	44.14
1977	1	25.44	20.71	43.71
1977	2	13.96	24.65	10.59
1977	3	15.64	12.48	7.70
1977	4	17.53	26.12	38.74
1977	5	18.66	10.63	8.43
1977	6	6.79	10.61	5.80
1977	7	5.68	9.95	23.02
1977	8	14.10	6.22	6.24
1977	9	5.37	3.64	5.34
1977	10	2.60	52.31	12.82
1977	11	13.13	15.78	5.08
1977	12	15.80	9.38	51.90
1978	1	34.92	32.09	28.89
1978	2	27.89	8.75	17.28
1978	3	0.16	9.75	7.21
1978	4	24.61	26.51	38.98
1978	5	24.82	7.21	6.29
1978	6	8.10	6.47	6.26
1978	7	5.20	3.02	11.73
1978	8	7.83	3.72	5.93
1978	9	4.23	9.63	3.84
1978	10	3.86	35.89	24.53
1978	11	10.18	18.54	43.91
1978	12	30.02	41.61	38.45
1979	1	23.48	17.24	29.46
1979	2	27.85	14.10	6.85
1979	3	44.72	24.46	10.13
1979	4	17.45	16.65	8.70
1979	5	7.59	5.54	5.11
1979	6	3.61	6.86	10.71
1979	7	3.73	9.49	6.37
1979	8	14.71	4.02	2.99
1979	9	3.22	3.83	2.34
1979	10	1.39	4.01	23.03
1979	11	16.93	16.54	11.12
1979	12	25.81	23.01	34.22
1980	1	29.33	8.59	9.46
1980	2	20.44	50.44	15.44
1980	3	8.21	4.45	8.03
1980	4	19.84	17.63	11.93
1980	5	13.35	5.52	55.44
1980	6	18.06	9.28	6.21
1980	7	4.09	4.66	13.48
1980	8	4.06	4.28	6.03

Table AI3 contd.

YEAR	MONTH	TENDAY VOLUMES		
1980	9	4.80	3.38	3.83
1980	10	2.77	3.17	4.06
1980	11	11.21	7.23	9.17
1980	12	5.50	10.05	47.57
1981	1	15.36	19.30	24.81
1981	2	36.80	8.58	8.31
1981	3	6.01	17.72	50.93
1981	4	18.42	8.61	4.84
1981	5	24.78	36.71	12.25
1981	6	9.43	8.33	5.18
1981	7	5.37	5.77	9.86
1981	8	12.57	4.86	2.64
1981	9	4.74	2.48	5.57
1981	10	4.66	12.51	3.45
1981	11	25.47	15.56	14.66
1981	12	20.22	20.22	20.22
1982	1	43.30	40.24	8.03
1982	2	8.39	5.10	4.32
1982	3	11.85	4.05	9.99
1982	4	6.65	5.48	8.09
1982	5	4.54	6.11	3.80
1982	6	2.93	3.38	3.49
1982	7	14.85	13.32	3.05
1982	8	6.29	9.61	13.24
1982	9	5.52	22.42	16.96
1982	10	26.15	23.95	14.86
1982	11	7.43	11.02	44.96
1982	12	18.16	45.43	32.47
1983	1	57.29	55.02	41.06
1983	2	16.59	18.18	6.40
1983	3	6.99	13.66	12.02
1983	4	7.81	18.46	17.39
1983	5	18.63	6.03	11.83
1983	6	7.88	6.77	4.80
1983	7	11.85	16.84	13.00
1983	8	21.75	18.15	22.05
1983	9	37.53	39.77	21.91
1983	10	42.27	10.36	2.47
1983	11	5.55	8.57	14.19
1983	12	22.24	31.18	22.20
1984	1	60.83	39.25	12.92
1984	2	51.77	59.71	43.14
1984	3	29.76	15.57	7.20
1984	4	9.07	4.14	4.29
1984	5	4.11	3.63	3.07
1984	6	3.49	4.91	7.69
1984	7	3.02	2.11	9.47
1984	8	8.91	3.21	9.49
1984	9	6.47	4.94	9.98
1984	10	5.19	7.53	27.17
1984	11	10.46	19.00	36.14
1984	12	11.65	15.95	94.81
1985	1	34.30	8.51	30.27
1985	2	32.66	9.67	4.14
1985	3	15.13	47.01	12.20
1985	4	15.17	6.15	24.23
1985	5	31.99	10.52	5.76
1985	6	5.39	4.55	3.33
1985	7	4.73	4.62	7.49
1985	8	2.93	4.01	62.13
1985	9	35.94	13.84	5.60
1985	10	8.44	29.10	17.26
1985	11	11.82	7.21	5.36
1985	12	19.94	40.54	51.43
1986	1	11.16	20.40	39.12
1986	2	9.20	5.30	14.02
1986	3	35.17	12.50	4.18
1986	4	10.56	13.49	14.02
1986	5	13.25	5.87	4.42
1986	6	19.99	27.78	22.99
1986	7	33.14	9.97	8.01
1986	8	11.66	4.14	3.16
1986	9	4.53	3.06	2.65
1986	10	2.04	6.21	4.00
1986	11	3.30	8.27	16.93
1986	12	26.81	55.41	46.40

Table AI4

Rochon Inflows

YEAR	MONTH	TENDAY VOLUMES		
1967	5	151.94	68.95	198.03
1967	6	83.12	57.71	75.8
1967	7	38.88	33.27	26.04
1967	8	72.69	68.53	126.2
1967	9	34.26	65.62	45.21
1967	10	66.53	71.34	77.68
1967	11	87.86	207.56	211.24
1967	12	442.34	536.59	308.37
1968	1	199.74	196.15	426.53
1968	2	171.4	286.46	274.01
1968	3	394.16	354.27	415.48
1968	4	12.88	6.78	2.67
1968	5	106.82	295.66	137.9
1968	6	37.35	31.75	28.23
1968	7	45.62	58.99	61.01
1968	8	53.89	54.86	69.19
1968	9	74.09	80.75	68.05
1968	10	53.05	154.26	149.58
1968	11	63.62	83.59	169.27
1968	12	140.56	207.07	435.25
1969	1	323.56	359.47	478.05
1969	2	76.1	42.16	45.63
1969	3	145.24	346.56	161.19
1969	4	90.21	84.56	89.62
1969	5	44.35	37.8	37.44
1969	6	33.15	24.14	24.91
1969	7	8.899	29.808	20.65
1969	8	17.021	22.464	27.907
1969	9	14.342	58.666	12.182
1969	10	20.563	9.504	46.31
1969	11	19.872	42.163	32.659
1969	12	42.509	506.909	338.515
1970	1	209.088	211.766	173.75
1970	2	210.384	112.838	60.912
1970	3	73.094	34.733	50.717
1970	4	42.509	40.176	79.834
1970	5	29.376	41.04	166.32
1970	6	94.176	32.918	50.458
1970	7	64.454	30.154	32.918
1970	8	47.174	64.886	21.427
1970	9	16.502	13.651	12.614
1970	10	23.76	19.699	86.918
1970	11	58.406	95.213	82.771
1970	12	98.755	333.158	280.109
1971	1	229.91	267.494	87.437
1971	2	108.605	38.102	85.795
1971	3	88.214	134.611	25.315
1971	4	48.125	89.51	69.638
1971	5	37.67	20.65	15.293
1971	6	17.28	50.026	19.613
1971	7	22.291	14.861	23.587
1971	8	39.917	139.277	57.11
1971	9	88.301	53.741	15.552
1971	10	12.096	18.23	21.254
1971	11	15.638	124.934	24.624
1971	12	181.354	25.142	58.147
1972	1	255.658	103.594	179.798
1972	2	86.659	26.525	76.118
1972	3	95.818	116.986	107.827
1972	4	46.138	39.571	37.152
1972	5	92.275	120.269	25.229
1972	6	60.394	22.378	30.672
1972	7	23.242	22.637	33.523
1972	8	25.488	30.931	75.773
1972	9	166.234	114.739	119.491
1972	10	139.536	520.474	74.995
1972	11	106.963	42.25	203.126
1972	12	455.155	345.514	197.251
1973	1	71.971	580.435	88.906
1973	2	122.429	162.518	106.445
1973	3	360.115	257.299	519.955
1973	4	173.405	157.075	60.998
1973	5	26.957	44.928	76.118
1973	6	31.795	36.634	39.053
1973	7	57.024	34.042	24.019
1973	8	26.525	24.624	51.84
1973	9	20.218	25.661	21.168
1973	10	38.189	20.65	26.525
1973	11	36.547	20.218	18.23
1973	12	25.142	188.957	72.662

YEAR	MONTH	TENDAY VOLUMES		
1974	1	198.288	271.21	312.509
1974	2	391.306	143.51	266.198
1974	3	65.664	51.494	98.669
1974	4	191.03	36.547	24.624
1974	5	22.032	20.045	21.6
1974	6	21.686	18.23	18.49
1974	7	19.354	18.922	38.794
1974	8	67.306	15.206	20.304
1974	9	48.47	39.139	92.88
1974	10	17.194	98.41	255.917
1974	11	85.104	115.085	99.014
1974	12	238.118	76.032	220.666
1975	1	248.314	405.994	168.048
1975	2	202.262	130.118	213.926
1975	3	140.054	48.384	40.522
1975	4	42.595	66.442	21.773
1975	5	28.08	29.117	27.475
1975	6	24.019	24.883	31.622
1975	7	26.006	22.205	38.275
1975	8	33.005	47.261	16.934
1975	9	19.008	28.253	22.291
1975	10	15.466	40.694	12.528
1975	11	13.651	29.462	132.451
1975	12	125.626	50.976	138.845
1976	1	343.699	88.214	119.491
1976	2	105.235	120.182	67.306
1976	3	152.496	47.693	35.77
1976	4	22.291	38.275	35.942
1976	5	26.179	16.243	21.514
1976	6	20.909	15.552	52.272
1976	7	81.13	18.662	42.854
1976	8	24.019	46.742	52.099
1976	9	20.995	19.181	39.83
1976	10	21.773	26.006	24.019
1976	11	20.218	17.194	12.874
1976	12	61.862	41.126	48.557
1977	1	57.283	39.226	147.658
1977	2	47.52	123.898	27.648
1977	3	74.822	54.173	31.795
1977	4	44.582	72.144	74.131
1977	5	40.435	34.128	31.19
1977	6	20.218	23.414	22.291
1977	7	12.96	32.659	29.203
1977	8	33.264	21.254	22.205
1977	9	15.379	16.416	37.066
1977	10	20.822	169.949	39.744
1977	11	22.118	30.931	15.552
1977	12	93.485	37.325	112.147
1978	1	114.653	101.088	72.922
1978	2	74.218	20.131	19.872
1978	3	22.378	18.144	23.242
1978	4	13.824	29.117	21.686
1978	5	32.918	46.57	16.762
1978	6	14.688	15.206	14.688
1978	7	20.045	15.206	33.696
1978	8	25.747	18.403	26.006
1978	9	25.574	36.461	19.613
1978	10	23.414	56.333	65.491
1978	11	21.341	23.933	122.256
1978	12	87.005	79.92	140.486
1979	1	87.96	61.05	108.82
1979	2	65.22	64.06	51.62
1979	3	108.93	109.38	118.19
1979	4	49.64	63.61	62.28
1979	5	20.39	16.07	14.54
1979	6	22.42	19.68	29.17
1979	7	15.27	27.91	27.82
1979	8	15.73	15.16	15.68
1979	9	23.75	22.84	9.98
1979	10	38.97	48.99	170.73
1979	11	39.42	44.08	43.16
1979	12	82.88	88.01	109.9
1980	1	51.91	35.31	25.2
1980	2	51.37	195.61	78.99
1980	3	18.88	18.75	18.53
1980	4	53.51	61.4	61.42
1980	5	64.85	67.32	71.02
1980	6	21.54	17.41	12.59
1980	7	14.94	13.41	52.59
1980	8	21.4	21.4	21.4

Table AI4 contd.

YEAR	MONTH	TENDAY VOLUMES		
1980	9	19.47	11	15.96
1980	10	15.23	14.68	24.17
1980	11	56.88	50.35	37.96
1980	12	24.93	37.16	113.38
1981	1	68.16	87.08	73.32
1981	2	100.79	24.42	24.54
1981	3	22.44	52.07	142.64
1981	4	66.57	30.88	32.23
1981	5	61.53	76.06	45.53
1981	6	28.06	13.39	15.27
1981	7	27.99	14.06	23.98
1981	8	44.58	15.71	10.25
1981	9	13.99	8.54	24.31
1981	10	37.33	37.98	24.43
1981	11	61.84	56.05	55.08
1981	12	140.14	140.14	140.14
1982	1	81.1	77.93	23.88
1982	2	24.24	22.03	11.99
1982	3	40.15	19.16	72.32
1982	4	31.86	43.95	60.45
1982	5	26.88	24.34	22.6
1982	6	19.12	20.22	22.8
1982	7	36.59	32.81	7.51
1982	8	20.02	30.59	42.15
1982	9	17.04	69.18	52.32
1982	10	95.71	87.66	54.39
1982	11	23.91	35.47	144.74
1982	12	54.62	85.02	72.94
1983	1	138.4	132.93	99.2
1983	2	47.99	52.57	18.52
1983	3	24.88	48.6	42.78
1983	4	32.53	76.89	72.43
1983	5	78.26	25.34	49.7
1983	6	36.45	31.34	31.68
1983	7	32.14	70.71	31.8
1983	8	48.78	37.42	54.89
1983	9	58.18	77.82	65.7
1983	10	59.33	31.18	19.23

YEAR	MONTH	TENDAY VOLUMES		
1983	11	22.04	20.96	62.18
1983	12	81.43	98.02	104.5
1984	1	63.39	94.7	56.24
1984	2	105.48	106.18	66.5
1984	3	38.84	27.82	16.49
1984	4	25.98	27.48	13.78
1984	5	27.61	10.61	5.46
1984	6	17.92	20.91	16
1984	7	8.49	6.23	30.71
1984	8	29.28	9.56	31.49
1984	9	29.59	10.64	34.33
1984	10	20.15	37.23	204.81
1984	11	49.66	58.19	78.35
1984	12	137.03	84.22	168.9
1985	1	59.29	29.88	70.64
1985	2	75.5	35.36	13.85
1985	3	48.94	184.23	61.92
1985	4	40.92	36.27	49.26
1985	5	77.43	21.42	14.39
1985	6	19.25	15.62	11.24
1985	7	20.53	11.62	26.03
1985	8	23.45	50.13	240.91
1985	9	88.91	31.99	18.37
1985	10	28.96	129.42	86.3
1985	11	36.97	34.09	20.49
1985	12	43.73	112.82	95.71
1986	1	31.93	43.73	104.37
1986	2	40.19	25.8	36.43
1986	3	91.76	32.62	17.45
1986	4	57.14	50.58	64.38
1986	5	40.42	26.06	20.77
1986	6	49.72	50.57	42.87
1986	7	70.08	27.41	20.17
1986	8	24.07	10.17	7.29
1986	9	18.46	11.11	10.16
1986	10	17.03	48.96	47.92
1986	11	10.29	18.23	63.83
1986	12	77.05	109.81	129.5

Table AI5

Cascade

YEAR	MONTH	TENDAY VOLUMES		
1967	5	225.33	102.26	293.69
1967	6	150.56	123.03	128.22
1967	7	126.62	94.9	51.8
1967	8	56.35	107.64	292.92
1967	9	134.43	97.93	91.84
1967	10	123.65	132.6	144.38
1967	11	124.24	293.51	298.72
1967	12	572.69	589.11	401.57
1968	1	284.88	255.72	518.43
1968	2	381.9	309.7	269.18
1968	3	472.13	403.56	553.8
1968	4	110.2	58.03	22.8
1968	5	270.98	201.51	280.56
1968	6	106.39	113.6	52.4
1968	7	101.48	180.26	64.74
1968	8	108.98	110.95	139.92
1968	9	135.82	148.03	124.75
1968	10	182.03	196	175.94
1968	11	164.15	181.97	164.01
1968	12	311.74	354.24	350.14
1969	1	337.52	440.48	648.43
1969	2	130.11	117.46	97.03
1969	3	320.98	355.89	198.33
1969	4	192.95	109.02	151.66
1969	5	117.23	111.34	67.97
1969	6	76.12	90.42	89.42
1969	7	55.88	55.66	56.74
1969	8	52.06	46.29	68.52
1969	9	117.27	72.91	64.85
1969	10	11.27	101.75	167.8
1969	11	220.13	163.09	187.18
1969	12	269.88	321.45	291.61
1970	1	178.54	180.91	246.12
1970	2	168.86	175.61	134.95
1970	3	253.72	165.72	159.16
1970	4	97.91	124.7	111.9
1970	5	150.45	159.77	176.24
1970	6	104.67	102.78	97.52
1970	7	93.09	92.16	96.27
1970	8	94.67	93.76	96.85
1970	9	76.34	42.85	18.83
1970	10	120.09	58.32	283.42
1970	11	210.68	177.26	178.94
1970	12	299.21	308.75	285.3
1971	1	406.02	299.41	311.96
1971	2	162.04	193.58	139.69
1971	3	248.76	212.82	227.99
1971	4	147.38	200.4	150.66
1971	5	255.11	128.58	42.95
1971	6	37.68	388.86	47.27
1971	7	73.29	79.15	77.34
1971	8	78.57	71.95	211.78
1971	9	134.9	106.21	67.95
1971	10	245.11	398.28	198.28
1971	11	81.63	330.72	253.98
1971	12	433.72	157.01	233.26
1972	1	264.46	256.62	287.49
1972	2	225.69	151.17	281.16
1972	3	267.73	285.41	206.52
1972	4	131.1	122.71	167.98
1972	5	133.87	164.78	168.93
1972	6	172.9	135.13	79.92
1972	7	61.96	47.15	51.83
1972	8	12.47	8.9	270.85
1972	9	65.56	74.39	52.7
1972	10	100	86.9	70.12
1972	11	49.62	53.49	107.77
1972	12	266.1	124.77	170.53
1973	1	254.86	280.45	290.07
1973	2	283.09	217	186.02
1973	3	120.94	153.89	208.18
1973	4	137.38	110.18	88.72
1973	5	177.57	149.8	178.54
1973	6	48.1	59.56	53.8
1973	7	85.72	58.53	38.35
1973	8	134.63	77.94	79.64
1973	9	68.19	61.32	63.15
1973	10	121.26	69.09	66.67
1973	11	75.31	63.89	71.68
1973	12	130.52	226.47	204.42

YEAR	MONTH	TENDAY VOLUMES		
1974	1	318.45	224.02	282.9
1974	2	296.39	209.12	180.6
1974	3	153.46	150.3	179.24
1974	4	136.21	120.5	79.56
1974	5	254.38	132.91	118.62
1974	6	55.44	51.39	54.63
1974	7	67.58	49.76	44.12
1974	8	107.56	121.06	65.85
1974	9	127.21	194.6	212.35
1974	10	100.24	224.36	372.94
1974	11	104.28	201.54	227.47
1974	12	295.57	252.58	297.54
1975	1	413.93	539.56	584.32
1975	2	506.95	356.96	373.3
1975	3	219.23	142.99	144.86
1975	4	163.41	185.34	142.39
1975	5	91.49	67.03	26.65
1975	6	126.17	96.38	32.71
1975	7	76.9	62.75	84.9
1975	8	223.06	84.32	42.62
1975	9	67.21	80.65	85.36
1975	10	90.95	66.61	170.38
1975	11	101.5	187.24	367.48
1975	12	144.15	508.25	244.38
1976	1	232.09	379.39	500.54
1976	2	397.08	538.31	625.89
1976	3	203.47	183.5	148.49
1976	4	125.76	117.07	174.45
1976	5	68.99	46.16	50.78
1976	6	34.68	31.54	143.32
1976	7	110.42	85.43	79.34
1976	8	97.86	127.22	175.79
1976	9	118.15	88.13	248.52
1976	10	117.072	121.651	142.456
1976	11	77.7	63.38	41.74
1976	12	121.565	300.499	505.526
1977	1	360.115	370.397	1116.979
1977	2	375.149	715.306	209.261
1977	3	280.627	216.364	163.295
1977	4	348.624	210.53	317.6
1977	5	246.758	139.069	82.813
1977	6	70.589	84.473	43.45
1977	7	97.08	70.22	69.68
1977	8	135.4	59.72	59.91
1977	9	102.69	57.5	79.6
1977	10	26.94	542.72	132.97
1977	11	153.43	184.36	59.33
1977	12	226.19	210.47	290.35
1978	1	397.85	524.99	657.18
1978	2	200.52	194.51	175.37
1978	3	120.1	114.18	113.13
1978	4	239.49	246.41	244.87
1978	5	130.73	113.23	120.11
1978	6	83.85	84.84	81.65
1978	7	40.89	23.75	92.14
1978	8	19.414	16.572	17.099
1978	9	17.798	27.821	19.518
1978	10	17.142	48.505	117.374
1978	11	45.706	151.995	475.718
1978	12	215.482	431.222	512.957
1979	1	273.715	211.16	376.41
1979	2	159.494	171.383	82.106
1979	3	349.574	197.77	109.892
1979	4	168.039	373.611	134.136
1979	5	114.471	51.088	51.987
1979	6	39.856	66.34	98.34
1979	7	51.45	94.08	93.78
1979	8	52.01	50.11	51.86
1979	9	24.84	21.384	33.34
1979	10	134.82	169.48	590.61
1979	11	455.414	115.923	198.772
1979	12	349.142	191.549	412.906
1980	1	177.3	120.61	86.07
1980	2	153.792	280.368	149.126
1980	3	65.915	54.397	33.454
1980	4	28.4	35.96	33.169
1980	5	223.74	232.25	245.02
1980	6	71.62	57.87	41.84
1980	7	50.57	45.41	178.05
1980	8	71.72	71.72	71.72

Table AI5 contd.

YEAR	MONTH	TENDAY VOLUMES		
1980	9	41.178	36.38	52.75
1980	10	50.77	48.93	80.54
1980	11	110.851	65.854	165.197
1980	12	73.881	127.94	390.39
1981	1	235.47	300.85	253.32
1981	2	1089.331	105.633	1196.964
1981	3	77.48	179.78	492.5
1981	4	228.05	105.79	110.41
1981	5	121.548	303.549	59.962
1981	6	39.856	34.992	31.164
1981	7	26.87	24.019	80.058
1981	8	43.191	39.493	26.663
1981	9	21.237	15.846	16.71
1981	10	127.12	129.35	83.2
1981	11	212.88	192.97	189.63
1981	12	429.235	1409.875	550.714
1982	1	432.518	523.757	94.375
1982	2	57.888	58.735	28.581
1982	3	157.861	31.268	54.596
1982	4	29.013	30.145	36.867
1982	5	174.804	24.866	24.801
1982	6	13.582	67.81	76.46
1982	7	43.692	38.889	24.935
1982	8	71.479	62.243	82.149
1982	9	697.403	1273.372	603.374
1982	10	299.22	200.88	196.741
1982	11	56.307	81.57	391.211
1982	12	188.55	293.48	251.79
1983	1	808.186	665.712	320.63
1983	2	98.133	109.218	37.904
1983	3	30.171	292.049	51.114
1983	4	31.657	854.323	414.72
1983	5	369.187	83.471	97.839
1983	6	184.965	46.535	46.025
1983	7	80.672	181.803	63.599
1983	8	166.787	105.425	147.321
1983	9	630.893	583.373	284.083
1983	10	425.347	120.01	57.162
1983	11	49.974	105.866	160.911
1983	12	199.178	395.971	204.44
1984	1	1166.486	326.92	194.15
1984	2	590.475	428.285	223.43
1984	3	135.13	70.451	50.302
1984	4	64.791	46.293	62.882
1984	5	29.964	25.842	22.758
1984	6	18.23	19.846	29.195
1984	7	17.798	14.403	22.861
1984	8	29.514	9.495	75.375
1984	9	25.142	12.044	35.675
1984	10	70.217	82.979	149.887
1984	11	172.549	214.116	498.165
1984	12	75.704	76.231	598.942
1985	1	200.189	96.077	477.965
1985	2	307.411	80.179	50.795
1985	3	231.742	544.579	103.559
1985	4	167.098	57.603	81.786
1985	5	199.912	64.178	58.735
1985	6	41.437	32.27	24.201
1985	7	27.242	24.071	55.158
1985	8	27.276	17.608	28.037
1985	9	194.296	113.46	62.891
1985	10	73.518	598.061	182.736
1985	11	192.154	125.28	81.778
1985	12	205.312	464.659	438.394
1986	1	107.741	293	614.65
1986	2	107.654	84.931	158.743
1986	3	309.398	99.956	59.763
1986	4	55.797	63.288	105.512
1986	5	72.388	48.272	42.828
1986	6	180.014	137.851	137.367
1986	7	218.35	58.605	60.428
1986	8	53.378	34.62	33.368
1986	9	31.579	20.529	16.658
1986	10	14.455	45.87	42.353
1986	11	15.552	135.769	106.039
1986	12	294.97	267.062	464.4

Table AI6

Cascade at coast road

YEAR	MONTH	TEN DAY VOLUMES		
1967	5	337.31	153.08	439.65
1967	6	225.38	184.17	191.94
1967	7	189.55	142.06	77.54
1967	8	84.35	161.13	438.49
1967	9	201.24	146.60	137.48
1967	10	185.10	198.50	216.13
1967	11	185.98	439.38	447.17
1967	12	857.30	881.88	601.14
1968	1	426.46	382.81	776.07
1968	2	571.69	463.61	402.95
1968	3	706.76	604.12	829.02
1968	4	164.97	86.87	34.13
1968	5	405.65	301.65	419.99
1968	6	159.26	170.06	78.44
1968	7	151.91	269.84	96.91
1968	8	163.14	166.09	209.46
1968	9	203.32	221.60	186.75
1968	10	272.49	2.93	263.38
1968	11	245.73	272.40	245.52
1968	12	466.67	530.29	524.15
1969	1	505.26	659.39	970.68
1969	2	194.77	175.83	145.25
1969	3	480.50	532.76	296.89
1969	4	288.84	163.20	227.03
1969	5	175.49	166.67	101.75
1969	6	113.95	135.36	133.86
1969	7	83.65	83.32	84.94
1969	8	77.93	69.29	102.57
1969	9	175.55	109.14	97.08
1969	10	16.87	152.32	251.19
1969	11	329.53	244.14	280.20
1969	12	404.00	481.20	436.53
1970	1	267.27	270.82	368.43
1970	2	252.78	262.88	202.02
1970	3	379.81	248.08	238.26
1970	4	146.57	186.67	167.51
1970	5	225.22	239.17	263.83
1970	6	156.69	153.86	145.98
1970	7	139.35	137.96	144.11
1970	8	141.72	140.36	144.98
1970	9	114.28	64.15	28.19
1970	10	179.77	87.30	424.27
1970	11	315.38	265.35	267.87
1970	12	447.91	462.19	427.09
1971	1	607.80	448.21	466.99
1971	2	242.57	289.78	209.11
1971	3	372.39	318.59	341.29
1971	4	220.62	299.99	225.53
1971	5	381.89	192.48	64.29
1971	6	56.41	582.11	70.76
1971	7	109.71	118.49	115.78
1971	8	117.62	107.71	317.03
1971	9	201.94	158.99	101.72
1971	10	366.92	596.21	296.82
1971	11	122.20	495.08	380.20
1971	12	649.27	235.04	349.18
1972	1	395.89	384.15	430.36
1972	2	337.85	226.30	420.89
1972	3	400.78	427.25	309.15
1972	4	196.25	183.69	251.46
1972	5	200.40	246.67	252.88
1972	6	258.83	202.29	119.64
1972	7	92.75	70.58	77.59
1972	8	18.67	13.32	405.45
1972	9	98.14	111.36	78.89
1972	10	1.50	130.09	104.97
1972	11	74.28	80.07	161.33
1972	12	398.34	186.78	255.28
1973	1	381.52	419.83	434.23
1973	2	423.78	3.25	278.47
1973	3	181.04	230.37	311.64
1973	4	205.65	164.94	132.81
1973	5	265.82	224.25	267.27
1973	6	72.00	89.16	80.54
1973	7	128.32	87.62	57.41
1973	8	201.54	116.67	119.22
1973	9	102.08	91.79	94.53
1973	10	181.52	103.43	99.80
1973	11	112.74	95.64	107.30
1973	12	195.38	339.02	306.01

YEAR	MONTH	TENDAY VOLUMES		
1974	1	476.71	335.35	423.49
1974	2	443.69	313.05	270.35
1974	3	229.73	224.99	268.32
1974	4	203.90	180.38	119.10
1974	5	380.80	198.96	177.57
1974	6	82.99	76.93	81.78
1974	7	101.17	74.49	66.05
1974	8	161.01	181.22	98.58
1974	9	190.43	291.31	317.88
1974	10	150.06	335.86	558.28
1974	11	156.10	301.70	340.52
1974	12	442.46	378.10	445.41
1975	1	619.64	807.71	874.71
1975	2	758.89	534.36	558.82
1975	3	328.18	214.05	216.85
1975	4	244.62	277.45	213.15
1975	5	136.96	100.34	39.89
1975	6	188.87	144.28	48.97
1975	7	115.12	93.93	127.09
1975	8	333.91	126.22	63.80
1975	9	100.61	120.73	127.78
1975	10	136.15	99.71	255.05
1975	11	151.94	280.29	550.11
1975	12	215.79	760.83	365.83
1976	1	347.43	567.94	749.29
1976	2	594.42	805.83	936.94
1976	3	304.59	274.69	222.29
1976	4	188.26	175.25	261.15
1976	5	103.28	69.10	76.02
1976	6	51.91	47.21	214.55
1976	7	165.30	127.89	118.77
1976	8	146.49	190.44	263.15
1976	9	176.87	131.93	372.03
1976	10	175.25	182.11	213.25
1976	11	116.31	94.88	62.48
1976	12	181.98	449.84	756.76
1977	1	539.08	554.47	1672.08
1977	2	561.59	1070.79	313.26
1977	3	420.09	323.89	244.45
1977	4	521.88	315.16	475.44
1977	5	369.39	208.18	123.97
1977	6	105.67	126.45	65.04
1977	7	145.33	105.12	104.31
1977	8	202.69	89.40	89.68
1977	9	153.72	86.08	119.16
1977	10	40.33	812.44	199.05
1977	11	229.68	275.98	88.82
1977	12	338.60	315.07	434.65
1978	1	595.57	785.89	983.78
1978	2	300.17	291.18	262.52
1978	3	179.79	170.92	169.35
1978	4	358.51	368.87	366.56
1978	5	195.70	169.50	179.80
1978	6	125.52	127.00	122.23
1978	7	61.21	35.55	137.93
1978	8	29.06	24.81	25.60
1978	9	26.64	41.65	29.22
1978	10	25.66	72.61	175.71
1978	11	68.42	227.53	712.14
1978	12	322.57	645.53	767.88
1979	1	409.74	316.10	563.47
1979	2	238.76	256.56	122.91
1979	3	523.30	296.06	164.51
1979	4	251.55	559.28	200.80
1979	5	171.36	76.48	77.82
1979	6	59.66	99.31	147.21
1979	7	77.02	140.83	140.39
1979	8	77.86	75.01	77.63
1979	9	37.18	32.01	49.91
1979	10	201.82	253.71	884.13
1979	11	681.74	173.53	297.56
1979	12	522.66	286.74	618.11
1980	1	265.41	180.55	128.84
1980	2	230.22	419.70	223.24
1980	3	98.67	81.43	50.08
1980	4	42.51	53.83	49.65
1980	5	334.93	347.67	366.79
1980	6	107.21	86.63	62.63
1980	7	75.70	67.98	266.54
1980	8	107.36	107.36	107.36

Table AI6 contd.

YEAR	MONTH	TENDAY VOLUMES		
1980	9	61.64	54.46	78.97
1980	10	76.00	73.25	120.57
1980	11	165.94	98.58	247.29
1980	12	110.60	191.52	584.40
1981	1	352.49	450.36	379.21
1981	2	1630.70	158.13	1791.82
1981	3	115.99	269.13	737.26
1981	4	341.38	158.36	165.28
1981	5	181.95	454.40	89.76
1981	6	59.66	52.38	46.65
1981	7	40.22	35.96	119.84
1981	8	64.66	59.12	39.91
1981	9	31.79	23.72	25.01
1981	10	190.29	193.63	124.55
1981	11	318.67	288.87	283.87
1981	12	642.55	2110.54	824.40
1982	1	647.47	784.05	141.28
1982	2	86.66	87.92	42.78
1982	3	236.31	46.81	81.73
1982	4	43.43	45.13	55.19
1982	5	261.68	37.22	37.13
1982	6	20.33	101.51	114.46
1982	7	65.41	58.22	37.33
1982	8	107.00	93.18	122.97
1982	9	1043.99	1906.20	903.23
1982	10	447.92	300.71	294.52
1982	11	84.29	122.11	585.63
1982	12	282.25	439.33	376.92
1983	1	1209.83	996.55	479.97
1983	2	146.90	163.50	56.74
1983	3	45.17	437.19	76.52
1983	4	47.39	1278.90	620.82
1983	5	552.66	124.95	146.46
1983	6	276.89	69.66	68.90
1983	7	120.76	272.15	95.21
1983	8	249.68	157.82	220.54
1983	9	944.43	873.29	425.26
1983	10	636.73	179.65	85.57

YEAR	MONTH	TENDAY VOLUMES		
1983	11	74.81	158.48	240.88
1983	12	298.16	592.76	306.04
1984	1	1746.19	489.39	290.64
1984	2	883.92	641.13	334.47
1984	3	202.29	105.46	75.30
1984	4	96.99	69.30	94.13
1984	5	44.86	38.68	34.07
1984	6	27.29	29.71	43.70
1984	7	26.64	21.56	34.22
1984	8	44.18	14.21	112.83
1984	9	37.64	18.03	53.40
1984	10	105.11	124.22	224.38
1984	11	258.30	320.53	745.74
1984	12	113.33	114.12	896.60
1985	1	299.68	143.82	715.50
1985	2	460.19	120.03	76.04
1985	3	346.91	815.22	155.02
1985	4	250.14	86.23	122.43
1985	5	299.26	96.07	87.92
1985	6	62.03	48.31	36.23
1985	7	40.78	36.03	82.57
1985	8	40.83	26.36	41.97
1985	9	290.86	169.85	94.15
1985	10	110.05	895.28	273.55
1985	11	287.65	187.54	122.42
1985	12	307.35	695.58	656.26
1986	1	161.29	4.39	920.11
1986	2	161.15	127.14	237.63
1986	3	463.16	149.63	89.46
1986	4	83.53	94.74	157.95
1986	5	138.30	72.26	64.11
1986	6	269.48	206.36	205.63
1986	7	326.86	87.73	90.46
1986	8	79.91	51.83	49.95
1986	9	47.27	30.73	24.94
1986	10	21.64	68.67	63.40
1986	11	23.28	203.24	158.74
1986	12	441.56	399.78	695.19

Table AI7

GRAND ANSE

YEAR	MONTH	TENDAY VOLUMES		
1967	5	292.62	235.04	201.25
1967	6	138.35	148.3	172.39
1967	7	95.94	110.56	94.54
1967	8	119.14	137.17	270.49
1967	9	112.12	138.91	112.58
1967	10	100.71	172.11	184.78
1967	11	245.31	311.78	288.88
1967	12	709.41	637.4	540.54
1968	1	308.47	430.21	528.51
1968	2	304.46	477.12	364.82
1968	3	440.01	377.97	904.77
1968	4	104.44	44.99	50.42
1968	5	273.63	314.5	302.81
1968	6	114.53	104.55	80.81
1968	7	146.38	162.44	82.17
1968	8	91.29	163.02	153.12
1968	9	87.78	244.08	135.55
1968	10	241.48	191.11	213.57
1968	11	195.51	160.5	236.23
1968	12	344.78	300.67	568.97
1969	1	493.18	549.03	676.78
1969	2	129.22	140.15	119.32
1969	3	334.78	363.89	342.48
1969	4	149.74	182.11	190.91
1969	5	122.44	149.26	57.89
1969	6	89.84	91.39	98.48
1969	7	45.87	47.44	76.56
1969	8	50.64	51.89	67.61
1969	9	68.86	94.51	115.18
1969	10	97.3	91.02	121.95
1969	11	137.09	293.99	235.26
1969	12	329.86	427.49	293.33
1970	1	186.45	262.49	260.64
1970	2	324.19	153.77	76.52
1970	3	335.44	164.79	176.2
1970	4	143.39	117.04	115.86
1970	5	229.45	159.04	174.63
1970	6	116.63	100.36	122.97
1970	7	110.82	92.46	107.86
1970	8	101.66	90.14	123.95
1970	9	50.43	37.45	46.8
1970	10	158.29	138.06	236.5
1970	11	224.67	228.02	209.32
1970	12	317.76	365.84	379.76
1971	1	559.79	395.34	247.43
1971	2	220.39	289.76	254.13
1971	3	195.99	167.09	235.91
1971	4	236.98	315.23	226.14
1971	5	68.78	63.04	67.91
1971	6	114.48	193.82	153.76
1971	7	100.47	100.15	137.72
1971	8	191.33	217.3	220.2
1971	9	129.12	124.75	91.11
1971	10	74.22	59.93	46.92
1971	11	159.19	331.67	284.29
1971	12	285.8	266.8	310.84
1972	1	359.14	438.8	418.05
1972	2	223.52	156.48	194.02
1972	3	249.98	283.83	279.08
1972	4	186.47	175.2	216.19
1972	5	161.82	173.87	153.88
1972	6	258.74	177.06	111.79
1972	7	70.83	59.43	117.24
1972	8	91.13	73.84	245.49
1972	9	143.27	85.64	186.44
1972	10	400.81	429.25	169.80
1972	11	74.71	335.52	374.09
1972	12	278.34	350.51	349.33
1973	1	249.2	366.24	343.77
1973	2	309.09	265.5	199.49
1973	3	142.18	399.41	357.47
1973	4	163.82	177.13	142.66
1973	5	98.38	178.1	263.43
1973	6	173.41	98.69	169.9
1973	7	51.05	51.05	60.75
1973	8	153.52	80.94	89.82
1973	9	62.16	65.24	74.46
1973	10	100.04	103.44	77.53
1973	11	115.67	68.46	40.13
1973	12	22.23	450.4	182.67

YEAR	MONTH	TENDAY VOLUMES		
1974	1	117.95	433.5	428.43
1974	2	241.3	291.03	276.3
1974	3	168.68	170.41	219.79
1974	4	135.38	114.43	128.64
1974	5	180.54	214.32	192.19
1974	6	60.13	53.08	90.27
1974	7	28.78	68.4	92.31
1974	8	97.29	99.5	170.25
1974	9	265.63	204.1	152.07
1974	10	145.21	164.04	513.45
1974	11	197.69	221.94	201.11
1974	12	280.07	239.78	485
1975	1	814	641.53	400.42
1975	2	358.53	531.06	596.71
1975	3	262.95	183.47	142.07
1975	4	191.67	222.27	154.95
1975	5	37.52	76.1	79.01
1975	6	127.73	75.35	75.76
1975	7	82.05	46.1	112.92
1975	8	198.22	132.07	65.03
1975	9	119.75	95.46	36.52
1975	10	52.91	183.34	131.97
1975	11	75.48	238.94	457.45
1975	12	244.03	326.83	476.81
1976	1	409.98	370.95	551.44
1976	2	574.99	767.8	541.99
1976	3	243.93	216.8	162.65
1976	4	36.789	62.623	152.021
1976	5	36.634	17.47	15.906
1976	6	17.124	13.003	73.25
1976	7	108.648	47.736	198.798
1976	8	58.847	207.567	234.014
1976	9	54.406	27.881	301.182
1976	10	58.355	40.703	113.486
1976	11	71.332	28.054	14.809
1976	12	199.187	238.81	410.573
1977	1	375.408	177.12	980.035
1977	2	148.789	445.565	110.177
1977	3	220.899	132.477	75.98
1977	4	249.445	226.541	660.01
1977	5	241.661	113.452	79.479
1977	6	31.743	97.468	44.807
1977	7	27.89	50.656	112.674
1977	8	194.158	75.928	67.746
1977	9	25.661	13.133	40.643
1977	10	25.514	554.774	77.579
1977	11	76.144	149.653	41.066
1977	12	102.272	75.125	456.624
1978	1	846.029	343.354	609.811
1978	2	216.026	80.43	237.341
1978	3	147.234	72.386	86.56
1978	4	235.91	254.07	373.57
1978	5	267.29	77.6	67.74
1978	6	40.15	40.902	24.736
1978	7	24.071	5.97	64.135
1978	8	10.99	1.719	2.713
1978	9	17.868	23.086	0.207
1978	10	4.899	69.008	209.437
1978	11	119.396	269.59	708.28
1978	12	441.504	668.39	851.558
1979	1	357.35	320.803	437.43
1979	2	379.728	275.53	82.037
1979	3	522.547	313.114	102.444
1979	4	365.869	378.086	159.322
1979	5	96.042	37.601	30.041
1979	6	25.177	44.142	147.01
1979	7	55.73	101.91	101.59
1979	8	96.83	35.6	21.85
1979	9	18.291	8.744	16.558
1979	10	11.889	109.054	341.997
1979	11	313.528	318.479	142.5
1979	12	327.456	257.731	626.072
1980	1	470.362	84.3	78.373
1980	2	233.703	810.173	230.982
1980	3	43.943	36.098	40.746
1980	4	194.858	42.31	79.669
1980	5	174.623	110.5	460.78
1980	6	268.963	78.123	66.459
1980	7	44.487	50.03	196.16
1980	8	133.3	133.3	133.3

Table AI7 contd.

YEAR	MONTH	TENDAY VOLUMES		
1980	9	63.055	41.697	16.572
1980	10	3.361	1.745	11.37
1980	11	58.389	81.924	166.985
1980	12	64.368	96.327	310.124
1981	1	164.385	201.865	221.668
1981	2	923.357	63.504	87.022
1981	3	51.261	117.927	475.252
1981	4	144.046	55.693	21.012
1981	5	334.204	276.48	123.008
1981	6	97.243	56.808	40.859
1981	7	80.006	46.146	90.167
1981	8	144.772	42.949	18.239
1981	9	12.761	28.34	80.67
1981	10	143.2	145.71	93.72
1981	11	249.25	225.92	222.02
1981	12	340.9	340.9	340.9
1982	1	328.04	315.22	96.6
1982	2	37.221	38.318	15.803
1982	3	158.48	75.63	285.47
1982	4	126.12	174.01	239.35
1982	5	98.81	89.47	83.06
1982	6	68.04	71.98	81.16
1982	7	189.648	128.857	27.683
1982	8	24.555	23.086	66.053
1982	9	52.134	431.326	205.252
1982	10	318.237	387.936	264.643
1982	11	65.128	161.352	777.091
1982	12	246.342	449.885	424.138
1983	1	947.549	824.255	452.477
1983	2	195.35	133.488	52.6
1983	3	44.556	796.528	112.925
1983	4	57.534	171.564	160.186
1983	5	245.808	59.72	108.959
1983	6	169.068	75.133	56.868
1983	7	168.739	263.589	117.677
1983	8	198.288	149.139	534.921
1983	9	728.266	829.244	332.381
1983	10	476.496	104.449	65.837

YEAR	MONTH	TENDAY VOLUMES		
1983	11	42.18	107.495	163.547
1983	12	322.393	471.398	193.787
1984	1	971.222	605.75	152.038
1984	2	538.177	425.866	261.014
1984	3	228.079	168.143	48.177
1984	4	38.496	30.53	41.628
1984	5	40.138	16.831	9.361
1984	6	37.43	57.37	94.95
1984	7	21.704	1.244	126.179
1984	8	81.251	34.84	114.78
1984	9	135.423	72.213	203.23
1984	10	78.538	285.01	640.47
1984	11	157.818	423.818	398.477
1984	12	100.043	151.347	761.967
1985	1	397.464	94.409	399.082
1985	2	367.027	79.445	28.685
1985	3	118.714	762.7	256.35
1985	4	109.4	46.155	314.911
1985	5	415.325	117.936	82.996
1985	6	37.781	40.297	19.889
1985	7	54.467	45.516	104.743
1985	8	35.804	55.106	1319.302
1985	9	614.909	126.161	32.988
1985	10	73.716	674.488	208.915
1985	11	190.426	166.579	89.631
1985	12	265.836	487.987	352.944
1986	1	106.756	171.616	594.95
1986	2	91.092	55.175	194.711
1986	3	521.942	179.34	73.224
1986	4	160.816	189.527	356.4
1986	5	288.403	138.689	66.804
1986	6	303.523	324.778	318.384
1986	7	377.563	174.442	109.979
1986	8	158.008	55.356	27.026
1986	9	19.293	13.988	15.111
1986	10	66.29	190.61	106.57
1986	11	39.1	69.29	242.53
1986	12	400.205	391.306	719.798

Table AI8

Grand Anse upper catchment

YEAR	MONTH	TENDAY VOLUMES		
1967	5	130.33	104.69	89.64
1967	6	61.62	66.05	76.78
1967	7	42.73	49.24	42.11
1967	8	53.06	61.10	120.48
1967	9	49.94	61.87	50.14
1967	10	44.86	76.66	82.30
1967	11	109.26	138.87	128.67
1967	12	315.97	283.90	240.76
1968	1	137.39	191.62	235.40
1968	2	135.61	212.51	162.49
1968	3	195.98	168.35	402.98
1968	4	46.52	20.04	22.46
1968	5	121.87	140.08	134.87
1968	6	51.01	46.57	35.99
1968	7	65.20	72.35	36.60
1968	8	40.66	72.61	68.20
1968	9	39.10	108.71	60.37
1968	10	107.56	85.12	95.12
1968	11	87.08	71.49	105.22
1968	12	153.57	133.92	253.42
1969	1	219.66	244.54	301.44
1969	2	57.55	62.42	53.15
1969	3	149.11	162.08	152.54
1969	4	66.69	81.11	85.03
1969	5	54.53	66.48	25.78
1969	6	40.01	40.71	43.86
1969	7	20.43	22.02	34.10
1969	8	22.56	23.11	30.11
1969	9	30.67	42.09	51.30
1969	10	43.34	40.54	54.32
1969	11	61.06	130.94	104.78
1969	12	146.92	190.40	130.65
1970	1	83.04	116.91	116.09
1970	2	144.39	68.49	34.08
1970	3	149.40	73.40	78.48
1970	4	63.87	52.13	51.60
1970	5	102.20	70.84	77.78
1970	6	51.95	44.70	54.77
1970	7	49.36	41.18	48.04
1970	8	45.28	40.15	55.21
1970	9	22.46	16.68	20.84
1970	10	70.50	61.49	105.34
1970	11	100.07	101.56	93.23
1970	12	141.53	162.95	169.15
1971	1	249.33	176.08	110.21
1971	2	98.16	129.06	113.19
1971	3	87.29	74.42	105.07
1971	4	105.55	140.40	100.72
1971	5	30.63	28.08	30.25
1971	6	50.99	86.33	68.48
1971	7	44.75	44.61	61.34
1971	8	85.22	96.79	98.08
1971	9	57.51	55.56	40.58
1971	10	33.06	26.69	20.90
1971	11	70.90	147.73	126.62
1971	12	127.30	118.83	138.45
1972	1	159.96	195.44	186.20
1972	2	99.56	69.70	86.42
1972	3	111.34	126.42	124.30
1972	4	83.05	78.03	96.29
1972	5	72.07	77.44	68.54
1972	6	115.24	78.86	49.79
1972	7	31.55	26.47	52.22
1972	8	40.59	32.89	109.34
1972	9	63.81	38.14	83.04
1972	10	178.52	191.19	75.66
1972	11	33.28	149.44	166.62
1972	12	123.97	156.12	155.59
1973	1	110.99	163.12	153.12
1973	2	137.67	118.25	88.85
1973	3	63.33	177.90	159.22
1973	4	72.97	78.89	63.54
1973	5	43.82	79.33	117.33
1973	6	77.24	43.96	75.67
1973	7	22.74	22.74	27.06
1973	8	68.38	36.05	40.01
1973	9	27.69	29.06	33.16
1973	10	44.56	46.07	34.53
1973	11	51.52	30.49	17.87
1973	12	9.90	200.61	81.36

YEAR	MONTH	TENDAY VOLUMES		
1974	1	52.53	193.08	190.82
1974	2	107.48	129.62	123.06
1974	3	75.13	75.90	97.89
1974	4	60.30	50.97	57.30
1974	5	80.41	95.46	85.60
1974	6	26.78	23.64	22.39
1974	7	12.82	30.47	41.11
1974	8	43.33	26.50	75.83
1974	9	118.31	90.91	67.73
1974	10	64.68	73.06	228.69
1974	11	88.05	98.85	89.57
1974	12	124.74	106.80	2.16
1975	1	3.63	285.74	178.35
1975	2	159.69	236.53	265.77
1975	3	117.12	81.72	63.28
1975	4	85.37	99.00	69.01
1975	5	16.71	33.89	35.19
1975	6	56.89	33.56	33.74
1975	7	36.55	20.53	50.29
1975	8	88.29	58.82	28.96
1975	9	53.34	42.52	16.27
1975	10	23.57	81.66	58.78
1975	11	33.62	106.42	203.75
1975	12	108.69	145.57	221.28
1976	1	182.61	165.22	245.61
1976	2	256.10	341.98	241.40
1976	3	108.65	96.56	72.44
1976	4	16.39	27.89	67.71
1976	5	16.32	7.78	7.08
1976	6	7.63	5.79	32.63
1976	7	48.39	21.26	88.54
1976	8	26.21	92.45	104.23
1976	9	24.23	12.42	134.15
1976	10	25.99	18.13	50.55
1976	11	31.77	12.50	6.60
1976	12	88.72	106.37	182.87
1977	1	167.21	78.89	436.51
1977	2	66.27	198.45	49.07
1977	3	98.39	59.01	33.84
1977	4	111.10	100.90	293.97
1977	5	107.64	50.53	35.40
1977	6	14.14	43.41	19.96
1977	7	12.42	22.56	50.19
1977	8	86.48	33.82	30.17
1977	9	11.43	5.85	18.10
1977	10	11.36	247.10	34.55
1977	11	33.91	66.66	18.29
1977	12	45.55	33.46	203.38
1978	1	376.82	152.93	271.61
1978	2	96.22	35.82	105.71
1978	3	65.58	32.24	38.55
1978	4	105.07	113.16	166.39
1978	5	119.05	34.56	30.17
1978	6	17.88	18.22	11.02
1978	7	10.72	2.66	28.57
1978	8	4.89	0.77	1.21
1978	9	7.96	10.28	0.09
1978	10	2.18	30.74	93.28
1978	11	53.18	120.08	315.47
1978	12	196.65	297.70	379.28
1979	1	159.16	142.89	195.72
1979	2	169.13	122.72	36.54
1979	3	232.74	139.46	45.63
1979	4	162.96	168.40	70.96
1979	5	42.78	16.75	13.38
1979	6	11.21	19.66	65.48
1979	7	24.82	45.39	45.25
1979	8	43.13	15.86	9.73
1979	9	8.15	3.89	7.37
1979	10	5.30	48.57	152.33
1979	11	139.65	141.85	63.47
1979	12	145.85	114.79	278.85
1980	1	209.50	37.55	34.91
1980	2	104.09	360.85	106.44
1980	3	19.57	16.08	18.15
1980	4	86.79	18.84	35.48
1980	5	77.78	49.22	205.23
1980	6	119.80	34.80	29.60
1980	7	19.81	22.28	87.37
1980	8	59.37	59.37	59.37

Table AI8 contd.

YEAR	MONTH	TENDAY VOLUMES		
1980	9	28.08	18.57	7.38
1980	10	1.50	0.78	5.06
1980	11	26.01	36.49	74.38
1980	12	28.67	42.90	138.13
1981	1	73.22	89.91	98.73
1981	2	411.26	28.28	38.76
1981	3	22.83	52.52	211.68
1981	4	64.16	24.81	9.36
1981	5	148.85	123.14	54.79
1981	6	43.31	25.30	18.20
1981	7	35.63	20.55	40.16
1981	8	64.48	19.13	8.12
1981	9	5.68	12.62	35.93
1981	10	63.78	64.90	41.74
1981	11	111.02	100.62	98.89
1981	12	151.84	151.84	151.84
1982	1	146.11	140.40	43.03
1982	2	16.58	17.07	7.04
1982	3	70.59	33.69	127.15
1982	4	56.17	77.50	106.61
1982	5	44.01	39.85	36.99
1982	6	30.31	32.06	36.15
1982	7	84.47	57.39	12.33
1982	8	10.94	10.28	29.42
1982	9	23.22	192.11	91.42
1982	10	141.74	172.79	117.87
1982	11	29.01	71.87	346.12
1982	12	109.72	200.38	188.91
1983	1	422.04	367.12	201.53
1983	2	87.01	59.46	23.43
1983	3	19.85	354.77	50.30
1983	4	25.63	76.41	71.35
1983	5	109.48	26.60	48.53
1983	6	75.30	33.46	25.33
1983	7	75.16	117.40	52.41
1983	8	88.32	66.43	238.25
1983	9	324.37	369.35	148.04
1983	10	212.23	46.52	29.32

YEAR	MONTH	TENDAY VOLUMES		
1983	11	18.79	48.77	72.84
1983	12	143.59	209.96	86.31
1984	1	432.58	269.80	67.72
1984	2	239.70	189.68	116.26
1984	3	101.59	74.89	21.46
1984	4	17.15	13.60	18.54
1984	5	17.88	7.50	4.17
1984	6	16.67	25.55	42.29
1984	7	9.67	0.55	56.20
1984	8	36.19	15.52	51.12
1984	9	60.32	32.16	90.52
1984	10	34.98	126.94	285.27
1984	11	70.29	188.77	177.48
1984	12	44.56	67.41	339.38
1985	1	177.03	42.05	177.75
1985	2	163.47	35.38	12.78
1985	3	52.88	339.71	114.18
1985	4	48.73	20.56	140.26
1985	5	184.99	52.53	36.97
1985	6	16.92	17.95	8.86
1985	7	24.26	20.27	46.65
1985	8	15.95	24.54	587.62
1985	9	273.88	56.19	14.69
1985	10	32.83	300.42	93.05
1985	11	84.82	74.19	39.92
1985	12	118.40	217.35	157.20
1986	1	47.55	76.44	264.99
1986	2	40.57	24.57	86.72
1986	3	232.47	79.88	32.61
1986	4	71.63	84.42	158.74
1986	5	128.45	61.77	29.75
1986	6	135.19	144.66	141.81
1986	7	168.17	77.70	48.98
1986	8	70.38	24.66	12.04
1986	9	8.59	6.23	6.73
1986	10	29.53	84.90	83.10
1986	11	17.42	30.86	108.02
1986	12	178.25	174.29	320.60

Table AI9

Baie Lazare

YEAR	MONTH	TENDAY VOLUMES		
1967	5	68.64	31.15	89.47
1967	6	45.88	37.49	39.07
1967	7	38.6	28.93	15.79
1967	8	17.17	32.8	89.25
1967	9	40.97	29.85	27.99
1967	10	37.68	40.41	44
1967	11	37.85	89.41	90.99
1967	12	174.41	179.41	122.3
1968	1	86.77	77.89	157.9
1968	2	116.32	94.33	81.99
1968	3	143.79	122.91	168.66
1968	4	33.61	17.7	6.95
1968	5	82.55	61.38	85.46
1968	6	32.43	34.63	15.97
1968	7	30.92	54.93	19.73
1968	8	33.21	33.81	42.64
1968	9	41.39	45.11	38.01
1968	10	55.46	59.71	53.6
1968	11	50.01	55.44	49.97
1968	12	94.95	107.9	106.65
1969	1	102.8	134.15	197.48
1969	2	39.65	35.8	29.57
1969	3	97.77	108.4	60.41
1969	4	58.79	33.22	46.21
1969	5	35.73	33.93	20.72
1969	6	23.21	27.57	27.26
1969	7	17.04	16.98	17.31
1969	8	15.88	14.12	20.9
1969	9	35.75	22.23	19.77
1969	10	3.44	31.02	51.15
1969	11	67.06	49.68	57.02
1969	12	82.2	97.91	88.82
1970	1	54.39	55.11	74.98
1970	2	51.45	53.5	41.12
1970	3	77.3	50.49	48.49
1970	4	29.84	38.01	34.1
1970	5	45.84	48.68	53.7
1970	6	31.9	31.33	29.72
1970	7	28.38	28.09	29.35
1970	8	28.86	28.58	29.52
1970	9	23.3	13.08	5.75
1970	10	36.59	17.77	86.36
1970	11	64.19	54	54.51
1970	12	91.14	94.04	86.9
1971	1	122.34	90.21	94
1971	2	64.78	77.39	55.85
1971	3	56.67	48.48	51.94
1971	4	59.58	81.02	60.91
1971	5	34.82	17.55	5.86
1971	6	9.8	101.1	12.29
1971	7	29.52	31.88	31.15
1971	8	35.67	32.67	96.14
1971	9	41.11	32.37	20.71
1971	10	15.61	25.37	12.63
1971	11	24.59	99.62	76.5
1971	12	117.16	42.41	63.01
1972	1	101.35	98.35	110.18
1972	2	51.76	34.67	64.48
1972	3	74.03	78.92	57.11
1972	4	47.2	44.18	60.48
1972	5	37.22	45.81	46.97
1972	6	64.34	50.28	29.74
1972	7	26.97	20.52	22.56
1972	8	4.71	3.36	102.34
1972	9	37.98	43.1	30.54
1972	10	99.75	86.69	69.94
1972	11	47.76	51.49	103.74
1972	12	118.97	55.78	76.24
1973	1	76.05	83.69	86.56
1973	2	82.71	63.4	54.35
1973	3	57.94	73.72	99.73
1973	4	52.5	42.11	33.91
1973	5	50	42.18	50.28
1973	6	35.22	43.61	39.39
1973	7	23.05	15.74	10.31
1973	8	24.04	24.04	24.04
1973	9	20.79	18.7	19.26
1973	10	36.97	21.06	20.32
1973	11	22.96	19.48	21.86
1973	12	39.76	69	62.28

YEAR	MONTH	TENDAY VOLUMES		
1974	1	97	68.24	86.17
1974	2	90.29	63.7	55.01
1974	3	46.76	45.79	54.61
1974	4	41.51	36.72	24.25
1974	5	77.5	40.49	36.14
1974	6	16.91	15.68	16.66
1974	7	18.56	18.56	18.56
1974	8	32.79	36.9	20.07
1974	9	38.76	59.29	64.7
1974	10	30.54	68.34	113.61
1974	11	31.77	61.4	69.3
1974	12	90.03	76.94	90.63
1975	1	126.06	164.32	177.96
1975	2	154.4	108.72	113.69
1975	3	66.79	43.57	44.14
1975	4	49.79	56.47	43.38
1975	5	27.9	20.44	8.13
1975	6	38.46	29.38	9.97
1975	7	23.45	19.13	25.88
1975	8	67.98	25.7	12.99
1975	9	20.49	24.59	26.02
1975	10	27.72	20.3	51.93
1975	11	30.92	57.04	111.94
1975	12	43.91	154.81	74.44
1976	1	70.69	115.55	152.45
1976	2	120.93	163.94	190.62
1976	3	61.99	55.9	45.24
1976	4	38.32	35.67	53.16
1976	5	16.87	16.87	16.87
1976	6	21.3	21.3	21.3
1976	7	33.66	26.04	24.18
1976	8	29.82	38.77	53.57
1976	9	36	26.85	75.72
1976	10	29.86	31.03	36.34
1976	11	23.7	19.33	12.73
1976	12	47.99	118.63	199.56
1977	1	45.45	46.75	140.97
1977	2	89.46	170.57	49.9
1977	3	67.63	52.15	39.36
1977	4	56.87	64.13	96.75
1977	5	67.89	38.26	22.78
1977	6	24.57	22.79	13.25
1977	7	29.6	21.41	21.24
1977	8	11.491	12.727	12.606
1977	9	6.895	4.484	4.441
1977	10	2.903	210.341	70.114
1977	11	31.32	52.894	37.705
1977	12	76.758	55.875	119.249
1978	1	118.774	102.79	86.141
1978	2	74.701	60.057	51.667
1978	3	70.174	37.593	34.48
1978	4	72.95	75.06	74.59
1978	5	39.84	34.5	36.6
1978	6	31.717	25.86	24.89
1978	7	15.943	15.943	15.943
1978	8	9.323	7.016	6.281
1978	9	3.845	10.549	4.095
1978	10	3.923	20.442	20.477
1978	11	19.52	64.91	203.15
1978	12	182.39	225.072	107.058
1979	1	92.318	264.963	179.366
1979	2	110.851	73.647	39.848
1979	3	87.117	108.631	66.2
1979	4	71.98	89.243	55.745
1979	5	38.172	26.654	22.654
1979	6	17.764	16.07	16.788
1979	7	12.122	12.252	18.135
1979	8	11.197	8.614	7.767
1979	9	4.778	3.923	3.11
1979	10	2.281	6.394	21.954
1979	11	29.799	59.97	44.807
1979	12	48.825	35.7	58.285
1980	1	64.022	28.754	15.863
1980	2	17.159	74.356	37.705
1980	3	13.098	10.333	15.371
1980	4	68.083	22.3	62.91
1980	5	68.15	70.75	74.64
1980	6	70.114	49.231	33.575
1980	7	24.209	19.354	39.131
1980	8	18.688	12.424	17.531

Table AI9 contd.

YEAR	MONTH	TENDAY VOLUMES		
1980	9	13.522	7.819	5.296
1980	10	3.707	2.886	3.11
1980	11	8.528	22.36	24.278
1980	12	14.74	23.406	61.94
1981	1	67.66	45.835	41.826
1981	2	36.279	15.794	14.299
1981	3	42.405	31.121	168.368
1981	4	68.247	36.668	23.449
1981	5	40.375	74.736	35.191
1981	6	30.43	20.676	15.042
1981	7	13.003	9.91	41.38
1981	8	9.927	7.845	6.817
1981	9	4.501	2.955	3.033
1981	10	6.273	11.673	7.69
1981	11	8.942	138.033	39.182
1981	12	59.357	191.151	244.331
1982	1	187.402	125.271	63.608
1982	2	34.18	24.451	13.668
1982	3	29.048	17.168	28.408
1982	4	18.032	62.899	37.489
1982	5	24.373	18.999	20.252
1982	6	9.798	9.34	8.709
1982	7	35.83	25.548	12.018
1982	8	8.001	14.394	11.362
1982	9	8.562	71.62	33.94
1982	10	107.48	72.16	70.67
1982	11	71.271	33.08	158.63
1982	12	106.825	126.576	134.101
1983	1	176.33	145.24	69.95
1983	2	78.149	51.797	27.233
1983	3	26.343	70.874	31.501
1983	4	23.553	73.993	35.977
1983	5	103.611	48.522	35.7
1983	6	27.596	18.265	17.738
1983	7	16.632	37.074	27.43
1983	8	33.713	17.608	54.112
1983	9	89.25	82.53	40.19
1983	10	176.757	75.41	53.058

YEAR	MONTH	TENDAY VOLUMES		
1983	11	32.288	39.39	33.601
1983	12	35.355	71.064	131.985
1984	1	123.742	163.123	92.215
1984	2	104.916	78.46	56.428
1984	3	55.14	43.537	44.971
1984	4	41.55	27.976	29.687
1984	5	17.055	12.26	9.141
1984	6	9.815	10.653	9.374
1984	7	6.048	5.478	4.095
1984	8	6.022	6	47.61
1984	9	7.569	8.268	19.682
1984	10	20.045	75.436	118.662
1984	11	51.036	77.069	76.438
1984	12	36.184	34.387	243.579
1985	1	43.29	20.77	103.35
1985	2	88.042	40.418	27.933
1985	3	53.266	192.66	36.64
1985	4	78.581	44.081	35.21
1985	5	72.99	23.43	21.45
1985	6	31.683	23.795	18.887
1985	7	17.859	14.714	16.502
1985	8	10.619	9.037	79.834
1985	9	191.324	49.343	29.056
1985	10	18.939	222.929	62.787
1985	11	62.398	110.704	45.714
1985	12	49.404	127.276	100.492
1986	1	54.268	51.218	129.972
1986	2	44.807	28.417	44.392
1986	3	135.501	46.613	18.89
1986	4	64.394	108.173	66.891
1986	5	45.44	23.74	21.06
1986	6	68.74	45.33	45.18
1986	7	63.979	33.471	29.817
1986	8	27.89	17.738	13.09
1986	9	10.29	7.059	5.772
1986	10	4.89	12.537	12.433
1986	11	7.18	22.594	25.082
1986	12	48.28	42.872	201.424

APPENDIX II

STORAGE-YIELD DESIGN PROCEDURES

The large number of available reservoir yield design procedures can be broadly classified into three groups. The first group, "critical period techniques", analyses events when the demand cannot be met by the inflows to the reservoir. The second is based on probability matrix methods and the third depends on the generation of sequences of stochastic flows.

There has been much discussion concerning the choice of reservoir yield design methods. For this study we decided to use two methods to compare the different results. This will provide more information on which to base the final solution and may also indicate the variability of results. Also it will show there is no unique solution for data that does not fully describe the population statistics. The critical period techniques include many methods such as Stall, Rippl etc. and from there we have chosen to use the Deficient Volumes method (Parks and Gustard, 1982) as it is particularly concerned with the drawdown of reservoir capacity during low inflow sequences.

The most flexible of the matrix methods is the Gould procedure (McMahon and Mein, 1978). This incorporates a monthly water balance and a surface area related evaporation. We have adopted this method as our second storage-yield analysis technique.

The procedures requiring stochastic flow generation seem in appropriate for this study as the 12 years of patchy measured flows would not be sufficient to calibrate a generation model. The longer synthetic series could be used as a basis for generation but the data would have been generated through the use of two models and would have all the inherent errors that this implies. We have therefore not chosen a method for this category.

The following sections describe each of the methods in detail.

(i) Method A: Deficient Volumes

This method is based on reservoir simulation using monthly inflows, demands and evaporation. An initial reservoir capacity and yield are chosen within the likely range of interest. A monthly water balance is carried out to obtain the draught on reservoir storage required to meet the selected demand. Figure AII1 describes a typical summation of these draughts showing both the cases of spill and failure. The annual maximum draught is extracted from the monthly reservoir simulation and in the case of Figure AII1 these are S1, S2, S3 and S4. S1, S2 and S3 are typical examples of the deficient volumes that the reservoir must supply from storage in order to meet the demand. S4 must be discarded as the reservoir has failed and the yield has not been met.

The non-failure deficient volumes from each year are ranked and plotted. As they are an annual maximum series the most applicable distribution is likely to be that of the log normal. Blom's plotting position was used where the non-exceedence probability (Fi) of the i^{th} smallest storage is given by:

$$Fi = \frac{i - 0.375}{n + 0.25}$$

Typical summation of monthly draught on reservoir storage

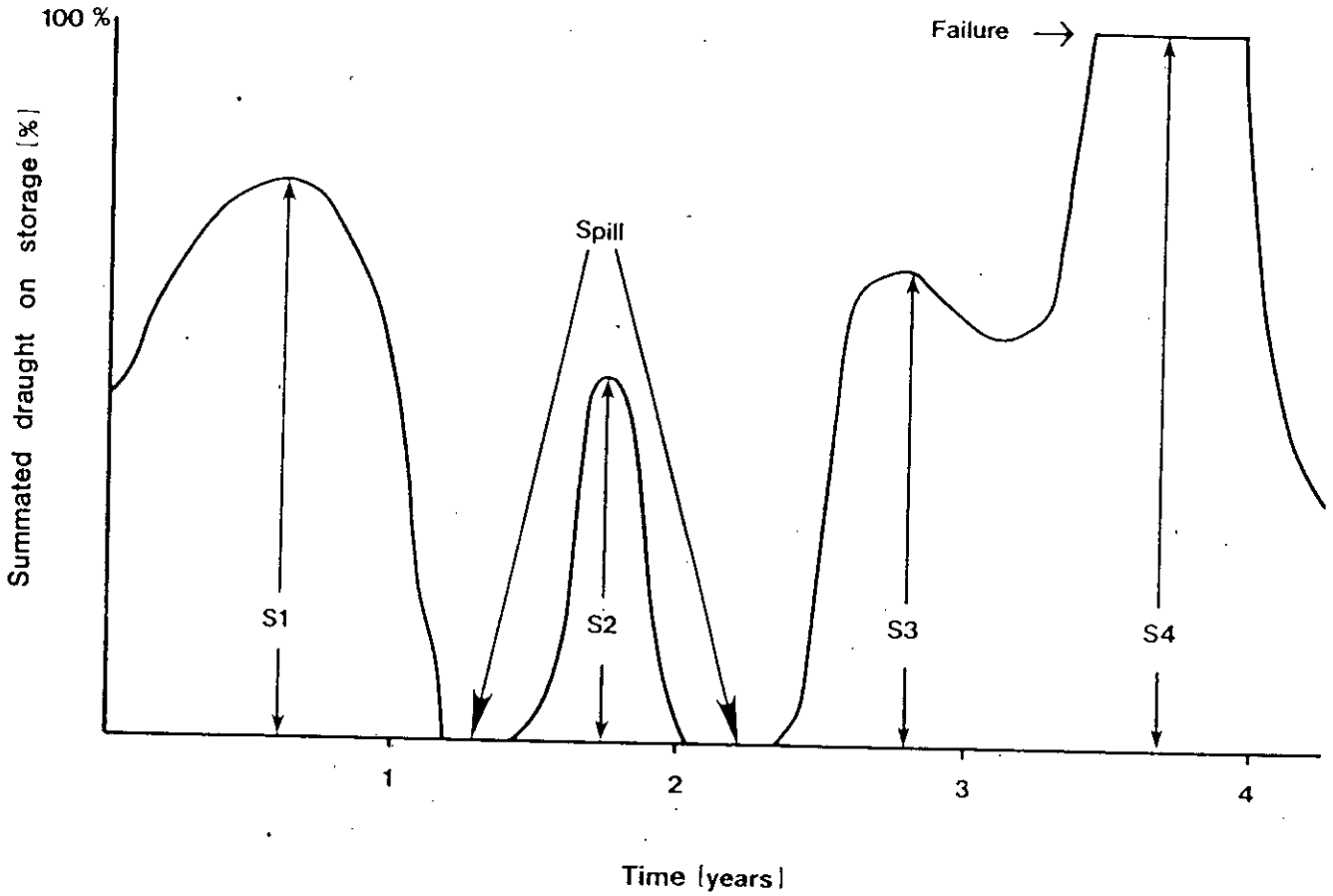

Figure AII 1

where n = total number of years of data available.

The results of plotting three ranked series of deficient volumes is shown in Figure AII2 for three different sized reservoirs. All values to the left of the true storage probability line are failures and not included in the analysis.

Considering the smallest reservoir capacity, the ranked deficient volumes increase as the probability of failure increases until a plateau is reached where failures occur and the storage required is equal to the capacity of the reservoir. The selected demand will be provided by this reservoir capacity with a probability of failure, P_1, determined from the intersection of the curve and plateau. Thus the probability of failure is determined from the distribution of the non-failures. The practical solution is found by extending the distribution of non-failures and using the point at which it crosses the horizontal line representing the capacity of the reservoir.

This method could be used to determine the reservoir capacity just capable of sustaining any yield for any specified probability of failure by successive simulation trials, but this iterative approach would be very time consuming. We have avoided this by simulating the behaviour of successively larger reservoir capacities and noting the probabilities of failure at the points of inflection on Figure AII1. If a line of best fit is drawn through these points of inflection, the reservoir capacity, A1, necessary to sustain the chosen yield with any required probability of failure, may be determined.

The process is repeated for a range of demands, and a series of storage-probability curves are produced. These curves define the reservoir capacities necessary to sustain the range of demands with the corresponding return periods of failure.

It is important to select realistic starting contents of the reservoir for the simulation trials. The choice of appropriate starting contents is only significant during early years of the simulation until the reservoir spills for the first time; subsequently reservoir contents are then independent of the starting condition. It is unrealistic to start the simulation with the reservoir empty since we are looking for the long term yield that can be sustained by any reservoir capacity with a specified risk of failure. We determined the initial reservoir contents by running the simulation program with some arbitrary starting contents, say one third of the total capacity, and determined the mean end of year contents from this trial simulation. This mean was subsequently used as the initial contents for the final reservoir simulation trial for that yield and reservoir capacity combination. Trials with a range of initial starting contents showed this procedure to be very robust and we suggest that these objectively determined initial contents provide a sound basis for subsequent yield estimation.

From this information we can carry out trials to determine the yield available for any capacity of reservoir and a certain return period of failure.

(ii) Method B: Gould

The Gould method requires that the reservoir is divided into several (N) states of equal storage. Each year of the inflow data is treated separately and is routed through the reservoir, on a monthly basis, starting the reservoir in each of the N states and noting the state in what it finishes. When this procedure has been repeated for each year of data the results are collated in a transition matrix. This expresses the probability of ending in any of the N states, conditional on the starting state.

Explanation of deficient volume analysis

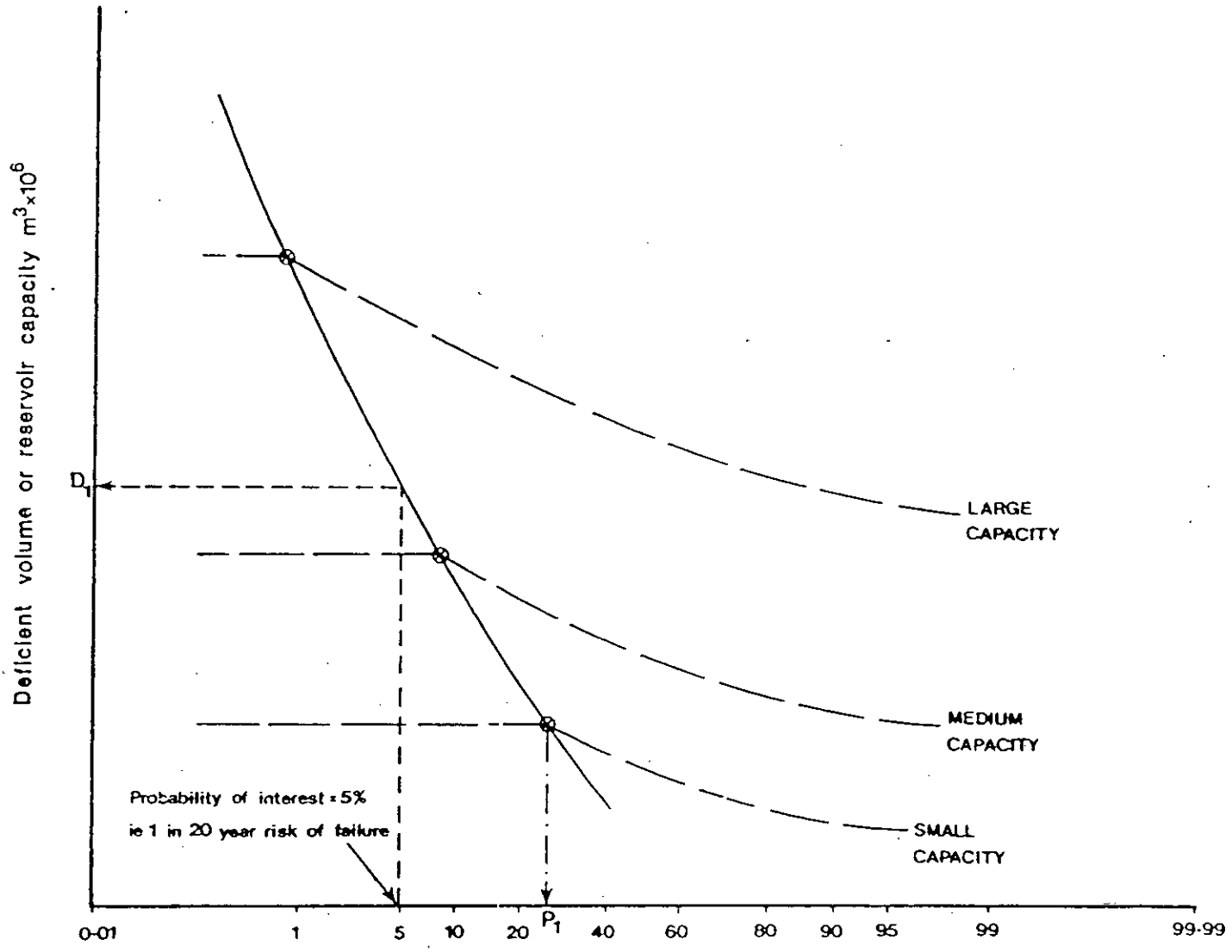

Figure AII 2

At the same time, the number of occasions in which the reservoir fails or spills is counted and noted with its corresponding starting date. Thus we can determine the probability of spilling, failing and ending in any particular state, conditional on the starting date. We need only determine the probability of being in each of the states at the start of a year, and then the joint probability of this and of failing will determine the steady state likelihood of failure.

The probability of being in any state at the start of a year is the same as being in any state at the end of the year and can be determined from the transition matrix and starting conditions of the reservoir. If the transition matrix, T, is multiplied by the initial vector of probabilities of starting contents, P, we will arrive at the vector of probabilities of starting contents at the second year.

That is:

$$|P|_2 = |T| \times |P|_1 .$$

This process can be continued according to the scheme

$$|P|_{t+1} = |T| \times |P|_t .$$

However, with time, the vector P_t reaches a steady state as the effect of the initial conditions at the beginning of the first year become negligible. Conceptually this is explained as follows. A reservoir's starting condition becomes less relevant to its state at any time t as t increases. The likely reservoir state at time t relates progressively more to the characteristics of the river flow sequence. Eventually the likelihood of starting a year in any state is totally dependent on the nature of the inflows and withdrawals. This is then the steady state situation.

Once the vector P_t reaches a steady state this describes the likelihood of being in any of the N states and this occurs when

$$|P|_{t+1} = |P|_t$$

We are now in a position to determine the probability of failure which is the sum of the products of the probability of the reservoir being in each particular zone and the probability of failure for starting in that zone.

This procedure is carried out, for each reservoir capacity, varying the demand, until the desired probability of failure is reached.

We can now produce results, from the same initial assumptions of reservoir size and return period of failure, for comparison with the deficient volume results.

For further information concerning matrix methods the reader is referred to McMahon and Mein (1978).

APPENDIX III

FLOW DURATION CURVES

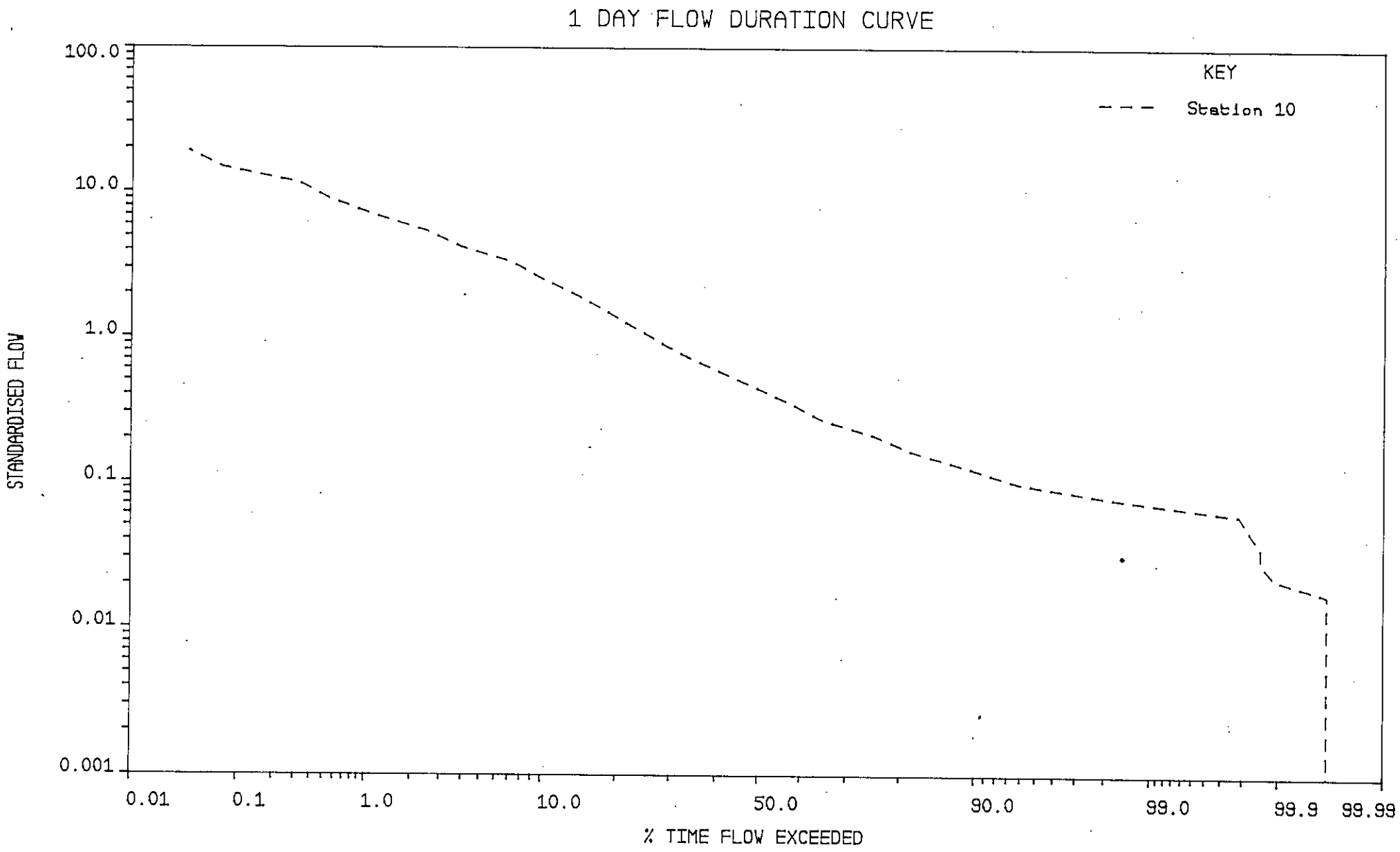

Figure AIII 1

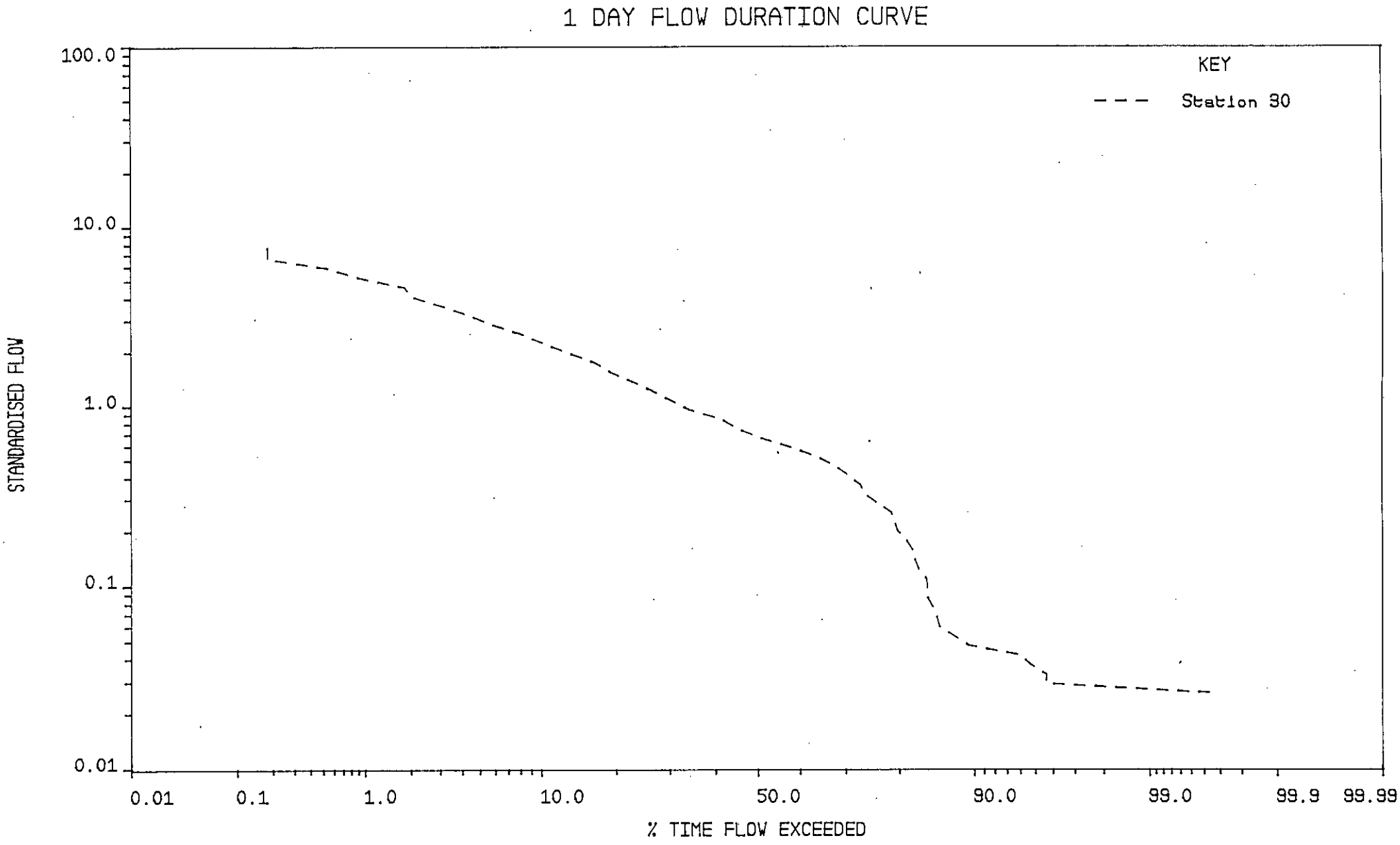

Figure AIII 2

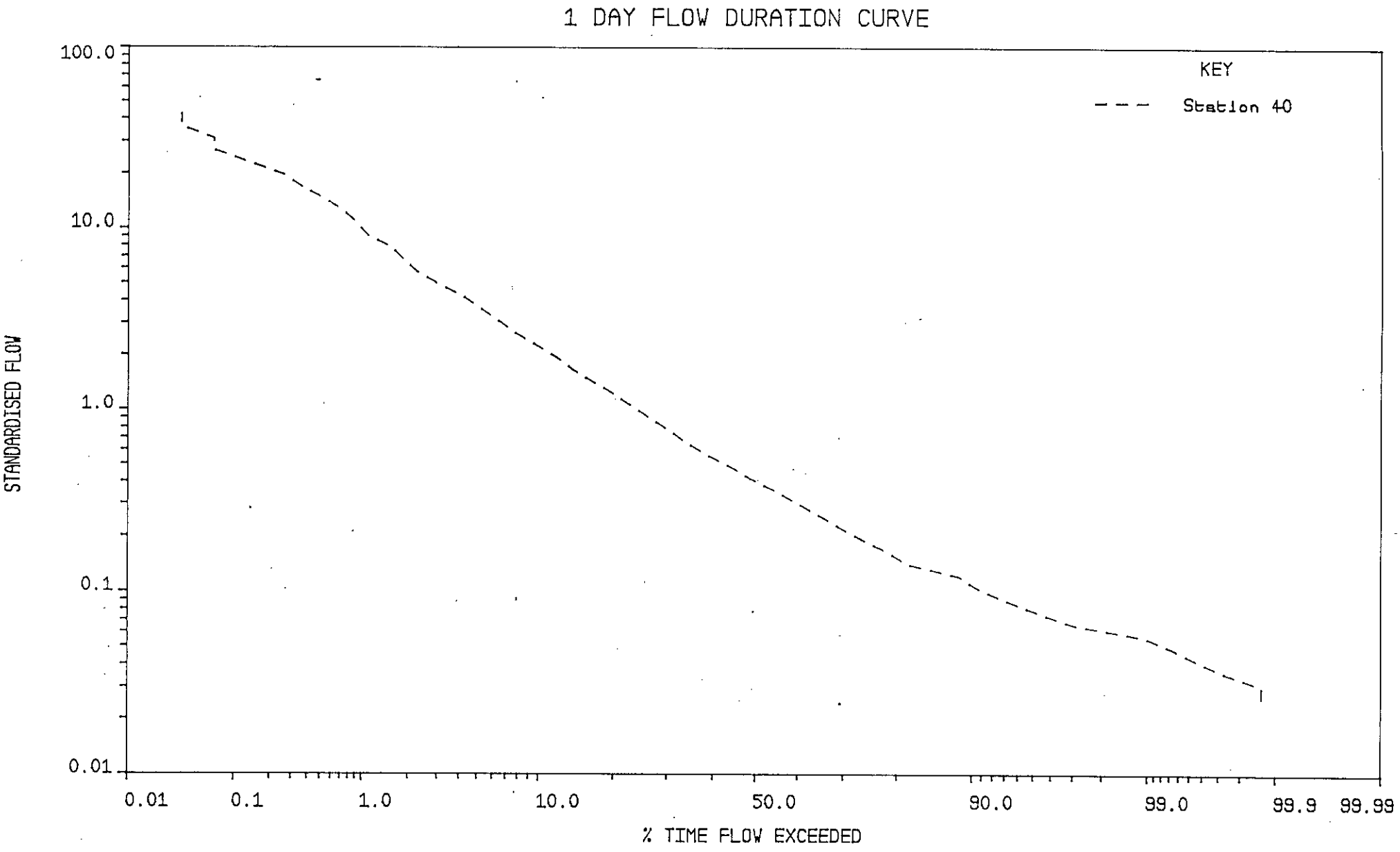

Figure AIII 3

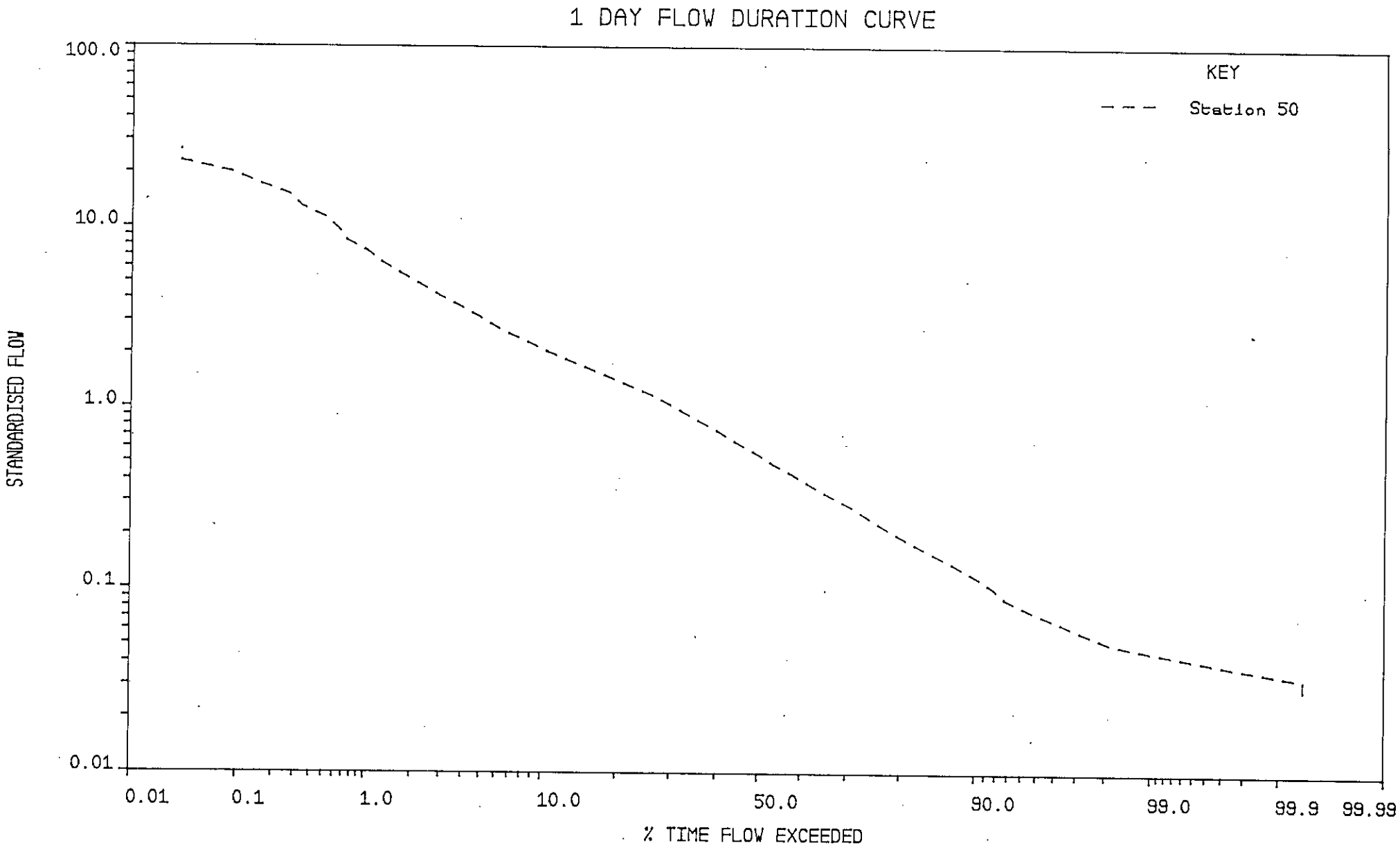

Figure AIII 4

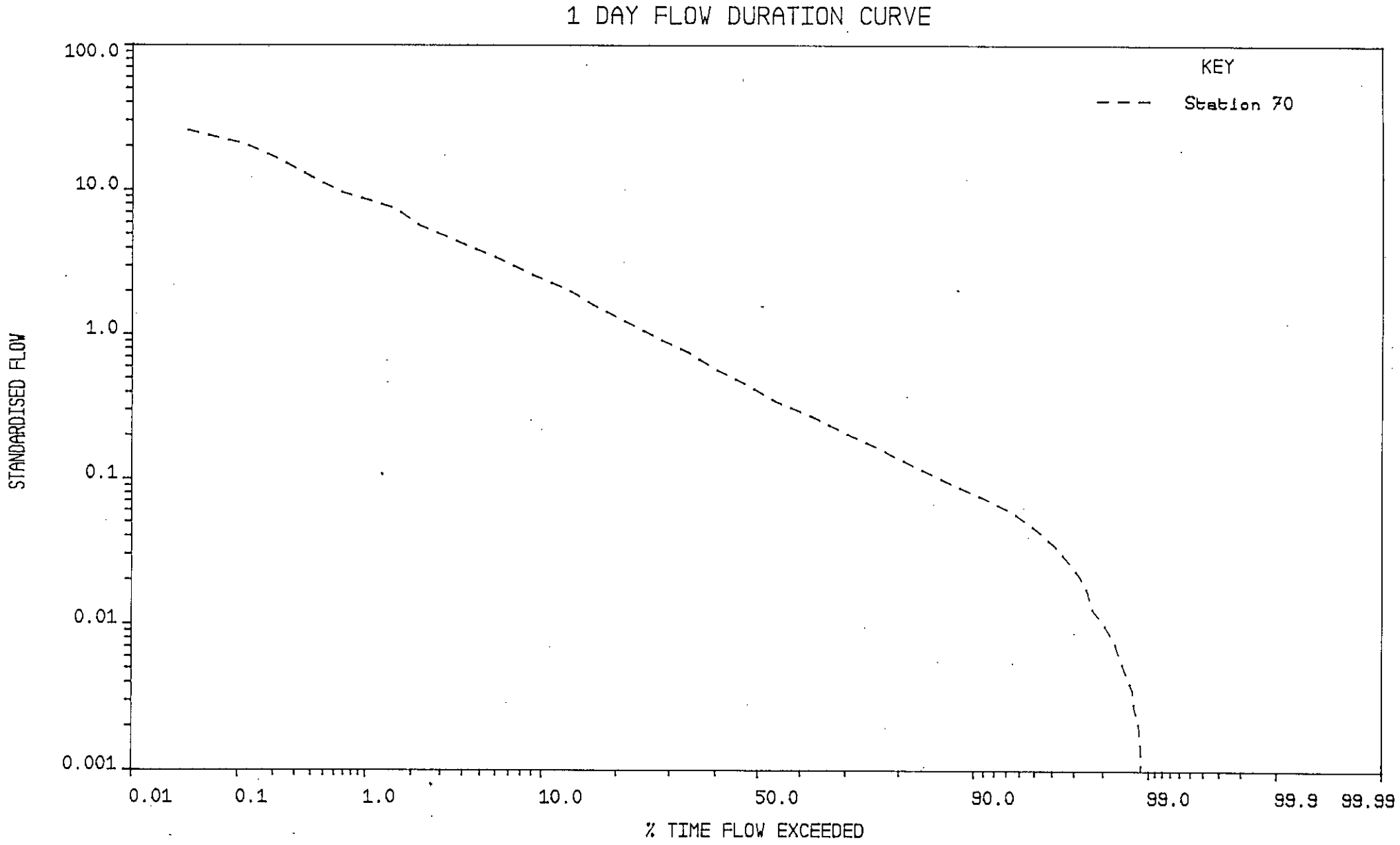

Figure AIII 5

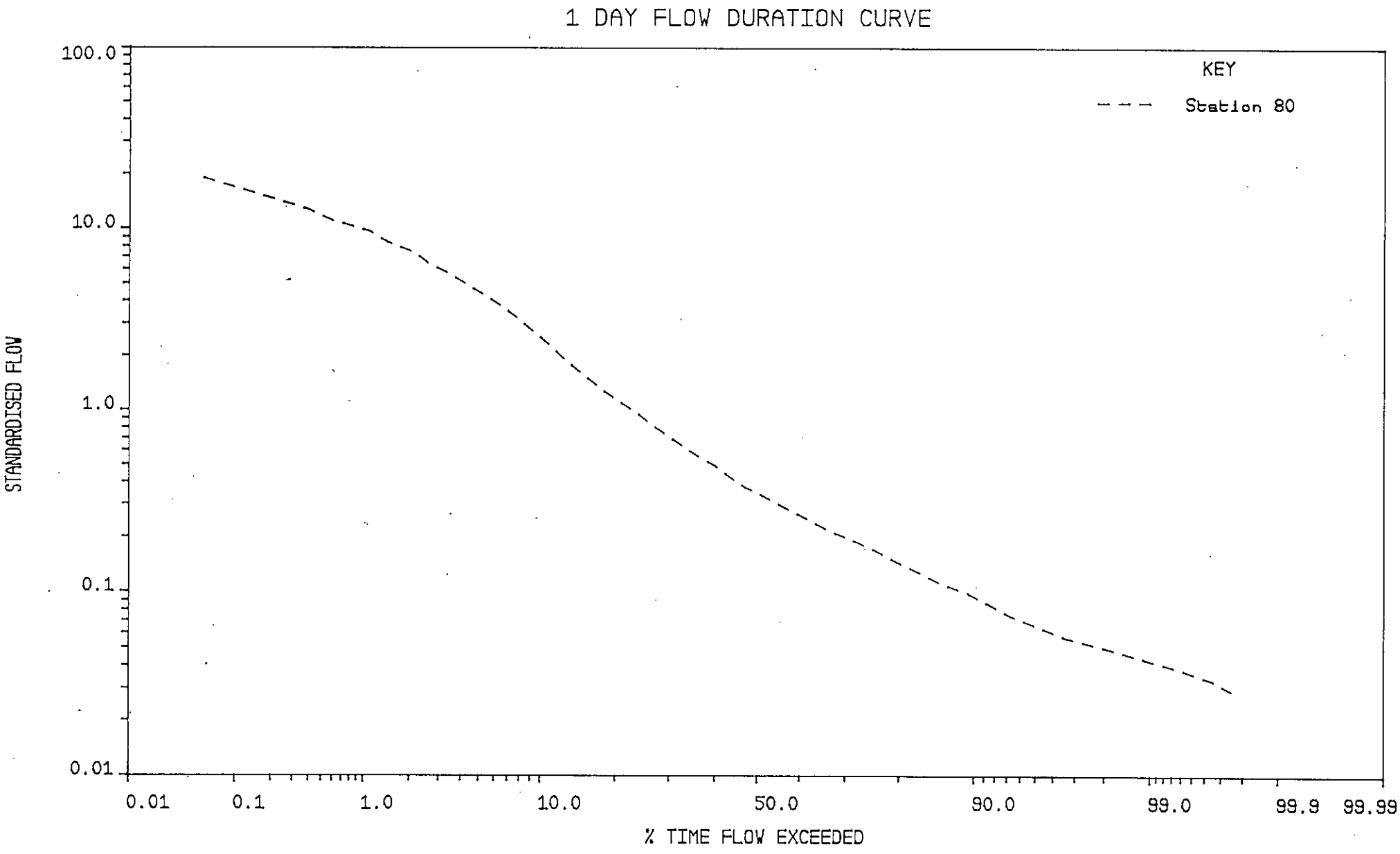

Figure AIII 6

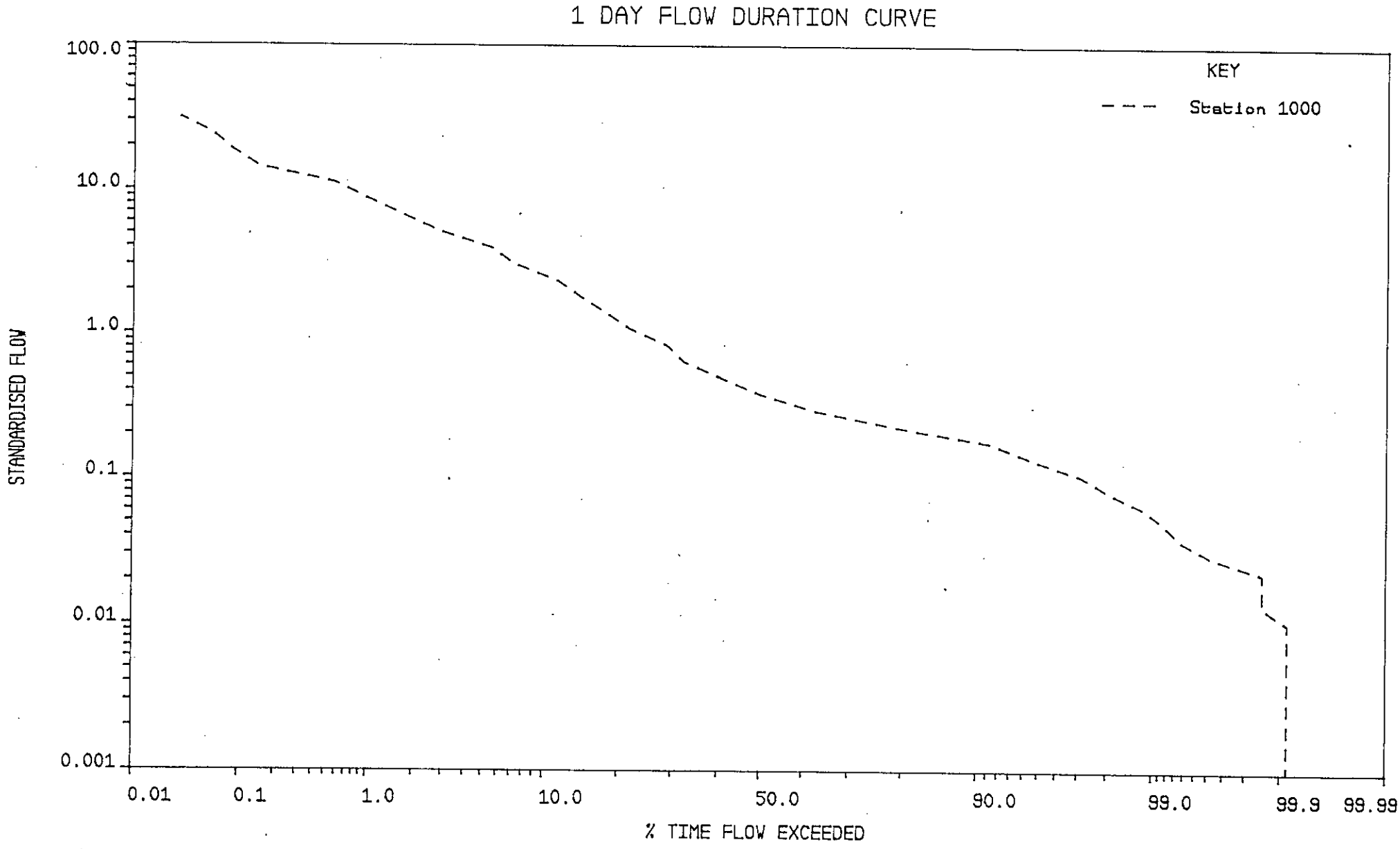

Figure AIII 7

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