



**BASIC PHYSICAL GEOGRAPHY/HYDRO
DATA FOR "ESTUARIES" OF THE
SOUTHERN CAPE (CMS 0-50)**

SEDIMENT DYNAMICS DIVISION
COASTAL ENGINEERING AND HYDRAULICS
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY
COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH

NRIO DATA REPORT D8706

Stellenbosch, South Africa
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Key Words

Estuaries
Physical Geography
Sediment
Simulated Run-off

FOREWORD

Basic physical geography, simulated run-off and sediment yield data provide an important background for the CSIR's Hydrological/Hydraulic Study of the Cape Estuaries.

It has become evident that these data, which in many cases have been difficult and/or time-consuming to obtain and process, would be useful to other scientists. In this report these data are therefore presented in concise, tabular form with brief explanatory notes as to their origin and/or derivation. The work described was done by J. Crowther.

This report on the estuaries of the Southern Cape is the third in a series planned for the various groups of Cape estuaries and follows the format used for a similar Data Report on Natal's estuaries.

J.E. Perry

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ABBREVIATIONS USED

DWA	Department of Water Affairs
HRU	Hydrological Research Unit
MAP	Mean Annual Precipitation
MAR	Mean Annual Run-off
NRIO	National Research Institute for Oceanology

BRIEF NOTES

1. Introduction

This report covers the 51 estuaries of the southern Cape located between Mossel Bay and Port Elizabeth. The term "estuary" is not strictly correct but is used for convenience to cover the range of estuaries, lagoons, river mouths and combinations of these found along this coast.

2. Locality: Table I and Figure 1

This table gives a list of the estuaries with reference numbers CMS (Cape Middle South) 0-50. Their localities are shown in Figure 1. The reference numbers form part of an index system for estuaries around the coast of South Africa, from the Orange River to Kosi Bay, which was drawn up by J.E. Perry in 1978 for use within the NRIO. In several cases, a river may be known by various names with a multiplicity of spellings. Therefore, for ease of reference and consistency, it was decided to adopt the name and spelling for each of the rivers as printed in blue, nearest the mouth, on the 1:50 000 series of topographical maps available at the time.

The latitudes and longitudes given are the positions of the river mouths. They are part of a list drawn up for the whole South African coast by M. van Niekerk and J.E. Perry (NRIO) in 1978, using 1:50 000 topographical maps. Similarly, a list of distance intervals between estuaries and harbour sites was compiled by M. van Niekerk. The coastal distance intervals in Table 1 were taken from this list.

3. Basic Physical Geography Data: Table II

River lengths were measured from 1:50 000 series of topographical maps using a flat-bed digitizer. These maps were also used to estimate the elevation of the sources of the rivers.

Catchment areas are based upon tertiary and quaternary catchment data in Volumes IV and V of Surface Water Resources of South Africa (Pitman et al., 1981; Middleton et al., 1981). This basis was used to tie in with our source of run-off data (see Section 4, below). Several of the estuary catchments form only part of the afore-mentioned tertiary and quaternary catchments. In these cases, areas were measured from 1:50 000 maps using a flat-bed digitizer. Weighted averaging was used to ensure that totals agreed with the relevant basic tertiary and quaternary catchment areas.

4. Simulated Run-off Data

4.1 Background

At present there is a paucity of actual relevant discharge and run-off data available from DWA. Simulated monthly run-off data for the period 1921-1976 and 1921-1979 became available for all CMS tertiary catchments in 1982 (Middleton et al., 1981; Pitman et al., 1981), in HRU Reports No's 12/81 and 13/81, respectively. To obtain much needed hydro data for estuary studies, a method was evolved to derive simulated run-off for each estuary from these report data.

4.2 Modus Operandi

1. Each "estuary" was located in relation to tertiary and quaternary catchments according to HRU Report No's 12/81 and 13/81.
2. In the few cases where the "estuary" is fed by whole tertiary catchment areas (that is, where no other coastal river is involved) the relevant tertiary catchment run-off data were simply summed.
3. In most cases, however, allowance had to be made for smaller coastal catchments which comprise part of the basic tertiary and/or quaternary catchments. In these cases, "estuary sub-catchment" areas were obtained as described in

Section 3 above. Multiplying factors were then derived for use with the simulated monthly run-off data for tertiary catchments to obtain the best estimate of run-off for these "sub-catchments". Sometimes, for lack of any other information, the multiplying factors were directly proportional to the "sub-catchment" areas. Where the quaternary catchment MAR data indicated that run-off is not directly proportional to area, multiplying factors were derived which were based upon this additional hydro information.

4. A table was then drawn up indicating which of the run-off data for tertiary catchments and/or part of these catchments had to be used for each "estuary" and stating how they were to be used (e.g. summed and/or multiplying factors to be applied).
5. Based upon the latter item "4", J Serdyn (NRIO) wrote a computer program which allows the simulated run-off for each "estuary" to be shown in
 - (i) tabular form - giving monthly and annual totals, means, standard deviations, coefficients of variation and median values and
 - (ii) graphical form - giving annual, monthly and cumulative run-off.

An example of each of the above for the Storms River (CMS 32) is given in the appendix.

4.3 Notes for Potential Users

1. HRU Reports No's 12/81 and 13/81, as reprinted in 1985, incorporate corrections as per the Addendum to Surface Water Resources of South Africa (Midgley et al., 1983). The latter contained some important quaternary catchment re-assessments.

2. Copies of individual tables and graphs of simulated run-off from the 51 CMS "estuaries" processed may be obtained from the NRIO.
3. Despite some shortcomings, these simulated data are believed to be the best available assessment of run-off into the "estuaries" and are likely to remain so for many years.
4. NRIO hopes that the invaluable basic tertiary catchment run-off data will be revised and updated to 1986 in the near future.

4.4 Tables III, IV and V

Table III gives a synopsis of the processed simulated MAR (m^3) values for CMS "estuaries" together with average annual and monthly coefficients of variation (%). Median annual run-off (m^3) and median/MAR (%) values are also listed. Table IV gives monthly coefficients of variation.

For some studies, MAR expressed in catchment millimetres is preferred. This is given in Table V together with MAP (mm) and MAR/MAP (%) values. The data source for precipitation is also the HRU Reports No's 12/81 and 13/81.

5. **Sediment Yield: Table VI**

Catchment sediment yields are given in average annual totals (tons) and in average rates ($tons/km^2/yr$).

The basis for these data is a sediment yield map (Rooseboom, 1975). Although this map is being updated, Prof. Rooseboom confirmed in 1987 (pers. communication) that there were no areas in the Cape Middle South affected by the revision. Prof. Rooseboom (pers. communication) has also drawn attention to the fact that the sediment yield data indicate the 'maximum relative values' only.

6. Conclusion

It is hoped that the data in this report will be of practical use to various people involved in studies of the lower reaches of the rivers of the Southern Cape.

REFERENCES

MIDDLETON, B.J., LORENTZ, S.A., PITMAN, W.V. and MIDGLEY, D.C. (1981). Surface water resources of South Africa, Vol. V, The Eastern Cape, Hydrological Research Unit Report No. 12/81.

MIDGLEY, D.C., PITMAN, W.V. and MIDDLETON, B.J. (1983). Addendum to surface water resources of South Africa. Water Research Commission Report.

PITMAN, W.V., POTGIETER, D.J., MIDDLETON, B.J. and MIDGLEY, D.A. (1981). Surface water resources of South Africa, Vol. IV, The Western Cape, Hydrological Research Unit Report No. 13/81.

ROOSEBOOM, A. (1975). Sedimentproduksiekaart vir Suid-Afrika, Technical Report No. 61, Department of Water Affairs.

TABLE I: CAPE MIDDLE SOUTH (CMS) ESTUARIES: LOCALITY

Reference	River	Latitude " S			Longitude " E			Coastal distance (km)	
								Interval	Cumulative
CMS 0a		34	09	05	22	06	40		0
CMS 1	HARTENBOS	34	06	55	22	07	35	4,2	4,2
CMS 2	KLEIN-BRAKRIVIER	34	05	35	22	08	55	3,9	8,1
CMS 3	GROOT-BRAKRIVIER	34	03	25	22	14	25	9,8	17,9
CMS 4	ROOI	34	03	05	22	17	10	4,5	22,4
CMS 5	MAALGATE	34	03	15	22	20	15	6,8	29,2
CMS 6	GWAING	34	03	25	22	25	10	9,6	38,8
CMS 7	SKAAPROP	34	02	25	22	30	00	7,9	46,7
CMS 8	MEUL	34	00	50	22	32	40	5,1	51,8
CMS 9	KAATMANS	34	00	00	22	33	30	2,4	54,2
CMS 10	TOUWS	33	59	45	22	34	55	2,0	56,2
CMS 11	SWARTVLEI	33	59	55	22	47	30	28,0	84,2
CMS 12	GOUKAMMA	34	04	40	22	57	10	15,8	100,0
CMS 13	KNYSNA	34	04	50	23	03	35	15,5	115,5
CMS 14	NOETSIE	34	04	50	23	07	45	9,0	124,5
CMS 15	GROOT EILAND	34	05	10	23	12	35	11,2	135,7
CMS 16	KRANSHOEK	34	05	10	23	13	30	2,5	138,2
CMS 17	CROOKS	34	05	30	23	14	45	4,0	142,2
CMS 18	PIESANG	34	03	35	23	22	45	28,0	170,2
CMS 19	KEURBOOMS	34	02	05	23	23	25	2,2	172,4
CMS 20	MATJIES	34	00	10	23	28	15	8,9	181,3
CMS 21	BRAK	33	59	50	23	31	55	6,7	188,0
CMS 22	SOUT	33	59	20	23	32	15	1,2	189,2
CMS 23	GROOT (WEST)	33	58	55	23	34	15	3,3	192,5
CMS 24	HELPEKAARS	33	58	50	23	36	00	3,0	195,5
CMS 25	KLIP	33	58	45	23	37	00	1,8	197,3
CMS 26	BLOUKRANS	33	58	45	23	38	55	3,5	200,8
CMS 27	WITELS	33	59	20	23	42	10	5,0	205,8
CMS 28	LOTTERING	33	59	40	23	44	10	3,5	209,3
CMS 29	ELANDBOS	34	00	10	23	46	05	3,5	212,8
CMS 30	GELHOUTBOS	34	00	20	23	47	10	2,3	215,1
CMS 31	KLEINBOS	34	00	40	23	48	50	3,0	218,1
CMS 32	STORMS	34	01	05	23	54	15	9,8	227,9
CMS 33	BRUGLAAGTE	34	01	35	23	56	15	3,5	231,4
CMS 34	LANGBOS	34	02	00	23	58	30	3,5	234,9
CMS 35	SANDDRIF	34	02	15	24	00	20	3,0	237,9
CMS 36	ELANDS	34	02	35	24	04	45	7,0	244,9
CMS 37	GROOT (EAST)	34	03	35	24	11	40	15,0	259,9
CMS 38	EEERSTE	34	04	40	24	14	40	6,3	266,2
CMS 39	KLIPDRIF (WEST)	34	05	10	24	16	35	3,3	269,5
CMS 40	BOSKLOOF	34	05	30	24	17	45	2,2	271,7
CMS 41	KAAPSEDRIFF	34	06	20	24	23	20	10,0	281,7
CMS 42	TSITSIKAMMA	34	08	05	24	26	25	6,0	287,7
CMS 43	KLIPDRIF (EAST)	34	10	20	24	37	55	22,5	310,2
CMS 44	SLANG	34	10	20	24	39	00	1,7	311,9
CMS 45	KROMME	34	08	30	24	50	30	32,8	344,7
CMS 46	SEEKOEI	34	05	15	24	54	40	9,0	353,7
CMS 47	KABELJOUS	34	00	20	24	56	15	10,0	363,7
CMS 48	GAMTOOS	33	58	05	25	03	30	12,0	375,7
CMS 49	VAN STADENS	33	58	15	25	13	20	15,0	390,7
CMS 50	MAITLAND	33	59	20	25	17	40	7,0	397,7

TABLE II: CAPE MIDDLE SOUTH (CMS) ESTUARIES: BASIC PHYSICAL GEOGRAPHY

Reference	River	Catchment area (km ²)	River length (km)	Elevation of source (m above MSL)	River gradient (1:)
CMS 0a		34	13,1	178	74
CMS 1	HARTENBOS	205	34,2	360	95
CMS 2	KLEIN-BRAKRIVIER	550	49,9	1 100	45
CMS 3	GROOT-BRAKRIVIER	190	31,5	1 260	25
CMS 4	ROOI	3	3,1	195	16
CMS 5	MAALGATE	177	27,7	1 100	25
CMS 6	GWAING	185	24,8	1 300	19
CMS 7	SKAAPKOP	30	13,8	210	66
CMS 8	MEUL	18	11,0	220	50
CMS 9	KAAIMANS	107	23,3	731	32
CMS 10	TOUWS	155	27,8	1 036	27
CMS 11	SWARTVLEI	455	37,8	1 300	29
CMS 12	GOUKAMMA	235	47,1	1 110	42
CMS 13	KNYSNA	525	60,3	1 021	59
CMS 14	NOETSIE	39	13,5	340	40
CMS 15	GROOT EILAND	12	8,1	280	30
CMS 16	KRANSHOEK	5	3,3	260	13
CMS 17	CROOKS	3	3,9	260	15
CMS 18	PIESANG	96	19,9	260	77
CMS 19	KEURBOOMS	1 080	85,3	1 300	66
CMS 20	MATJIES	22	13,4	244	55
CMS 21	BRAK	5	5,0	198	25
CMS 22	SOUT	34	20,0	910	22
CMS 23	GROOT (WEST)	119	19,2	940	20
CMS 24	HELPEKAARS	2	2,7	230	12
CMS 25	KLIP	10	5,7	240	24
CMS 26	BLOUKRANS	93	21,9	1 400	16
CMS 27	WITELS	10	7,4	420	18
CMS 28	LOTTERING	47	19,5	1 240	16
CMS 29	ELANDBOS	85	19,7	1 300	15
CMS 30	GELHOUTBOS	15	7,3	260	28
CMS 31	KLEINBOS	33	16,9	1 180	14
CMS 32	STORMS	180	23,3	1 140	20
CMS 33	BRUGLAAGTE	9	6,5	238	27
CMS 34	LANGBOS	5	5,1	205	25
CMS 35	SANDDRIF	27	12,8	900	14
CMS 36	ELANDS	149	12,7	884	14
CMS 37	GROOT (EAST)	144	33,4	899	37
CMS 38	EERSTE	17	9,9	240	41
CMS 39	KLIPDRIF (WEST)	14	8,3	225	37
CMS 40	BOSKLOOF	10	4,8	180	27
CMS 41	KAAPSEDRIFF	25	16,4	200	82
CMS 42	TSITSIKAMMA	225	32,3	660	49
CMS 43	KLIPDRIF (EAST)	169	24,7	215	115
CMS 44	SLANG	26	6,5	150	43
CMS 45	KROMME	1 085	109,2	1 100	99
CMS 46	SEEKOEI	224	37,4	520	72
CMS 47	KABELJOUS	276	33,6	460	73
CMS 48	GAMTOOS	34 635	644,8	2 188	295
CMS 49	VAN STADENS	271	25,8	590	44
CMS 50	MAITLAND	187	22,1	240	92

TABLE III: CAPE MIDDLE SOUTH (CMS) ESTUARIES: SIMULATED RUN-OFF

Reference	River	$(m^3 \times 10^6)$ MAR	Coefficients of Variation $\bar{V}\%$		Median Annual Run-off $(m^3 \times 10^6)$	Median/Mean (%)
			Annual	Monthly		
CMS 0a		0,53	66,38	138,4	0,44	83
CMS 1	HARTENBOS	5,00	66,38	138,4	4,13	83
CMS 2	KLEIN-BRAKRIVIER	59,53	44,58	131,4	51,91	87
CMS 3	GROOT-BRAKRIVIER	38,79	47,58	118,7	33,17	86
CMS 4	ROOI	0,45	57,80	151,9	0,38	84
CMS 5	MAALGATE	26,64	57,80	151,9	22,21	83
CMS 6	GWAING	43,53	57,80	151,9	36,28	83
CMS 7	SKAAPKOP	7,06	57,80	151,9	5,88	83
CMS 8	MEUL	4,24	57,80	151,9	3,53	83
CMS 9	KAAIMANS	39,50	57,80	151,9	32,95	83
CMS 10	TOUWS	39,01	46,38	96,2	34,32	88
CMS 11	SWARTVLEI	109,36	46,38	96,2	96,20	88
CMS 12	GOUKAMMA	52,90	39,12	96,2	49,26	93
CMS 13	KNYSNA	132,74	39,12	96,2	123,62	93
CMS 14	NOETSIE	4,78	49,35	133,0	4,33	91
CMS 15	GROOT EILAND	1,47	49,35	133,0	1,33	90
CMS 16	KRANSHOEK	0,61	49,35	133,0	0,56	92
CMS 17	CROOKS	0,37	49,35	133,0	0,33	89
CMS 18	PIESANG	11,76	49,35	133,0	10,66	91
CMS 19	KEURBOOMS	176,86	49,35	133,0	160,36	91
CMS 20	MATJIES	5,59	43,30	98,6	5,06	91
CMS 21	BRAK	1,27	43,30	98,6	1,15	91
CMS 22	SOUT	8,64	43,30	98,6	7,81	90
CMS 23	GROOT (WEST)	30,23	43,30	98,6	27,35	90
CMS 24	HELPMEKAARS	0,74	43,30	98,6	0,67	91
CMS 25	KLIP	3,69	43,30	98,6	3,34	91
CMS 26	BLOUKRANS	34,34	43,30	98,6	31,06	90
CMS 27	WITELS	3,89	38,75	95,2	3,78	97
CMS 28	LOTTERING	18,30	38,75	95,2	17,75	97
CMS 29	ELANDBOS	33,10	38,75	95,2	32,11	97
CMS 30	GEELHOUBOS	5,84	38,75	95,2	5,67	97
CMS 31	KLEINBOS	12,85	38,75	95,2	12,46	97
CMS 32	STORMS	75,99	38,75	95,2	73,71	97
CMS 33	BRUGLAAGTE	3,84	38,75	95,2	3,72	97
CMS 34	LANGBOS	2,13	38,75	95,2	2,07	97
CMS 35	SANDDRIF	11,51	38,75	95,2	11,16	97
CMS 36	ELANDS	63,51	38,75	95,2	61,60	97
CMS 37	GROOT (EAST)	45,92	38,75	95,2	44,54	97
CMS 38	EERSTE	5,42	38,75	95,2	5,26	97
CMS 39	KLIPDRIF (WEST)	4,46	39,75	95,2	4,33	97
CMS 40	BOSKLOOF	3,19	38,75	95,2	3,09	97
CMS 41	KAAPSEDRIF	6,10	38,75	95,2	5,92	97
CMS 42	TSITSIKAMMA	54,89	38,75	95,2	53,24	97
CMS 43	KLIPDRIF (EAST)	32,93	38,75	95,2	31,94	97
CMS 44	SLANG	5,07	38,75	95,2	4,91	97
CMS 45	KROMME	122,95	54,26	141,4	104,87	85
CMS 46	SEEKOEI	14,33	54,26	141,4	12,22	85
CMS 47	KABELJOUS	17,66	54,26	141,4	15,06	85
CMS 48	GAMTOOS	502,51	81,94	171,2	315,98	63
CMS 49	VAN STADENS	21,41	103,58	226,6	11,56	54
CMS 50	MAITLAND	14,75	103,58	226,6	7,97	54

TABLE IV: CAPE MIDDLE SOUTH (CMS) ESTUARIES: MONTHLY RUN-OFF COEFFICIENTS OF VARIATION (%)

Reference	River	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	\bar{x}
CMS 0a		232,3	113,9	74,8	138,5	138,9	130,5	246,6	106,0	75,9	137,2	139,1	127,1	138,4
CMS 1	HARTENBOS	232,3	113,9	74,8	138,5	138,9	130,5	246,6	106,0	75,9	137,2	139,1	127,1	138,4
CMS 2	KLEIN-BRAKRIVIER	109,8	135,8	154,6	139,2	162,1	135,9	161,5	132,1	68,5	112,0	155,9	108,9	131,4
CMS 3	GROOT-BRAKRIVIER	75,6	118,2	192,4	129,4	153,1	120,9	117,1	129,3	54,4	77,7	142,9	113,0	118,7
CMS 4	ROOI	120,7	105,1	261,8	130,5	125,9	194,6	210,5	169,2	110,3	94,8	151,2	146,7	151,9
CMS 5	MAALGATE	120,7	105,1	261,8	130,5	129,9	194,6	210,5	169,2	110,3	94,8	151,2	146,7	151,9
CMS 6	GWAING	120,7	105,1	261,8	130,5	129,9	194,6	210,5	169,2	110,3	94,8	151,2	146,7	151,9
CMS 7	SKAAPKOP	120,7	105,1	262,8	130,5	125,9	194,6	210,5	169,2	110,3	94,8	151,2	146,7	151,9
CMS 8	MEUL	120,7	105,1	262,8	130,5	125,9	194,6	210,5	169,2	110,3	94,8	151,2	146,7	151,9
CMS 9	KAAIMANS	120,7	105,1	262,8	130,5	125,9	194,6	210,5	169,2	110,3	94,8	151,2	146,7	151,9
CMS 10	TOUWS	79,0	102,5	174,2	123,9	112,9	115,1	105,5	156,7	96,6	76,3	135,8	97,8	114,7
CMS 11	SWARTVLEI	79,0	102,5	174,2	123,9	112,9	115,1	105,5	156,7	96,6	76,3	135,8	97,8	114,7
CMS 12	GOUKAMMA	65,0	82,9	131,4	96,4	113,3	93,2	91,5	156,4	69,5	69,1	100,9	84,5	96,2
CMS 13	KNYSNA	65,0	82,9	131,4	96,4	113,3	93,2	91,5	156,4	69,5	69,1	100,9	84,5	96,2
CMS 14	NOETSIE	86,4	97,8	213,9	130,1	145,2	121,9	189,6	162,2	92,7	117,1	116,6	121,9	133,0
CMS 15	GROOT EILAND	86,4	97,8	213,9	130,1	145,2	121,9	189,6	162,2	92,7	117,1	116,6	121,9	133,0
CMS 16	KRANSHOEK	86,4	97,8	213,9	130,1	145,2	121,9	189,6	162,2	92,7	117,1	116,6	121,9	133,0
CMS 17	CROOKS	86,4	97,8	213,9	130,1	145,2	121,9	189,6	162,2	92,7	117,1	116,6	121,9	133,0
CMS 18	PIESANG	86,4	97,8	213,9	130,1	145,2	121,9	189,6	162,2	92,7	117,1	116,6	121,9	133,0
CMS 19	KEURBOOMS	86,4	97,8	213,9	130,1	145,2	121,9	189,6	162,2	92,7	117,1	116,6	121,9	133,0
CMS 20	MATJIES	85,8	80,1	171,8	69,1	116,1	98,2	98,3	137,2	65,3	65,7	81,2	114,8	98,6
CMS 21	BRAK	85,8	80,1	171,8	69,1	116,1	98,2	98,3	137,2	65,3	65,7	81,2	114,8	98,6
CMS 22	SOUT	85,8	80,1	171,8	69,1	116,1	98,2	98,3	137,2	65,3	65,7	81,2	114,8	98,6
CMS 23	GROOT (WEST)	85,8	80,1	171,8	69,1	116,1	98,2	98,3	137,2	65,3	65,7	81,2	114,8	98,6
CMS 24	HELPMEKAARS	85,8	80,1	171,8	69,1	116,1	98,2	98,3	137,2	65,3	65,7	81,2	114,8	98,6
CMS 25	KLIP	85,8	80,1	171,8	69,1	116,1	98,2	98,3	137,2	65,3	65,7	81,2	114,8	98,6
CMS 26	BLOUKRANS	85,8	80,1	171,8	69,1	116,1	98,2	98,3	137,2	65,3	65,7	81,2	114,8	98,6
CMS 27	WITELS	71,7	99,4	164,7	73,2	109,5	103,3	92,6	117,7	73,5	66,5	80,6	90,5	95,2
CMS 28	LOTTERING	71,7	99,4	164,7	73,2	109,5	103,3	92,6	117,7	73,5	66,5	80,6	90,5	95,2
CMS 29	ELANDBOS	71,7	99,4	164,7	73,2	109,5	103,3	92,6	117,7	73,5	66,5	80,6	90,5	95,2
CMS 30	GEELOUTBOS	71,7	99,4	164,7	73,2	109,5	103,3	92,6	117,7	73,5	66,5	80,6	90,5	95,2
CMS 31	KLEINBOS	71,7	99,4	164,7	73,2	109,5	103,3	92,6	117,7	73,5	66,5	80,6	90,5	95,2
CMS 32	STORMS	71,7	99,4	164,7	73,2	109,5	103,3	92,6	117,7	73,5	66,5	80,6	90,5	95,2
CMS 33	BRUGLAAGTE	71,7	99,4	164,7	73,2	109,5	103,3	92,6	117,7	73,5	66,5	80,6	90,5	95,2
CMS 34	LANGBOS	71,7	99,4	164,7	73,2	109,5	103,3	92,6	117,7	73,5	66,5	80,6	90,5	95,2
CMS 35	SANDDRIF	71,7	99,4	164,7	73,2	109,5	103,3	92,6	117,7	73,5	66,5	80,6	90,5	95,2
CMS 36	ELANDS	71,7	99,4	164,7	73,2	109,5	103,3	92,6	117,7	73,5	66,5	80,6	90,5	95,2
CMS 37	GROOT (EAST)	71,7	99,4	164,7	73,2	109,5	103,3	92,6	117,7	73,5	66,5	80,6	90,5	95,2
CMS 38	EERSTE	71,7	99,4	164,7	73,2	109,5	103,3	92,6	117,7	73,5	66,5	80,6	90,5	95,2
CMS 39	KLIPDRIF (WEST)	71,7	99,4	164,7	73,2	109,5	103,3	92,6	117,7	73,5	66,5	80,6	90,5	95,2
CMS 40	BOSKLOOF	71,7	99,4	164,7	73,2	109,5	103,3	92,6	117,7	73,5	66,5	80,6	90,5	95,2
CMS 41	KAAPSEDRIFF	71,7	99,4	164,7	73,2	109,5	103,3	92,6	117,7	73,5	66,5	80,6	90,5	95,2
CMS 42	TSITSIKAMMA	71,7	99,4	164,7	73,2	109,5	103,3	92,6	117,7	73,5	66,5	80,6	90,5	95,2
CMS 43	KLIPDRIF (EAST)	71,7	99,4	164,7	73,2	109,5	103,3	92,6	117,7	73,5	66,5	80,6	90,5	95,2
CMS 44	SLANG	71,7	99,4	164,7	73,2	109,5	103,3	92,6	117,7	73,5	66,5	80,6	90,5	95,2
CMS 45	KROMME	94,0	101,1	152,8	116,0	263,3	190,0	131,8	177,7	121,9	80,8	109,2	157,9	141,4
CMS 46	SEEKOEI	94,0	101,1	152,8	116,0	263,3	190,0	131,8	177,7	121,9	80,8	109,2	157,9	141,4
CMS 47	KABELJOUS	94,0	101,1	152,8	116,0	263,3	190,0	131,8	177,7	121,9	80,8	109,2	157,9	141,4
CMS 48	GAMTOOS	148,0	125,3	214,6	234,6	197,0	170,3	148,0	222,5	169,6	122,7	184,9	116,6	171,2
CMS 49	VAN STADENS	236,4	171,7	179,1	259,2	272,5	272,8	188,8	271,0	207,5	155,4	271,9	232,3	226,6
CMS 50	MAITLAND	236,4	171,7	179,1	259,2	272,5	272,8	188,8	271,0	207,5	155,4	271,9	232,3	226,6

TABLE V: CAPE MIDDLE SOUTH (CMS) ESTUARIES: SIMULATED RUN-OFF/PRECIPITATION

Reference	River	MAR (mm)	MAP (mm)	MAR/MAP (%)
CMS 0a		16	428	3,7
CMS 1	HARTENBOS	24	493	4,9
CMS 2	KLEIN-BRAKRIVIER	108	657	16,4
CMS 3	GROOT-BRAKRIVIER	204	775	26,3
CMS 4	ROOI	150	702	21,4
CMS 5	MAALGATE	151	702	21,5
CMS 6	GWAING	235	830	28,3
CMS 7	SKAAPKOP	235	830	28,3
CMS 8	MEUL	235	830	28,3
CMS 9	KAAIMANS	369	865	42,7
CMS 10	TOUWS	252	915	27,5
CMS 11	SWARTVLEI	240	843	28,4
CMS 12	GOUKAMMA	225	883	25,4
CMS 13	KNYSNA	253	928	27,2
CMS 14	NOETSIE	123	769	16,0
CMS 15	GROOT EILAND	123	769	16,0
CMS 16	KRANSHOEK	122	769	15,9
CMS 17	CROOKS	123	769	16,0
CMS 18	PIESANG	123	769	16,0
CMS 19	KEURBOOMS	164	836	19,6
CMS 20	MATJIES	254	970	26,1
CMS 21	BRAK	254	970	26,1
CMS 22	SOUT	254	970	26,1
CMS 23	GROOT (WEST)	254	970	26,1
CMS 24	HELPMEKAARS	370	970	38,1
CMS 25	KLIP	369	1 097	33,6
CMS 26	BLOUKRANS	369	1 097	33,6
CMS 27	WITELS	389	1 097	35,4
CMS 28	LOTTERING	389	1 110	35,0
CMS 29	ELANDBOS	389	1 110	35,0
CMS 30	GEELOUTBOS	389	1 110	35,0
CMS 31	KLEINBOS	389	1 110	35,0
CMS 32	STORMS	422	1 152	36,6
CMS 33	BRUGLAAGTE	427	1 152	37,1
CMS 34	LANGBOS	426	1 152	37,0
CMS 35	SANDDRIF	426	1 152	37,0
CMS 36	ELANDS	426	1 152	37,0
CMS 37	GROOT (EAST)	319	1 045	30,5
CMS 38	EERSTE	319	1 045	30,5
CMS 39	KLIPDRIF (WEST)	319	1 045	30,5
CMS 40	BOSKLOOF	319	1 045	30,5
CMS 41	KAAPSEDRIF	244	963	25,3
CMS 42	TSITSIKAMMA	244	963	25,3
CMS 43	KLIPDRIF (EAST)	195	901	21,6
CMS 44	SLANG	195	901	21,6
CMS 45	KROMME	113	723	15,6
CMS 46	SEEKOEI	64	599	10,7
CMS 47	KABELJOUS	64	599	10,7
CMS 48	GAMTOOS	15	230	6,1
CMS 49	VAN STADENS	79	707	11,2
CMS 50	MAITLAND	79	707	11,2

TABLE VI: CAPE MIDDLE SOUTH (CMS) ESTUARIES: SEDIMENT YIELD

Reference	River	Average catchment sediment yield	
		tons/year	tons/km ² /yr
CMS 0a		5 100	150
CMS 1	HARTENBOS	37 332	182
CMS 2	KLEIN-BRAKRIVIER	110 000	200
CMS 3	GROOT-BRAKRIVIER	38 000	200
CMS 4	ROOI	450	150
CMS 5	MAALGATE	30 456	177
CMS 6	GWAING	28 779	156
CMS 7	SKAAPKOP	4 500	150
CMS 8	MEUL	2 700	150
CMS 9	KAAIMANS	19 100	178
CMS 10	TOUWS	27 270	176
CMS 11	SWARTVLEI	78 215	172
CMS 12	GOUKAMMA	39 292	167
CMS 13	KNYSNA	87 945	168
CMS 14	NOETSIE	5 850	150
CMS 15	GROOT EILAND	1 800	150
CMS 16	KRANSHOEK	750	150
CMS 17	CROOKS	450	150
CMS 18	PIESANG	14 400	150
CMS 19	KEURBOOMS	202 266	187
CMS 20	MATJIES	4 400	200
CMS 21	BRAK	1 000	200
CMS 22	SOUT	5 100	150
CMS 23	GROOT (WEST)	17 850	150
CMS 24	HELPMKAARS	300	150
CMS 25	KLIP	1 500	150
CMS 26	BLOUKRANS	13 950	150
CMS 27	WITELS	1 500	150
CMS 28	LOTTERING	7 050	150
CMS 29	ELANDBOS	12 750	150
CMS 30	GEELOHOUTBOS	2 250	150
CMS 31	KLEINBOS	4 950	150
CMS 32	STORMS	27 000	150
CMS 33	BRUGLAAGTE	1 350	150
CMS 34	LANGBOS	750	150
CMS 35	SANDDRIF	4 050	150
CMS 36	ELANDS	22 350	150
CMS 37	GROOT (EAST)	21 600	150
CMS 38	EERSTE	2 550	150
CMS 39	KLIPDRIF (WEST)	2 100	150
CMS 40	BOSKLOOF	1 500	150
CMS 41	KAAPSEDRIF	3 750	150
CMS 42	TSITSIKAMMA	33 750	150
CMS 43	KLIPDRIF (EAST)	25 350	150
CMS 44	SLANG	3 900	150
CMS 45	KROMME	185 729	171
CMS 46	SEEKOEI	35 046	156
CMS 47	KABELJOUS	41 400	150
CMS 48	GAMTOOS	12 611 958	364
CMS 49	VAN STADENS	40 650	150
CMS 50	MAITLAND	28 050	150

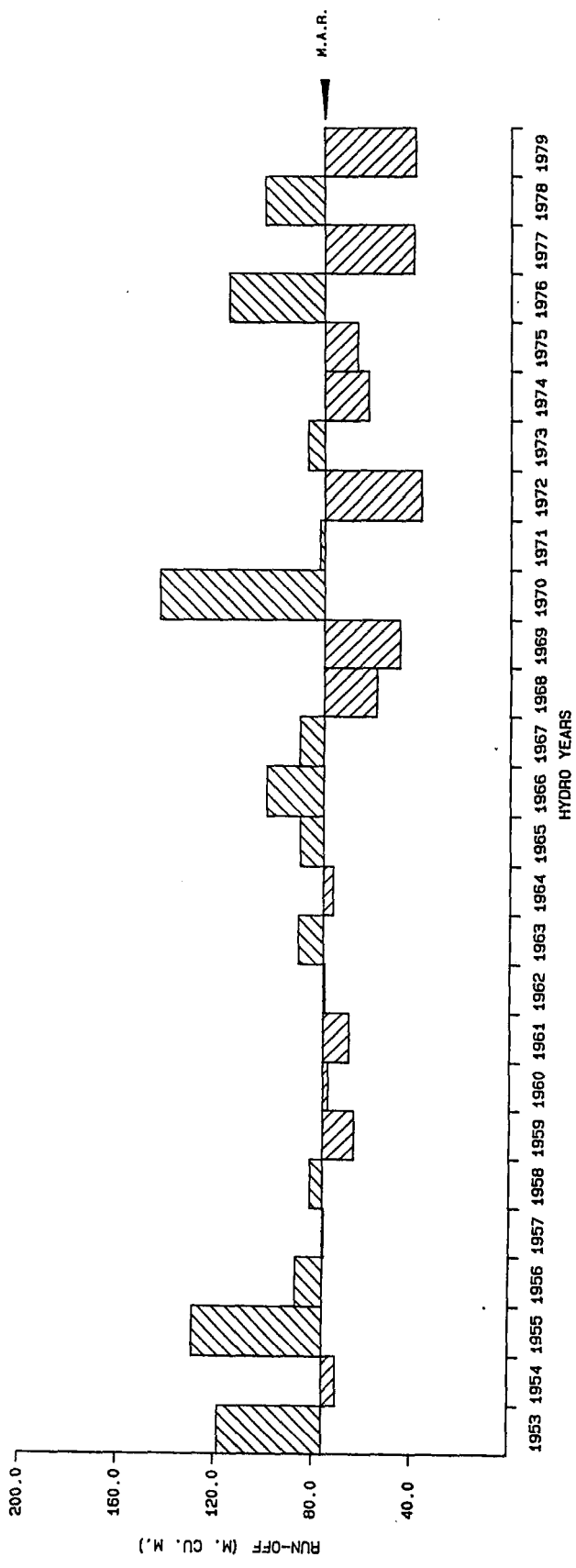
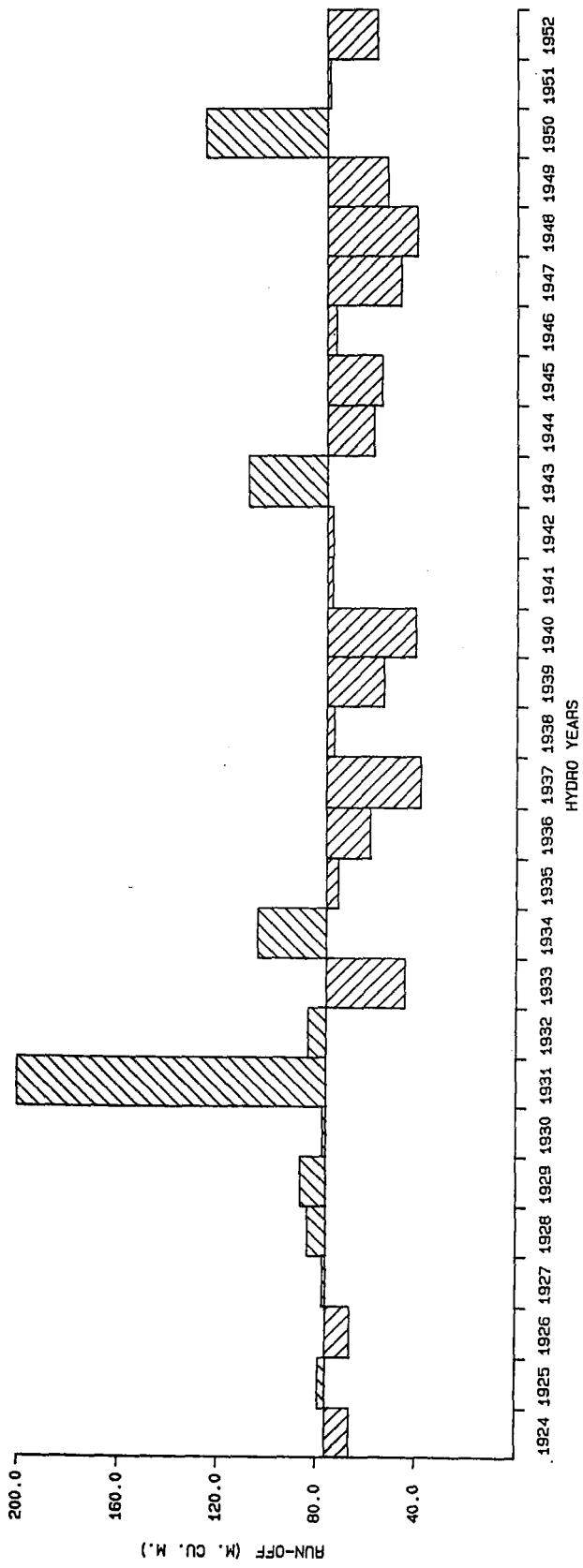
APPENDIX

TABLE CMS 32/I SIMULATED RUN-OFF FOR STURMS CMS 32

CATCHMENT AREA: 180.0 SQ. KM.

YEAR	DLT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL	M.A.R.
1924	4.04	4.37	3.60	1.52	.87	2.12	5.66	2.91	12.11	5.20	6.34	17.64	56.33	37.35
1925	12.72	8.03	16.76	3.47	2.48	6.62	2.11	1.84	2.28	7.07	6.55	9.17	79.03	104.06
1926	7.64	11.93	2.76	2.47	1.75	3.53	1.45	17.18	3.42	3.07	6.78	4.30	66.33	87.30
1927	3.84	3.62	1.88	1.89	7.85	20.43	6.17	3.40	4.88	4.06	6.39	12.96	71.36	101.80
1928	9.62	19.29	8.32	2.42	2.62	2.19	1.58	4.13	3.85	11.88	9.12	8.49	83.51	109.89
1929	9.58	4.43	6.01	2.66	18.00	4.16	4.68	5.73	6.31	5.67	11.01	8.07	36.35	113.63
1930	9.44	4.39	4.75	6.52	2.15	2.24	2.66	4.11	4.19	12.58	6.12	18.33	77.48	101.97
1931	21.25	5.55	69.47	12.56	3.71	5.01	2.28	2.87	7.54	5.53	4.71	60.53	201.02	264.55
1932	14.75	6.53	2.91	1.43	3.55	2.27	2.44	14.57	5.23	4.30	18.92	6.20	83.10	104.36
1933	3.72	5.56	1.83	1.54	3.35	4.09	1.92	1.76	2.30	7.97	5.16	5.04	44.23	58.21
1934	26.79	5.65	2.03	1.44	2.13	1.99	2.50	31.07	7.01	6.75	6.50	5.97	103.84	136.65
1935	12.58	8.60	5.61	2.66	2.59	3.00	2.67	7.88	3.74	9.06	4.40	8.46	71.25	93.77
1936	8.53	13.13	3.51	2.29	3.82	4.23	2.10	1.45	2.26	4.05	3.76	9.25	58.39	76.84
1937	6.20	3.87	2.92	3.96	1.06	3.92	1.95	2.23	1.93	1.82	3.12	5.11	38.08	50.11
1938	4.76	4.64	4.94	1.54	11.41	10.02	3.95	2.49	1.72	6.45	10.99	10.16	79.05	96.14
1939	6.44	4.34	3.89	6.72	4.30	4.48	3.67	2.79	3.09	6.43	3.12	5.86	53.13	69.92
1940	4.38	3.69	2.16	2.23	1.65	2.36	4.28	2.69	5.47	3.36	2.36	5.36	40.35	53.11
1941	12.54	8.57	11.45	9.04	2.20	2.15	2.18	5.42	3.92	6.00	5.47	5.02	73.97	77.34
1942	5.03	3.12	2.64	6.12	3.03	2.24	1.67	1.27	10.14	6.66	8.90	24.84	73.71	97.00
1943	8.41	11.79	9.89	2.04	3.32	1.97	2.02	42.50	5.59	6.31	5.12	9.05	107.99	142.12
1944	6.73	4.73	3.22	1.37	.72	.63	.55	14.71	9.92	5.82	5.25	3.52	57.17	75.24
1945	4.34	2.63	4.87	3.46	2.36	9.08	2.75	2.27	2.29	6.71	6.84	6.35	53.94	70.98
1946	5.99	3.23	1.84	6.19	1.44	4.40	4.87	5.96	8.13	16.31	5.94	8.01	72.31	95.15
1947	5.80	5.19	2.08	3.76	1.82	1.53	8.34	2.58	2.77	2.98	3.49	5.86	46.24	60.86
1948	7.17	6.76	3.63	4.21	1.96	.97	1.99	3.06	1.89	1.60	2.73	3.81	39.84	52.42
1949	2.67	18.10	3.45	1.45	.76	.84	1.35	2.52	1.60	8.15	5.63	5.18	51.67	68.00
1950	5.67	22.69	7.93	13.83	2.99	2.12	1.30	4.97	13.82	20.06	17.26	12.70	125.34	164.95
1951	5.74	2.63	1.96	6.21	2.72	1.47	2.59	2.01	2.89	3.00	13.10	30.40	74.78	98.41
1952	5.47	3.22	2.09	2.05	.97	1.04	.82	4.25	6.80	6.80	11.24	9.49	55.71	73.32
1953	35.67	10.63	5.01	1.59	.69	2.55	1.90	12.41	5.29	10.11	24.18	8.40	118.43	155.86
1954	6.00	10.56	2.90	4.70	19.73	2.99	2.69	3.25	3.12	3.26	5.32	5.82	70.21	92.39
1955	7.66	54.92	4.06	1.82	3.29	4.46	2.50	26.97	4.51	3.26	4.49	11.14	129.09	169.88
1956	15.57	10.06	10.29	2.23	3.80	2.23	2.09	7.00	6.09	4.51	9.74	13.26	86.88	114.33
1957	9.17	3.83	2.84	1.88	1.28	11.93	4.70	16.24	6.11	4.44	7.35	5.79	75.26	99.04
1958	7.52	3.45	3.09	11.29	2.06	3.07	6.73	6.77	3.82	7.79	16.92	8.43	80.94	106.52
1959	12.71	4.77	2.85	7.83	1.39	1.37	2.96	2.94	3.36	8.51	5.13	9.21	63.05	82.98
1960	5.30	5.54	4.45	3.06	1.83	26.72	2.69	7.38	3.38	3.40	5.54	4.43	73.71	97.01
1961	7.86	3.04	1.89	2.47	1.37	10.16	3.95	2.73	2.34	2.47	21.79	5.19	65.25	85.88
1962	18.29	7.12	2.29	2.29	1.31	14.46	4.43	4.54	4.87	7.03	5.07	3.50	75.19	98.95
1963	3.99	2.62	5.46	4.68	2.01	4.67	5.46	3.00	13.21	5.17	9.78	26.06	86.11	113.32
1964	6.21	6.71	3.12	1.96	1.40	14.39	10.53	8.35	6.46	5.09	4.02	3.62	71.85	94.56
1965	17.49	17.44	4.67	5.84	4.50	3.27	2.52	3.98	2.59	3.15	11.92	8.14	85.50	112.52
1966	5.05	4.27	2.24	1.31	2.04	9.67	21.87	10.61	6.11	8.67	6.56	20.84	99.25	130.62
1967	6.28	6.62	2.78	2.22	4.49	3.99	3.08	3.51	24.74	5.07	7.86	15.16	85.79	112.89
1968	7.92	8.07	3.43	3.92	3.91	3.01	2.08	1.77	5.39	4.95	5.19	4.71	54.35	71.53
1969	7.81	3.37	1.79	3.08	2.96	1.82	1.32	1.12	1.21	2.13	13.70	4.89	45.03	59.26
1970	9.22	3.84	21.66	2.97	4.07	3.40	12.58	15.89	6.33	22.60	34.11	6.27	142.95	188.12
1971	6.38	11.49	2.99	3.46	14.44	3.50	2.91	4.22	7.16	6.28	9.93	4.90	77.68	102.22
1972	3.31	2.14	1.62	1.69	1.23	4.39	3.52	3.76	2.81	3.13	4.01	4.85	36.45	47.97
1973	3.96	7.64	2.05	5.56	2.61	5.56	1.98	8.43	3.78	2.87	27.25	11.29	82.78	108.94
1974	6.76	4.51	1.83	4.00	3.91	2.72	2.32	1.74	2.23	5.97	4.92	17.13	58.05	76.40
1975	4.61	6.34	7.06	3.14	3.60	8.55	2.44	3.43	7.92	6.96	6.96	5.24	62.55	82.32
1976	28.78	10.92	6.77	2.05	11.61	3.91	2.10	26.73	5.77	4.26	5.71	6.21	114.82	151.10
1977	5.00	7.51	3.63	2.09	.99	.96	1.39	2.18	5.56	3.20	3.57	3.47	39.56	52.06
1978	6.90	5.30	7.30	4.44	1.80	1.07	5.69	3.99	4.16	14.23	34.18	11.08	100.14	131.79
1979	6.96	3.76	2.57	3.16	1.45	1.02	2.80	2.33	5.31	2.97	2.95	3.57	38.83	51.11

MEAN 3.05 7.84 5.72 3.79 3.61 4.77 3.61 7.00 5.24 6.31 9.01 10.03 75.93
 S 6.49 7.79 9.42 2.77 3.95 4.92 3.34 8.25 3.85 4.20 7.26 9.08 29.44
 VZ 71.73 99.36 164.68 73.16 109.51 103.32 92.61 117.72 73.49 66.52 30.59 90.50 38.75
 MEAN ANNUAL RUN-OFF = 75.99 MILLION CUBIC METRES. COMPILED FROM HRU REPORT NO.12/81 DATA

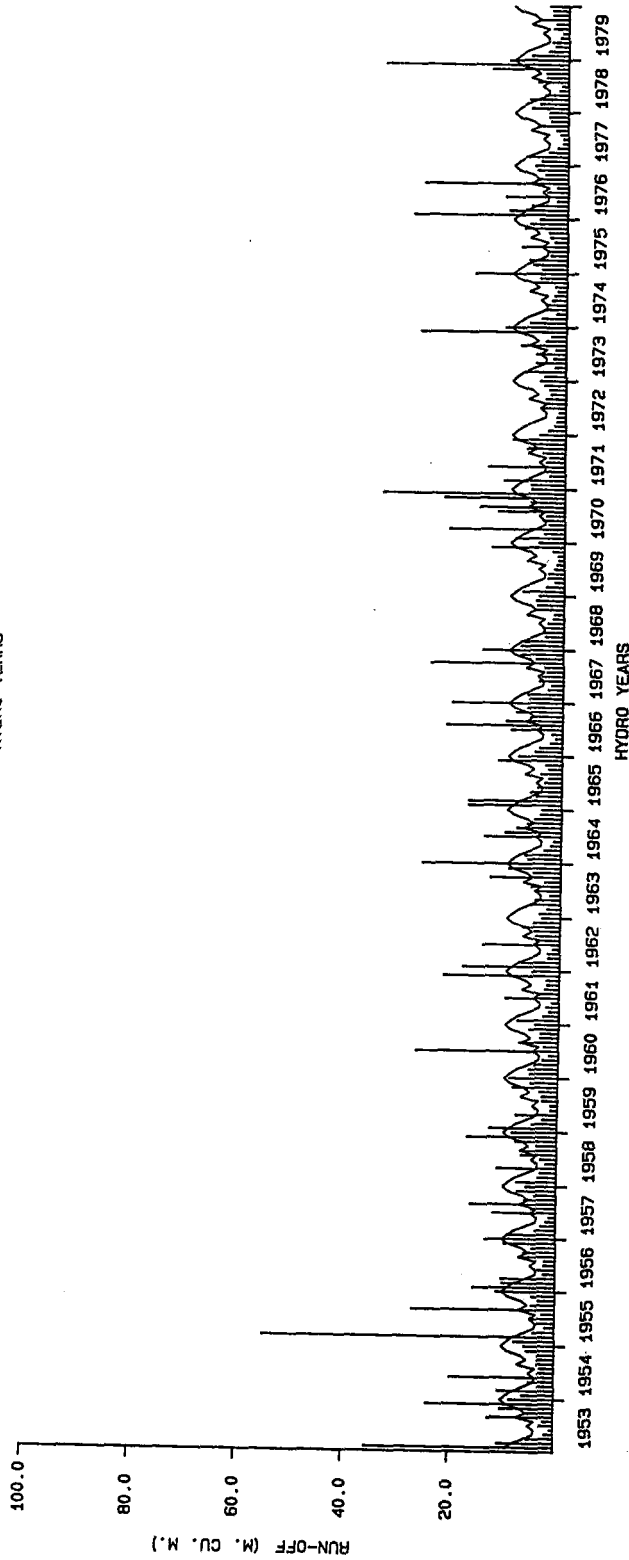
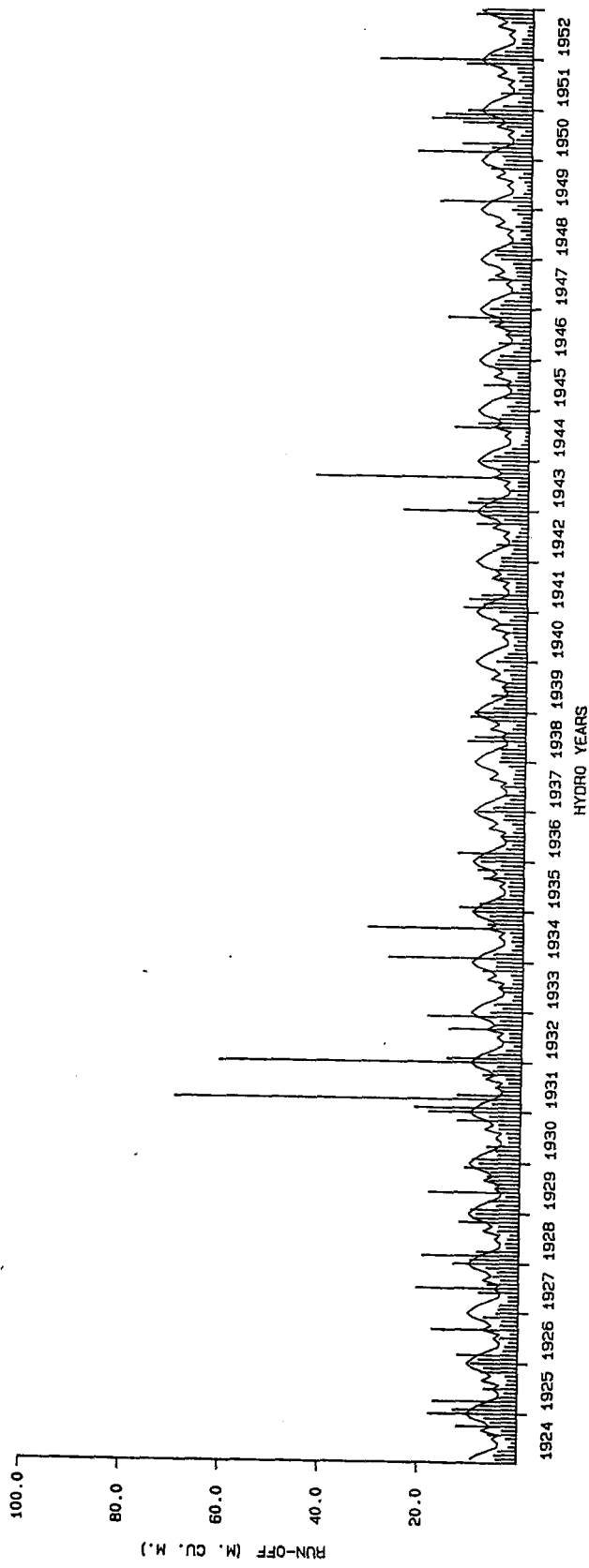


TRACED : RAIN
 CHECKED : H.J.A.D.
 DATE : AUG. 1987
 REF. : 720 41064

CAPE ESTUARIES : CMS STORMS
 SIMULATED ANNUAL RUN-OFF
 1924-1979

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FIGURE
 CMS 32/1

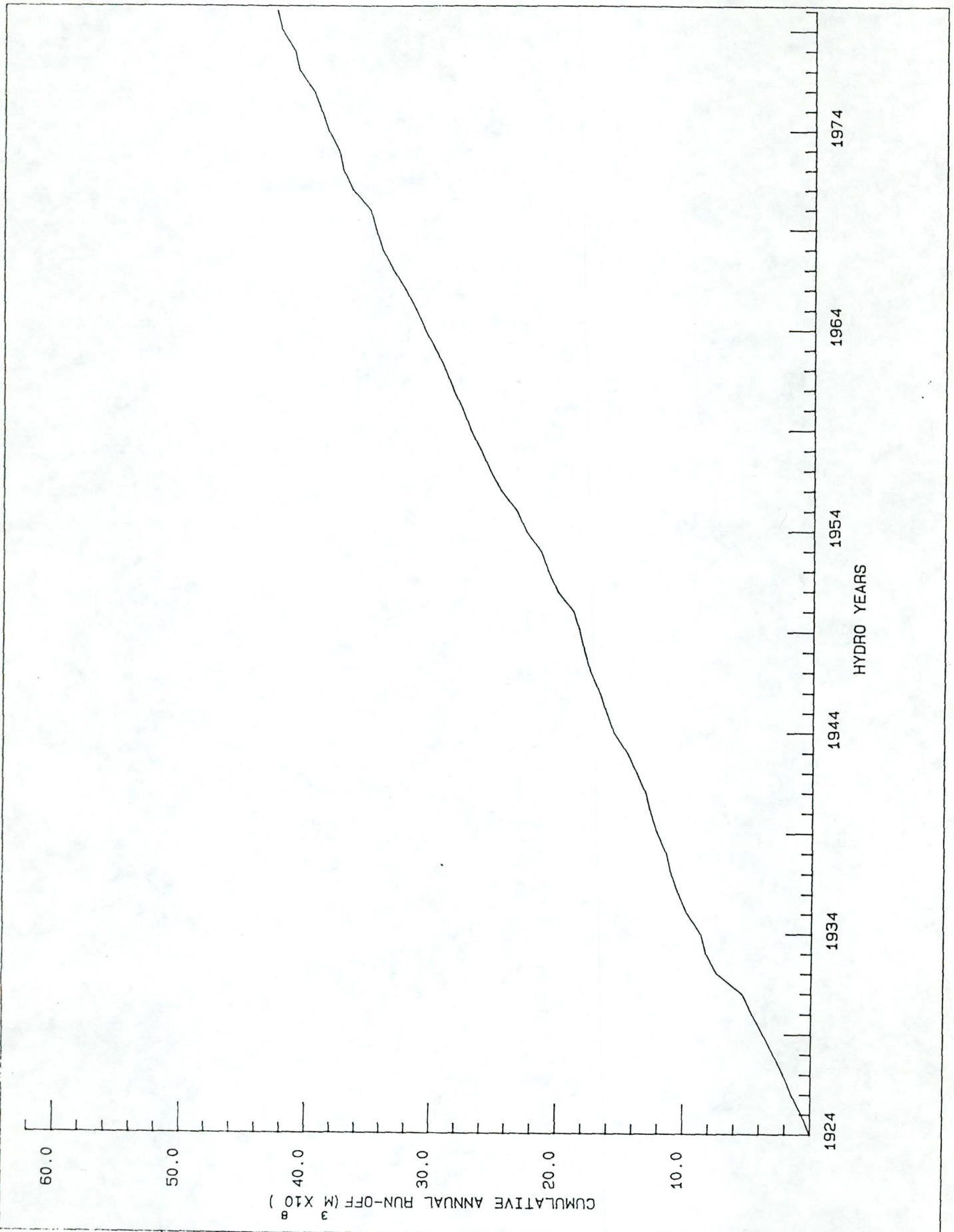


TRACED : RAIN
 CHECKED: H.J.A.D.
 DATE : AUG. 1967
 REF. : 720 41084

CAPE ESTUARIES : CMS STORMS
 SIMULATED MONTHLY RUN-OFF
 1924-1979

FIGURE
 CMS 32/2


 MONTHLY MEANS



TRACED : RAIN
 CHECKED: H.J.A.D.
 DATE : AUG. 1987
 REF. : 720 41064

CAPE ESTUARIES: CMS STORMS
CUMULATIVE ANNUAL RUN-OFF

FIGURE
 CMS 32/3