



CONFIDENTIAL

**HYDROLOGICAL/HYDRAULIC STUDY
OF NATAL ESTUARIES
DATA REPORT NO. 22
MPENJATI NS7**

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

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Stellenbosch, South Africa
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BRIEF NOTESMPENJATI NS7Location

The Mpenjati discharges into the Indian Ocean on the Natal South Coast at 30°59'S, 30°17'E. The head of the reach under review is the National Road (NR) bridge of the old south coast road, 1,3 km from the mouth (Photograph NS7/1).

Hydro Data

The M.A.R. from a catchment of 100 km² is $25,52 \times 10^6$ m³ (23,7% of the precipitation). Of particular interest to this study is the erratic nature of the run-off. This is quantified by the high coefficients of variation for monthly run-off (Table NS7/XII) ranging from 74,8 per cent to 198,6 per cent ($\bar{V}\% = 125,5\%$) and by the wide spectrum of annual and monthly run-off shown in Figures NS7/2 and 3. Figure NS7/4 shows the trends in the annual run-off for the period 1921-1976. The aforementioned Table and Figures are based upon simulated run-off data for tertiary catchments (Middleton *et al.*, 1981). The Mpenjati is subject to frequent, high monthly run-off periods: major flood flows occurring in June 1929, July 1931, November 1936, October 1954, May 1959, March 1963 and January 1964 (Figure NS7/3).

For classification purposes, current and antecedent run-off conditions must be considered for each of the time slices covered by the aerial photographs. The following important facts emerge regarding the eight relevant photographs:

- 1) 1937 below-average run-off but above-average two to five months previous and a major flood flow six months previous.
- 2) 1943 near-average run-off - likewise for six months previous, well above-average for the next six months previous.

water levels behind the sandbar, overflow channels occur - again towards the right bank (Photographs NS7/2 and 8).

Begg (pers. comm.) estimates the mouth to be closed for 65 per cent of the year.

Land-use

(a) **Agriculture**

There has been no cultivation on the flood plain for the period under review but in very recent years 30 per cent of the left valley side has been given over to sugar cane plantations.

(b) **Structures**

The National Road (NR) bridge, at the head of the reach under review, was built in 1929. It is situated 1,4 km from the mouth. Four hundred metres downstream of the NR bridge a freeway was constructed in 1983. An embankment for the freeway bridge extends for 140 m diagonally across the left bank flood plain.

(c) **Urbanization**

Sand extraction from the river channel bed commenced in October 1969. There were four sites for these operations by 1976 (Begg, 1978). Since 1978 the sand extraction works have escalated (Begg, 1984; Heydorn, pers. comm.).

A brick and cement block factory was established near the head of the reach in 1983.

Siltation

The lowest 1,4 km of the Mpenjati show severe siltation for the period under review. The 1937 photograph (Photograph NS7/2) gives a classic example of a sub-aerial delta deposited by the

major flood flows of November 1936 and earlier floods. This delta formed where the river first emerges from an incised meander course with the check on river velocities, gradually extending towards the mouth. By May 1937 the delta was approximately 800 m long, extending to the position where the river flowed into a fair-sized "lagoon" behind the sandbar at the mouth. It should be noted that siltation continued thereafter without the aid of any adverse human influences in the lower reaches until the 1970s. Until then, the siltation was the result of a highly erratic run-off, very steep gradients (1:38 overall checking to 1:462 in the lowest 1,4 km) and no coastal plain. For a sediment source, one must look to erodible soils and land-use malpractices in the catchment. From a sediment production map of S. Africa (Rooseboom, 1975) a sediment yield of 60 000 tons per year is derived for the Mpenjati catchment. This represents a rate of 600 tons/km²/yr, which is very high.

Bearing in mind that the rate of siltation in the lower reaches is not steady but is mainly the result of major hydro-events, one should study the changes from two viewpoints:

- (a) spatially (area-changes over time) and
- (b) vertically (aggradation/degradation over time).

- (a) Changes in siltation over time

Photographs NS7/2-9 show changes in siltation from 1937 to 1984. Areal measurements of the flood plain quantify these changes and the results may be seen in the "Abstract" (Table NS7/I). Care must be taken in studying the changes in composition of the flood plain - some changes are due to differences in stage. One should compare only time slices with similar mouth conditions, which give similar water level stages. Then two clear facts emerge:

- (1) there has been a reduction in open water areas, stage for stage, over time, and
- (2) there has been an increase in siltation areas since 1937.

A x-section surveyed for the Freeway bridge, 400 m downstream of the NR bridge, in January 1982 gives a river bed level of +0,79 m to M.S.L.

Nearer the mouth, a short profile taken by Cerff at low tide on 10 January 1981 (Begg, 1984) gives a water level and lowest bed level equating approximately to -0,54 m and -1,24 m to M.S.L. respectively. The profile was taken about 150 m upstream of the sand-spit at the mouth. The human influence of sand extraction might well have brought about a slight reduction in bed levels in recent years in the lowest reaches but nothing quantitative may be given in this regard.

Lateral Stability

For easy visual reference, an envelope of mobility, lines of measurement and lateral shift are superimposed on an orthophoto (Photograph NS7/11).

The lateral displacement increases steadily from the head of the reach to the mouth, where it is considerable owing to the various mouth positions (Figure NS7/1 and Table NS7/XI). Expressed as a percentage of the average river width, this lateral shift is high (226,5%). Overall, the Mpenjati river course has moved towards the right valley side during the period under review as a result of the deposition of silt and formation of considerable salt marsh areas on the left bank (Table NS7/XI). The average lateral shift of 142,9 m with a coefficient of variation of 28,8 per cent indicates moderately unstable conditions.

Even allowing for differing flow stages, the river widths have decreased in the period 1937 to 1984 (Table NS7/X).

The sinuosity has been variable, ranging from 1,07 to 1,25. This mainly reflects differing flow stages and mouth conditions. The freeway bridge embankment is too recent and too high up in the reach markedly to affect the sinuosity.

Overall, the Mpenjati shows considerable siltation and has been moderately unstable for the period under review: 1937-1984.

Details of the classification may be found in Tables NS7/II-IX and an abstract of results is given in Table NS7/I.

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

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

ABBREVIATIONS/SYMBOLS/TERMS USED

M.A.R.	Mean annual run-off
L.B.	Left bank
R.B.	Right bank
P	Perimeter
$\bar{x}$	Arithmetic mean
s	Standard deviation
V	Coefficient of variation $\frac{s}{\bar{x}}$
MSL	Mean sea level
R	River
d/s	Downstream
u/s	Upstream
—	Maximum value
---	Minimum value
N.R.	No record
Head of reach	An arbitrary control point selected at the first convenient place u/s of the maximum known limit of saline penetration/tidal influence where the R is confined (preferably a bridge e.g. to facilitate demarcation of flood plain areas).

TABLE NS7/I

ABSTRACT

RIVER MPENJATI NS 7

BASIC DATA/CALCULATIONS

Lateral displacement (1937-1984) $\bar{x}$ 142.9 m (226.5 $\bar{x}$ R width)
 Relative lateral stability (1937-1984) $\bar{V}$ 28.8 %
 Area of catchment 100 km²
 Area of flood plain/valley 33.7 ha
 Area of envelope of mobility 27.7 ha
 Simulated run-off ($\times 10^6$ m³) M.A.R. 25.52 s 13.25
 (1921-1976) $\bar{V}$ 51.92 %
 Major floods: 6/29, 7/31, 11/36, 10/54, 5/59, 3/63, 1/64

HUMAN INFLUENCES

Within the Reach
 Cultivation: L.V.S. R.V.S. Flood Plain To Channel Edge
 30% Nil Nil Nil
 (since '83)
 Bridges & Embankments: Position (m from head of reach) Date
 National Road 0 1929
 Freeway 400 1983
 Canals: Nil
 Urbanization/Industry: Brick/Cement factory, 1983
 Sandbar breaching: 1970+ (more frequent since 1978) to facilitate
 sand extraction & freeway bridge building (Boag, 1984).
 Others: Sand extraction (1969+) which has escalated since 1978.

Upstream of the Reach

Dams: Nil

Construction/Canalization immediately upstream of reach: Nil

Land-use malpractices/Silt supply: Marked siltation indicative
 of land-use malpractices in the catchment.

STABILITY FOR PERIOD UNDER REVIEW (1937-1984)

Moderately Unstable

MEASUREMENTS/CALCULATIONS FROM PHOTOGRAPHS

Date	2-5-37	Dec. '43	June/July 1955	5-5-63	24-6-69	23-6-76	2-8-83	6-2-84
thalweg (m)	1455	1287	1267	1287	1416	1248	1425	1497
% estuarine	?	?	?	?	?	93	67	?
% braided	52	88	32	73	72	44	114	27
aerial distance (m)	1162	1162	1155	1206	1242	1169	1197	1237
sinuosity	1.25	1.11	1.10	1.07	1.14	1.07	1.19	1.21
open water area (ha)	13.0	12.9	14.3	8.4	5.0	4.2	10.6	5.8
$\bar{x}$ river width (m)	90.1	107.6	98.7	47.0	29.3	26.0	68.3	37.6
Flood Plain/Valley								
% open water	39	38	42	25	15	12	32	17
% sand (marine)	15	17	4	6	9	12	12	7
% sand/silt (fluvial)	31	28	13	32	23	20	5	17
% swamp/marsh			19	18	27	25	19	19
% grass/trees/bush	15	17	22	19	26	31	27	32
% cultivated								
% built-up							5	8
Valley Sides (L/R)								
% dune forest	L 18 38	R 20 38	L 20 38	R 20 38	L 20 38	R 20 38	L 20 38	R 20 38
sand								
% trees	20 29	18 29	20 29	24 33	28 33	20 33	20 33	16 33
% grass	62 33	62 33	60 33	56 29	52 29	60 29	32 26	28 26
% cultivated							28	32
% built-up							3	4
Mouth								
L.B. % vegetated	9	9	9	10	10	9	12	12
R.B. % vegetated	7	NIL	7	NIL	NIL	NIL	12	12
open/closed (O/C)	O*	O $\rightarrow$ C	C	O $\rightarrow$ C	O $\rightarrow$ C	O	O*	O
spit/bar:								
direction (°)	220	223, 37	220	212	213	217	217	214
length (m)	300	73+412	522	310	580	275	472	517
width (m)	99	55+75	66	79	70	80	94	71

NRIO NS 7

RIVER VALLEY AND RIVER MOUTH FEATURES

RIVER VALLEY AND RIVER MOUTH FEATURES

Valley Sides (~~Not~~ Well-defined)

Terrain	Vegetation	Land-use	Slumping	Vegetation and Land-use	Left	Right
mountainous	almost none	none	✓ none	coastal dune forest	18	38
✓ hilly	✓ grass	scattered cultivation	occasional	sand		
undulating	✓ sparsely forested (0-25%)	partly cultivated	frequent	trees	20	29
plains	moderately forested (25-75%)	mainly cultivated		grass	62	33
	heavily forested (75-100%)	✓ scattered settlement		cultivated		
	✓ riverine forest: tributaries	partly built-up		built-up		
		urbanized		Concrete		

Valley Characteristics

Measurements	Terraces	Relation of Channel to Valley Bottom (Vertical)	Relation of Channel to Valley Sides or Resistant Terraces (Lateral)	Surface Geology
valley length <u>1200</u> m	✓ none	not applicable	not applicable (no valley or free)	bedrock
bottom width (av.) <u>306</u> m	indefinite	not obviously degrading	✓ occasionally confined	lacustrine deposits
valley area <u>33.7</u> ha	fragmentary	or aggrading	frequently confined	✓ fluvial deposits
height at head of reach _____ m to MSL	continuous	partly entrenched	entrenched	aeolian
valley slope 1:	✓ aggrading	entrenched		
		✓ aggrading		
			Comments	

River Mouth

Characteristics

* open/ closed	right bank breakwater length	_____	m	
✓ natural/ artificial	left bank breakwater length	_____	m	
canalized	rock sill	_____	m	to MSL
✓ sandy	cliffs on left bank: height	_____	m	to MSL
rocks on right/left bank	spit/ bar : direction of growth	<u>220</u>	°	
outer bar	length of spit/bar	<u>300</u>	m	
silt plume (fluvial)	length stabilized	<u>NIL</u>	m	
✓ suspended sediment (marine)	width	<u>99</u>	m	

Comments * overflow channel

FLOOD PLAIN AND CHANNEL FEATURES

Description of Flood Plain

Presence		Extent		Areal Measurements: % Flood Plain/Valley			Crops, Animal Husbandry
none	none			open water	39	swamp, marsh	
indefinite	average width	306	m	sand (marine)	15	cultivated	
fragmentary	maximum width	500	m	* sand, silt (fluvial)	31	built-up	
✓ continuous	area	33,7	ha	trees, bush	9		
				grass	6		

Channel Description N.B. - Estimate of flow stage: ~~LOW/MID~~ ~~LONG TERM~~ ~~MEAN~~ ~~HIGH~~

Pattern	Measurements	Islands/ Shoals	Type of Flow	Bar Type
straight	*thalweg <u>14.55</u> m	none	stagnant/still	none
sinuous	*aerial length <u>116.2</u> m	✓ occasional (1)	uniform water surface	✓ channel side bars
irregular	*sinuosity <u>1.25</u>	frequent	uniform with rapid in reach	✓ point bars
regular meanders	*open water area <u>13.0</u> ha	split	✓ irregular	channel junction bars
✓ irregular meanders	perimeter <u>3705</u> m	✓ braided	pool and riffle sequence	mid-channel bars
tortuous meanders	river X-sections available		**turbid	diamond bars
bifurcated	channel slope			diagonal bars
lake/s	channel width $\bar{x}$ _____ m	s = _____ m		sand waves/large dunes
lagoon	river slope			
	river width $\bar{x}$ <u>90.1</u> m	s = <u>107.6</u> m		
			Comments *whole reach	

Obstructions/Constructions

Natural	Degree	Man-made	Degree of Obstruction/Constriction for Each		Position (from head of reach)
✓ none	none	road bridge/	N.R. bridge	R. confined	head of reach
logs	minor	rail bridge/s			
boulders	major	causeway			
vegetation		weir/dam			
		fish traps			
		embankment/s			
Comments		groynes			
		canals			
		drainage furrows			
		others			

Lateral Channel Activity

Lateral Activity	Nature of Banks	Bank Vegetation	Lateral Stability	
not detectable	✓ alluvium	✓ none almost	stable	
downstream progression	natural levees	weak	slightly unstable	
progression and cut-offs	rock/boulders	good	✓ moderately unstable	
mainly cut-offs	protected/stabilized	very strong	unstable	
entrenched loop development	cultivation to	left bank $\frac{9}{\quad}$ %	highly unstable	
irregular lateral activity	channel edge	right bank $\frac{7}{\quad}$ %		
✓ avulsion			Comments	

TABLE NS7/III

CLASSIFICATION OF THE LOWER REACHES OF NATAL RIVERS

NRIO NS 7

RIVER MPENJATI, ? % ESTUARINE, REACH from N.R. Bridge, 1.5 km from mouth. REF. DEAT 402e
 AERIAL PHOTO DATE Dec. '43 SCALE 1:10 000 CATCHMENT AREA 100 km², M.A.R. 25.52 m³/10⁶, No. of DAMS NIL

RIVER VALLEY AND RIVER MOUTH FEATURES

General Description of the Terrain above the Valley

Valley Sides (~~Not~~ Well-defined)

Terrain	Vegetation	Land-use	Slumping	Vegetation and Land-use	Left	Right
mountainous	almost none	none	✓ none	coastal dune forest	20	38
hilly	✓ grass	✓ scattered cultivation	occasional	sand	18	29
undulating	✓ sparsely forested (0-25%)	partly cultivated	frequent	trees	62	33
plains	moderately forested (25-75%)	mainly cultivated		grass		
	heavily forested (75-100%)	✓ scattered settlement		cultivated		
	✓ riverine forest: tributaries	partly built-up		built-up		
		urbanized		Comments		

Valley Characteristics

Measurements	Terraces	Relation of Channel to Valley Bottom (Vertical)	Relation of Channel to Valley Sides or Resistant Terraces (Lateral)	Surface Geology
valley length <u>1200</u> m	✓ none	not applicable	not applicable (no valley or free)	bedrock
bottom width (av.) <u>306</u> m	indefinite	not obviously degrading	✓ occasionally confined	lacustrine deposits
valley area <u>33.7</u> ha	fragmentary	or aggrading	frequently confined	✓ fluvial deposits
height at head of reach _____ m to MSL	continuous	partly entrenched	entrenched	aeolian
valley slope 1: _____		✓ aggrading		Comments

River Mouth

Characteristics	Measurements	Comments
* open/closed	right bank breakwater length _____ m	
natural/artificial	left bank breakwater length _____ m	
canalized	rock sill level _____ m to MSL	
✓ sandy	cliffs on left bank: height _____ m to MSL	
rocks on right/left bank	spit/bar: direction of growth <u>223</u> 0 + 37°	
outer bar	length of spit/bar <u>73</u> m + 412 m	
silt plume (fluvial)	length stabilized <u>NIL</u> m NIL	
✓ suspended sediment (marine)	width <u>55</u> m + 75 m	

FLOOD PLAIN AND CHANNEL FEATURES

Description of Flood Plain	Areal Measurements: % Flood Plain/Valley	Crops, Animal Husbandry
Presence		
Extent		
none	open water <u>38</u>	swamp, marsh
indefinite	sand (marine) <u>17</u>	cultivated
fragmentary	sand, silt (fluvial) <u>28</u>	built-up
✓ continuous	trees, bush <u>14</u>	
	grass <u>3</u>	
	Comments	

Channel Description N.B. - Estimate of flow stage: ~~low~~/NEAR LONG-TERM MEAN/~~high~~

Pattern	Measurements	Islands/Shoals	Type of Flow	Bar Type
straight	*thalweg <u>1287</u> m	none	stagnant/still	none
sinuous	*aerial length <u>1162</u> m	occasional	uniform water surface	✓ channel side bars
✓ irregular	*sinuosity <u>1.11</u>	frequent	uniform with rapid in reach	✓ point bars
regular meanders	*open water area <u>12.9</u> ha	split	✓ irregular	channel junction bars
irregular meanders	perimeter <u>4515</u> m	✓ braided	pool and riffle sequence	mid-channel bars
tortuous meanders	river X-sections available		✓ turbid	✓ diamond bars
bifurcated	channel slope _____ m	s = _____ m		diagonal bars
lake/s	channel width $\bar{x}$ _____ m			sand waves/large dunes
lagoon	river slope _____ m	s = <u>93.4</u> m		Comments *whole reach
	river width $\bar{x}$ <u>107.6</u> m			

Obstructions/Constructions

Natural	Degree	Man-made	Degree of Obstruction/Constriction for Each	Position (from head of reach)
✓ none	none	road bridge/s	N.R. bridge	head of reach
logs	minor	rail bridge/s	R. confined	
boulders	major	causeway		
vegetation		weir/dam		
		fish traps		
		embankment/s		
		groyne/s		
		canals		
		drainage furrows		
		others		
		Comments		

Lateral Channel Activity

Lateral Activity	Nature of Banks	Bank Vegetation	Lateral Stability
not detectable	✓ alluvium	✓ none almost	stable
downstream progression	natural levees	weak	slightly unstable
progression and cut-offs	rock/boulders	good	✓ moderately unstable
mainly cut-offs	protected/stabilized	very strong	unstable
entrenched loop development	cultivation to	left bank <u>9</u> %	highly unstable
irregular lateral activity	channel edge	right bank <u>7</u> %	Comments
✓ avulsion			

TABLE NS/IV

CLASSIFICATION OF THE LOWER REACHES OF NATAL RIVERS

NRIO NS 7

RIVER MPENJATI, ? % ESTUARINE, REACH from N.R. bridge, 1.3 km from mouth.REF. DEAT 402eAERIAL PHOTO DATE Jun/Jul '55 SCALE 1:10 000 CATCHMENT AREA 100 km², M.A.R. 25.52 m³x10⁶, No. of DAMS NIL

RIVER VALLEY AND RIVER MOUTH FEATURES

General Description of the Terrain above the Valley

Terrain	Vegetation	Land-use	Slumping	Vegetation and Land-use	Left	Right
mountainous	almost none	none	✓ none	coastal dune forest	<u>20</u>	<u>38</u>
✓ hilly	✓ grass	✓ scattered cultivation	occasional	sand		
undulating	✓ sparsely forested (0-25%)	partly cultivated	frequent	trees	<u>20</u>	<u>29</u>
plains	moderately forested (25-75%)	mainly cultivated		grass	<u>60</u>	<u>33</u>
	heavily forested (75-100%)	✓ scattered settlement		cultivated		
	✓ riverine forest: tributaries	partly built-up		built-up		
		urbanized		Comments		

Valley Characteristics

Measurements	Terraces	Relation of Channel to Valley Bottom (Vertical)	Relation of Channel to Valley Sides or Resistant Terraces (Lateral)	Surface Geology
valley length <u>1200</u> m	✓ none	not applicable	not applicable (no valley or free)	bedrock
bottom width (av.) <u>306</u> m	indefinite	not obviously degrading	✓ occasionally confined	lacustrine deposits
valley area <u>33.7</u> ha	fragmentary	or aggrading	frequently confined	✓ fluvial deposits
height at head of reach _____ m to MSL	continuous	partly entrenched	entrenched	aeolian
valley slope 1: _____		✓ aggrading		Comments

River Mouth

Characteristics

Characteristics	Measurements	Comments
✓ open/closed	right bank breakwater length _____ m	
✓ natural/✓ artificial	left bank breakwater length _____ m	
canalized	rock sill level _____ m to MSL	
✓ sandy	cliffs on left bank: height _____ m to MSL	
rocks on right/left bank	spit/bar: direction of growth <u>220</u> °	
outer bar	length of spit/bar <u>522</u> m	
silt plume (fluvial)	length stabilized <u>NIL</u> m	
✓ suspended sediment (marine)	width <u>66</u> m	

FLOOD PLAIN AND CHANNEL FEATURES

Description of Flood Plain

Presence	Extent	Areal Measurements: % Flood Plain/Valley	Crops, Animal Husbandry
none	none	open water <u>42</u>	swamp, marsh <u>19</u>
indefinite	average width <u>306</u> m	sand (marine) <u>4</u>	cultivated _____
fragmentary	maximum width <u>500</u> m	sand, silt (fluvial) <u>13</u>	built-up _____
✓ continuous	area <u>33.7</u> ha	trees, bush <u>20</u>	_____
		grass <u>2</u>	_____
		Comments	

Channel Description N.B. - Estimate of flow stage: LOW/~~medium~~ HIGH

Pattern	Measurements	Islands/Shoals	Type of Flow	Bar Type
straight	*thalweg <u>1267</u> m	none	stagnant/still	none
sinuous	*aerial length <u>1155</u> m	occasional	uniform water surface	✓ channel side bars
irregular	*sinuosity <u>1.10</u>	frequent	uniform with rapid in reach	✓ point bars
regular meanders	*open water area <u>14.3</u> ha	✓ split	✓ irregular	channel junction bars
✓ irregular meanders	perimeter <u>323.7</u> m	✓ braided	pool and riffle sequence	✓ mid-channel bars
tortuous meanders	river X-sections available		✓ turbid	diamond bars
bifurcated	channel slope _____	s = _____ m		diagonal bars
lake/s	channel width $\bar{x}$ _____ m			sand waves/large dunes
lagoon	river slope _____	s = <u>109.1</u> m		
	river width $\bar{x}$ <u>98.7</u> m			Comments *whole reach
				** to last detected "open" position

Obstructions/Constructions

Natural	Degree	Man-made	Degree of Obstruction/Constriction for Each	Position (from head of reach)
✓ none	none	road bridge/s <u>N.R. bridge</u>	<u>R. confined</u>	<u>head of reach</u>
logs	minor	rail bridge/s _____		
boulders	major	causeway _____		
vegetation		weir/dam _____		
		fish traps _____		
		embankment/s _____		
Comments		groynes _____		
		canals _____		
		drainage furrows _____		
		others _____		

Lateral Channel Activity

Lateral Activity	Nature of Banks	Bank Vegetation	Lateral Stability
not detectable	✓ alluvium	✓ none almost	stable
downstream progression	natural levees	weak	slightly unstable
progression and cut-offs	rock/boulders	good	✓ moderately unstable
mainly cut-offs	protected/stabilized	very strong	unstable
entrenched loop development	cultivation to	left bank <u>9</u> %	highly unstable
✓ irregular lateral activity	channel edge	right bank <u>NIL</u> %	Comments
avulsion			

TABLE NS7/V

CLASSIFICATION OF THE LOWER REACHES OF NATAL RIVERS

NRIO NS 7

RIVER MPENJATI, ? % ESTUARINE, REACH from N.R. Bridge, 1/3 km from mouth.REF. DEAT 402eAERIAL PHOTO DATE 5-5-63 SCALE 1:10000 CATCHMENT AREA 100 km², M.A.R. 25.52 m³x10⁶, No. of DAMS NIL

RIVER VALLEY AND RIVER MOUTH FEATURES

General Description of the Terrain above the Valley			Valley Sides (Not Well-defined)		
Terrain	Vegetation	Land-use	Slumping	Vegetation and Land-use	Left Right
mountainous	almost none	none	✓ none	coastal dune forest	20 38
✓ hilly	✓ grass	✓ scattered cultivation	occasional	sand	
undulating	✓ sparsely forested (0-25%)	partly cultivated	frequent	trees	24 33
plains	moderately forested (25-75%)	mainly cultivated		grass	56 29
	heavily forested (75-100%)	✓ scattered settlement		cultivated	
	* riverine forest: tributaries	partly built-up		built-up	
		urbanized			
				Comments	* very little

Valley Characteristics

Measurements	Terraces	Relation of Channel to Valley Bottom (Vertical)	Relation of Channel to Valley Sides or Resistant Terraces (Lateral)	Surface Geology
valley length <u>1200</u> m	none	not applicable	not applicable (no valley or free)	bedrock
bottom width (av.) <u>306</u> m	indefinite	not obviously degrading	✓ occasionally confined	lacustrine deposits
valley area <u>33.7</u> ha	* fragmentary	or aggrading	frequently confined	✓ fluvial deposits
height at head	continuous	partly entrenched	entrenched	aeolian
of reach _____ m to MSL		entrenched		
valley slope 1:		✓ aggrading		
				Comments

River Mouth

Characteristics	Measurements		Comments
* open/closed	right bank breakwater length _____ m		* about to close
✓ natural/artificial	left bank breakwater length _____ m		
canalized	rock sill level _____ m to MSL		
✓ sandy	cliffs on left bank: height _____ m to MSL		
rocks on right/left bank	spit/_____ direction of growth <u>212</u> °		
outer bar	length of spit/_____ <u>310</u> m		
silt plume (fluvial)	length stabilized <u>NIL</u> m		
✓ suspended sediment (marine)	width <u>79</u> m		

FLOOD PLAIN AND CHANNEL FEATURES

Description of Flood Plain		Areal Measurements: % Flood Plain/Valley	Crops, Animal Husbandry
Presence	Extent		
none	none	open water <u>25</u>	swamp, marsh <u>18</u>
indefinite	average width <u>306</u> m	sand (marine) <u>6</u>	cultivated _____
fragmentary	maximum width <u>500</u> m	sand, silt (fluvial) <u>32</u>	built-up _____
✓ continuous	area <u>33.7</u> ha	trees, bush <u>18</u>	_____
		grass <u>1</u>	_____
			Comments

Channel Description N.B. - Estimate of flow stage: ~~near~~/NEAR LONG-TERM MEAN/~~near~~

Pattern	Measurements	Islands/Shoals	Type of Flow	Bar Type
✓ straight	*thalweg <u>1287</u> m	none	stagnant/still	none
sinuous	*aerial length <u>1206</u> m	occasional	uniform water surface	✓ channel side bars
irregular	*sinuosity <u>1.07</u>	frequent	uniform with rapid in reach	✓ point bars
regular meanders	*open water area <u>8.4</u> ha	split	✓ irregular	channel junction bars
irregular meanders	perimeter <u>4016</u> m	✓ braided	pool and riffle sequence	mid-channel bars
tortuous meanders	river X-sections available		✓ turbid	diamond bars
bifurcated	channel slope _____			diagonal bars
lake/s	channel width $\bar{x}$ _____ m	s = _____ m		sand waves/large dunes
lagoon	river slope _____	s = <u>28.0</u> m		
	river width $\bar{x}$ <u>47.0</u> m			
				Comments

Obstructions/Constructions

Natural	Degree	Man-made	Degree of Obstruction/Constriction for Each	Position (from head of reach)
✓ none	none	road bridge/s <u>N.R. bridge</u>	<u>R. confined</u>	<u>head of reach</u>
logs	minor	rail bridge/s _____		
boulders	major	causeway _____		
vegetation		weir/dam _____		
		fish traps _____		
		embankment/s _____		
Comments		groynes _____		
		canals _____		
		drainage furrows _____		
		others _____		

Lateral Channel Activity

Lateral Activity	Nature of Banks	Bank Vegetation	Lateral Stability
not detectable	✓ alluvium	✓ none almost	stable
downstream progression	natural levees	weak	slightly unstable
progression and cut-offs	rock/boulders	good	✓ moderately unstable
mainly cut-offs	protected/stabilized	very strong	unstable
entrenched loop development	cultivation to	left bank <u>10</u> %	highly unstable
irregular lateral activity	channel edge	right bank <u>NIL</u> %	Comments
✓ avulsion			

TABLE NS 7/VI

CLASSIFICATION OF THE LOWER REACHES OF NATAL RIVERS

NR10 NS 7

RIVER MPENJATI, ? % ESTUARINE, REACH from N.R. Bridge, 1.4 km from mouth.REF. DEAT 402eAERIAL PHOTO DATE 24-6-69 SCALE 1:10 000 CATCHMENT AREA 100 km², M.A.R. 25,52 m³/106, No. of DAMS NIL

RIVER VALLEY AND RIVER MOUTH FEATURES

General Description of the Terrain above the Valley

Valley Sides (~~Not~~ Well-defined)

Terrain	Vegetation	Land-use	Slumping	Vegetation and Land-use	Left	Right
mountainous	almost none	none	none	coastal dune forest	20	38
✓ hilly	✓ grass	✓ scattered cultivation	occasional	sand		
undulating	✓ sparsely forested (0-25%)	partly cultivated	frequent	trees	28	33
plains	moderately forested (25-75%)	mainly cultivated		grass	52	29
	heavily forested (75-100%)	✓ scattered settlement		cultivated		
	*riverine forest: tributaries	partly built-up		built-up		
		urbanized				

Comments * very little

Valley Characteristics

Measurements	Terraces	Relation of Channel to Valley Bottom (Vertical)	Relation of Channel to Valley Sides or Resistant Terraces (Lateral)	Surface Geology
valley length <u>1200</u> m	none	not applicable	not applicable (no valley or free)	bedrock
bottom width (av.) <u>306</u> m	indefinite	not obviously degrading	occasionally confined	lacustrine deposits
valley area <u>33,7</u> ha	*fragmentary	or aggrading	frequently confined	✓fluvial deposits
height at head	continuous	partly entrenched	entrenched	aeolian
of reach _____ m to MSL		entrenched		
valley slope 1: _____		✓aggrading		

Comments * Left bank

River Mouth

Characteristics

Measurements

*open/ closed	right bank breakwater length _____ m			
✓natural/ artificial	left bank breakwater length _____ m			
canalized	rock sill _____ level _____ m to MSL			
✓sandy	cliffs on left bank: height _____ m to MSL			
rocks on right/left bank	spit/ bar : direction of growth <u>213</u> °			
outer bar	length of spit/ bar <u>580</u> m			
silt plume (fluvial)	length stabilized <u>NIL</u> m			
✓suspended sediment (marine)	width <u>70</u> m			

Comments * about to close

FLOOD PLAIN AND CHANNEL FEATURES

Description of Flood Plain

Presence	Extent	Areal Measurements: % Flood Plain/Valley	Crops, Animal Husbandry
none	none	open water <u>15</u>	swamp, marsh <u>27</u>
indefinite	average width <u>306</u> m	sand (marine) <u>9</u>	cultivated _____
fragmentary	maximum width <u>500</u> m	sand, silt (fluvial) <u>23</u>	built-up _____
✓continuous	area <u>33,7</u> ha	trees, bush <u>25</u>	_____
		grass <u>1</u>	_____

Comments _____

Channel Description N.B. - Estimate of flow stage: ~~LOW~~/NEAR LONG-TERM MEAN/~~HIGH~~

Pattern	Measurements	Islands/Shoals	Type of Flow	Bar Type
straight	*thalweg <u>1416</u> m	none	stagnant/still	none
sinuous	*aerial length <u>1242</u> m	occasional	uniform water surface	✓channel side bars
✓irregular	*sinuosity <u>1,14</u>	frequent	uniform with rapid in reach	✓point bars
regular meanders	*open water area <u>5,0</u> ha	split	✓irregular	channel junction bars
irregular meanders	perimeter <u>3100</u> m	✓braided	pool and riffle sequence	mid-channel bars
tortuous meanders	river X-sections available		✓turbid	diamond bars
bifurcated	channel slope _____			diagonal bars
lake/s	channel width $\bar{x}$ _____ m	s = _____ m		sand waves/large dunes
lagoon	river slope _____	s = <u>13,2</u> m		
	river width $\bar{x}$ <u>29,3</u> m			

Comments * whole reach

Obstructions/Constructions

Natural	Degree	Man-made	Degree of Obstruction/Constriction for Each	Position (from head of reach)
✓none	none	road bridge/s <u>N.R. bridge</u>	R. confined	head of reach
logs	minor	rail bridge/s _____		
boulders	major	causeway _____		
vegetation		weir/dam _____		
		fish traps _____		
		embankment/s _____		
		groynes _____		
		canals _____		
		drainage furrows _____		
		others _____		

Lateral Channel Activity

Lateral Activity	Nature of Banks	Bank Vegetation	Lateral Stability
not detectable	✓alluvium	✓none almost	stable
downstream progression	natural levees	weak	slightly unstable
progression and cut-offs	rock/boulders	good	✓moderately unstable
mainly cut-offs	protected/stabilized	very strong	unstable
entrenched loop development	cultivation to	left bank <u>10</u> %	highly unstable
irregular lateral activity	channel edge	right bank <u>NIL</u> %	
✓avulsion			Comments _____

TABLE NS 7/VII

CLASSIFICATION OF THE LOWER REACHES OF NATAL RIVERS

NRIO NS 7

RIVER MPENJATI, 93 % ESTUARINE, REACH from N.R. Bridge, 1,2 km from mouth.REF. DEA T 402eAERIAL PHOTO DATE 23-6-76 SCALE 1:10 000 CATCHMENT AREA 100 km², M.A.R. 25,52 m³x10⁶, No. of DAMS NIL
(Orthophoto)

RIVER VALLEY AND RIVER MOUTH FEATURES

General Description of the Terrain above the Valley

Terrain	Vegetation	Land-use	Slumping	Vegetation and Land-use	Left	Right
mountainous	almost none	none	✓ none	coastal dune forest	20	38
✓ hilly	✓ grass	✓ scattered cultivation	occasional	sand		
undulating	✓ sparsely forested (0-25%)	partly cultivated	frequent	trees	20	33
plains	moderately forested (25-75%)	mainly cultivated		grass	60	29
	heavily forested (75-100%)	✓ scattered settlement		cultivated		
	* riverine forest: tributaries	partly built-up		built-up		
		urbanized				
Comments * very little						

Valley Characteristics

Measurements	Terraces	Relation of Channel to Valley Bottom (Vertical)	Relation of Channel to Valley Sides or Resistant Terraces (Lateral)	Surface Geology
valley length <u>1200</u> m	none	not applicable	not applicable (no valley or free)	bedrock
bottom width (av.) <u>306</u> m	indefinite	not obviously degrading	✓ occasionally confined	lacustrine deposits
valley area <u>33,7</u> ha	* fragmentary	or aggrading	frequently confined	✓ fluvial deposits
* height at head	continuous	partly entrenched	entrenched	aeolian
of reach $\pm$ <u>+2,6</u> m to MSL		entrenched		
valley slope $\pm$ <u>1:462</u>		✓ aggrading		
Comments * from orthophoto & 1929 N.R. bridge x-section				
* very little				

River Mouth

Characteristics	Measurements	Comments
* open/obscured	right bank breakwater length _____ m	Comments * possibly a result of "mechanical breaching": was "closed" & W.L. high on 12-6-76 & run-off decreasing
* natural/artificial	left bank breakwater length _____ m	
canalized	rock sill level _____ m to MSL	
✓ sandy	cliffs on left bank: height _____ m to MSL	
rocks on right/left bank	spit/bar: direction of growth <u>217</u> °	
outer bar	length of spit/bar <u>275</u> m	** vegetation growth
silt plume (fluvial)	* length stabilized <u>100</u> m	
✓ suspended sediment (marine)	width <u>80</u> m	

FLOOD PLAIN AND CHANNEL FEATURES

Description of Flood Plain	Areal Measurements: % Flood Plain/Valley	Crops, Animal Husbandry
Presence	Extent	
none	none	
indefinite	average width <u>306</u> m	open water <u>12</u> swamp, marsh <u>25</u>
fragmentary	maximum width <u>500</u> m	sand (marine) <u>12</u> cultivated _____
✓ continuous	area <u>33,7</u> ha	sand, silt (fluvial) <u>20</u> built-up _____
		trees, bush <u>30</u> _____
		grass <u>1</u> _____
Comments		

Channel Description N.B. - Estimate of flow stage: LOW/NEAR LOW/NEAR HIGH

Pattern	Measurements	Islands/Shoals	Type of Flow	Bar Type
straight	*thalweg <u>1248</u> m	none	stagnant/still	none
sinuous	*aerial length <u>1169</u> m	occasional	uniform water surface	✓ channel side bars
✓ irregular	*sinuosity <u>1,07</u>	frequent	uniform with rapid in reach	✓ point bars
regular meanders	*open water area <u>4,2</u> ha	split	✓ irregular	channel junction bars
irregular meanders	perimeter <u>3320</u> m	✓ braided	pool and riffle sequence	mid-channel bars
tortuous meanders	river X-sections available		✓ turbid	diamond bars
bifurcated	channel slope _____	s = _____ m		diagonal bars
lake/s	channel width $\bar{x}$ _____ m	s = <u>18,4</u> m		sand waves/large dunes
lagoon	river slope _____			
	river width $\bar{x}$ <u>26,0</u> m			
Comments *whole reach				

Obstructions/Constructions

Natural	Degree	Man-made	Degree of Obstruction/Constriction for Each	Position (from head of reach)
✓ none	none	road bridge/s <u>N.R. bridge</u>	<u>R. confined</u>	<u>head of reach</u>
logs	minor	rail bridge/s _____		
boulders	major	causeway _____		
vegetation		weir/dam _____		
		fish traps _____		
		embankment/s _____		
Comments		groynes _____		
		canals _____		
		drainage furrows _____		
		others <u>sand extraction</u>	<u>± channel width</u>	<u>180, 380 + 700 m</u>

Lateral Channel Activity

Lateral Activity	Nature of Banks	Bank Vegetation	Lateral Stability
not detectable	✓ alluvium	✓ none almost	stable
downstream progression	natural levees	weak	slightly unstable
progression and cut-offs	rock/boulders	good	✓ moderately unstable
mainly cut-offs	protected/stabilized	very strong	unstable
entrenched loop development	cultivation to	left bank <u>9</u> %	highly unstable
✓ irregular lateral activity	channel edge	right bank <u>NIL</u> %	Comments
avulsion			

TABLE NS 7/VIII

CLASSIFICATION OF THE LOWER REACHES OF NATAL RIVERS

NR10 NS 7

RIVER MPENIATI, 67 % ESTUARINE, REACH from N.R. Bridge, 1.4 km from mouth. REF. DEAT 402e
 AERIAL PHOTO DATE 2-8-83 SCALE 1:10 000 CATCHMENT AREA 100 km², M.A.R. 25,52 m³/106, No. of DAMS NIL

RIVER VALLEY AND RIVER MOUTH FEATURES

General Description of the Terrain above the Valley

Terrain	Vegetation	Land-use	Slumping	Vegetation and Land-use	Left	Right
mountainous	almost none	none	✓ none	coastal dune forest	20	38
✓ hilly	✓ grass	✓ scattered cultivation	occasional	sand		
undulating	✓ sparsely forested (0-25%)	partly cultivated	frequent	trees	20	33
plains	moderately forested (25-75%)	mainly cultivated		grass	32	26
	heavily forested (75-100%)	✓ scattered settlement		cultivated	28	
	riverine forest: tributaries	partly built-up		built-up		3
		urbanized				

Comments * Freeway construction

Valley Characteristics

Measurements	Terraces	Relation of Channel to Valley Bottom (Vertical)	Relation of Channel to Valley Sides or Resistant Terraces (Lateral)	Surface Geology
valley length <u>1200</u> m	none	not applicable	not applicable (no valley or free)	bedrock
bottom width (av.) <u>306</u> m	indefinite	not obviously degrading	occasionally confined	lacustrine deposits
valley area <u>33.7</u> ha	* fragmentary	or aggrading	frequently confined	✓ fluvial deposits
height at head of reach _____ m to MSL	continuous	partly entrenched	entrenched	aeolian
valley slope 1: _____		entrenched		
		✓ aggrading		

Comments * Left bank

River Mouth

Characteristics	Measurements
* open/closed	right bank breakwater length _____ m
natural/artificial	left bank breakwater length _____ m
canalized	rock sill level _____ m to MSL
✓ sandy	cliffs on left bank: height _____ m to MSL
rocks on right/left bank	spit/bar: direction of growth <u>217</u> °
outer bar	length of spit/bar <u>472</u> m
silt plume (fluvial)	* length stabilized <u>100</u> m
✓ suspended sediment (marine)	width <u>94</u> m

Comments * overflow channel** vegetation growth

FLOOD PLAIN AND CHANNEL FEATURES

Description of Flood Plain

Presence	Extent	Area Measurements: % Flood Plain/Valley	Crops, Animal Husbandry
none	none	open water <u>32</u>	swamp, marsh <u>19</u>
indefinite	average width <u>306</u> m	sand (marine) <u>12</u>	cultivated _____
fragmentary	maximum width <u>500</u> m	sand, silt (fluvial) <u>5</u>	built-up <u>5</u>
✓ continuous	area <u>33.7</u> ha	trees, bush <u>26</u>	_____
		grass <u>1</u>	_____

Comments _____

Channel Description N.B. - Estimate of flow stage: LOW/NEAR LOW/NEAR HIGH/HIGH

Pattern	Measurements	Islands/Shoals	Type of Flow	Bar Type
* straight	*thalweg <u>1425</u> m	none	✓ <u>sluggish</u> /still	none
sinuous	*aerial length <u>1197</u> m	✓ occasional	uniform water surface	✓ channel side bars
irregular	*sinuosity <u>1.19</u>	frequent	uniform with rapid in reach	✓ point bars (at head of reach)
regular meanders	*open water area <u>10.6</u> ha	split	irregular	channel junction bars
irregular meanders	perimeter <u>351.0</u> m	✓ braided	pool and riffle sequence	mid-channel bars
tortuous meanders	river X-sections available		turbid	diamond bars
bifurcated	channel slope _____			diagonal bars
lake/s	channel width $\bar{x}$ _____ m	s = _____ m		sand waves/large dunes
lagoon	river slope _____	s = <u>63.6</u> m		
	river width $\bar{x}$ <u>68.3</u> m			

Comments * whole reach** H.W.L. behind spit/bar

Obstructions/Constructions

Natural	Degree	Man-made	Degree of Obstruction/Constriction for Each	Position (from head of reach)
✓ none	none	road bridge/s <u>N.R. + Freeway (under construction)</u>	R. confined	<u>0.7400 m</u>
logs	minor	rail bridge/s _____		
boulders	major	causeway _____		
vegetation		weir/dam _____		
		fish traps _____		
		embankment/s _____		
		groynes _____		
		canals _____		
		drainage furrows _____		
		others _____		

Lateral Channel Activity

Lateral Activity	Nature of Banks	Bank Vegetation	Lateral Stability
* not detectable	✓ alluvium	none	stable
downstream progression	natural levees	✓ weak	slightly unstable
progression and cut-offs	rock/boulders	good	✓ moderately unstable
mainly cut-offs	protected/stabilized	very strong	unstable
entrenched loop development	cultivation to	left bank <u>12</u> %	highly unstable
irregular lateral activity	channel edge	right bank <u>12</u> %	
avulsion			Comments * <u>H.W.L. behind spit/bar</u>

TABLE NS 7/IX

CLASSIFICATION OF THE LOWER REACHES OF NATAL RIVERS

NRIO NS 7

RIVER MPENZATI, ? % ESTUARINE, REACH from N.R. Bridge, 1.5 km from mouth. REF. DE A T 402e
 AERIAL PHOTO DATE 6-2-84 SCALE 1:10000 CATCHMENT AREA 100 km², M.A.R. 25.52 m³x10⁶, No. of DAMS NIL

RIVER VALLEY AND RIVER MOUTH FEATURES

General Description of the Terrain above the Valley

Valley Sides (~~Not~~ Well-defined)

Terrain	Vegetation	Land-use	Slumping	Vegetation and Land-use	Left	Right
mountainous	almost none	none	✓ none	coastal dune forest	20	38
✓ hilly	✓ grass	✓ scattered cultivation	occasional	sand		
undulating	✓ sparsely forested (0-25%)	partly cultivated	frequent	trees	16	33
plains	moderately forested (25-75%)	mainly cultivated		grass	28	26
	heavily forested (75-100%)	✓ scattered settlement		cultivated	32	
	riverine forest: tributaries	partly built-up		built-up	* 4	* 3
		urbanized				
Comments * Freeway construction						

Valley Characteristics

Measurements	Terraces	Relation of Channel to Valley Bottom (Vertical)	Relation of Channel to Valley Sides or Resistant Terraces (Lateral)	Surface Geology
valley length <u>1200</u> m	none	not applicable	not applicable (no valley or free)	bedrock
bottom width (av.) <u>306</u> m	indefinite	not obviously degrading	✓ occasionally confined	lacustrine deposits
valley area <u>33.7</u> ha	* fragmentary	or aggrading	frequently confined	✓ fluvial deposits
height at head of reach _____ m to MSL	continuous	partly entrenched	entrenched	aeolian
valley slope 1: _____		✓ aggrading		
Comments * Left bank				

River Mouth

Characteristics

Measurements

✓ open/ closed	right bank breakwater length _____ m	Comments * vegetation growth
✓ natural/ artificial	left bank breakwater length _____ m	
canalized	rock sill level _____ m to MSL	
✓ sandy	cliffs on left bank: height _____ m to MSL	
rocks on right/left bank	spit/ bar : direction of growth <u>214</u> °	
outer bar	length of spit/ bar <u>5.17</u> m	
silt plume (fluvial)	* length stabilized <u>100</u> m	
✓ suspended sediment (marine)	width <u>71</u> m	

FLOOD PLAIN AND CHANNEL FEATURES

Description of Flood Plain

Presence	Extent	Areal Measurements: % Flood Plain/Valley		Crops, Animal Husbandry
none	none	open water <u>17</u>	swamp, marsh <u>19</u>	
indefinite	average width <u>306</u> m	sand (marine) <u>7</u>	cultivated	
fragmentary	maximum width <u>500</u> m	sand, silt (fluvial) <u>17</u>	built-up <u>8</u>	
continuous	area <u>33.7</u> ha	trees, bush <u>31</u>		
		grass <u>1</u>		
Comments				

Channel Description N.B. - Estimate of flow stage: ~~LOW~~/NEAR LONG-TERM MEAN/~~HIGH~~

Pattern	Measurements	Islands/Shoals	Type of Flow	Bar Type
straight	*thalweg <u>14.97</u> m	✓ none	stagnant/still	none
sinuous	*aerial length <u>1237</u> m	occasional	uniform water surface	✓ channel side bars
✓ irregular	*sinuosity <u>1.21</u>	frequent	uniform with rapid in reach	✓ point bars
regular meanders	*open water area <u>5.8</u> ha	split	✓ irregular	channel junction bars
irregular meanders	perimeter <u>4037</u> m	braided	pool and riffle sequence	mid-channel bars
tortuous meanders	river X-sections available		✓ turbid	diamond bars
bifurcated	channel slope _____ m	s = _____ m		diagonal bars
lake/s	channel width $\bar{x}$ _____ m	s = <u>35.4</u> m		sand waves/large dunes
lagoon	river slope _____ m			
	river width $\bar{x}$ <u>37.6</u> m			
Comments *whole reach				

Obstructions/Constructions

Natural	Degree	Man-made	Degree of Obstruction/Constriction for Each	Position (from head of reach)
✓ none	none	road bridge/s <u>N.R. & Freeway</u>	<u>R. confined</u>	<u>0 & 400 m</u>
logs	minor	rail bridge/s _____		
boulders	major	causeway _____		
vegetation		weir/dam _____		
		fish traps _____		
		embankment/s _____		
		groynes _____		
		canals _____		
		drainage furrows _____		
		others _____		
Comments				

Lateral Channel Activity

Lateral Activity	Nature of Banks	Bank Vegetation	Lateral Stability
not detectable	✓ alluvium	none	stable
downstream progression	natural levees	✓ weak	slightly unstable
progression and cut-offs	rock/boulders	good	✓ moderately unstable
mainly cut-offs	protected/stabilized	very strong	unstable
entrenched loop development	cultivation to	left bank <u>12</u> %	highly unstable
irregular lateral activity	channel edge	right bank <u>12</u> %	
✓ avulsion			Comments

TABLE NS 7/X

RIVER WIDTHS

MPENJATI NS 7

Station	Approx. distance along 1976 river course from NR bridge	River widths (m)										$\bar{x}$	s	V%					
		Date								6.2.84	2.8.83				23.6.76	24.6.69	5.5.63	Jun/Jul 55	Dec 1943
		2.5.37	Dec 1943	Jun/Jul 55	5.5.63	24.6.69	23.6.76	2.8.83	6.2.84										
1	0	25	60	40	40	30	24	30	20	33,6	12,9	38,2							
2	200	25	66 (10+56)	45	50	34	16	54	34	40,5	16,3	40,3							
3	400 (freeway 1983)	36	56 (5+15+36)	30	40	34	24	8	20	31,0	14,3	46,3							
4	600	50	136 (6+130)	94	50	45	18 (5+8+5)	88	40	65,1	38,0	58,3							
5	800	215 (140+75)	140 (75+20+45)	170 (96+74)	44	28	24	110	22 (12+5+5)	94,1	75,3	80,0							
6	1 000	274	290	312	100 (5+92+3)	32 (4+28)	66 (60+6)	182 (5+5+172)	115 (60+55)	171,4	109,1	63,7							
7	1 200 (mouth)	6	5	0	5	2	10	6	12	5,8	3,9	67,5							
$\bar{x}$		90,1	107,6	98,7	47,0	29,3	26,0	68,3	37,6	63,1									
s		107,6	93,4	109,1	28,0	13,2	18,4	63,6	35,4										
V%		119,4	86,8	110,5	59,5	45,1	70,8	93,1	94,3										

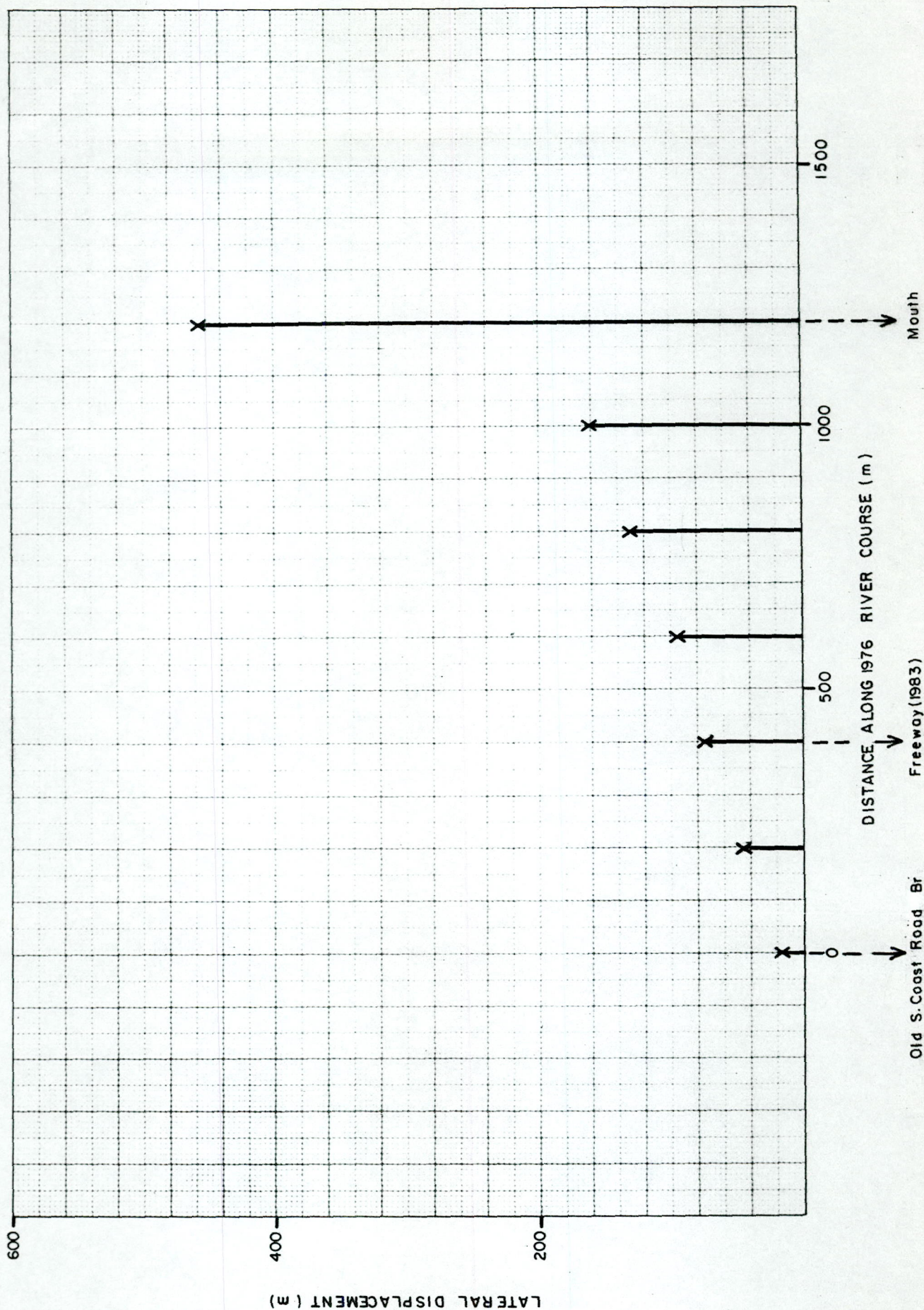
TABLE NS 7/XI

LATERAL STABILITY

MPENJATI NS 7

Station	Approx. distance along 1976 river course from NR bridge	Distance from maximum observed L.B. position to mid-river (m)										Max - Min	$\bar{x}$	s	V%
		Date													
		2.5.37	Dec 43	Jun/Jul 55	5.5.63	24.6.69	23.6.76	2.8.83	6.2.84						
		2.5.37	Dec 43	Jun/Jul 55	5.5.63	24.6.69	23.6.76	2.8.83	6.2.84						
1	0	12,5	30,0	30,0	25,0	30,0	22,0	20,0	13,0	17,5	22,8	7,3	31,9		
2	200	95,0	85,9	80,0	70,0	70,0	95,0	117,0	124,0	54,0	92,1	20,1	21,8		
3	400 (Freeway 1983)	154,0	95,0	174,0	155,0	162,0	157,0	155,0	160,0	79,0	151,5	23,7	15,7		
4	600	60,0	119,6	140,0	155,0	158,0	153,9	135,0	116,0	98,0	129,7	32,3	24,9		
5	800	137,7	190,4	184,5	268,0	270,0	243,0	245,0	217,5	132,3	219,5	46,1	21,0		
6	1 000	133,0	145,0	187,0	183,0	298,9	227,0	191,8	203,3	161,9	196,6	50,6	25,8		
7	1 200 (mouth)	208,0	2,5	N.R.	208,0	460,0	180,0	362,0	407,0	457,5	261,1	158,2	60,6		
$\bar{x}$		114,9	95,5	132,6	152,0	207,0	154,0	175,1	177,3	142,9	153,3		28,8		
s		64,7	64,6	64,4	82,1	147,7	76,2	107,7	121,8	146,7	151,1		14,9		
V%		56,3	67,7	48,5	54,0	71,4	49,5	61,5	68,7	102,7			51,6		

Average lateral displacement 1937-1984 = 142,9 m (i.e. 226,5% $\bar{R}$)
 Average coefficient of variation 1937-1984 = 28,8%

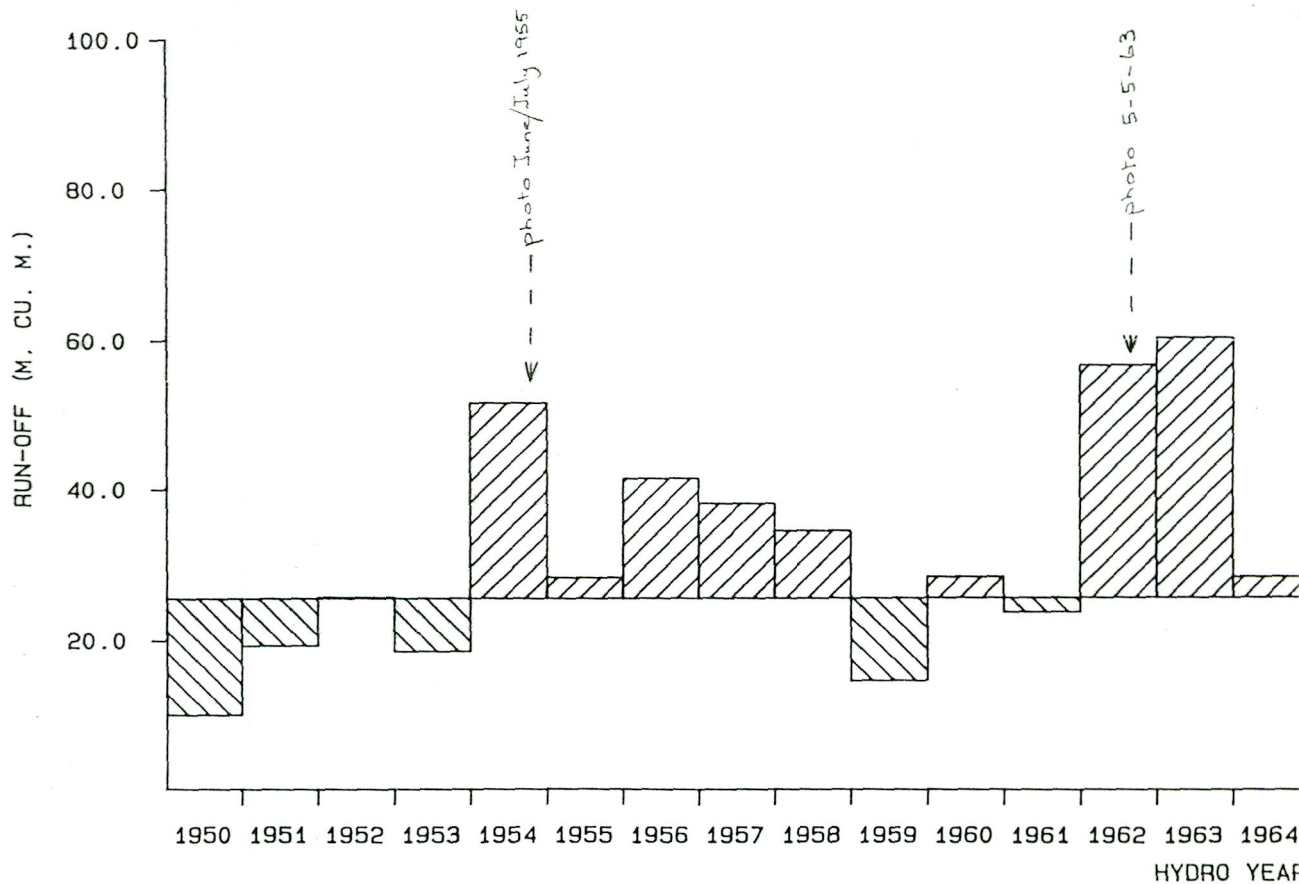
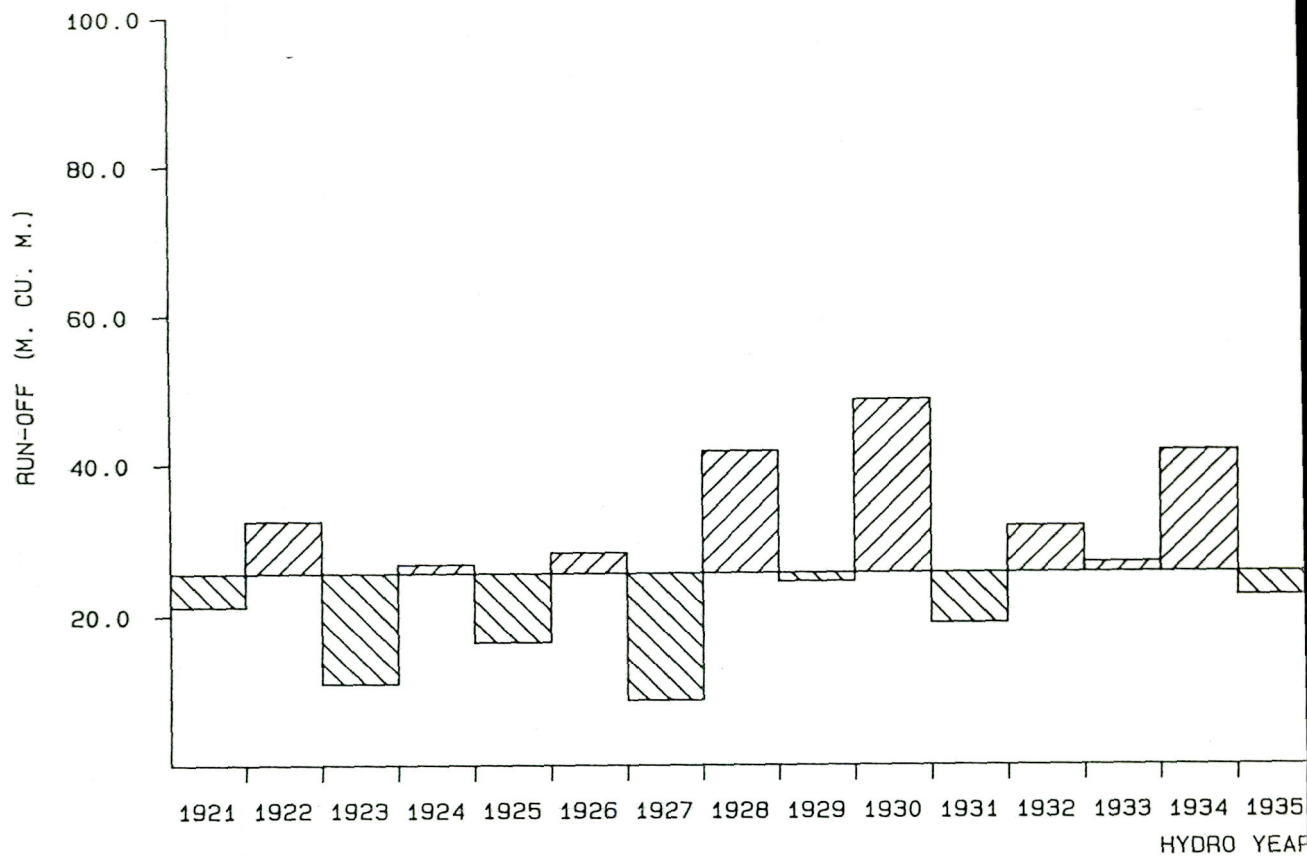


NATAL ESTUARIES: MPENJATI

THALWEG DISPLACEMENT
(1937 - 1984)

FIGURE

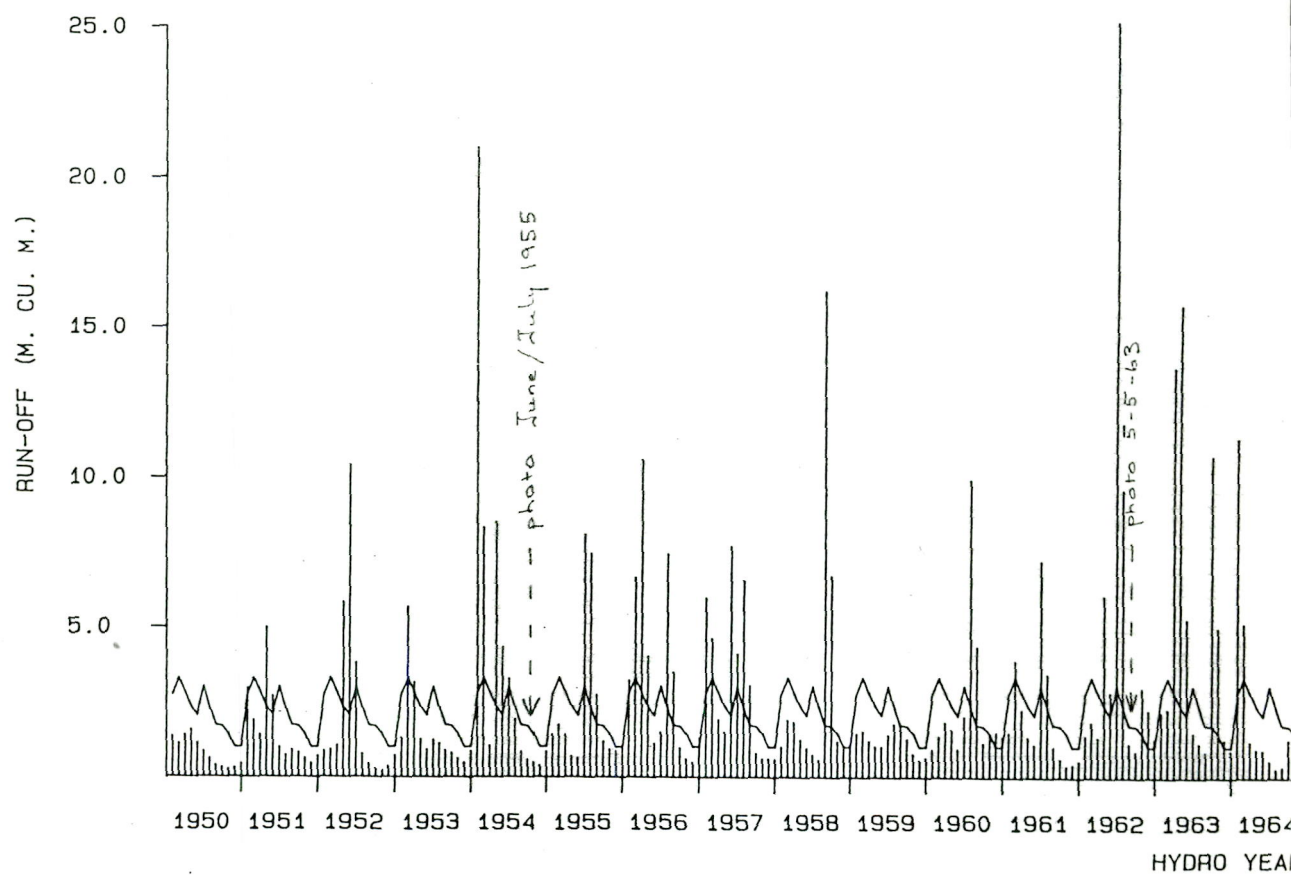
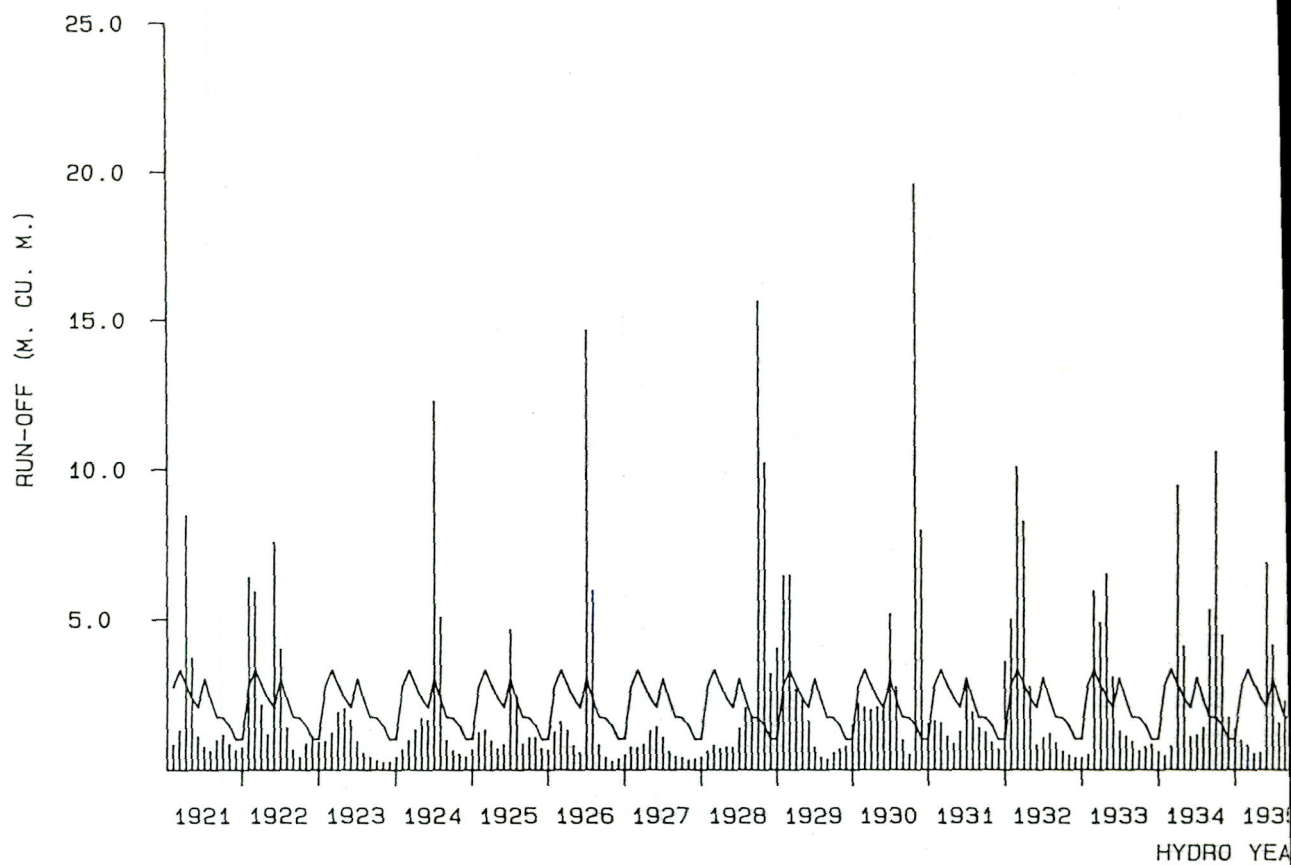
NS 7/1



TRACED : COMPLIT
 CHECKED:
 DATE :
 REF. :

NATAL ESTUARIES : MPENJATI
 SIMULATED ANNUAL RUN-OFF
 1921-1976

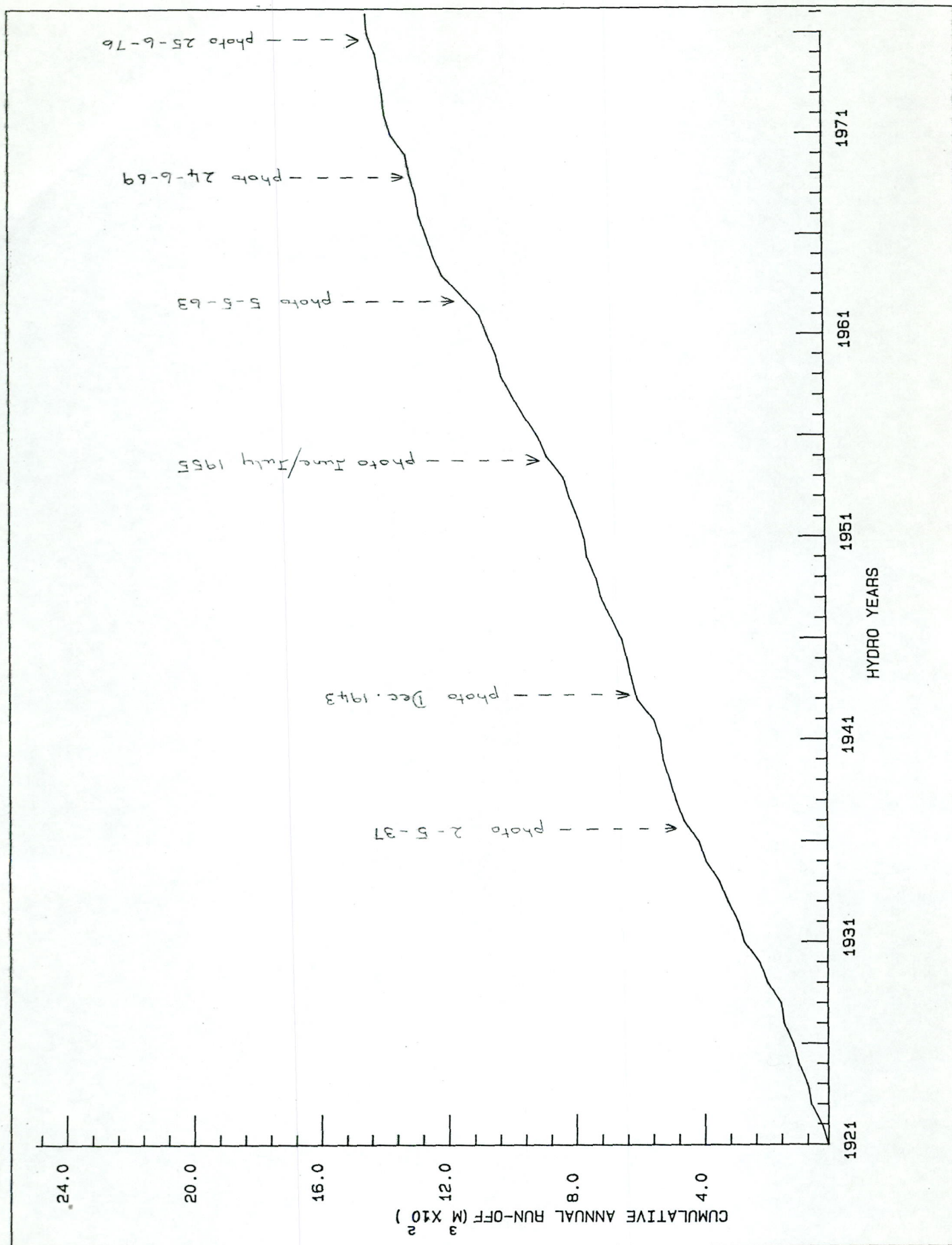
FIGURE
 NS 7/2



TRACED : COMPLIT
CHECKED:
DATE :
REF. :

NATAL ESTUARIES : MPENJATI
SIMULATED MONTHLY RUN-OFF
1921-1976

FIGURE
NS 7/3



TRACED : COMPLIT

CHECKED:

DATE :

REF. :

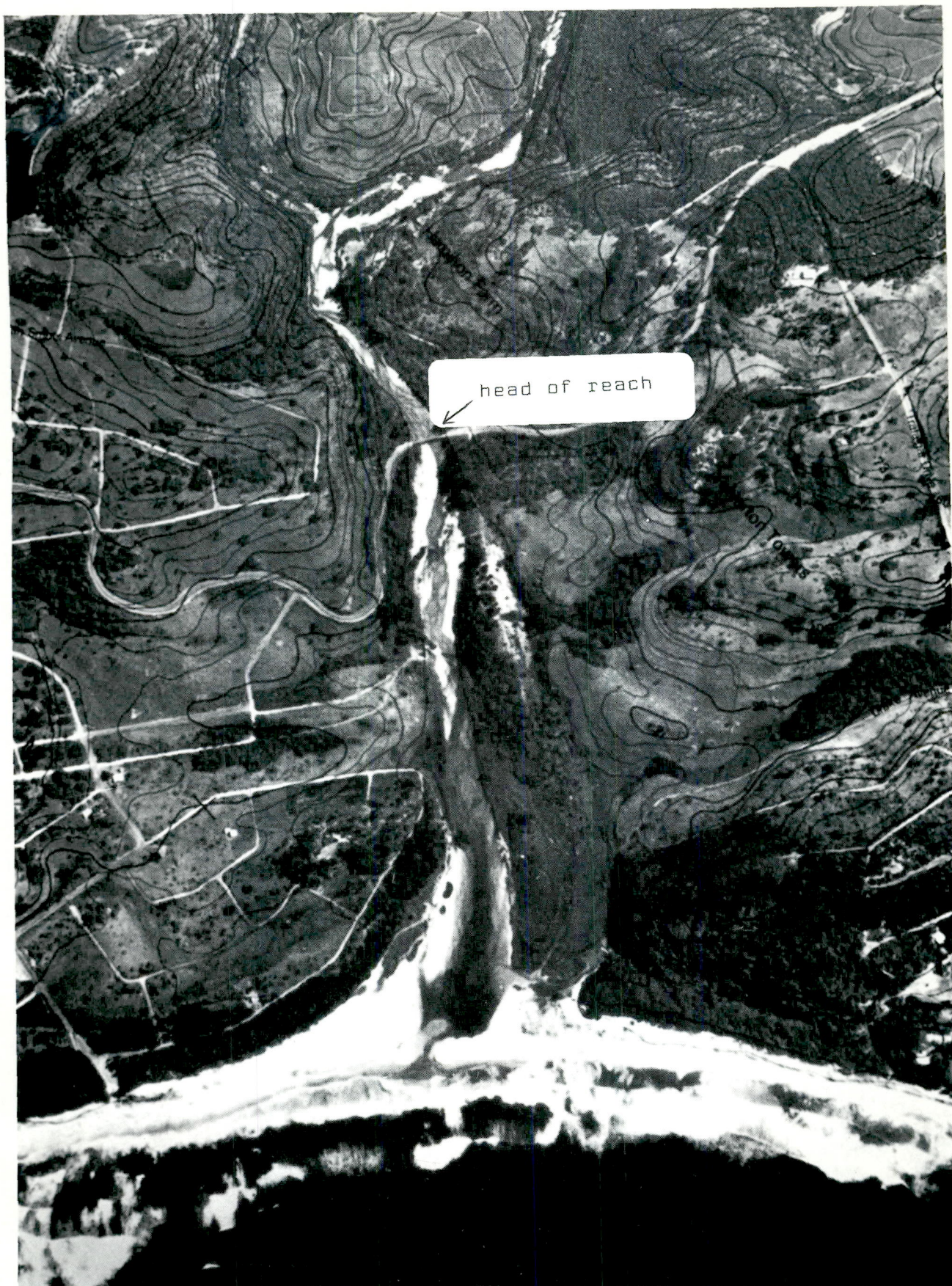
NATAL ESTUARIES: MPENJATI

CUMULATIVE ANNUAL RUN-OFF

FIGURE

NS 7/4

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SCALE: 1 : 10 000 approx

TRACED :
CHECKED :
DATE :
REF :

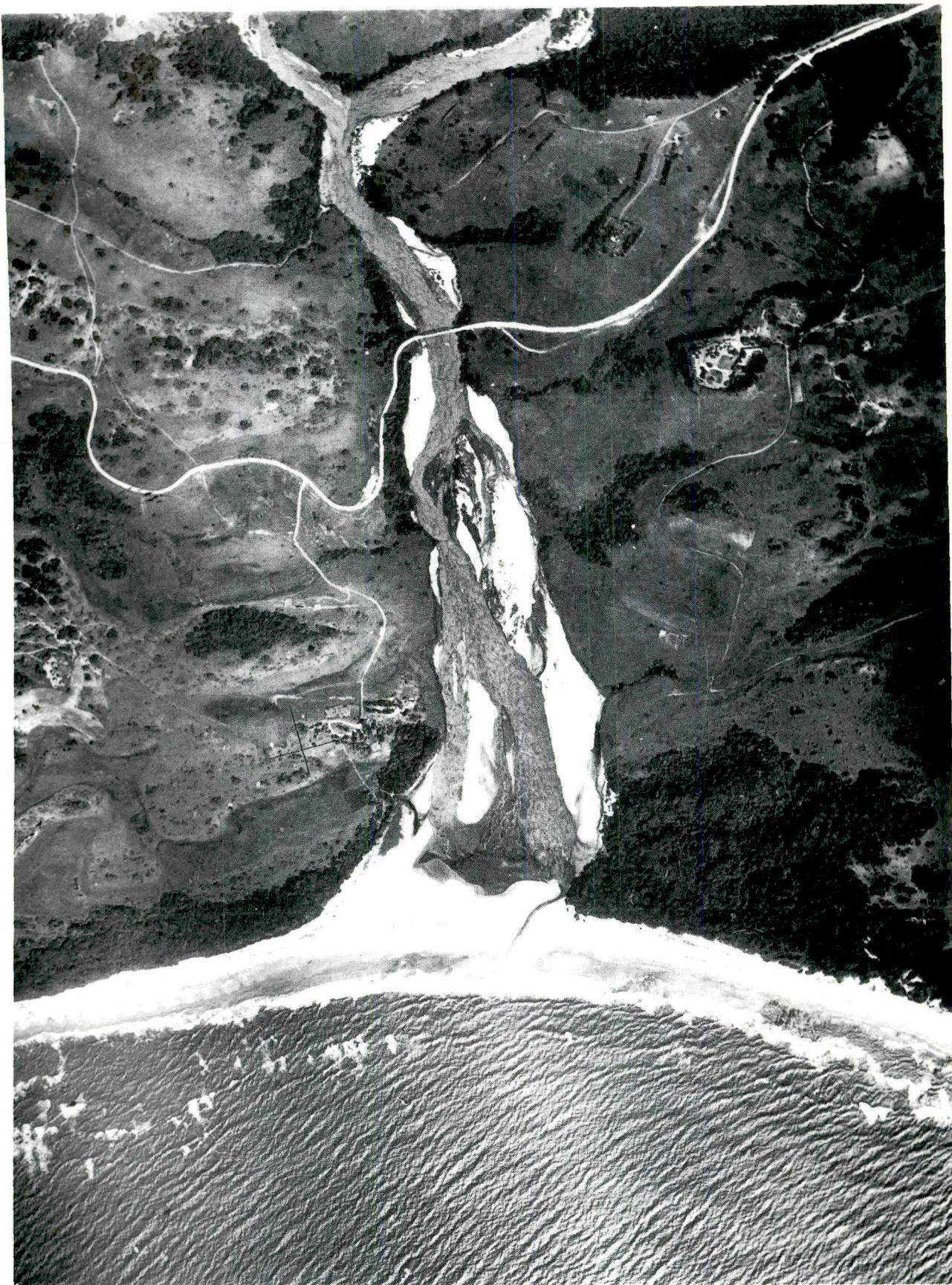
NATAL ESTUARIES : MPENJATI
23 - 6 - 76 (ORTHOPHOTO)

PHOTOGRAPH
NS 7/1



SCALE: 1 : 10 000 approx.

TRACED : CHECKED : DATE : REF :	NATAL ESTUARIES : MPENJATI 2 - 5 - 37 (13h12)	PHOTOGRAPH NS 7/2
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



SCALE: 1 : 10 000 approx.

TRACED :
CHECKED :
DATE :
REF :

NATAL ESTUARIES : MPENJATI
DECEMBER 1943 (10h12)

PHOTOGRAPH
NS 7/3



SCALE: 1 : 10 000 approx

TRACED :
CHECKED :
DATE :
REF :

NATAL ESTUARIES : MPENJATI
JUNE / JULY 1955 (11h05)

PHOTOGRAPH
NS 7/4

NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY



SCALE: 1 : 10 000 approx

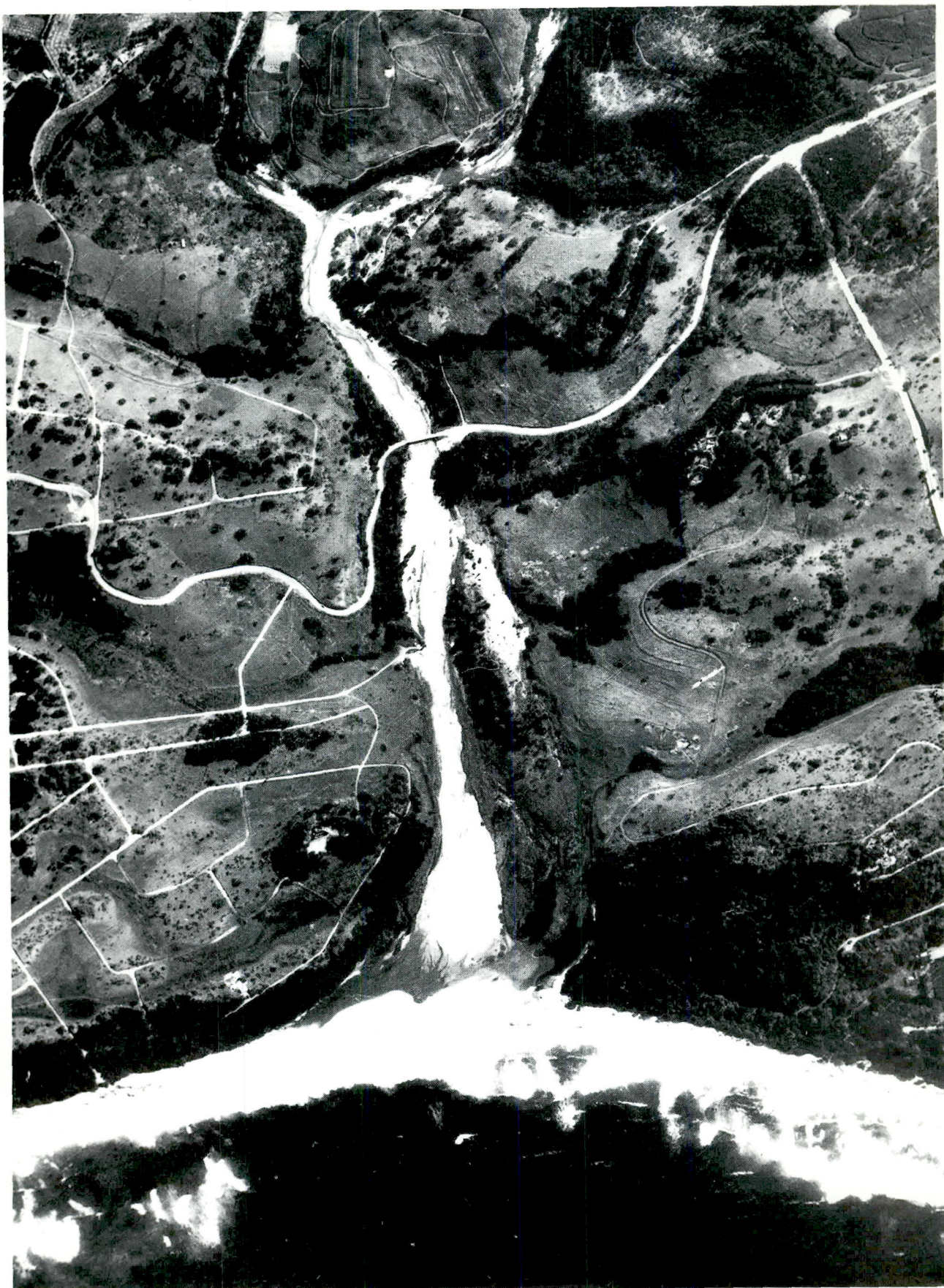
TRACED :
CHECKED :
DATE :
REF :

NATAL ESTUARIES : MPENJATI

5 - 5 - 63 (10h 29)

PHOTOGRAPH
NS 7/5

NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY



SCALE: 1 : 10 000 approx

TRACED :
CHECKED :
DATE :
REF :

NATAL ESTUARIES : MPENJATI

24 - 6 - 69 (12h27)

PHOTOGRAPH

NS 7/6

NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY



SCALE: 1 : 10 000 approx

TRACED :	NATAL ESTUARIES : MPENJATI	PHOTOGRAPH
CHECKED :	23 - 6 - 76 (08h23)	NS 7/7
DATE :		
REF. :		

NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY



SCALE: 1 : 10 000 approx

TRACED :
CHECKED :
DATE :
REF :

NATAL ESTUARIES : MPENJATI

2 - 8 - 83 (11h 52)

PHOTOGRAPH

NS 7/8

NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY



SCALE: 1 : 10 000 approx

TRACED :
CHECKED :
DATE :
REF :

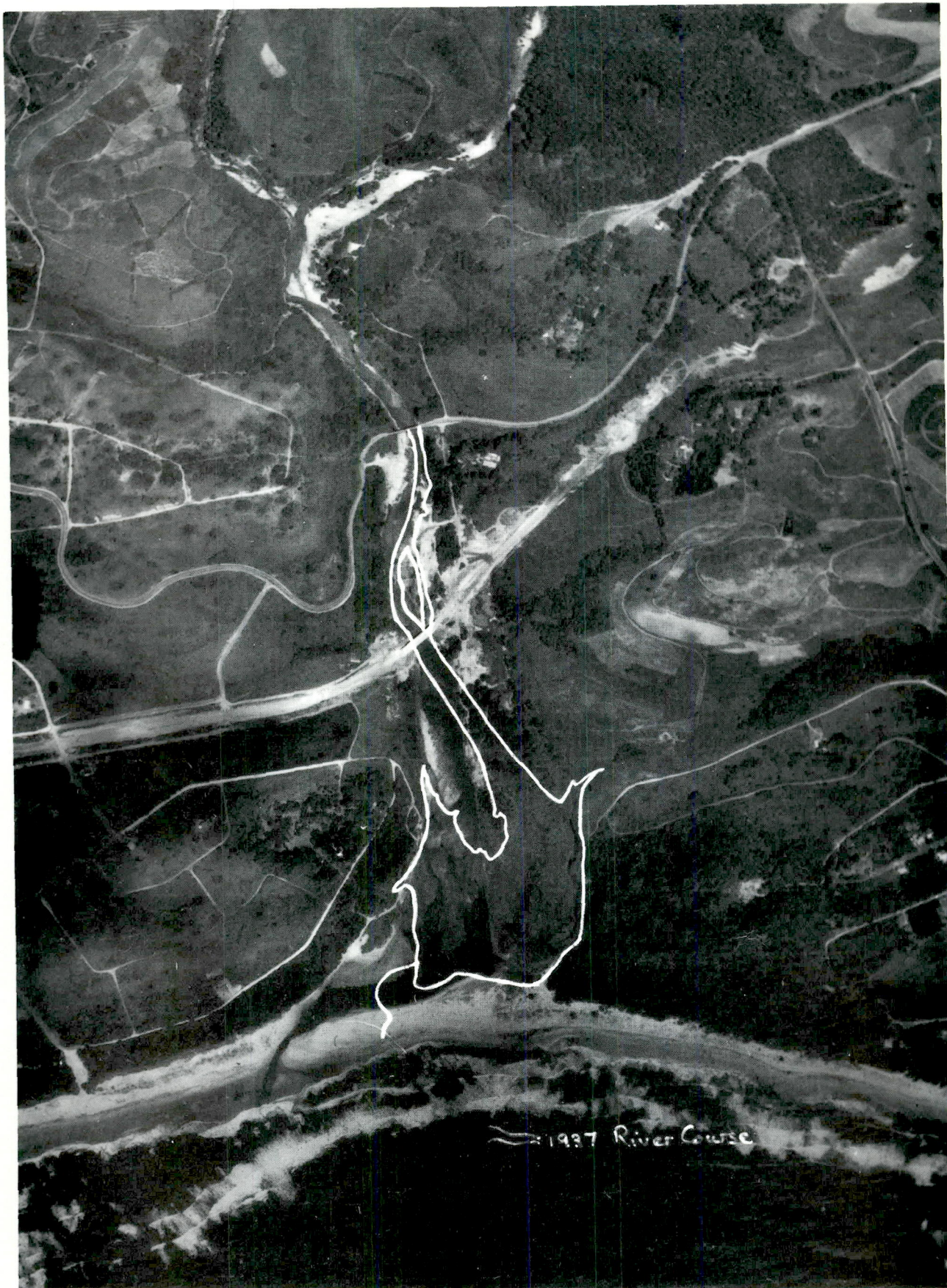
NATAL ESTUARIES : MPENJATI

6.-2-84 (15h52)

PHOTOGRAPH

NS 7/9

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1997 River Course

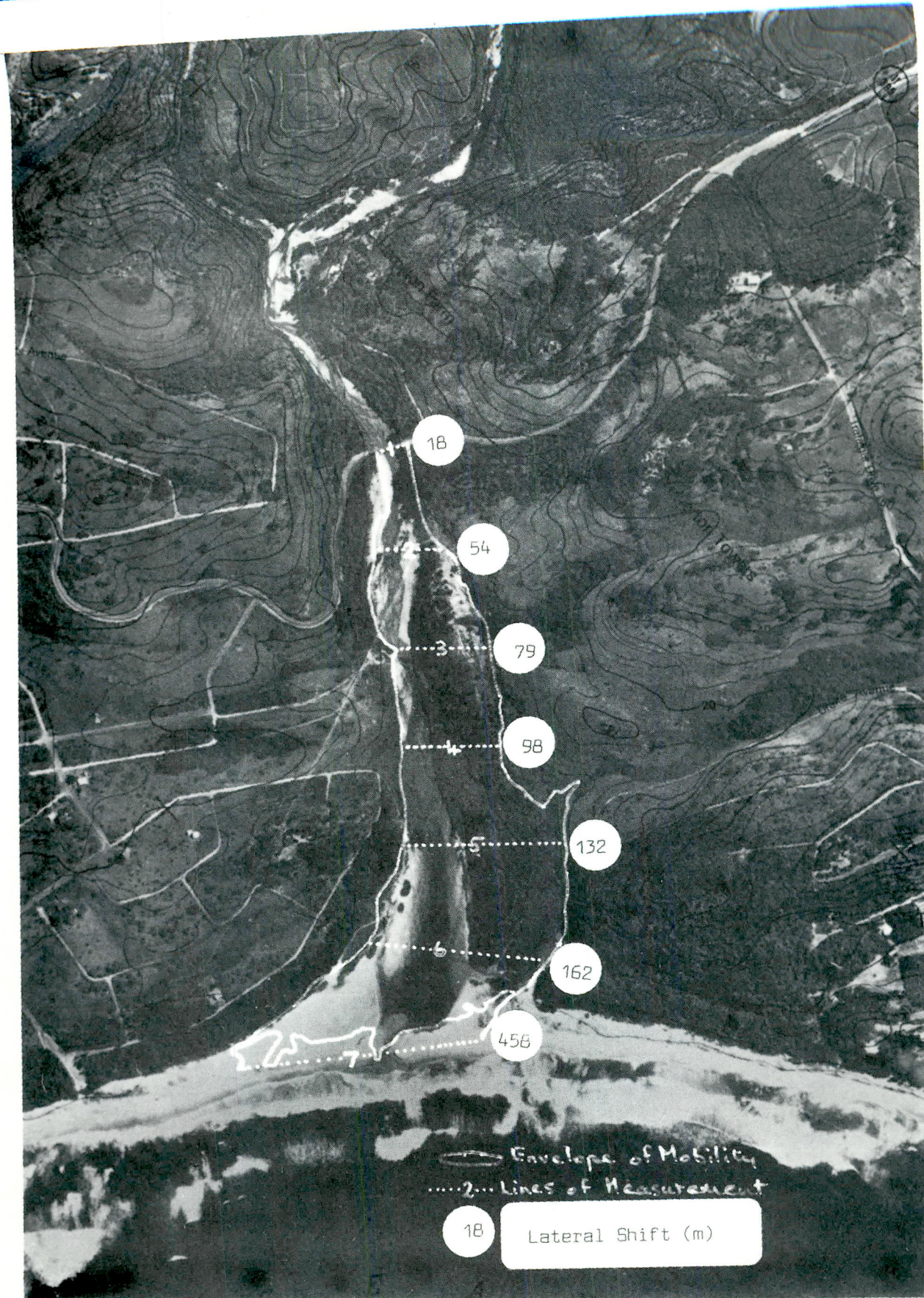
SCALE: 1 : 10 000 approx

TRACED :
CHECKED :
DATE :
REF :

NATAL ESTUARIES : MPENJATI
6 - 2 - 84
(2 - 5 - 37 RIVER COURSE SUPERIMPOSED)

PHOTOGRAPH
NS 7/10

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SCALE: 1 : 10 000 approx

TRACED : CHECKED : DATE : REF :	NATAL ESTUARIES : MPENJATI ORTHOPHOTO (ENVELOPE OF MOBILITY, LINES OF MEASUREMENT & LATERAL SHIFT SUPERIMPOSED)	PHOTOGRAPH NS 7/11
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		