

CONFIDENTIAL

**HYDROLOGICAL / HYDRAULIC STUDY
OF NATAL ESTUARIES**

DATA REPORT No. 13
MHLALI NN5

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

NRIO DATA REPORT D8303

Stellenbosch, South Africa
August 1983

NN 5

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REFERENCES

- BEGG, G.W. 1978 The estuaries of Natal
- PITMAN, W.V., MIDDLETON, B.J. and MIDGLEY, D.C. 1981
Surface water resources of South Africa, Vol. VI.
Hydrological Research Unit Report No. 9/81.

Hydro Data

The M.A.R. from a catchment area of 304 km² is 58,9 x 10⁶m³. Of particular interest to this study is the nature of the run-off which is very erratic. This is quantified by the very high coefficients of variation (V%) for monthly run-off given in Table NN5/IX. The wide spectrum of annual and monthly flows is clearly shown in Figures NN5/3 and 4. Figure NN5/5 shows the trends in the annual run-off for the period 1921 - 1975. For classification purposes, consideration must be given as to when the photographs were taken with regard to run-off. The following important facts emerge regarding the five relevant photographs and antecedent run-off conditions:

- (i) 1937; below-average run-off for the previous four months within near-average annual flow period. Major flood two years previous.
- (ii) 1959; below-average for previous twelve months, previous two hydro years well above-average.
- (iii) 1967; below-average and within a dry phase.
- (iv) 1973; below-average for previous months and previous hydro-year.
- (v) 1976; above-average and following three months of flood flows which broke a dry phase.

River Mouth

The Mhlali is diverted at its mouth by a long, southerly-extending spit and discharges into the ocean alongside rocks on its right bank. Anabranching during flood periods, combined with a spit well stabilized with vegetation, prevent the river from breaking out to sea in a more northerly position. The mouth is often closed and the bar is presumably breached when water levels rise too high (Begg, 1978).

Land-use

Most of the valley sides are under sugar cane. The percentage of the flood plain under sugar cane increased from 32,5% to 48,8% during the period under review and there was some cultivation to the channel edge. There is a weir across the main channel, 500 m from the head of the reach. The 1976 aerial photograph shows sand being excavated from the spit.

Siltation

The estuary is quite severely silted. When the mouth is closed, the open water areas naturally increase until such time as the sandbar is breached (naturally or artificially). However, when the mouth is open, the trend has been for the areas of open water to decrease during the period under review (Figure NN5/2). This is particularly true for the main, more northerly channel area. One should especially bear in mind that the lowest open water area was measured from the 1976 photograph which was taken when the river stage (with the mouth open) was higher, following flood flows. The river flow is generally turbid in the main channel and there are bars and shoals. The river has been aggrading for some considerable time, as is indicated by avulsion higher in the reach. For sources of silt supply, one must consider land-use malpractices both within and upstream of the reach. The whole catchment area comprises mostly sugar cane estates; sugar cane encroachment on the flood plain within the reach is shown in Figure NN5/2. Construction of the NR bridge, 1 km upstream of the head of the reach, may also have increased the silt supply in the period $\pm$ 1960.

Stability

For a river the size of the Mhlali, the average lateral displacement of 35,4 m is quite high. This is caused mostly by changes in widths during periods when the mouth is closed. Furthermore, the morphometry of the channel changes slightly after prolonged flood periods when anabranching occurs, forming an island of 33 ha (Photograph NN5/6). More commonly, the river flows along its northerly channel only (Photographs NN5/2-5), with the southerly channel being cut off by avulsion and filled with almost still water to a greater or lesser extent, according to whether the mouth is open or closed. The average coefficient of variation of 17,8% reflects slightly unstable conditions. The sinuosity for the whole reach is fairly constant.

The Mhlali estuary has been slightly unstable for the period under review.

ABBREVIATIONS/SYMBOLS USED IN THE TABLES

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
—	Maximum value
....	Minimum value
N.R.	No record

BASIC DATA / CALCULATIONS

Lateral displacement (1937 - 1976)	$\bar{x}$	35.4	m
Relative lateral stability (1937 - 1976)	$\bar{v}$	17.8	%
Area of catchment		30.4	km ²
Area of flood plain		94.2	ha
Area of envelope of mobility	$\bar{x}$	60.6	ha
Simulated M.A.R. (1921 - 1975)	$\bar{s}$	58.90	$\times 10^6 \text{ m}^3$
	$\bar{v}$	41.59	$\times 10^6 \text{ m}^3$
		70.6	%

Dates of major floods: March 1925, June 1935 and March 1976

MEASUREMENTS/CALCULATIONS FROM PHOTOGRAPHS

Date	1-5-37	6-6-59	2-8-67	3-6-73	14-5-76
Thalweg (m)	312.7	320.0	306.8	319.5	316.6
% Thalweg estuarine	?	?	?	?	66
Aerial D (m)	199.4	196.8	192.7	196.2	196.4
Sinuosity	1.57	1.63	1.59	1.63	1.61
$\bar{x}$ River width (m)	75.0	57.4	95.3	64.4	64.0
Open water area (ha)	24.4	19.7	30.1	20.4	19.4
% envelope of mobility	40.3	32.5	49.7	33.7	32.0
Bar/island area (ha)	1.2	2.8	0.4	1.8	35.8
River braided	x	x	x	x	x
% Flood plain cultivated	32.5	40.6	41.9	46.1	48.8
Left valley side:					
% grass	4	4	4	4	NIL
% trees	17	17	17	17	17
% cultivated	79	79	79	79	79
% built up	NIL	NIL	NIL	NIL	NIL
Right valley side:					
% grass	NIL	NIL	NIL	NIL	NIL
% trees	8	8	8	8	8
% cultivated	92	92	92	92	92
% built up	NIL	NIL	NIL	NIL	NIL
L.B. % vegetated	6	14	13	24	33
R.B. % vegetated	13	13	11	29	29
Mouth open/closed (o/c)	0	0	C	0	0
Spit/bar:					
Direction (°)	220	223	223	224	223
Length (m)	456	436	471	438	448
$\bar{x}$ width (m)	92	95	63	88	91

HUMAN INFLUENCES

Within the Reach

1. Land-use

(a) Cultivation: Valley sides mostly under sugar cane

Flood plain % under sugar cane increased steadily from 32.5 to 48.8 between 1937 & 1976

To channel edge yes, in some areas

(b) Bridge building and embankments

NIL

(c) Canals

NIL

(d) Urbanization/Industry

NIL

2. Breaching of sandbar

Begg, 1978, reports that the mouth is often closed & that sugar farmers presumably breach the bar when water levels rise too high.

3. Others

(a) Weir across main channel, 500m from head of reach
(b) Sand extraction from bar (1976 photo)

Upstream of Reach

(a) Dams in the catchment

Date of construction

NIL

(b) Building construction or canalization immediately upstream of reach

NR bridge, approx. 1km upstream of head of reach: built 1960

(c) Land-use malpractices/silt supply

The estuary shows siltation with avulsion, turbidity, shoals & bars in the main channel. This is indicative of land-use malpractices providing ample silt.

TABLE NNS/II

CLASSIFICATION OF THE LOWER REACHES OF NATAL RIVERS

NRIO NNS

RIVER MHLALI, ? % ESTUARINE, REACH from old ferry to mouth, 3.1 km from mouth. REF. DEA U 302 b
 AERIAL PHOTO DATE 1-5-37 SCALE 1:10 000 CATCHMENT AREA 304 km², M.A.R. 58,90 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	none		
hilly	grass	scattered cultivation	occasional	grass	<u>4</u>	<u>NIL</u> %
✓ undulating	✓ sparsely forested (0-25%)	partly cultivated	frequent	trees	<u>17</u>	<u>8</u> %
plains	moderately forested (25-75%)	✓ mainly cultivated		cultivated	<u>79</u>	<u>92</u> %
	heavily forested (75-100%)	✓ scattered settlement		built-up	<u>NIL</u>	<u>NIL</u> %
	swamp/bog	partly built-up				
		urbanised				

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>2400</u> m	none	not applicable	not applicable (no valley or free)	bedrock
bottom width (av.) <u>360</u> m	indefinite	not obviously degrading	✓ occasionally confined	lacustrine deposits
valley slope	✓ fragmentary	partly entrenched	frequently confined	✓ fluvial deposits
height at head of reach ___ m to MSL	continuous	entrenched	entrenched	aeolian
		✓ aggrading		sand covered <u>1</u> % area

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 right bank: height ___ m to MSL	
✓ rocks on right bank	cliffs on left bank: height ___ m to MSL	
rocks on left bank	spit/bar: direction of growth <u>220</u> °	
outer bar	length of spit/bar <u>456</u> m	
silt plume (fluvial)	length stabilized <u>180</u> m	
✓ suspended sediment (marine)	width <u>92</u> m	

Comments

FLOOD PLAIN AND CHANNEL FEATURES

Description of Flood Plain

Presence	Extent	Vegetation	Forest Type	Land-Use
none	none	almost none	not known/applicable	✓ not cultivated, not built-up
indefinite	average width <u>360</u> m	grass	✓ riverine (<u>Acacia</u>)	✓ cultivated <u>33</u> % area
fragmentary	maximum width <u>700</u> m	reed swamp <u>41</u> % area	✓ main channel	✓ crop/s <u>sugar cane</u>
✓ continuous	aerial length <u>994</u> m	sparsely forested	tributaries	partly built-up
	area <u>94,2</u> ha	moderately forested	✓ coastal dune/evergreen	mainly built-up
		heavily forested	mangroves	

Comments

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

Pattern	Measurements	Islands/Shoals	Type of Flow	Bar Type
straight	thalweg <u>3127</u> m	none	stagnant/still	none
sinuous	*sinuosity <u>1,57</u>	occasional	uniform water surface	✓ channel side bars
✓ irregular	*open water area <u>24,4</u> ha	frequent	uniform with rapid in reach	point bars
regular meanders	perimeter <u>10004</u> m	split	irregular	channel junction bars
irregular meanders	lake/lagoon area ___ ha	braided	pool & 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 x ___ m s = ___ m			sand waves/large dunes
lagoon	river slope ___ m s = ___ m			
	river width x <u>75,0</u> m s = <u>47,4</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		
logs	minor	rail bridge/s		
boulders	major	causeway		
vegetation		weir/dam	<u>across main channel</u>	<u>500 m</u>
		fish traps		
		embankment/s		
		groynes		
		canals		
		drainage furrows		
		others		

Comments

Lateral Channel Activity

Lateral Activity	Nature of Banks	Bank Vegetation	Lateral Stability	Comments
not detectable	✓ alluvium (silt/sand)	none	stable	
downstream progression	natural levées	weak	✓ slightly unstable	
progression & cut-offs	rock/boulders	✓ good	moderately unstable	
mainly cut-offs	protected/stabilized	very strong	highly unstable	
entrenched loop development	✓ cultivation to	left bank <u>6</u> %		
irregular lateral activity	channel edge	right bank <u>13</u> %		
✓ avulsion				

TABLE NN5/III

CLASSIFICATION OF THE LOWER REACHES OF NATAL RIVERS

NRIO NN 5

RIVER MHLALI, ? % ESTUARINE, REACH from old ferry to mouth, 3,2 km from mouth. REF. DEA 4302 b

AERIAL PHOTO DATE 6-6-59 SCALE 1:10 000 CATCHMENT AREA 304 km², M.A.R. 58,90 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	none		
hilly	grass	scattered cultivation	occasional	grass	4	NIL %
undulating	✓ sparsely forested (0-25%)	partly cultivated	✓ frequent	trees	17	8 %
plains	moderately forested (25-75%)	✓ mainly cultivated		cultivated	79	92 %
	heavily forested (75-100%)	✓ scattered settlement		built-up	NIL	NIL %
	swamp/bog	partly built-up urbanised				

Comments * HRU Report 9/81

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>2400</u> m	none	not applicable	not applicable (no valley or free)	bedrock
bottom width (av.) <u>360</u> m	indefinite	not obviously degrading	✓ occasionally confined	lacustrine deposits
valley slope	✓ fragmentary	partly entrenched	frequently confined	✓ fluvial deposits
height at head of reach ___ m to MSL	continuous	entrenched	entrenched	aeolian
		✓ aggrading		sand covered <u>1</u> % area

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 right bank: height ___ m to MSL	
✓ rocks on right bank	cliffs on left bank: height ___ m to MSL	
rocks on left bank	spit/bar: direction of growth <u>223</u> °	
outer bar	length of spit/bar <u>436</u> m	
silt plume (fluvial)	length stabilized <u>335</u> m	
✓ suspended sediment (marine)	width <u>95</u> m	

FLOOD PLAIN AND CHANNEL FEATURES

Description of Flood Plain

Presence	Extent	Vegetation	Forest Type	Land-Use
none	none	almost none	not known/applicable	✓ not cultivated, not built-up
indefinite	average width <u>360</u> m	grass	✓ riverine: (o) hibiscus	✓ cultivated <u>41</u> % area
fragmentary	maximum width <u>700</u> m	reed swamp <u>9</u> % area	✓ main channel	✓ crop/s <u>sugar cane</u>
✓ continuous	aerial length <u>1968</u> m	sparsely forested	tributaries	partly built-up
	area <u>94,2</u> ha	moderately forested	✓ coastal dune/evergreen mangroves	mainly built-up
		heavily forested		

Comments

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

Pattern	Measurements	Islands/Shoals	Type of Flow	Bar Type
straight	thalweg <u>3200</u> m	none	stagnant/still	none
sinuous	* sinuosity <u>1,63</u>	✓ occasional	uniform water surface	✓ channel side bars
✓ irregular	* open water area <u>19,7</u> ha	frequency ✓	uniform with rapid in reach	point bars
regular meanders	perimeter <u>10450</u> m	split	irregular	channel junction bars
irregular meanders	lake/lagoon area ___ ha	braided	pool & 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 x ___ m s = ___ m			sand waves/large dunes
lagoon	river slope ___ m s = ___ m			
	river width x <u>57,4</u> m s = <u>42,6</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		
logs	minor	rail bridge/s		
boulders	major	causeway		
vegetation		weir/dam	<u>across main channel</u>	<u>500 m</u>
		fish traps		
		embankment/s		
		groynes		
		canals		
		drainage furrows		
		others		

Lateral Channel Activity

Lateral Activity	Nature of Banks	Bank Vegetation	Lateral Stability
not detectable	✓ alluvium (silt/sand)	none	stable
downstream progression	natural levées	weak	✓ slightly unstable
progression & cut-offs	rock/boulders	good	moderately unstable
mainly cut-offs	protected/stabilized	very strong	highly unstable
entrenched loop development	✓ cultivation to channel edge	left bank <u>14</u> %	
irregular lateral activity		right bank <u>13</u> %	
✓ avulsion			

Comments

TABLE NNS/IV

CLASSIFICATION OF THE LOWER REACHES OF NATAL RIVERS

NRIO NN 5

RIVER MHLALI, ? % ESTUARINE, REACH from old ferry to mouth, 3.1 km from mouth. REF. DEA U 3026
 AERIAL PHOTO DATE 2-8-67 SCALE 1:10 000 CATCHMENT AREA 304 km², M.A.R. 58.90 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	none		
hilly	grass	scattered cultivation	occasional	grass	<u>4</u>	<u>NIL</u> %
✓ undulating	✓ sparsely forested (0-25%)	partly cultivated	✓ frequent	trees	<u>17</u>	<u>8</u> %
plains	moderately forested (25-75%)	✓ mainly cultivated		cultivated	<u>79</u>	<u>92</u> %
	heavily forested (75-100%)	✓ scattered settlement		built-up	<u>NIL</u>	<u>NIL</u> %
	swamp/bog	partly built-up				
		urbanised				

Comments * HRA Report 7/81

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>2400</u> m	none	not applicable	not applicable (no valley or free)	bedrock
bottom width (av.) <u>360</u> m	indefinite	not obviously degrading	✓ occasionally confined	lacustrine deposits
valley slope	✓ fragmentary	partly entrenched	frequently confined	✓ fluvial deposits
height at head of reach	continuous	entrenched	entrenched	aeolian
of reach	m to MSL	✓ aggrading		sand covered <u>—</u> % area

Comments

River Mouth

Characteristics	Measurements
✓ open /closed	right bank breakwater length
natural/artificial	left bank breakwater length
canalized	rock sill level
✓ sandy	cliffs on right bank: height
✓ rocks on right bank	cliffs on left bank: height
rocks on left bank	apert/bar: direction of growth
outer bar	length of apert/bar
silt plume (fluvial)	length stabilized
✓ suspended sediment (marine)	width

Comments

FLOOD PLAIN AND CHANNEL FEATURES

Description of Flood Plain

Presence	Extent	Vegetation	Forest Type	Land-Use
none	none	almost none	not known/applicable	✓ not cultivated, not built-up
indefinite	average width <u>360</u> m	grass	✓ riverine: (5 hibiscus)	✓ cultivated <u>42</u> % area
fragmentary	maximum width <u>700</u> m	reed swamp <u>6</u> % area	✓ main channel	✓ crop/s <u>sugar cane</u>
✓ continuous	aerial length <u>1927</u> m	sparsely forested	tributaries	partly built-up
	area <u>94.2</u> ha	moderately forested	✓ coastal dune/evergreen mangroves	mainly built-up
		heavily forested		

Comments

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

Pattern	Measurements	Islands/Shoals	Type of Flow	Bar Type **
straight	thalweg <u>3068</u> m	none	✓ segment /still	none
sinuous	* sinuosity <u>1.59</u>	✓ occasional	uniform water surface	channel side bars
✓ irregular	* open water area <u>30.1</u> ha	frequent	uniform with rapid in reach	point bars
regular meanders	perimeter <u>10498</u> m	split	irregular	channel junction bars
irregular meanders	lake/lagoon area	braided	pool & riffle sequence	mid-channel bars
tortuous meanders	river X-sections available		turbid	diamond bars
bifurcated	channel slope			diagonal bars
lake/s	channel width x			sand waves/large dunes
lagoon	river slope			
	river width x			

Comments *whole reach

** Nil : mouth closed & water level higher

Obstructions/Constructions

Natural	Degree	Man-made	Degree of Obstruction/Constriction for Each	Position (from head of reach)
✓ none	none	road bridge/s		
logs	minor	rail bridge/s		
boulders	major	causeway		
vegetation		weir/dam	<u>across main channel</u>	<u>500m</u>
		fish traps		
		embankment/s		
		groynes		
		canals		
		drainage furrows		
		others		

Lateral Channel Activity

Lateral Activity	Nature of Banks	Bank Vegetation	Lateral Stability
not detectable	✓ alluvium (silt/sand)	none	stable
downstream progression	natural levées	weak	✓ slightly unstable
progression & cut-offs	rock/boulders	✓ good	moderately unstable
mainly cut-offs	protected/stabilized	very strong	highly unstable
entrenched loop development	✓ cultivation to	left bank <u>13</u> %	
irregular lateral activity	channel edge	right bank <u>11</u> %	
✓ avulsion			

Comments

TABLE NN5/V

CLASSIFICATION OF THE LOWER REACHES OF NATAL RIVERS

NRIO NN 5

RIVER MHLALI, ? % ESTUARINE, REACH from old ferry to mouth, 3,2 km from mouth. REF. DEA U 302 b
 AERIAL PHOTO DATE 3-6-73 SCALE 1:10 000 CATCHMENT AREA 304 km², M.A.R. 58,90 m³x10⁶, No. of DAMS NIL
 (Orthophoto)

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	none		
hilly	grass	scattered cultivation	occasional	grass	<u>4</u>	<u>NIL</u> %
✓ undulating	✓ sparsely forested (0-25%)	partly cultivated	✓ frequent	trees	<u>17</u>	<u>8</u> %
plains	moderately forested (25-75%)	✓ mainly cultivated		cultivated	<u>79</u>	<u>92</u> %
	heavily forested (75-100%)	✓ scattered settlement		built-up	<u>NIL</u>	<u>NIL</u> %
	swamp/bog	partly built-up				
		urbanised				

Comments * HRL Report 9/81

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>2400</u> m	none	not applicable	not applicable (no valley or free)	bedrock
bottom width (av.) <u>360</u> m	indefinite	not obviously degrading	occasionally confined	lacustrine deposits
valley slope <u>1:1636</u>	✓ fragmentary	partly entrenched	frequently confined	✓ fluvial deposits
height at head of reach <u>+35</u> m to MSL approx.	continuous	entrenched	entrenched	aeolian
		✓ aggrading		sand covered <u>—</u> % area

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 right bank: height _____ m to MSL	
✓ rocks on right bank	cliffs on left bank: height _____ m to MSL	
rocks on left bank	spit/bar: direction of growth <u>224</u> °	
outer bar	length of spit/bar <u>438</u> m	
✓ silt plume (fluvial)	length stabilized <u>370</u> m	
✓ suspended sediment (marine)	width <u>98</u> m	

FLOOD PLAIN AND CHANNEL FEATURES

Description of Flood Plain

Presence	Extent	Vegetation	Forest Type	Land-Use
none	none	almost none	not known/applicable	✓ not cultivated, not built-up
indefinite	average width <u>360</u> m	grass	✓ riverine: (hibiscus)	✓ cultivated <u>46</u> % area
fragmentary	maximum width <u>700</u> m	reed swamp <u>6</u> % area	✓ main channel	✓ crops <u>sugar cane</u>
✓ continuous	aerial length <u>962</u> m	sparsely forested	tributaries	partly built-up
	area <u>74,2</u> ha	moderately forested	✓ coastal dune/evergreen mangroves	mainly built-up
		heavily forested		

Comments

Channel Description N.B. Estimate of flow stage: LOW/NEAR LOWS/BEHIND MEAN/HIGH

Pattern	Measurements	Islands/Shoals	Type of Flow	Bar Type
straight	thalweg <u>3195</u> m	none	stagnant/still	none
sinuous	* sinuosity <u>1,63</u>	✓ occasional	uniform water surface	✓ channel side bars
✓ irregular	* open water area <u>20,4</u> ha	frequent	uniform with rapid in reach	point bars
regular meanders	perimeter <u>10450</u> m	split	irregular	channel junction bars
irregular meanders	lake/lagoon area _____ ha	braided	pool & 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 x _____ m			sand waves/large dunes
lagoon	river slope _____ m s = <u>50,3</u> m			
	river width x <u>64,4</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		
logs	minor	rail bridge/s		
boulders	major	causeway		
vegetation		weir/dam	across main channel	<u>500</u>
		fish traps		
		embankment/s		
		groynes		
		canals		
		drainage furrows		
		others		

Lateral Channel Activity

Lateral Activity	Nature of Banks	Bank Vegetation	Lateral Stability	Comments
not detectable	✓ alluvium (silt/sand)	none	stable	
downstream progression	natural levées	weak	✓ slightly unstable	
progression & cut-offs	rock/boulders	✓ good	moderately unstable	
mainly cut-offs	protected/stabilized	very strong	highly unstable	
entrenched loop development	✓ cultivation to channel edge	left bank <u>24</u> %		
irregular lateral activity		right bank <u>29</u> %		
✓ avulsion				

TABLE NN5 / VI

CLASSIFICATION OF THE LOWER REACHES OF NATAL RIVERS

NRIO NN5

RIVER MHLALI, 66 % ESTUARINE, REACH from old ferry to mouth, 3,2 km from mouth. REF. DEA U3026
 AERIAL PHOTO DATE 14-5-76 SCALE 1:10 000 CATCHMENT AREA 304 km², M.A.R. 58,90 m³x10⁶, No. of DAMS NIL

RIVER VALLEY AND RIVER MOUTH FEATURES

General Description of the Terrain above the Valley

Valley Sides (Most Well-defined)

Terrain	Vegetation	Land-Use	Slumping	Vegetation and Land-Use	Left	Right
mountainous	almost none	none	none	none	4	%
hilly	grass	scattered cultivation	occasional	grass	<u>NIL</u>	<u>NIL</u>
✓ undulating	✓ sparsely forested (0-25%)	partly cultivated	✓ frequent	grass	<u>17</u>	<u>8</u>
plains	moderately forested (25-75%)	✓ mainly cultivated		trees	<u>79</u>	<u>92</u>
	heavily forested (75-100%)	✓ scattered settlement		cultivated	<u>NIL</u>	<u>NIL</u>
	swamp/bog	partly built-up		built-up		
		urbanised				

Comments * HRU Report 9/81

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>2400</u> m	none	not applicable	not applicable (no valley or free)	bedrock
bottom width (av.) <u>360</u> m	indefinite	not obviously degrading	occasionally confined	lacustrine deposits
valley slope	✓ fragmentary	partly entrenched	frequently confined	✓ fluvial deposits
height at head of reach _____ m to MSL	continuous	entrenched	entrenched	aeolian
		✓ aggrading		sand covered <u>2</u> % area

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 right bank: height _____ m to MSL	
✓ rocks on right bank	cliffs on left bank: height _____ m to MSL	
rocks on left bank	spit/bar: direction of growth <u>223</u> °	
outer bar	length of spit/bar <u>448</u> m	
silt plume (fluvial)	length stabilized <u>385</u> m	
✓ suspended sediment (marine)	width <u>91</u> m	

FLOOD PLAIN AND CHANNEL FEATURES

Description of Flood Plain

Presence	Extent	Vegetation	Forest Type	Land-Use
none	none	almost none	not known/applicable	not cultivated, not built-up
indefinite	average width <u>360</u> m	grass	✓ riverine: Hibiscus	cultivated <u>49</u> % area
fragmentary	maximum width <u>700</u> m	reed swamp <u>7</u> % area	✓ main channel	crop/sugar cane
✓ continuous	aerial length <u>964</u> m	sparsely forested	tributaries	partly built-up
	area <u>94,2</u> ha	moderately forested	✓ coastal dune/evergreen	mainly built-up
		heavily forested	mangroves	

Comments

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

Pattern	Measurements	Islands/Shoals	Type of Flow	Bar Type
straight	thalweg <u>3166</u> m	none	stagnant/still	none
sinuous	* sinuosity <u>1,61</u>	✓ occasional	uniform water surface	✓ channel side bars
✓ irregular	* open water area <u>19,4</u> ha	frequent	uniform with rapid in reach	point bars
regular meanders	perimeter <u>10380</u> m	split	irregular	channel junction bars
irregular meanders	lake/lagoon area _____ ha	braided	pool & riffle sequence	✓ mid-channel bars
✓ bifurcated meanders	river X-sections available		✓ turbulent	diamond bars
lake/s	channel slope _____ m s = _____ m			diagonal bars
lagoon	channel width x _____ m s = <u>51,3</u> m			sand waves/large dunes

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		
logs	minor	rail bridge/s		
boulders	major	causeway		
vegetation		weir/dam	<u>across main channel</u>	<u>500m</u>
		fish traps		
		embankment/s		
		groynes		
		canals		
		drainage furrows		
		others		

Lateral Channel Activity

Lateral Activity	Nature of Banks	Bank Vegetation	Lateral Stability
not detectable	✓ alluvium (silt/sand)	none	stable
downstream progression	natural levées	weak	✓ slightly unstable
progression & cut-offs	rock/boulders	✓ good	moderately unstable
mainly cut-offs	protected/stabilized	very strong	highly unstable
entrenched loop development	✓ cultivation to channel edge	left bank <u>33</u> %	
irregular lateral activity		right bank <u>29</u> %	
✓ avulsion			

Comments

TABLE NN5/VII

RIVER WIDTHS

MHLALI NN 5

Station	Approx. distance along 1973 R. course from old ferry (?) (m)	River widths (m)					$\bar{x}$	s	V%
		Date							
		01.05.37	06.06.59	02.08.67	03.06.73	14.05.76			
1	0	18	12	12	3	3	9,6	6,5	67,7
2	300	20	8	12	5	5	10,0	6,3	62,8
3	600	58 (32+26)	16 (8+8)	37 (27+10)	24 (10+14)	38 (28+10)	34,6	16,0	46,2
4	900	62 (32+30)	55 (15+40)	90 (22+68)	63 (18+45)	43 (18+25)	62,6	17,3	27,6
5	1 200	72 (38+34)	65 (30+35)	72 (32+40)	64 (24+40)	62 (17+35)	67,0	4,7	7,0
6	1 500	82 (5+34+40)	55 (17+38)	114 (70+44)	55 (16+39)	55 (16+39)	72,2	26,1	36,2
7	1 800	97 (40+14+43)	73 (23+10+40)	144 (74+70)	98 (44+10+44)	96 (35+8+45+8)	101,6	25,9	25,5
8	2 100	98 (50+48)	86 (45+38)	188 (55+18+115)	98 (50+48)	121 (48+5+68)	118,2	41,0	34,7
9	2 400	160 (80+80)	140 (70+70)	195 (102+93)	155 (75+80)	140 (10+55+75)	158,0	22,5	14,3
10	2 700	140 (75+65)	105 (55+50)	184	125 (80+45)	133 (73+60)	137,4	29,2	21,2
11	3 000 (month)	18	16	0 (closed)	18	8	12,0	7,9	65,6
$\bar{x}$		75,0	57,4	95,3	64,4	64,0	71,2		
s		47,4	42,6	74,9	50,3	51,3			
V%		63,2	74,3	78,6	78,2	80,2			

TABLE NN5/VIII

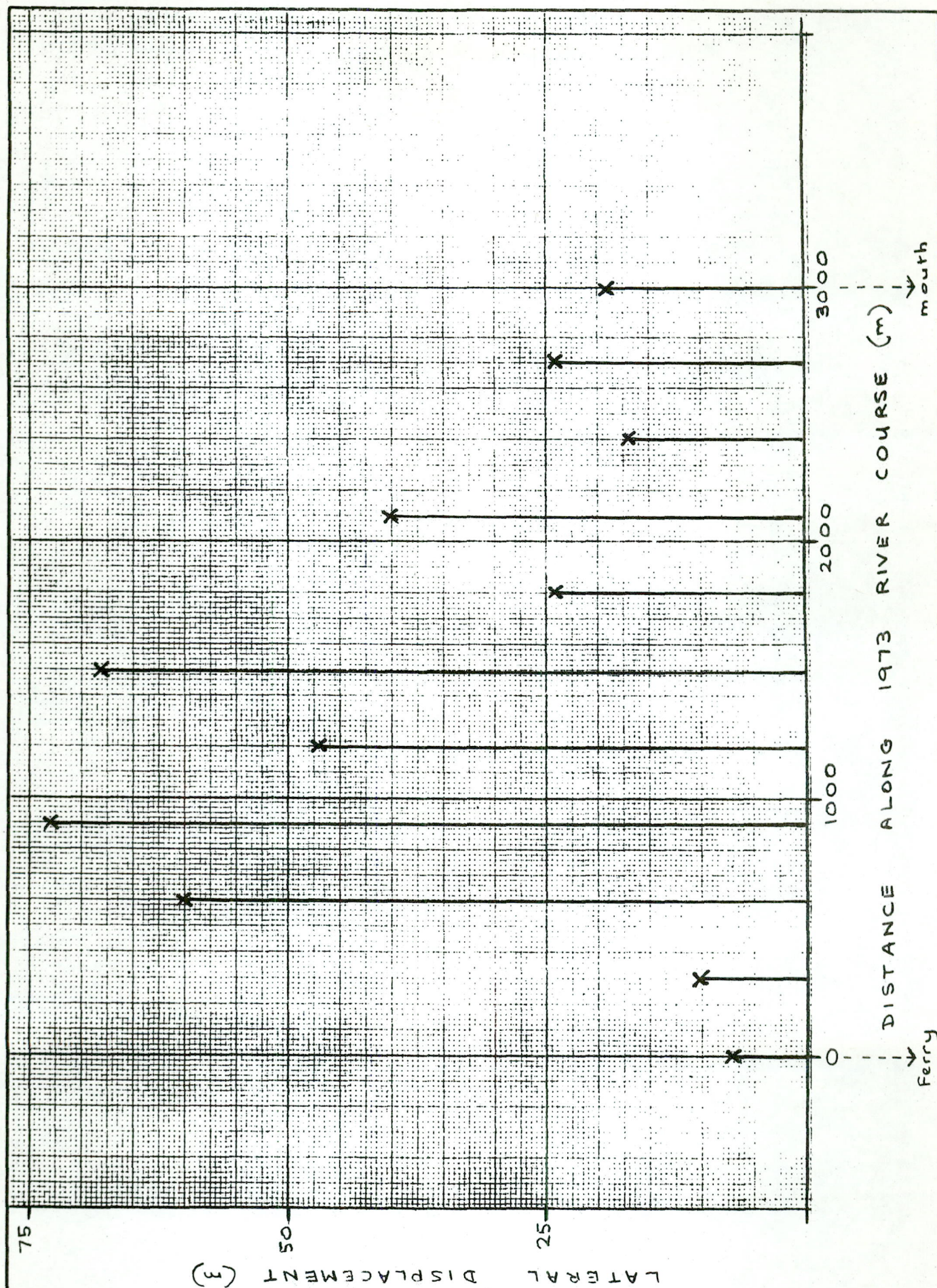
LATERAL STABILITY

MHLALI NN 5

Station	Approx. distance along 1973 R. course from old ferry (?) (m)	Distance from maximum observed L.B. position to mid-river (m)					Max - Min	$\bar{x}$	s	V%
		Date								
		01.05.37	06.06.59	02.08.67	03.06.73	14.05.76				
1	0	9.	11	15	14	<u>16</u>	7	13,0	2,9	22,4
2	300	10.	18	17	<u>20</u>	13	10	15,6	4,0	25,9
3	600	90	108	62	<u>120</u>	<u>60.</u>	60	88,0	26,9	30,5
4	900	<u>155.</u>	220	<u>228</u>	213	171	73	197,4	32,3	16,4
5	1 200	141	<u>130.</u>	153	<u>177</u>	160	47	152,2	18,0	11,8
6	1 500	124	165	<u>101.</u>	164	<u>169</u>	68	144,6	30,5	21,1
7	1 800	<u>102.</u>	120	109	105	<u>126</u>	24	112,4	10,2	9,1
8	2 100	198	<u>182.</u>	217	199	<u>222</u>	40	203,6	16,1	7,9
9	2 400	164	175	<u>159.</u>	171	<u>176</u>	17	169,0	7,3	4,3
10	2 700	98	105	<u>115</u>	<u>91.</u>	97	24	101,2	9,2	9,1
11	3 000 (mouth)	30	<u>16.</u>	N.R.	18	<u>35</u>	19	24,8	9,2	37,2
$\bar{x}$		101,9	113,6	117,6	117,5	113,2	35,4	111,1 112,8		17,8
s		63,5	72,1	73,9	74,4	73,0	23,6			10,5
V%		62,3	63,5	62,8	63,3	64,5	66,7			59,1

Average lateral displacement 1937-76 = 35,4 m

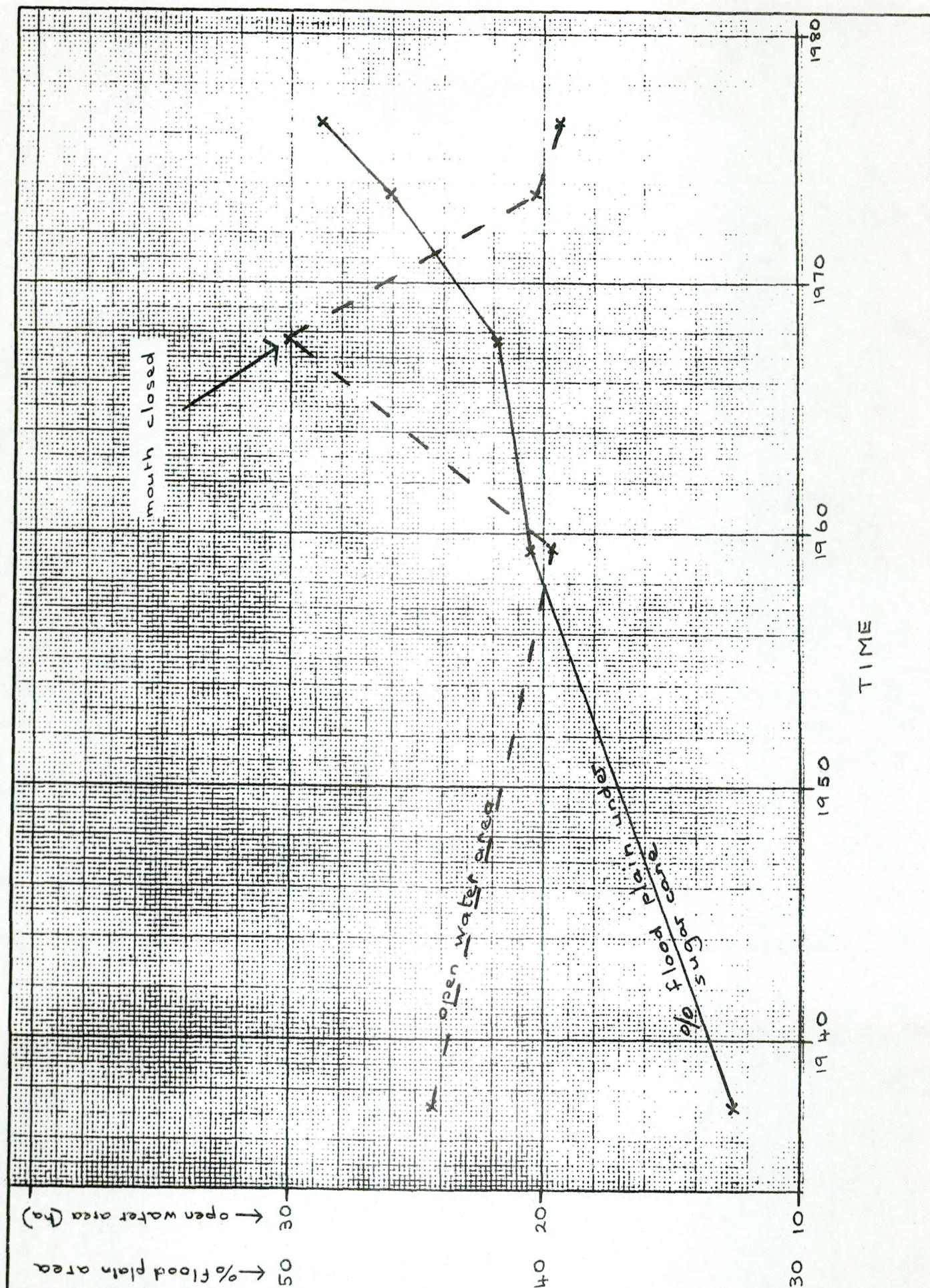
Average coefficient of variation 1937-76 = 17,8%



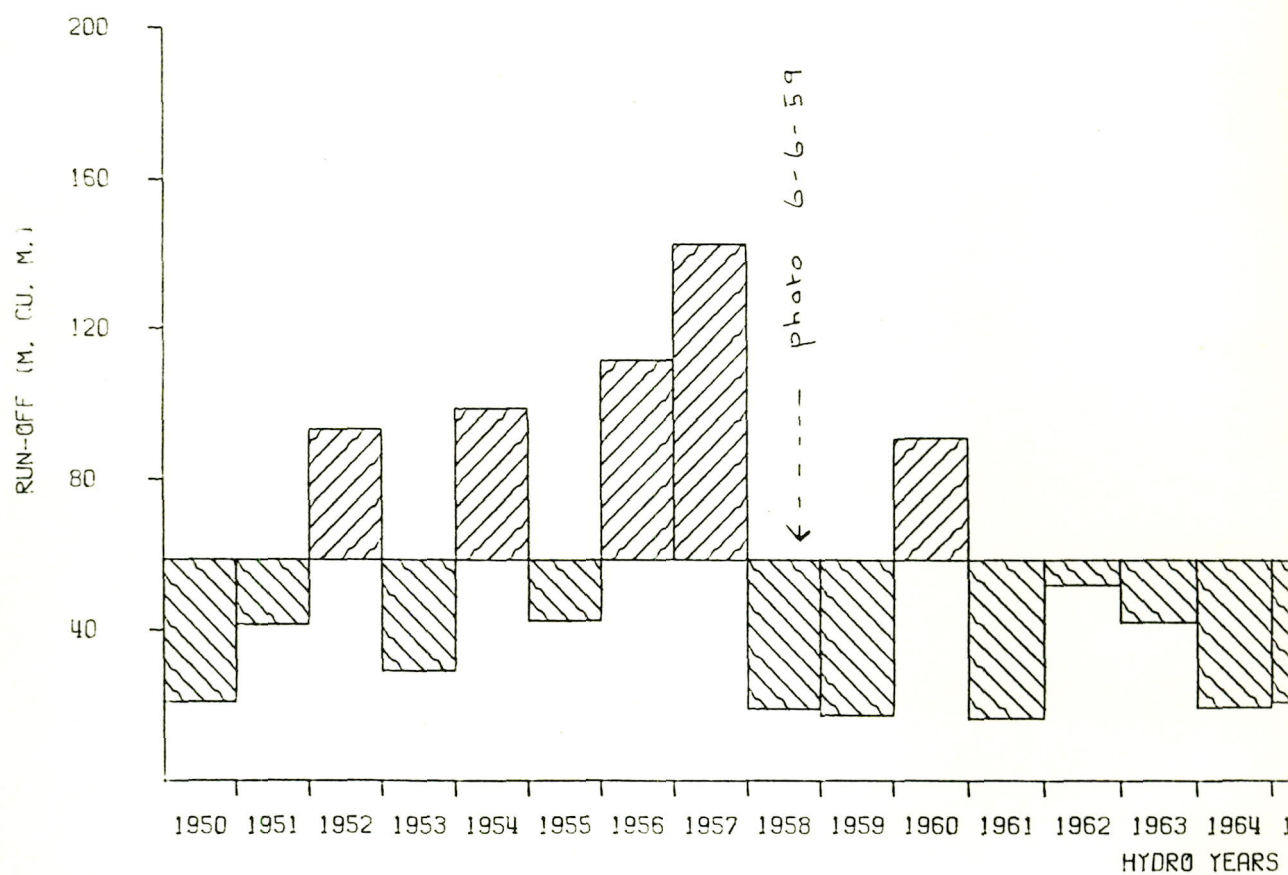
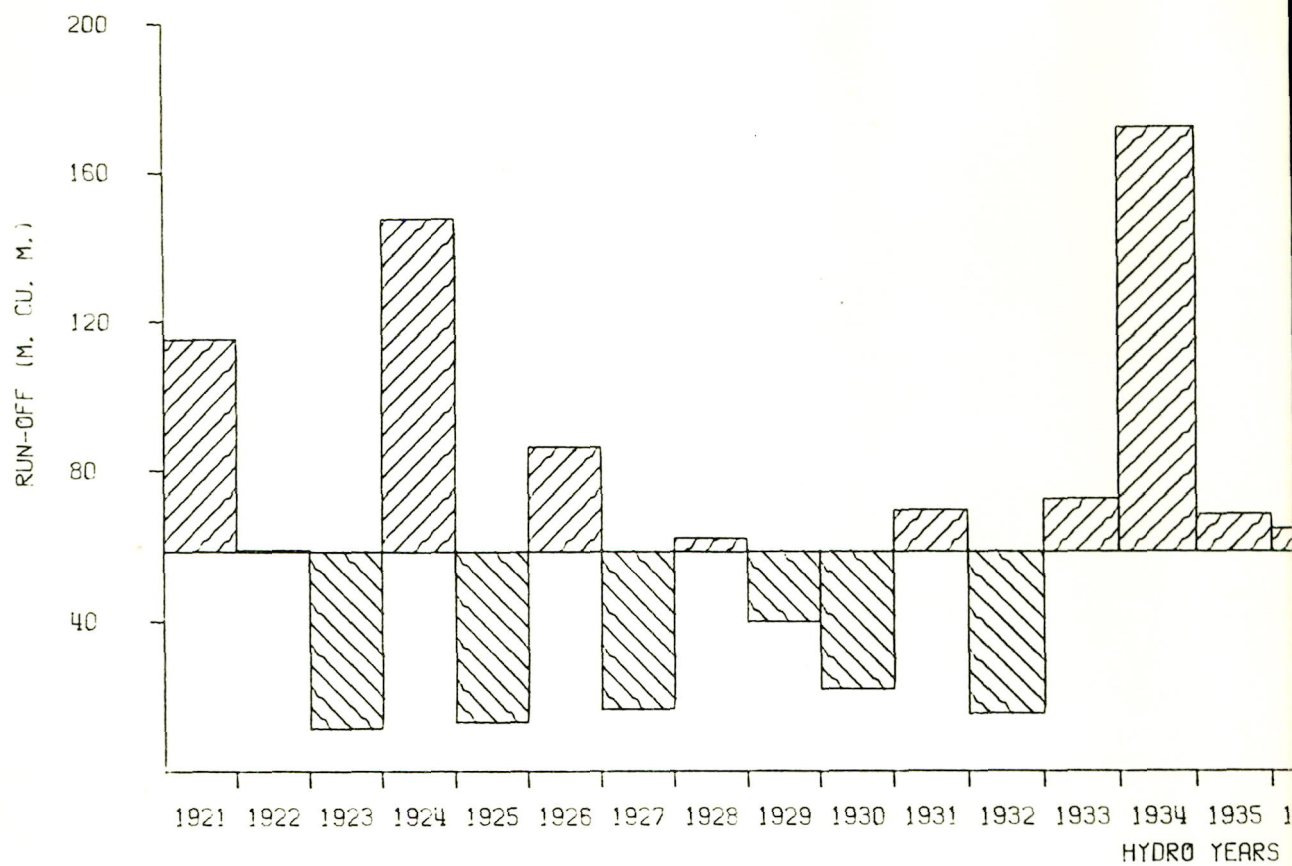
TRACED
CHECKED
DATE
REF

NATAL ESTUARIES: MHLALI
THALWEG DISPLACEMENT
(1937 - 1976)

FIGURE
NN5/ I



TRACED CHECKED DATE: REF:	NATAL ESTUARIES: MHLALI OPEN WATER & CULTIVATION AREAS (1937 - 1976)	FIGURE NN5/2
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



TRACED : COMPILOT

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DATE :

REF. :

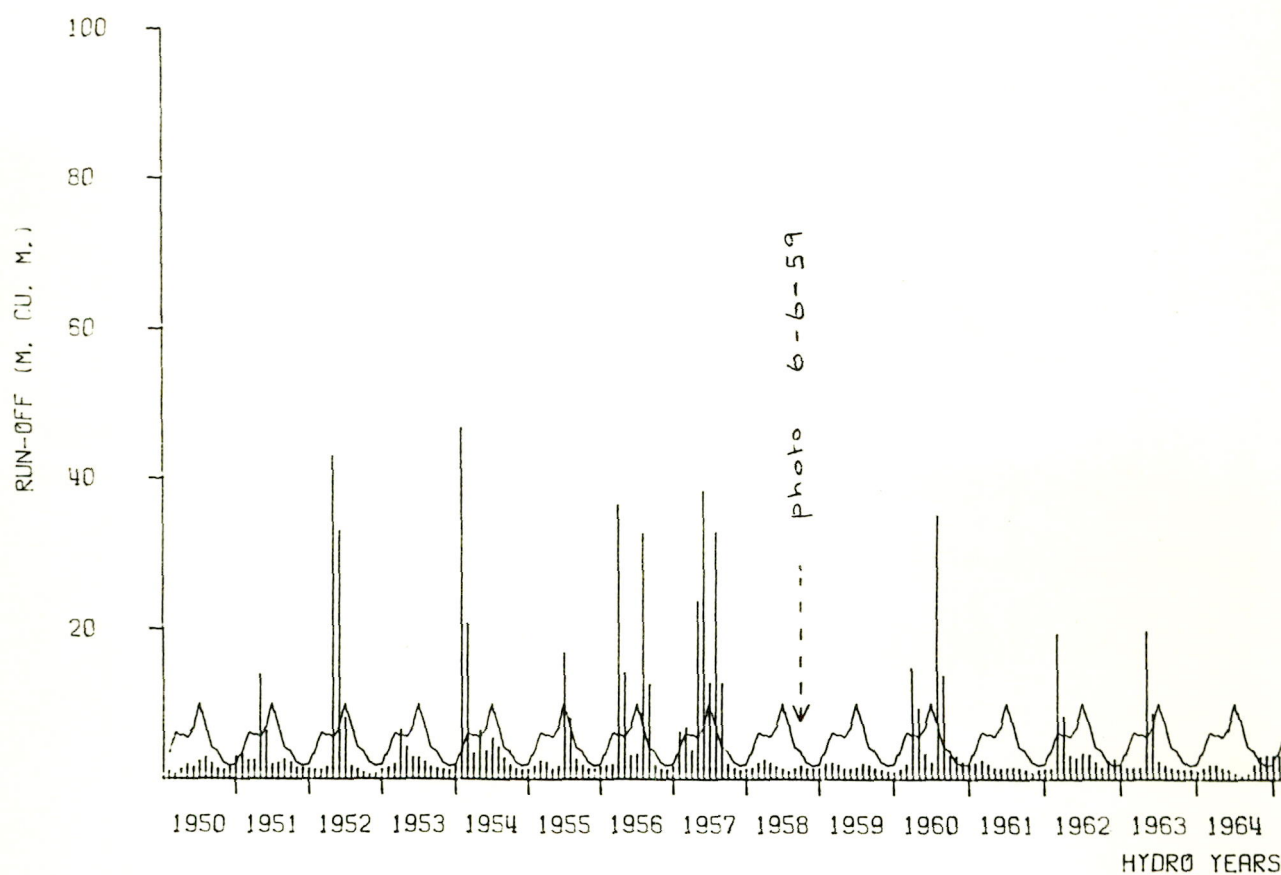
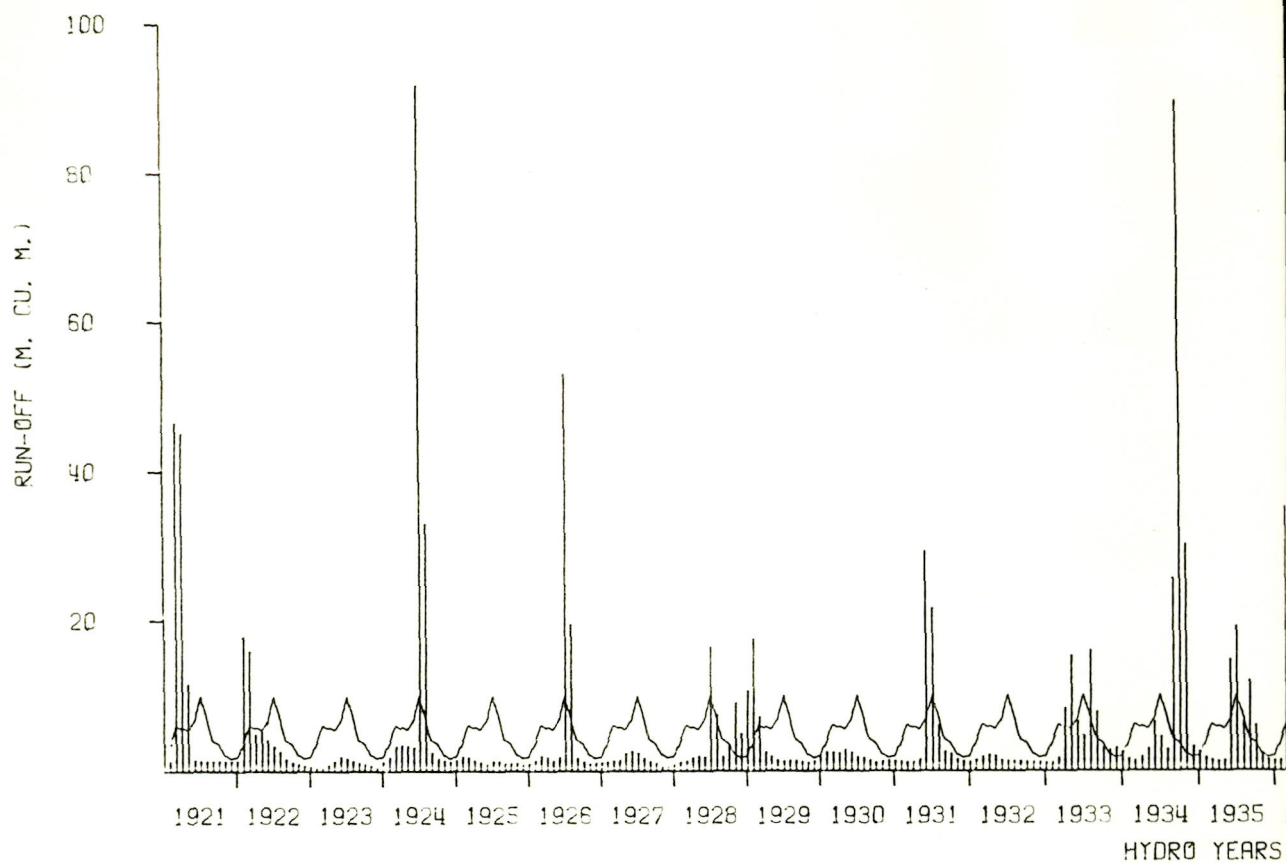
NATAL ESTUARIES (MHLALI)

SIMULATED ANNUAL RUN-OFF

1921-1975

FIGURE

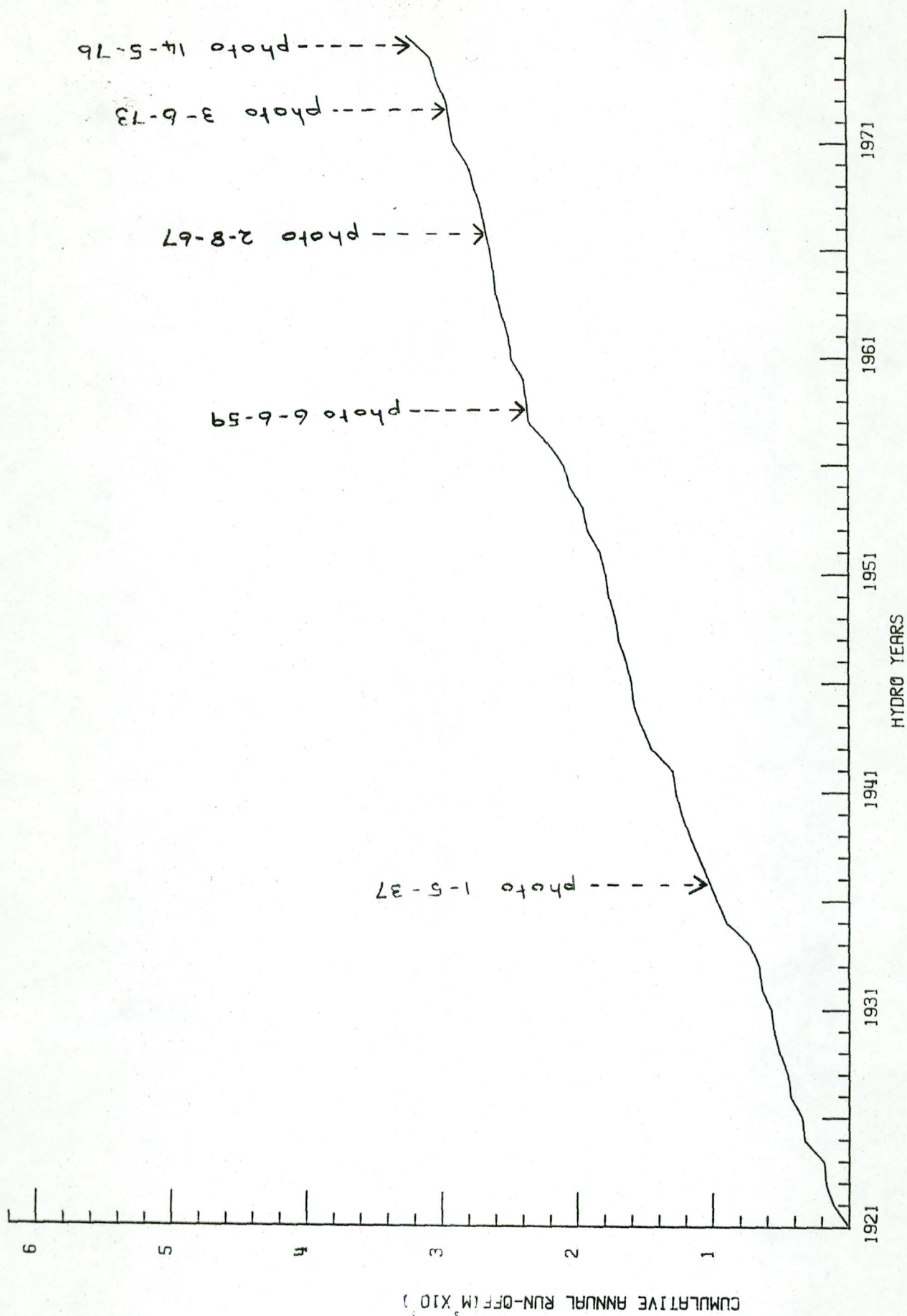
NN5/3



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 DATE :
 REF. :

NATAL ESTUARIES :MHLALI
 SIMULATED MONTHLY RUN-OFF
 1921-1975

FIGURE
 NN5/4



TRACED : COMPUT
 CHECKED:
 DATE :
 REF. :

NATAL ESTUARIES: MHLALI
 CUMULATIVE ANNUAL RUN-OFF

FIGURE
 NN5/5



SCALE 1 : 10 000 approx

TRACED JGAN CHECKED DATE: REF	NATAL ESTUARIES MHLALI 14-5-76 (1-5-37 RIVER COURSE SUPERIMPOSED)	PHOTOGRAPH NN5/1
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



SCALE: 1 : 10 000 approx.

TRACED JGAN
CHECKED
DATE
REF

NATAL ESTUARIES MHLALI

1-5-37 (12h15)

PHOTOGRAPH
NN5/2

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DATE
REF

NATAL ESTUARIES MHLALI

6-6-59 (11h27)

PHOTOGRAPH

NN5/3

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TRACED JGAN
CHECKED
DATE
REF

NATAL ESTUARIES MHLALI

2-8-67 (12h42)

PHOTOGRAPH

NN5/4

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DATE
REF

NATAL ESTUARIES MHLALI

3-6-73 (12h00)

PHOTOGRAPH

NN5/5

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SCALE: 1:10 000 approx

TRACED JGAN
CHECKED
DATE
REF

NATAL ESTUARIES: MHLALI

14-5-76 (14h 29)

PHOTOGRAPH

NN5/6

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SCALE 1 : 10 000 approx

TRACED JGAN
CHECKED
DATE
REF

NATAL ESTUARIES MHLALI

3-6-73 (ORTHOPHOTO)

PHOTOGRAPH
NN5/7

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