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**HYDROLOGICAL / HYDRAULIC STUDY
OF NATAL ESTUARIES**

DATA REPORT NO. 16

MDLOTANE NN 8

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

NRIO DATA REPORT D 8307

Stellenbosch, South Africa
November 1983

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REFERENCES

- BEGG, G W 1978 The estuaries of Natal
- BEGG, G W 1983 Comparative ecology of Natal's smaller estuaries.
Unpublished Ph.D. thesis.
- 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

Location

The Mdlotane River discharges into the Indian Ocean on the Natal North coast at 29°21'S, 31°23'E. The head of the reach under review is just downstream of some rapids, 2,4 km from the river mouth.

Hydro Data

The M.A.R. from a catchment of 43 km² is 7,32 x 10⁶ m³. Of particular interest to this study is the nature of the run-off which is very erratic: long, dry periods are broken by major floods such as those which occurred in March 1925, December 1944 and January to March 1976. This is quantified by the very high coefficients of variation (V%) for monthly run-off (Table NN8/X) and the wide spectrum of annual and monthly run-off values which can be clearly seen in Figures NN8/2 and 3. Figure NN8/4 shows the trends in the annual run-off for the period 1921 - 1975. For classification purposes, current and antecedent run-off conditions must be considered for each of the time slices covered by the aerial photography. The following important facts emerge regarding the six relevant photographs:

- (i) 1937; below-average run-off within a generally dry phase.
- (ii) 1953; below-average run-off within a dry phase
- (iii) 1959; run-off a little above average for 1,5 months preceded by 12 dry months and then a wetter phase
- (iv) 1967; below-average run-off within a dry phase
- (v) 1973; below-average run-off within a dry phase
- (vi) 1976; near-average run-off preceded by five months of well above-average flows.

River Mouth

The six photographs show the typical winter conditions of the mouth blocked by a sandbar. Begg (1983) estimates the mouth to be closed for 95 per cent of the year. There are rocks near and at the mouth on the right bank and this is the position at which the sandbar is breached naturally following flood flows. The bar is, however, occasionally breached mechanically (Begg 1978 and 1983).

Land-use

The narrow flood plain is left under natural, mostly swamp, conditions. The valley sides, including those of the ephemeral tributaries, are covered with coastal dune or riverine forests. Forest plantations have increased in area on the right side of the valley in recent years. Above the narrow forest strip along the left valley side are sugar cane plantations.

Siltation

The swamp areas, approximately 12 per cent of the flood plain, are areas of siltation but the size of these has remained fairly constant during the period under review. The small changes in average river widths (Table NN8/VIII) merely reflect various water levels behind the sandbar at the mouth. Therefore, although the river does show some turbidity following higher flow periods (Photograph NN8/7), the Mdlotane has no siltation problems at present. In this regard, note should be taken of the forested valley sides both within the estuary and in the catchment area further upstream.

Stability

The meanders of the estuary are incised and even where there is some room for lateral shift, the river has remained stable for the period under review (Photograph NN8/1). This is quantified by the low average lateral displacement of 6,1 m and average coefficient of variation of 10,9 per cent (Table NN8/IX). Furthermore, the sinuosity remains constant; the only small change is caused by the extent to which the sandbar blocks the mouth.

The Mdlotane shows no siltation and has been stable for the period under review. This reflects some wise land-use practices in key areas within and along the periphery of the estuary as well as in the whole catchment. For an abstract of study results see Table NN8/I.

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

ABSTRACT

HUMAN INFLUENCES

- Within the Reach
- Land-use
 - (a) Cultivation: Valley sides Negligible
 - Flood plain Nil
 - To channel edge Nil
 - Bridge building and embankments Nil
 - Canals Nil
 - Urbanization/Industry Nil

2. Breaching of sandbar
This does occur occasionally (Beg, 1978, 1983)

3. Others

Upstream of Reach

- Dams in the catchment
 - Ashdene ?
 - New Gwalesland ?
- Building construction or canalization immediately upstream of reach Nil
- Land-use malpractices/silt supply Nil

STABILITY FOR PERIOD UNDER REVIEW: Stable

TABLE NN8/I

BASIC DATA / CALCULATIONS

Lateral displacement (1937 - 1976)	\bar{x}	6.1	m
Relative lateral stability (1937 - 1976)	\bar{v}	10.9	%
Area of catchment		43	km ²
Area of flood plain		36.4	ha
Area of envelope of mobility	\bar{x}	14.4	ha
Simulated M.A.R. (1921 - 1975)	\bar{s}	7.32	x 10 ⁶ m ³
	\bar{v}	6.21	x 10 ⁶ m ³
		84.8	%

Dates of major floods: March 1925, Dec. 1944, Minor floods: April 1943, Jan 1945, Dec 1956
Jan - March 1976

MEASUREMENTS/CALCULATIONS FROM PHOTOGRAPHS

Date	1-5-37	1953	6-6-59	2-8-67	3-6-73	14-5-76
Thalweg (m)	2424	2357	2420	2424	2425	2490
% Thalweg estuarine	?	?	?	?	?	100
Aerial D (m)	1689	1697	1710	1687	1688	1724
Sinuosity	1.44	1.39	1.42	1.44	1.44	1.44
\bar{x} River width (m)	36.8	32.6	34.1	32.6	36.4	41.4
Open water area (ha)	9.7	8.3	8.3	8.2	8.5	9.7
% envelope of mobility	67.4	57.6	57.6	56.9	59.0	67.4
Bar/embankment area (ha)	X	X	X	X	X	X
River braided	Nil	Nil	Nil	Nil	Nil	Nil
% Flood plain cultivated	9	88	9	9	9	9
Left valley side:						
% grass	88	88	88	88	88	91
% trees	3	3	3	3	3	Nil
% cultivated	Nil	Nil	Nil	Nil	Nil	Nil
% built up	21	Nil	Nil	Nil	Nil	Nil
Right valley side:						
% grass	75	96	96	96	100	100
% trees	4	4	4	4	Nil	Nil
% cultivated	Nil	Nil	Nil	Nil	Nil	Nil
% built up	27	29	30	31	32	43
L.B. % vegetated	9	5	4	11	11	22
R.B. % vegetated	C	C	C	C	C	C
Mouth open/closed	217	217	217	217	217	217
Direction (°)	230	230	230	230	230	230
Length (m)	40	42	31	37	37	48
\bar{x} width (m)						

TABLE NNB/II

CLASSIFICATION OF THE LOWER REACHES OF NATAL RIVERS

NRIO NN 8

RIVER MDLOTANE, ? ESTUARINE, REACH from RAPIDS, 2.4 km from mouth. REF. DEA U500a

AERIAL PHOTO DATE 1-5-37 SCALE 1:10 000 CATCHMENT AREA 43 km², M.A.R. 7.32 m³ x 10⁶, No. of DAMS 2

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	9	8
hilly	✓ grass	scattered cultivation	occasional	grass	9	21
✓ undulating plains	✓ sparsely forested (0-25%) moderately forested (25-75%) heavily forested (75-100%) swamp/bog	✓ partly cultivated mainly cultivated ✓ scattered settlement partly built-up urbanised	frequent	trees/bush cultivated built-up	79	67
					3	4

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 2330 m bottom width (av.) 157 m valley slope height at head of reach ___ m to MSL	none indefinite ✓ fragmentary continuous	not applicable not obviously degrading or aggrading ✓ partly entrenched entrenched aggrading	not applicable (no valley or free) occasionally confined ✓ frequently confined entrenched	bedrock lacustrine deposits ✓ fluvial deposits aeolian sand covered <u>NIL</u> % area lower reach only

Comments

River Mouth

Characteristics	Measurements
✓ open/closed natural/artificial canalized sandy ✓ rocks on right bank rocks on left bank outer bar silt plume (fluvial) ✓ suspended sediment (marine)	right bank breakwater length ___ m left bank breakwater length ___ m rock sill level ___ m to MSL cliffs on right bank: height ___ m to MSL cliffs on left bank: height ___ m to MSL spike/bar: direction of growth 217° length of spike/bar 230 m length stabilized <u>NIL</u> m width 40 m

Comments

FLOOD PLAIN AND CHANNEL FEATURES

Description of Flood Plain

Presence	Extent	Vegetation	Forest Type	Land-Use
none indefinite fragmentary ✓ continuous	none average width 157 m maximum width 375 m aerial length 1689 m area 36.4 ha	almost none grass reed swamp 14 % area sparsely forested moderately forested heavily forested	not known/applicable riverine: ✓ main channel ✓ tributaries ✓ mangroves	✓ not cultivated, not built-up cultivated <u>NIL</u> % area crop/s partly built-up mainly built-up

Comments

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

Pattern	Measurements	Islands/Shoals	Type of Flow	Bar Type
straight sinuous irregular regular meanders ✓ irregular meanders cortuous meanders bifurcated lake/s lagoon	thalweg 2.424 m sinuosity 1.44 open water area 9.7 ha perimeter 4952 m lake/lagoon area ___ ha river X-sections available ___ ha channel slope ___ channel width x ___ m river slope ___ river width x 36.8 m s = 19.3 m	✓ none occasional frequent split braided	✓ meandering /still ✓ uniform water surface uniform with rapid in reach irregular pool & riffle sequence turbid	none ✓ channel side bars ✓ point bars channel junction bars mid-channel bars diamond bars diagonal bars 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 logs boulders vegetation	none minor major	<u>NIL</u> road bridge/s rail bridge/s causeway 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 downstream progression progression & cut-offs mainly cut-offs entrenched loop development irregular lateral activity avulsion	✓ alluvium (silt/sand) natural levees rock/boulders protected/stabilized cultivation to channel edge	none weak good very strong *left bank 27 % *right bank 9 %	✓ stable slightly unstable moderately unstable unstable highly unstable Comments *mostly swamps ** trees

RIVER MDLOTANE, ? ESTUARINE, REACH from RAPIDS, 2,4 km from mouth. REF. DEA U 500 a

AERIAL PHOTO DATE Sept/Oct '53 SCALE 1:10 000 CATCHMENT AREA 43 km², M.A.R. 7,32 m³x10⁶, No. of DAMS 2

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	coastal dune	9 8 %
hilly	✓ grass	scattered cultivation	occasional	grass	9 %
✓ undulating	✓ sparsely forested (0-25%)	✓ partly cultivated	frequent	trees/bush	79 88 %
plains	moderately forested (25-75%)	mainly cultivated		cultivated	3 %
	heavily forested (75-100%)	✓ scattered settlement		built-up	4 %
	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 2330 m	none	not applicable	not applicable (no valley or free)	bedrock
bottom width (av.) 157 m	indefinite	not obviously degrading or aggrading	occasionally confined	lacustrine deposits
valley slope _____	✓ fragmentary	✓ partly entrenched	✓ frequently confined	✓ fluvial deposits
height at head _____	continuous	entrenched	entrenched	aeolian
of reach _____ m to MSL		aggrading		sand covered NIL % area

Comments *lower reach only

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 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 217°
outer bar	length of spit/bar 230 m
silt plume (fluvial)	length stabilized NIL m
✓ suspended sediment (marine)	width 40 m

Comments _____

FLOOD PLAIN AND CHANNEL FEATURES

Description of Flood Plain	Vegetation	Forest Type	Land-Use
Presence			
none	almost none	not known/applicable	✓ not cultivated, not built-up
indefinite	grass	riverine:	cultivated NIL % area
fragmentary	reed swamp 12 % area	✓ main channel	crop/s
✓ continuous	sparsely forested	✓ tributaries	partly built-up
	moderately forested	✓ mangroves	mainly built-up
	heavily forested		

Comments _____

Channel Description N.B. Estimate of flow stage: LOW/WATER LOW - 1000 mm/yr

Pattern	Measurements	Islands/Shoals	Type of Flow	Bar Type
straight	thalweg 2357 m	✓ none	✓ alignment/still	none
sinuous	* sinuosity 1.39	occasional	✓ uniform water surface	✓ channel side bars
irregular	* open water area 18.3 ha	frequent	uniform with rapid in reach	✓ point bars
regular meanders	perimeter 4820 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 _____			diagonal bars
lake/s	channel width x _____ m s = _____ m			sand waves/large dunes
lagoon	river slope _____			
	river width x 32,6 m s = 22,0 m			

Comments *whole reach

Obstructions/Constructions

Natural	Degree	Man-made	Degree of Obstruction/Constriction for Each	Position (from head of reach)
none	none	NIL		
logs	minor	road bridge/s _____		
boulders	major	rail bridge/s _____		
vegetation		causeway _____		
		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 (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	unstable
entrenched loop development	cultivation to	** left bank 29 %	highly unstable
irregular lateral activity	channel edge	* right bank 5 %	
avulsion			

Comments *mostly swamps
** trees

RIVER MDLOTANE, ? ESTUARINE, REACH from RAPIDS, 2.4 km from mouth. REF. DEA 4500a
 AERIAL PHOTO DATE 6-6-59 SCALE 1:10 000 CATCHMENT AREA 43 km², M.A.R. 7,32 m³x10⁶, No. of DAMS 2

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	9	8
hilly	grass	scattered cultivation	occasional	grass	9	
✓ undulating	sparately forested (0-25%)	✓ partly cultivated	frequent	trees/bush	79	88
plains	✓ moderately forested (25-75%)	mainly cultivated		cultivated	3	4
	heavily forested (75-100%)	✓ scattered settlement		built-up		
	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>2330</u> m	none	not applicable	not applicable (no valley or free)	bedrock
bottom width (av.) <u>157</u> m	indefinite	not obviously degrading or aggrading	occasionally confined	lacustrine deposits
valley slope _____	✓ fragmentary		✓ frequently confined	✓ fluvial deposits
height at head _____	continuous	✓ partly entrenched	entrenched	aeolian
of reach _____ m to MSL		entrenched		sand covered <u>NIL</u> % area

Comments: lower reach only

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>217</u> °	
outer bar	length of spit/bar <u>230</u> m	
silt plume (fluvial)	length stabilized <u>NIL</u> m	
✓ suspended sediment (marine)	width <u>42</u> m	

FLOOD PLAIN AND CHANNEL FEATURES

Description of Flood Plain	Vegetation	Forest Type	Land-Use
Presence			
none	almost none	not known/applicable	✓ not cultivated, not built-up
indefinite	grass	riverine:	cultivated <u>NIL</u> % area
fragmentary	reed swamp <u>14</u> % area	✓ main channel	crop/s
✓ continuous	sparately forested	✓ tributaries	partly built-up
	moderately forested	✓ mangroves	mainly built-up
	heavily forested		

Comments _____

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

Pattern	Measurements	Islands/Shoals	Type of Flow	Bar Type
straight	thalweg <u>2420</u> m	✓ none	✓ submerged /still	none
sinuous	sinuosity <u>1.42</u>	occasional	✓ uniform water surface	✓ channel side bars
irregular	open water area <u>83</u> ha	frequent	uniform with rapid in reach	✓ point bars
regular meanders	perimeter <u>4920</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 _____			diagonal bars
lake/s	channel width x _____ m			sand waves/large dunes
lagoon	river slope _____			
	river width x <u>34.1</u> m			

Comments: *whole reach

Obstructions/Constructions

Natural	Degree	Man-made	Degree of Obstruction/Constriction for Each	Position (from head of reach)
✓ none	none	<u>NIL</u>		
logs	minor	road bridge/s		
boulders	major	rail bridge/s		
vegetation		causeway		
		weir/dam		
		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 levees	weak	slightly unstable	
progression & cut-offs	rock/boulders	good	moderately unstable	
mainly cut-offs	protected/stabilized	very strong	unstable	
entrenched loop development	cultivation to	* left bank <u>30</u> %	highly unstable	
irregular lateral activity	channel edge	** right bank <u>4</u> %		
avulsion				<u>* mostly swamps</u> <u>** trees</u>

RIVER MDL. IANE, ? ESTUARINE, REACH from RAPIDS, 2.4 km from mouth. REF. DEA U 5009

AERIAL PHOTO DATE 2-8-67 SCALE 1:10 000 CATCHMENT AREA 43 km², M.A.R. 7,32 m³x10⁶, No. of DAMS 2

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	<u>9</u>	<u>8</u>
hilly	✓ grass	scattered cultivation	occasional	grass	<u>9</u>	<u>8</u>
✓ undulating	sparsely forested (0-25%)	✓ partly cultivated	frequent	trees/bush	<u>79</u>	<u>88</u>
plains	✓ moderately forested (25-75%)	mainly cultivated		cultivated	<u>3</u>	<u>4</u>
	heavily forested (75-100%)	✓ scattered settlement		built-up		<u>2</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>2330</u> m	none	not applicable	not applicable (no valley or free)	bedrock
bottom width (av.) <u>157</u> m	indefinite	not obviously degrading or aggrading	occasionally confined	lacustrine deposits
valley slope _____	✓ fragmentary	partly entrenched	✓ frequently confined	fluvial deposits
height at head _____	continuous	entrenched	entrenched	aeolian
of reach _____ m to MSL		aggrading		sand covered <u>NIL</u> % area

Comments lowest reach only

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>217</u> °	
outer bar	length of spit/bar <u>230</u> m	
silt plume (fluvial)	length stabilized <u>NIL</u> m	
✓ suspended sediment (marine)	width <u>31</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>157</u> m	grass	riverine:	cultivated _____ % area
fragmentary	maximum width <u>375</u> m	reed swamp <u>12</u> % area	✓ main channel	crop/s _____
✓ continuous	serial length <u>1687</u> m	sparsely forested	✓ tributaries	partly built-up
	area <u>36.4</u> ha	moderately forested	✓ mangroves	mainly built-up
		heavily forested		

Comments _____

Channel Description N.B. Estimate of flow stage: LOW

Pattern	Measurements	Islands/Shoals	Type of Flow	Bar Type
straight	thalweg <u>2424</u> m	✓ none	✓ segment/still	none
sinuous	sinuosity <u>1.44</u>	occasional	uniform water surface	✓ channel side bars
irregular	open water area <u>8.2</u> ha	frequent	uniform with rapid in reach	✓ point bars
regular meanders	perimeter <u>4976</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 _____			diagonal bars
lake/s	channel width \bar{x} _____ m			sand waves/large dunes
lagoon	river slope _____			
	river width \bar{x} <u>32.6</u> m			

Comments *whole reach

Obstructions/Constructions

Natural	Degree	Man-made	Degree of Obstruction/Constriction for Each	Position (from head of reach)
✓ none	none	<u>NIL</u>		
logs	minor	road bridge/s _____		
boulders	major	rail bridge/s _____		
vegetation		causeway _____		
		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 (silt/sand)	none	✓ stable
downstream progression	natural levees	weak	slightly unstable
progression & cut-offs	rock/boulders	good	moderately unstable
mainly cut-offs	protected/stabilized	very strong	unstable
entrenched loop development	cultivation to channel edge	** left bank <u>31</u> %	highly unstable
irregular lateral activity		** right bank <u>11</u> %	
evulsion			

Comments *mostly swamps
** trees

TABLE NN8/VI

CLASSIFICATION OF THE LOWER REACHES OF NATAL RIVERS

NRIO NN 8

RIVER MDLOTANE, ? ESTUARINE, REACH from RAPIDS, 2.4 km from mouth. REF. DEA U500a
 AERIAL PHOTO DATE 3-6-73 SCALE 1:10 000 CATCHMENT AREA 43 km², M.A.R. 7.32 m³x10⁶, No. of DAMS 2
 (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	9	8
hilly	✓ grass	scattered cultivation	occasional	grass	9	
✓ undulating	sparingly forested (0-25%)	✓ partly cultivated	frequent	trees/bush	79	92
plains	✓ moderately forested (25-75%)	mainly cultivated		cultivated	3	
	heavily forested (75-100%)	✓ scattered settlement		built-up		
	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 2330 m	none	not applicable	not applicable (no valley or free)	bedrock
bottom width (av.) 157 m	indefinite	not obviously degrading or aggrading	occasionally confined	lacustrine deposits
valley slope 1:117	✓ fragmentary	✓ partly entrenched	✓ frequently confined	✓ fluvial deposits
height at head of reach + 2 m to MSL approx.	continuous	entrenched	entrenched	aeolian
		aggrading		sand covered 11% area

Comments *lower reach only

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 217 °	
outer bar	length of spit/bar 230 m	
silt plume (fluvial)	length stabilized 114 m	
✓ suspended sediment (marine)	width 37 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 157 m	grass	riverine:	cultivated 11% area
fragmentary	maximum width 375 m	reed swamp 11 % area	✓ main channel	crop/s
✓ continuous	aerial length 1688 m	sparingly forested	✓ tributaries	partly built-up
	area 36.4 ha	moderately forested	✓ mangroves	mainly built-up
		heavily forested		

Comments _____

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

Pattern	Measurements	Islands/Shoals	Type of Flow	Bar Type
straight	thalweg 2425 m	✓ none	✓ stagnant/still	none
sinuous	*sinuosity 1.44	occasional	✓ uniform water surface	✓ channel side bars
irregular	*open water area 8.5 ha	frequent	uniform with rapid in reach	✓ point bars
regular meanders	perimeter 4950 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 _____			
	river width x 36.4 m s = 21.0 m			

Comments *whole reach

Obstructions/Constructions

Natural	Degree	Man-made	Degree of Obstruction/Constriction for Each	Position (from head of reach)
✓ none	none	NIL		
logs	minor	road bridge/s _____		
boulders	major	rail bridge/s _____		
vegetation		causeway _____		
		weir/dam _____		
		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	unstable	
entrenched loop development	cultivation to channel edge	** left bank 32 %	highly unstable	* mostly swamps
irregular lateral activity		** right bank 11 %		** trees
avulsion				

RIVER MDLOTANE, 100 % ESTUARINE, REACH from RAPIDS, 2,4 km from mouth. REF. DEA U 500a
 AERIAL PHOTO DATE 14-5-76 SCALE 1:10 000 CATCHMENT AREA 43 km², M.A.R. 7,32 m³x10⁶, No. of DAMS 2

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	<u>9</u>	<u>8</u> %
hilly	✓ grass	scattered cultivation	occasional	grass	<u>9</u>	<u>2</u> %
✓ undulating plains	sparsely forested (0-25%)	✓ partly cultivated	frequent	trees/bush	<u>82</u>	<u>92</u> %
	✓ moderately forested (25-75%)	mainly cultivated		cultivated		<u>2</u> %
	heavily forested (75-100%)	✓ scattered settlement		built-up		<u>2</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>2330</u> m	none	not applicable	not applicable (no valley or free)	bedrock
bottom width (av.) <u>157</u> m	indefinite	not obviously degrading or aggrading	occasionally confined	lacustrine deposits
valley slope _____	✓ fragmentary	✓ partly entrenched	✓ frequently confined	✓ fluvial deposits
height at head _____	continuous	entrenched	entrenched	aeolian
of reach _____ m to MSL		aggrading		sand covered <u>NIL</u> % area

Comments lower reach only

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 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>217</u> °
outer bar	length of spit/bar <u>230</u> m
silt plume (fluvial)	length stabilized <u>NIL</u> m
✓ suspended sediment (marine)	width <u>48</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>157</u> m	grass	riverine:	cultivated <u>NIL</u> % area
fragmentary	maximum width <u>375</u> m	reed swamp <u>12</u> % area	✓ main channel	crop/s
✓ continuous	serial length <u>1724</u> m	sparsely forested	✓ tributaries	partly built-up
	area <u>36,4</u> ha	moderately forested	✓ 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>2490</u> m	✓ none	stagnant/still	none
sinuous	*sinuosity <u>144</u>	occasional	✓ uniform water surface	✓ channel side bars
irregular	*open water area <u>97</u> ha	split	uniform with rapid in reach	✓ point bars
regular meanders	perimeter <u>5030</u> m	braided	irregular	channel junction bars
✓ irregular meanders	lake/lagoon area _____ ha		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 _____ m s = _____ m			sand waves/large dunes
lagoon	river slope _____			
	river width x <u>41,4</u> m s = <u>24,0</u> m			

Comments *whole reach

Obstructions/Constructions

Natural	Degree	Man-made	Degree of Obstruction/Constriction for Each	Position (from head of reach)
✓ none	none	<u>NIL</u>		
logs	minor	road bridge/s _____		
boulders	major	rail bridge/s _____		
vegetation		causeway _____		
		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 (silt/sand)	none	✓ stable
downstream progression	natural levees	weak	slightly unstable
progression & cut-offs	rock/boulders	good	moderately unstable
mainly cut-offs	protected/stabilized	very strong	unstable
entrenched loop development	cultivation to	***left bank <u>43</u> %	highly unstable
irregular lateral activity	channel edge	**right bank <u>5</u> %	
avulsion			

Comments * mostly swamps
** trees

RIVER WIDTHS

TABLE NNS/VIII

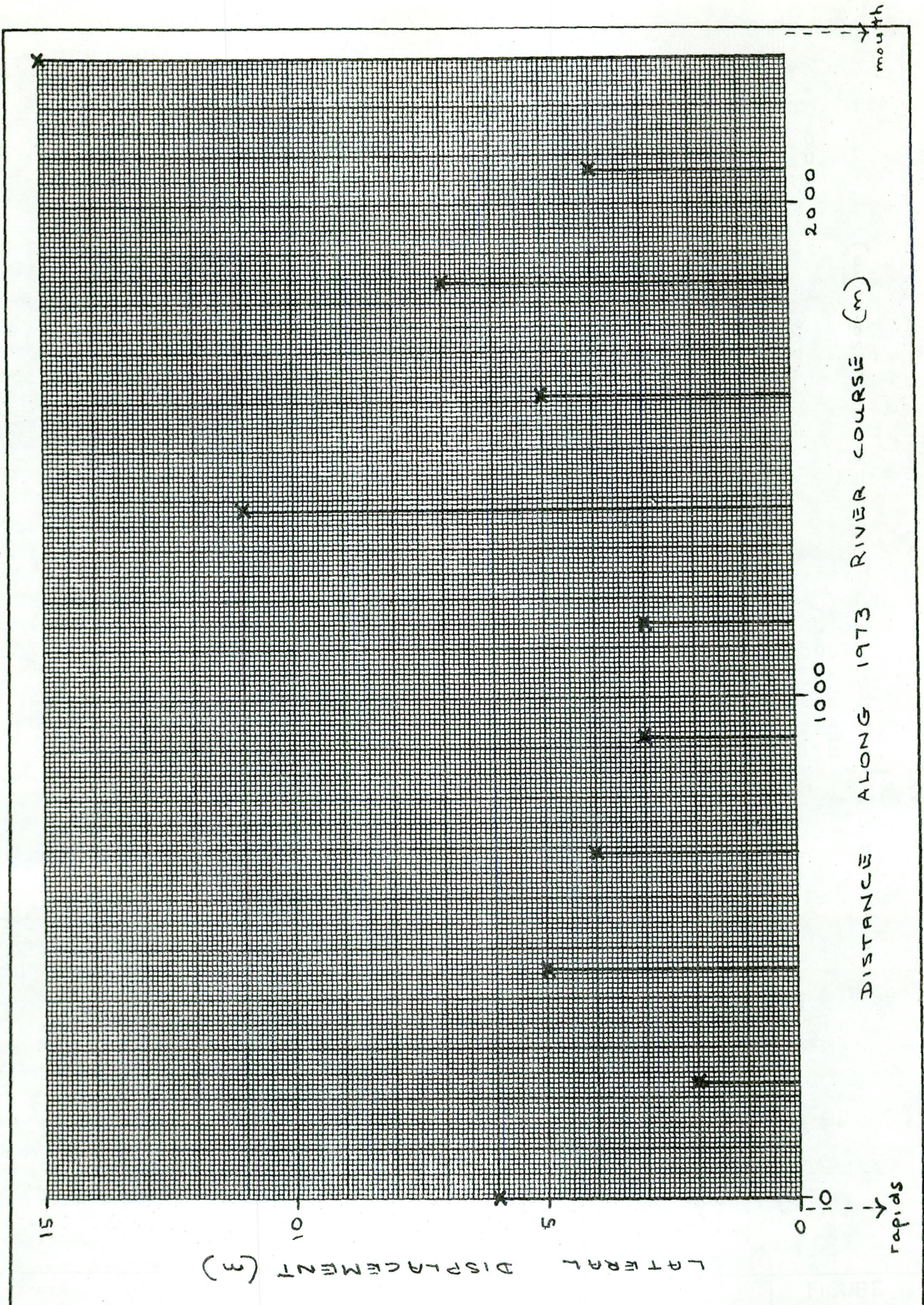
Station	Approx. distance along 1973 river course from rapids (m)	River widths (m)								\bar{x}	s	V%
		Date										
		01.05.37	Sep/Oct 53	06.06.59	02.08.67	03.06.73	14.05.76					
1	0	15	15	12	20	15	20	15	20	16,2	3,2	19,7
2	230	18	22	18	18	12	18	12	16	17,3	3,3	18,8
3	460	18	18	15	18	15	18	15	16	16,7	1,5	9,0
4	690	32	35	24	29	42	29	42	33	32,5	6,0	18,5
5	920	32	29	24	24	34	24	34	32	29,2	4,3	14,8
6	1 150	24	18	18	18	18	18	18	24	20,0	3,1	15,5
7	1 380	48	44	42	42	42	42	42	46	44,0	2,5	5,7
8	1 610	48	39	44	40	44	40	44	44	43,2	3,3	7,5
9	1 840	68	66	64	60	67	60	67	72	66,2	4,0	6,1
10	2 070	70	73	67	70	75	70	75	86	73,5	6,7	9,1
11	2 300 (near mouth)	32	0	47	20	36	20	36	66	33,5	22,6	67,4
\bar{x}		36,8	32,6	34,1	32,6	36,4	32,6	36,4	41,4	35,7		
s		19,3	22,0	19,7	18,3	21,0	18,3	21,0	24,0			
V%		52,5	67,5	57,8	56,0	57,7	56,0	57,7	58,1			

Station	Approx. distance along 1973 river course from rapids (m)	Distance from maximum observed L.B. position to mid-river (m)							Max - Min	\bar{x}	s	V%
		Date										
		01.05.37	Sep/Oct 53	06.06.59	02.08.67	03.06.73	14.05.76					
1	0	12	10	<u>9</u>	10	12	<u>15</u>	6	11,3	2,2	19,1	
2	230	<u>9</u>	<u>11</u>	<u>9</u>	10	10	10	2	9,8	0,8	7,6	
3	460	9	9	12	9	<u>8</u>	<u>13</u>	5	10,0	2,0	20,0	
4	690	20	<u>18</u>	20	20	21	<u>22</u>	4	20,2	1,3	6,6	
5	920	17	<u>15</u>	<u>18</u>	<u>15</u>	<u>18</u>	<u>18</u>	3	16,8	1,5	8,7	
6	1 150	12	13	<u>11</u>	13	13	<u>14</u>	3	12,7	1,0	8,2	
7	1 380	29	<u>34</u>	29	31	26	<u>23</u>	11	28,7	3,8	13,4	
8	1 610	<u>27</u>	<u>27</u>	25	<u>27</u>	<u>22</u>	<u>22</u>	5	25,0	2,4	9,8	
9	1 840	<u>43</u>	37	<u>36</u>	40	40	39	7	39,2	2,5	6,3	
10	2 070	42	40	42	40	<u>39</u>	<u>43</u>	4	41,0	1,5	3,8	
11	2 300 (near mouth)	<u>44</u>	NR	<u>29</u>	40	42	33	15	37,6	6,3	16,9	
\bar{x}		24,0	20,2	21,8	23,2	22,8	22,9	6,1	22,9		10,9	
s		13,9	13,4	11,3	12,9	12,5	10,9	3,8	22,5		5,5	
V%		57,8	66,3	51,9	55,5	54,7	47,8	62,1			50,6	

Average lateral displacement 1937-1976 = 6,1 m
Average coefficient of variation 1937-1976 = 10,9%

TABLE NNR/Σ SIMULATED RUN-OFF FOR MLOTANE NNR/ CATCHMENT AREA= 43.050 KM. TOTAL \$M.A.N.

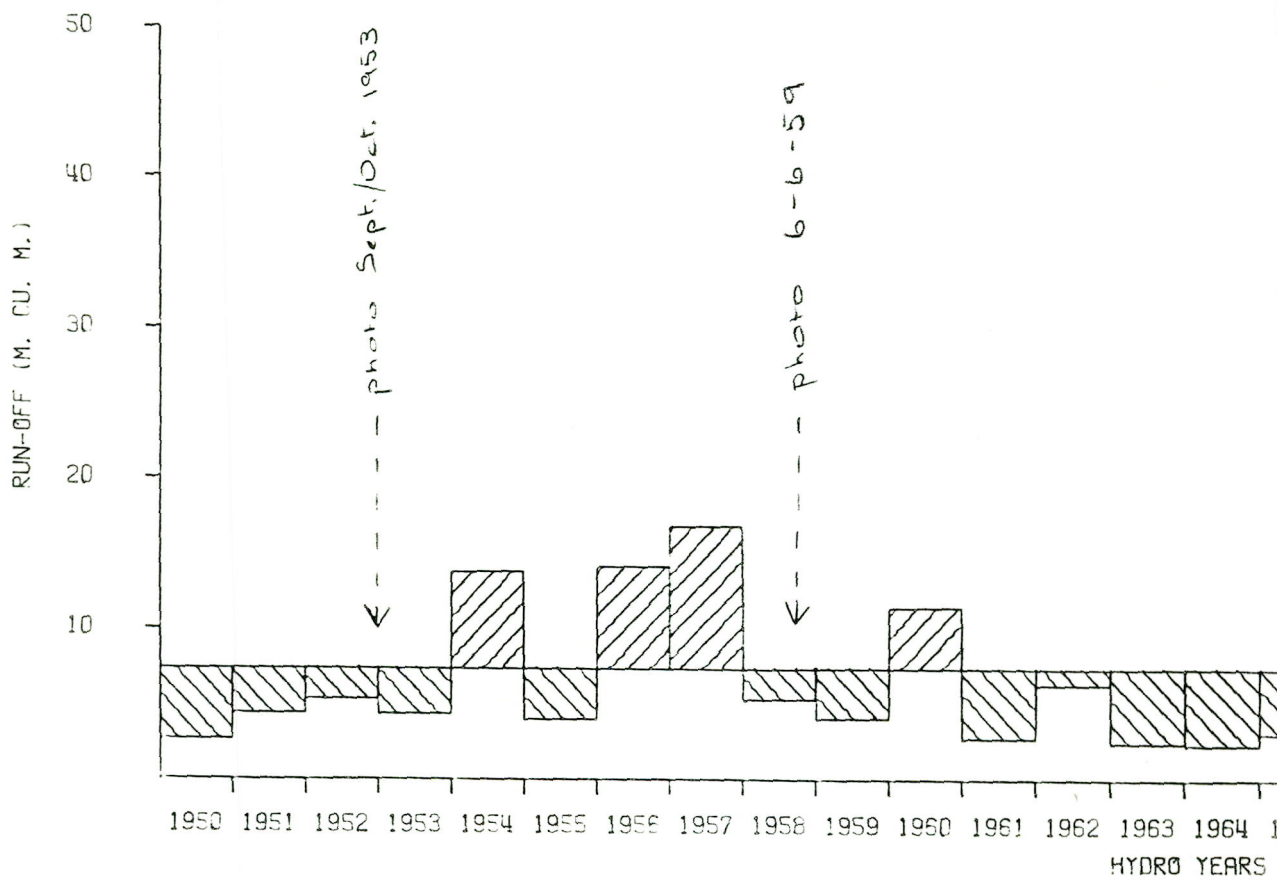
YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL
1921	.14	1.62	3.50	1.22	.25	.24	.21	.20	.22	.19	.21	.22	8.22
1922	.25	.43	.42	3.51	1.49	.41	.29	.17	.10	.09	.09	.07	7.32
1923	.06	.08	.13	.17	.21	.21	.20	.17	.20	.23	.08	.12	1.66
1924	.22	3.00	3.11	1.07	.44	11.49	4.35	.46	.31	.23	.18	.26	25.51
1925	.40	.36	.27	.21	.17	.18	.17	.11	.10	.10	.08	.10	2.27
1926	.24	.39	.39	.29	.26	2.33	1.02	.24	.15	.11	.11	.09	5.65
1927	.11	.13	.18	.34	.39	.33	.26	.18	.11	.08	.07	.12	2.31
1928	.18	.19	.16	.17	.21	1.52	.77	.24	.19	.22	.20	.20	4.24
1929	.29	.38	.36	.38	.36	.34	.34	.26	.16	.12	.12	.19	3.29
1930	.26	.38	.39	.39	.38	.33	.26	.18	.11	.08	.07	.05	2.89
1931	.07	.11	.16	.22	2.16	2.66	.91	.30	.25	.18	.11	.10	7.22
1932	.13	.21	.34	.34	.29	.27	.26	.12	.11	.11	.11	.09	2.45
1933	.09	.25	.83	2.58	1.08	1.51	.99	.52	.35	.25	.25	.23	8.93
1934	.23	.30	3.07	1.30	.35	.40	.39	.32	2.20	1.03	.32	.22	10.12
1935	.18	.17	.17	.28	2.26	2.37	.82	.40	.40	.30	.18	.14	7.68
1936	.19	2.86	1.21	.25	.28	.31	.24	.16	.11	.11	.10	.08	5.91
1937	.10	.13	.26	1.25	1.56	.63	.30	.27	.21	.23	.22	.16	5.32
1938	.20	.29	1.97	.98	2.11	.99	.34	.27	.21	.23	.22	.16	5.32
1939	.29	2.04	1.93	.82	.45	.39	.33	2.97	1.84	.59	.26	.24	12.14
1940	.26	.34	2.53	1.07	.26	.22	.30	.30	.20	.14	.10	.11	5.82
1941	.15	.21	.19	.22	.31	1.90	.91	.25	.21	.21	.21	.25	70.27
1942	.35	2.07	4.77	1.69	.42	1.70	5.33	1.93	.35	.84	3.34	1.34	24.14
1943	2.96	2.53	.83	.29	.28	.38	.35	.22	.19	.20	.16	.28	8.68
1944	.42	.42	17.99	6.34	.40	3.07	1.27	.25	.15	.09	.07	.05	30.52
1945	.05	.06	.07	.14	.23	.29	.26	.18	.12	.09	.06	.06	21.97
1946	.17	2.44	1.17	1.81	1.39	2.43	1.06	.34	.27	.25	.19	.16	11.68
1947	.17	.97	.80	.52	.38	.41	.46	.37	.24	.15	.11	.08	4.65
1948	.13	.21	.22	.24	.50	.49	.48	.42	.28	.19	.14	.12	3.42
1949	.19	.37	2.10	.95	.34	.94	.63	.37	.25	.16	.14	.13	6.56
1950	.10	.08	.20	.34	.30	.23	.21	.18	.16	.13	.26	.43	2.62
1951	.45	.34	.35	.90	.54	.32	.27	.30	.30	.24	.18	.13	4.32
1952	.10	.17	.24	.57	2.38	1.00	.24	.16	.11	.08	.08	.11	5.25
1953	.14	.20	.24	.27	.94	.60	.42	.43	.36	.25	.18	.24	4.27
1954	4.24	3.71	1.03	2.08	.96	.38	.40	.35	.24	.16	.11	.09	13.75
1955	.12	.21	.26	.16	.42	1.20	.65	.27	.18	.13	.12	.16	3.89
1956	.20	.26	5.83	2.29	.45	.44	1.06	.58	.24	.16	.14	.24	14.07
1957	3.47	1.27	1.19	3.28	3.46	1.14	1.52	.75	.24	.15	.10	.12	16.70
1958	.15	.23	.65	.49	.75	.45	.22	.99	.60	.26	.21	.21	5.21
1959	.28	.37	.39	.30	.28	.37	.79	.50	.25	.16	.13	.13	3.94
1960	.18	.33	2.36	2.50	.87	.40	2.55	1.09	.31	.27	.21	.22	11.29
1961	.28	.30	.31	.32	.29	.28	.26	.19	.12	.08	.10	.15	2.69
1962	.21	.33	.43	1.56	.74	.80	.57	.32	.26	.36	.36	.23	6.18
1963	.18	.21	.19	.43	.37	.23	.19	.16	.12	.11	.10	.09	2.38
1964	.17	.21	.26	.21	.18	.14	.10	.08	.14	.21	.25	.29	2.29
1965	.31	.36	.37	.41	.42	.28	.18	.17	.16	.13	.11	.12	3.01
1966	.14	.18	.21	.64	.49	2.74	1.23	.35	.21	.16	.12	.09	6.55
1967	.11	.23	.28	.29	.28	.28	.29	.22	.14	.09	.11	.15	2.48
1968	.24	.20	.31	.34	.37	3.69	1.53	.40	.30	.20	.14	.13	7.79
1969	.24	.30	.31	.26	.19	.14	.10	.10	.10	.09	.09	.18	2.11
1970	.30	.32	.34	.38	.44	.41	.33	.39	.38	.32	.34	.31	4.28
1971	.28	.27	.35	.38	.40	.43	.34	.27	.25	.20	.15	.11	3.44
1972	.10	.15	.17	.22	.85	.57	.36	.27	.17	.11	.13	.28	3.39
1973	.37	.35	.31	3.19	1.40	.46	.40	.30	.21	.16	.12	.08	7.34
1974	.06	.09	.16	1.47	3.18	1.18	.30	.22	.13	.08	.06	.21	7.13
1975	.33	1.22	3.40	5.36	3.77	5.87	2.04	.37	.24	.14	.10	.10	22.94
MEAN	.39	.63	1.27	1.05	.80	1.15	.73	.40	.28	.20	.21	.22	7.32
S	.79	.86	2.62	1.29	.87	1.84	.96	.46	.36	.17	.44	.35	6.21
V ₈	204.11	135.65	206.97	123.14	108.35	160.11	131.37	116.04	126.47	85.48	209.58	157.31	84.80
MEAN ANNUAL RUN-OFF=	7.32 MILLION CUBIC METRES. COMPILED FROM HRU REPORT NO.9/81 DATA												



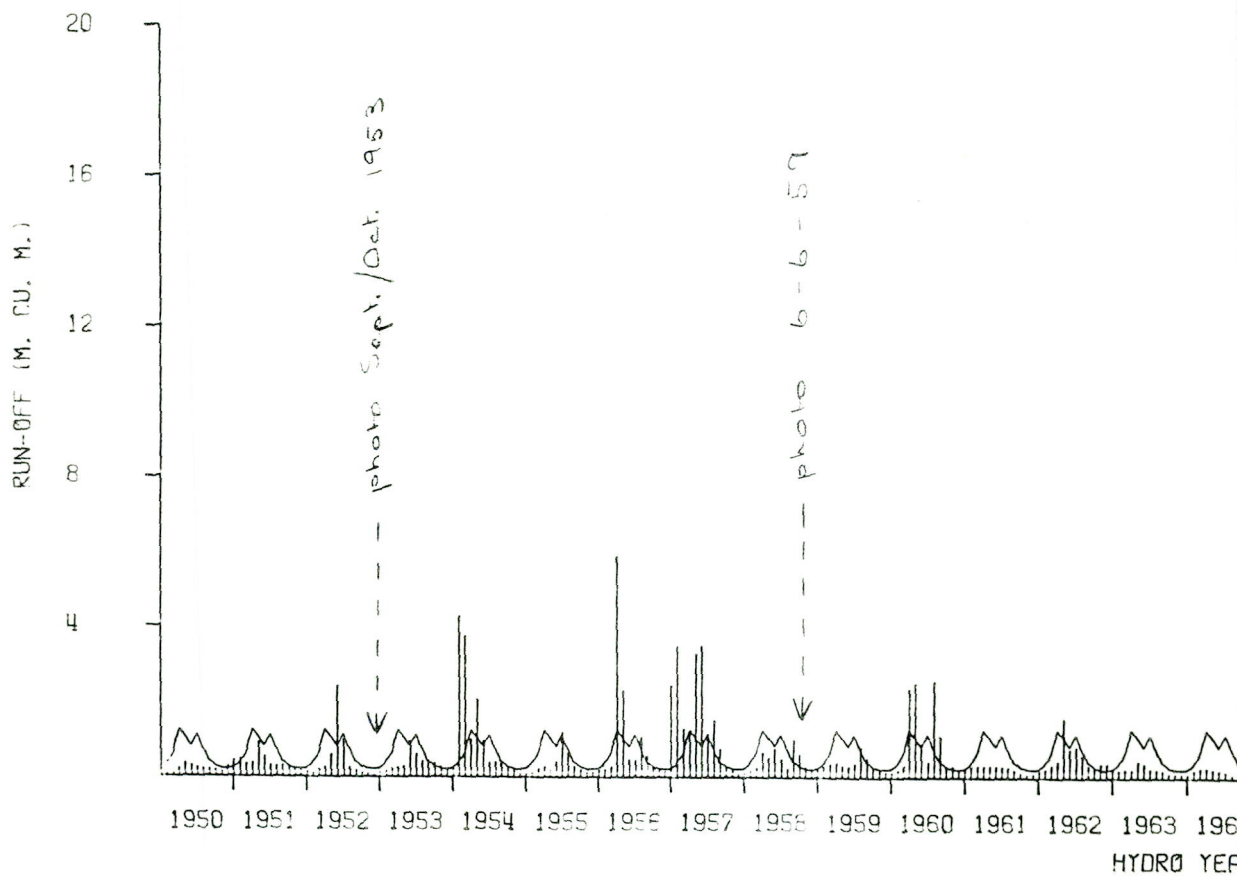
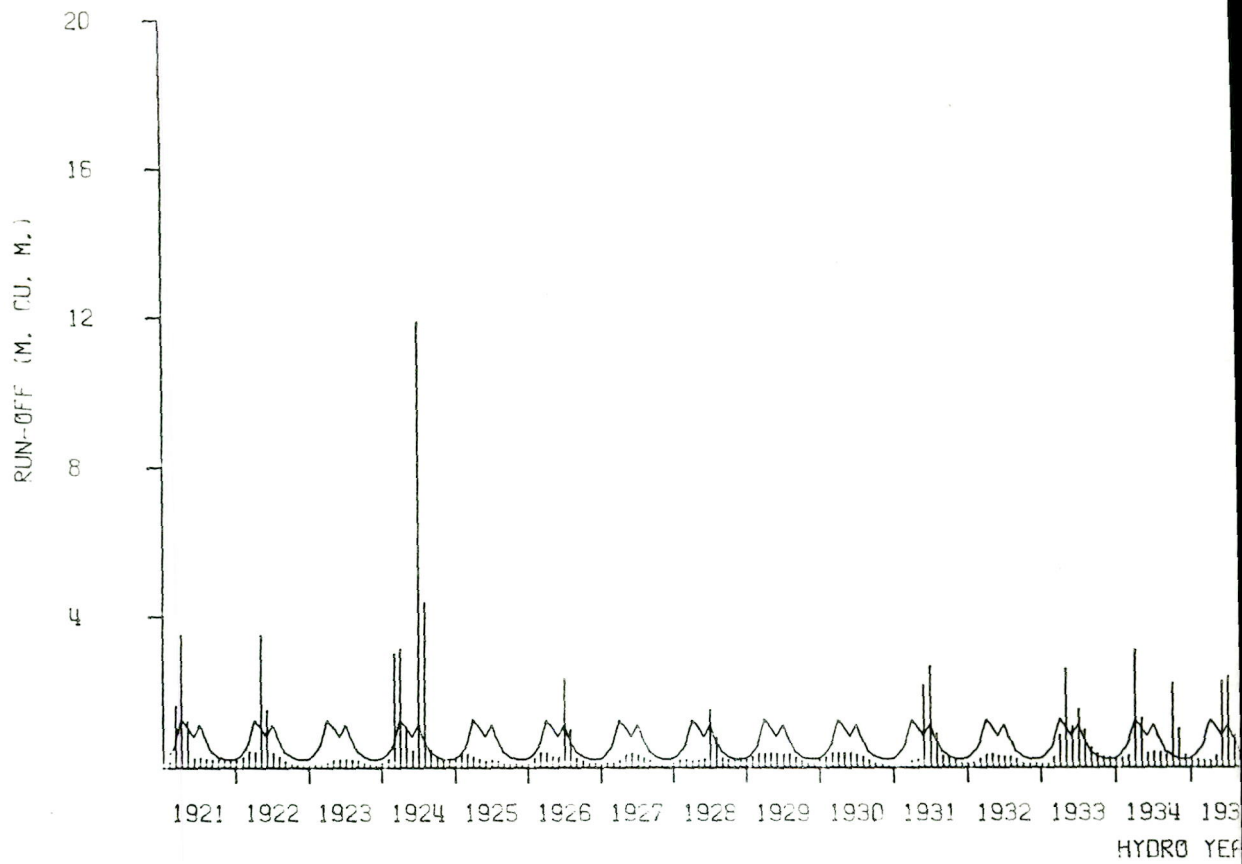
TRACED:
 CHECKED:
 DATE:
 REF.:

NATAL ESTUARIES: MOLOTANE
 THALWEG DISPLACEMENT
 (1937-1976)

FIGURE
 NN8/1



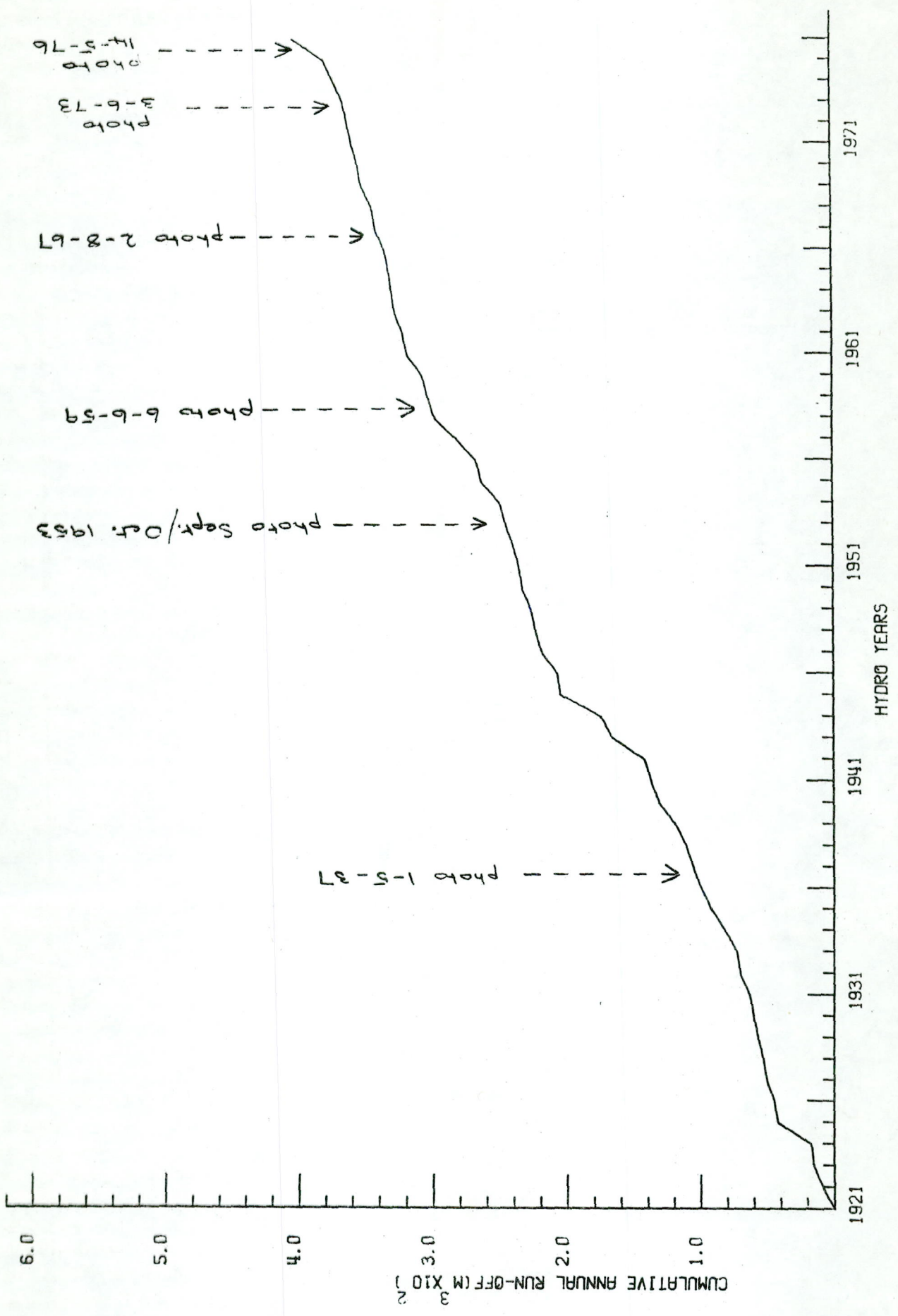
TRACED : COMPLETE CHECKED : DATE : REF. :	NATAL ESTUARIES MDLOTANE SIMULATED ANNUAL RUN-OFF 1921-1975	FIGURE NN8/2
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



TRACED : COMPLETE
 CHECKED:
 DATE :
 REF. :

NATAL ESTUARIES - MDLOTANE
 SIMULATED MONTHLY RUN-OFF
 1921-1977

FIGURE
 NN8/3



TRACED : COMPLET
 CHECKED:
 DATE :
 REF. :

NATAL ESTUARIES: MDLOTANE
CUMULATIVE ANNUAL RUN-OFF

FIGURE
 NN8/4



head of reach

1937 river course

SCALE : 1:10 000 approx.

TRACED:
CHECKED
DATE:
REF:

NATAL ESTUARIES : MDLOTANE

14-5-76

(1-5-37 RIVER COURSE SUPERIMPOSED)

PHOTOGRAPH

NN8/1

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SCALE : 1:10 000 approx.

TRACED:
CHECKED:
DATE:
REF:

NATAL ESTUARIES : MDLOTANE

1-5-37 (12 h08)

PHOTOGRAPH

NN8/2

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SCALE : 1 : 10 000 approx.

TRACED :
CHECKED :
DATE :
REF :

NATAL ESTUARIES : MDLOTANE
SEPT./OCT. 1953 (11h06)

PHOTOGRAPH

NN8/3

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SCALE : 1 : 10 000 approx.

TRACED:
CHECKED:
DATE:
REF:

NATAL ESTUARIES : MDLOTANE

2-8-67 (11h33)

PHOTOGRAPH

NN8/5

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SCALE : 1 : 10 000 approx.

TRACED :
CHECKED :
DATE :
REF :

NATAL ESTUARIES : MDLOTANE

3-6-73 (12 h02)

PHOTOGRAPH

NN8/6

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SCALE : 1 : 10 000 approx.

TRACED :
CHECKED :
DATE :
REF :

NATAL ESTUARIES : MDLOTANE

14 - 5 - 76 (14h25)

PHOTOGRAPH

NN8/7

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SCALE : 1 : 10 000 approx.

TRACED :
CHECKED :
DATE :
REF :

NATAL ESTUARIES : MDLOTANE

3-6-73 (ORTHO PHOTO)

PHOTOGRAPH

NN8/8

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