

CONFIDENTIAL

**HYDROLOGICAL / HYDRAULIC STUDY
OF NATAL ESTUARIES**

DATA REPORT No. 12
MVOTI NN7

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

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Booklet lay-out

Details of the classification of the lower reaches of the Mvoti for 1937, 1959, 1967, 1973 and 1976 are given in Tables NN7/I-V. River widths and details of lateral stability appear in Tables NN7/VI and VII. Simulated run-off for the period 1921-1975 is given in Table NN7/VIII and an abstract of results in Table NN7/IX. Thalweg displacement from 1937-1976 and a sketch map illustrating various mouth positions are shown in Figures NN7/1 and 2. Graphs of simulated annual and monthly run-off are given in Figures NN7/3 and 4. Photograph NN7/1 shows the 1937 river course superimposed on a 1976 photograph. Photographs used for classification purposes are reproduced as Photographs NN7/2-6. Photograph NN7/7 shows the orthophoto compiled from the 1973 photography.

Hydro Data

The M.A.R. from a catchment area of 2829 km² is 481,71 x 10⁶ m³. (Table NN7/VIII). Of particular interest to this study is the nature of the run-off: it is very erratic. The mean run-off is far higher than the median run-off during the summer rainy season, the higher averages being the result of the occasional major floods to which the Mvoti is subject. Long dry phases broken by short wet phases are clearly shown in Figure NN7/3 and more detailed, erratic nature of the monthly run-off in Figure NN7/4. 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 photographs studied and antecedent run-off conditions:

- (i) 1937; below-average run-off for four months. The fifth month previous and three years previous were above-average
- (ii) 1959; above-average run-off and following a wetter phase
- (iii) 1967; below-average run-off and within a dry phase
- (iv) 1973; below-average run-off and within a dry phase
- (v) 1976; near-average run-off but following a five month period of prolonged major floods and high run-off.

River Mouth

The Mvoti is often diverted at its mouth by a long, southerly-extending spit and discharges into the ocean alongside rocks on its right bank. The mouth position is, however, variable (Figure NN7/2). Under flood conditions, the river takes a straighter course to the ocean and breaks through the spit in a more northerly position. This is a natural functioning of the estuary. The mouth usually remains open but occasionally, if it closes, the bar is breached mechanically to ensure that sugar cane does not become flooded (Begg 1978).

Land-use

Most of the valley sides and more than half of the flood plain are under sugar cane cultivation (in some areas to the channel edge). Drainage furrows are to be seen on the flood plain and some of the natural reed swamp area has given way to sugar cane cultivation. The service railway bridge and the NR (National Road) bridge, together with their embankments have restricted normal lateral movement of the river in the upper part of the reach under review.

Siltation

The estuary shows severe siltation. The increase in bar areas is indicative of an abundant supply of silt from upstream and within the estuarine reach.

Stability

The Mvoti has shifted its course laterally to a marked degree during the period under review (and for previous decades, from photographic evidence). This is partly a result of the changing mouth position in response to wet and dry phases already discussed and is quantified by the high average lateral displacement of 218,9 m and high average coefficient of variation of 53,7% (Table NN7/VII). However, it should be noted that during the "normal" conditions of lower to average flow, with the mouth in its southerly position, the trend has been for thalweg lengths and sinuosity to increase. This is typical of aggrading conditions.

The Mvoti estuary has been unstable for the period under review.

LIST OF TABLES

NN7/I	Classification of the lower reaches of the Mvoti	1937
NN7/II	" " " " "	1959
NN7/III	" " " " "	1967
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NN7/VI	River widths	
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NN7/2	Mouth positions: 1937 - 76
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NN7/4	Simulated monthly run-off: 1921 - 1975

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NN7/1	14-5-76 (1-5-37 river course superimposed)
NN7/2	1-5-37 (12h10)
NN7/3	6-6-59 (11h25)
NN7/4	2-8-67 (12h28)
NN7/5	3-6-73 (11h40)
NN7/6	14-5-76 (14h26)
NN7/7	3-6-73 (orthophoto)

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.

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

RIVER MVOTI, ? % ESTUARINE, REACH from Rwy Br to Mouth, 4.4 km from mouth. REF. DEA 4403
 AERIAL PHOTO DATE 1-5-37 SCALE 1:10 000 CATCHMENT AREA 2829 km², M.A.R. 481, 71 m³x10⁶, No. of DAMS 1

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		
✓ undulating	✓ sparsely forested (0-25%)	partly cultivated	frequent	trees	<u>3</u>	<u>7</u>
plains	moderately forested (25-75%)	✓ mainly cultivated		cultivated	<u>97</u>	<u>93</u>
	heavily forested (75-100%)	✓ scattered settlement		built-up		
	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>4250</u> m	none	not applicable	not applicable (no valley or free)	bedrock
bottom width (av.) <u>723</u> m	indefinite	not obviously degrading	✓ 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>6</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>204</u> ° (210° → 134° → 120°)	
outer bar	length of spit/bar <u>1280</u> m	
✓ silt plume (fluvial)	length stabilized <u>NIL</u> m	
suspended sediment (marine)	width <u>87</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>723</u> m	grass	riverine:	cultivated <u>51</u> % area
fragmentary	maximum width <u>1200</u> m	reed swamp <u>17</u> % area	main channel	cropland <u>sugar cane</u>
✓ continuous	aerial length <u>4014</u> m	sparsely forested	tributaries	partly built-up
	area <u>313</u> ha	moderately forested	✓ coastal dune/evergreen mangroves	mainly built-up
		heavily forested		

Comments

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

Pattern	Measurements	Islands/Shoals	Type of Flow	Bar Type
straight	thalweg <u>4425</u> m	✓ none	stagnant/still	none
sinuous	*sinuosity <u>1.10</u>	occasional	✓ uniform water surface	✓ channel side bars
irregular	*open water area <u>26.2</u> ha	frequent	uniform with rapid in reach	✓ point bars
regular meanders	perimeter <u>9239</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			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>64.1</u> m s = <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 _____		
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	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>3</u> %		
irregular lateral activity		right bank <u>5</u> %		
✓ avulsion				

Comments

RIVER MVOTI, ? % ESTUARINE, REACH from ^{Service} Kiloby Pt to Mouth, 4.4 km from mouth. REF. DEA U 403

AERIAL PHOTO DATE 6-6-59 SCALE 1:10 000 CATCHMENT AREA 2829 km², M.A.R. 481,71 m³x10⁶, No. of DAMS 1

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		
✓ undulating	✓ sparsely forested (0-25%)	partly cultivated	frequent	trees	<u>5</u>	<u>7</u>
plains	moderately forested (25-75%)	✓ mainly cultivated		cultivated	<u>95</u>	<u>93</u>
	heavily forested (75-100%)	✓ scattered settlement		built-up		
	swamp/bog	partly built-up				
		urbanised				

Comments *HRU 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>4250</u> m	none	not applicable	not applicable (no valley or free)	bedrock
bottom width (av.) <u>723</u> m	indefinite	not obviously degrading	✓ 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>6</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>222</u> °	
outer bar	length of spit/bar <u>250</u> m	
✓ silt plume (fluvial)	length stabilized <u>NIL</u> m	
suspended sediment (marine)	width <u>80</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>723</u> m	grass	riverine:	cultivated <u>51</u> % area
fragmentary	maximum width <u>1200</u> m	reed swamp <u>17</u> % area	main channel	crop/s <u>sugar cane</u>
✓ continuous	aerial length <u>4014</u> m	sparsely forested	tributaries	partly built-up
	area <u>313</u> ha	moderately forested	✓ coastal duna/evergreen	mainly built-up
		heavily forested	mangroves	

Comments

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

Pattern	Measurements	Islands/Shoals	Type of Flow	Bar Type
straight	thalweg <u>4430</u> m	✓ none	stagnant/still	none
sinuous	*sinuosity <u>1.10</u>	occasional	✓ uniform water surface	✓ channel side bars
irregular	*open water area <u>25.9</u> ha*	frequent	uniform with rapid in reach	✓ point bars
regular meanders	perimeter <u>9240</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			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>58.8</u> m s = <u>27.4</u> m			

Comments *whole reach
** + 5.3ha cut off

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	<u>Service rdwy</u>	<u>2 Confined</u>
boulders	major	causeway		<u>0 (at head)</u>
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 (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	highly unstable
entrenched loop development	✓ cultivation to	left bank <u>11</u> %	
irregular lateral activity	channel edge	right bank <u>21</u> %	
avulsion			

Comments

RIVER MVOTI, ? % ESTUARINE, REACH from Service Rly. Br. to Mouth, 5.4 km from mouth. REF. DEA U 403
 AERIAL PHOTO DATE 2-8-67 SCALE 1:10000 CATCHMENT AREA 2829 km², M.A.R. 481,71 m³x10⁶, No. of DAMS 1

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		
✓ undulating	✓ sparsely forested (0-25%)	partly cultivated	frequent	trees	<u>6</u>	<u>7</u>
plains	moderately forested (25-75%)	✓ mainly cultivated		cultivated	<u>94</u>	<u>93</u>
	heavily forested (75-100%)	✓ scattered settlement		built-up		
	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>4250</u> m	none	not applicable	not applicable (no valley or free)	bedrock
bottom width (av.) <u>723</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 sand covered <u>2</u> % area

Comments

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>203</u> ° (222° → 197° → 72°)
outer bar	length of spit/bar <u>1265</u> m
silt plume (fluvial)	length stabilized <u>Nil</u> m
✓ suspended sediment (marine)	width <u>65</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>723</u> m	grass	riverine:	cultivated <u>61</u> % area
fragmentary	maximum width <u>1200</u> m	reed swamp <u>15</u> % area	main channel	crop/s <u>sugar cane</u>
✓ continuous	aerial length <u>4186</u> m	sparsely forested	tributaries	partly built-up
	area <u>313</u> ha	moderately forested	✓ coastal dune/evergreen mangroves	mainly built-up

Comments

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

Pattern	Measurements	Islands/Shoals	Type of Flow	Bar Type
straight	thalweg <u>5357</u> m	none	stagnant/still	none
sinuous	*sinuosity <u>1,28</u>	occasional	uniform water surface	✓ channel side bars
irregular	*open water area <u>24,7</u> ha	frequent	uniform with rapid in reach	✓ point bars
regular meanders	perimeter <u>11050</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			✓ 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>45,0</u> m s = <u>18,6</u> m			

Comments *whole reach
** upper part of 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. br.</u>	<u>R. Confined</u>	<u>400 m</u>
logs	minor	rail bridge/s <u>Service Rly</u>	<u>R. Confined</u>	<u>0 (at head)</u>
boulders	major	causeway		
vegetation		weir/dam		
		fish traps		
		embankment/s		
		groynes		
Comments		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>8</u> %	
irregular lateral activity		right bank <u>22</u> %	
✓ avulsion			

Comments

TABLE NN7/V

CLASSIFICATION OF THE LOWER REACHES OF NATAL RIVERS

NRIO NN 7

RIVER MVOTI, 11? % ESTUARINE, REACH from ^{Service} Roady. Br. to Mouth, 4.5 km from mouth. REF. DEA U403
 AERIAL PHOTO DATE 14-5-76 SCALE 1:10 000 CATCHMENT AREA 2829 km², M.A.R. 48,71 m³x10⁶, No. of DAMS 1

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		
✓ undulating	✓ sparsely forested (0-25%)	partly cultivated	frequent	trees	<u>5</u>	<u>7</u>
plains	moderately forested (25-75%)	✓ mainly cultivated		cultivated	<u>95</u>	<u>93</u>
	heavily forested (75-100%)	✓ scattered settlement		built-up		
	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>4250</u> m	none	not applicable	not applicable (no valley or free)	bedrock
bottom width (av.) <u>723</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>5</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>40</u> °	
outer bar	length of spit/bar <u>345</u> m	
✓ silt plume (fluvial)	length stabilized <u>NIL</u> m	
suspended sediment (marine)	width <u>70</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>723</u> m	grass	riverine:	✓ cultivated <u>57</u> % area
fragmentary	maximum width <u>1200</u> m	reed swamp <u>12</u> % area	main channel	✓ crop/s <u>sugar cane</u>
✓ continuous	aerial length <u>4128</u> m	sparsely forested	tributaries	partly built-up
	area <u>313</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/~~HIGH~~ after prolonged flood flows for 5 months

Pattern	Measurements	Islands/Shoals	Type of Flow	Bar Type
straight	thalweg <u>4483</u> m	✓ none	stagnant/still	none
sinuous	* sinuosity <u>1.09</u>	occasional	✓ uniform water surface	✓ channel side bars
✓ irregular	* open water area <u>55.9</u> ha**	frequent	uniform with rapid in reach	✓ point bars
regular meanders	perimeter <u>9388</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 _____			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>119.3</u> m s = <u>61.0</u> m			

Comments *whole reach
** + 8,4 ha cut off

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. br.</u>	<u>R. confined</u>	<u>400 m</u>
logs	minor	rail bridge/s <u>Service Hwy</u>	<u>R. confined</u>	<u>0 (at head)</u>
boulders	major	causeway _____		
vegetation		weir/dam _____		
		fish traps _____		
		embankment/s _____		
		groynes _____		
		canals _____		
Comments		✓ 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>11</u> %		
irregular lateral activity		right bank <u>4</u> %		
✓ avulsion				

Station	Approx. distance along 1973 R. course from Service Rlwy. Bridge (m)	River widths (m)					\bar{x}	s	V%
		Date							
		1-5-37	6-6-59	2-8-67	3-6-73	14-5-76			
1	0	105	94	68	54	75	79,2	20,4	25,7
2	450	85	126	53	48	120	86,4	36,4	42,1
3	900	74	45	68	70	110	73,4	23,4	31,9
4	1 350	100	48	55	50	110	72,6	29,9	41,2
5	1 800	75	65	65	35	95	67,0	21,7	32,4
6	2 250	64	48	33	34	65	48,8	15,5	31,8
7	2 700	50	38	33	35	175	66,2	61,2	92,4
8	3 150	42	45	40	40	95	52,4	23,9	45,6
9	3 600	78	43	32	40	188	76,2	64,9	85,2
10	4 050	64	57	40	50	245	91,2	86,4	94,8
11	4 500	26	N.R.	30	60	N.R.	38,7	18,6	48,1
12	4 950	50	N.R.	62 (52+10)	116	N.R.	76,0	35,2	46,3
13	5 400	20	38	6	15	34	22,6	13,3	58,8
\bar{x}		64,1	58,8	45,0	49,8	119,3	(65,4)		
s		26,0	27,4	18,6	24,2	61,0	67,4		
V%		40,5	46,6	41,4	48,6	51,1			

Station	Approx. distance along 1973 R. course from Service Rlwy Bridge (m)	Distance from maximum observed L.B. position to mid-river (m)				Max-Min	\bar{x}	s	V%
		Date							
		1-5-37	6-6-59	2-8-67	3-6-73				
1	0	135	47	74	68	88	78,4	33,3	42,4
2	450	43	88	75	85	45	71,2	18,2	25,5
3	900	37	220	210	207	193	180,8	80,9	44,7
4	1 350	75	25	55	45	55	56,0	22,5	40,1
5	1 800	142	55	34	25	117	72,2	49,8	69,0
6	2 250	32	52	80	85	56	67,4	24,4	36,2
7	2 700	65	25	27	18	122	55,0	50,9	92,6
8	3 150	22	35	50	46	33	41,6	13,2	31,7
9	3 600	150	22	43	35	128	74,4	57,6	77,4
10	4 050	370	130	135	107	263	181,4	107,4	59,2
11*	4 500								
12*	4 950								
13	5 400 (mouth)	1 325	390	1 305	1 315	1 308	870,4	623,0	71,6
\bar{x}		217,8	99,0	190,7	185,1	218,9	159,0		53,7
s		380,3	113,2	373,2	378,4	367,7	159,2		21,5
V%		174,6	114,4	195,7	204,5	168,0			40,1

Average lateral displacement 1937-76 = 218,9 m

Average coefficient of variation 1937-76 = 53,7%

* Station not comparable for all years owing to deflection of river course by sand-spit

TABLE NNT/VIII SIMULATED RUN-OFF FOR MVOYI NNT CATCHMENT AREA= 2829.0 SQ. KM.

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL
1921	9.53	106.68	230.10	80.50	16.18	15.75	13.91	13.21	14.19	12.54	13.72	14.59	540.89
1922	16.37	26.07	27.71	230.99	98.19	26.92	18.98	11.24	6.55	5.81	5.80	4.78	481.40
1923	4.12	5.29	8.36	11.39	13.69	13.89	13.19	11.51	8.60	6.07	5.14	7.81	109.06
1924	18.36	197.18	204.67	70.45	29.12	782.30	286.33	30.04	20.11	15.08	11.87	17.07	1678.60
1925	26.27	23.90	17.69	13.86	11.10	12.15	11.16	7.40	6.77	6.81	5.31	6.63	149.04
1926	16.00	25.54	25.65	19.09	17.43	15.34	66.95	15.85	10.03	7.94	7.38	6.23	371.44
1927	7.49	8.42	12.04	22.05	25.38	21.90	17.11	11.81	7.53	5.30	4.77	7.92	151.72
1928	11.64	12.24	10.69	10.99	13.99	100.16	50.56	16.08	12.22	14.18	13.14	13.24	279.12
1929	18.79	24.86	23.44	25.05	23.83	22.36	22.56	17.11	10.65	7.71	7.90	12.19	216.47
1930	17.43	25.27	25.73	25.38	25.15	21.46	17.27	11.86	7.09	5.28	4.45	3.54	189.91
1931	4.85	6.99	10.75	14.59	14.82	174.80	59.74	19.57	16.74	11.66	7.36	6.35	475.21
1932	8.59	16.14	22.10	22.26	18.99	18.00	16.80	12.38	7.69	7.09	7.13	5.87	161.06
1933	6.19	16.71	54.89	169.62	70.89	99.46	65.30	33.97	23.09	16.41	16.14	15.17	587.84
1934	15.03	19.49	202.09	85.81	23.30	26.32	25.72	20.96	144.65	67.71	20.87	14.15	666.11
1935	11.93	11.01	11.07	18.50	148.65	156.12	54.09	26.06	26.61	19.55	12.12	9.32	505.03
1936	12.44	188.11	79.76	16.62	18.53	20.31	15.72	10.36	7.50	7.30	6.66	5.51	388.80
1937	6.46	6.46	17.10	81.92	102.93	41.40	19.72	17.92	14.00	15.07	14.71	10.50	350.18
1938	13.23	18.95	129.81	64.36	138.49	64.85	22.04	19.78	17.28	13.72	11.28	15.27	529.47
1939	19.33	134.50	127.03	53.80	29.29	25.68	21.48	195.28	120.83	38.85	17.11	15.50	798.68
1940	17.05	22.26	166.78	70.13	16.85	14.37	19.64	19.81	13.19	9.02	6.64	7.06	382.79
1941	9.78	13.68	12.61	14.59	20.59	125.07	60.15	21.49	16.74	14.01	13.55	16.25	338.51
1942	23.15	136.20	313.82	111.51	27.54	112.02	350.98	126.83	22.75	55.22	219.85	88.04	1587.93
1943	194.55	166.28	54.89	18.97	18.65	25.25	22.80	14.40	12.72	13.27	10.85	18.52	571.15
1944	27.58	27.96	1163.51	417.42	26.04	202.23	83.44	16.13	9.64	6.19	4.32	3.18	2007.66
1945	3.27	3.68	4.56	9.24	15.39	19.01	16.99	11.91	7.94	5.63	4.13	4.09	105.82
1946	11.51	160.70	76.95	119.19	91.68	160.17	69.60	22.18	17.59	16.47	12.28	10.27	768.60
1947	11.11	63.92	52.40	33.89	25.00	27.10	30.29	24.14	15.48	10.11	7.13	5.50	306.07
1948	8.72	13.69	14.38	15.57	32.66	32.09	31.31	27.37	18.70	12.79	9.40	8.07	224.74
1949	12.53	24.12	137.85	62.82	22.30	62.09	41.17	24.26	16.27	10.46	9.23	8.41	431.50
1950	6.64	5.33	13.10	22.49	19.42	15.19	13.62	11.81	10.40	8.52	17.33	28.27	172.12
1951	29.80	22.50	23.13	58.94	35.46	20.94	18.08	19.67	19.41	15.56	12.10	8.40	283.98
1952	6.67	11.37	15.80	37.79	156.75	65.65	15.56	10.29	7.41	5.30	5.59	7.43	345.59
1953	9.24	13.24	15.65	17.72	61.81	39.59	27.31	28.42	23.73	16.62	11.71	15.86	280.91
1954	279.19	244.35	67.86	136.52	63.38	24.77	26.29	22.92	15.84	10.59	7.02	6.01	904.73
1955	7.92	14.05	16.95	10.70	27.96	78.73	42.51	18.06	11.56	8.32	8.17	10.83	255.75
1956	12.89	16.86	383.38	150.46	29.80	29.17	69.78	38.39	15.51	10.55	9.28	159.41	925.48
1957	228.40	83.46	78.18	215.89	227.91	74.99	100.33	49.43	16.10	9.81	6.43	7.94	1098.88
1958	10.00	15.24	42.89	32.52	49.18	29.75	14.19	65.01	39.65	17.00	14.05	13.58	343.07
1959	18.40	24.46	25.56	20.00	18.20	24.18	51.71	32.94	16.17	10.67	8.37	8.33	258.99
1960	11.60	21.79	155.50	164.17	57.33	26.50	168.07	71.99	20.19	17.45	13.50	14.55	742.66
1961	18.43	20.01	20.26	21.20	19.16	18.40	17.26	12.60	7.93	5.39	6.76	9.80	177.19
1962	13.73	21.94	20.38	102.36	48.99	52.39	37.58	21.14	17.09	23.94	23.88	15.23	406.65
1963	11.71	14.02	12.47	28.37	24.59	15.15	12.73	10.50	7.59	6.95	6.33	6.12	156.54
1964	11.50	16.09	16.96	14.14	12.01	9.48	6.57	5.43	9.19	13.63	16.42	19.35	150.96
1965	20.88	23.50	24.20	26.85	27.43	18.36	11.68	11.29	10.55	8.46	7.40	7.71	197.91
1966	9.07	11.79	14.08	41.81	32.18	180.36	80.88	22.79	13.81	10.20	8.11	5.75	430.83
1967	7.16	15.40	18.64	19.16	18.38	18.54	19.14	14.75	9.07	5.94	7.16	9.96	163.33
1968	11.70	13.37	20.07	22.43	24.57	242.58	100.78	26.14	19.77	13.26	9.42	8.75	512.83
1969	15.60	20.03	20.59	16.97	12.38	9.24	6.87	6.54	6.72	5.86	6.13	11.93	138.85
1970	19.74	20.81	22.61	26.47	29.06	26.94	21.54	25.49	25.29	21.22	22.23	20.35	281.64
1971	18.53	17.91	23.22	24.89	28.45	22.27	18.02	16.44	13.29	9.90	9.90	6.95	226.35
1972	6.45	10.03	11.50	14.37	55.79	37.61	23.57	17.63	11.06	7.25	8.65	18.64	222.76
1973	24.60	23.18	20.15	210.03	92.20	29.98	26.42	19.78	13.69	10.26	7.62	5.23	483.13
1974	3.88	5.89	10.29	96.84	209.06	77.32	19.73	14.31	8.65	5.41	3.80	13.68	468.87
1975	21.44	80.28	223.76	352.48	248.16	386.28	134.47	24.05	15.61	9.40	6.46	6.67	1509.05

MEAN 25.35 41.73 93.34 69.02 52.58 47.89 26.01 16.57 13.24 13.72 14.69 481.71
 MEAN ANNUAL RUN-OFF = 481.71 MILLION CUBIC METRES
 COMPILED FROM HKU REPORT NO. 9/81 DATA

HUMAN INFLUENCES

ABSTRACT

TABLE NN7/IX

BASIC DATA / CALCULATIONS

Lateral displacement (1937 - 1976) \bar{x} 2.18, 9 m
 Relative lateral stability (1937 - 1976) \bar{v} 53.7 km²
 Area of catchment 2822.9 ha
 Area of flood plain 313.3 ha
 Area of envelope of mobility 101.6 ha
 Simulated M.A.R. (1921 - 1975) \bar{x} 481.71 x 10⁶ m³
 s 412.24 x 10⁶ m³
 \bar{v} 85.6 %

Dates of major floods: March 1925, Dec. 1944, Dec. 1975 - March 1976

MEASUREMENTS/CALCULATIONS from PHOTOGRAPHS

Date	1-5-37	6-6-59	2-8-67	3-6-73	14-5-76
Thalweg (m)	44.25	44.30	53.57	54.38	44.83
% Thalweg estuarine	?	?	?	2.6	? 11
Aerial D (m)	4014	4014	4186	4190	4128
Sinuosity	1.10	1.10	1.28	1.30	1.09
\bar{x} River width (m)	64.1	58.8	45.0	49.8	119.3
Open water area (ha)	26.2	25.5	24.7	28.3	55.9
% envelope of mobility	25.8	25.1	24.3	27.9	55.0
Bar/island area (ha)	0.2	0.2	2.1	0.8	10.0
River braided	x	x	✓	x	x
% Flood plain cultivated	50.8	50.5	60.6	61.3	56.8
Left valley side:					
% grass	NIL	NIL	NIL	NIL	NIL
% trees	3	5	6	5	5
% cultivated	97	95	94	95	95
% built up	NIL	NIL	NIL	NIL	NIL
Right valley side:					
% grass	NIL	NIL	NIL	NIL	NIL
% trees	7	7	7	7	7
% cultivated	93	93	93	93	93
% built up	NIL	NIL	NIL	NIL	NIL
L.B. % vegetated	3	11	8	9	11
R.B. % vegetated	5	21	22	6	4
Mouth open/closed (o/c)	0	0	0	0	0
Spit/bar:					
Direction (°)	204	222	203	205	40
Length (m)	1280	250	1265	1200	345
\bar{x} width (m)	87	80	65	58	70

Within the Reach

- Land-use
 - (a) Cultivation: Valley sides under sugar cane
 - Flood plain > 50% under sugar cane
 - To channel edge yes, in some areas

(b) Bridge building and embankments Initially none
 By 1959 service railway bridge at head of reach built with embankments
 By 1967, NR bridge 400m from head of reach across flood plain

(c) Canals Nil

(d) Urbanization/Industry Nil

2. Breaching of sandbar Mouth seldom closed but if necessary, bar is breached artificially to prevent flooding of cane fields. (Beag, 1978)

3. Others Gladhow Sugar Co. mechanically alter channel positions during low flow periods to prevent erosion of a particular bank beyond which is planted sugar cane. (Beag, 1978) precisely when & where.

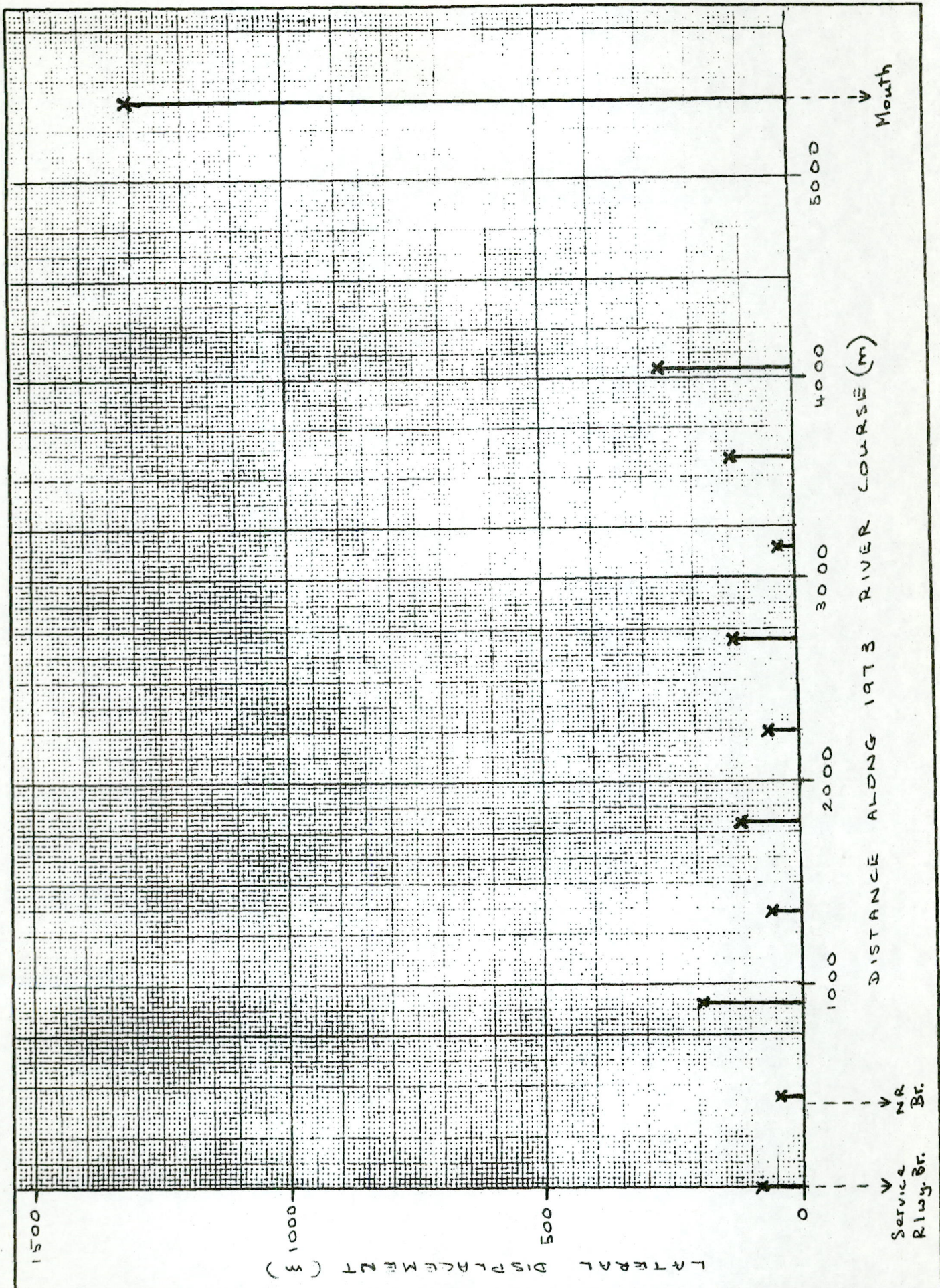
Upstream of Reach

(a) Dams in the catchment Lake Methley Date of construction ?

(b) Building construction or canalization immediately upstream of reach Nil

(c) Land-use malpractices/silt supply

The increase in bar areas is indicative of land-use malpractices providing abundant silt

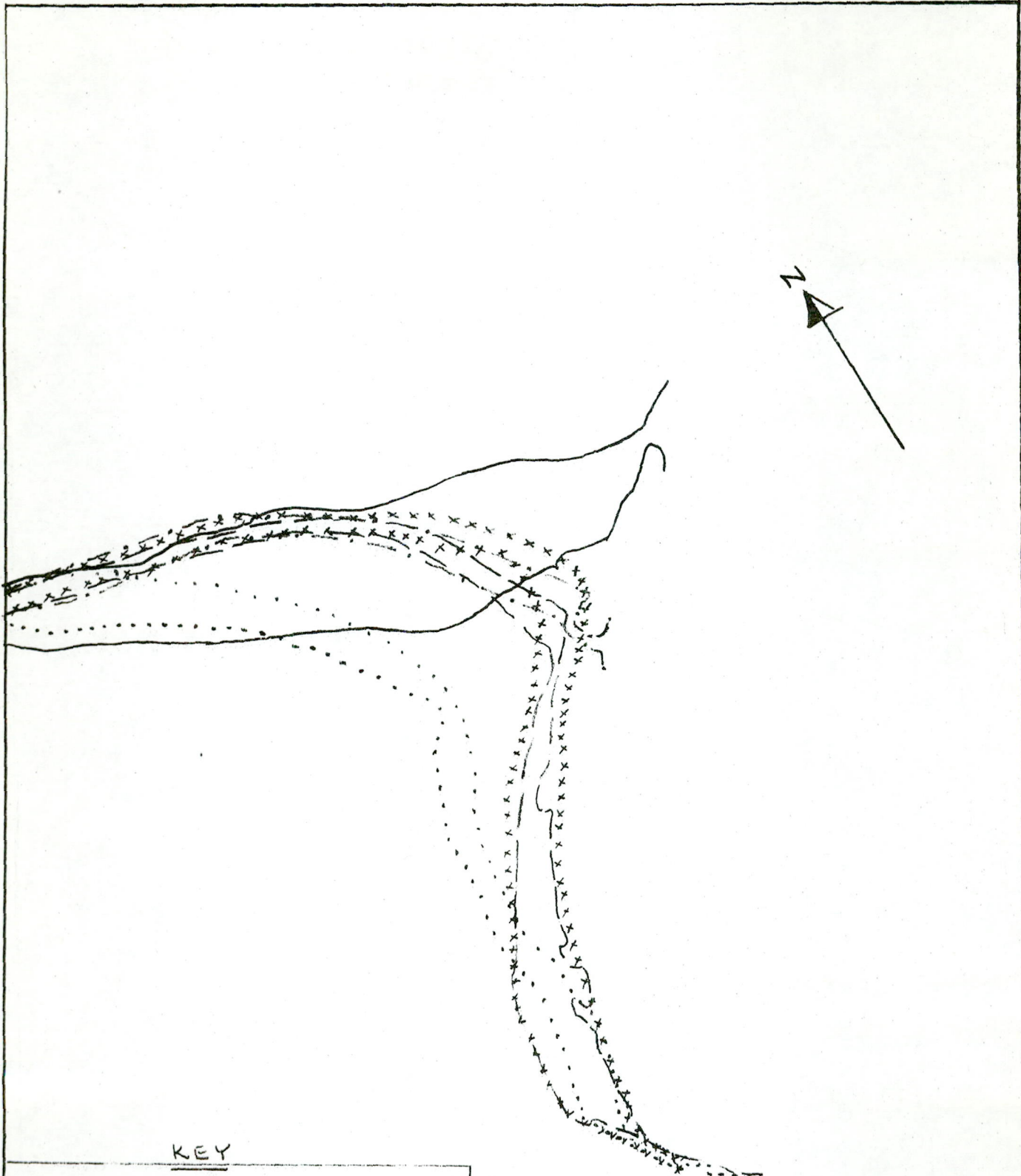


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




NATAL ESTUARIES: MVOTI

THALWEG DISPLACEMENT
 1937 - 1976

FIGURE
 NN 7/1



KEY

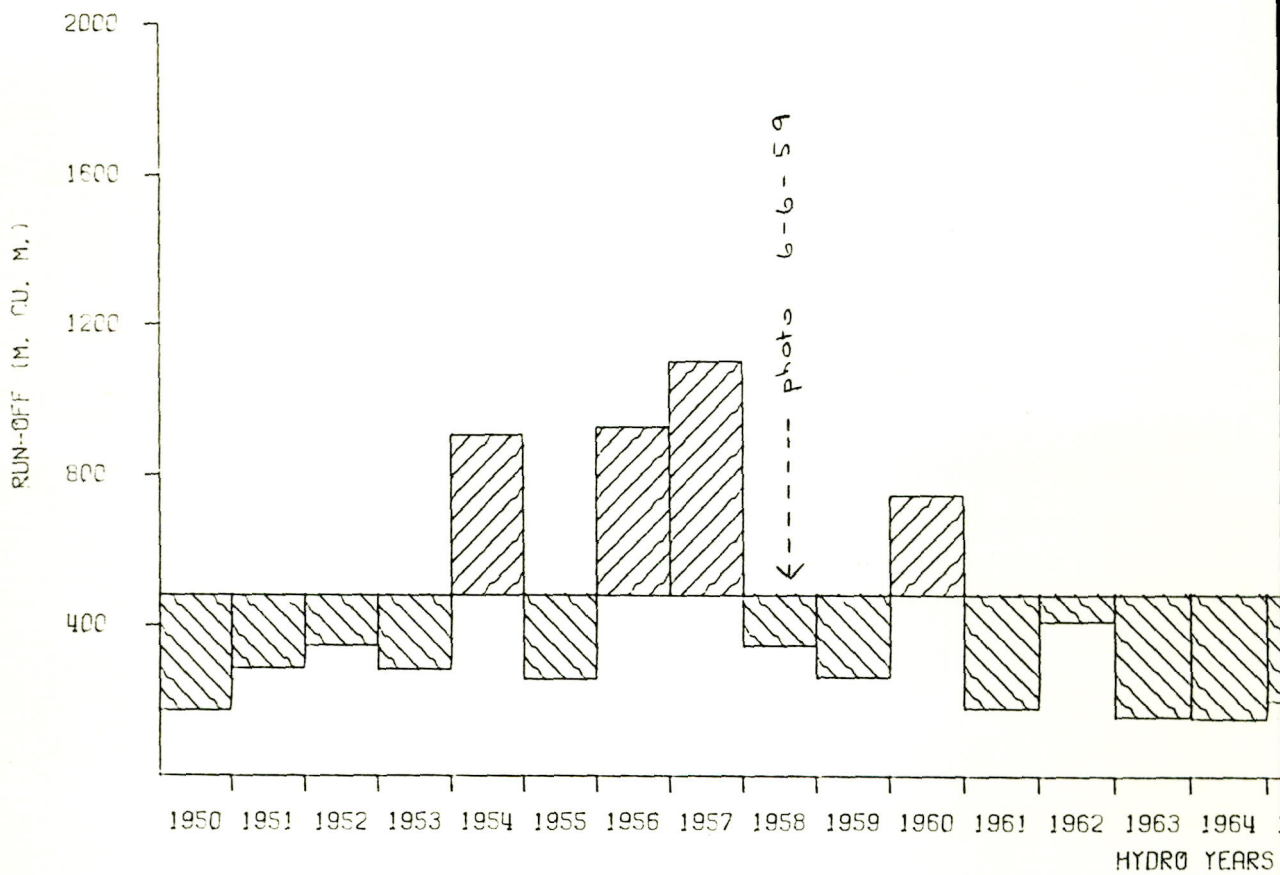
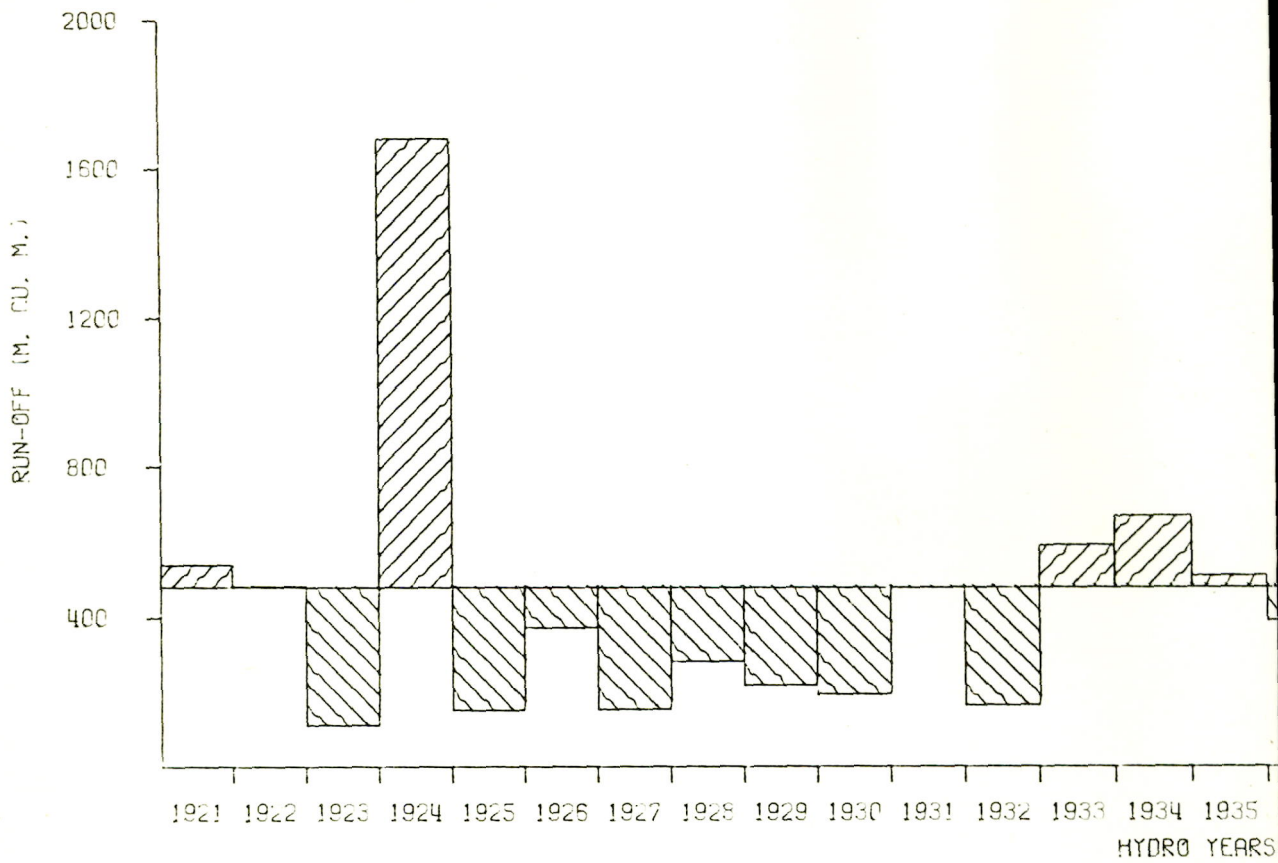
	1-5-37 river course
	6-6-59 river course
	2-8-67 river course
	3-6-73 river course
	14-5-76 river course

SCALE
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NATAL ESTUARIES: MVOTI
MOUTH POSITIONS
1937 - 1976

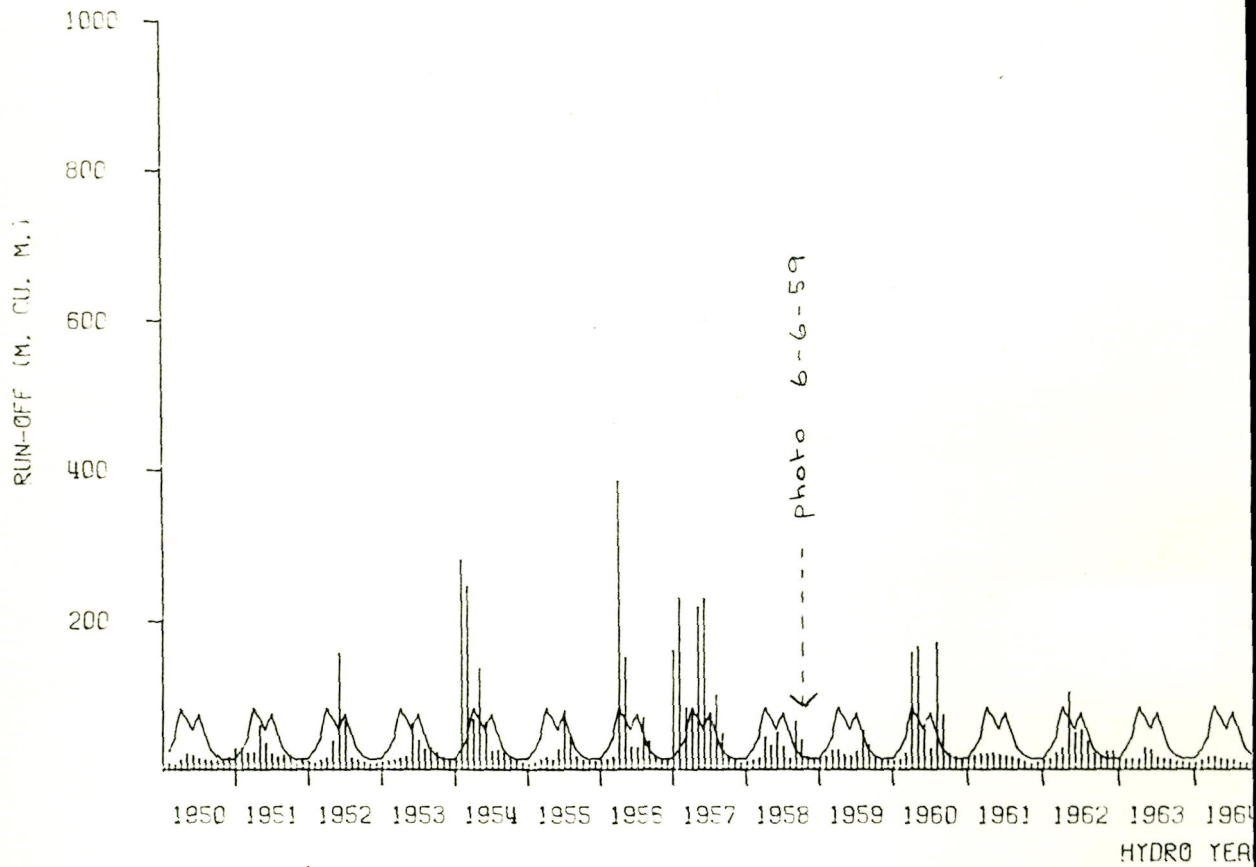
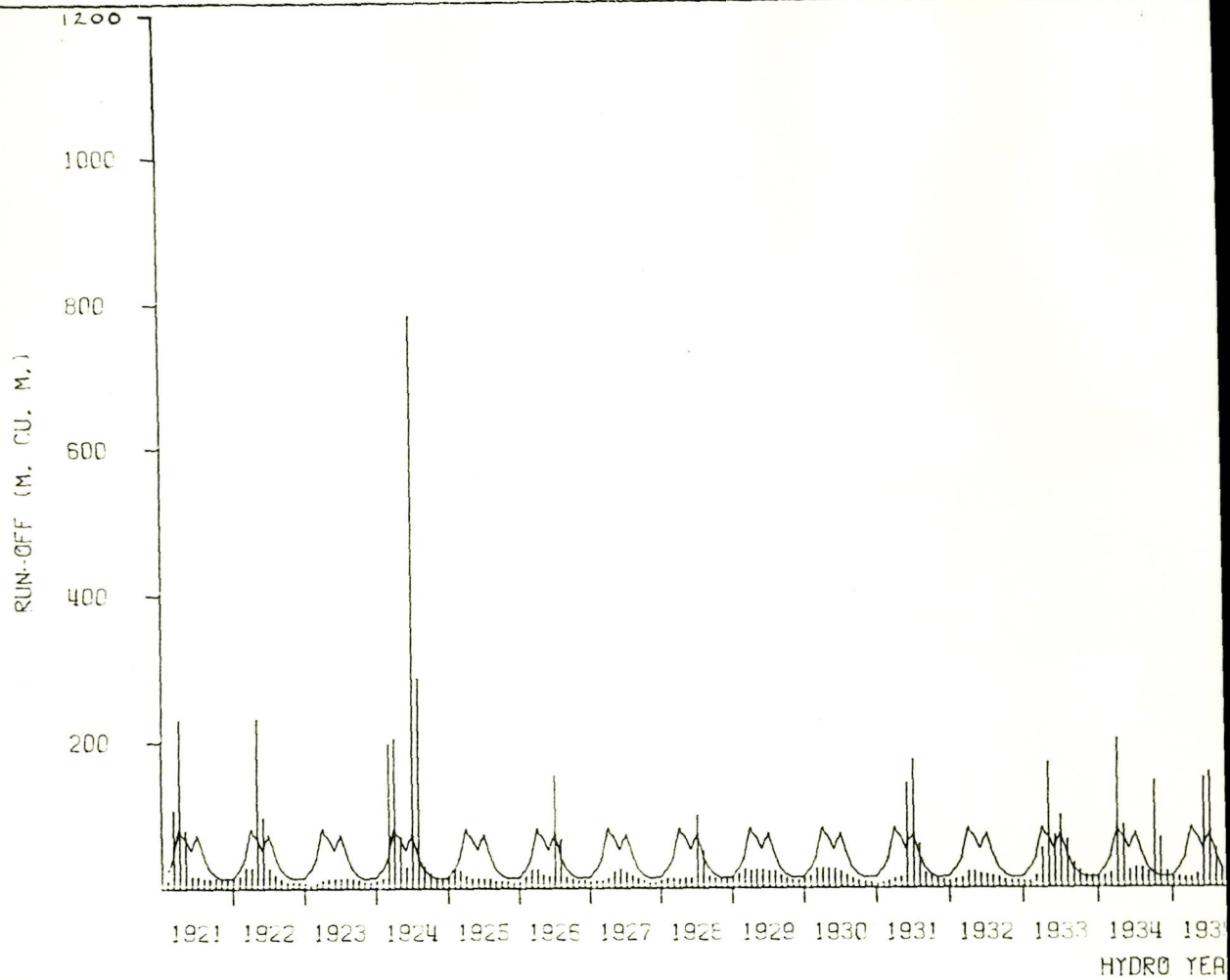
FIGURE
NN 7/2



TRACED : COMPLETE
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NATAL ESTUARIES (MVOTI)
 SIMULATED ANNUAL RUN-OFF
 1921-1975

FIGURE
 NN7/3



TRACED : COMPLETE
 CHECKED :
 DATE :
 REF :

NATAL ESTUARIES : MV071
 SIMULATED MONTHLY RUN-OFF
 1921-1975

FIGURE
 NN 7/4



SCALE: 1 : 20 000 approx.

TRACED : JGAN CHECKED : DATE : REF :	NATAL ESTUARIES : MVOTI 14-5-76 (1-5-37 RIVER COURSE SUPERIMPOSED)	PHOTOGRAPH NN 7/1
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



SCALE: 1:20 000 approx.

TRACED: JGAN
CHECKED:
DATE:
REF:

NATAL ESTUARIES: MVOTI
1-5-37 (12 h 10)

PHOTOGRAPH
NN 7/2



SCALE: 1 : 20 000 approx.

TRACED: JGAN
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DATE:
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NATAL ESTUARIES: MVOTI
6-6-59 (11h25)

PHOTOGRAPH
NN 7/3

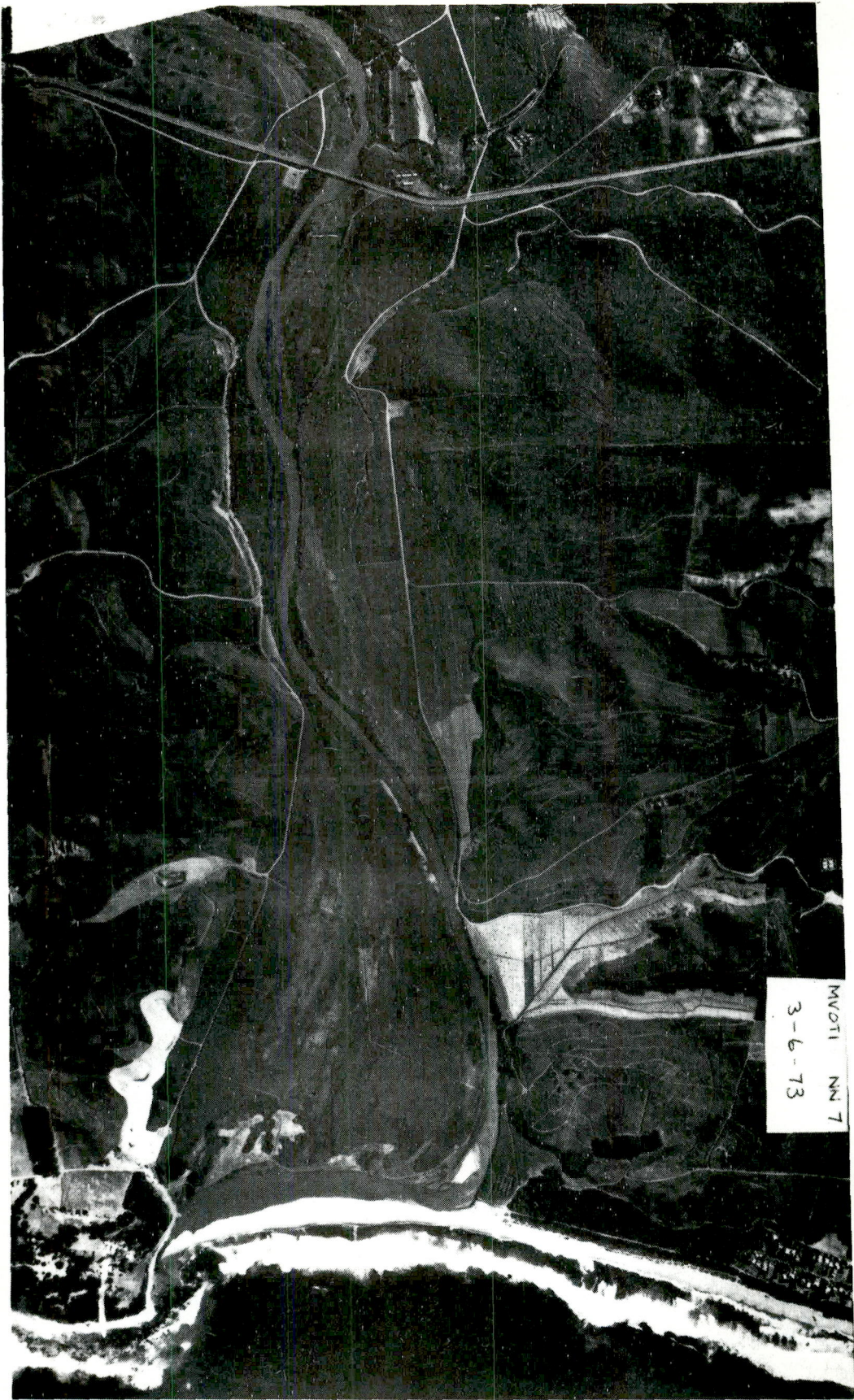


SCALE: 1 : 20 000 approx.

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CHECKED :
DATE:
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NATAL ESTUARIES : MVOTI
2-8-67 (12h28)

PHOTOGRAPH
NN 7/4



SCALE: 1:20000 approx.

TRACED JGAN
CHECKED
DATE
REF

NATAL ESTUARIES: MVOTI

3-6-73 (11h 40)

PHOTOGRAPH

NN 7/5



SCALE: 1 : 20 000 approx.

TRACED: JGAN
CHECKED:
DATE:
REF:

NATAL ESTUARIES: MVOTI
14-5-76 (14h 26)

PHOTOGRAPH
NN 7/6



SCALE: 1 : 20 000 approx

TRACED JGAN
CHECKED :
DATE :
REF :

NATAL ESTUARIES : MVOTI

3-6-73 (ORTHO PHOTO)

PHOTOGRAPH

NN 7/7

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