

HYDROLOGICAL / HYDRAULIC STUDY
OF NATAL ESTUARIES

DATA REPORT No. 5

MZUMBE NS 26

ESTUARINE DYNAMICS (CESD)
NRIO / CSIR
STELLENBOSCH

December 1981

Confidential

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Details of the classification of the lower reaches of the Mzumbe River for 1937, 1955, 1959, 1966, 1976 and 1979 are given in Tables NS26/I - VI. Photographs of the river course for the same years are shown in Photographs NS26/1 - 6. Details of river widths and lateral stability appear in Tables NS26/VII and VIII and an abstract of results in Table NS 26/IX. A locality map is given in Figure NS26/1. Thalweg displacement and sinuosity for 1937 - 1979 are shown in Figures NS 26/2 & 3.

Under natural conditions, the Mzumbe River course was diverted near the mouth by a long, southerly-extending sand-spit, behind which sedimentation occurred. During major floods, the spit would be breached, allowing the river to flow almost straight out to sea. The building of the old railway line bridges in the 1930's, approximately 300 m inland from the spit (see Figure NS 26/1 and Photograph NS 26/1), still allowed this function. Since the 1950's, however, the spit at the mouth has been stabilised in order to accommodate the national road and the railway line. It was nevertheless breached once more during the major flood of May 1959. Following this flood a canal was built, approximately 800 m upstream of the road bridge, in an effort to divert the river flow towards the road and rail bridges. The silted-up remnants of this canal may be seen in Photograph NS 26/4.

There has been little riverine vegetation during the period under review, 1937 - 1979, and the reed swamp area has ranged from 8% - 21%. To a limited extent, the valley sides are cultivated with sugar cane. The flood plain is also cultivated to a certain extent, (in places down to the river's edge), the area fluctuating with periods of flooding. Following floods, much of the flood plain is covered with silt (see Photograph NS 26/3), there being an ample supply of sediment from higher up in the catchment.

The key to the instability of the reach is given by the high average lateral displacement (122 m) with an average coefficient of variation of 40%. ...

40%. Upstream of the proposed freeway bridge (for location see Figure NS 26/1) the river is relatively stable but downstream, in that section which is largely estuarine, the river is markedly unstable. Quantitatively these facts are clearly seen in Table NS 26/VIII on lateral stability and in Figure NS 26/2 showing thalweg displacement. The effect of the canalisation on the sinuosity and the river's natural response to readjust is seen in Figure NS 26/3. Qualitatively the river's adjusting may be seen in Photographs NS 26/4 - 6. The latter photographs also show the extent of recent sedimentation in the estuary.

For the period under review the Mzombe demonstrates a river trying to adjust to the human influences of bridge building, stabilisation of sand-spits and canalisation. The whole reach is moderately unstable, the estuarine section being more highly unstable.

LIST OF TABLES

NS 26/I	Classification of the lower reaches of the Mzumbe:	1937
NS 26/II	" " " " " "	: 1955
NS 26/III	" " " " " "	: 1959
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NS 26/5	Orthophoto: 23-6-76
NS 26/6	20-6-79

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 MZUMBE, 30 % ESTUARINE, REACH from Steel Br. to Mouth, 3,6 km from mouth. REF. DEA U 801F
 AERIAL PHOTO DATE 2-5-37 SCALE 1:10 000 CATCHMENT AREA 593 km², M.A.R. 74,8 m³x10⁶, No. of DAMS NIL

RIVER VALLEY AND RIVER MOUTH FEATURES

General Description of the Terrain above the Valley

Terrain	Vegetation	Land-Use	Valley Sides (Now Well-defined)		Left	Right
			Slumping	Vegetation and Land-Use		
mountainous	almost none	none	✓ none	none		
✓ hilly	✓ grass	✓ scattered cultivation	occasional	grass	55	67 %
undulating	✓ sparsely forested (0-25%)	partly cultivated	frequent	trees	16	10 %
plains	moderately forested (25-75%)	mainly cultivated		cultivated	29	23 %
	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>3100</u> m	none	not applicable	not applicable (no valley or free)	bedrock
bottom width (av.) <u>675</u> m	indefinite	not obviously degrading	✓ occasionally confined	lacustrine deposits
valley slope (straight-line)	fragmentary	partly entrenched	frequently confined	✓ fluvial deposits
height at head of reach _____ m to MSL	✓ continuous*	entrenched	entrenched	aeolian
		✓ aggrading		sand covered <u>8</u> % area

Comments * for 1 km on L.B. _____

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> ° → 210°	
outer bar	length of spit/ bar <u>115</u> m	
silt plume (fluvial)	length stabilized <u>NIL</u> m	
✓ suspended sediment (marine)	width <u>97</u> m	

Comments _____

FLOOD PLAIN AND CHANNEL FEATURES

Presence	Extent	Vegetation	Forest Type	Land-Use
none	none	almost none	✓ not known/ applicable	✓ not cultivated, not built-up
indefinite	average width <u>675</u> m	grass	riverine:	cultivated <u>27</u> % area
fragmentary	maximum width <u>1700</u> m	✓ reed swamp <u>14</u> % area	✓ main channel*	crop/s <u>sugar</u> + ?
✓ continuous	serial length <u>2940</u> m	✓ sparsely forested	tributaries	partly built-up
	area <u>205</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/~~high~~

Pattern	Measurements	Islands/Shoals	Type of Flow	Bar Type
straight	thalweg <u>3580</u> m	none	stagnant/still	none
sinuous	*sinuosity <u>1,22</u>	occasional	uniform water surface	✓ channel side bars
✓ irregular	*open water area <u>18,20</u> ha	frequent	uniform with rapid in reach	✓ point bars
regular meanders	perimeter <u>10820</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>48,7</u> m s = <u>19,0</u> m			

Comments *whole reach _____

Obstructions/Constructions

Natural	Degree	Man-made	Degree of Obstruction/Constriction for Each	Position (from head of reach)
✓ none	none	road bridge/s	<u>Steel br (old S. coast road). R. confined</u>	at head
logs	minor	rail bridge/s	<u>4 bridges (2 normal, 1 flood g. 1 rib + flood flow)</u>	2,6 km
boulders	major	causeway		
vegetation		weir/dam		
		fish traps		
		embankment/s	<u>for rwy line - right across flood plain</u>	
Comments		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	highly unstable	
entrenched loop development	✓ cultivation to channel edge	left bank _____ %		
✓ irregular lateral activity		right bank _____ %		
✓ avulsion				

Comments _____

RIVER MZUMBE, 30 % ESTUARINE, REACH from Steel Br. to Mouth, 3,6 km from mouth. REF. DEA 4801F
 AERIAL PHOTO DATE June/July '55 SCALE 1:10 000 CATCHMENT AREA 593 km², M.A.R. 74,8 m²x10⁶, No. of DAMS NIL

NRIO NS 26

RIVER VALLEY AND RIVER MOUTH FEATURES

General Description of the Terrain above the Valley

Terrain	Vegetation	Land-Use	Valley Sides (Most Well-defined)		Left	Right	Comments
			Slumping	Vegetation and Land-Use			
mountainous	almost none	none	✓ none	none	6		
✓ hilly	✓ grass	scattered cultivation	occasional	grass	52	71	%
undulating	✓ sparsely forested (0-25%)	✓ partly cultivated	frequent	trees	12	6	%
plains	moderately forested (25-75%)	mainly cultivated		cultivated	30	23	%
	heavily forested (75-100%)	✓ scattered settlement		built-up			%
	swamp/bog	partly built-up urbanised					

Valley Characteristics

Measurements	Terraces	Relation of Channel to Valley Bottom (Vertical)	Relation of Channel to Valley Sides or Resistant Terraces (Lateral)	Surface Geology	Comments
valley length <u>3100</u> m	none	not applicable	not applicable (no valley or free)	bedrock	
bottom width (av.) <u>675</u> m	indefinite	not obviously degrading	✓ occasionally confined	lacustrine deposits	
valley slope	fragmentary	partly entrenched	frequently confined	✓ fluvial deposits	
(straight-line)	✓ continuous	entrenched	entrenched	aeolian	
height at head of reach _____ m to MSL		✓ aggrading		sand covered <u>3</u> % area	

* for 1 km on LB

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/_____ direction of growth <u>220</u> → 207°	
outer bar	length of spit/_____ <u>1030</u> m	
silt plume (fluvial)	length stabilized <u>720</u> m	
✓ suspended sediment (marine)	width <u>80</u> m	

Description of Flood Plain

Presence	Extent	Vegetation	Forest Type	Land-Use	Comments
none	none	almost none	not known/applicable	✓ not cultivated, not built-up	
indefinite	average width <u>675</u> m	grass	riverine:	cultivated <u>50</u> % area	
fragmentary	maximum width <u>1700</u> m	✓ reed swamp <u>9</u> % area	✓ main channel*	crop/s <u>sugar</u> ?	
✓ continuous	aerial length <u>2918</u> m	✓ sparsely forested	tributaries	partly built-up	
	area <u>205</u> ha	moderately forested	✓ coastal dune/evergreen**	mainly built-up	
		heavily forested	mangroves		

** area reduced.

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

Pattern	Measurements	Islands/Shoals	Type of Flow	Bar Type
straight	thalweg <u>3580</u> m	none	stagnant/still	none
sinuous	*sinuosity <u>1,23</u>	occasional	uniform water surface	✓ channel side bars
✓ irregular	*open water area <u>15,7</u> ha	frequent	uniform with rapid in reach	✓ point bars
regular meanders	perimeter <u>8700</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>32,9</u> m s = <u>16,6</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	Steel br. (old S. coast road) R. confined	at head
logs	minor	rail bridge/s	one water construction at mouth	3,6 km
boulders	major	causeway	" " " "	2,6 km
vegetation		weir/dam	" " " "	4 bridges
		fish traps		
		embankment/	for rly line right across flood plain	
		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 _____ %		
✓ irregular lateral activity		right bank _____ %		
✓ avulsion				

RIVER MZUMBE, 30 % ESTUARINE, REACH from Steel Br. to Mouth, 3,6 km from mouth. REF. DEA U 801 f
 AERIAL PHOTO DATE 6-6-59 SCALE 1:10 000 CATCHMENT AREA 593 km², M.A.R. 74,8 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	6	
hilly	grass	scattered cultivation	occasional	grass	50	84
undulating	sparsely forested (0-25%)	partly cultivated	frequent	trees	15	6
plains	moderately forested (25-75%)	mainly cultivated		cultivated	29	10
	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>3100</u> m	none	not applicable	not applicable (no valley or free)	bedrock
bottom width (av.) <u>675</u> m	indefinite	not obviously degrading	occasionally confined	lacustrine deposits
valley slope (straight-line)	fragmentary	partly entrenched	frequently confined	fluvial deposits
height at head of reach _____ m to MSL	continuous*	entrenched	entrenched	aeolian
		aggrading		sand covered <u>35</u> % area

Comments _____
 * for 1 km on L.B.

River Mouth

Characteristics	Measurements
open/natural	right bank breakwater length _____ m
canalized	left bank breakwater length _____ m
sandy	rock sill level _____ m to MSL
rocks on right bank	cliffs on right bank: height _____ m to MSL
rocks on left bank	cliffs on left bank: height _____ m to MSL
outer bar	spit/bars: direction of growth <u>218</u> °
silt plume (fluvial)	length of spit/bars <u>810</u> m
suspended sediment (marine)	length stabilized <u>720</u> m
	width <u>85</u> m

Comments _____

FLOOD PLAIN AND CHANNEL FEATURES

Presence	Extent	Vegetation	Forest Type	Land-Use
none	none	almost none	* not known/applicable	not cultivated, not built-up
indefinite	average width <u>675</u> m	grass	riverine:	cultivated <u>12</u> % area
fragmentary	maximum width <u>1700</u> m	reed swamp <u>16</u> % area	main channel	crops <u>sugar</u>
continuous	aerial length <u>2906</u> m	sparsely forested	tributaries	partly built-up
	area <u>205</u> ha	moderately forested	coastal dune/evergreen	mainly built-up
		heavily forested	mangroves	

Comments * 9 months covered with sand

Channel Description N.B. Estimate of flow stage: LOW / MODERATE / HIGH (major flood 1320 cumecs 19-5-59)

Pattern	Measurements	Islands/Shoals	Type of Flow	Bar Type
straight	thalweg <u>3630</u> m	none	stagnant/still	none
sinuous	* sinuosity <u>1,25</u>	occasional	uniform water surface	channel side bars
irregular	* open water area <u>28,5</u> ha	frequent	uniform with rapid in reach	point bars
regular meanders	perimeter <u>7630</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			sand waves/large dunes
lagoon	** river slope _____			
	river width x <u>65,7</u> m			

Comments * whole reach ** at peak flood flow
 (a) 1:539 prior to breach of sand-spit (dabn's levels)
 (b) 1:309 post breach (NRIO model tests)

Obstructions/Constructions

Natural	Degree	Man-made	Degree of Obstruction/Constriction for Each	Position (from head of reach)
none	none	road bridge/s	Steel Br. R. confined (not during major flood)	at head
logs	minor	rail bridge/s	at mouth, R. normally confined; during major flood, 162m embankment collapsed, L.B.	3,6 km
boulders	major	causeway		
vegetation		weir/dam		
		fish traps		
		embankment/s	remnants of old rly line embankment	2,6 km
		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 _____ %	
irregular lateral activity		right bank _____ %	
avulsion			

Comments _____

RIVER MZUMBE, 30 % ESTUARINE, REACH from Steel Br to Mouth, 3,3 km from mouth. REF. DEA 4801F
 AERIAL PHOTO DATE 10-6-66 SCALE 1:10 000 CATCHMENT AREA 593 km², M.A.R. 74,8 m³x10⁶, No. of DAMS NIL

NR10 NS 26
 DEA 4801F

RIVER VALLEY AND RIVER MOUTH FEATURES

General Description of the Terrain above the Valley

Valley Sides (Well-defined)

Terrain	Vegetation	Land-Use	Slumping	Vegetation and Land-Use	Left	Right
mountainous	almost none	none	none	none	3	
✓ hilly	✓ grass	scattered cultivation	✓ none	none		
undulating	✓ sparsely forested (0-25%)	✓ partly cultivated	occasional	grass	53	73
plains	moderately forested (25-75%)	mainly cultivated	frequent	trees	16	5
	heavily forested (75-100%)	✓ scattered settlement		cultivated	28	22
	swamp/bog	partly built-up		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>3100</u> m	none	not applicable	not applicable (no valley or free)	bedrock
bottom width (av.) <u>675</u> m	indefinite	not obviously degrading	✓ occasionally confined	lacustrine deposits
valley slope (straight-line)	fragmentary	partly entrenched	frequently confined	✓ fluvial deposits
height at head of reach _____ m to MSL	✓ continuous +	entrenched	entrenched	aeolian
		✓ aggrading		sand covered <u>19</u> % area

Comments _____
 * 1 km on LB.

River Mouth

Characteristics	Measurements
open/closed	right bank breakwater length _____ m
natural/modified	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/barr: direction of growth <u>220</u> ° → <u>215</u> °
outer bar	length of spit/barr <u>1050</u> m
silt plume (fluvial)	length stabilized <u>760</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>675</u> m	grass	riverine:	cultivated <u>17</u> % area
fragmentary	maximum width <u>1700</u> m	reed swamp <u>8</u> % area	✓ main channel +	crop/s <u>sugar</u> + ?
✓ continuous	serial length <u>2912</u> m	✓ sparsely forested	tributaries	partly built-up
	area <u>205</u> ha	moderately forested	✓ coastal dune/evergreen	mainly built-up
		heavily forested	mangroves	

Comments _____
 + a little

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

Pattern	Measurements	Islands/Shoals	Type of Flow	Bar Type
straight	thalweg <u>3336</u> m	none	stagnant/still	none
sinuous	*sinuosity <u>1,15</u>	✓ occasional	uniform water surface	✓ channel side bars
✓ irregular	*open water area <u>16,8</u> ha	frequent	uniform with rapid in reach	✓ point bars
regular meanders	**perimeter <u>6835</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 \bar{x} _____ m			sand waves/large dunes
✓ lagoon	river slope _____			
	river width \bar{x} <u>45,9</u> m $s = 21,0$ m			

Comments *whole reach
 ** + 2000m from former flood course - now almost dry.

Obstructions/Constructions

Natural	Degree	Man-made	Degree of Obstruction/Constriction for Each	Position (from head of reach)
✓ none	none	road bridge/s	Steel Br. R. confined	at head
logs	minor	rail bridge/s	N.R. Br. R. confined	at mouth
boulders	major	causeway	R. confined	3,3 km
vegetation		weir/dam		3,3 km
		fish traps		
		embankment/s	remnant of old railway line - L.B. : NIL	2,6 km
		groynes		
		canals	built 59/60 to divert R → NR bridge, silted up by mid/61	2,1 km
		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 _____ %	
✓ irregular lateral activity		right bank _____ %	
avulsion			

Comments _____

RIVER MZUMBE, 30 % ESTUARINE, REACH from Steel Br to Mouth, 3.6 km from mouth. REF. DEA U 801 F
 AERIAL ~~DATE~~ DATE 23-6-76 SCALE 1:10 000 CATCHMENT AREA 593 km², M.A.R. 74.8 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	3
✓ hilly	✓ grass	scattered cultivation	✓ none	grass	53
undulating	✓ sparsely forested (0-25%)	✓ partly cultivated	occasional	trees	72
plains	moderately forested (25-75%)	mainly cultivated	frequent	cultivated	28
	heavily forested (75-100%)	✓ scattered settlement		built-up	22
	swamp/bog	partly built-up			2
		urbanised			2

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>3100</u> m	none	not applicable	not applicable (no valley or free)	bedrock
bottom width (av.) <u>675</u> m	indefinite	not obviously degrading	✓ occasionally confined	lacustrine deposits
valley slope <u>1:310</u>	fragmentary	partly entrenched	frequently confined	✓ fluvial deposits
(straight-line)	✓ continuous*	entrenched	entrenched	aeolian
height at head of reach <u>+10</u> m to MSL		✓ aggrading		sand covered <u>12</u> % area

Comments _____
 * for 1 km on LB

River Mouth

Characteristics	Measurements
open/ channel	right bank breakwater length _____ m
natural/ modified	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>219</u> ° → 205°
outer bar	length of spit/bar <u>175</u> m
✓ silt plume (fluvial)	length stabilized <u>760</u> m
suspended sediment (marine)	width <u>78</u> m

Comments _____

FLOOD PLAIN AND CHANNEL FEATURES

Presence	Extent	Vegetation	Forest Type	Land-Use
none	none	almost none	not known/applicable	not cultivated, not built-up
indefinite	average width <u>675</u> m	grass	riverine:	cultivated <u>14</u> % area
fragmentary	maximum width <u>700</u> m	reed swamp <u>19</u> % area	✓ main channel*	crop/s <u>sugar</u> + ?
✓ continuous	serial length <u>3005</u> m	✓ sparsely forested	tributaries	partly built-up
	area <u>205</u> ha	moderately forested	✓ coastal dune/evergreen	mainly built-up
		heavily forested	mangroves	

Comments _____
 * a little

Channel Description	N.B. Estimate of flow stage: low /NEAR LONG-TERM MEAN/ high	Measurements	Islands/Shoals	Type of Flow	Bar Type
straight		thalweg <u>3575</u> m	none	stagnant/still	none
sinuous		*sinuosity <u>1.19</u>	✓ occasional	✓ uniform water surface	✓ channel side bars
✓ irregular		*open water area <u>27.2</u> ha	frequent	uniform with rapid in reach	✓ point bars
regular meanders		perimeter <u>7780</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 \bar{x} _____ m			sand waves/large dunes
✓ lagoon		river slope _____			
		river width \bar{x} <u>70.6</u> m			

Comments *whole reach
 ** a little above av. following March '76 flood

Obstructions/Constructions

Natural	Degree	Man-made	Degree of Obstruction/Constriction for Each	Position (from head of reach)
✓ none	none	road bridge/s	Steel Br. R. confined	at head
logs	minor	rail bridge/s	NR Br. R. confined	3.3 km
boulders	major	causeway	✓ R. confined	at mouth
vegetation		weir/dam		3.3 km
		fish traps		
		embankment/s	remnant of old rwy line on L.B. in L.	2.6 km
		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 _____ %	
irregular lateral activity		right bank _____ %	
avulsion			

Comments _____

RIVER M ZUMBE, 30 % ESTUARINE, REACH from Steel Br. to Mouth, 3,4 km from mouth. REF. DEA 4801 F

* AERIAL PHOTO DATE 20-6-79 SCALE 1:10 000 CATCHMENT AREA 593 km², M.A.R. 74,8 m³x10⁶, No. of DAMS NIL

RIVER VALLEY AND RIVER MOUTH FEATURES

General Description of the Terrain above the Valley

Valley Sides (Not Well-defined)

Terrain	Vegetation	Land-Use	Slumping	Vegetation and Land-Use	Left	Right
mountainous	almost none	none	none	none	3	
hilly	grass	scattered cultivation	occasional	grass	53	72 %
undulating	sparsely forested (0-25%)	partly cultivated	frequent	trees	16	6 %
plains	moderately forested (25-75%)	mainly cultivated		cultivated	28	22 %
	heavily forested (75-100%)	scattered settlement		built-up		
	swamp/bog	partly built-up urbanised				

Comments

* 1:2000 map compiled therefrom

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>3100</u> m	none	not applicable	not applicable (no valley or free)	bedrock
bottom width (av.) <u>675</u> m	indefinite	not obviously degrading	occasionally confined	lacustrine deposits
valley slope <u>1:310</u> (straight-line)	fragmentary	partly entrenched	frequently confined	fluvial deposits
height at head of reach <u>+10</u> m to MSL	continuous	entrenched	entrenched	aeolian
		aggrading		sand covered <u>6</u> % area

Comments

* for 1 km on L.B.

River Mouth

Characteristics

Measurements

open/closed	right bank breakwater length _____ m
natural/artificial	left bank breakwater length _____ m
canalized	rock sill level <u>+0,7 to +1,2</u> 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/wave: direction of growth <u>218</u> ° → 210°
outer bar	length of spit/wave <u>1040</u> m
silt plume (fluvial)	length stabilized <u>760</u> m
suspended sediment (marine)	width <u>77</u> m

Comments

* Beqq.

Description of Flood Plain

FLOOD PLAIN AND CHANNEL FEATURES

Presence	Extent	Vegetation	Forest Type	Land-Use
none	none	almost none	not known/applicable	not cultivated, not built-up
indefinite	average width <u>675</u> m	grass	riverine:	cultivated <u>23</u> % area
fragmentary	maximum width <u>1700</u> m	reed swamp <u>21</u> % area	main channel *	crop/s
continuous	serial length _____ m	sparsely forested	tributaries	partly built-up
	area <u>205</u> ha	moderately forested	coastal dune/evergreen mangroves	mainly built-up

Comments

* a little

Channel Description N.B. Estimate of flow stage: LOW/NEAR LOW/AT RISE/AT HIGH/IN FLOOD

Pattern	Measurements	Islands/Shoals	Type of Flow	Bar Type
straight	thalweg <u>3412</u> m	none	stagnant/still	none
sinuous	*sinuosity <u>1,18</u>	occasional	uniform water surface	channel side bars
irregular	*open water area <u>23,3</u> ha	frequent	uniform with rapid in reach	point bars
regular meanders	perimeter <u>7000</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 (15-8-79)			diamond bars
bifurcated	** channel slope <u>1:531</u>			diagonal bars
lake/s	channel width <u>_____</u> m			sand waves/large dunes
lagoon	** river slope <u>1:574</u>			
	river width <u>60,4</u> m			

Comments

* whole reach ** from 15-8-79 X-section survey

Obstructions/Constructions

Natural	Degree	Man-made	Degree of Obstruction/Constriction for Each	Position (from head of reach) at head
none	none	road bridge/s	Steel Br. R. confined	
logs	minor	rail bridge/s	N.R. Br. R. confined ?	3,3 km
boulders	major	causeway	R. confined at mouth	3,3 km
vegetation		weir/dam		
		fish traps		
		embankment/s	remnant of old river line: nil	2,6 km
		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/stabilised	very strong	highly unstable
entrenched loop development	cultivation to channel edge	left bank _____ %	
irregular lateral activity		right bank _____ %	
avulsion			

Comments

Steel Bridge to Proposed Freeway

<u>Date</u>	<u>Width (m)</u> \bar{x}	<u>s</u>	<u>V%</u>	<u>Mid-river length (m)</u>
2-5-37	48,5	11,7	24,1	2 100
June/July '55	31,6	6,7	21,1	2 100
6-6-59	62,3	14,6	23,5	2 100
10-6-66	46,5	23,3	50,2	2 100
23-6-76	64,9	6,8	10,4	2 100
20-6-79	64,4	6,8	10,6	2 110

Downstream Proposed Freeway to Mouth

	\bar{x}	<u>s</u>	<u>V</u>	<u>L</u>
2-5-37	49,0	27,9	56,9	1 250
June/July '55	35,0	26,1	74,6	1 270
6-6-59	71,3	25,5	35,8	1 400
10-6-66	44,9	17,7	39,4	1 050
23-6-76	79,6	25,4	31,9	1 320
20-6-79	54,0	21,5	39,8	1 200

Whole Reach (weighted)

	\bar{x}	<u>s</u>	<u>V</u>	<u>L</u>
2-5-37	48,7	19,0	39,0	3 350
June/July '55	32,9	16,6	50,5	3 370
6-6-59	65,7	19,5	29,7	3 500
10-6-66	45,9	21,0	45,8	3 150
23-6-76	70,6	17,7	25,1	3 420
20-6-79	60,4	14,9	24,7	3 310

Average width 1937-79 = 54,1 m

Station	Approx distance along 1979 R. course from steel bridge (m)	Distance from maximum observed L.B. position to mid-river (m)										Max-Min	\bar{x}	s	V%
		Date													
		2-5-37	Jun/Jul. '55	6-6-59	10-6-66	23-6-76	20-6-79	23-6-76	10-6-66	6-6-59	2-5-37				
1	0	25	20	33	11	33	33	33	33	33	31	22	25,5	8,8	34,3
2	300	75	11	70	80	38	38	38	38	38	45	69	53,2	26,7	50,2
3	600	35	19	40	20	48	48	48	48	48	50	31	35,3	13,4	38,0
4	900	30	18	40	27	31	31	31	31	31	33	22	29,8	7,3	24,3
5	1 200	50	30	43	23	45	45	45	45	45	45	27	39,3	10,4	26,6
6	1 500	80	75	35	30	35	35	35	35	35	60	50	52,5	22,1	42,1
7	1 800	108	62	70	48	35	35	35	35	35	40	73	60,5	26,7	44,2
8	2 100 (free-way)	98	22	70	115	40	40	40	40	40	50	93	65,8	35,5	54,0
9	2 400	262	82	60	415	310	310	310	310	310	205	355	222,3	136,2	61,3
10	2 740	310	255	60	485	495	495	495	495	495	485	435	348,3	174,5	50,1
11	2 980	50	88	60	65	60	60	60	60	60	65	38	64,7	12,7	19,6
12	3 300 (mouth)	190	210	80	230	325	325	325	325	325	220	245	209,2	78,8	37,7
\bar{x}		109,4	74,3	55,1	129,1	124,6	124,6	124,6	124,6	124,6	110,8	121,7	100,5		40,2
s		94,5	79,4	16,1	162,2	158,4	158,4	158,4	158,4	158,4	134,5	142,4			12,7
V%		86,4	106,8	29,2	125,6	127,1	127,1	127,1	127,1	127,1	121,4	117,0			31,5

Average lateral displacement 1937-79 = 121,7 m

Average coefficient of variation 1937-79 = 40,2%

TABLE NS 26/IX

ABSTRACT

MZUMBE

1937 - 1979

1. Sinuosity	Range 1,15 - 1,25
2. River width	Range 32,9 m - 70,6 m
3. Lateral displacement	\bar{x} 121,7 m \bar{v} 40,2%
4. Thalweg	Range 3336 m - 3630 m
5. Open water area	Range 16,8 ha - 28,5 ha
6. Reed swamp area	Range 8% - 21%
7. Cultivation:	
Valley sides L.B.	Range 28% - 30%
R.B.	Range 10% - 23%
Flood plain	Range 12% - 50%
8. Human influence	
(a) Cultivation (mostly sugar cane): fluctuation in area linked with effect of major floods (1959, 1963 and 1976).	
(b) Cultivation to the river's edge.	
(c) 1937 - 59 : railway line with its embankment and four bridges right across the flood plain.	
(d) 1959 + : road and rail bridges near the mouth & stabilization of sand-spit.	
(e) 1959/60 : canal built which shortened the river course and directed flow towards the bridges at the mouth. It was silted up by mid-1961 and river is gradually returning to "natural" course.	

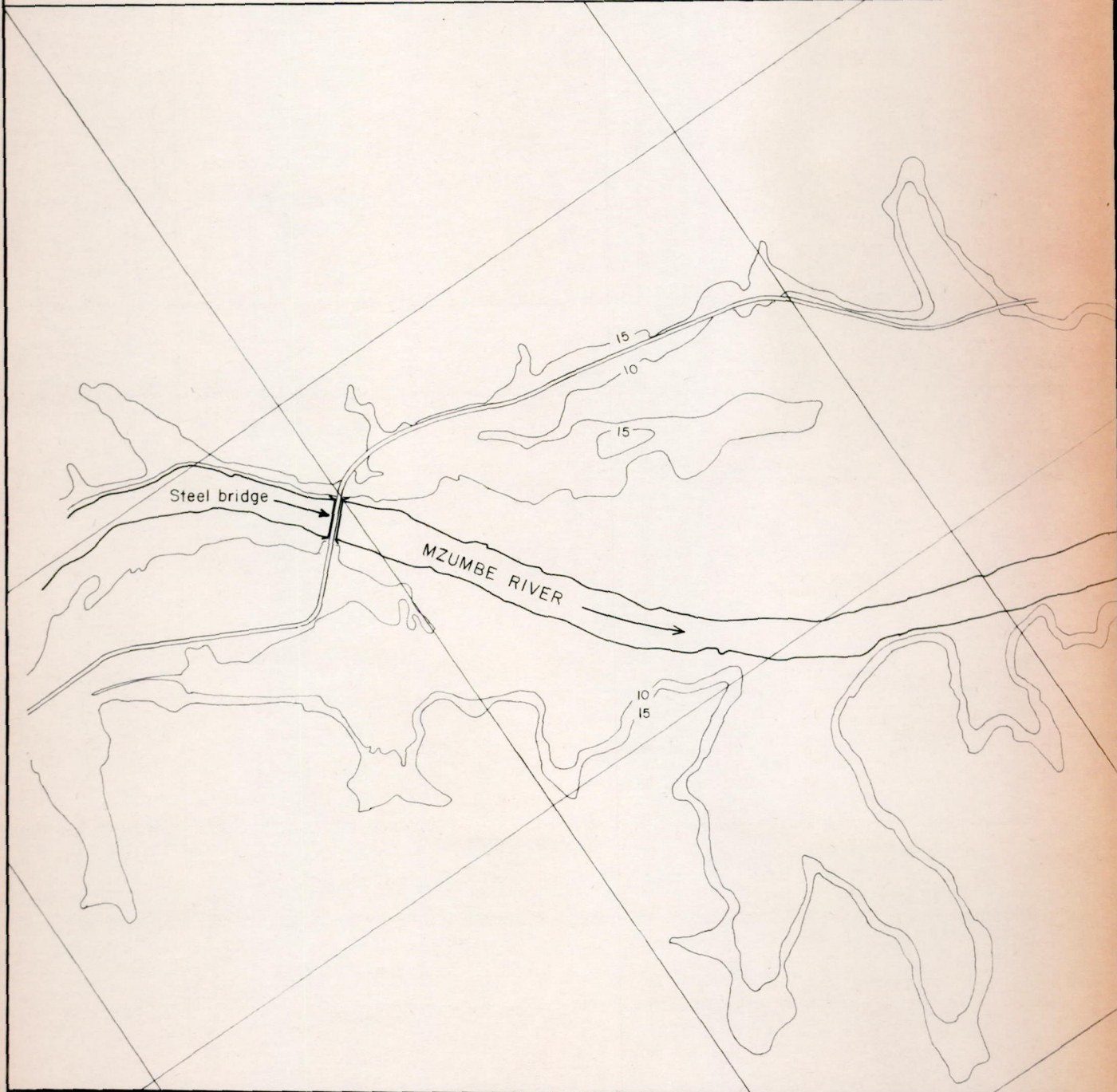
KEY

SCALE : 1:10 000

HEIGHT DATUM : MSL

CONTOUR INTERVAL : 5 m

(SURVEY BASED ON AERIAL PHOTOGRAPHY 20-6-1979)

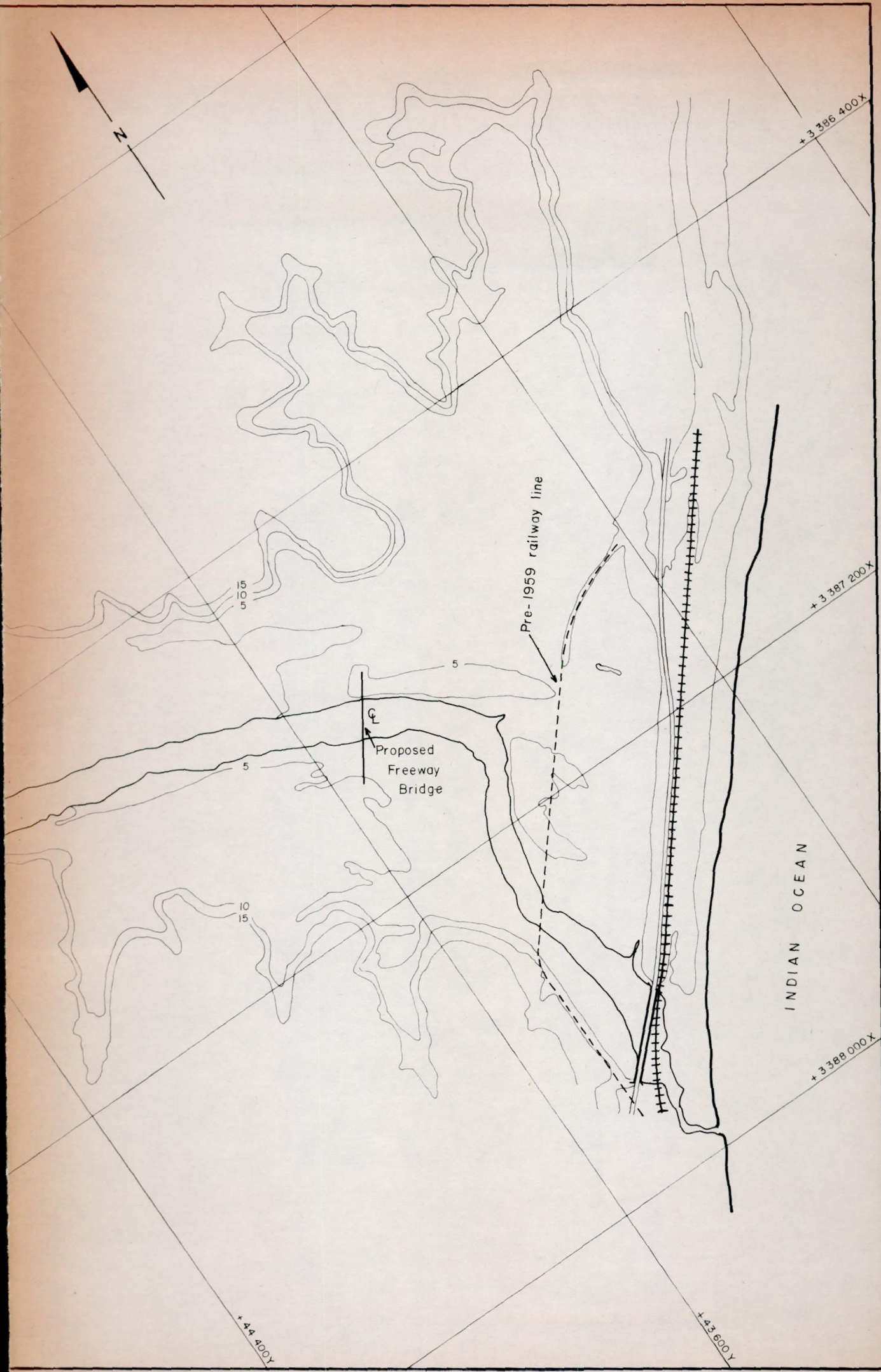


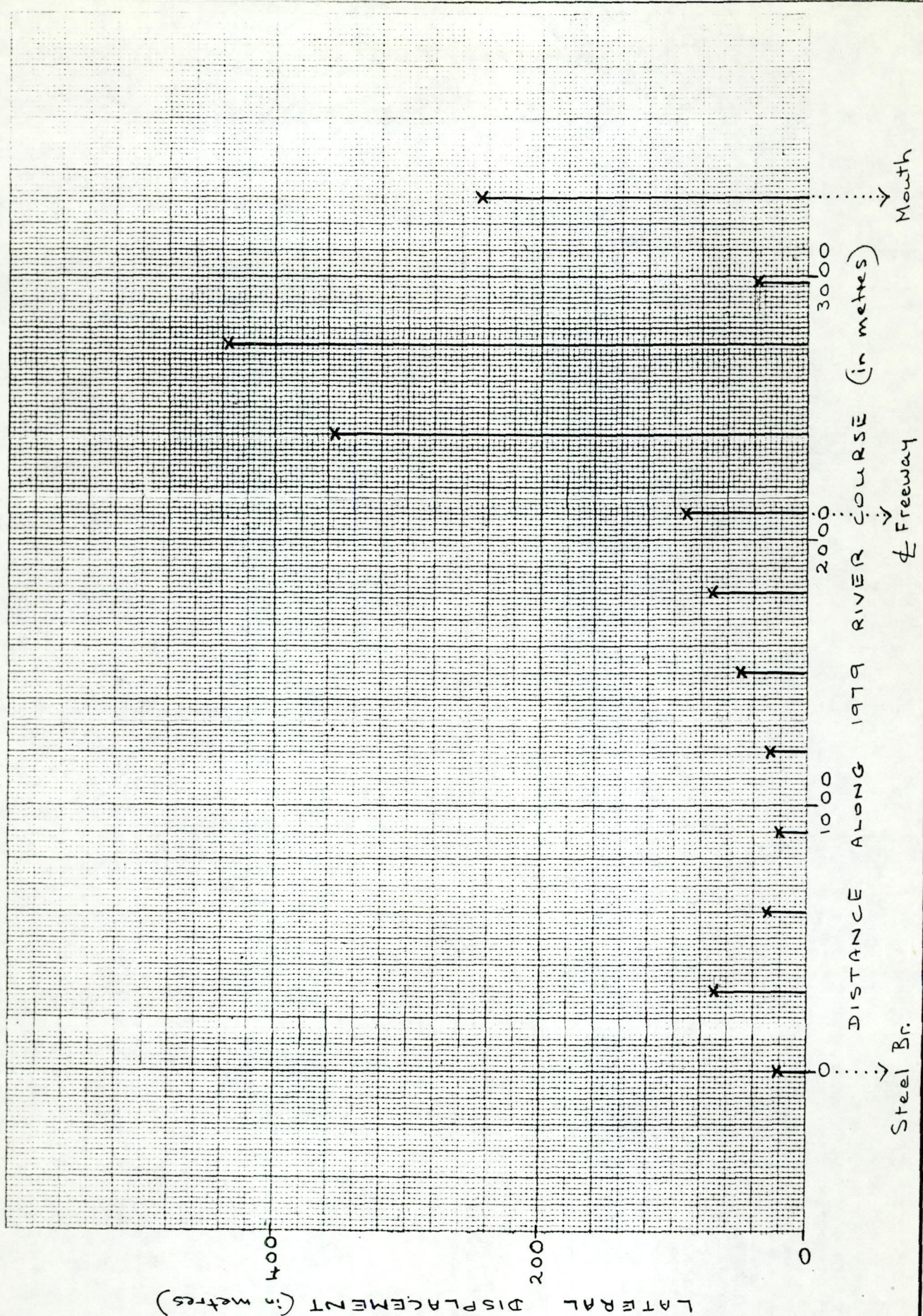
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CHECKED:
DATE:
REF.:

NATAL ESTUARIES: MZUMBE

LOCALITY MAP

FIGURE
NS 26/1



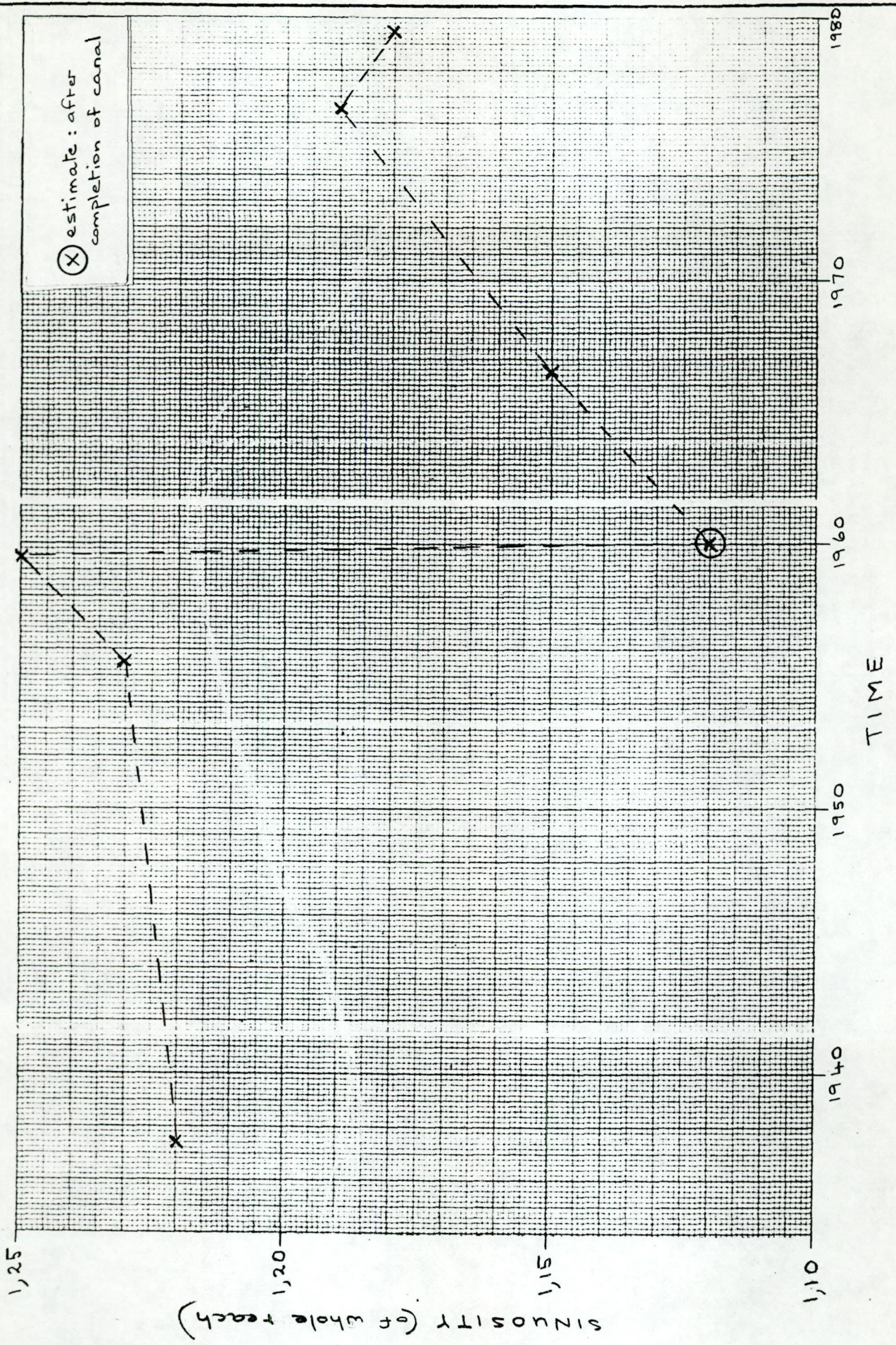


TRACED: DS
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 DATE:
 REF:

NATAL ESTUARIES: MZUMBE

THALWEG DISPLACEMENT: 1937-79

FIGURE
 NS 26/2

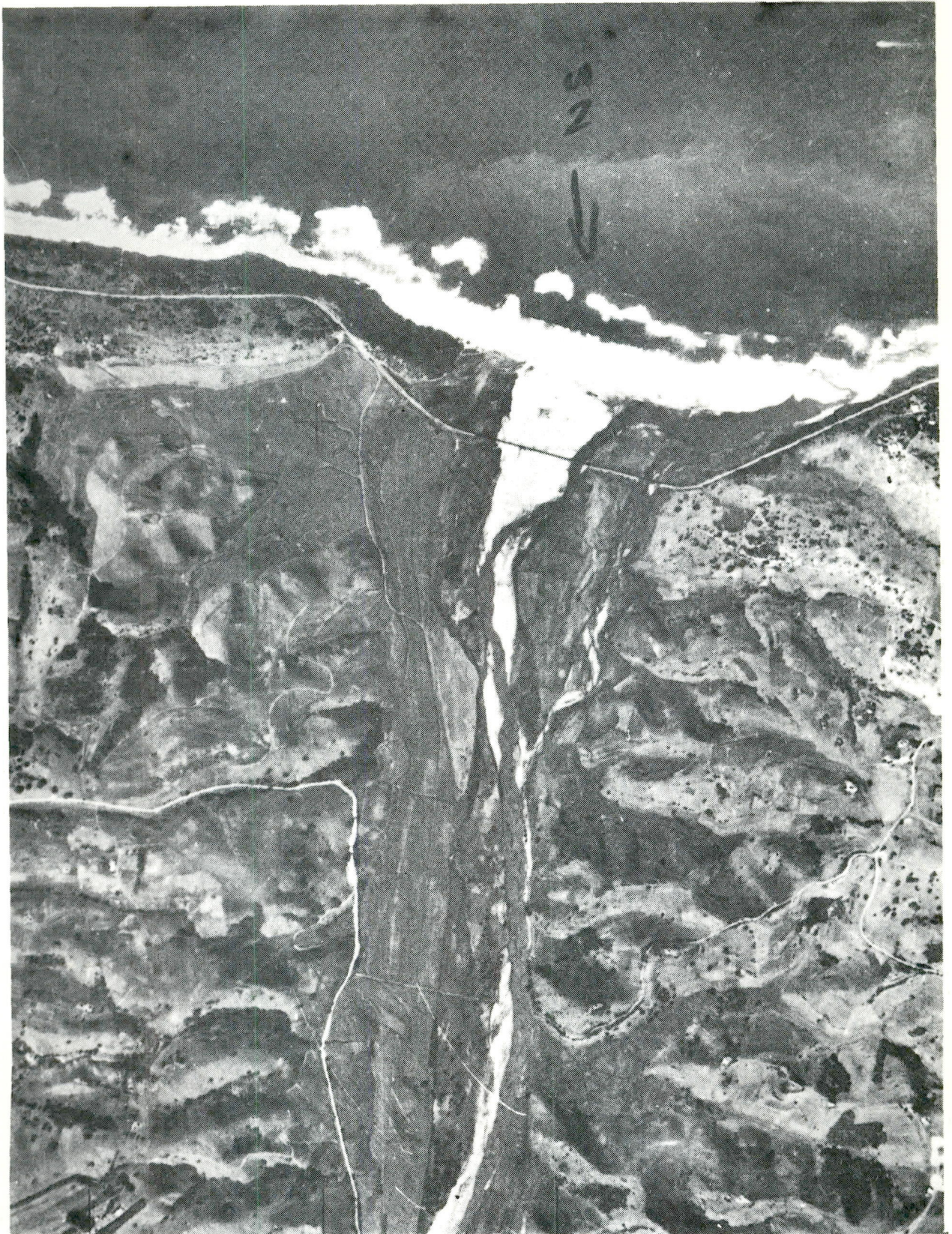


(X) estimate: after completion of canal

TRACED: DS
 CHECKED:
 DATE:
 REF.:

NATAL ESTUARIES: MZUMBE
 SINUOSITY: 1937 - 79

FIGURE
 NS 26/3



SCALE: 1 : 15 000 approx.

TRACED DS
CHECKED
DATE
REF

NATAL ESTUARIES : MZUMBE

2 - 5 - 37

PHOTOGRAPH
NS 26/1



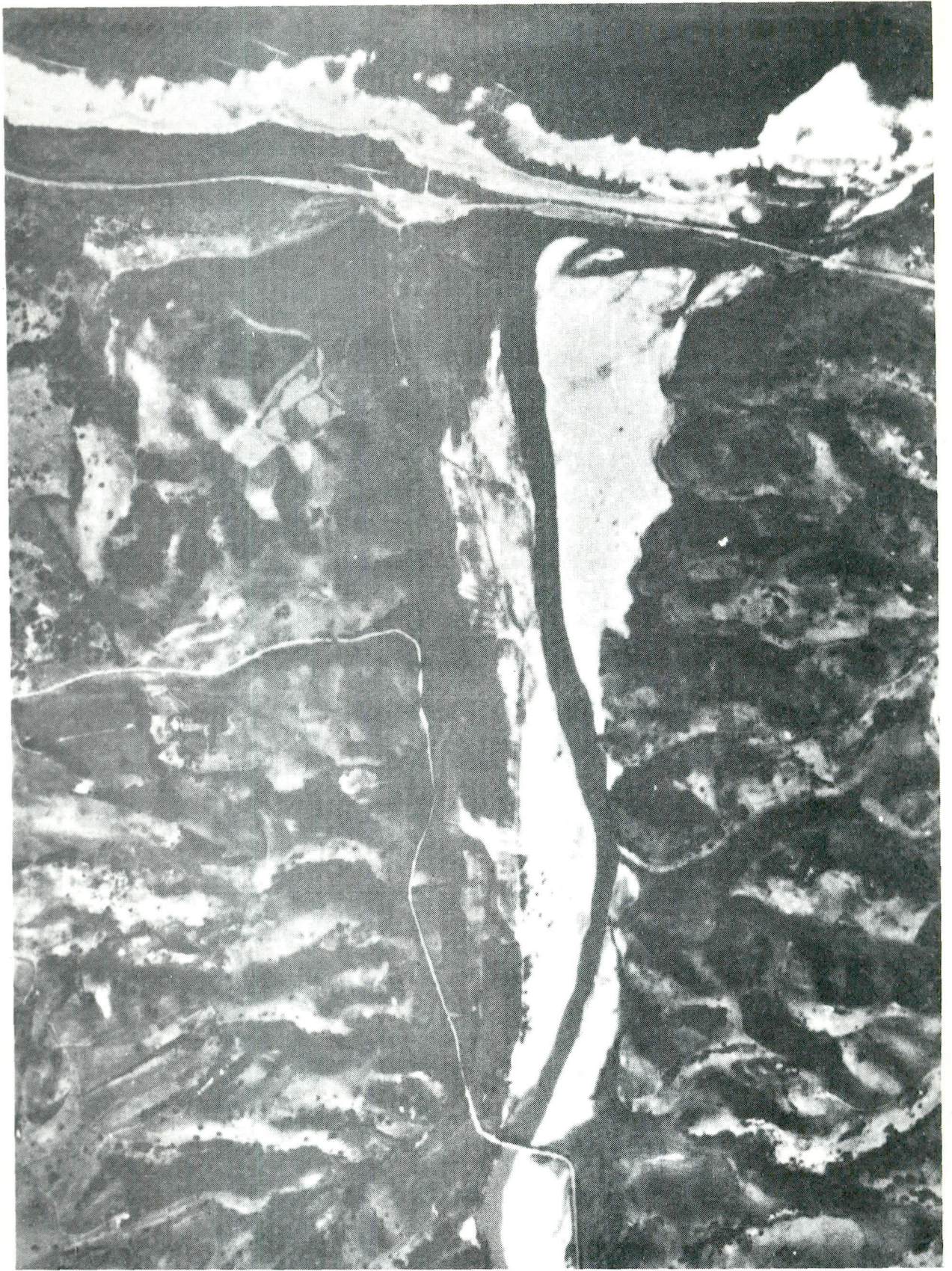
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NATAL ESTUARIES: MZUMBE

JUNE / JULY 1955

PHOTOGRAPH
NS 26/2



SCALE: 1:15 000 approx.

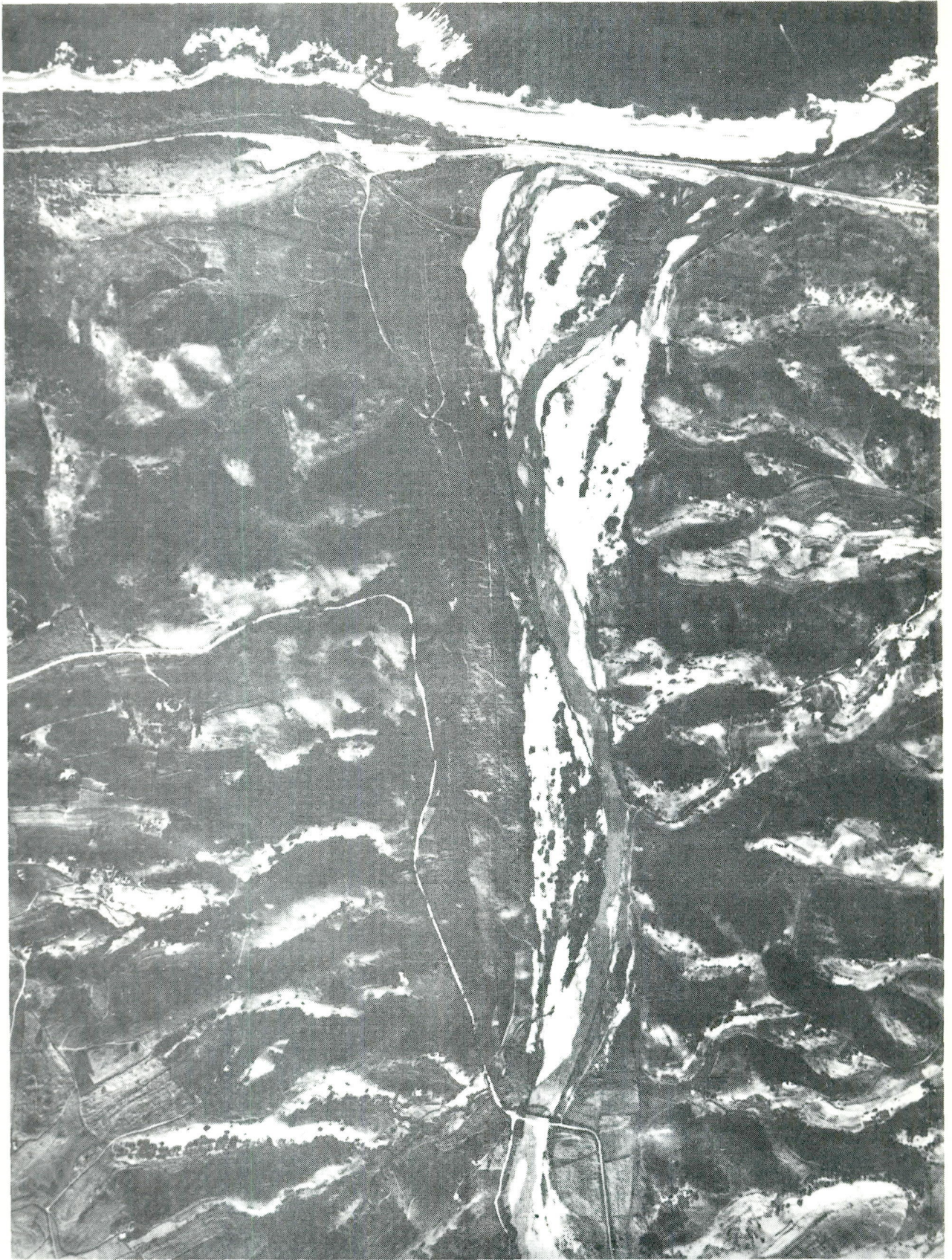
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NATAL ESTUARIES : MZUMBE

6 - 6 - 59

PHOTOGRAPH
NS 26/3

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SCALE: 1 : 14 500 approx.

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DATE:
REF :

NATAL ESTUARIES : MZUMBE

10 - 6 - 66

PHOTOGRAPH
NS 26/4



SCALE: 1 : 14 900 approx.

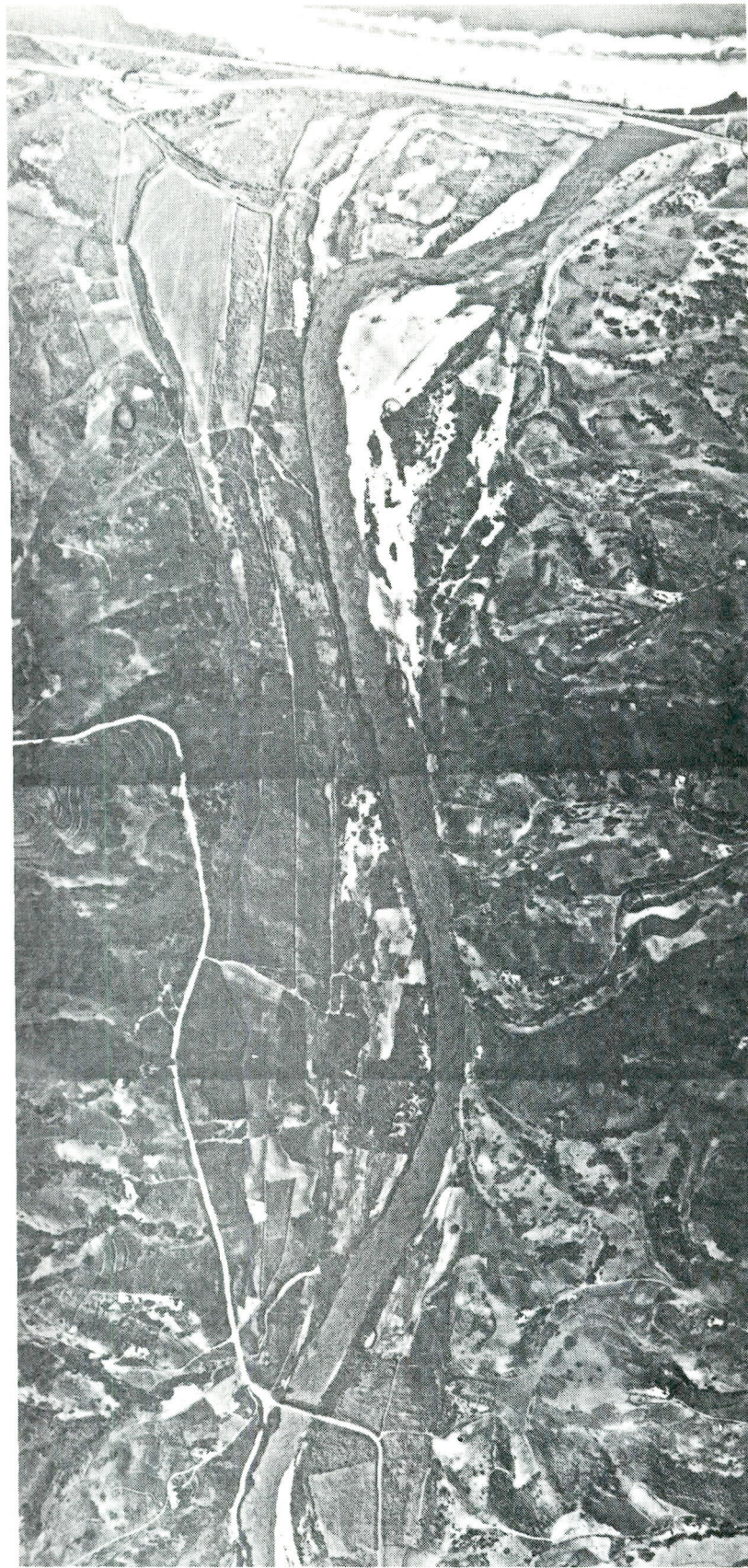
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DATE
REF

NATAL ESTUARIES : MZUMBE

ORTHOPHOTO: 23-6-76

PHOTOGRAPH
NS 26 / 5

NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY



SCALE: 1 : 13 500 approx.

TRACED DS
CHECKED
DATE:
REF

NATAL ESTUARIES : MZUMBE

20-6-79

PHOTOGRAPH
NS 26/6