

CONFIDENTIAL

**HYDROLOGICAL / HYDRAULIC STUDY
OF NATAL ESTUARIES**

DATA REPORT NO. 15

NONOTI NN 9

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

NRIO DATA REPORT D 8306

**Stellenbosch, South Africa
September 1983**

NN 9

CONFIDENTIAL

**HYDROLOGICAL / HYDRAULIC STUDY
OF NATAL ESTUARIES**

**DATA REPORT NO. 15
NONOTI NN 9**

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

NRIO DATA REPORT D 8306

**Stellenbosch, South Africa
September 1983**

CONTENTS

BRIEF NOTES

LIST OF TABLES

NN9/I	Abstract, Nonoti NN9
NN9/II	Classification of the lower reaches of the Nonoti 1937
NN9/III	" " " " " 1953
NN9/IV	" " " " " 1959
NN9/V	" " " " " 1967
NN9/VI	" " " " " 1973
NN9/VII	" " " " " 1976
NN9/VIII	River widths: 1937 - 1976
NN9/IX	Lateral stability: 1937 - 1976
NN9/X	Simulated run-off: 1921 - 1975

LIST OF FIGURES

NN9/1	Thalweg displacement: 1937 - 1976
NN9/2	Simulated annual run-off: 1921 - 1975
NN9/3	Simulated monthly run-off: 1921 - 1975
NN9/4	Cumulative annual run-off: 1921 - 1975

LIST OF PHOTOGRAPHS

NN9/1	14-5-76 (1-5-37 river course superimposed)
NN9/2	1-5-37 (12h05)
NN9/3	Sept./Oct. 1953 (11h05)
NN9/4	6-6-59 (11h23)
NN9/5	21-8-67 (11h40)
NN9/6	3-6-73 (12h04)
NN9/7	14-5-76 (10h00)
NN9/8	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.

River Mouth

The river mouth is closed for 94 per cent of the year (Begg, pers. comm.). The photographs studied are thus truly representative in that on only one occasion (14-5-76) was the mouth open. The Nonoti is diverted at its mouth by a long southerly-extending spit. There are rocks on the right bank near the mouth; at the mouth itself they are a subdued feature.

Land-use

A large percentage of the valley sides and one-third of the flood plain are under sugar cane. There is some cultivation to the channel edge in the upper part of the reach. One small tributary on the left bank has been channelled, most probably to facilitate drainage. The sandbar at the mouth is breached artificially by a sugar cane farmer on the right bank when his lands become inundated. This is not done at the natural position of the river mouth (Begg, 1978).

Siltation

The lower reaches show siltation. Quantification of this is a little difficult as it is not always possible to differentiate between areas covered by water hyacinth and reeds. Water hyacinth areas, which are part of the open water system, are quite widespread during the long dry phases. Most of the reed swamp areas, which reflect siltation, developed prior to our period of study. Furthermore, the rising lagoon levels when the mouth is closed and the artificial breaching of the sandbar preclude our deducing trends from average widths of the river. It is, however, noteworthy that the average width of the river was greatest in 1937, which was itself in a dry phase. The river flow is turbid, especially after higher flows (e.g. January - March 1976). This, together with the increase in bar areas at such periods, shows an ample silt supply from both upstream and the upper part of the reach.

Stability

The lower reaches of the Nonoti form one large meander which is largely geomorphologically controlled. There is some lateral displacement where the river is free to move on the outer bend and very near the mouth (depending upon water levels in the lagoon). The fairly low average lateral displacement (17,8 m) and average coefficient of variation of 19,2 per cent, however, reflect only slight instability.

The Nonoti shows moderate siltation and has been slightly unstable for the period under review. For an overall abstract of study results see Table NN9/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

HUMAN INFLUENCES

Within the Reach

Lateral displacement (1937 - 1976)

Relative lateral stability (1937 - 1976)

Area of catchment

Area of flood plain

Area of envelope of mobility

Simulated M.A.R.

(1921 - 1975)

$\bar{x}$	17.8	m
$\bar{v}$	19.2	%
	210	km ²
	59.2	ha
	27.1	ha
$\bar{x}$	35.76	x 10 ⁶ m ³
$\bar{s}$	30.32	x 10 ⁶ m ³
$\bar{v}$	84.8	%

Dates of major floods: March 1925, Dec. 1944, Dec. 1956, 8-2-74 (localised), March 1976

MEASUREMENTS/CALCULATIONS FROM PHOTOGRAPHS

Date	1-5-37	Sept/Oct 1953	6-6-59	21-8-67	3-6-73	14-5-76
Thalweg (m)	28.72	2.780	2.900	2.733	2.815	2.948
% Thalweg estuarine	?	?	?	?	?	65
Aerial D (m)	1306	1288	1331	1297	1300	1364
Sinuosity	2.20	2.16	2.18	2.11	2.17	2.16
$\bar{x}$ River width (m)	76.7	60.8	63.1	63.0	69.9	61.7
Open water area (ha)	23.7	19.0	19.6	19.3	21.3	18.9
% envelope of mobility	87.5	70.1	72.3	71.2	78.6	69.7
Bar/island area (ha)	1.4	1.4	1.4	1.8	1.5	3.0
River braided	x	x	x	x	x	x
Water hyacinth area (ha)	0.5	6.2	2.9	6.9	6.1	0.5
% Flood plain cultivated	30.1	31.6	34.0	32.6	34.1	31.9
Left valley side:						
% grass	NIL	NIL	NIL	NIL	NIL	NIL
% trees	36	46	50	54	50	54
% cultivated	64	54	50	46	50	46
% built up	NIL	NIL	NIL	NIL	NIL	NIL
Right valley side:						
% grass	17	17	17	17	17	17
% trees	21	21	21	21	21	21
% cultivated	62	62	62	62	62	62
% built up	NIL	NIL	NIL	NIL	NIL	NIL
L.B. % vegetated	14	9	7	7	9	14
R.B. % vegetated	15	11	15	15	15	17
Mouth open/closed O/C	C	C	C	C	C	O
Spit/bar:						
Direction (°)	225	225	225	225	225	224
Length (m)	860	860	860	860	860	790
$\bar{x}$ width (m)	66	68	62	63	62	72

L.V.S. $\pm 50\%$ under sugar cane at lower levels
 $\pm 95\%$ under sugar cane at higher levels
 R.V.S. 62% under sugar cane

Flood plain $\pm 1/8$ under sugar cane

To channel edge yes, in upper part of reach

(b) Bridge building and embankments

NIL

(c) Canals

NIL

(d) Urbanization/Industry

NIL

2. Breaching of sandbar (from Begu, 1978 + pers. comm.)

The mouth is closed for 94% of the year. The bar is breached artificially by sugar cane farmer on the R.B. - not at natural point of exit.

3. Others

Upstream of Reach

(a) Dams in the catchment

NIL

Date of construction

(b) Building construction or canalization immediately upstream of reach

NIL

(c) Land-use malpractices/silt supply

Turbidity & increased bar areas following higher flows slow ample silt supply from upstream (upper part) of reach.

RIVER NONOTI, ? % ESTUARINE, REACH from 2.7 km upstream of 1976 mouth, REF. DEA U 500bAERIAL PHOTO DATE 1-5-37 SCALE 1:10 000 CATCHMENT AREA 210 km², M.A.R. 35.76 m³x10⁶, No. of DAMS NIL

RIVER VALLEY AND RIVER MOUTH FEATURES

General Description of the Terrain above the Valley

Terrain	Vegetation	Land-Use	Slumping	Vegetation and Land-Use	Left	Right
mountainous	almost none	none	none	none		
hilly	✓ grass	scattered cultivation	✓ occasional	grass	<u>NIL</u>	<u>17</u> %
✓ undulating	✓ sparsely forested (0-25%)	partly cultivated	frequent	trees	<u>36</u>	<u>21</u> %
plains	moderately forested (25-75%)	✓ mainly cultivated		cultivated	<u>64</u>	<u>62</u> %
	heavily forested (75-100%)	✓ scattered settlement		built-up	<u>NIL</u>	<u>NIL</u> %
	swamp/bog	partly built-up				
		urbanised				

Comments _____

Valley Characteristics

Measurements	Terraces	Relation of Channel to Valley Bottom (Vertical)	Relation of Channel to Valley Sides or Resistant Terraces (Lateral)	Surface Geology
valley length <u>2130</u> m	none	not applicable	not applicable (no valley or free)	bedrock
bottom width (av.) <u>300</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>NIL</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	split/bar: direction of growth <u>225</u> °
outer bar	length of split/bar <u>860</u> m
silt plume (fluvial)	length stabilized <u>180</u> m
✓ suspended sediment (marine)	width <u>68</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>300</u> m	grass	✓ riverine:	✓ cultivated <u>30</u> % area
fragmentary	maximum width <u>500</u> m	✓ reed swamp <u>17</u> % area	main channel	✓ crop/s <u>sugar cane</u>
✓ continuous	aerial length <u>1306</u> m	sparsely forested	tributaries	partly built-up
	area <u>59.2</u> ha	moderately forested	✓ coastal dune/evergreen	mainly built-up
		heavily forested	mangroves	

Comments _____

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

Pattern	Measurements	Islands/Shoals	Type of Flow	Bar Type
straight	thalweg <u>2872</u> m	✓ none	stagnant/still	none
sinuous	* sinuosity <u>2.20</u>	occasional	✓ uniform water surface	✓ channel side bars
irregular	* open water area <u>23.7</u> ha	frequent	uniform with rapid in reach	✓ point bars
regular meanders	perimeter <u>6100</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 (slightly)	diamond bars
bifurcated	channel slope _____			diagonal bars
lake/s	channel width x _____ m			sand waves/large dunes
lagoon	river slope _____			
	river width x <u>76.7</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 * 0.5 ha water hyacinth

Lateral Channel Activity

Lateral Activity	Nature of Banks	Bank Vegetation	Lateral Stability
not detectable	✓ alluvium (silt/sand)	none	stable
✓ downstream progression *	natural levées	✓ weak	✓ slightly unstable
progression & cut-offs	rock/boulders	good	moderately unstable
mainly cut-offs	protected/stabilized	very strong	highly unstable
entrenched loop development	✓ cultivation to channel edge	left bank <u>14</u> %	
irregular lateral activity		right bank <u>15</u> %	
avulsion			

Comments * restricted geomorphology

RIVER NONOTI ? % ESTUARINE, REACH from 2.9 km upstream of 1976 mouth. REF. DEA U 500 B
 AERIAL PHOTO DATE Sept./Oct '53 SCALE 1:10 000 CATCHMENT AREA 210 km², M.A.R. 35.76 m³x10⁶, No. of DAMS NIL

RIVER VALLEY AND RIVER MOUTH FEATURES

General Description of the Terrain above the Valley

Terrain	Vegetation	Land-Use	Slumping	Valley Sides (Not Well-defined)	Vegetation and Land-Use	Left	Right
mountainous	almost none	none	none	none			
hilly	✓ grass	scattered cultivation	✓ occasional	grass		<u>NIL</u>	<u>17</u> %
undulating	✓ sparsely forested (0-25%)	partly cultivated	frequent	trees		<u>4.6</u>	<u>21</u> %
plains	moderately forested (25-75%)	✓ mainly cultivated		cultivated		<u>5.4</u>	<u>62</u> %
	heavily forested (75-100%)	✓ scattered settlement		built-up		<u>NIL</u>	<u>NIL</u> %
	swamp/bog	partly built-up					
		urbanised					

Comments

Valley Characteristics

Measurements	Terraces	Relation of Channel to Valley Bottom (Vertical)	Relation of Channel to Valley Sides or Resistant Terraces (Lateral)	Surface Geology
valley length <u>2130</u> m	none	not applicable	not applicable (no valley or free)	bedrock
bottom width (av.) <u>300</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>NIL</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>225</u> °
outer bar	length of spit/bar <u>860</u> m
silt plume (fluvial)	length stabilized <u>195</u> m
✓ suspended sediment (marine)	width <u>68</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>300</u> m	grass	✓ riverine:	✓ cultivated <u>32</u> % area
fragmentary	maximum width <u>500</u> m	✓ reed swamp <u>17</u> % area	main channel	✓ crop/sugar cane
✓ continuous	aerial length <u>1288</u> m	sparsely forested	tributaries	partly built-up
	area <u>59.2</u> ha	moderately forested	✓ coastal dune/evergreen mangroves	mainly built-up
		heavily forested		

Comments

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

Pattern	Measurements	Islands/Shoals	Type of Flow	Bar Type
straight	thalweg <u>2780</u> m	✓ none	stagnant/still	none
sinuous	* sinuosity <u>2.16</u>	occasional	uniform water surface	✓ channel side bars
irregular	* open water area <u>19.0</u> ha	frequent	uniform with rapid in reach	✓ point bars
regular meanders	perimeter <u>5750</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 (slightly)	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>60.8</u> m s = <u>62.4</u> m			

Comments *whole reach

** 'water hyacinth

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 <u>L.B. tributary channelled</u>		<u>500 m</u>
		drainage furrows _____		
		others _____		

Comments * 6.2 ha water hyacinth

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>9</u> %	
irregular lateral activity	channel edge	right bank <u>11</u> %	
avulsion			

Comments * restricted

geomorphology

RIVER NONOTI, ? % ESTUARINE, REACH from 2.9 km upstream of 1976 mouth. REF. DEA U500b
 AERIAL PHOTO DATE 6-6-59 SCALE 1:10 000 CATCHMENT AREA 210 km², M.A.R. 35,76 m³x10⁶, No. of DAMS NIL

RIVER VALLEY AND RIVER MOUTH FEATURES

General Description of the Terrain above the Valley

Valley Sides (~~None~~ Well-defined)

Terrain	Vegetation	Land-Use	Slumping	Vegetation and Land-Use	Left	Right
mountainous	almost none	none	none	none		
hilly	✓ grass	scattered cultivation	✓ occasional	grass	<u>NIL</u>	<u>17</u> %
✓ undulating	✓ sparsely forested (0-25%)	partly cultivated	frequent	trees	<u>50</u>	<u>21</u> %
plains	moderately forested (25-75%)	✓ mainly cultivated		cultivated	<u>50</u>	<u>62</u> %
	heavily forested (75-100%)	✓ scattered settlement		built-up	<u>NIL</u>	<u>NIL</u> %
	swamp/bog	partly built-up				
		urbanised				

Comments

Valley Characteristics

Measurements	Terraces	Relation of Channel to Valley Bottom (Vertical)	Relation of Channel to Valley Sides or Resistant Terraces (Lateral)	Surface Geology
valley length <u>2130</u> m	none	not applicable	not applicable (no valley or free)	bedrock
bottom width (av.) <u>300</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>NIL</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>225</u> °
outer bar	length of spit/bar <u>860</u> m
silt plume (fluvial)	length stabilized <u>200</u> m
suspended sediment (marine)	width <u>62</u> 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 <u>34</u> % area
fragmentary	✓ reed swamp <u>19</u> % area	main channel	✓ crop/ <u>sugar cane</u>
✓ continuous	sparsely forested	tributaries	partly built-up
	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~~ (a little above av.)

Pattern	Measurements	Islands/Shoals	Type of Flow	Bar Type
straight	thalweg <u>2700</u> m	✓ none	stagnant/still	none
sinuous	* sinuosity <u>2.18</u>	occasional	✓ uniform water surface	✓ channel side bars
irregular	* open water area <u>19.6</u> ha	frequent	uniform with rapid in reach	✓ point bars
regular meanders	perimeter <u>6033</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		✓ <u>turbid (slightly)</u>	diamond bars
bifurcated	channel slope _____ m s = _____ m			diagonal bars
lake/s	channel width x _____ m			sand waves/large dunes
lagoon	river slope _____ m			
	river width x <u>63.1</u> m s = <u>62.1</u> m			

Comments *whole reach

Obstructions/Constructions

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

Comments * 2.9 ha water hyacinth

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>7</u> %	
irregular lateral activity	channel edge	right bank <u>15</u> %	
avulsion			

Comments

* restricted geomorphology

RIVER NONOTI, ? % ESTUARINE, REACH from 2.9 km upstream of 1976 mouth. REF. DEA U 500b
 AERIAL PHOTO DATE 21-8-67 SCALE 1:10 000 CATCHMENT AREA 210 km², M.A.R. 35.76 m³x10⁶, No. of DAMS NIL

RIVER VALLEY AND RIVER MOUTH FEATURES

General Description of the Terrain above the Valley

Terrain	Vegetation	Land-Use	Slumping	Vegetation and Land-Use	Left	Right
mountainous	almost none	none	none	none		
hilly	✓ grass	scattered cultivation	✓ occasional	grass	<u>NIL</u>	<u>17</u> %
✓ undulating	✓ sparsely forested (0-25%)	partly cultivated	frequent	trees	<u>54</u>	<u>21</u> %
plains	moderately forested (25-75%)	✓ mainly cultivated		cultivated	<u>46</u>	<u>62</u> %
	heavily forested (75-100%)	✓ scattered settlement		built-up	<u>NIL</u>	<u>NIL</u> %
	swamp/bog	partly built-up				
		urbanised				

Comments _____

Valley Characteristics

Measurements	Terraces	Relation of Channel to Valley Bottom (Vertical)	Relation of Channel to Valley Sides or Resistant Terraces (Lateral)	Surface Geology
valley length <u>2130</u> m	none	not applicable	not applicable (no valley or free)	bedrock
bottom width (av.) <u>300</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>NIL</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	direction of growth <u>225</u> °	
outer bar	length of spit/bar <u>860</u> m	
silt plume (fluvial)	length stabilized _____ m	
suspended sediment (marine)	width _____ 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>300</u> m	grass	✓ riverine:	✓ cultivated <u>33</u> % area
fragmentary	maximum width <u>500</u> m	✓ reed swamp <u>20</u> % area	main channel	✓ crop/✓ sugarcane
✓ continuous	aerial length <u>1297</u> m	sparsely forested	tributaries	partly built-up
	area <u>59.2</u> ha	moderately forested	✓ coastal dune/evergreen	mainly built-up
		heavily forested	mangroves	

Comments _____

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

Pattern	Measurements	Islands/Shoals	Type of Flow	Bar Type
straight	thalweg <u>2733</u> m	✓ none	stagnant/still	none
sinuous	* sinuosity <u>2.11</u>	occasional	uniform water surface	✓ channel side bars
irregular	* open water area <u>19.3</u> ha	frequent	uniform with rapid in reach	✓ point bars
regular meanders	perimeter <u>5800</u> m	split	✓ irregular * x	✓ channel junction bars
✓ irregular meanders	lake/lagoon area _____ ha	braided	pool & riffle sequence	mid-channel bars
contortuous meanders	river X-sections available		✓ hybrid (slightly)	diamond bars
bifurcated	channel slope _____ m s = _____ m			diagonal bars
lake/s	channel width x _____ m s = _____ m			sand waves/large dunes
lagoon	river slope _____ m s = <u>66.4</u> m			
	river width x <u>63.0</u> m s = <u>66.4</u> m			

Comments *whole reach

xx water hyacinth

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	✓ considerable	weir/dam		
		fish traps		
		embankment/s		
		groynes		
		canals	<u>L.B. tributary channelled</u>	<u>500 m</u>
		drainage furrows		
		others		

Comments *6.9 ha water hyacinth

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	left bank <u>7</u> %		
irregular lateral activity	channel edge	right bank <u>15</u> %		
avulsion				

Comments *restricted geomorphology

RIVER NONOTI, ? % ESTUARINE, REACH from 2.7 km upstream of 19th mouth. REF. DEA U 500b
 AERIAL PHOTO DATE 3-6-73 SCALE 1:10 000 CATCHMENT AREA 210 km², M.A.R. 35.76 m³x10⁶, No. of DAMS NIL

(orthophoto)

RIVER VALLEY AND RIVER MOUTH FEATURES

General Description of the Terrain above the Valley

Terrain	Vegetation	Land-Use	Slumping	Vegetation and Land-Use	Left	Right
mountainous	almost none	none	none	none		
hilly	✓ grass	scattered cultivation	✓ occasional	grass	<u>NIL</u>	<u>17</u> %
✓ undulating	✓ sparsely forested (0-25%)	partly cultivated	frequent	trees	<u>50</u>	<u>21</u> %
plains	moderately forested (25-75%)	✓ mainly cultivated		cultivated	<u>50</u>	<u>62</u> %
	heavily forested (75-100%)	✓ scattered settlement		built-up	<u>NIL</u>	<u>NIL</u> %
	swamp/bog	partly built-up				
		urbanised				

Comments

Valley Characteristics

Measurements	Terraces	Relation of Channel to Valley Bottom (Vertical)	Relation of Channel to Valley Sides or Resistant Terraces (Lateral)	Surface Geology
valley length <u>2130</u> m	none	not applicable	not applicable (no valley or free)	bedrock
bottom width (av.) <u>300</u> m	indefinite	not obviously degrading	✓ occasionally confined	lacustrine deposits
valley slope <u>1:533</u>	✓ fragmentary	partly entrenched	frequently confined	✓ fluvial deposits
height at head of reach <u>4</u> m to MSL approx	continuous	entrenched	entrenched	aeolian
		✓ aggrading		sand covered _____ % 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>225</u> °
outer bar	length of spit/bar <u>850</u> m
silt plume (fluvial)	length stabilized _____ m
suspended sediment (marine)	width _____ 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>300</u> m	grass	✓ riverine:	✓ cultivated <u>34</u> % area
fragmentary	maximum width <u>500</u> m	✓ reed swamp <u>17</u> % area	main channel	✓ crop/✓ sugarcane
✓ continuous	aerial length <u>1300</u> m	sparsely forested	tributaries	partly built-up
	area <u>59.2</u> ha	moderately forested	✓ coastal dune/evergreen	mainly built-up
		heavily forested	mangroves	

Comments

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

Pattern	Measurements	Islands/Shoals	Type of Flow	Bar Type
straight	thalweg <u>2515</u> m	✓ none	stagnant/still	none
sinuous	* sinuosity <u>2.17</u>	occasional	uniform water surface	channel side bars
irregular	* open water area <u>21.3</u> ha	frequent	uniform with rapid in reach	point bars
regular meanders	perimeter <u>5850</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		✓ hybrid (slightly)	diamond bars
bifurcated	channel slope _____ m s = _____ m			diagonal bars
lake/s	channel width x _____ m			sand waves/large dunes
lagoon	river slope _____ m s = <u>67.0</u> m			

Comments *whole reach

*water high in 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	<u>L.S. tributary channelled</u>	<u>500 m</u>
		drainage furrows		
		others		

Comments *6.1 ha water hyacinth

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>9</u> %	
irregular lateral activity		right bank <u>15</u> %	
avulsion			

Comments

*restricted

geomorphology

RIVER NONOTI, 65 % ESTUARINE, REACH from 2.9 km upstream of 1976 mouth, REF. DEA U 5006
 AERIAL PHOTO DATE 14-5-76 SCALE 1:10 000 CATCHMENT AREA 210 km², M.A.R. 35,76 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		
hilly	✓ grass	scattered cultivation	✓ occasional	grass	<u>NIL</u>	<u>17</u> %
✓ undulating	✓ sparsely forested (0-25%)	partly cultivated	frequent	trees	<u>54</u>	<u>21</u> %
plains	moderately forested (25-75%)	✓ mainly cultivated		cultivated	<u>46</u>	<u>62</u> %
	heavily forested (75-100%)	✓ scattered settlement		built-up	<u>NIL</u>	<u>NIL</u> %
	swamp/bog	partly built-up				
		urbanised				

Comments

Valley Characteristics

Measurements	Terraces	Relation of Channel to Valley Bottom (Vertical)	Relation of Channel to Valley Sides or Resistant Terraces (Lateral)	Surface Geology
valley length <u>2130</u> m	none	not applicable	not applicable (no valley or free)	bedrock
bottom width (av.) <u>300</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 _____ % 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>224</u> °
outer bar	length of spit/bar <u>790</u> m
✓ silt plume (fluvial)	length stabilized <u>290</u> m
suspended sediment (marine)	width <u>72</u> m

Comments *submerged feature at the mouth

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>300</u> m	grass	✓ riverine:	✓ cultivated <u>32</u> % area
fragmentary	maximum width <u>500</u> m	reed swamp <u>14</u> % area	main channel	✓ crop/s <u>sugar cane</u>
✓ continuous	areal length <u>1364</u> m	sparsely forested	tributaries	partly built-up
	area <u>59,2</u> ha	moderately forested	✓ coastal dune/evergreen	mainly built-up
		heavily forested	mangroves	

Comments

Channel Description N.B. Estimate of flow stage: ~~near~~ NEAR LONG-TERM MEAN/NEAR (Floods Jan - March 1976)

Pattern	Measurements	Islands/Shoals	Type of Flow	Bar Type
straight	thalweg <u>2948</u> m	none	stagnant/still	none
sinuous	* sinuosity <u>2.16</u>	occasional	✓ uniform water surface	✓ channel side bars
irregular	* open water area <u>18,4</u> ha	frequent	uniform with rapid in reach	✓ point bars
regular meanders	perimeter <u>6229</u> m	split	irregular	✓ channel junction bars
✓ irregular meanders	lake/lagoon area _____ ha	braided	pool & riffle sequence	✓ mid-channel bars
contortuous meanders	river X-sections available		✓ turbid	diamond bars
bifurcated	channel slope _____ m s = _____ m			diagonal bars
lake/s	channel width x _____ m			sand waves/large dunes
lagoon	river slope _____ m s = <u>56.7</u> m			
	river width x _____ 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 *0.5 ha water hyacinth

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 channel edge	left bank <u>14</u> %	
irregular lateral activity		right bank <u>17</u> %	
avulsion			

Comments *restricted geomorphology

RIVER WIDTHS

TABLE NN9/VIII

Station	Approx. distance along 1976 river course (m)	River widths (m)							$\bar{x}$	s	V%
		Date									
		01.05.37	Sep/Oct 53	06.06.59	21.08.67	03.06.73	14.05.76				
1	0	25	14	17	17	17	17	17,8	3,7	20,8	
2	200	28	18	19	14	20	20	19,8	4,6	23,1	
3	400	34	15	24	12	22	20	21,2	7,7	36,4	
4	600	42	37	28	26	50	30	35,5	9,3	26,2	
5	800	54	39	28	30	20	28	33,2	11,9	35,8	
6	1 000	35	35	24	31	32	26	30,5	4,6	15,1	
7	1 200	45	40	40	22	40	54	40,2	10,4	26,0	
8	1 400	115	74	78	68	72	56 (8 + 48)	77,2	20,0	25,9	
9	1 600	107	104	95	112	112	79 (65 + 14)	101,5	12,7	12,5	
10	1 800	148	124	100	120	140	86	119,7	23,5	19,6	
11	2 000	230	205	208	214	230	206	215,5	11,7	5,4	
12	2 200	180	170	186	190	180	165	178,5	9,5	5,3	
13	2 400	37	10	30	35	44	44	33,3	12,6	37,9	
14	2 600	70	27	70	54	70	76	61,2	18,3	29,9	
15	2 800 (month)	0 (closed)	0 (closed)	0 (closed)	0 (closed)	0 (closed)	18	3,0	7,3	244,9	
$\bar{x}$		76,7	60,8	63,1	63,0	69,9	61,7	65,9			
s		65,7	62,4	62,1	66,4	67,0	55,9				
V%		85,7	102,6	98,3	105,4	95,8	90,7				

TABLE NN9/IX

LATERAL STABILITY

NONOTI NN9

Station	Approx. distance along 1976 river course (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	21.08.67	03.06.73	14.05.76					
1	0	13	.7.	13	18	16	16	11	13,8	3,9	28,0	
2	200	25	13	11	20	16	10.	15	15,8	5,8	36,5	
3	400	17	16	13.	30	22	21	17	19,8	6,0	30,2	
4	600	31	29	14.	33	26	36	22	28,2	7,7	27,4	
5	800	27	30	16	26	15.	20	15	22,3	6,2	27,8	
6	1 000	24	25	14.	20	20	16	11	19,8	4,3	21,7	
7	1 200	32	35	24.	30	24.	27	11	28,7	4,5	15,5	
8	1 400	68	50	45	50	38.	55,3	30	51,1	10,1	19,9	
9	1 600	65	65	48.	68	66	53,3	20	60,9	8,2	13,4	
10	1 800	88	66	65	80	70	55,2.	32,8	70,7	11,7	16,5	
11	2 000	115	121	104.	125	115	120	21	116,7	7,3	6,2	
12	2 200	100.	108	100.	102	105	108	8	103,8	3,7	3,6	
13	2 400	32	43	40	33	32	22.	21	33,7	7,3	21,8	
14	2 600	54	70	55	50	50	38.	32	52,8	10,4	19,6	
15	2 800 (mouth)	N.R.	N.R.	N.R.	N.R.	N.R.	9	0	9,0	0	0	
$\bar{x}$		49,4	48,4	40,1	48,9	43,9	40,5	17,8	43,1		19,2	
s		32,8	34,4	31,8	33,2	33,2	33,8	9,2	45,2		10,3	
V%		66,5	71,0	79,1	67,8	75,6	83,4	51,8			53,7	

Average lateral displacement 1937-76 = 17,8 m

Average coefficient of variation 1937-76 = 19,2%

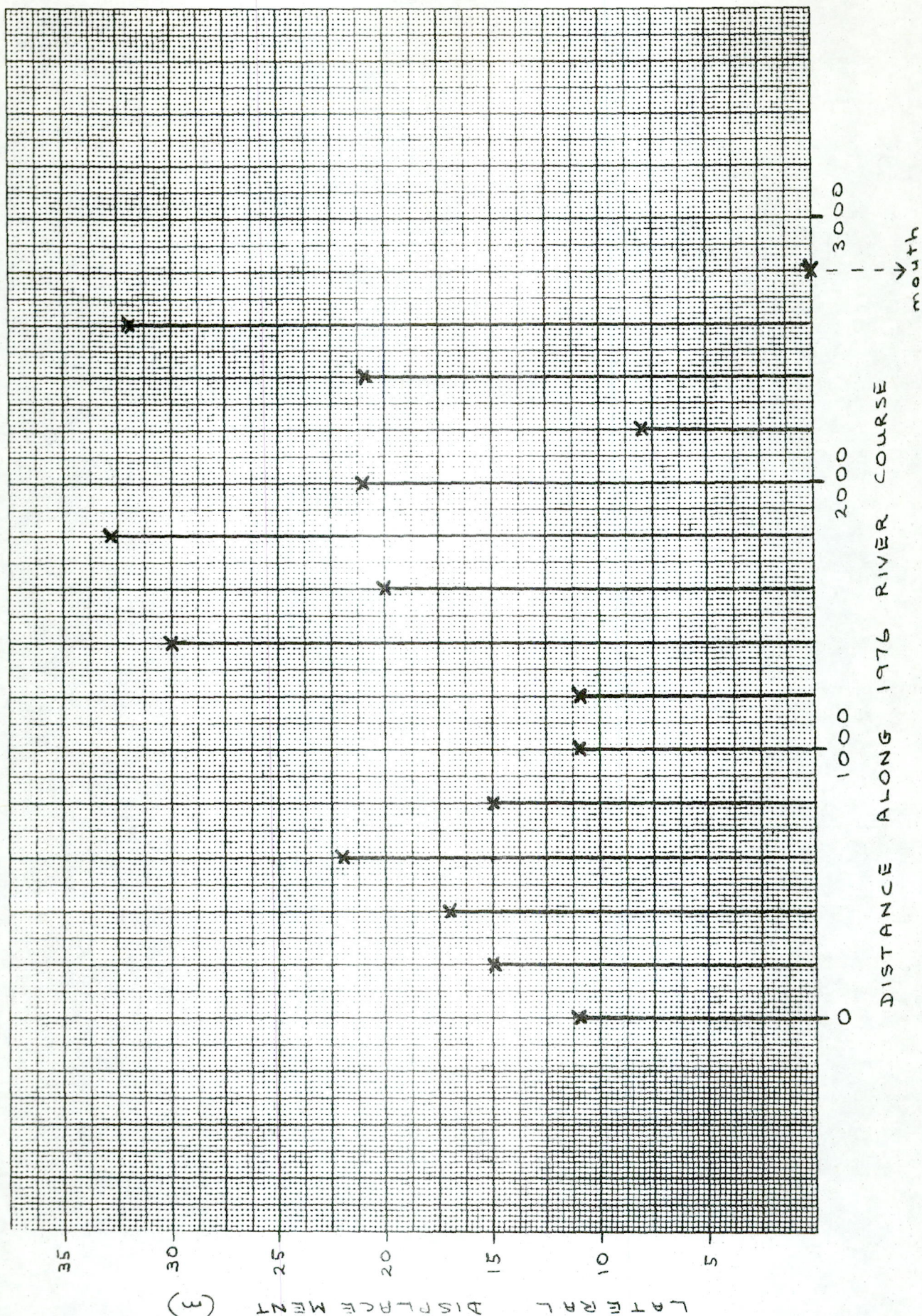
TABLE I. SIMULATED RUN-OFF FOR NONOYI

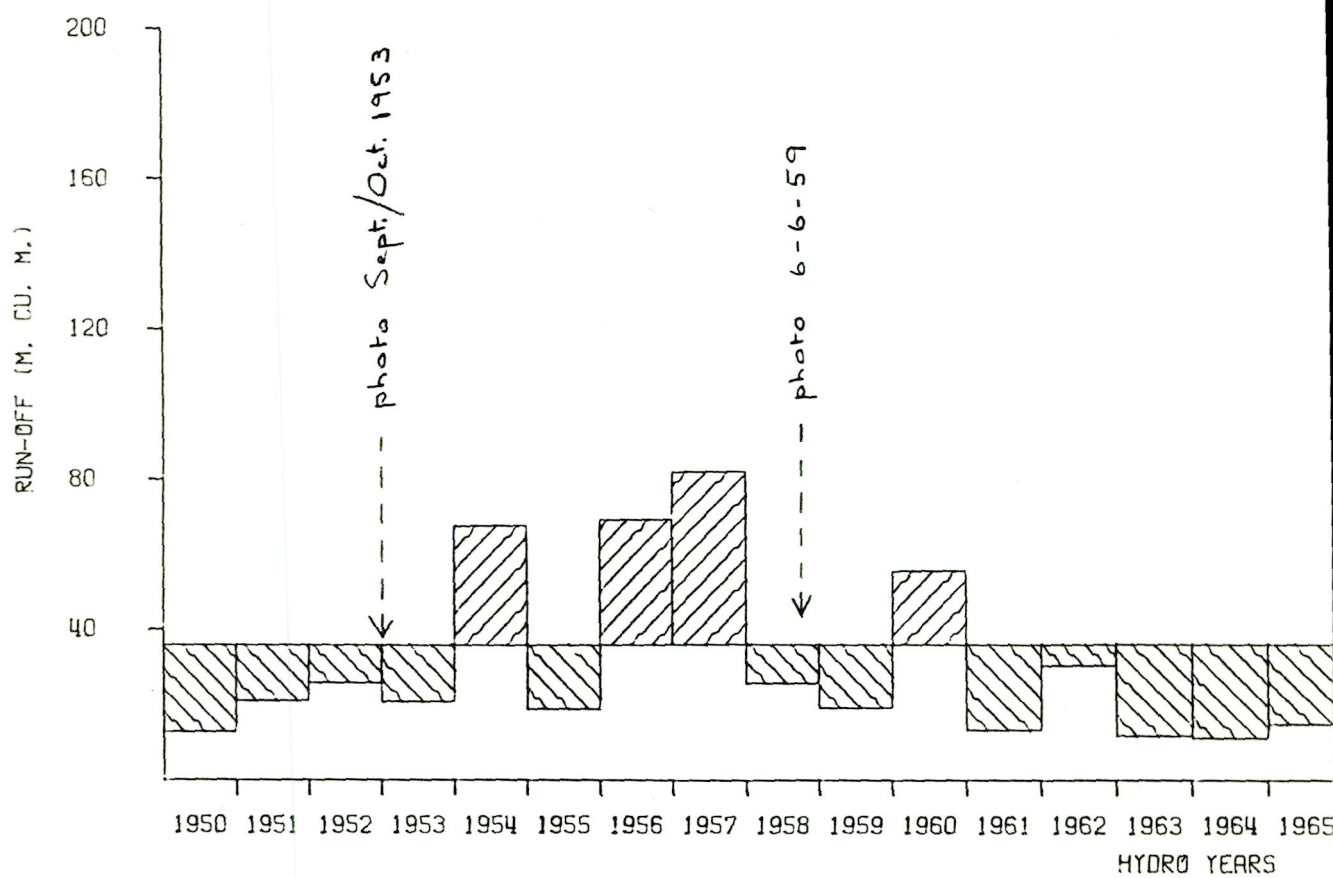
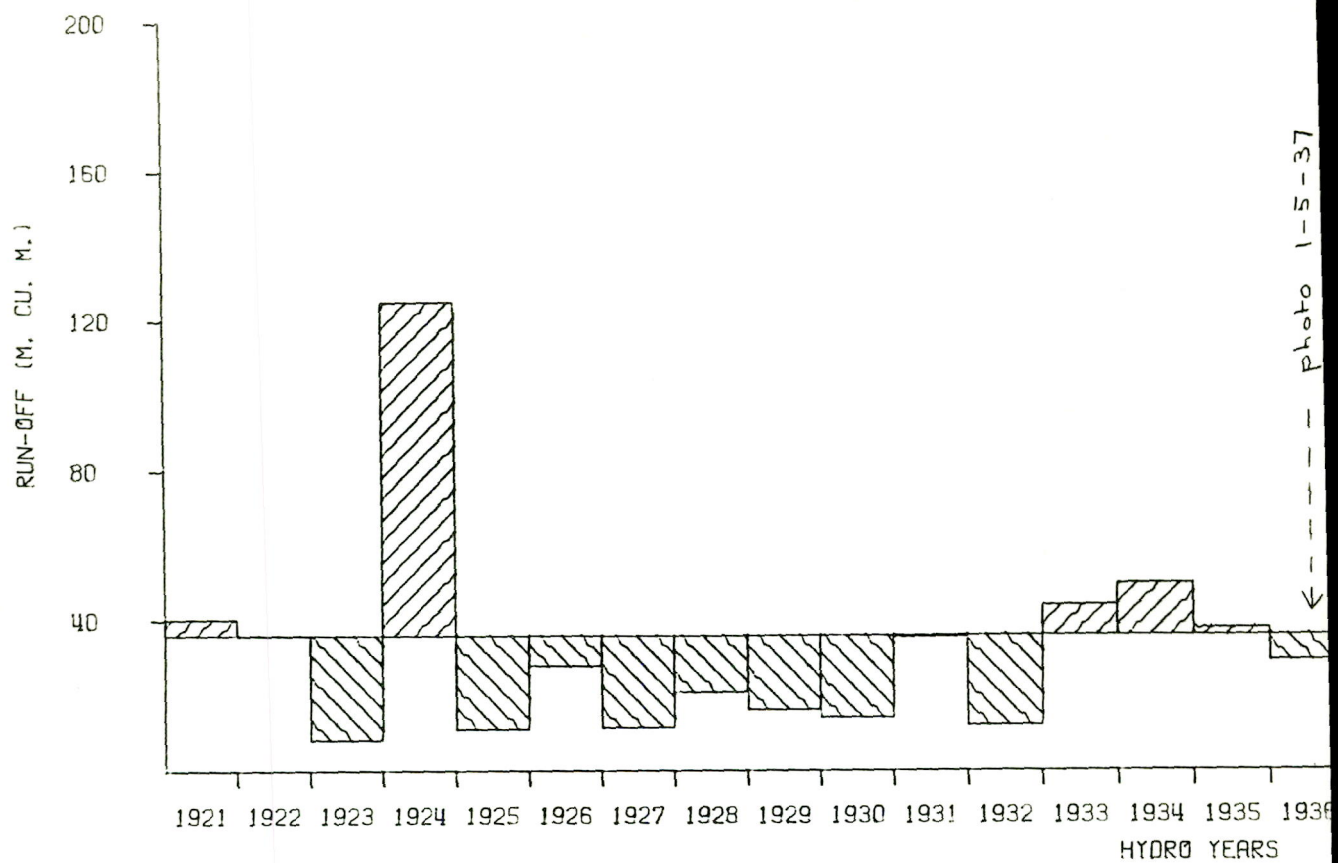
CATCHMENT AREA = 210.0 SQ. KM.

•
•
•
•
•
•
•

TABLE NN9/X SIMULATED RUN-OFF FOR NONOTI													CATCHMENT AREA												SM.A.P.	
YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL	SM.A.P.												
1921	71	7.92	17.08	5.98	1.20	1.17	1.03	.94	1.05	.93	1.02	1.08	40.15	112.29												
1922	122	2.08	2.06	17.15	7.29	2.00	1.41	.83	.49	.43	.35	.35	35.73	99.94												
1923	131	.39	.62	.85	1.02	1.03	.94	.85	.64	.45	.38	.27	8.10	22.64												
1924	107	14.64	15.19	5.23	2.16	58.07	21.25	2.23	1.49	1.12	.88	1.27	124.60	348.47												
1925	1.95	1.77	1.31	1.03	.82	.90	.83	.55	.50	.51	.39	.49	11.06	30.94												
1926	1.19	1.90	1.90	1.42	1.29	11.38	4.97	1.18	.74	.59	.55	.46	27.57	77.11												
1927	.56	.62	.89	1.64	1.88	1.63	1.27	1.88	.56	.39	.35	.59	11.26	31.50												
1928	.86	.91	.79	1.86	1.77	1.66	1.67	1.27	.91	1.05	.98	.98	20.72	57.94												
1929	1.40	1.85	1.74	.82	1.04	7.43	3.75	1.19	.91	.59	.57	.91	16.07	44.94												
1930	1.29	1.88	1.91	1.88	1.87	1.59	1.28	.88	.53	.39	.33	.26	14.10	39.43												
1931	.36	.52	.80	1.08	10.53	12.98	4.43	1.45	1.24	.87	.55	.44	35.27	98.65												
1932	.64	1.05	1.64	1.65	1.41	1.34	1.25	.92	.57	.53	.44	.44	11.96	33.44												
1933	.46	1.24	4.07	12.59	5.26	7.38	4.85	2.52	1.71	1.22	1.20	1.13	43.64	122.03												
1934	1.12	1.45	15.00	6.37	1.73	1.95	1.91	1.56	10.74	5.03	1.55	1.05	49.45	138.28												
1935	.89	.82	.82	1.37	11.03	11.59	4.01	1.93	1.98	1.45	.90	.69	37.49	104.84												
1936	.92	13.96	5.92	1.23	1.38	1.51	1.17	.77	.56	.54	.49	.41	28.86	80.71												
1937	.48	.63	1.27	6.08	7.64	3.07	1.66	1.33	1.04	1.12	1.09	.78	25.99	72.69												
1938	.98	1.41	9.64	4.78	10.31	4.81	1.64	1.47	1.28	1.02	.84	1.13	39.30	109.91												
1939	1.44	9.98	12.38	3.99	2.17	1.91	1.59	14.50	8.97	2.88	1.27	1.15	59.29	165.80												
1940	1.27	1.65	9.28	5.21	1.25	1.07	1.46	1.47	.98	.67	.49	.52	28.41	79.47												
1941	.73	1.02	.94	1.08	1.53	9.28	4.46	1.60	1.24	1.04	1.01	1.21	25.13	70.27												
1942	1.72	10.11	23.29	8.28	2.04	8.32	26.05	9.41	1.69	4.10	1.32	6.54	117.87	329.65												
1943	14.44	12.34	4.07	1.41	1.38	1.87	1.69	1.07	.94	.81	.81	1.37	42.40	118.57												
1944	2.05	2.08	97.85	30.99	1.93	15.01	6.20	1.20	.72	.46	.32	.24	149.03	416.78												
1945	.24	.27	.34	.69	1.14	1.41	1.26	.88	.59	.42	.31	.30	7.86	21.97												
1946	.85	11.93	5.71	8.85	6.81	11.89	5.17	1.65	1.31	1.22	.91	.76	57.05	159.56												
1947	.82	4.75	3.89	2.52	1.86	2.01	2.25	1.79	1.15	.75	.53	.41	22.72	63.54												
1948	.65	1.02	1.07	1.16	2.42	2.38	2.32	2.03	1.39	.95	.70	.60	16.68	46.66												
1949	.93	1.79	10.23	4.66	1.66	4.61	3.06	1.80	1.21	.78	.68	.62	32.03	89.58												
1950	.49	.40	.97	1.67	1.44	1.13	1.01	.88	.77	.63	1.29	2.10	12.70	35.73												
1951	2.21	1.67	1.72	4.37	2.63	1.55	1.34	1.46	1.44	1.15	.90	.62	21.08	58.95												
1952	.50	.84	1.17	2.80	11.64	4.87	1.15	.76	.55	.39	.41	.55	25.65	71.74												
1953	.69	.98	1.16	1.32	4.59	2.94	2.03	2.11	1.76	1.23	.87	1.18	20.85	58.32												
1954	.59	1.04	5.04	10.13	4.70	1.84	1.95	1.70	1.18	.79	.52	.45	67.16	187.82												
1955	.25	.59	1.26	.79	2.08	5.84	3.16	2.85	.86	.62	.61	.80	18.98	53.09												
1956	6.20	1.25	28.46	11.17	2.21	2.17	5.18	2.85	1.15	.78	.69	11.83	68.70	192.13												
1957	16.95	6.20	5.80	16.03	16.92	5.57	7.45	3.67	1.20	.73	.44	.59	81.57	228.12												
1958	.74	1.13	3.18	2.41	3.65	2.21	1.05	4.83	2.94	1.26	1.04	1.01	25.47	71.22												
1959	1.37	1.82	1.90	1.48	1.35	1.80	3.84	2.45	1.20	.79	.62	.62	13.22	53.76												
1960	.86	1.62	11.54	12.19	4.26	1.97	12.48	5.34	1.50	1.30	1.00	1.08	55.13	154.17												
1961	1.37	1.49	1.50	1.57	1.42	1.37	1.28	.94	.59	.40	.50	.73	30.19	84.42												
1962	1.02	1.63	2.11	7.60	3.64	3.99	2.79	1.57	1.27	1.74	1.77	1.13	30.19	84.42												
1963	.87	1.04	.93	2.11	1.83	1.12	.95	.78	.56	.52	.47	.45	11.62	32.50												
1964	.85	1.19	1.26	1.05	.89	.70	.49	.40	.68	1.01	1.23	1.44	11.21	31.34												
1965	1.52	1.74	1.80	1.99	2.04	1.36	.87	.84	.78	.63	.55	.57	14.69	41.09												
1966	.67	.84	1.04	3.10	2.39	13.39	6.00	1.69	1.03	.76	.60	.43	31.98	89.44												
1967	.53	1.14	1.38	1.42	1.36	1.34	1.42	1.09	.67	.44	.53	.74	12.12	33.91												
1968	.87	.99	1.49	1.66	1.62	18.01	7.48	1.94	.98	.70	.65	.38	38.07	106.46												
1969	1.66	1.49	1.53	1.26	.42	.69	.51	.49	.50	.43	.46	.89	10.31	28.82												
1970	1.46	1.54	1.68	1.96	2.16	1.99	1.60	1.89	1.88	1.57	1.65	1.51	20.91	58.47												
1971	1.38	1.33	1.72	1.85	1.97	2.11	1.65	1.34	.94	.73	.52	.52	16.80	46.99												
1972	.46	.74	.85	1.07	4.14	2.79	1.75	1.31	.82	.54	.66	1.38	16.54	46.24												
1973	1.83	1.72	1.50	15.59	6.84	2.23	1.96	1.47	1.02	.76	.57	.39	35.86	100.30												
1974	.29	.54	.76	7.19	5.52	5.74	1.46	1.06	.64	.40	.28	1.02	34.80	97.33												
1975	1.59	5.96	16.61	26.16	18.42	28.67	9.98	1.79	1.16	.70	.48	.50	112.02	313.27												

	1.44	3.10	7.19	5.12	3.90	5.61	3.55	1.93	1.38	.44	1.00
MEAN	3.84	4.20	12.40	6.31	4.23	8.98	4.67	2.24	1.74	.44	2.1
S	204.11	135.65	200.97	123.14	104.25	140.11	131.37	116.04	126.47	85.44	209.5
V	COMPILED FROM HRU REPORT NO. 9/H1 DATA										
MEAN ANNUAL RUN-OFF=	35.76 MILLION CUBIC METERS.										

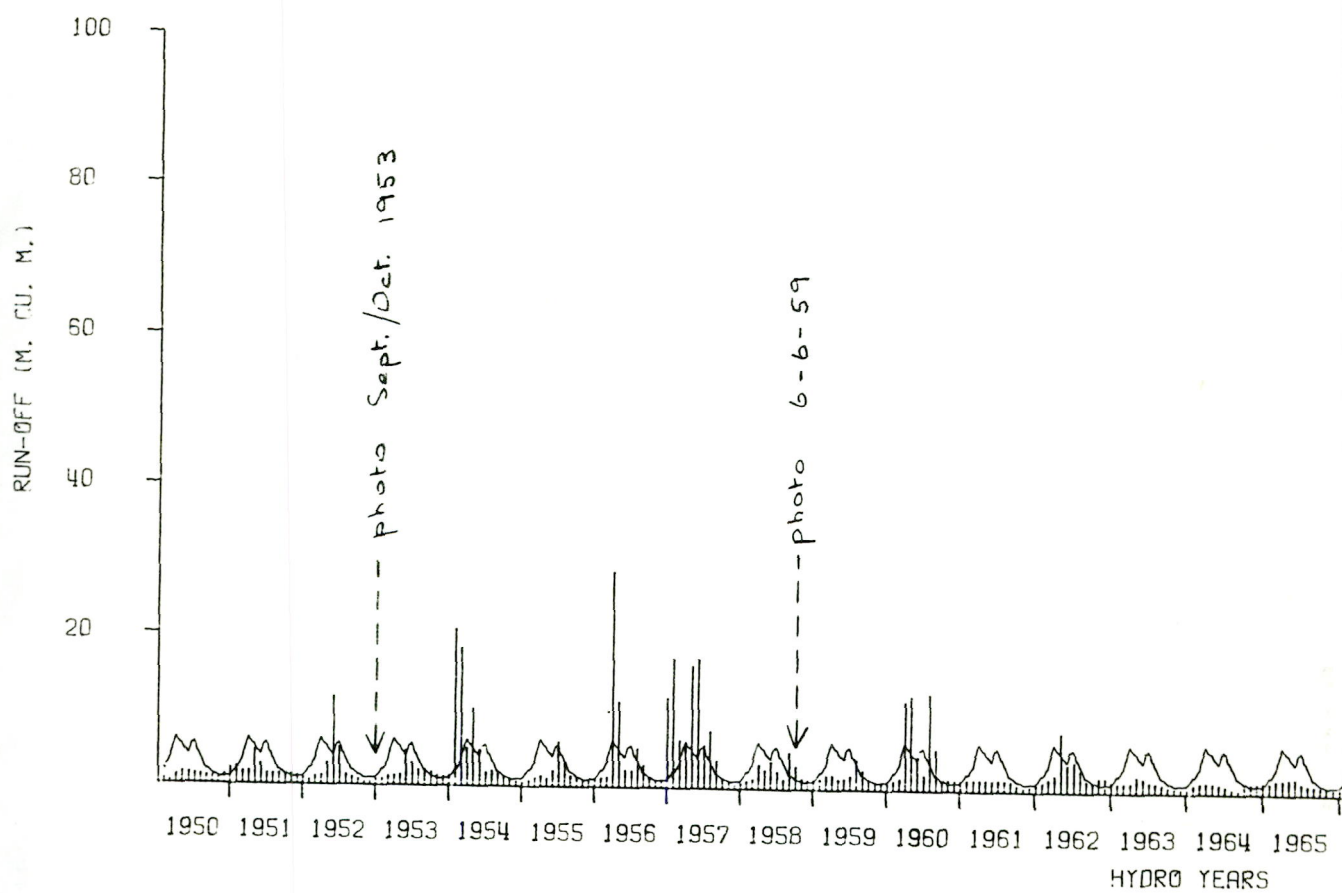
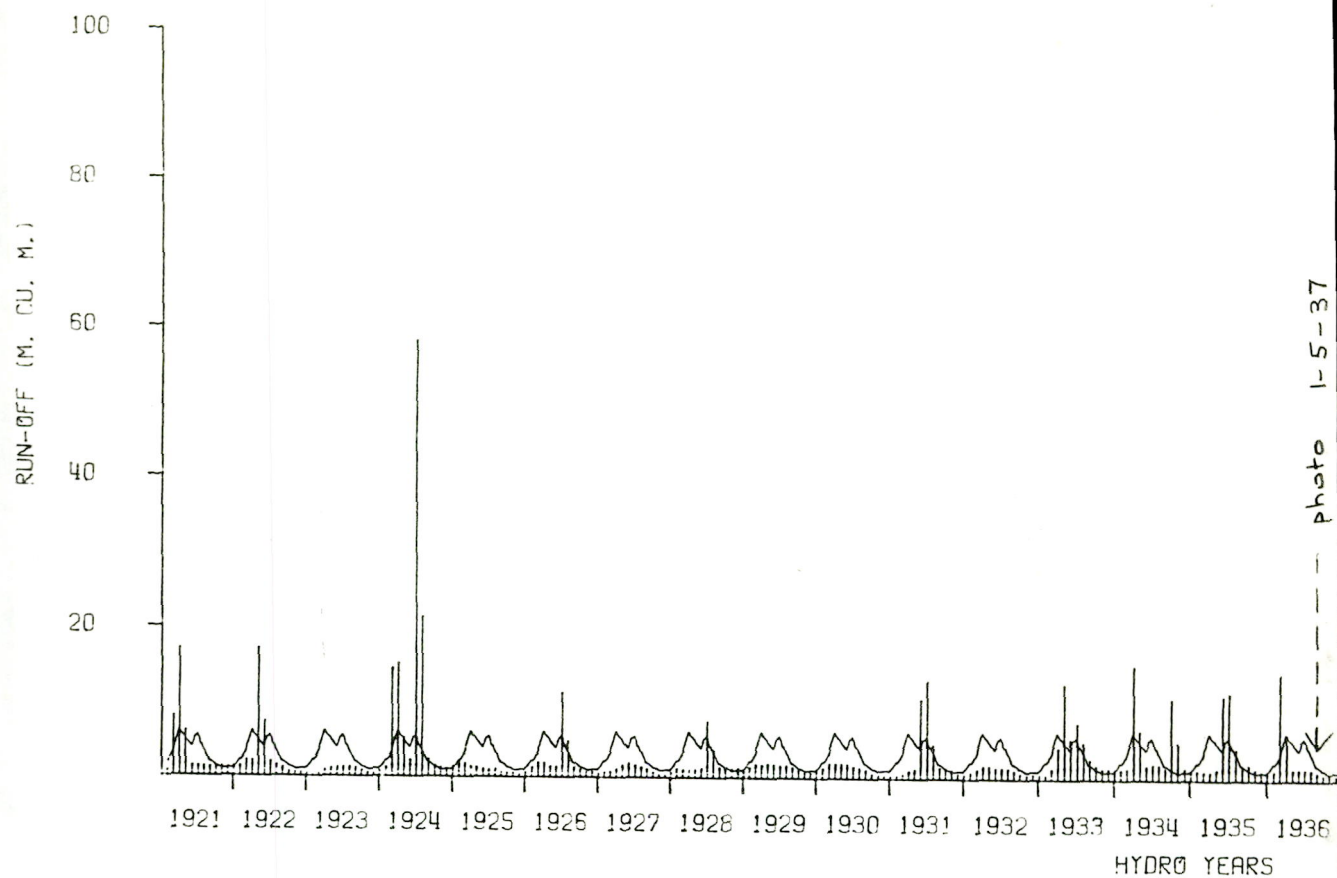




TRACED : COMPILOT
 CHECKED:
 DATE :
 REF. :

NATAL ESTUARIES : NONOTI
 SIMULATED ANNUAL RUN-OFF
 1921-1975

FIGURE
 NN 9/2



TRACED : COMPLETE

CHECKED :

DATE :

REF. :

NATAL ESTUARIES : NONOT!

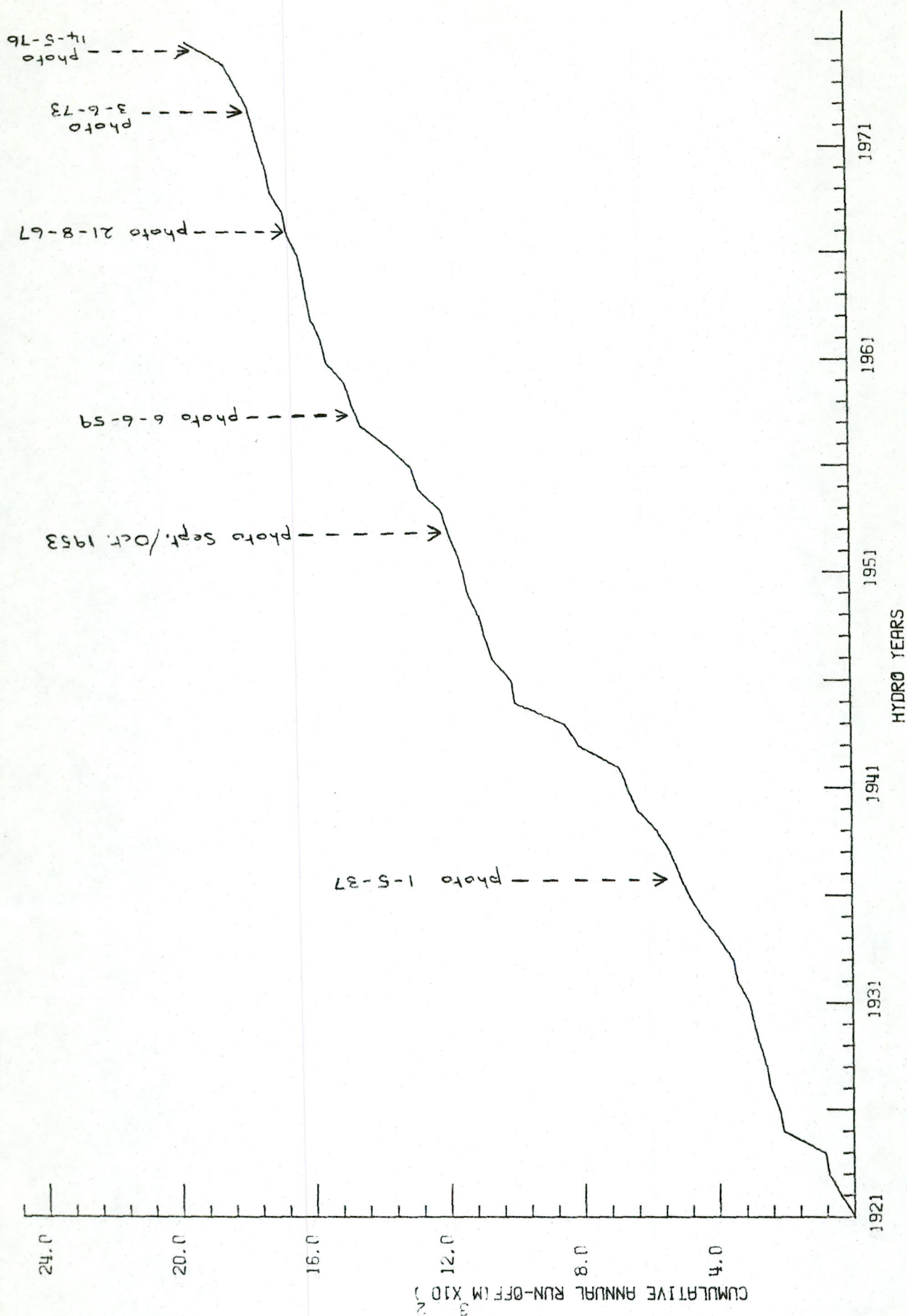
SIMULATED MONTHLY RUN-OFF

1921-1975

FIGURE

NN 9/3

NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY



TRADED : COMLOT

CHECKED :

DATE :

REF. :

NATAL ESTUARIES: NONOTI

CUMULATIVE ANNUAL RUN-OFF

FIGURE

NN9/4



SCALE: 1:10 000 approx.

TRACED DD
CHECKED:
DATE:
REF.:

NATAL ESTUARIES: NONOTI

14-5-76

(1-5-37 RIVER COURSE SUPERIMPOSED)

PHOTOGRAPH

NN9/1

NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY



SCALE: 1:10 000 approx

TRACED: DD
CHECKED:
DATE:
REF.:

NATAL ESTUARIES: NONOTI

1-5-37 (12h05)

PHOTOGRAPH

NN9/ 2

NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY



553

SCALE: 1:10 000 approx.

TRACED: DD
CHECKED:
DATE:
REF.:

NATAL ESTUARIES: NONOTI
SEPT./OCT. 1953 (11h05)

PHOTOGRAPH
NN9/ 3

NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY



SCALE: 1:10 000 approx

TRACED: DD
CHECKED:
DATE:
REF:

NATAL ESTUARIES: NONOTI

6-6-59 (11h23)

PHOTOGRAPH

NN9/4

NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY



SCALE: 1:10 000 approx.

TRACED DD
CHECKED:
DATE:
REF:

NATAL ESTUARIES: NONOTI

21-8-67 (11h40)

PHOTOGRAPH

NN9/5

NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY



SCALE: 1:10 000 approx.

TRACED DD

CHECKED:

DATE:

REF.:

NATAL ESTUARIES: NONOTI

3-6-73 (12h04)

PHOTOGRAPH

NN9/6

NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY



SCALE: 1:10 000 approx.

TRACED DD
CHECKED:
DATE:
REF.:

NATAL ESTUARIES: NONOTI

14 - 5 - 76 (10h00)

PHOTOGRAPH

NN9/7

NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY



SCALE: 1:10 000 approx

TRACED: DD
CHECKED:
DATE:
REF.:

NATAL ESTUARIES: NONOTI

3-6-73 (ORTHOPHOTO)

PHOTOGRAPH

NN9/8

NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY