

TRAINING OF FULTA JAMES AND MARY REACH OF HOOGHLY

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Fulta James and Mary Reach

PREFACE

The maintenance of 100 mile long approaches to the port of Calcutta has engaged the attention of the Port Authorities since the middle of the 19th century. Consequent on the increase of size of the vessels and their draughts, the problem of improving the navigability of the river Hooghly became more acute than in olden days. Port Commissioners sought the advice of various recognised experts. They were generally of the opinion that the James and Mary Reach was a bottleneck in the way of navigation. In 1947, Sir Claude Inglis, whom the Port Commissioners consulted, advised them to investigate the measures for improving the navigability of the river Hooghly by hydraulic model studies. The problem was, therefore, referred to the Central Water & Power Research Station in May 1947.

The memorandum gives a resume of model studies conducted to evolve an optimum solution for the improvement of the Fulta James and Mary Reach. These investigations were conducted on a hydraulic model of the Hooghly extending from the Sand Heads to Bansbaria at the field laboratory of the CWPRS.

The authors gratefully acknowledge the help of Shri A S Maik, B Sc, in conducting the model tests.

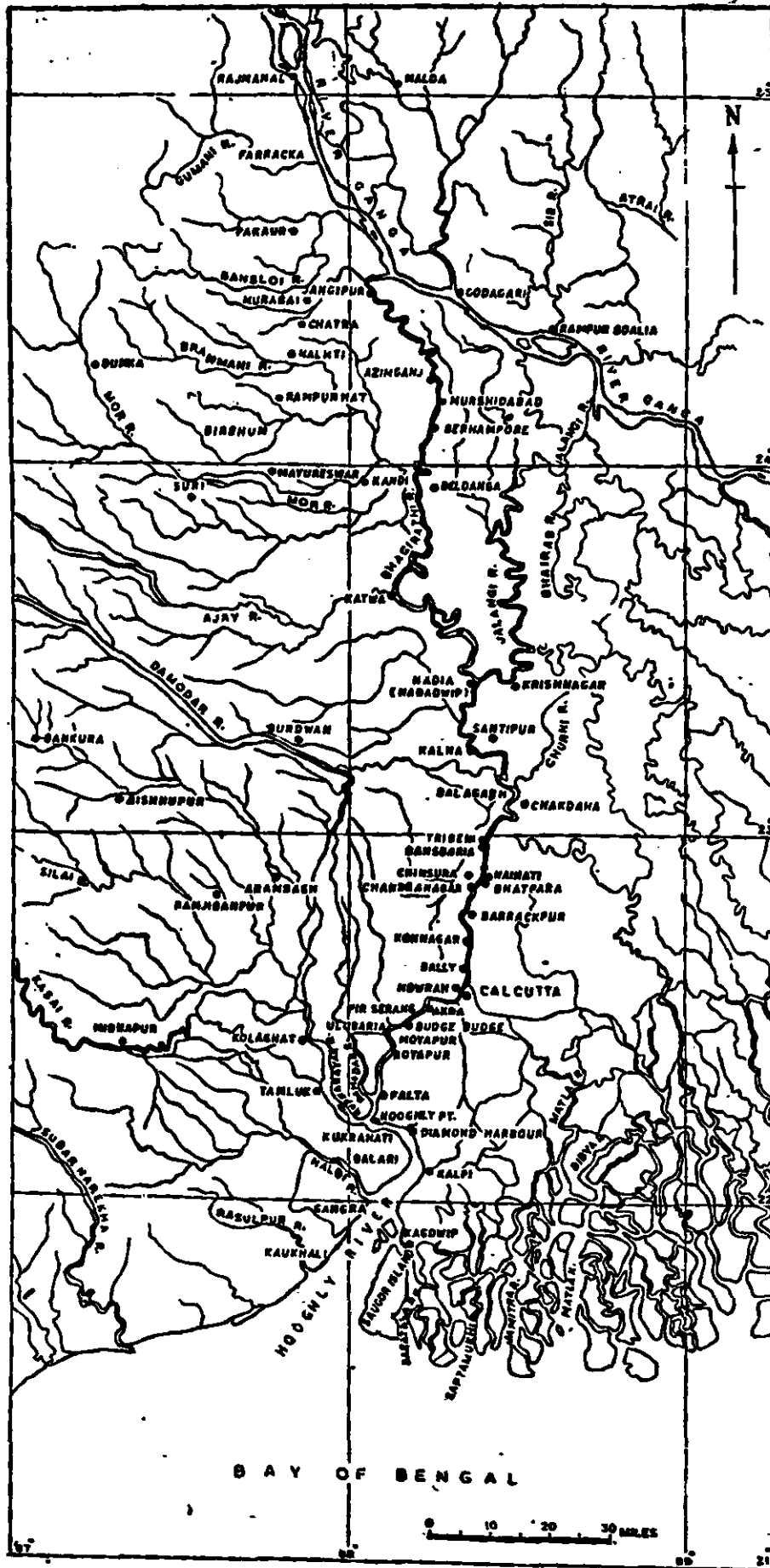


Fig 1 : Index Plan

APPENDIX I

Design of scale ratios of the Model of Hooghly River from Bansbaria to Reefs 25 miles below Saugor

The model of the Hooghly Estuary covers a reach of 115 N miles from Bansbaria down to Reefs 15 miles below the Saugor Light House. The object of model experiments is to investigate the means of improving the navigability of the river.

Length scale ratio: Considering the area available immediately, the length scale of 1/2000 suggested by Sir Claude Inglis is suitable and is adopted.

Depth scale ratio: Sir Claude Inglis had proposed a depth scale of 1/160; presumably this was based on Lacey's formula which gives

$$\text{depth scale} = (\text{length scale ratio})^{2/3} = 1/158$$

However, it was expedient to examine the choice of depth scale ratio from the view point of bed movement, turbulence etc.

Table 3 gives the computations for Allen's criterion for different depth scales at various sections along the river from Saugor to Calcutta. First row gives 'h', the depth; second computed velocity; and the third the Reynold's number. Computed velocity was worked out by Dr Jack Allen's formula

$$V = 1.3(F - F')^{.27} L^{.27} M^{-.27} h^{.23}$$

where

- V = velocity in ft/sec
- F = specific gravity of sand used in the model
- F' = specific gravity of water assumed unity in this case
- L = length of the side of a cube having the same weight as the average grain (inches)
- M = uniformity modulus of material
- h = depth of water in inches

The average grain size was taken to be the weighted mean diameter of the Ninan sand viz .094 mm with which the model bed was proposed to be moulded. Fig 16 shows the sand distribution graph from which the modulus of uniformity of Ninan sand was worked out to be .483.

Comparison of prototype and model values for 1/160 scale shows that bed movement may be expected in the model with this depth scale. It was noted that considering the high computed threshold velocities it may be necessary to go in for a higher exaggeration or material of lower specific gravity, unless on account of curvature effect and consequent velocity distribution satisfactory bed movement was possible. Further considering the availability of discharge it was considered better to work with the depth scale of 1/160 at the outset.

From the tabulated values of Reynold's number it will be seen that in each case turbulent flow in the model was satisfactorily ensured.

Table 4 shows the computations for Reynolds' criterion. It will be seen that except in the case of the depth scale of 1/80 Gibson's criterion of $h^3 \sqrt{H/30} \geq 0.09$ was not satisfied. However, in the light of experience of other tidal models it was likely that the depth scale of 1/160 may give satisfactory results.

TABLE 3

		: Prototype	: Model values for depth scale			
		: values for	:	:	:	:
		: maximum	: 1/80	: 1/120	: 1/160	: 1/200
		: flood	:	:	:	:
SAUGOR	h	25' 0"	3.756"	2.496"	1.884"	1.500"
	V (ft/sec)	5.2	.513	.467	.443	.416
	*R x 10 ⁻⁵	130.0	.1666	.0971	.0695	.0520
GANGRA	h	26' 1"	3.912"	2.616"	1.956"	1.572"
	V (ft/sec)	7.41	.520	.472	.442	.420
	R x 10 ⁻⁵	193.29	.1695	.1092	.0720	.0550
BALARI	h	25' 0"	3.756"	2.496"	1.884"	1.500"
	V (ft/sec)	5.4	.513	.467	.443	.416
	R x 10 ⁻⁵	135.0	.1606	.0971	.0695	.0520
HOOGHLY POINT	h	27' 4"	4.116"	2.748"	2.064"	1.644"
	V (ft/sec)	7.5	.524	.478	.447	.424
	R x 10 ⁻⁵	205.0	.1707	.1095	.0769	.0581
KING GEORGE DOCKS	h	35' 0"	5.250"	3.492"	2.628"	2.100"
	V (ft/sec)	10.7	.554	.505	.473	.449
	R x 10 ⁻⁵	374.5	.2426	.1469	.1036	.0786

* Reynold's number

TABLE 4

Depth: h	≡	:	:	:	: Verti-	: Max	: Q in	: Time	: Model
scale: 16.33 ft:	:	:	:	:	: cal	: flood:	model	: scale	: Tidal
: below	: 100h ³ :	e	: h ³ e ^{√H/30} :	Velor	: in	: =	: ratio	: period	:
: Saugor	:	:	:	: city	: model:	50x10 ⁶ :	:	: 12 hrs	:
: (ft)	:	:	:	: ratio	: 10 ⁶ :	cfs	:	: 18 min	:
:	:	:	:	: L/d	: 10 ⁶ :	:	:	: min	:
1/80	.204	.85	25.00	.157	2.80	1/1.43	35.00	1/223	3.30
1/120	.136	.25	16.67	.0307	1.52	1/2.63	19.00	1/183	4.03
1/160	.102	.11	12.50	.0101	.988	1/4.05	12.35	1/158	4.66
1/200	.082	.06	10.00	.00442	.706	1/5.66	8.82	1/141	5.24

* $\sqrt{H/30} = 0.737$

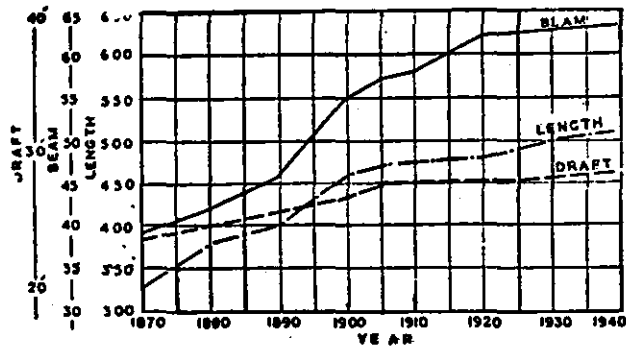


Fig 2: The increase in size of vessels trading with the Port of Calcutta worked out from average of the ten largest ships.

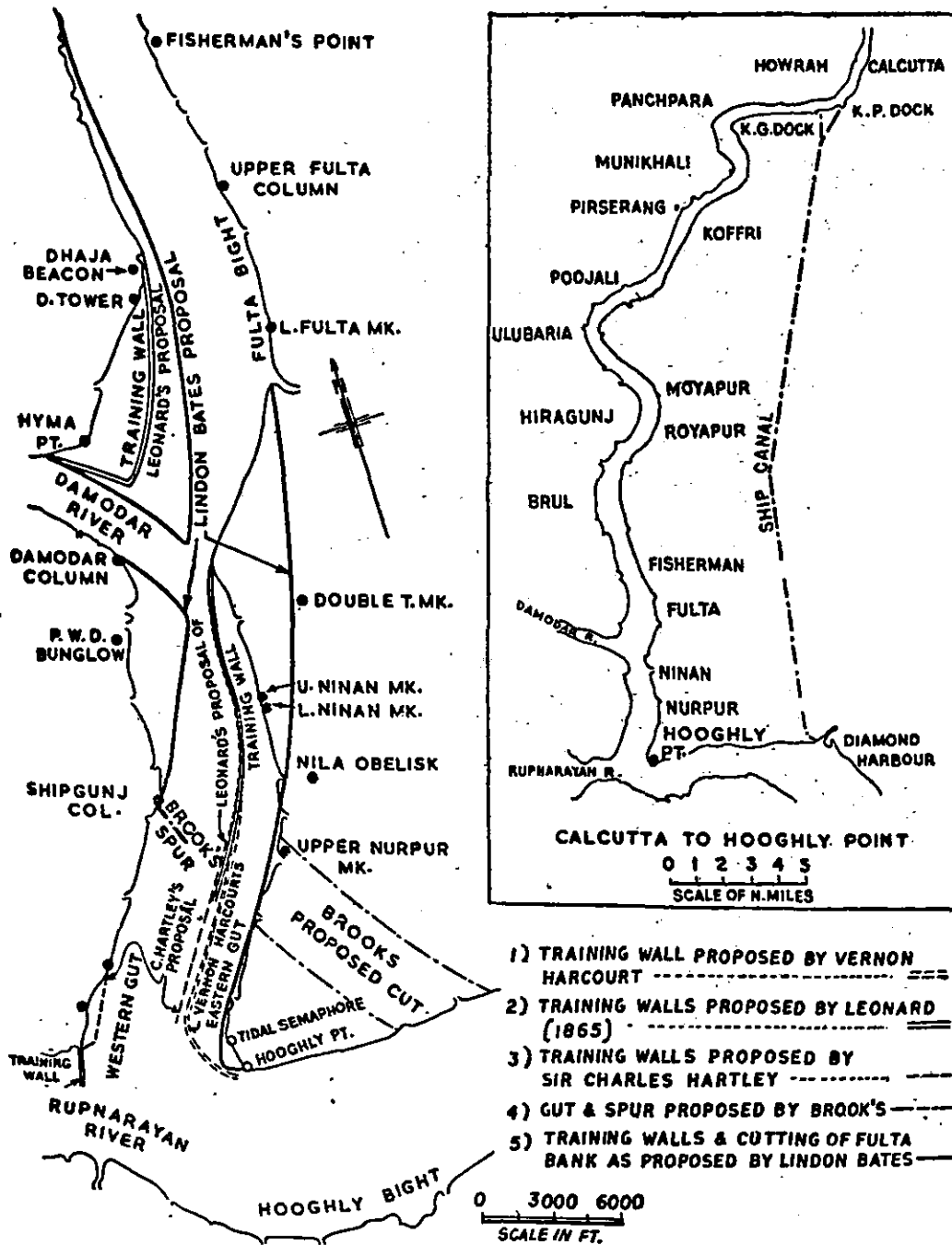


Fig 3: 1/2000 : 1/160 model of the Hooghly estuary showing proposals of experiment in the Fulta Reach.



Photo 1: Flood flow pattern on the last of the flood



Photo 3: Flood eddy between Fort Mornington and Bungalow point

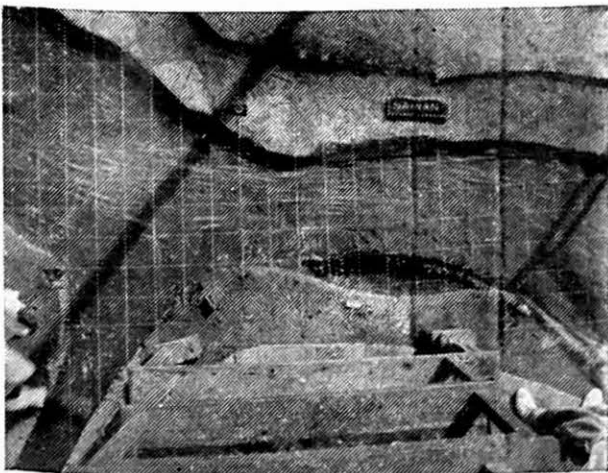


Photo 4: Effect of realigning bank at Shipgunj

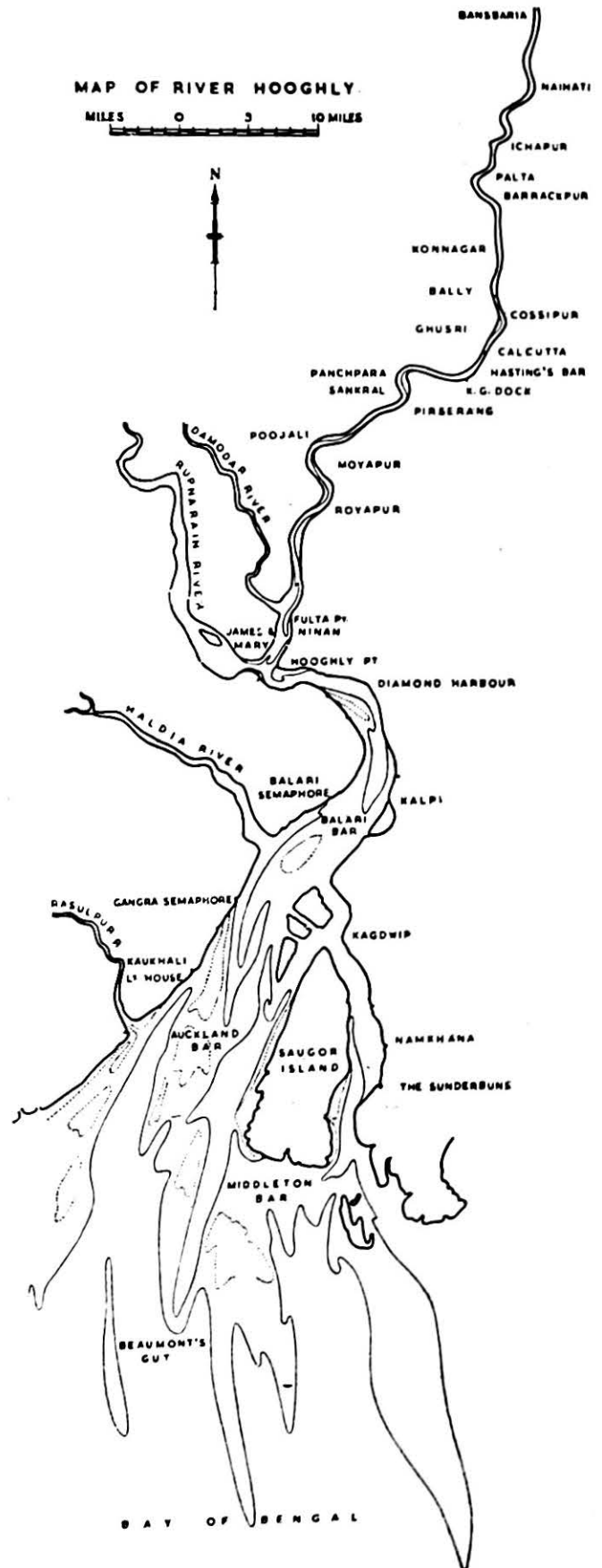


Photo 2: The reach reproduced in the model

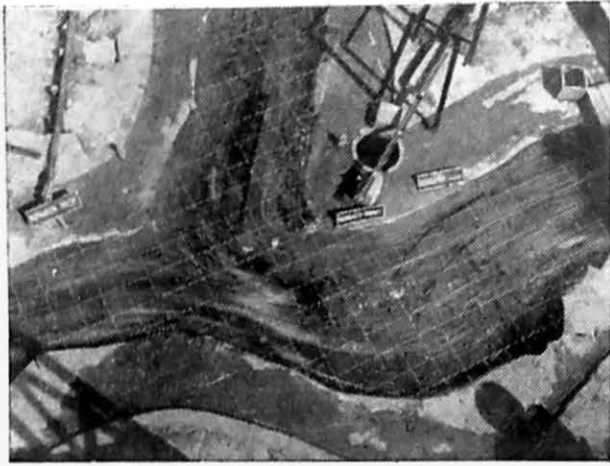


Photo 5: Flood flow pattern 40 seconds (1 hr 45 mts) after making of flood

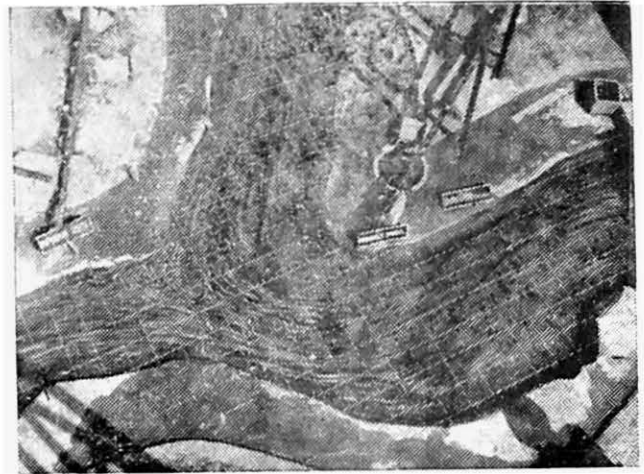


Photo 6: Flood flow pattern 1 m (2 hrs 38 mts) after making of flood



Photo 7: Ebb flow pattern 20 seconds (52 mts) after making of ebb



Photo 8: Ebb flow pattern 1 m (2 hrs 38 mts) after making of ebb

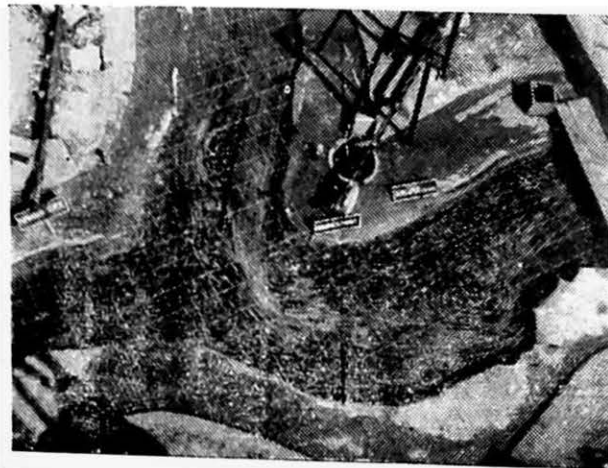
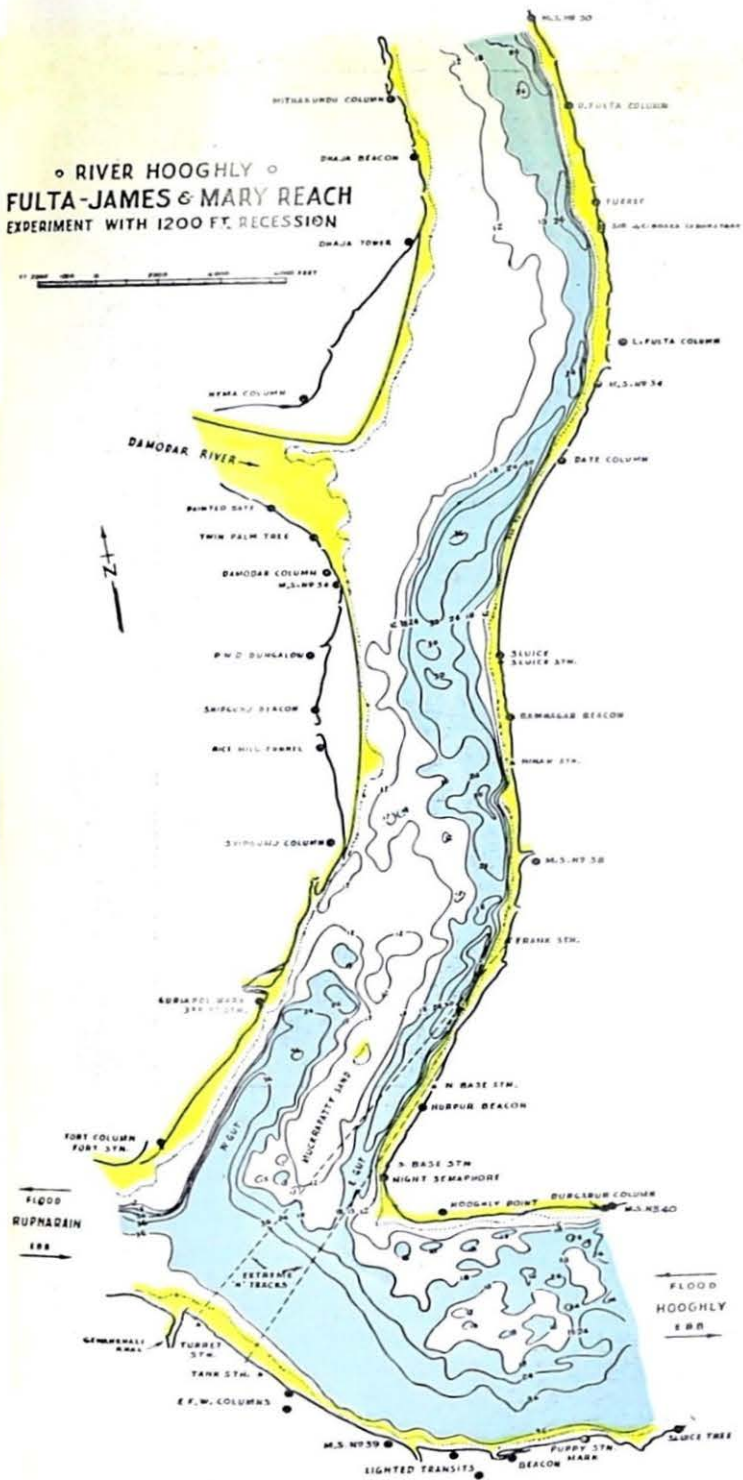
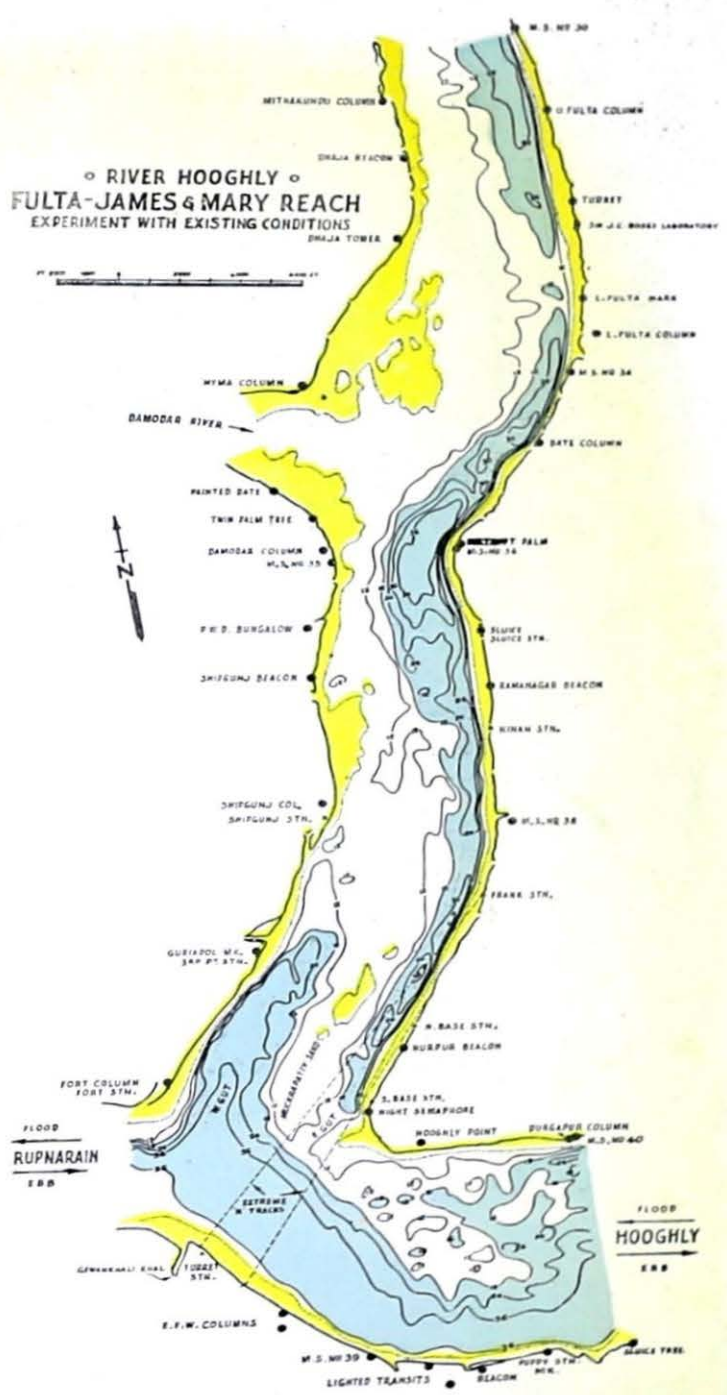


Photo 9: Ebb flow pattern 2 mts and 20 seconds (6 hrs 8 mts) after making of ebb

◦ RIVER HOOGHLY ◦
FULTA-JAMES & MARY REACH
 EXPERIMENT WITH 1200 FT. RECESSION



◦ RIVER HOOGHLY ◦
FULTA-JAMES & MARY REACH
 EXPERIMENT WITH EXISTING CONDITIONS



Photos 10 & 11

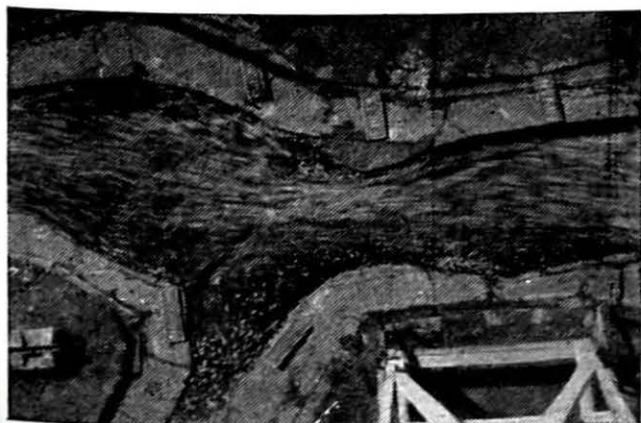


Photo 14: Flood flow pattern with only half tide groynes above and below Damodar outfall



Photo 12 : Flood flow pattern with existing conditions
3 hrs after L W

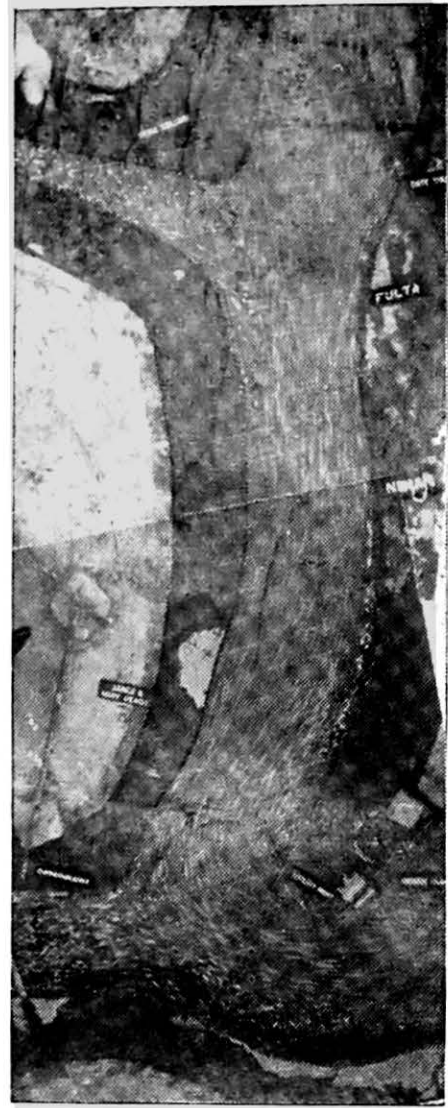


Photo 13 : Flood flow pattern with 1200 ft recessio
and reclamations, 3 hrs after L W



Photo 15 : Flood flow pattern 47.4 mts after L W

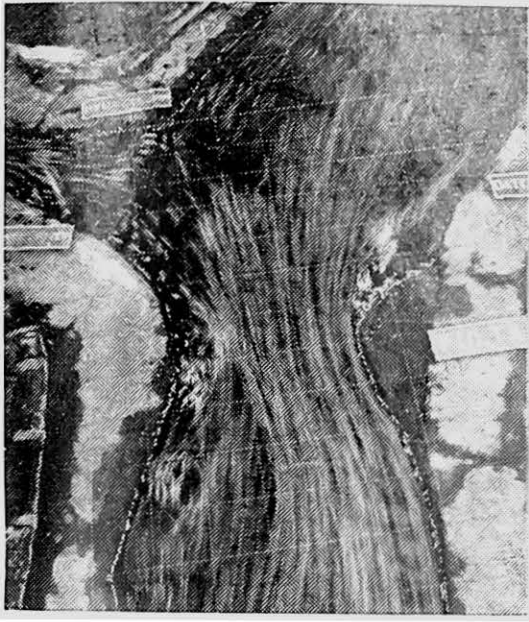


Photo 16 : Flood flow pattern 1 hr 27 mts
after L W



Photo 17 : Flood flow pattern 2 hrs 19.7 mt
after L W



Photo 18 : Flood flow pattern 3 hrs 15 mts
after L W

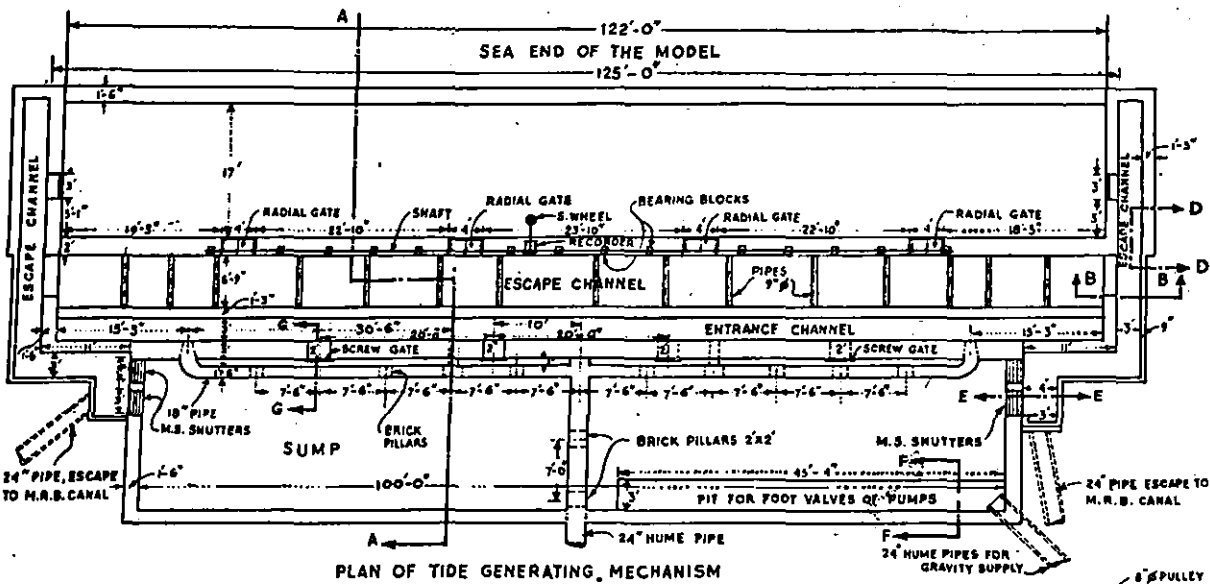
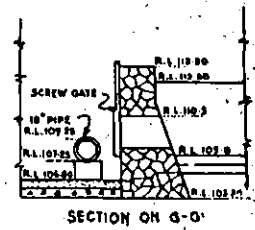
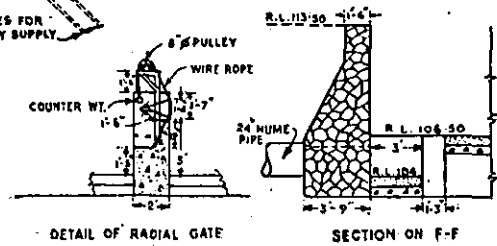
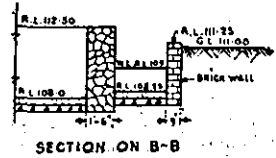
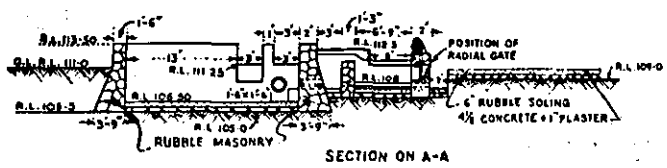
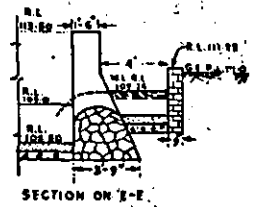
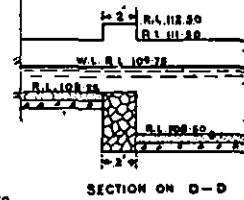


FIG. 4.
TIDE MECHANISM OF
HOOGHLY MODEL

0 6 12 FOR PLAN
0 3 6 FOR SECTIONS
SCALE IN FEET



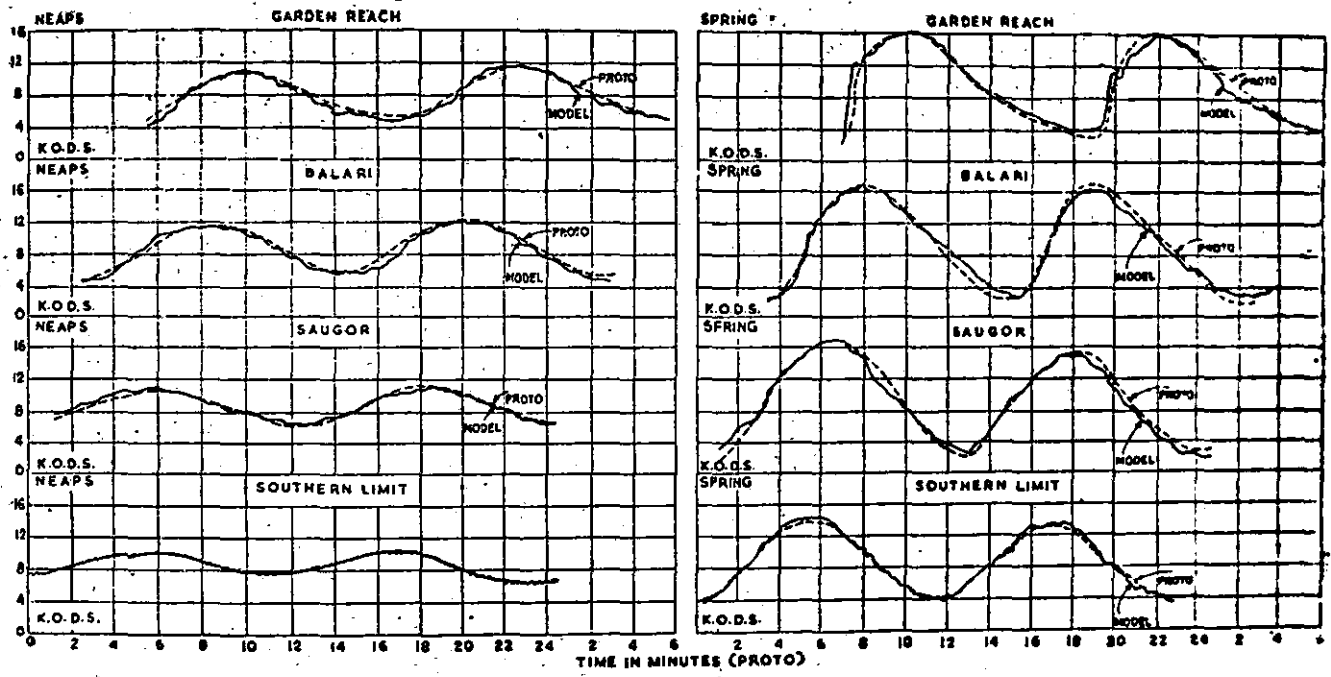


Fig 5: Tides obtained in the model. Semilunation chosen 5th to 19th Feb 1939

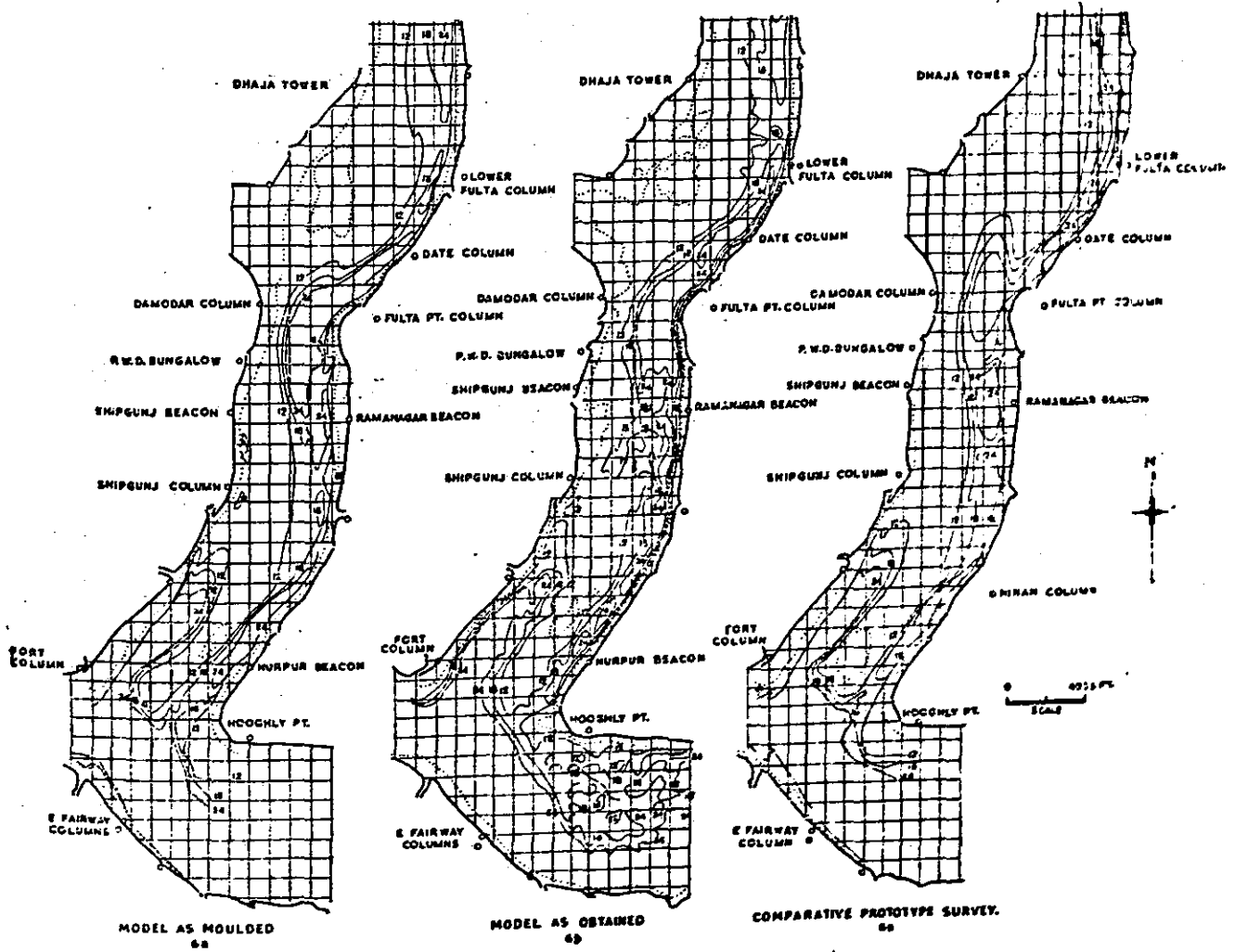
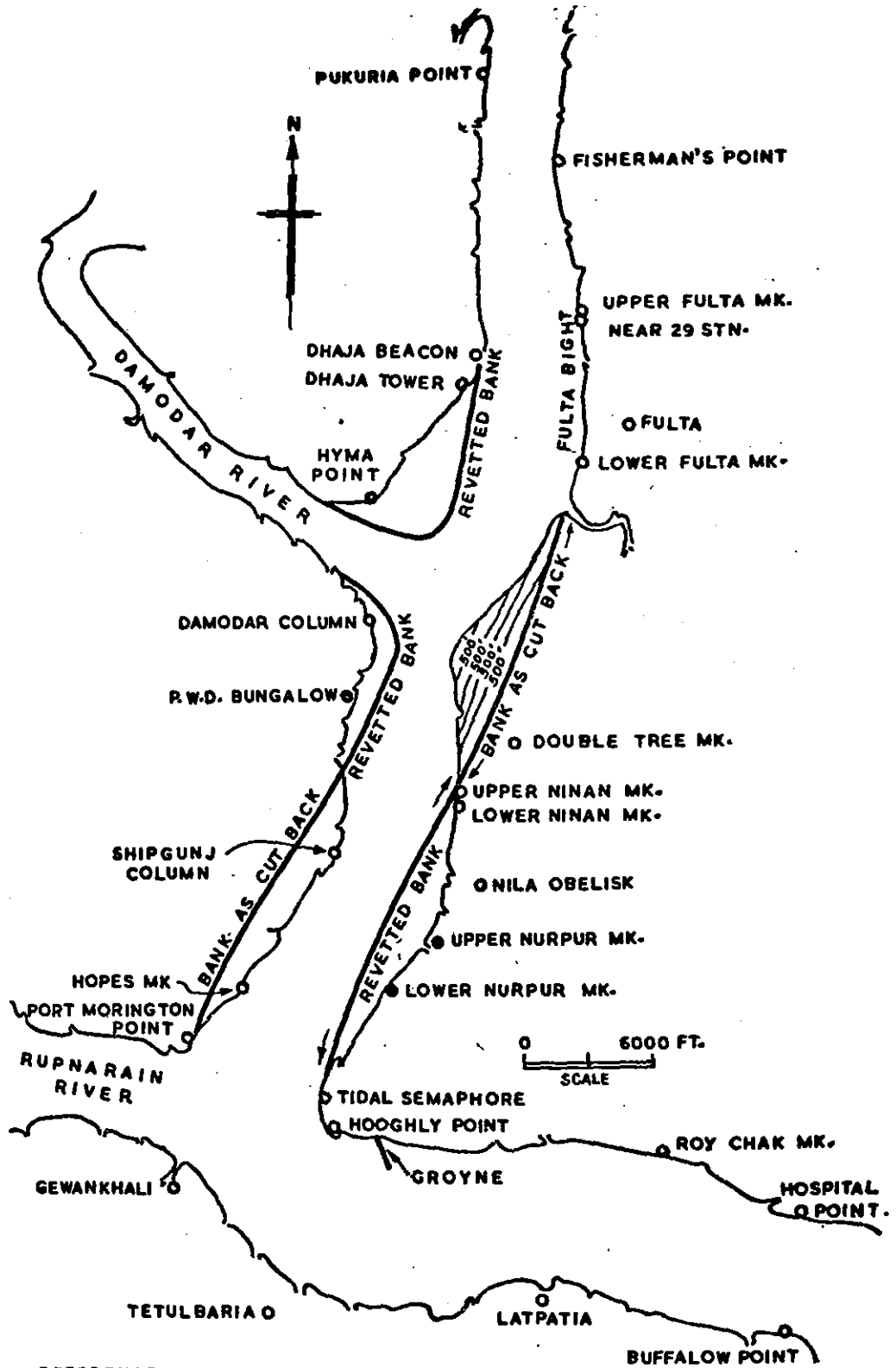


Fig 6 (a, b, c): Comparative model and prototype bed changes



REFERENCE :-
 PROPOSED PARTIAL RECESSION OF FULTA BANK IN STAGES & GROUYNE
 RECESSION OF FULTA POINT WITH CONVEX LEFT BANK BELOW NINAN & CORRESPONDING CONCAVE TO RIGHT BANK

FIG. 7-
 1/2000: 1/160 MODEL
 OF THE HOOGHLY ESTUARY SHOWING PROPOSALS OF EXPERIMENTS

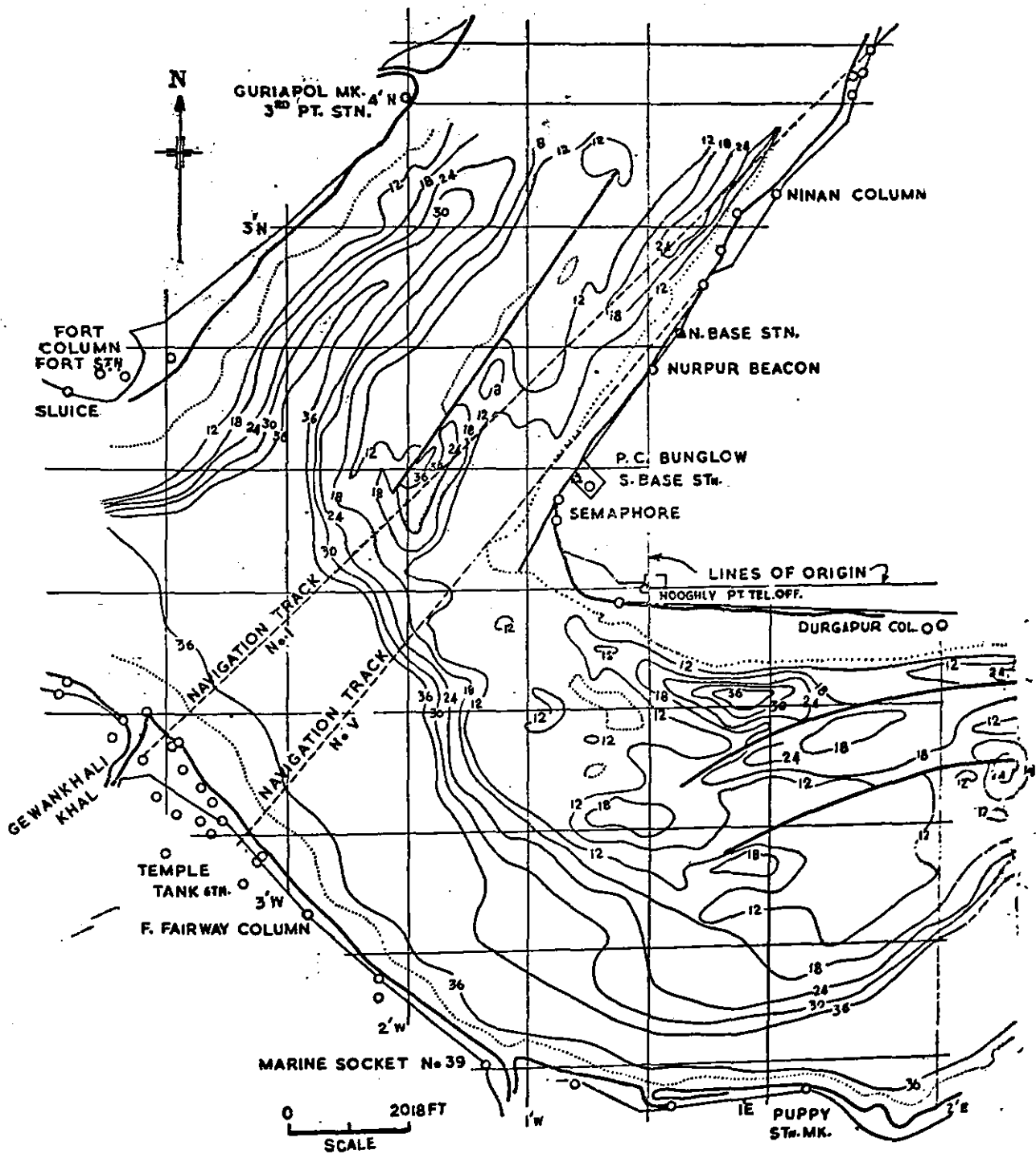


Fig 8 : Experiment with mid-river training wall on the Muckrapatty sand, two curved submerged vanes on the Hooghly shoal, 1000 ft recession of Fulta Point. A short extension of the left bank near Hooghly Pt and are as above and below the outfall of Damodar reclaimed.

The model bed laid to 1945 (Nov-Dec) survey and dry season spring tides run. Contours after running 367 D. S. Spring tides. Datum for contours = KODS

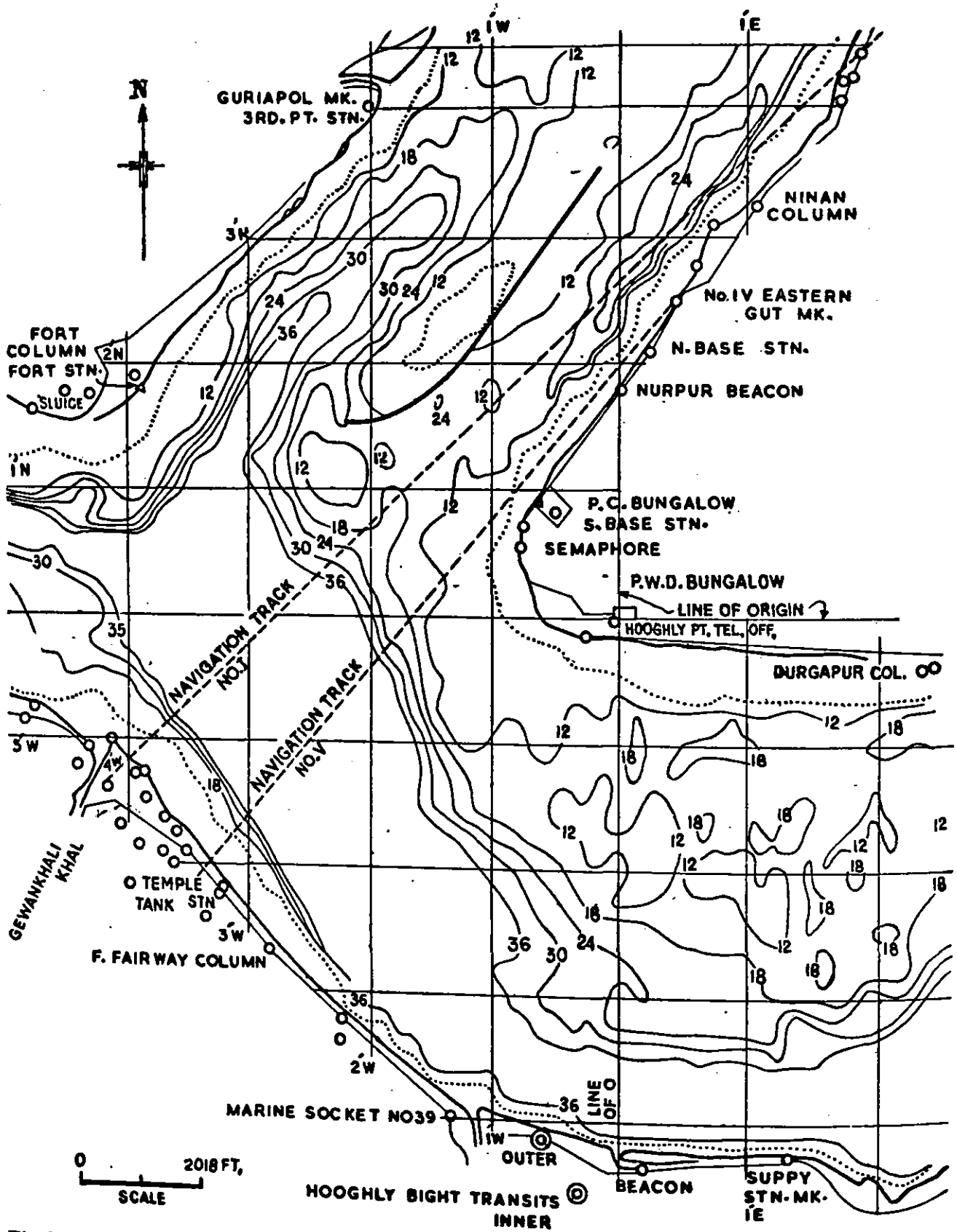


Fig 9 : Experiment with a bell-mouthed training wall on the Muckrapatty sand, 1000 ft recession of Fulta Point and areas above and below outfall of Damodar reclaimed. The model bed laid to Nov-Dec 1945 Survey. Contours taken after running 368 D. S. Spring tides. Datum for contours = KODS

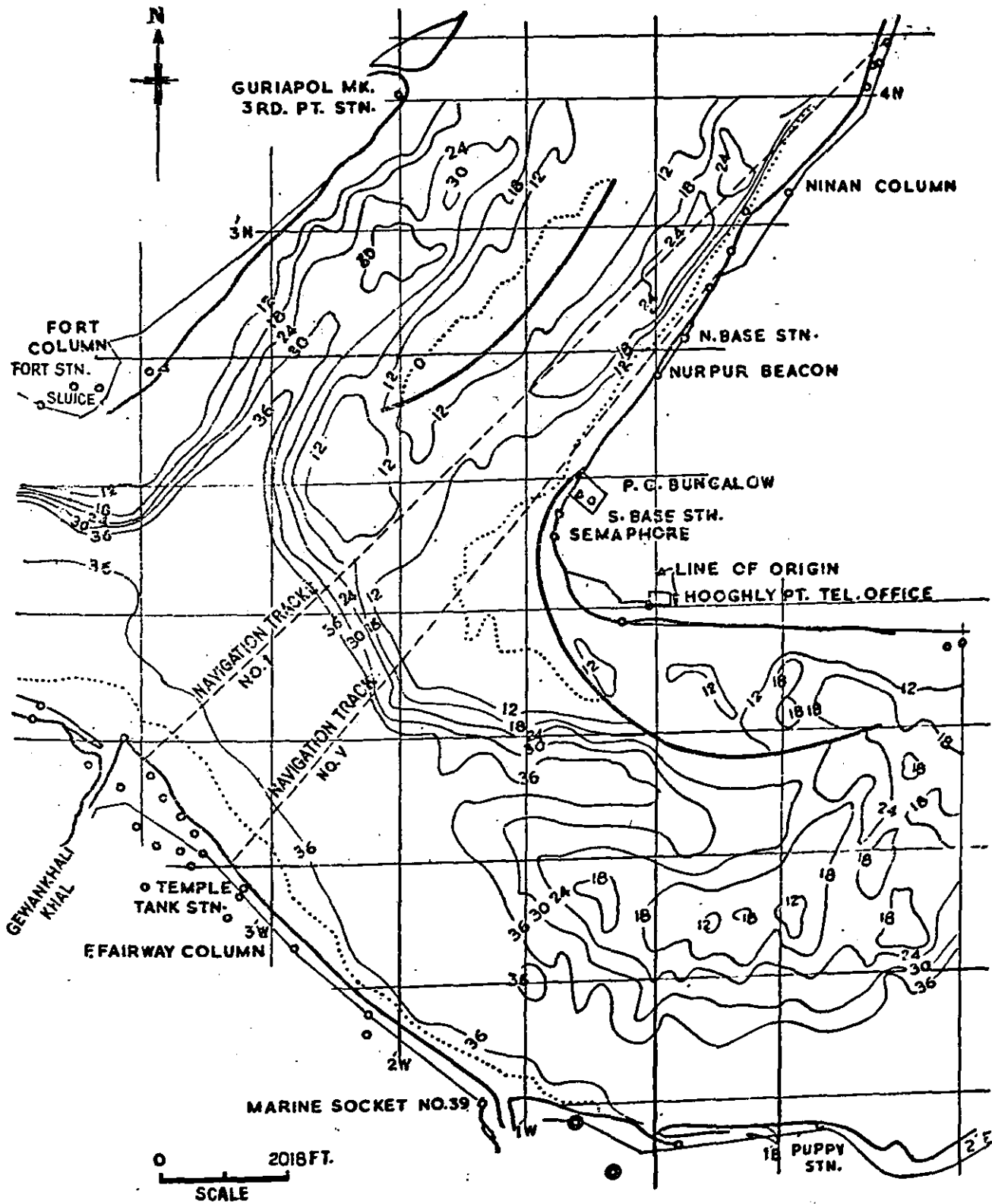


Fig 10 : Experiment with bell-mouthed training wall on the Muckrapatty sand, a curved embankment near Hooghly Point corner as shown in the figure.

1000 ft recession of Fulda Point and areas above and below outfall of Damodar reclaimed.

The model bed laid to Nov-Dec 1945 survey and dry season spring tides run. Contours after running 370 D S Spring tides. Datum for contours = KODS

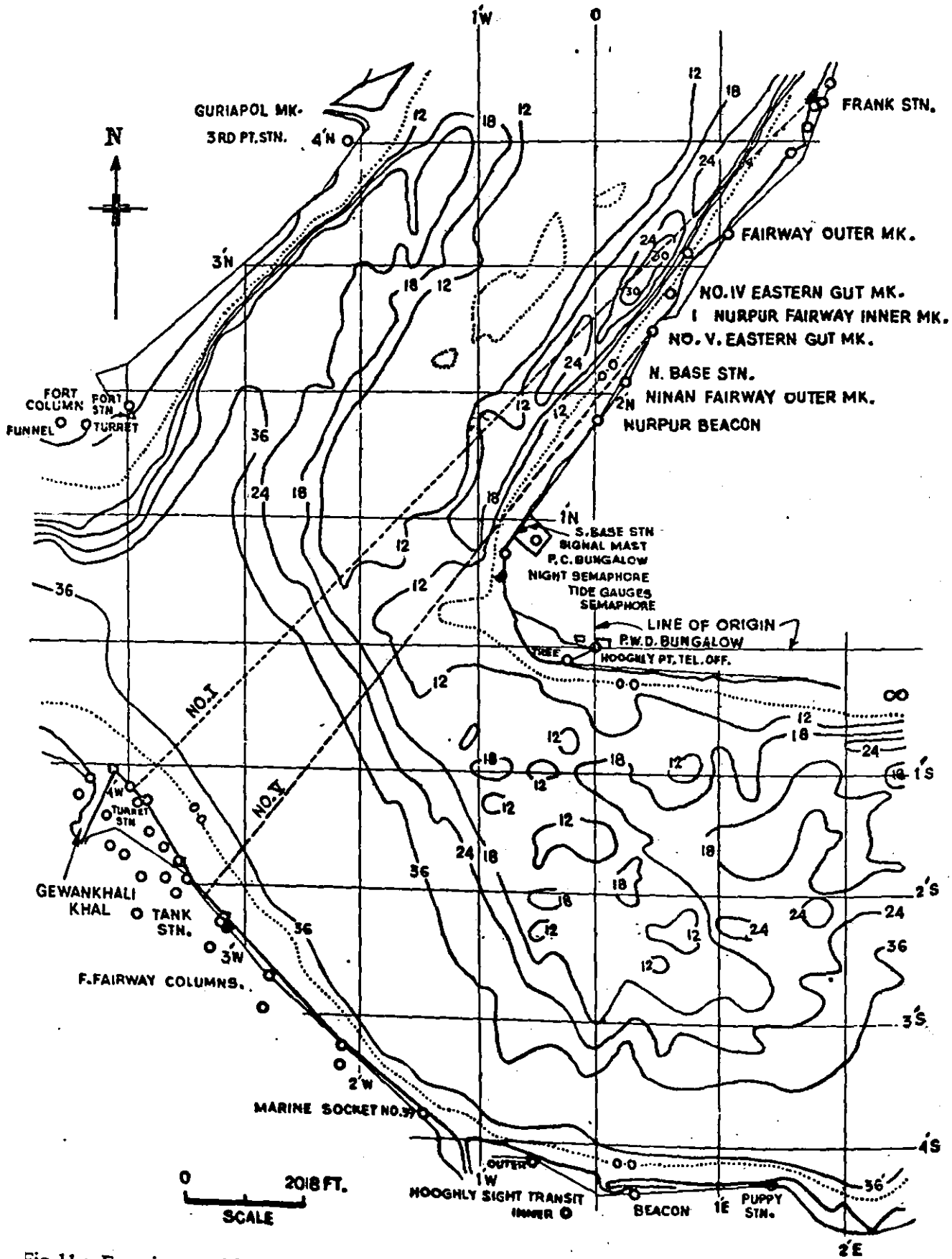
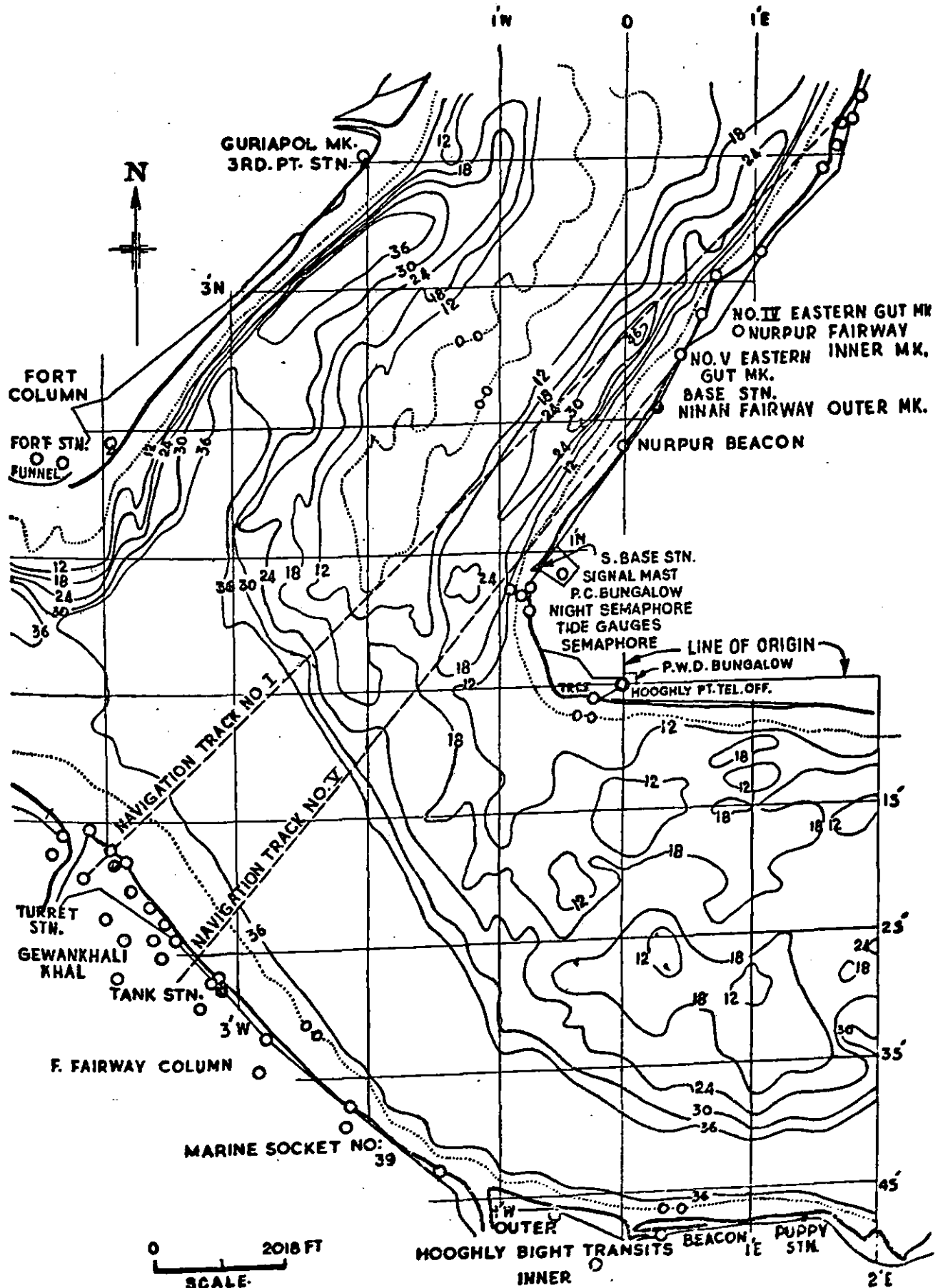
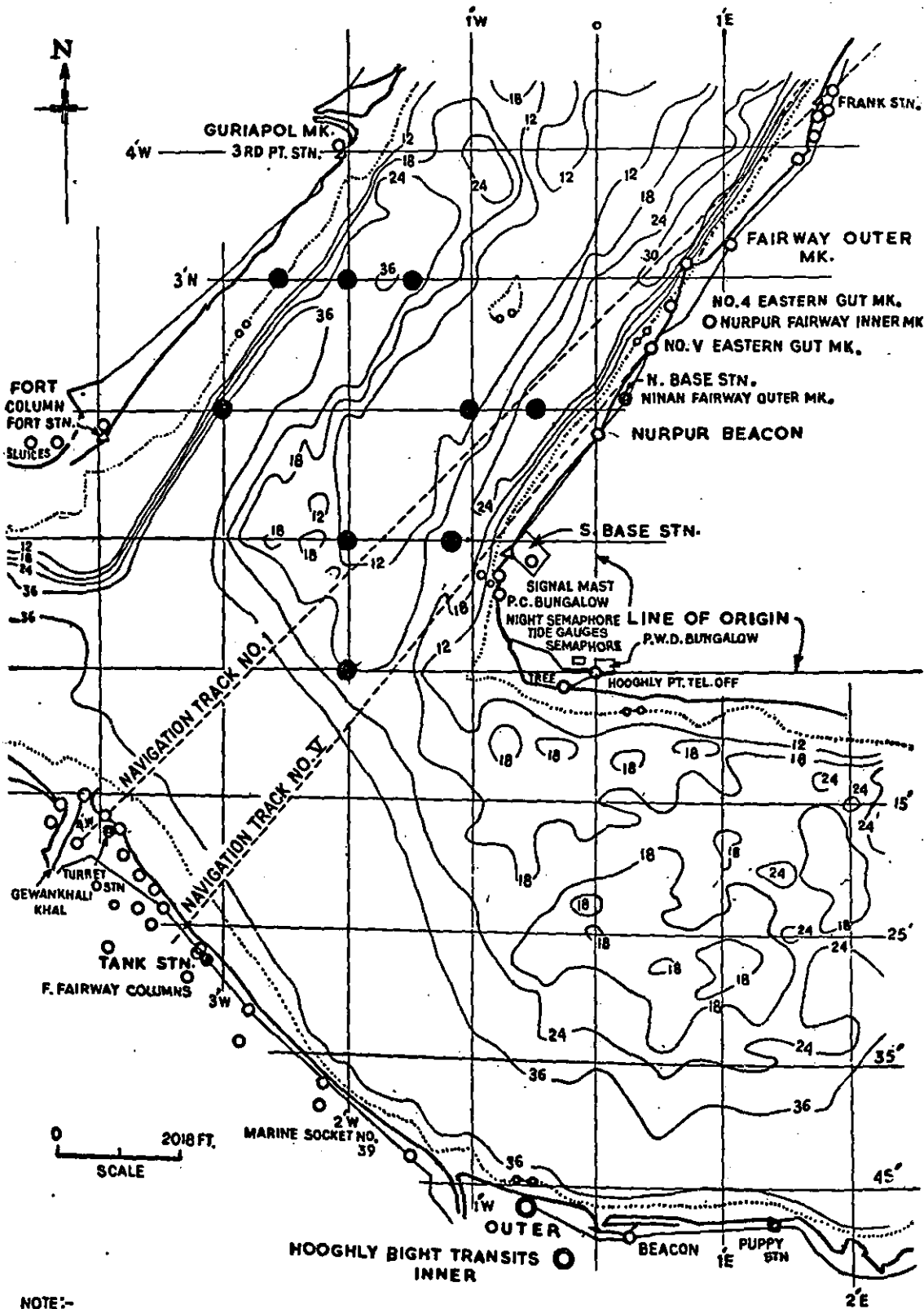


Fig 11 : Experiment with existing conditions. Contours at the end of model dry season. Datum for contours = KODS

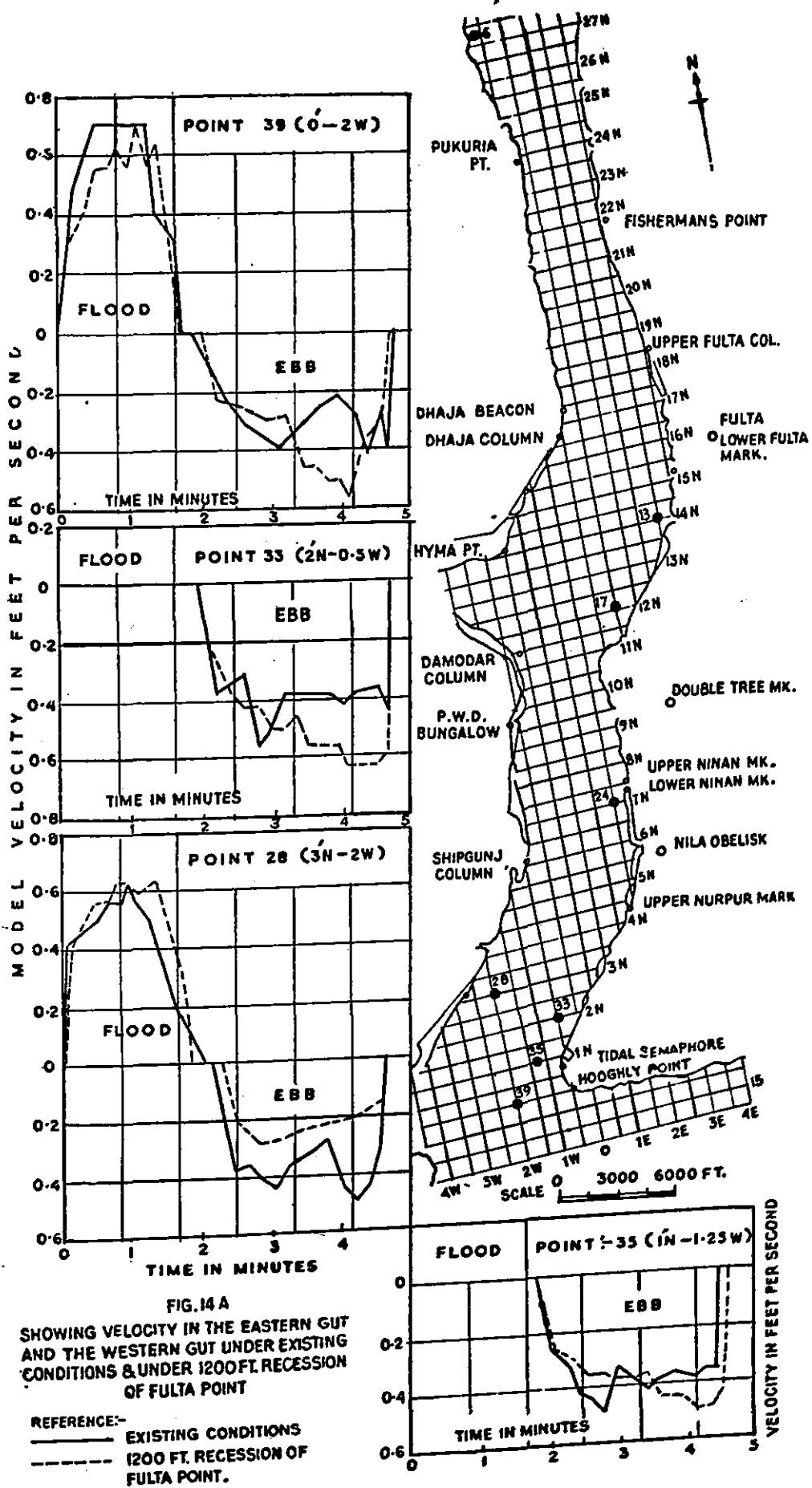


Note: Experiment with 1000 ft recession of Fulda Point and areas above and below outfall of Damodar reclaimed. Datum for contours = KODS
 Fig 12: Contours after running 367 dry season spring tides



NOTE:-
 EXPERIMENT WITH 1200' RECESSON OF FULTA POINT
 AND AREAS ABOVE & BELOW.
 OUTFALL OF DAMODAR RECLAIMED.
 VELOCITY OBSERVATION POINTS — ●
 Datum for contours = K.O.D.S.

FIG.13.
 FULTA JAMES & MARY REACH.
 SHOWING CONTOURS TAKEN AFTER
 RUNNING 367 DRY SEASON SPRING
 TIDE.



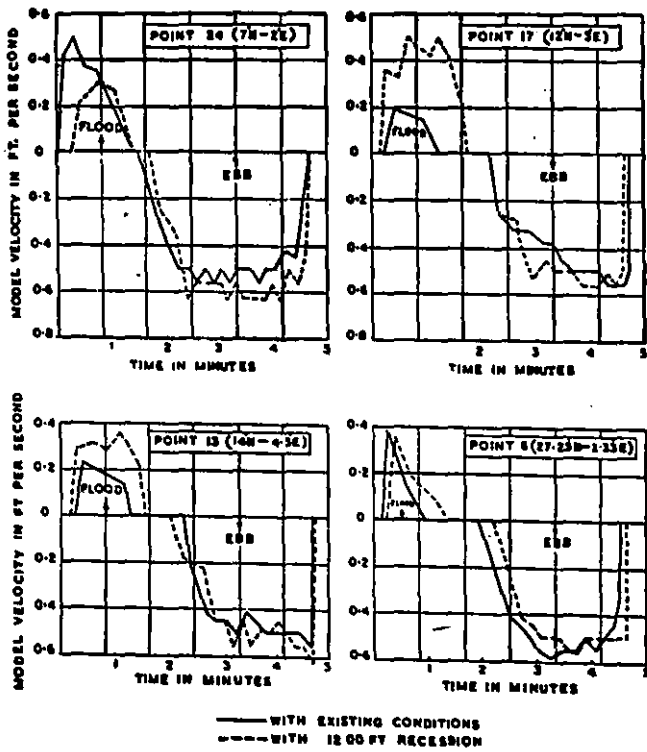


Fig 14 B : Velocities in the Ninan Reach and Fulra Bight under existing conditions and under 1200 ft recession of Fulra Point

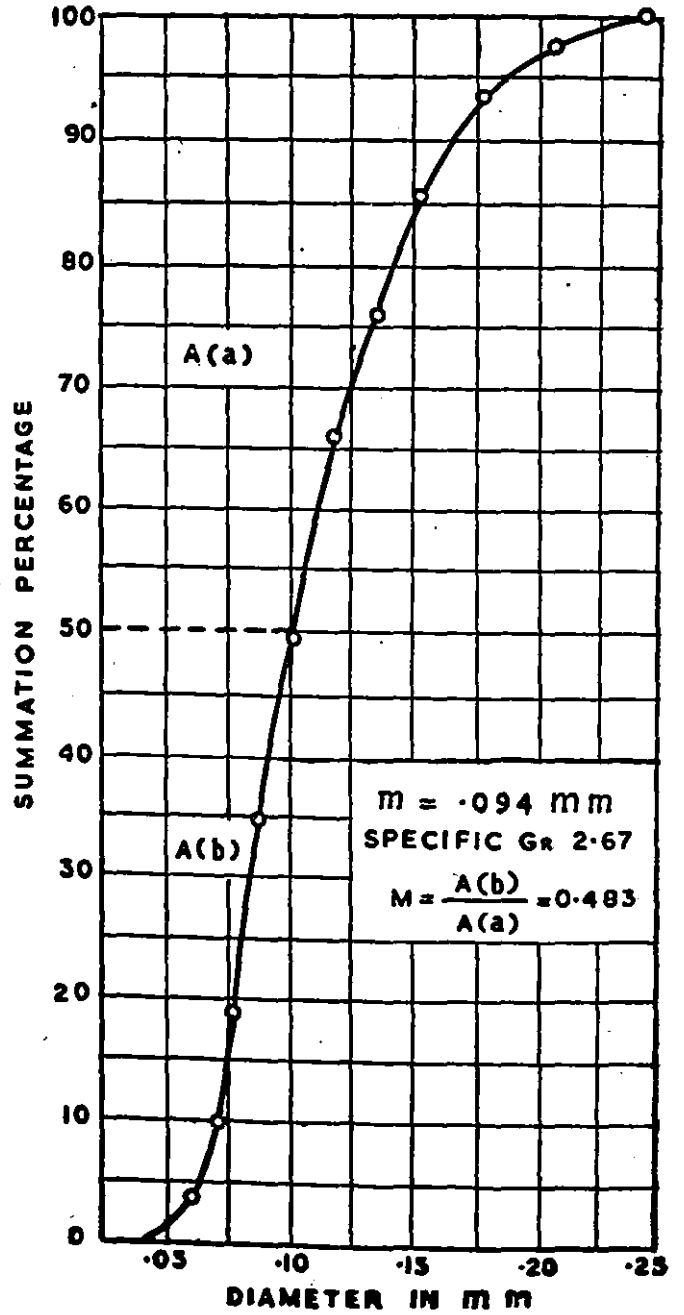


Fig 16 : Summation curve of Ninan sand for computing uniformity modulus

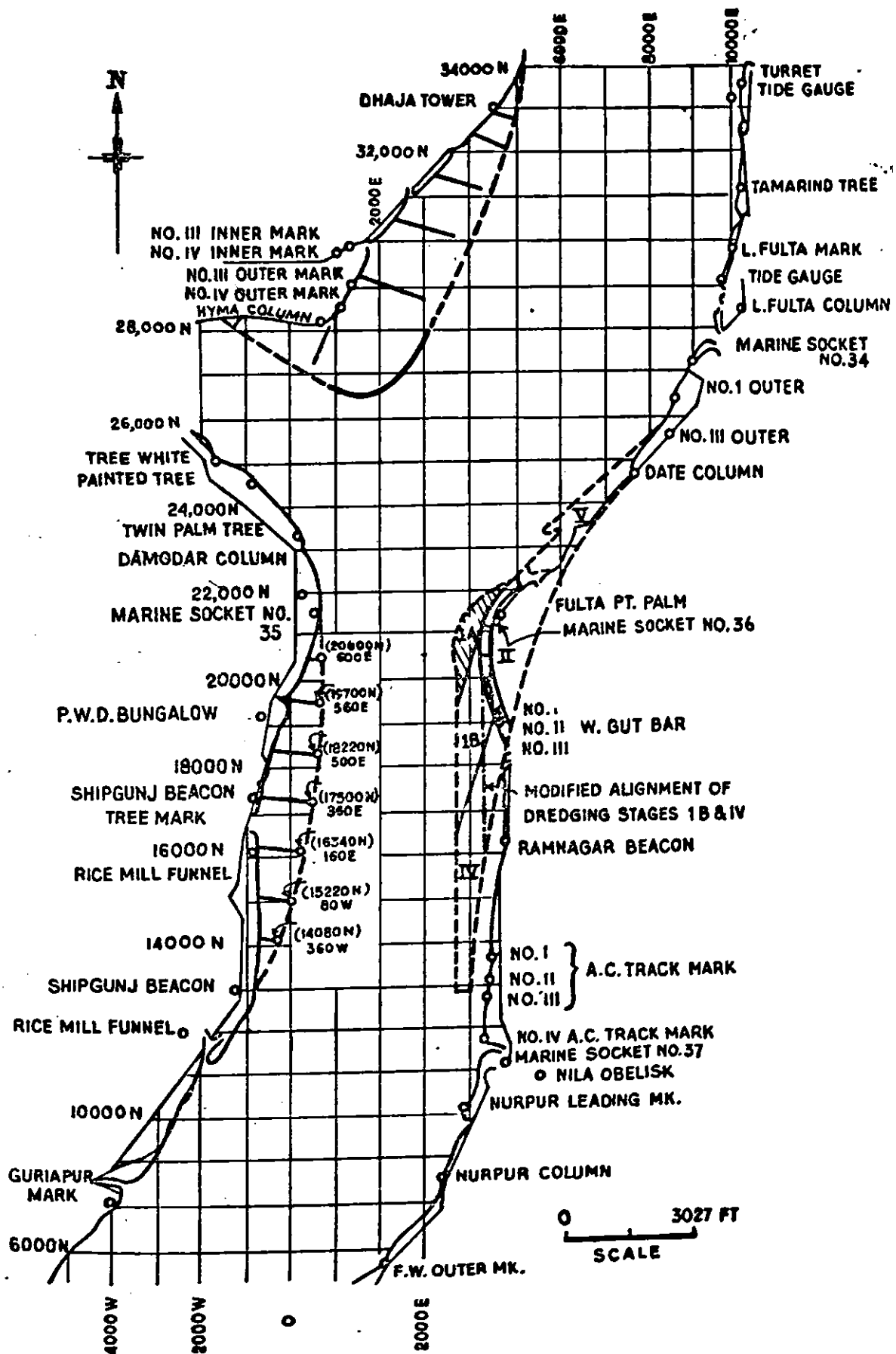


Fig 15 : Different stages of Fulta Pt scheme and the permeable spurs above and below Damodar outfall

CWPRS TECHNICAL MEMORANDUMS

SUBJECT CLASSIFICATION

Subject	Symbol
Water studies & Hydrology	HLO
Rainfall & Runoff	
Regeneration & Losses	
Quantity of Water	
Fluid Mechanics	FLM
Design of Hydraulic Structures	HYD
River Training & Flood Control	HYR
Irrigation, Drainage & Reclamation	IRD
Surface & subsurface irrigation	
Water requirements of crops	
Soil survey and crop pattern	
Drainage	
Reclamation	
Navigation	NAV
Ports, Harbours & Estuaries	
Inland Navigation	
Coastal Erosion	
Ships & Navigation Crafts	
Structural Design	STD
Soil Mechanics & Foundation Engineering	SFE
Investigations	
Stability, deformations & displacements of earth structures	
Foundation studies including geophysical	
Construction Materials & Practices	CMP
Concrete Technology	
Building & other Materials	
Instrumentation	IST
Model and Prototype comparisons	MPC
Other miscellaneous	MIS

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