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No. 2

VOLUME 3 APPENDICES

THE COMPREHENSIVE STUDY ON THE DEVELOPMENT OF CALCUTTA AND HALDIA DOCK SYSTEMS OF CALCUTTA PORT TRUST IN INDIA

OCTOBER 1989

FINAL REPORT

JAPAN INTERNATIONAL COOPERATION AGENCY

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89-124(3/3)

VOLUME 3 APPENDICES

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3-1 Meteorological Conditions

Table A-3-1-1 Meteorological Table at Calcutta (Alipure)

Month	Temperature Mean (of) Daily Max.	Daily Min.	Highest	Lowest	Humidity Relative Humidity	Rainfall Mean Total Monthly	No. of Rainy days	Visibility No. of days up to 1 Km	1 - 4 Km	Above 4 Km	Weather Phenoaena No. of days with Precipitation 0.3 mm or more	Thunder	Squall
	°C	°C	°C	°C	%	mm							
JAN.	26.8	13.6	29.9	9.9	78	13.8	0.8	6	19	6	1.4	0.5	0.1
FEB.	29.5	16.5	33.6	11.5	75	24.2	1.8	4	15	9.3	3	1.5	0.3
MAR.	34.3	21.3	38.1	16.4	71	26.5	2.0	0.6	10	18.2	4	4	2
APR.	36.3	25.0	40.2	20.9	71	42.7	2.8	0	3	27	5	6	3
MAY	35.8	26.5	39.8	22.1	74	120.8	6.4	0	1.9	29.1	10	11	4
JUNE	34.1	26.7	38.0	23.6	80	259.1	12.2	0.1	3	26.9	17	13	5
JULY	32.0	26.3	34.6	24.5	84	300.6	16.9	0	5	26	23	9	1.5
AUG.	32.0	26.3	34.4	24.4	85	306.3	17.6	0.1	4	26.9	24	12	1.3
SEPT.	32.3	26.1	34.6	24.2	84	289.7	13.8	0.1	5	24.9	20	16	1.1
OCT.	31.8	23.9	34.3	20.2	80	160.2	7.8	0.1	10	20.9	12	9	0.9
NOV.	29.5	18.4	31.9	14.5	74	34.9	1.3	0.9	8	22.1	1.9	0.5	0.1
DEC.	27.0	14.2	28.4	11.0	78	3.2	0.3	3	20	8	0.7	0.9	0.1
Anual Total/mean	31.8	22.1	41.1	9.6		1,531.8	83.7	15	114	238.3	122	83	19
Number of Years	30	30	30	30		30	30						

* Based on observation from 1931 to 1960
* Lat. 22° 32 ' N
Longi. 88° 20 ' E

* Height above M.S.L. 6 metres

Table A-3-1-2 Meteorological Table at Calcutta (Dum Dum)

Month	Temperature Mean (of) Daily Max.	Daily Min.	Highest	Lowest	Humidity Relative Humidity	Rainfall Mean Total Monthly	No. of Rainy days	Visibility No. of days up to 1 Km	1 - 4 Km	Above 4 Km	Weather Phenoaena No. of days with Precipitation 0.3 mm or more	Thunder	Squall
	°C	°C	°C	°C	%	mm							
JAN.	26.4	12.3	29.5	8.5	74	13.2	0.9	1.4	15	14.6	1.5	0.5	0.1
FEB.	29.0	15.1	33.2	10.1	72	21.8	1.8	1.7	13	13.8	2	0.6	0.1
MAR.	33.8	20.4	37.8	14.7	70	29.6	1.9	0.8	9	21.2	4	4	0.5
APR.	36.0	24.3	40.1	19.4	70	49.8	2.6	0.1	4	25.9	4	5	3
MAY	35.7	26.0	39.7	21.6	75	134.6	6.3	0	0.9	30.1	9	7	3
JUNE	33.8	26.2	37.6	23.0	79	263.2	12.3	0	1.3	28.7	17	11	3
JULY	31.8	26.0	34.4	24.1	83	320.1	17.8	0.1	2	28.9	24	7	0.1
AUG.	31.8	26.0	34.3	24.0	82	318.1	18.1	0	1.8	29.2	24	9	0.2
SEPT.	32.0	25.9	34.1	23.5	81	252.7	13.1	0.1	2	27.9	15	10	0.5
OCT.	31.4	23.6	33.9	19.9	77	134.2	6.7	0.1	5	25.9	11	7	0.1
NOV.	29.0	17.6	31.5	13.6	72	29.2	1.3	0	8	22	3	0.5	0
DEC.	26.5	13.0	29.0	9.7	75	3.6	0.2	1.1	14	15.9	0.4	0.2	0
Anual Total/mean	31.4	21.4	41.1	8.1		1,570.1	83.0	5	76	284.3	115	62	11
Number of Years	21	21	21	21		30	30						

* Based on observation from 1931 to 1960
* Lat. 22° 39 ' N
Longi. 88° 27 ' E

* Height above M.S.L. 6 metres

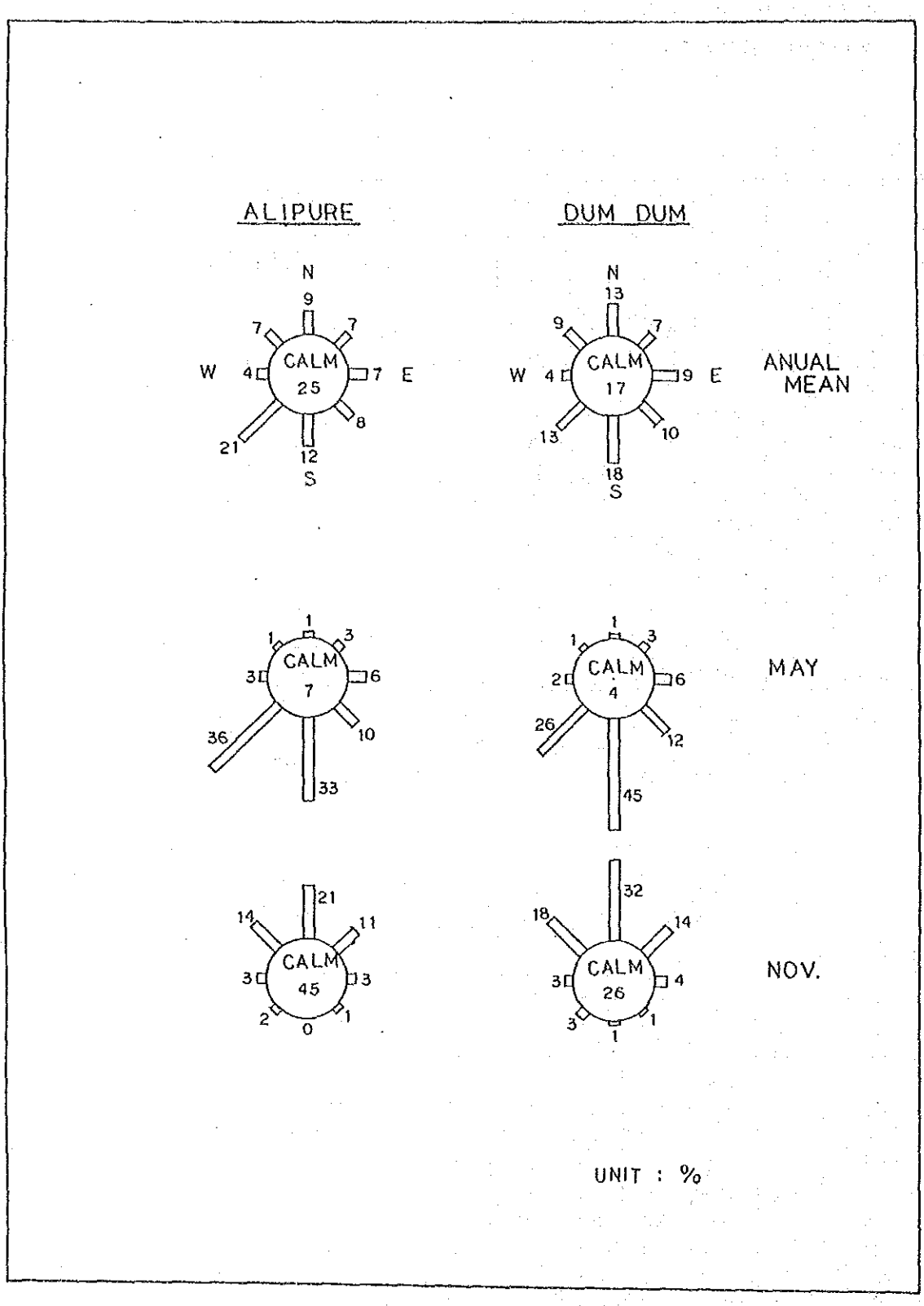
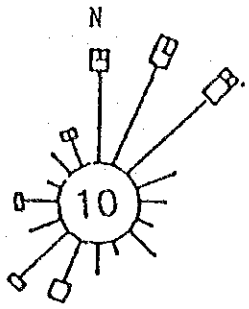
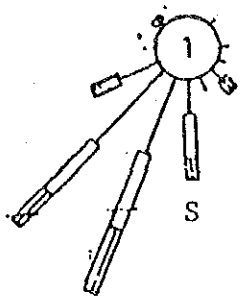


Fig. A-3-1-1 Wind Distribution at Calcutta

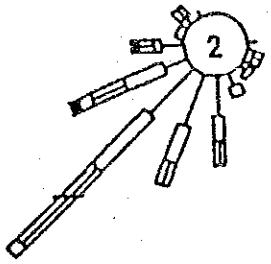
January



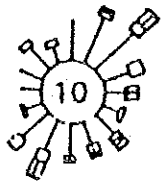
April



July

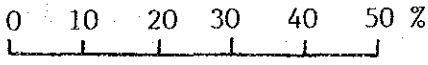


October

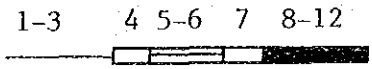


EXPLANATION

Arrows fly with the wind. The freqency of Wind from any direction is given according to the scale:-



This scale is further subdivided to indicate the frequency of winds of different Beaufort force according to the legent:-



The figure in the centre of the circle indicates the percentage frequency of light variable winds including calms.

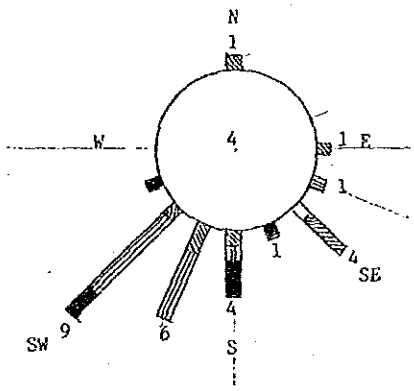
Fig. A-3-1-2 Wind Rose at Bay of Bengal

Table A-3-1-3 Frequency Analysis of Storms in Bay During 45-Years Periods

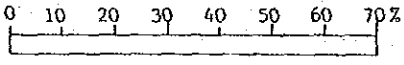
Month	No. of Storms
Juanuary	3
February	0
March	4
April	15
May	19
June	25
July	22
August	14
September	19
October	33
November	39
December	19
Total	212
Number of stroms per year	4.7

Wind Distribution - July, 1988

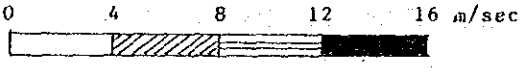
Maximum Wind Speed in a day



Arrows fly with the wind. The frequency of wind from any direction is given according to the scale:



This scale is further subdivided to indicate the frequency of different wind velocity shown as below



The figure in the center of the circle indicates the days of light variable winds (below 4 m/sec.) including calms.

Fig. A-3-1-3 Wind Distribution, July 1988 at Sagar Island

Table A-3-1-4 Wind Data at Sagar Lighthouse (Observatory)

July, 1988

July	Wind Direction	Maximum Wind Speed		Average Wind Velocity m/sec.	
		m/sec.	Situation		
day 1	SSW	9	over 8/1 hr.	6	
2	SW	10	over 8/2 hrs.	7	
3	SSW	11	over 10/6 hrs.	10	Remarks
4	SSW	12	Const.	11	
5	SSW	11	Const.	11	
6	SW	12	2 hrs.	8	1. "Instant" descried in the situation means less than one hour, but more than ten minutes.
7	SW	14	Instant	7	
8	SW	12	Instant	7	
9	SW	9	over 8/3 hrs.	7	
10	SW	11	2 hrs.	6	2. Maximum wind speed in shown as the max. in a day (24 hours)
11	SW	8	3 hrs.	4	
12	SSW	8	Instant	3	
13	S	9	Instant	3	
14	SE	5	over 4/2 hrs.	Calm	3. Average wind velocity is shown as the mean value in a day (24 hours)
15	SE	8	over 7/3 hrs.	Calm	
16	E	8	3 hrs.	Calm	
17	SSE	16	Instant	10	
18	S	13	over 11/4 hrs.	7	
19	S	8	over 7/2 hrs.	6	4. wind direction is shown as prevailing direction in a day (24 hours)
20	SSW	5	3 hrs.	4	
21	SE	6	Instant	6	
22	S	13	Instant	10	
23	SW	14	Instant	8	
24	SW	12	1 hr.	8	
25	WSW	13	Instant	6	
26	Calm	8	Instant	Calm	
27	Calm	6	Instant	Calm	
28	ESE	10	Instant	5	
29	SE	4	3 hrs.	Calm	
30	Calm	-	-	Calm	
31	N	8	Instant	Calm	

Table A-3-2-1 Direction of Waves in the Estuary (Sand Head)

Direction	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
N	12.90	6.47	—	—	1.08	—	—	—	1.67	13.44	22.24	19.39
NNE	9.67	1.18	1.61	—	—	1.11	—	1.61	1.11	5.91	3.89	17.20
NE	24.19	2.35	1.08	—	—	1.11	—	1.08	5.56	11.83	18.90	29.03
NEE	—	—	—	—	—	—	1.08	—	1.11	2.15	1.67	3.22
E	1.08	1.18	1.08	—	—	—	2.15	—	6.12	3.23	2.78	1.08
NES	—	—	1.08	—	—	—	1.61	—	—	—	3.34	—
ES	—	1.76	2.15	1.11	—	7.23	6.99	2.61	5.56	5.38	1.11	3.22
SSE	—	—	2.15	1.69	—	1.69	2.69	1.61	2.22	3.23	—	1.08
S	—	—	5.38	8.34	3.7	11.12	20.43	4.84	10.56	5.91	—	—
SSW	—	9.41	12.36	16.68	11.83	11.68	11.83	3.23	12.79	3.76	—	—
SW	1.08	28.24	45.16	53.93	25.80	41.70	46.23	56.45	24.46	8.60	1.67	1.61
SWW	—	5.88	5.91	4.44	51.07	2.22	2.69	6.45	2.22	2.15	—	1.08
W	—	1.18	3.23	2.78	—	1.69	—	3.76	3.34	1.61	1.11	—
WNN	—	1.76	2.15	—	2.15	—	—	2.69	1.11	—	—	—
WN	1.61	4.12	1.08	—	—	3.34	—	1.08	4.44	3.23	3.34	—
NNW	3.26	—	—	—	—	—	—	—	1.11	1.61	1.11	2.69
Non-Ascertainable	43.33	34.12	14.52	8.90	2.69	3.34	2.15	14.52	16.68	26.88	37.25	22.58

Table A-3-2-2 Wave Observation at Sagar Semaphore

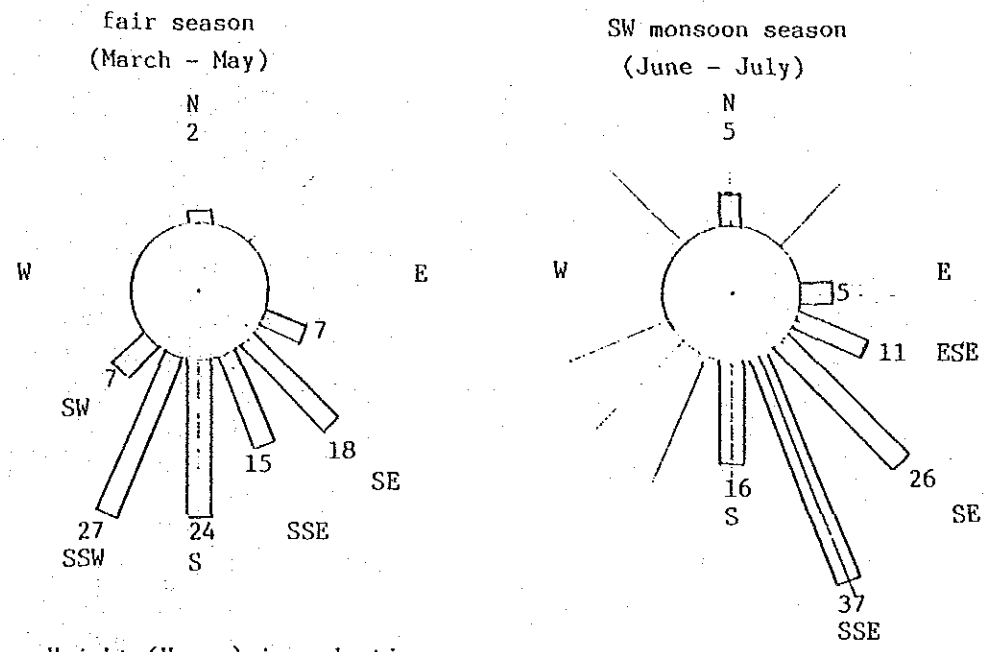
Time	AM 8:00			AM 11:00			PM 3:00			PM 5:00		
	8~10			10~12			14~16			16~18		
Day	H max cm	H 1/3 cm	T sec	H max cm	H 1/3 cm	T sec	H max cm	H 1/3 cm	T sec	H max cm	H 1/3 cm	T sec
7/12	60	46	5	40	27	4	20	20	5	20	20	6
13	60	48	5	40	37	6	20	20	4	20	17	5
14	60	51	7	40	34	8	20	20	4	20	20	5
15	60	49	5	50	40	5	20	20	5	20	20	5
16	50	40	5	50	35	6	20	20	5	20	18	4
17	60	54	6	80	63	5	30	24	6	30	22	6
18	90	71	8	100	86	8	80	61	8	20	20	6
19	80	79	*11	110	92	8	50	48	7	20	18	7
20	40	33	8	100	87	5	60	52	6	20	20	7
21	20	19	6	30	30	4	50	43	5	30	22	8
22	20	20	7	60	47	8	80	68	* 8	60	50	5
23	20	20	9	30	21	8	80	81	7	80	53	*11
24	40	37	8	30	25	9	80	81	7	80	64	5
25	70	51	7	30	30	7	60	43	* 9	60	63	*10
26	60	68	8	40	34	8	20	19	*10	60	46	4
27	80	64	6	30	30	8	20	13	*10	40	28	7
28	60	50	7	40	37	6	20	16	8	20	15	7
29	100	81	4	80	59	* 9	20	16	*10	20	16	*10
30	100	88	8	80	84	5	20	20	8	20	19	8
31	120	88	5	80	72	6	30	20	7	20	19	8
8/ 1	100	84	7	80	60	8	30	27	8	20	20	9
2	70	57	4	100	82	4	60	41	6	20	20	8
3	40	36	5	120	92	4	80	74	3	30	22	7
4	30	22	7	80	63	4	120	102	4	40	33	6

. Remarks:

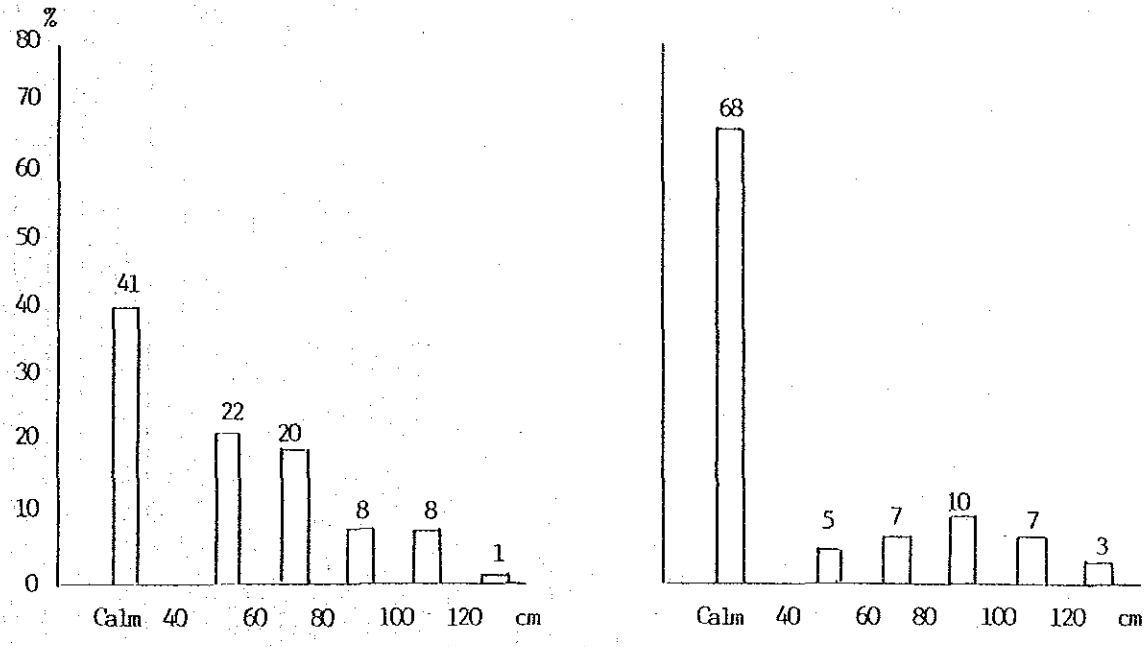
1. Wave height was observed every half hour and measured for 30 continuous waves, therefore four groups of wave data at each observed time (AM 8:00, AM 11:00, PM 3:00, PM 5:00) are available. The group having highest waves (H max) or highest significant waves (H 1/3) in those the four groups is listed in this table.
2. Values marked with an asterix(*) were omitted as abnormal values.

3-2 Wave conditions at the Estuary

Table — Wind Direction and Wave height at Haldia Oil Jetty
- observed on 15/March to 31/July in 1982 -
Wind direction at H max. above 40cm in daytime



Wave Height (H max) in daytime



Source: by Commander of Haldia Port Survey Unit

Fig. A-3-2-1 Wind Rose and frequency of H max in Haldia

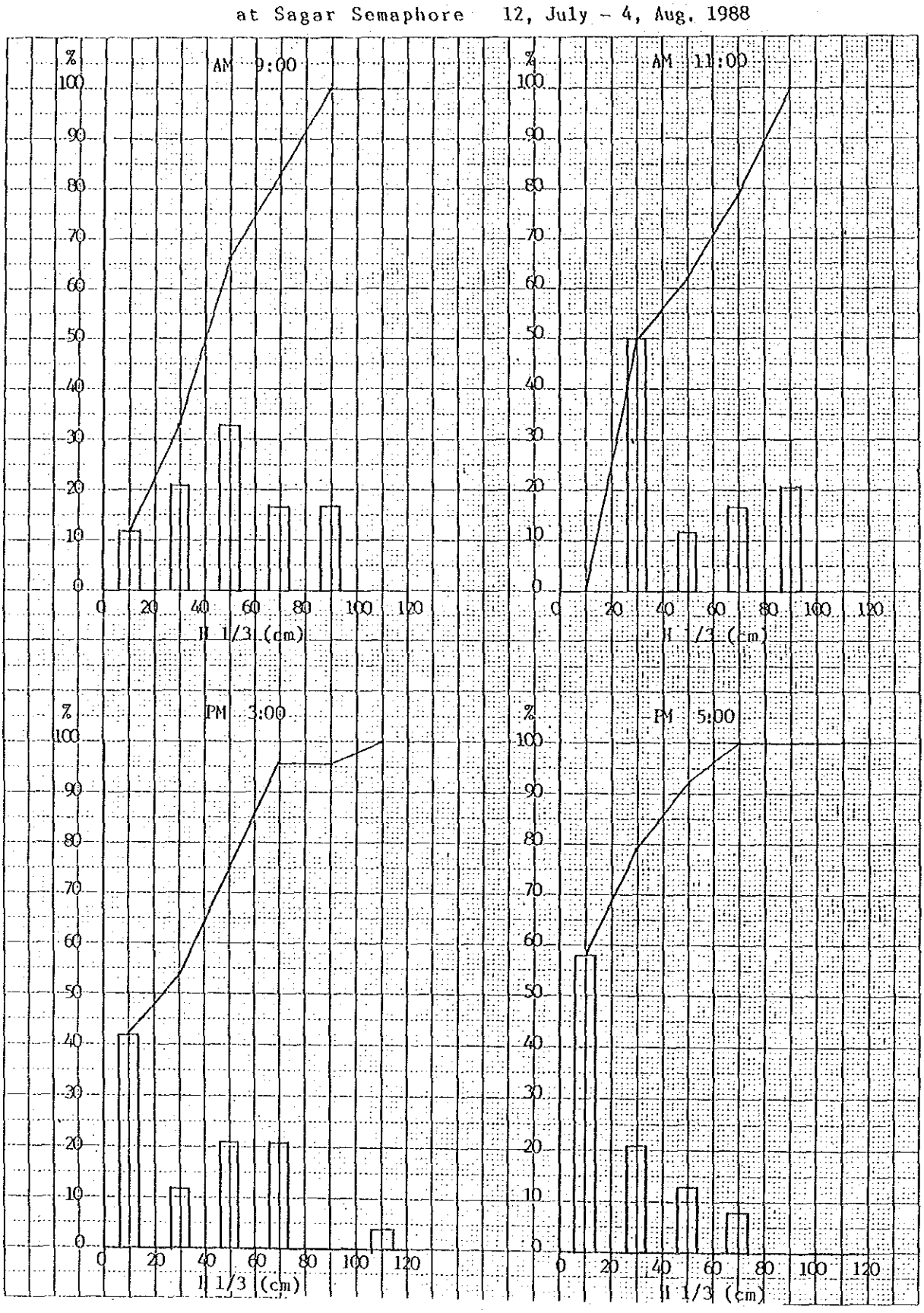


Fig. A-3-2-2 Frequency of Wave Height (H 1/3)

Table A-3-2-3 Significant Wave Height and Period

Wave data at Sagar Semaphore

observed from 12/July to 4/Aug. 1988

Significant Wave Height (H 1/3)

Time (cm)	9		11		15		17	
	8~10		10~12		14~16		16~18	
	N	%	N	%	N	%	N	%
0 < H 1/3 ≦ 20	3	12	0		10	42	14	58
20 < H 1/3 ≦ 40	5	21	12	50	3	12	5	21
40 < H 1/3 ≦ 60	8	33	3	12	5	21	3	13
60 < H 1/3 ≦ 80	4	17	4	17	5	21	2	8
80 < H 1/3 ≦ 100	4	17	5	21	0	0	0	0
100 < H 1/3					1	4		
	24	100	24	100	24	100	24	100
H max.	7/31	120	7/19	110	8/4	120	7/24	80
Max. H 1/3 (cm)	7/31	88	7/19	92	8/4	102	7/24	64
Mean H 1/3 (cm)		52		52		38		28
		1,256		1,242		919		683

Wave Period (T 1/3)

Time H 1/3 (cm)	9		11		15		17	
	8~10		10~12		14~16		16~18	
	N	T sec	N	T sec	N	T sec	N	T sec
0 < H 1/3 ≦ 20	3	7.3	0		7	5.3	13	6.6
20 < H 1/3 ≦ 40	5	6.2	12	6.4	3	7.0	5	6.8
40 < H 1/3 ≦ 60	8	5.8	2	7.0	4	6.0	2	4.5
60 < H 1/3 ≦ 80	3	6.7	4	5.0	4	6.3	1	5.0
80 < H 1/3 ≦ 100	4	5.5	5	5.4				
Over 100					1	4.0		
	23	6.1	23	6.0	19	5.9	21	6.4

Table A-3-2-4 Continuous Calm & Chopy Hours in Daytimes

Date	Calm H≦0.3m		Chopy H≧0.7m		Remarks
	Time	Hours	Time	Hours	
7/12	10:30~18:00	7.5		—	
13	11:30~18:00	6.5		—	
14	11:30~18:00	6.5		—	
15	11:30~18:00	6.5		—	Total days
16	11:30~18:00	6.5		—	21 days
17	14:00~18:00	4.0	10:00~10:30	0.5	
18	15:00~18:00	3.0	09:00~14:30	5.5	
19	15:00~18:00	3.0	09:30~12:30	3.0	Total hours
20	14:30~18:00	3.5	11:00~13:00	2.0	24 × 10 hours
21	08:00~12:00 16:00~18:00	6.0		—	≒ 240 hours
22	08:00~10:30 17:00~18:00	3.5	12:00~15:00	3.0	
23	08:00~12:30	4.5	14:30~16:00	1.5	Daytime
24	09:30~12:30	3.0	15:30~17:00	1.5	8:00~18:00
25	10:00~15:30	5.5	17:00~18:00	1.0	(10 hours)
26	10:30~16:00	5.5	08:00~09:00	1.0	
27	10:00~17:30	7.5	08:00~09:30	1.5	
28	11:00~18:00	7.0		—	
29	14:00~18:00	4.0	10:00~11:30	1.5	
30	14:00~16:00	4.0	08:00~10:30	2.5	
31	14:00~18:00	4.0	08:00~11:30	3.5	
8/ 1	14:00~18:00	4.0	09:00~11:30	2.5	
2	08:00~09:30 15:00~18:00	4.5	09:30~12:00	2.5	
3	08:00~09:30 16:00~18:00	3.5	10:30~15:00	4.5	
4	08:00~10:30 16:30~18:00	4.0	11:00~15:30	4.5	
Occurence days		21 days		17 days	
Occurence times		20 times		17 times	
Total hours		117.5 hrs.		42 hrs.	
Percentage		49 %		17.5 %	
Average hours per time		4 hrs.		2.5 hrs.	

3-3 Sub-soil conditions at Calcutta region

Stratification of alluvial deposit on a regional basis would have some deficiency, particularly when a detailed geomorphological and sedimentological study is not available. Nevertheless the stratification has been made to permit comparison of available information from various localities. No stratification has been attempted for areas showing river channel deposit, where basically cohesionless materials have been encountered all throughout the depth of the channel.

The stratification of the Normal Calcutta Deposit, as can be conceived at the present time is given below.

Stratum I ... Brownish grey/light brown, silty clay/clayey silt/sandy silt with occasional lenses of silty fine sand. This is encountered right from the top ground surface to a depth of about 10 to 12 ft.

Stratum II .. Grey/dark grey silty clay with semi-decomposed timber pieces, having lenses of silt and peaty clay.

Strata I and II may be considered to be the components of the first horizon and represent generally soft deposits.

Stratum III . Blunish grey and mottled brown/grey, silty clay with kankar nodules and minute pockets of silt and sand.

Stratum IV .. Brown/yellowish brown, sandy silt/silty fine sand/clayey silt with lenses and pockets of brown/grey silty clay.

Stratum V ... Mottled brown/grey, grey silty clay and brown silty clay frequently showing laminar character.

Stratum VI .. Brown/light brown, silty fine to medium sand.

The material of stratum I exhibits primarily grey colour and soft consistency. Dark grey colour within the stratum is associated with relatively high organic content. Wherever high silt content is encountered the colour tends to be light grey or blusih grey. The typical identifying characteristic of stratum II is that the semi-decayed timber pieces of moderate size (75mm to 150mm on an average) are intimately mixed with the soil mass particularly at depths between 8m and 13m. One or two lenses of highly decomposed vegetable matter in small thickness (0.5m to 1m) generally occur within this stratum at varying elevations. In some boreholes such lenses were not encountered. In the lower horizon of this stratum, very thin thread-like calcareous elements of dark colour have been found.

The second horizon comprises the stiffer components of the subsoil. They are represented by strata III, IV, V and VI. There are two clay layers (strata III and V) separated by a predominantly cohesionless layer (stratum IV).

The stiff clay of stratum III has always been found to be associated with calcareous nodules of dull white colour. The calcareous nodules exhibit a high degree of concentration at about 2 to 3 metres below the top surface of this stratum. Below this level the colour of the stratum generally changes from bluish grey to mottled brown/grey. The stiff clay of this stratum generally has haircracks within its mass. On many occasions the samples exhibit a high degree of slickness. Minute pockets of sand and silt within the mottles portion of this stratum were also frequent.

Stratum IV has been generally recognised as water bearing. Further the material of this stratum is basically cohesionless. Boreholes through this stratum cannot normally be advanced without casing or other means of stabilisation. A slightly cohesive nature has, however, been encountered at some locations due to the presence of a small quantity of clay. Where the material has a high silt content with a trace of clay, thin laminations have generally been observed. Occasionally hard stone sized particles of calcareous origin are encountered.

The lower clay (stratum V) occurs in three distinct colour groups. No definite sequence of occurrence of each colour group could be established within this deposit so as to permit any sub-stratification. In general rusty brown spots and pockets of silt have been encountered throughout its mass. Dull white calcareous nodules have been encountered occasionally. Black spots within the mass are rather common. At different depths of some boreholes this clay way found to exhibit secondary structures. In some regions this clay has given a very interesting laminar texture. This texture has been termed as intensely laminated and identified as an assemblage of laminations of various thicknesses between 2mm and 3mm with their boundaries sprinkled with coarse silt or fine sand of nominal thickness. At some locations, a transitional zone was apparent in the lower portion from the presence of alternate sand and clay bands exhibiting laminar character.

Stratum VI comprising a thick deposit of brown silty fine sand occurs as the lowest stratum since this constitutes the stratum where the deepest

boreholes were terminated. This stratum is definitely water bearing and probably the shallow tubewells in Calcutta region draw water from this stratum. Its top elevations so far revealed suggest an undulating character. The colour of the sand is generally light brown but exhibits a wide range of shades from yellowish white to brown.

The S.P.T. values obtained from stratum I have been found to vary widely (3 to 16). This wide variation is understood to be the effect of the varying degrees of silt and sand content encountered and of the desiccation to which the upper crust was subjected in the recent past.

Stratum II also exhibits a wide variation in its SPT values (2 to 12) but the bulk of the values are around 4 to 6 signifying its overall soft consistency. The higher values are believed to be the effect of timber pieces probably encountered at the tip of the split spoon during a field test. Within this stratum occasionally dense non-plastic silt lenses have been encountered. SPT values, when taken within these lenses also indicated high results. It has, however, been generally observed that the lower portion of this stratum, at some locations, tend to be firm. However, the increase in consistency appears to be marginal. It may be noted that this increase in consistency has not been encountered at quite a few locations.

S.P.T. values obtained from stratum III indicate the material to be in a stiff state. 'N' values generally range between 8 and 15. A good number of results indicated values higher than 15. Higher values appear to have been affected primarily by the concentration of calcium nodules as mentioned earlier.

In stratum IV, visual inspection of the soil samples suggested a scatter in its strength characteristics, as is also represented by S.P.T. values which range between 10 and 40. The wide scatter has been particularly observed when the constituents of the stratum are predominantly silt. When the deposit is basically sand, the degree of scatter although prominent is relatively lower.

S.P.T. values of stratum V indicate its consistency to be between very stiff and hard. Some of the values have been recorded even above 50. It appears that the higher values were obtained when the material had kankar, lenses of sand and silt.

The brown sand (stratum VI) indicated generally very high S.P.T. values. This material may be described to be dense to very dense. Values

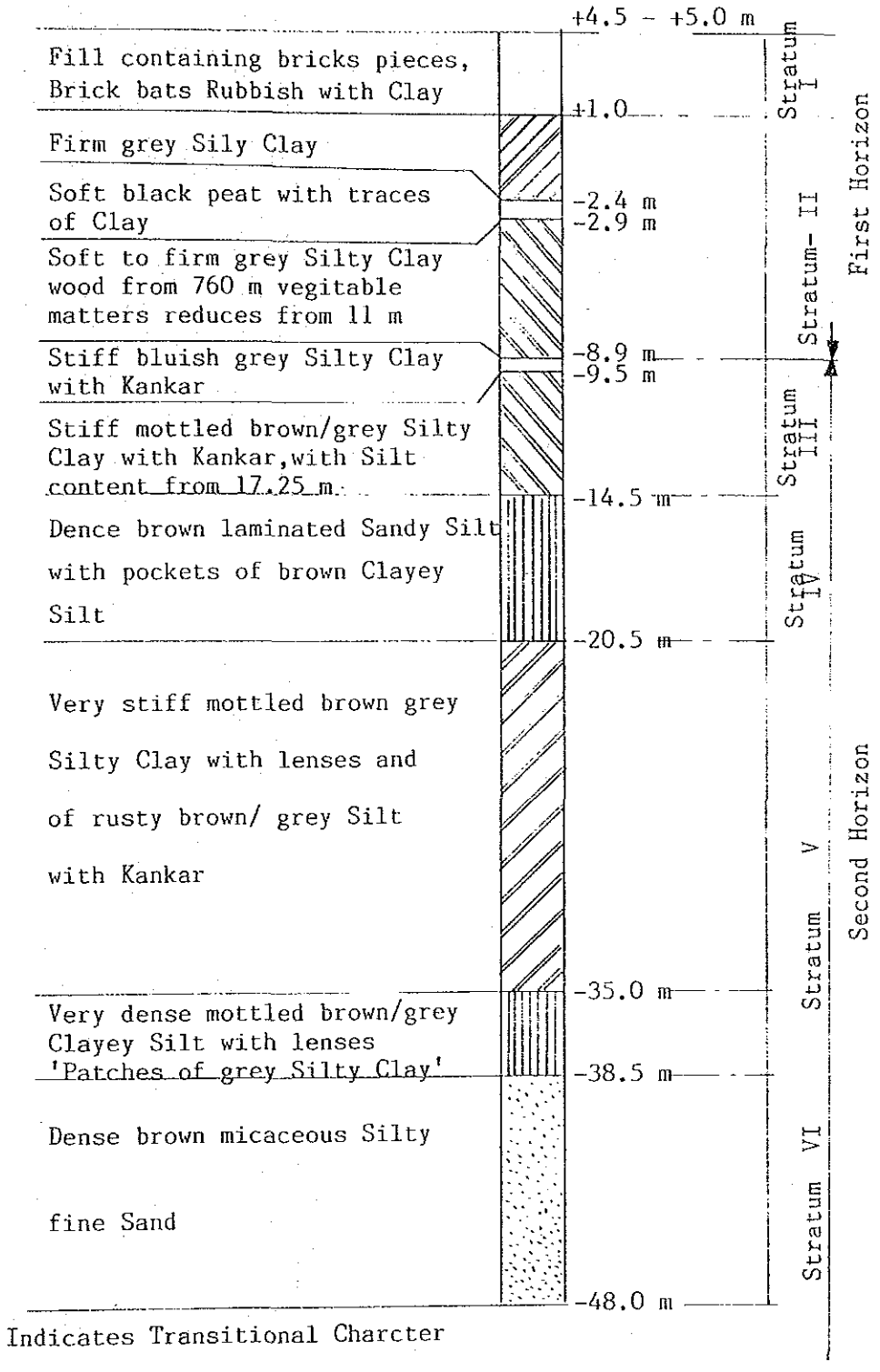


Fig. A-3-3-1 Typical Borehole Log for Normal Calcutta Deposit

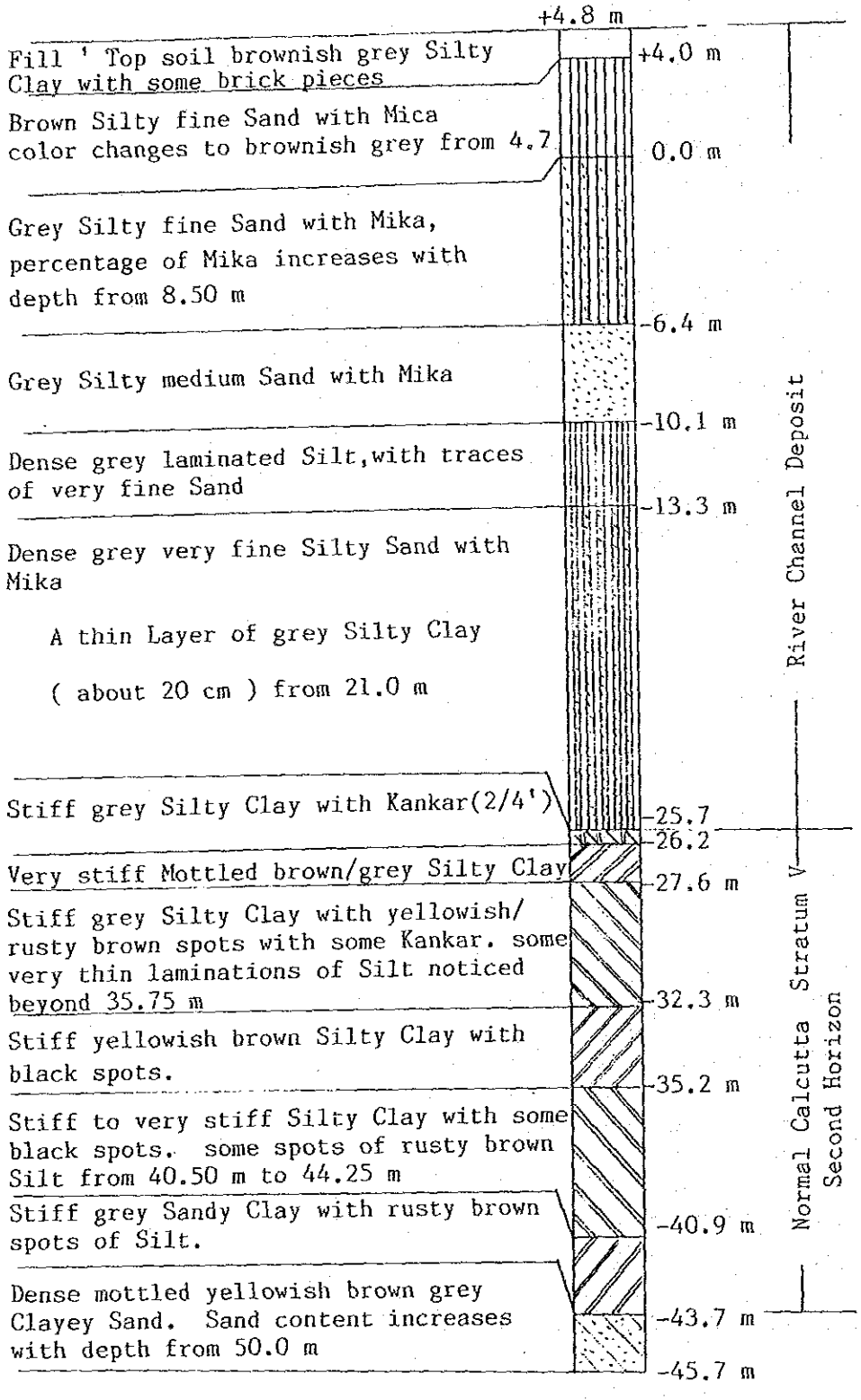


Fig. A-3-3-2 Typical Borehole Log for River Channel Deposit

3-4 Existing channels of River Hooghly & Estuary

Table A-3-4-1 Existing Channel of River Hooghly at Calcutta to Kalpi

Name of Place		Channel Side	Distance (Km)		Latest Sounding	Remarks
			Length	Accumlated		
K.P. Dock	Entrance	East	0	0	3 / 1988	
College	Reach	East	1.5	1.5	12 / 1988	
Garden	Reach	East	3.5	5.0	4 / 1988	N.S. Dock
Panch Para	Fairway	Center	2.5	7.5	5 / 1988	
Panch Para	Crossing	West	2.5	10.0	5 / 1988	
Sankral	Reach	West	4.5	14.5	5 / 1988	Crossing at ending part
Jarmakers	Reach	East	1.5	16.0	2 / 1988	
Pir Serang	Crossing	E → W	2.5	18.5	5 / 1988	
Koffri	Reach	W & Center	4.0	22.5	4 / 1988	Possible to Anchor
Baj Baj	Anchorage	East	2.5	25.0	5 / 1988	
Baj Baj	Reach	East	1.5	26.5	5 / 1988	
Poojali	Crossing	E → W	3.0	29.5	5 / 1988	
Uluberiya	Reach	West	4.0	33.5	4 / 1988	
Mayapur	Bar	W → E	4.0	37.5	5 / 1988	Sand Bar at Center
Hiragunji	Reach	East	3.0	41.0	5 / 1988	
Royapur	Crossing	E → W	4.0	45.0	5 / 1988	Sand Bar at Center
Brul	Reach	West	4.5	49.5	2 / 1988	
Fisherman's	Anchorage	W → E	2.0	51.5	5 / 1988	Crossing
Fisherman's	Reach	East	1.5	53.5	5 / 1988	
Phalta	Reach	East	3.0	56.0	5 / 1988	Sand Bar at Center
Ninan-Nurpur	Reach	East	3.5	59.5	5 / 1988	Estuary of Riv. Damodar
Eastern Gut	Bar	East	1.0	60.5	5 / 1988	Estuary of Papuna Rain River
Kukrahatti	Reach	West	4.0	64.5	4 / 1988	Crossing at Beginning Part
Kukrahatti	Crossing	W → E	1.5	66.0	4 / 1988	
Diamond	Reach	Center	)		2-3 / 1987	
			) 18.0			
	Anchorage	East	)			
Kalpi Road				84.0		

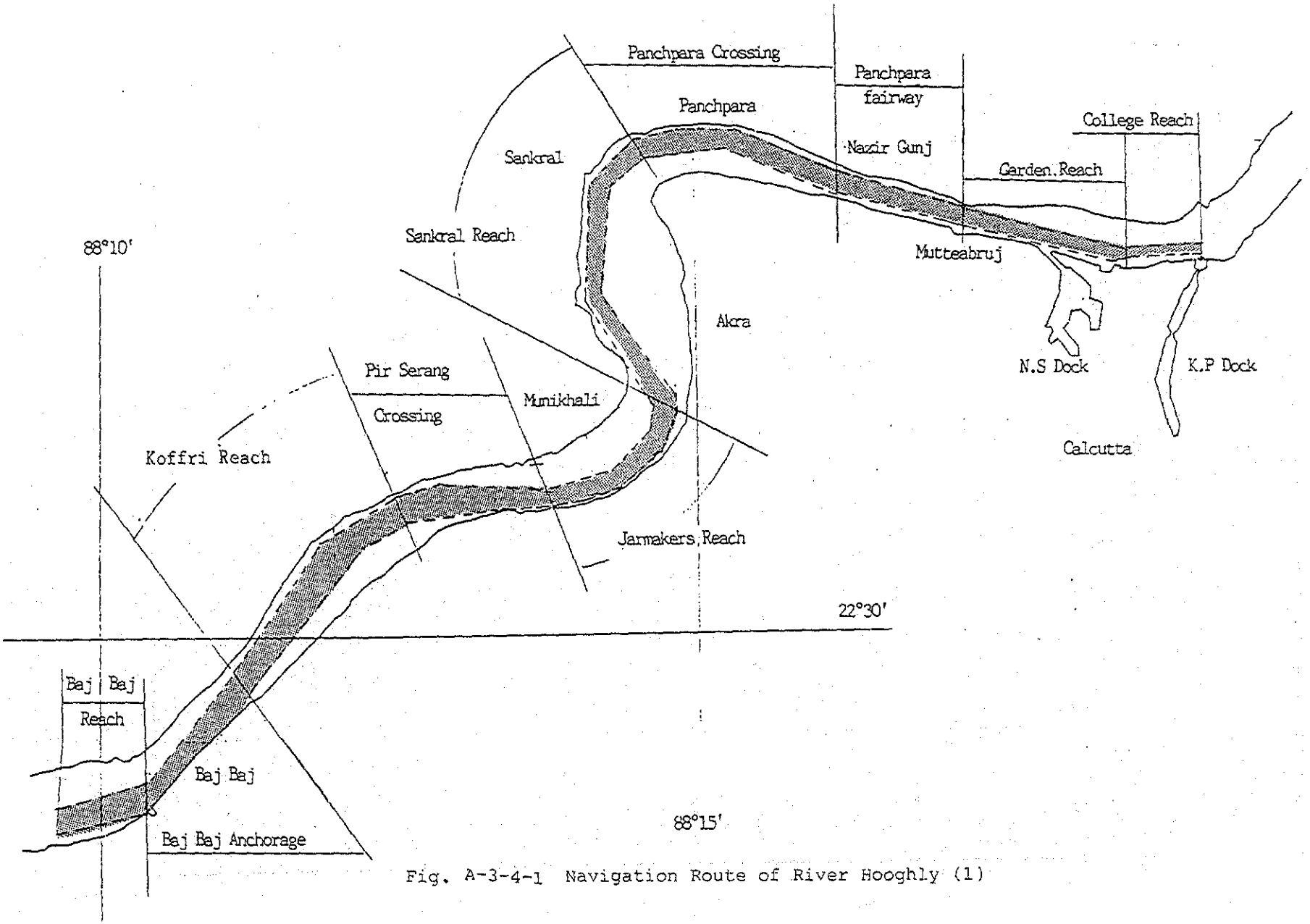


Fig. A-3-4-1 Navigation Route of River Hooghly (1)

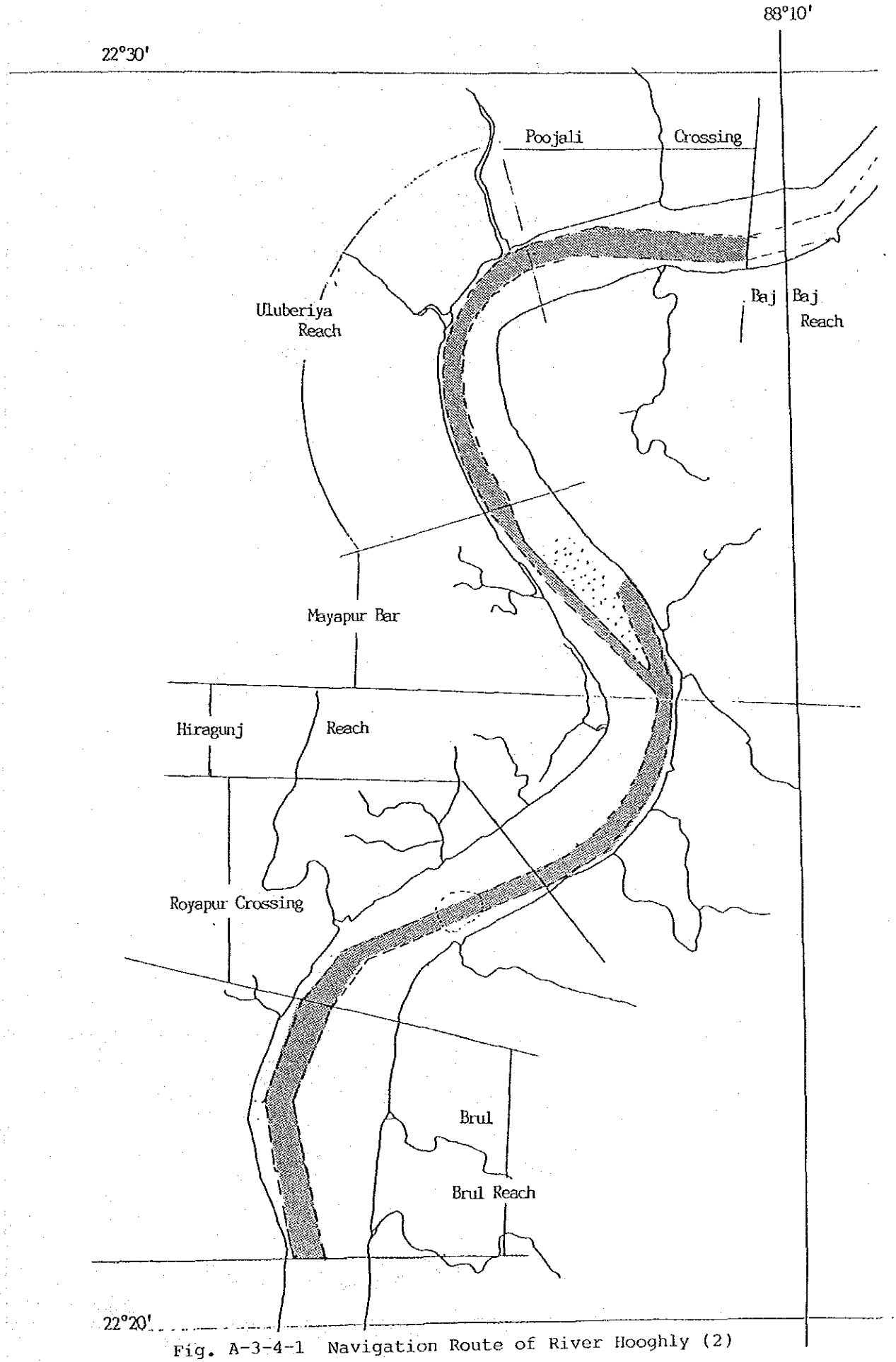


Fig. A-3-4-1 Navigation Route of River Hooghly (2)

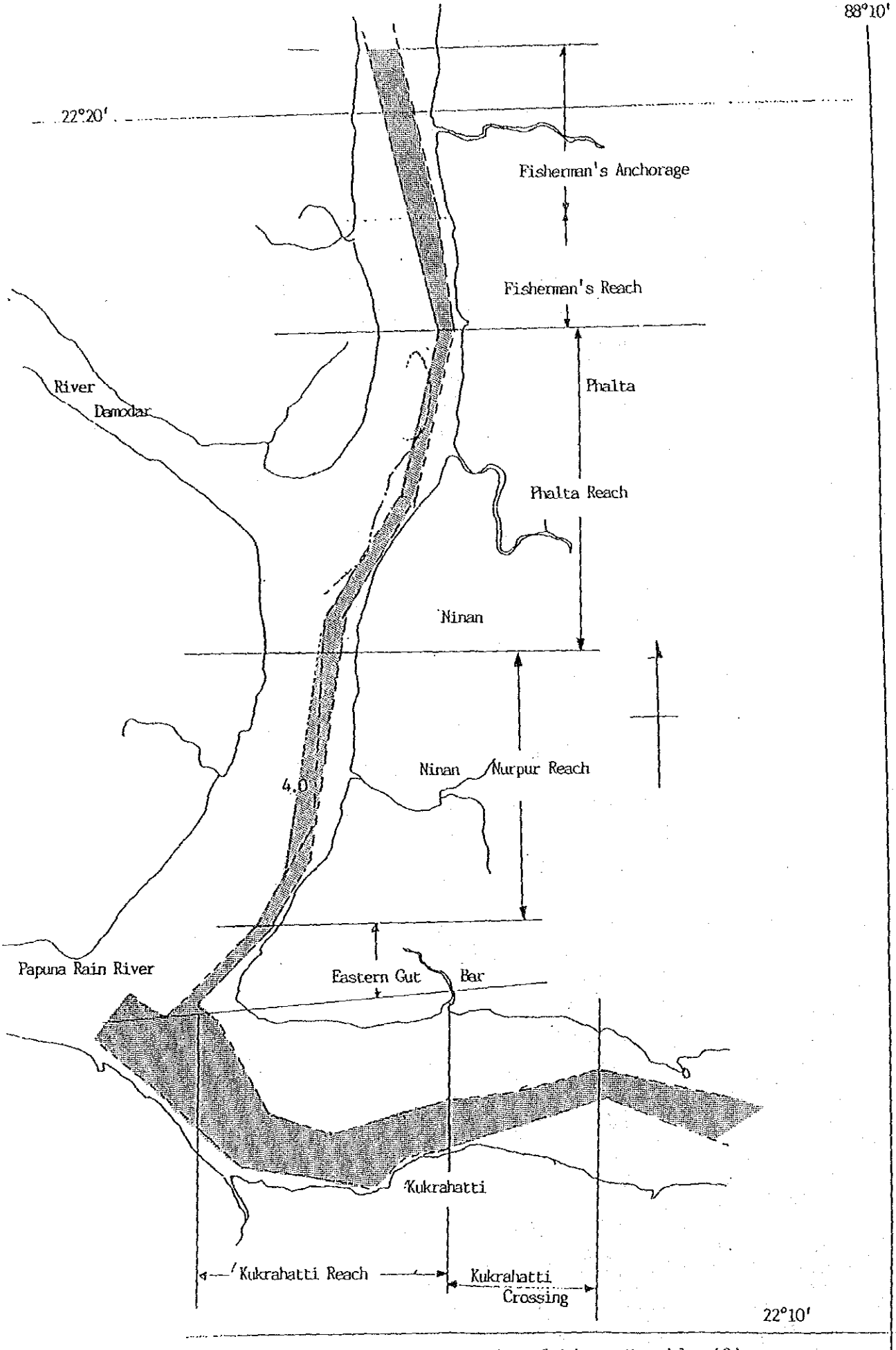


Fig. A-3-4-1 Navigation Route of River Hooghly (3)

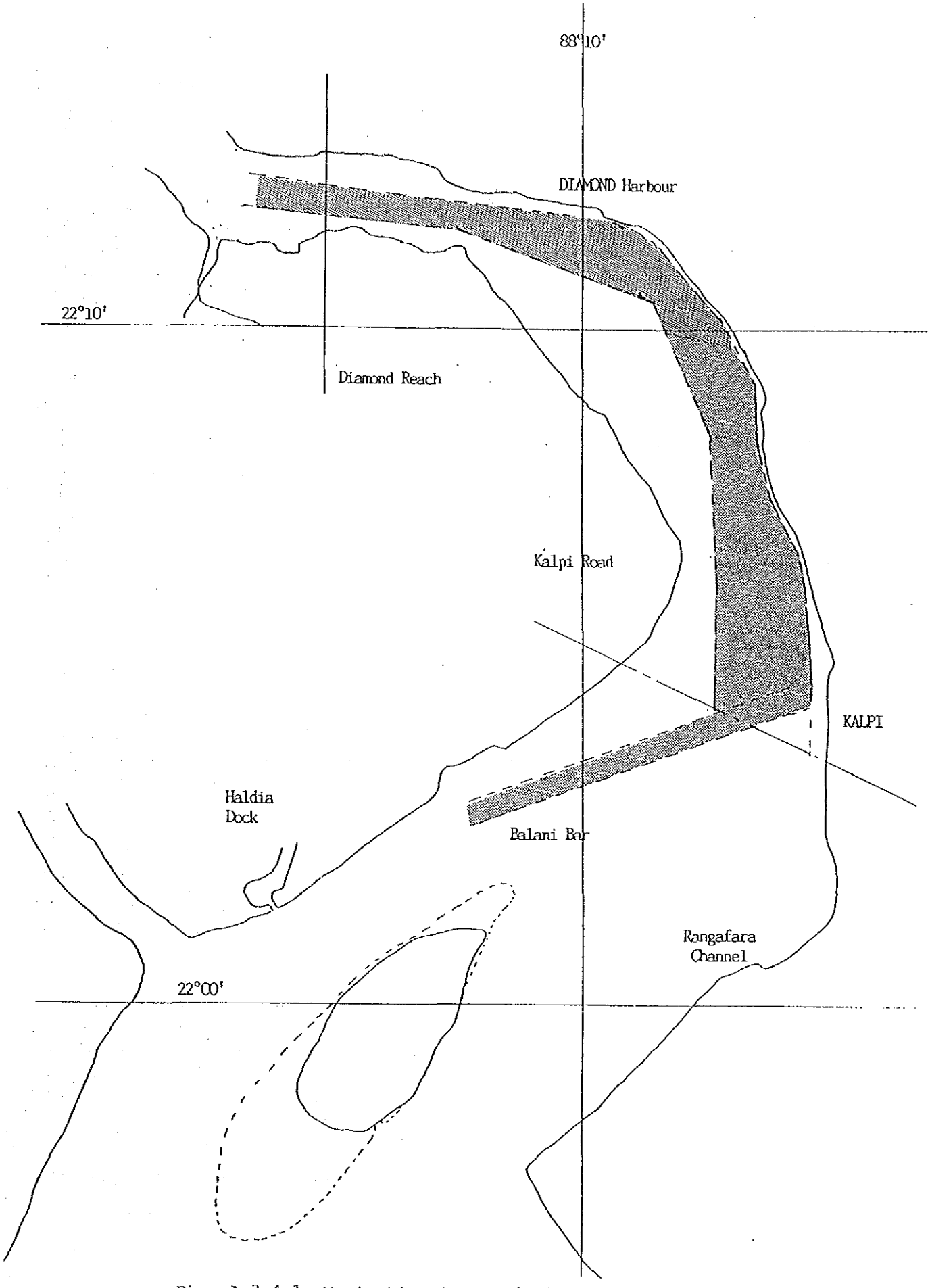


Fig. A-3-4-1 Navigation Route of River Hooghly (4)

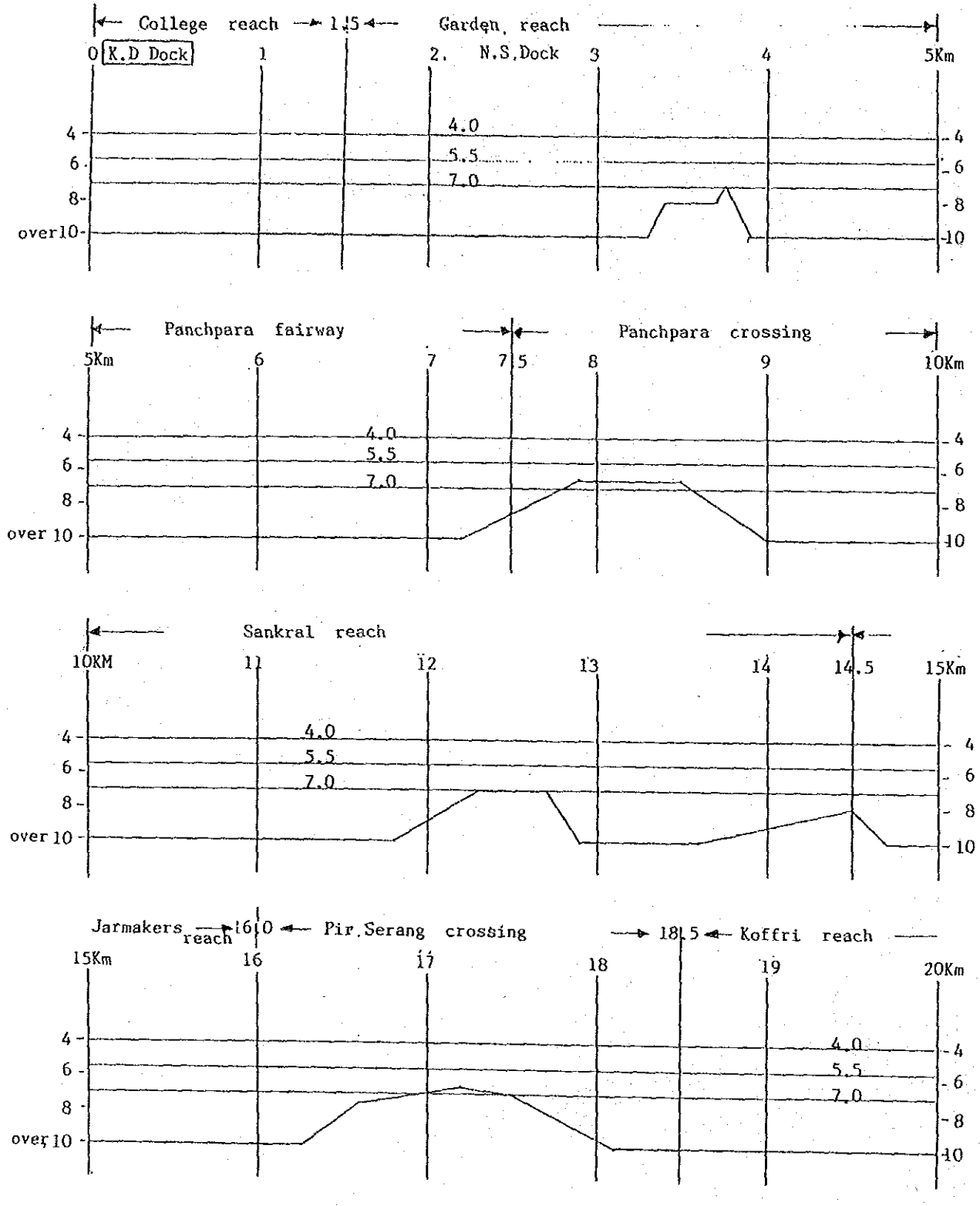


Fig. A-3-4-2 Bottom Profile of Existing Channel at River Hooghly (1)

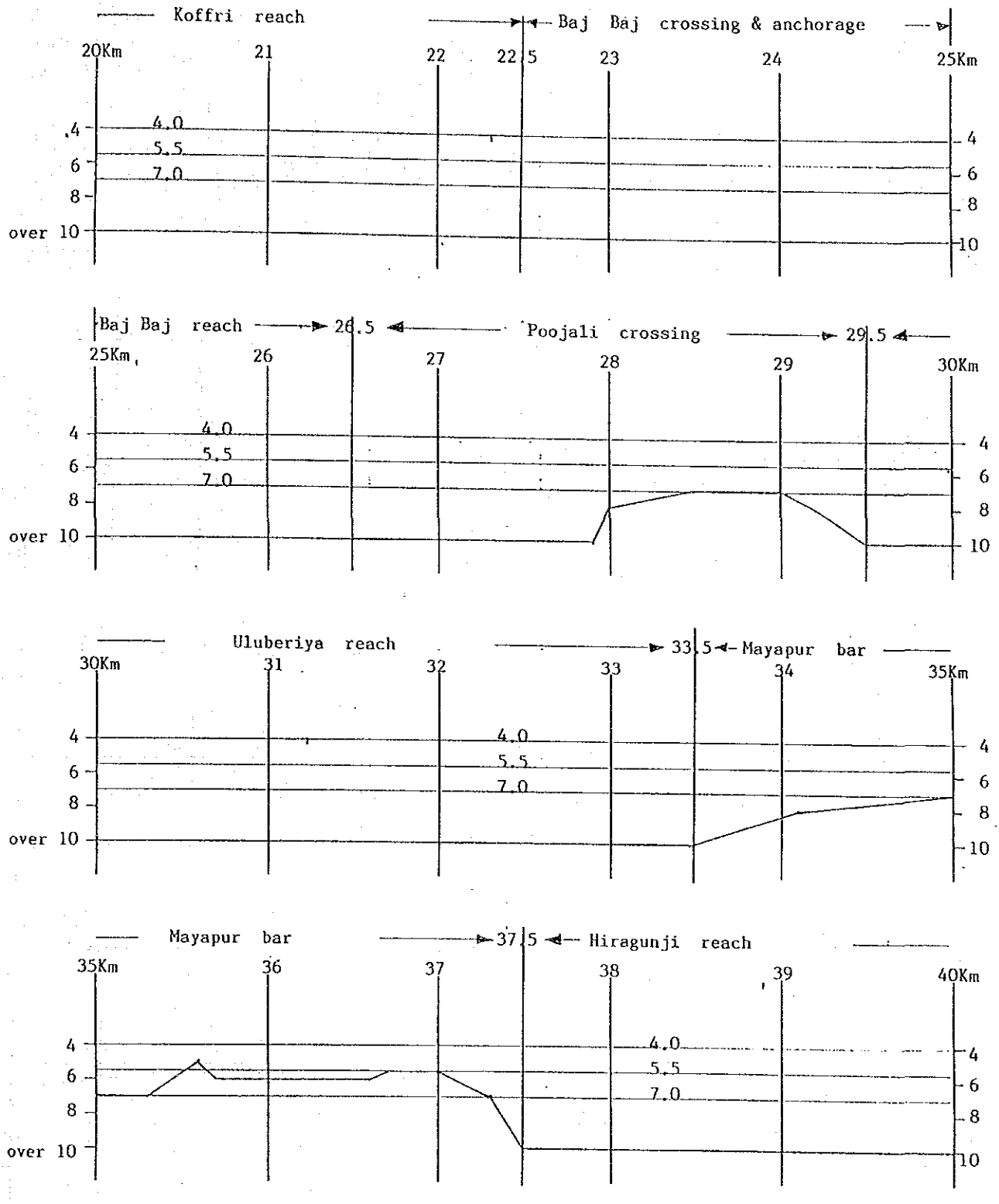


Fig. A-3-4-2 Bottom Profile of Existing Channel at River Hooghly (2)

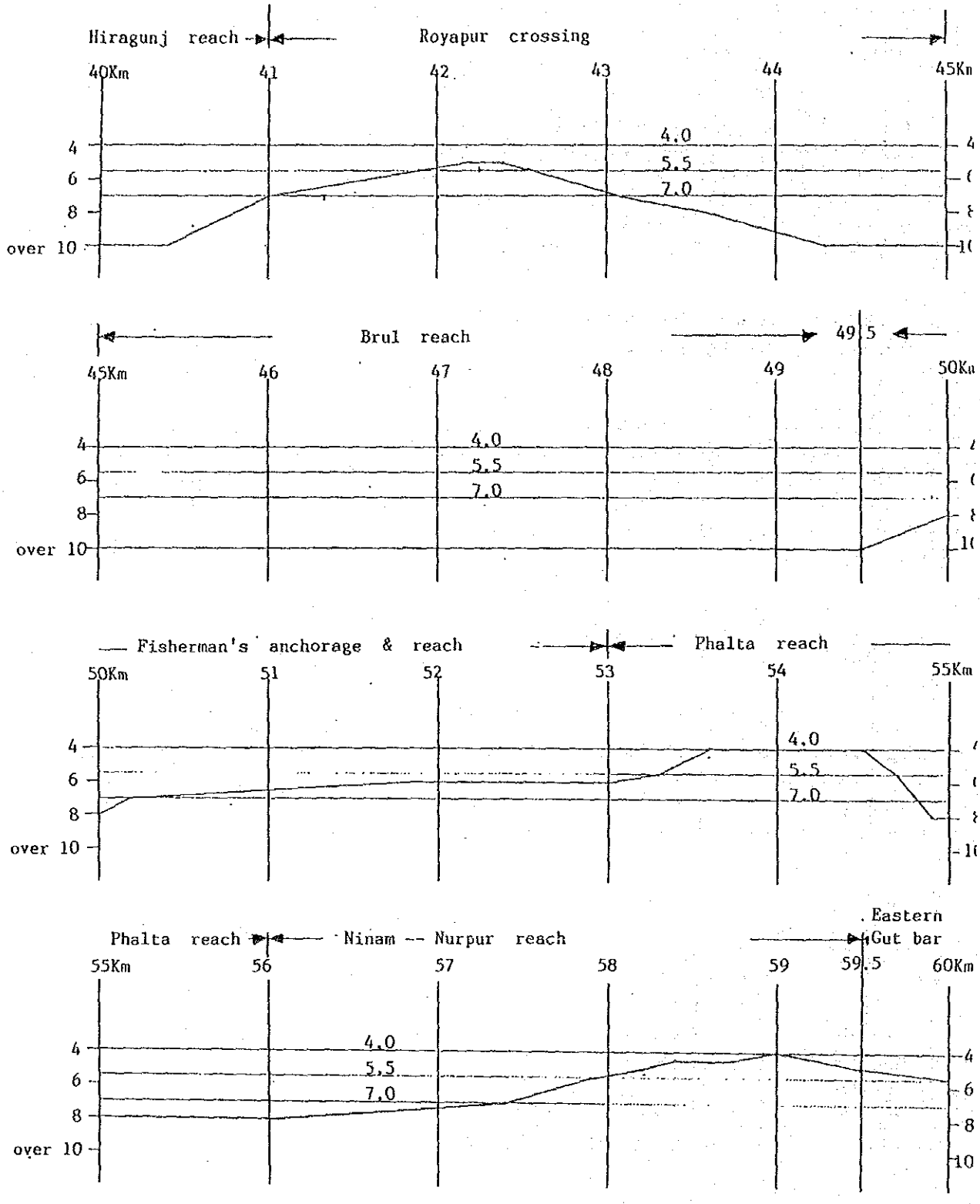


Fig. A-3-4-2 Bottom Profile of Existing Channel at River Hooghly (3)

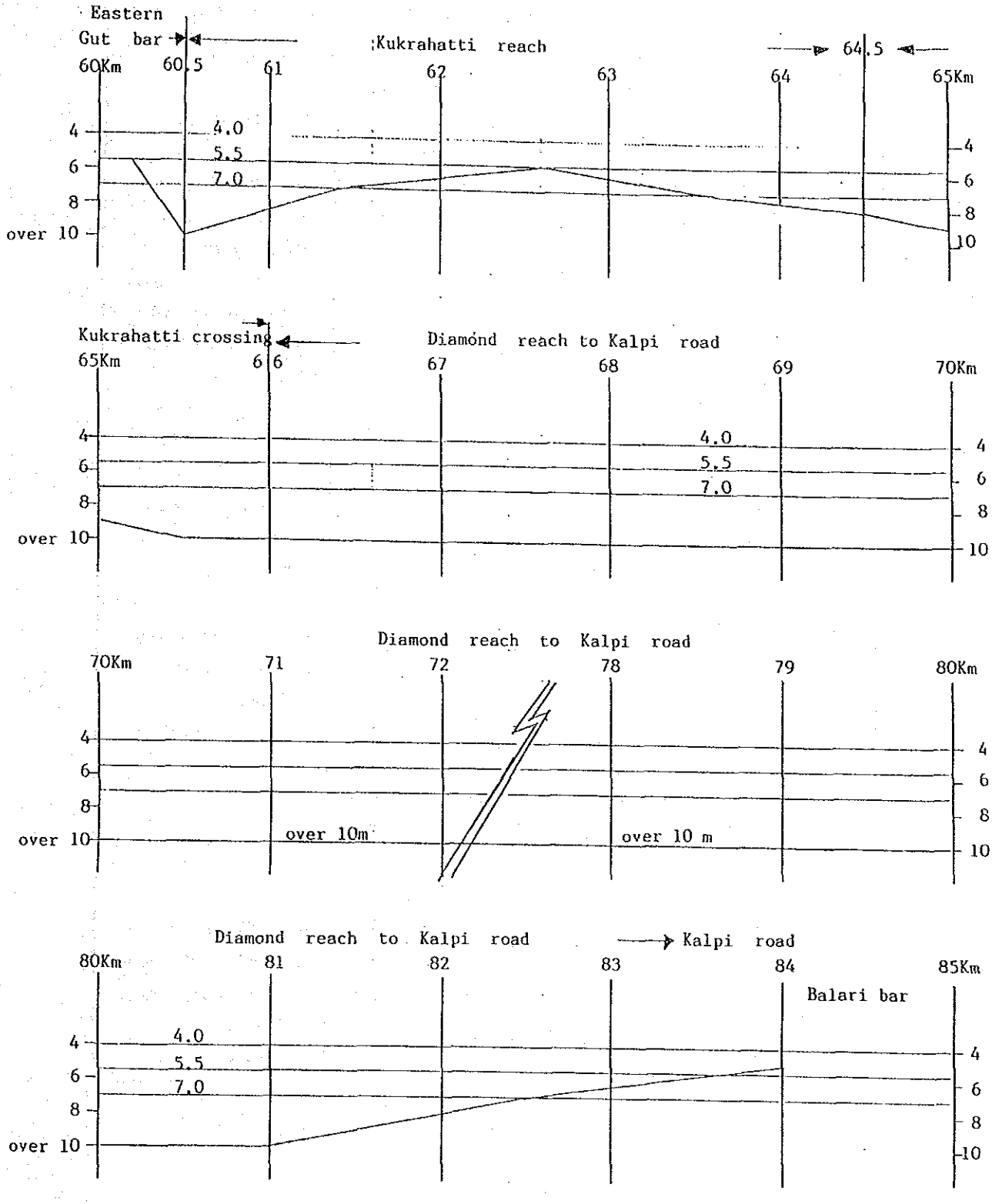


Fig. A-3-4-2 Bottom Profile of Existing Channel at River Hooghly (4)

Table A-3-4-2 Channels to Calcutta & Haldia at River Hooghly Estuary

Name of Channel		Distance (Km)		Latest	Remarks
		Length	Accum.	Sounding	
Balari	Balari Bar	8	8	12 / 1987	The sedimentation of this area is increasing year by year, therefore the channel has not been used since 1987.
Rangafala	Kalpi Roads				
	Rangafala Channel	23	23	7 / 1988	
	Rangafala Crossing	13	36	7 / 1988	This channel has been used since 1987 instead of Balari Channel.
	Jellingham Channel				
Haldia	Haldia Channel	9.5	9.5	4 / 1988	at 3.0Km Haldia Lock at 9.5Km Sandic Column
	Upper Jellingham Shoal	8.5	18.0	4 / 1988	at 13.5Km Gangra Senaphore
	Jellingham Crossing	4.5	22.5	4 / 1988	
	Upper Auckland Bar	15.0	37.5	2 / 1988	
	Lower Auckland Bar	6.5	44.0	2 / 1988	
Eastern Channel	Sagar Roads	6.0	50.0	1 / 1988	Anchorage
	Middleton Bar	19.0	69.0	3 / 1988	at 57~60Km West Side Bar at 61~64Km East Side Bar
	Gasper Channel	12.0	81.0	2 / 1988	Lower Gasper Light Vessel
	Eastern Channel	54.0	135.0		Sand Head

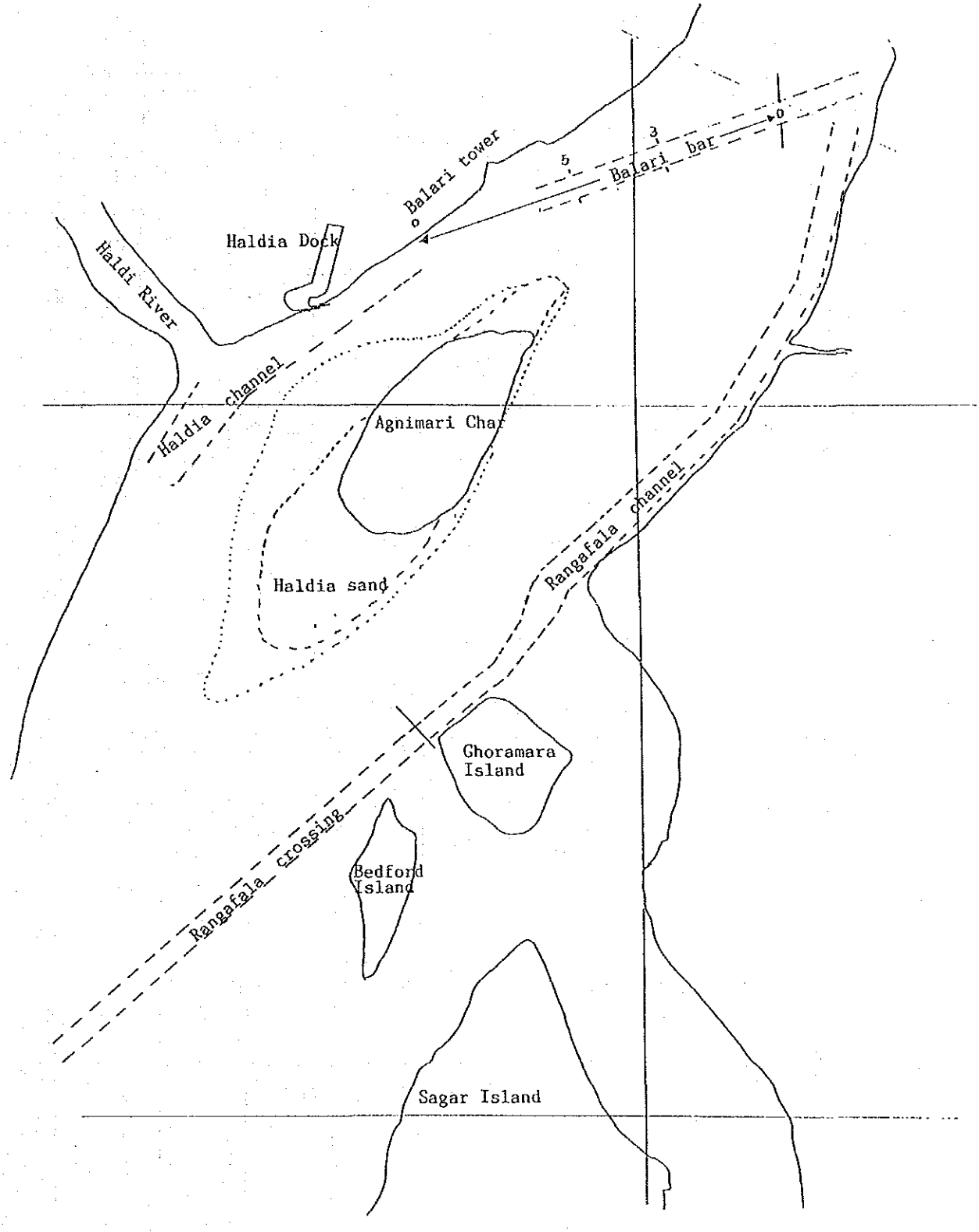
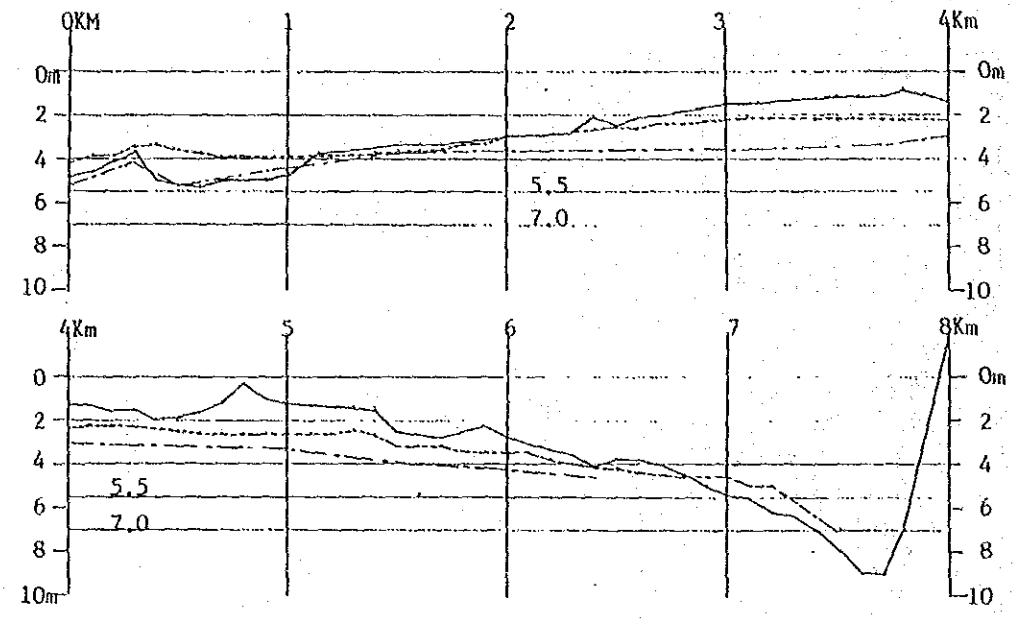


Fig. A-3-4-3 Channels at the Estuary



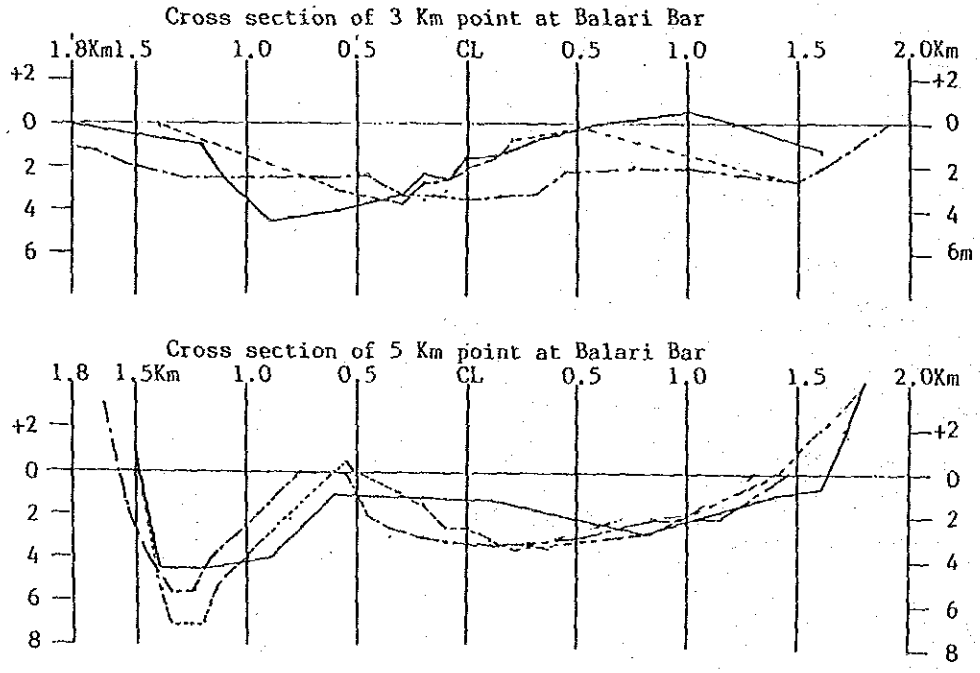


Fig. A-3-4-4 Bottom Profile of Balari Bar

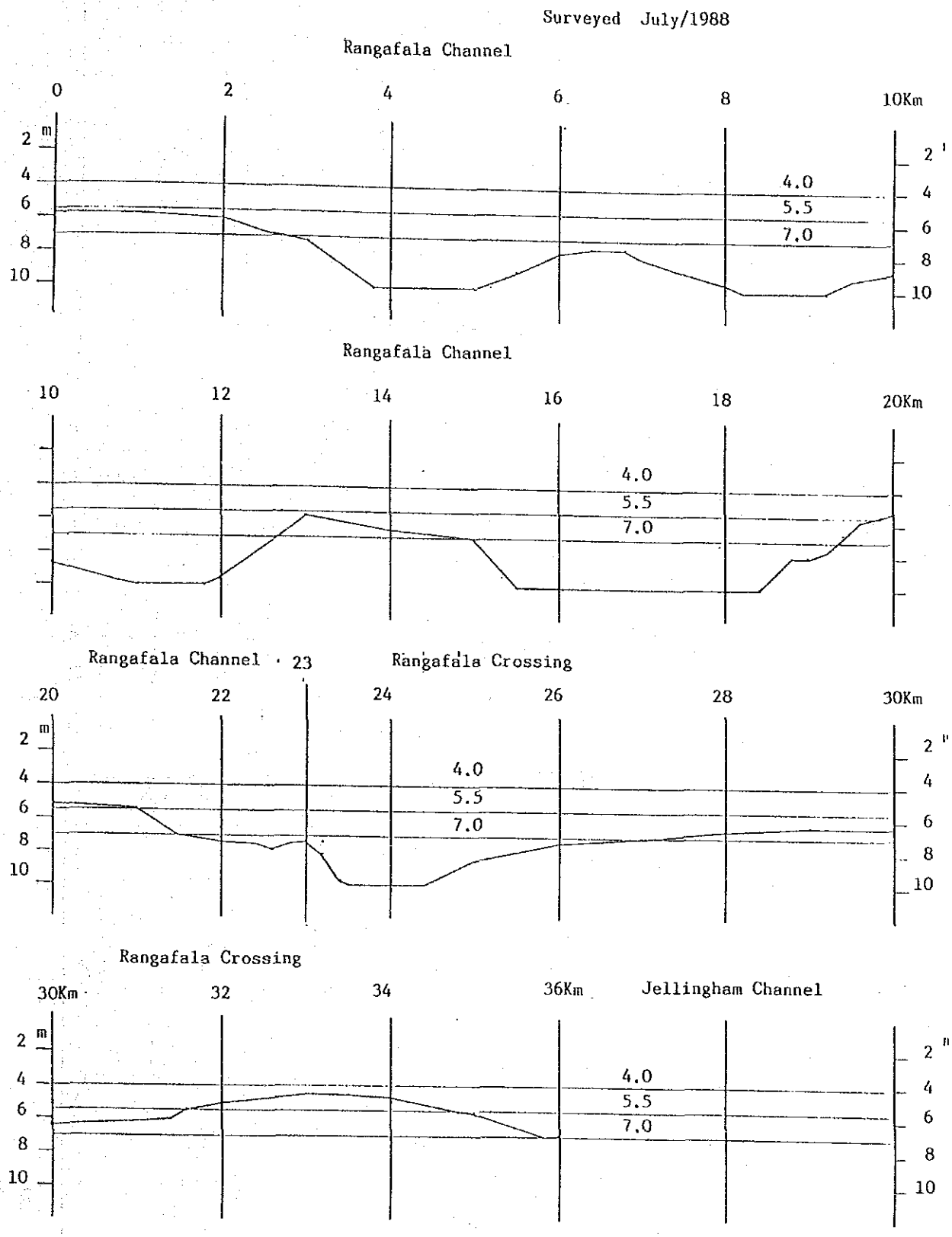


Fig. A-3-4-5 Bottom Profile of Rangafala

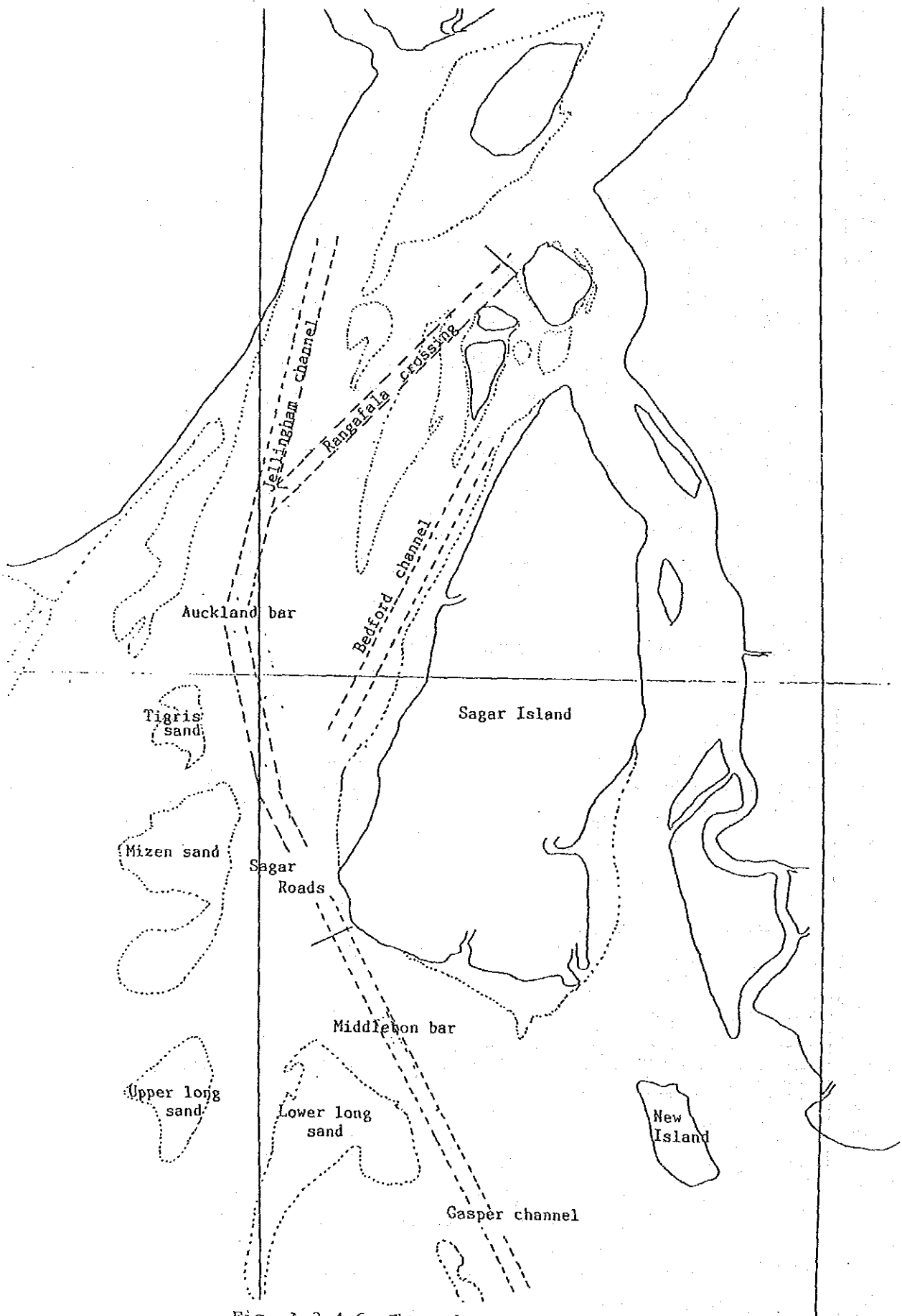


Fig. A-3-4-6 Channels at the Estuary

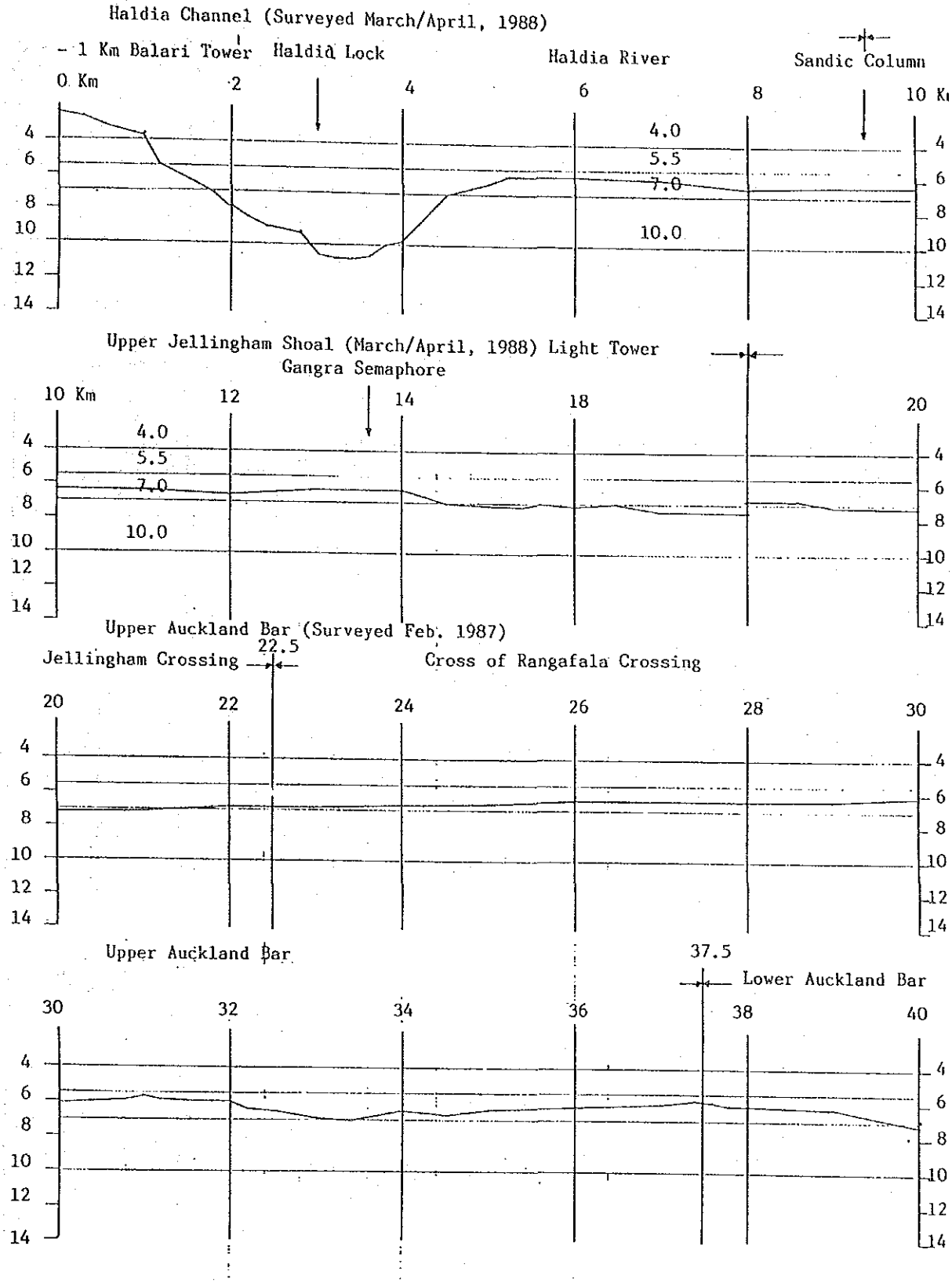


Fig. A-3-4-7 Bottom Profile of the Estuary (1)

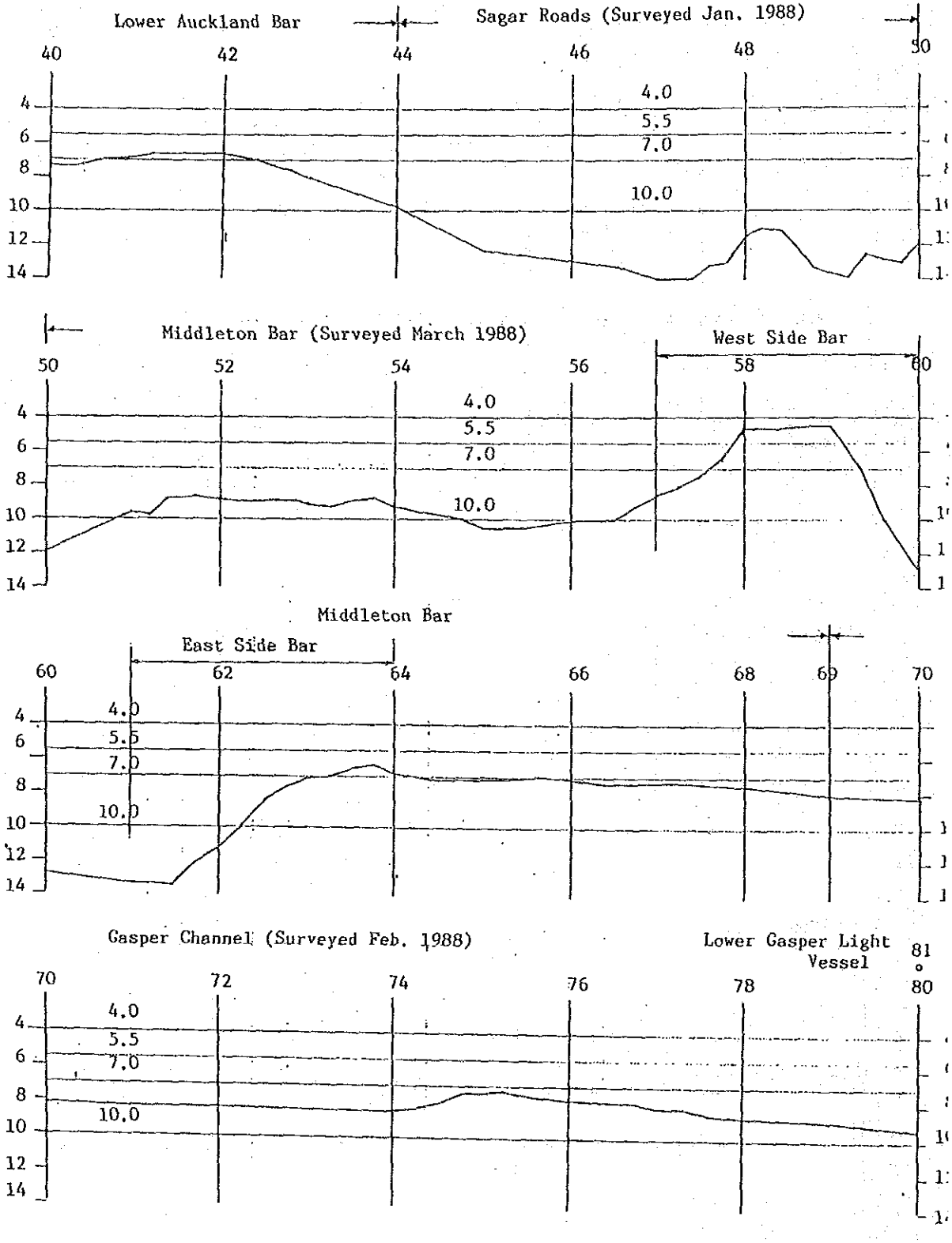


Fig. A-3-4-7 Bottom Profile of the Estuary (2)

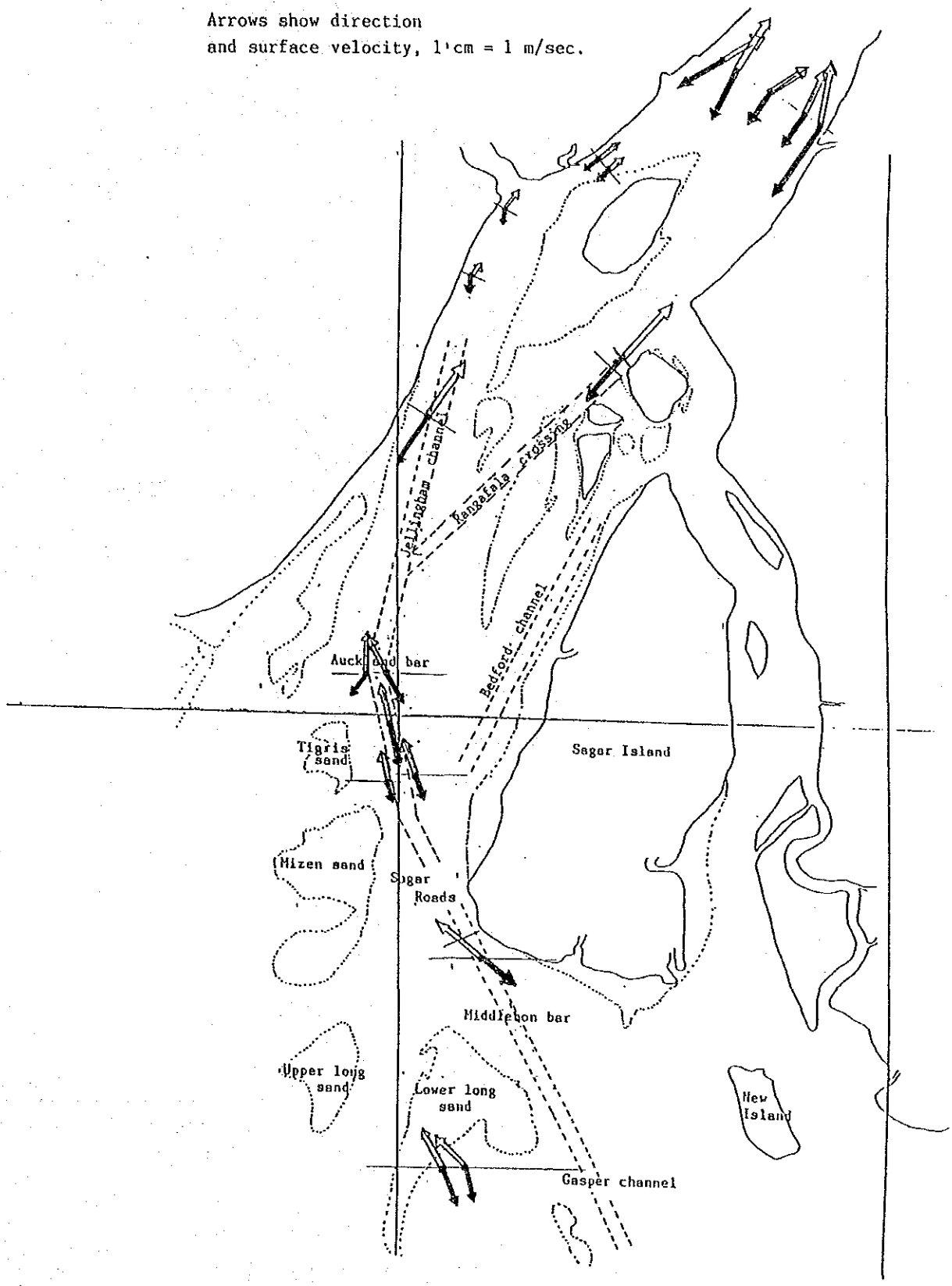


Fig. A-3-4-8 Maximum Surface Current Velocity

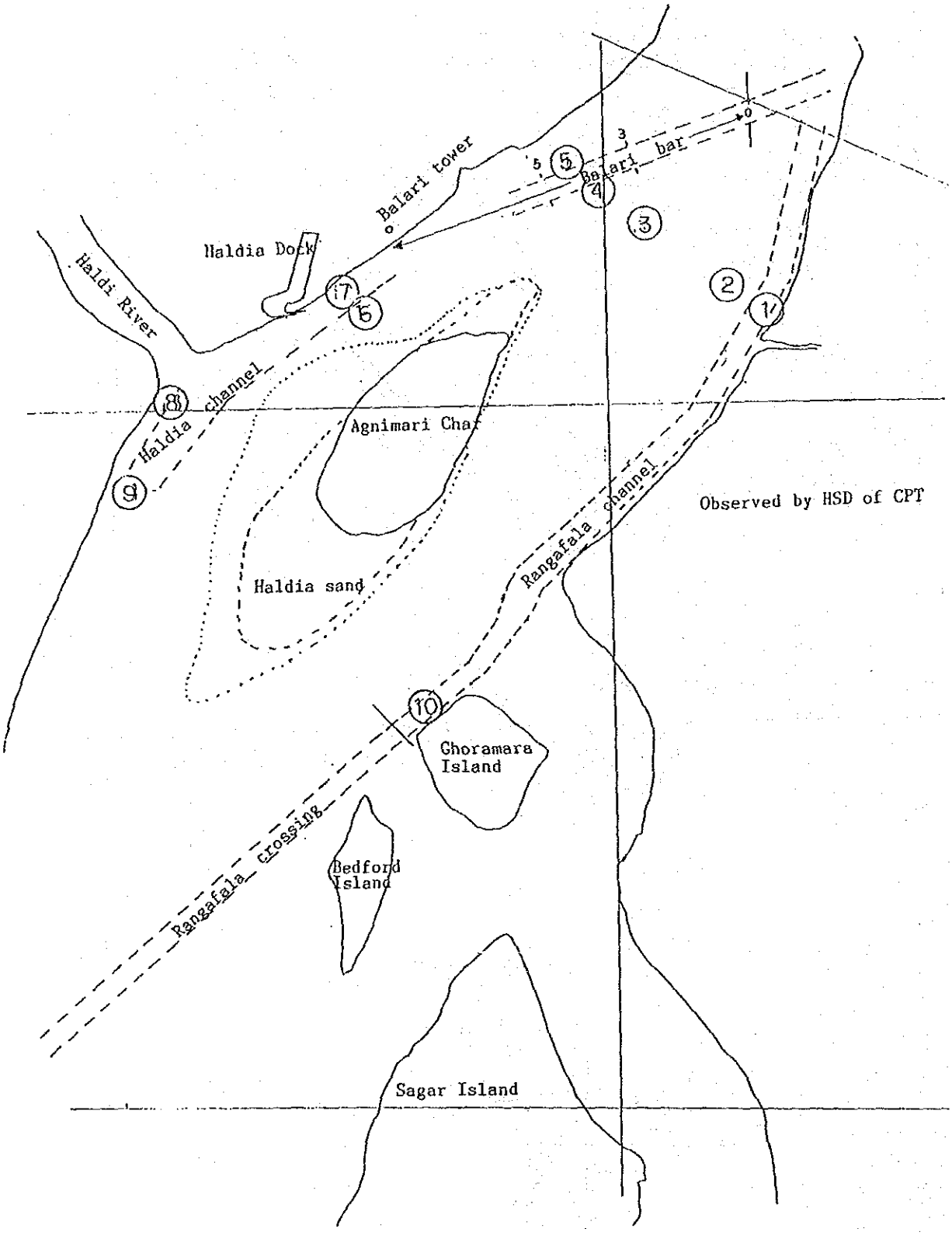


Fig. A-3-4-9 Surface Current Observation at the Estuary (1)

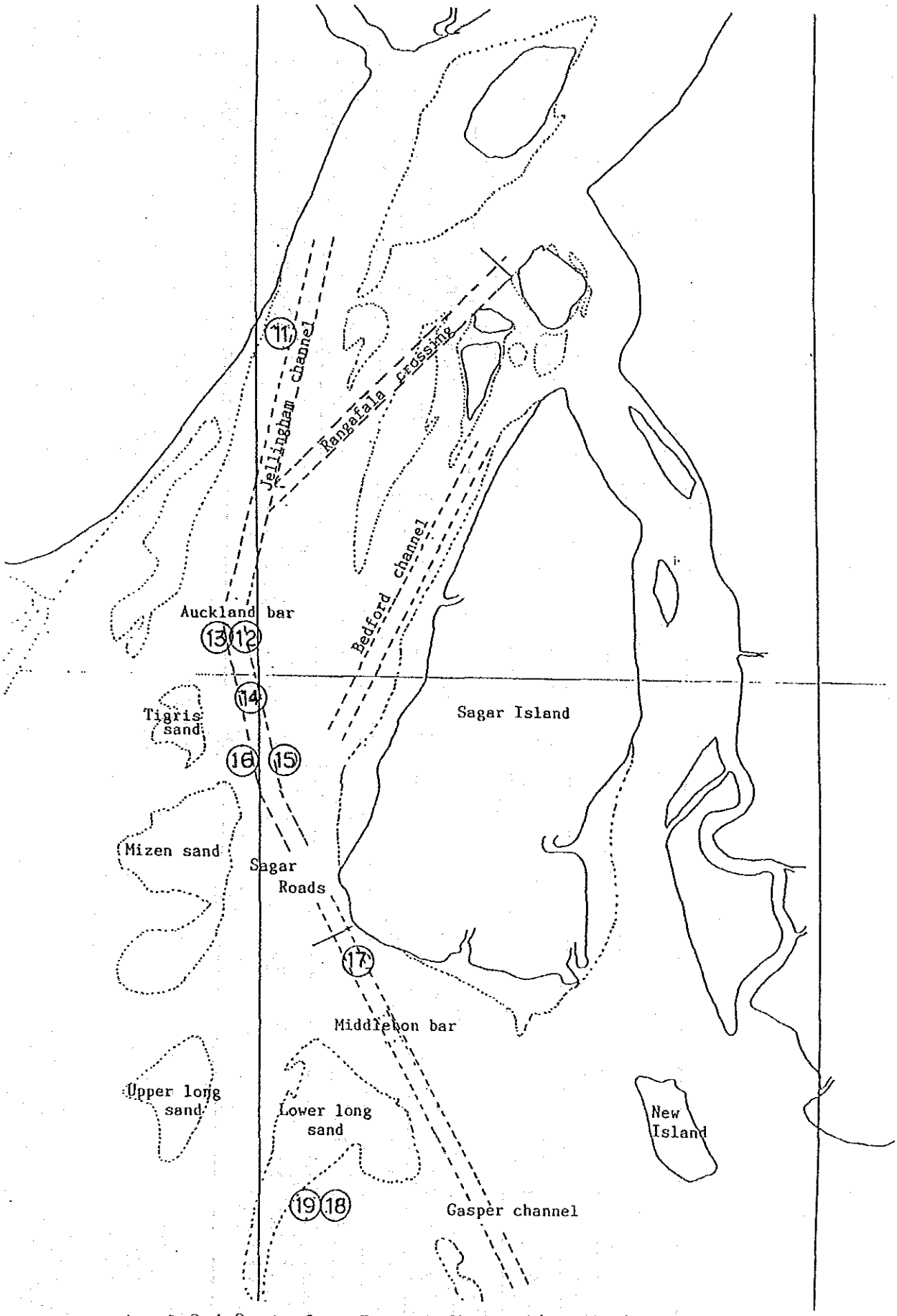


Fig. A-3-4-9 Surface Current Observation at the Estuary (2)

Table A-3-4-3 Surface Current at the Estuary (1)

No.	Observed Time		Velocity	Direction		Tide		Remarks
	Day	Time	m/sec	Stream	Degree	(m) Tide	Ebb /Flood	
①	17/Feb. 1984	8	0.8	up	40° E	1.5	Flood	Tide range
		9	0.8	〃	20° E	3.2	〃	4.95m
		10	1.25	〃	20° E	4.5	〃	High tide
		11	1.3	〃	15° E	5.2	High	5.25m
		12	1.3	〃	15° E	5.2	〃	11h19m
		13	1.15	〃	25° E	4.4	Ebb	Low tide
		14	0	〃	0	3.8	〃	0.30m
		15	0.2	〃	70° E	2.8	〃	18h54m
		16	1.8	down	0	2.0	〃	
		17	1.2	〃	5° W	1.3	〃	
		18	0.6	〃	15° W	0.8	〃	
		19	0.45	〃	10° W	0.4	Low	
	18/Feb. 1984	8	0.3	up	55° E	0.6	Flood	Tide range
		9	0.7	〃	15° E	2.0	〃	5.27m
		10	1.25	〃	20° E	4.0	〃	High tide
		11	1.4	〃	10° E	5.1	〃	5.46m
		12	1.4	〃	10° E	5.4	〃	11h59m
		13	1.3	〃	15° E	5.1	High	Low tide
		14	1.0	〃	15° E	4.3	Ebb	0.24m
		15	0.8	down	0	3.4	〃	07h30m
		16	1.7	〃	0	2.6	〃	0.24m
		17	1.7	〃	0	1.8	〃	19h38m
		18	0.8	〃	0	1.1	〃	
		19	0.35	〃	50° W	0.5	Low	

Table A-3-4-3 Surface Current at the Estuary (2)

No.	Observed Time		Velocity	Direction		Tide		Remarks
	Day	Time	m/sec	Stream	Degree	(m) Tide	Ebb /Flood	
③	20/Feb. 1984	8	0.25	up	50° E	0.4	Low	
		9	0.85	〃	20° E	0.6	Flood	Tide Range
		10	1.2	〃	25° E	1.1	〃	4.93m
		11	1.3	〃	20° E	2.8	〃	High Tide
		12	1.3	〃	10° E	4.3	〃	5.41m
		13	1.2	〃	10° E	5.3	High	13h26m
		14	1.15	〃	10° E	5.1	〃	Low Tide
		15	0.5	down	15° W	4.2	Ebb	0.25m
		16	1.9	〃	0	3.1	〃	08h48m
		17	1.55	〃	0	2.3	〃	
		18	0.9	〃	5° E	1.5	〃	
		19	0.15	〃	15° W	0.8	Low	
②	17/Feb. 1984	8	0.2	up	80° E	1.5	Flood	
		9	0.5	〃	20° E	3.2	〃	
		10	0.8	〃	0	4.5	〃	Tide Range
		11	0.95	〃	0	5.2	High	4.95m
		12	0.95	〃	0	5.2	〃	High Tide
		13	1.0	〃	5° E	4.4	Ebb	5.25m
		14	0.55	〃	0	3.8	〃	11h19m
		15	0	—	—	2.8	〃	Low Tide
		16	0.55	down	5° E	2.0	〃	0.30m
		17	0.5	〃	55° W	1.3	〃	18h54m
		18	0.6	〃	5° W	0.8	〃	
		19	0.25	〃	0	0.4	Low	

Table A-3-4-3 Surface Current at the Estuary (3)

No.	Observed Time		Velocity	Direction		Tide		Remarks
	Day	Time	m/sec	Stream	Degree	(m) Tide	Ebb /Flood	
②	18/Feb. 1984	8	0	—	—	0.6	Flood	Tide Range
		9	0.7	up	15° E	2.0	〃	5.22m
		10	1.15	〃	15° W	4.0	〃	High Tide
		11	1.10	〃	5° E	5.1	〃	5.46m
		12	1.10	〃	5° W	5.4	High	11h59m
		13	0.95	〃	0	5.1	Ebb	Low Tide
		14	0.85	〃	5° W	4.3	〃	0.24m
		15	0.05	〃	80° W	3.4	〃	07h30m
		16	0.95	down	10° E	2.6	〃	0.24m
		17	0.7	〃	5° W	1.8	〃	19h38m
		18	0.8	〃	5° E	1.1	〃	
		19	0.3	〃	5° W	0.5	Low	
③	17/Feb. 1984	8	0.05	up	30° W	1.5	Flood	
		9	0	—	—	3.2	〃	Tide Range
		10	0.8	up	20° W	4.5	〃	4.95m
		11	0.7	〃	25° W	5.2	High	High Tide
		12	0.8	〃	20° W	5.2	〃	5.25m
		13	0.7	〃	25° W	4.4	Ebb	11h19m
		14	0.45	〃	10° W	3.6	〃	Low Tide
		15	0.3	down	20° W	2.8	〃	0.3 〃
		16	0.7	〃	0	2.0	〃	18h54m
		17	0.85	〃	5° E	1.3	〃	
		18	0.7	〃	5° E	0.8	〃	
		19	0.4	〃	0	0.4	Low	

Table A-3-4-3 Surface Current at the Estuary (4)

No.	Observed Time		Velocity	Direction		Tide		Remarks
	Day	Time	m/sec	Stream	Degree	(m) Tide	Ebb /Flood	
①	18/Feb. 1984	8	0.45	up	15° W	0.6	Flood	
		9	0.8	〃	30° W	2.0	〃	Tide Range
		10	0.8	〃	30° W	4.0	〃	5.22m
		11	0.8	〃	20° W	5.1	〃	High Tide
		12	0.7	〃	30° W	5.4	High	5.40m
		13	0.8	〃	30° W	5.1	Ebb	11h59m
		14	0.5	〃	20° W	4.3	〃	Low Tide
		15	0.6	down	15° W	3.4	〃	0.24m
		16	0.8	〃	0 W	2.6	〃	7h30m
		17	0.7	〃	20° E	1.8	〃	19h38m
		18	0.5	〃	10° W	1.1	〃	
		19	0.15	〃	30° E	0.5	Low	
	20/Feb. 1984	8	0.1	up	15° W	0.4	Low	
		9	0.5	〃	30° W	0.6	Flood	
		10	0.95	〃	30 W	1.1	〃	Tide Range
		11	0.95	〃	20 W	2.8	〃	4.93m
		12	0.95	〃	30 W	4.3	〃	High Tide
		13	0.8	〃	30° W	5.3	High	5.41m
		14	0.7	〃	20° W	5.1	〃	13h26m
		15	0.3	down	15° W	4.2	Ebb	Low Tide
		16	0	〃	0	3.1	〃	0.25m
		17	0.7	〃	20° E	2.3	〃	8h48m
		18	0.5	〃	5° W	1.5	〃	
		19	0.3	〃	10° E	0.8	〃	

Table A-3-4-3 Surface Current at the Estuary (5)

No.	Observed Time		Velocity	Direction		Tide		Remarks
	Day	Time	m/sec	Stream	Degree	(m) Tide	Ebb /Flood	
④	17/Feb. 1984	8	0.2	down	20° E	1.5	Flood	Tide Range
		9	0.6	up	25° E	3.2	"	4.95m
		10	1.1	"	20° E	4.5	"	High Tide
		11	1.1	"	20° E	5.2	High	5.25m
		12	0.9	"	15° E	5.2	"	11h19m
		13	0.6	"	10° E	4.4	Ebb	Low Tide
		14	0.4	"	5° W	3.6	"	0.30m
		15	0.6	down	10° W	2.8	"	18h54m
		16	1.1	"	0	2.0	"	
		17	1.0	"	5° W	1.3	"	
		18	0.6	"	15° W	0.8	"	
		19	0.3	"	5° E	0.4	Low	
	18/Feb. 1984	8	0.45	down	45° E	0.6	Flood	
		9	0.5	up	15° E	2.6	"	Tide Range
		10	1.1	"	15° E	4.0	"	5.22m
		11	1.1	"	10° E	5.1	"	High Tide
		12	1.0	"	5° E	5.4	High	5.46m
		13	0.7	"	5° E	5.1	Ebb	11h59m
		14	0.5	"	5° E	4.3	"	Low Tide
		15	0.45	down	25° W	3.4	"	0.24m
		16	1.1	"	0	2.6	"	7h30m
		17	0.9	"	15° W	1.8	"	19h38m
		18	0.7	"	25° W	1.1	"	
		19	0.8	"	5° E	0.5	Low	

Table A-3-4-3 Surface Current at the Estuary (6)

No.	Observed Time		Velocity	Direction		Tide		Remarks
	Day	Time	m/sec	Stream	Degree	(m) Tide	Ebb /Flood	
④	20/Feb. 1984	8	0.2	—	90° E	0.4	Low	
		9	0.9	up	10° E	0.6	Flood	Tide Range
		10	1.2	"	10° E	1.1	"	4.93m
		11	1.25	"	0	2.8	"	High Tide
		12	0.9	"	0	4.3	"	5.41m
		13	0.7	"	0	5.3	High	13h26m
		14	0.5	"	0	5.1	"	Low Tide
		15	0	—	—	4.2	Ebb	0.25m
		16	1.25	down	25° W	3.1	"	8h48m
		17	1.05	"	15° W	2.3	"	
		18	0.8	"	15° W	1.5	"	
		19	0.65	"	0	0.8	"	
⑤	20/Feb. 1984	8	0.4	up	0	0.4	Low	
		9	1.0	"	20° W	0.6	Flood	
		10	1.0	"	20° W	1.1	"	Tide Range
		11	0.95	"	40° W	2.8	"	4.03m
		12	0.5	"	65° W	4.3	"	High Tide
		13	0.45	"	55° W	5.3	High	5.41m
		14	0.3	—	90° W	5.1	"	13h26m
		15	0.95	—	80° E	4.2	Ebb	Low Tide
		16	1.05	down	30° E	3.1	"	0.25m
		17	1.10	"	50° E	2.3	"	8h48m
		18	0.95	"	35° E	1.5	"	
		19	0.4	"	35° E	0.8	"	

Table A-3-4-3 Surface Current at the Estuary (7)

No.	Observed Time		Velocity	Direction		Tide		Remarks
	Day	Time	m/sec	Stream	Degree	(m) Tide	Ebb /Flood	
⑥	21/Aug. 1980	16	0.3	down	0	3.8	Flood	
		17	0.35	〃	5° E	4.0	〃	
		18	0.25	〃	50° W	4.3	High	
⑦	22/Aug. 1980	8	0.05	down	45° W	4.5	Ebb	
		9	0	—	—	4.2	〃	
		10	0.35	up	10° E	3.7	〃	
		11	0.5	〃	5° E	3.0	〃	
		12	0.55	〃	0	2.5	〃	
		13	0.4	〃	0	2.2	Low	
		14	0	—	—	2.2	〃	
		15	0.15	down	5° W	2.5	Flood	
		16	0.3	〃	5° W	3.2	〃	
		17	0.4	〃	0	3.8	〃	
		18	0.3	〃	0	4.5	〃	
		19	0.15	〃	0	4.6	〃	

Table A-3-4-3 Surface Current at the Estuary (8)

No.	Observed Time		Velocity	Direction		Tide		Remarks
	Day	Time	m/sec	Stream	Degree	(m) Tide	Ebb /Flood	
⑤	4/Sep. 1980	10	0.4	up	15° W	3.2	Ebb	Tide Range
		11	0.4	〃	10° W	2.7	〃	2.4 m
		12	0.5	〃	10° W	2.4	〃	High Tide
		13	0.3	〃	15° W	2.2	Low	4.6 m
		14	0.2	〃	25° W	2.4	Flood	Low Tide
		15	0	—	—	2.7	〃	2.2 m
		16	0.25	down	10° W	3.4	〃	
		17	0.3	〃	10° E	3.8	〃	
		18	0.25	〃	15° W	4.3	〃	
		19	0.15	〃	10° W	4.6	High	
⑤	3/Sep. 1980	8	0	—	—	3.2	Ebb	
		9	0.1	up	30° E	3.0	〃	Tide Range
		10	0.3	〃	10° E	2.7	〃	2.1 m
		11	0.3	〃	10° E	2.5	Low	High Tide
		12	0.3	〃	10° E	2.6	Flood	4.6 m
		13	0	—	—	3.0	〃	Low Tide
		14	0	—	—	3.4	〃	2.5 m
		15	0.1	down	15° W	3.9	〃	
		16	0.25	〃	10° E	4.4	〃	
		17	0.3	〃	10° E	4.5	〃	
		18	0.25	〃	10° W	4.6	High	
		19	0.1	〃	10° E	4.2	Ebb	

Table A-3-4-3 Surface Current at the Estuary (9)

No.	Observed Time		Velocity	Direction		Tide		Remarks
	Day	Time	m/sec	Stream	Degree	(m) Tide	Ebb /Flood	
⑨	15/July 1980	9	0.7	up	5° W	3.5	Flood	
		10	1.2	"	5° W	4.4	"	Tide Range
		11	1.35	"	0	5.3	"	4.3 m
		12	1.55	"	0	5.6	High	High Tide
		13	1.3	"	20° E	5.0	Ebb	5.5 m
		14	0.8	"	10° E	4.1	"	Low Tide
		15	0.9	down	65° W	3.4	"	1.2 m
		16	1.15	"	0	2.6	"	
		17	1.1	"	0	1.8	"	
		18	0.75	"	0	1.5	"	
		19	0.4	"	10° W	1.2	Low	
⑩	21/May 1981	8	0.45	up	15° W	2.8	Flood	
		9	0.75	"	5° W	4.0	"	Tide Range
		10	1.0	"	0	4.8	"	4.1 m
		11	1.4	"	0	5.4	High	High Tide
		12	1.4	"	35° W	5.3	Ebb	5.4 m
		13	1.35	"	30° E	4.8	"	Low Tide
		14	0.4	"	40° E	3.8	"	1.3 m
		15	0.4	down	10° E	3.1	"	
		16	1.0	"	20° E	2.3	"	
		17	1.15	"	10° W	1.7	"	
		18	0.6	"	5° E	1.3	Low	
		19	0.15	"	10° W	1.4	"	

Table A-3-4-3 Surface Current at the Estuary (10)

No.	Observed Time		Velocity	Direction		Tide		Remarks
	Day	Time	m/sec	Stream	Degree	(m) Tide	Ebb /Flood	
⑱	25/Apr. 1981	9	0.4	up	S20° E	2.8	Flood	
		10	0.65	"	S40° E	3.4	"	Tide Range
		11	0.8	"	S30° E	4.0	"	1.8 m
		12	0.85	"	S20° E	4.3	"	High Tide
		13	0.4	"	S40° E	4.5	High	4.5 m
		14	0.3	"	S50° E	4.2	Ebb	13h28m
		15	0.3	down	N30° E	3.7	"	Low Tide
		16	0.7	"	N15° W	3.0	"	1.7 m
		17	0.5	"	N30° W	2.5	"	
		18	0.4	"	N15° W	2.0	"	
		19	0.2	"	N15° W	1.7	Low	
⑲	3/Feb. 1981	9	0.7	up	S20° W	4.2	Ebb	
		10	0.9	"	S 5° E	3.8	"	
		11	0.8	"	S 0°	3.4	"	Tide Range
		12	0.8	"	S 0°	2.5	"	3.7 m
		13	0.4	"	S20° E	1.8	"	High Tide
		14	0.3	down	N40° E	1.3	"	4.7 m
		15	0.55	"	N40° E	1.1	"	Low Tide
		16	0.5	"	N50° E	1.0	Low	1.0 m
		17	0.4	"	N60° E	1.0	Flood	
		18	0.2	East	East	2.5	"	
		10	0.55	up	S 0°	3.6	"	
		20	0.6	"	S 5° W	3.3	"	

Table A-3-4-3 Surface Current at the Estuary (11)

No.	Observed Time		Velocity	Direction		Tide		Remarks
	Day	Time	m/sec	Stream	Degree	(m) Tide	Ebb /Flood	
⑭	24/Apr. 1981	8	0.2	down	N60° W	2.2	Flood	
		9	0.6	up	S 0°	3.1	〃	
		10	0.8	〃	S20° E	3.6	〃	Tide Range
		11	0.9	〃	S15° E	4.3	〃	3.1 m
		12	0.8	〃	S20° E	4.7	High	High Tide
		13	0.3	〃	S20° E	4.6	Ebb	4.7 m
		14	0.2	down	N55° E	4.0	〃	Low Tide
		15	0.7	〃	N10° W	3.3	〃	1.6 m
		16	0.8	〃	N20° W	2.7	〃	
		17	0.6	〃	N20° W	2.0	〃	
		18	0.3	〃	N20° W	1.7	〃	
		19	0.2	〃	N60° W	1.6	Low	
⑮	26/Apr. 1981	8	0.4	up	S10° E	1.6	Low	
		9	0.45	〃	S20° E	1.8	Flood	
		10	0.65	〃	S25° E	2.5	〃	Tide Range
		11	0.75	〃	S30° E	3.2	〃	2.7 m
		12	0.8	〃	S10° E	3.7	〃	High Tide
		13	0.5	〃	S 0	4.2	〃	4.3 m
		14	0	—	—	4.3	High	Low Tide
		15	0.25	down	N50° E	4.0	Ebb	1.6 m
		16	0.25	〃	N50° E	3.6	〃	
		17	0.5	〃	N20° W	3.0	〃	
		18	0.35	〃	N30° W	2.5	〃	

Table A-3-4-3 Surface Current at the Estuary (12)

No.	Observed Time		Velocity	Direction		Tide		Remarks
	Day	Time	m/sec	Stream	Degree	(m) Tide	Ebb /Flood	
⑯	28/March 1981	8	0.15	up	S30° W	1.7	Low	
		9	0.2	〃	S10° E	1.9	Flood	Tide Range
		10	0.5	〃	S10° E	2.3	〃	2.2 m
		11	0.6	〃	S20° E	3.0	〃	High Tide
		12	0.65	〃	S10° E	3.4	〃	3.9 m
		13	0.4	〃	S25° E	3.8	High	Low Tide
		14	0.15	down	N30° W	3.9	〃	1.7 m
		15	0.45	〃	N20° E	3.6	Ebb	
		16	0.4	〃	N10° W	3.3	〃	
		17	0.3	〃	N10° W	2.9	〃	
		18	0.15	〃	N20° W	2.5	〃	
⑰	14/June 1980	7	0.4	up	S60° E	3.0	Flood	
		8	0.8	〃	S60° E	3.8	〃	Tide Range
		9	1.1	〃	S60° E	4.5	〃	4.1 m
		10	1.25	〃	S50° E	5.2	〃	High Tide
		11	0.55	〃	S65° E	5.4	High	5.4 m
		12	0.4	〃	S25° E	4.7	Ebb	Low Tide
		1	0	—	—	3.8	〃	1.3 m
		2	0.9	down	N50° W	2.8	〃	
		3	0.9	〃	N60° W	2.1	〃	
		4	0.85	〃	N45° W	1.6	〃	
		5	0.4	〃	N40° W	1.3	Low	

Table A-3-4-3 Surface Current at the Estuary (13)

No.	Observed Time		Velocity	Direction		Tide		Remarks
	Day	Time	m/sec	Stream	Degree	(m) Tide	Ebb /Flood	
⑧	14/Jan. 1980	14	0.8	down	N30° W	1.4	Low	
		15	0.5	"	N25° W	1.7	Flood	Tide Range
		16	0.7	"	N30° W	2.4	"	2.9 m
		17	0.25	"	N20° W	3.1	"	High Tide
		18	0	—	—	3.7	"	4.3 m
		19	0.15	up	East	4.2	"	Low Tide
		20	0.4	"	S60° E	4.3	High	1.4 m
		21	0.7	"	S40° E	4.0	Ebb	
		22	0.9	"	S60° E	3.5	"	
		23	0.4	"	S40° E	2.7	"	
⑨	15/June 1980	8	0.7	down	S30° E	3.4	Flood	
		9	0.8	"	S35° E	4.0	"	
		10	0.5	"	S10° E	4.7	"	
		11	0.4	"	S40° E	5.3	High	High Tide
		12	0.45	"	S45° W	5.4	High	5.5 m
		13	0.45	up	N55° W	4.6	Ebb	
		14	0.9	"	N50° W	3.7	"	
		15	0.95	"	N20° W	2.8	"	
		16	0.6	"	N20° W	2.2	"	
		17	0.3	"	N20° E	1.7	"	
		18	0.15	"	N55° E	1.5	Low	
		19	0.35	down	S70° E	1.9	Flood	

Appendix-4 Present Port Traffic Facilities

Table A-4-1 Condition of C.P.T. Locomotives (As on 1.5.1988)

Sl. No.	Type	Horse Power.	Total No.	Year of Purchase.	Age	Present Condition.
1.	6 Wheeler Canadian (D46 to D51)	320	6	1959	29 Yrs.	2 running in poor condition. 4 out of commission of which 1 at S Workshop for POH from 21.9.83 (D/50)
2.	8 Wheeler Canadian (Twin Unit) (D52, 53 & 54)	640	3	1961	27 Yrs.	1 running in poor condition and 2 out of commission.
3.	12 Wheeler (Canadian - Twin Unit)	1,250	3	1967	21 Yrs.	1 running in single unit (D/67) 1 under heavy repair (D/64) 1 awaiting POH (D/63)
4.	6 Wheeler WDS-4B (CLW) (D68 to D71)	650	7	1970	18 Yrs.	5 out of 7 are in running condition, 2 are awaiting heavy repair and POH (D71,72)
5.	6 Wheeler WDS-4B (CLW) (D76 to D79)	650	4	1982	6 Yrs.	2 running, 2 out of commission (D/77, D/79) due to brake gear and other under carriage damages.

Source: CPT

Table A-4-2 Container movement in Calcutta port

Inward				Outward			
No. of wagons	No. of containers loaded	empty	Date	No. of wagons	No. of containers loaded	empty	Date
10 BFKI	20	-	13.10.85	31 BFKI	-	62	25. 6.87
40 BOX	-	80	5.12.87	40 BOX	-	80	31. 5.88
40 BOX	-	80	5. 2.88	40 BOX	-	80	4. 6.88
				33 BOX	-	66	29. 6.88
				40 BOX	-	80	7. 7.88

Source: CPT

Table A-4-3 C.P.T. Railway Staff (Operation branch)

	1978. 1.16	1988. 6. 1
Class-I	23	13
" II	-	8
" III	524	296
" IV	729	329
Total	1,276	646

Class-I Rly manager, Dy. Rly manager, ARM.

Class-II Asstt. Traffic Officer.

Class-III Yard Foreman, Supervisor, Yard clerk, Office clerk, Typist, Supg. Signaller.

Class-IV porter, Messenger, etc.

Source: CPT

Table A-4-4 Financial Condition of CPT Railway

(Rupees in Lakhs)

	1984-85	1985-86	1986-87
INCOME			
1. FREIGHT & HAULAGE CHARGE	60.69	67.31	71.65
2. SIDING CHARGE	6.90	12.78	9.18
3. TERMINAL CHARGE	14.53	19.05	19.96
4. DEMURRAGE	211.19	151.64	105.87
5. MISC. INCOME	103.11	135.03	151.42
6. FINANCE & MISC. INCOME	28.00	23.53	40.79
TOTAL RECEIPT	424.42	409.34	398.87
EXPENDITURE			
A) DIRECT EXPENDITURE:			
1. Operation & Maintenance of Locomotives, Loco Sheds etc.	223.82	206.92	213.22
2. Single Control & Neural Control Working.	85.36	92.04	89.25
3. Maintenance of P.T.Wagons.	0.30	5.20	23.68
4. Maintenence of P.Way.	120.37	132.40	130.02
5. Operation, Maintenance & Admn. of Station Yards, Sidings etc.	207.39	191.61	180.25
6. Operation & Maintenance of Plants, Machines, Installations etc.	0.10	0.06	0.03
7. Expenditure on General Facilities	0.56	0.05	0.01
8. Administration and General Expenses (R.M's Office, IRCA HQ, Wagon Hire)	230.34	210.10	220.98
9. Depreciation	24.98	24.63	24.01
TOTAL DIRECT EXPENSE:	893.22	863.01	881.45
B) INDIRECT EXPENSES:			
1. Share of Admn. and General Expenses - Traffic Manager's Office.	6.85	6.89	7.20
2. Share of Expenses on Management, Genl. Administration.	198.79	207.73	241.52
3. Share of Finance & Misc. Expenditure.	192.62	142.40	171.73
4. Share of Interest Charges on External Borrowings.	30.55	36.29	42.74
TOTAL INDIRECT EXPENSES:	428.81	393.31	463.19
TOTAL EXPENSES (A & B)	1,322.03	1,256.32	1,344.64
D E F I C I T	897.61	846.98	945.77

Source: CPT

Table A-4-5 Tracks of Haldia Railway System

GM Yard	Top electrified 5 departure tracks Fully electrified 5 reception tracks Line length, 2,400 ft each connected with S.E Railway main line.
BH Yard	5 Reception lines directly connected with S.E Rly main line Line length: 2,400 ft each 5 Departure lines. Line length: 2,400 ft each 3 lines for stabling loaded and empty tank wagons for I.O.C. Length: 2,400 ft each 4 feeder lines for tippler. Length: about 1,000 ft each 4 lines post tippling zone. Length: 1,200 ft each 2 by pass lines. Length: 600 ft each
Sorting Yard	5 lines for marshalling, grouping and segregation of damaged wagons from incoming rakes. Line length: 2,400 ft each

Source: CPT

Table A-4-6

Rolling Stock: Specification of Wagons, Avg. Load by Type of Wagon by Commodity.

CV	23.47 Tonnes	Genl.	F/grains, fertiliser, cement etc.
OP	23.47 "	"	Coal, piecemeal steel & other such commodities.
TLR	18.29 "	"	Smalls bookings/Parcels
TP	17.57 "	"	Vegetable oil
BOB	55.62 "	"	Railway materials.
BOBC	45.57 "	"	Limestone, Dolomite.
BOBX	63.80 "	"	Iron Ore & M/Ore.
BOBS	61.21 "	"	Iron Ore & M/Ore
BOX'T'	54.60 "	"	Coal
BOX	56.10 "	"	Coal
BOX'N'	58.81 "	"	Coal
BCX	52.80 "	"	Cement, F/grains, fertilisers, etc.
BOI	58.30 "	"	Bamboo
BOY	70.40 "	"	Iron Ore
BFR & BRH	57.40 "	"	Finished products from S/Plants.
BRHT	57.40 "	"	Logs
TPBL (Tank)	20.10 "	"	Mineral Oil
BWS	132.90 "	"	Oversize consignments.
BHS	91.40 "	"	Oversize consignments.

Table A-4-7 ICD Rakes Handled at Haldia During the Period form 22. 6.87 to 15.12.87.

Month	Received			Despatched		
	No. of Trains	No. of Containers		No. of Trains	No. of Containers	
		Loaded	Empty		Loaded	Empty
April-'87	-	Nil	-	-	Nil	-
May -'87	-	Nil	-	-	Nil	-
June -'87	1	Nil	Nil	1	Nil	60
July -'87	2	25	Nil	2	-	118
Aug. -'87	2	122	2	2	-	122
Sept.-'87	5	330	3	5	-	332
Oct. -'87	3	206	-	3	-	206
Nov. -'87	4	276	-	4	-	208
Dec. -'87	2	141	5	2	-	-
Jan. -'88	-	-	-	-	-	-
Feb. -'88	-	-	-	-	-	-
Total	19	1,100	10	19	Nil	1,406

Source: CPT

Table A-4-8 Average turn around time of wagons at Haldia

	(hrs)	
Coal		
Reception tracks	2.0	Examination for damaged wagons by SE
	2.5	Examination for wagons not suitable for passing through the beetle (14-15 wagons/rake) and break release
Operation by CPT	19.0	including waiting time for locomotives and tippling
Departure tracks	7.0	Examination by SE
	5.0	Clearance
Total	36.0 (1.5 days)	
P.O.L		
Reception tracks	10.0	Examination by SE
Operation by CPT	17.0	Sorting yd. - BH yd. I.O.C - Dep. yd.
Operation by I.O.C	30.0	
Departure tracks	6.0	Examination by SE
	9.0	Clearance
Total	72.0 (3.0 days)	
Container		
Reception tracks	3.0	Examination
Operation by CPT	18.0	Including loading/unloading
Departure tracks	3.0	Examination
	6.0	Clearance
Total	30.0 (1.25 days)	
Coking/Coal		
Departure track at BH	10.0	Examination
Operation by CPT	7.0	
Loading at GC	9.0/35	By SAIL
Departure tracks	6.0	Examination by SE
	9.0	Clearance
Total	41+23.5 (as coal wagon) (2.7 days)	

Source: CPT

Table A-4-9 Tippling Efficiency

	87/4	5	6	7	8	9	10	11	12	88/1	2	3	Total
No. of wagon tippled	2,616	3,834	3,510	2,342	3,001	2,045	2,102	1,224	2,894	3,772	3,507	3,706	34,553
Total tippling hrs. available	1,440	1,488	1,440	1,488	1,488	1,440	1,488	1,440	1,488	1,488	1,392	1,488	17,568
Idle time due to non-availability of wagons from S.E Railway	167	161	55	45	59	50	88	96	304	234	198	285	1,742
Idle time fue to shut down of plant for maintenance	183	80	245	585	200	752	216	71	186	113	116	56	2,803
Idle time due to plant breadoun	61	67	124	102	136	68	53	26	79	79	49	47	891
Tippler hrs. worked	293	308	282	175	233	144	184	122	277	349	312	304	2,983
Net tippler rate per hrs.	8.92	12.45	12.45	13.38	12.87	14.20	11.42	10.93	10.45	10.81	11.24	12.19	11.58

Source: CPT

Table A-4-10 Derailment statement for the month of June '88

Sl. No.	Date.	Site & location.	No. of wagon(s) or Engine(s)	Cause.
1.	3. 6.88.	Coal east feeder at B.H.Yard.	Four wagons.	Defection the Marshalling Beetle.
2.	9. 6.88.	East by pass line at B.H.Yard.	One wagons.	Slipping out of loaded wagon.
3.	10. 6.88.	West empty collection line at B.H. Yard.	One wagons.	Side collision.
4.	11. 6.88.	H.F.C.level xing at G.M.Yard.	One wagons.	Subsidence of track in curved portion (outerside) in the region where PHE pipe line crossed (week subsoil & water logging). Empty wagon jumped & dropped.
5.	12. 6.88.	Ore tippler west feeder at B.H.Yd.	One wagon.	Defective wagon.
6.	13. 6.88	Sorting end, xing of BH Yd. L/No. 12 & 12 curve at G.M.Yard.	Two wagons.	Two road due to sharp wheel flange & negligible gap in point.
7.	14. 6.88.	One Pt. No. 44 (blocking ore west feeder) at BH Yard.	One wagons.	Defective wagon (spring broken)
8.	15. 6.88.	On engine line at G.M.Yard (in front of 'B' cabin).	Four wagons.	Spread gauge.
9.	17. 6.88.	After the xing of coal west empty collection line & by line at BH Yard.	One wagons.	Empty wagon rolled down from the cradle & dashed over this stable wagons on by pass line due to which the rear pair of wheels jumped out & dropped & derailed. The central point pin of the rear trolly was also in broken condition.
10.	18. 6.88.	West empty collection line of ore tippler at BH Yd.	One wagon.	Side collision with another box wagon when empty wagons rolled from East & West toward convergent point.
11.	23. 6.88.	Coal west empty collection line at port tippling zone at BH Yd.	One wagon.	Hard Bump (incidental).
12.	24. 6.88.	H.C.C.loop line at G.M.Yard.	One wagon.	Side collision (Traffic).
13.	29. 6.88.	At reception leading point at east end (HY-2/4) at G.M.Yard.	Two wagons.	Could not be ascertained.

Source: CPT

Table A-4-11 Distribution of No. of Vehicles (Lorries) Leaving or Entering through Each Gate from 1.1.88 to 30.6.88

S.No.	Gate No.	No. of loaded trucks (1.1.88 to 30.6.88) In	Out	Total	No. of empty trucks (1.1.88 to 30.6.88) In	Out	Total
1.	KP-D-I						
	Gate No. 1	8,489	889	9,378	12,869	247	13,116
	Gate No. 2	2,223	1,233	3,456	14,428	527	14,955
	Gate No. 3	274	11,764	12,038	1,292	10,389	11,681
	Gate No. 4	99	16,072	16,171	721	4,044	4,765
	Total	11,085	29,958	41,043	29,310	15,207	44,517
2.	KP-D-II						
	Gate No. 5	5,004	6,498	11,502	5,318	3,954	9,272
	Gate No.11	9,039	14,316	23,355	14,421	6,424	20,845
	Gate No.13	-	5,717	5,717	5,808	-	5,808
	Total	14,043	26,531	40,574	25,547	10,378	35,925
3.	NSD						
	Gate No. 3	1,771	17,187	18,958	1,830	14,059	15,889
	Gate No. 7	2,047	8,752	10,799	2,437	11,436	13,873
4.	NSD-EXT.						
	Gate No. 9	859	8,029	8,888	8,029	859	8,888
	Total	4,677	33,968	38,645	12,296	26,354	38,650
			77,290			77,300	

Source: CPT

Table A-4-12 Average Load by Type of Vehicle Commodity

		Tons
Tea	Truck	10 to 12
C.I.Goods	"	8 to 10
Carpet	"	5 to 6
Cement	"	10 to 20
Fertiliser	"	8 to 15
Steel	Trailer	10 to 25
Bags of Mica Scrap	Truck	10 to 12
Cases of Mica	"	5 to 6
Jute	"	8 to 10
Jute Products	"	3 to 5
Reefer Carg	Van (Reefer)	3 to 5

Source: CPT

Appendix 6 Present Situation of Port Management and Operation

Appendix 6-1 Operation of Modern Container Terminal

1. Container Transportation and Documentation

The flow of simplified container transportation and documentation is shown in Fig. A-6-1-1, Fig. A-6-1-2, and Fig. A-6-1-3 and the operation and documentation flow is outlined as follows;

(1) Export

i) The Shipper makes booking to the Carrier.

ii) The carrier prepares the Booking Note based on the data from the Merchant and draws up the Booking List, which are sent to the parties concerned.

iii) Based on the indications of the Carrier, the CY operator releases necessary empty containers to the Shipper. At this time, the Equipment Receipt (E/R) is exchanged between the CY operator and the Shipper.

iv) In the case of FCL, the shipper loads the container with his cargo and delivers it to the designated CY. The Container Load Plan (CLP) showing the description of the goods and the gross weight and measurement of the contents by each container, the Dock Receipt (D/R) by each B/L, the Export Declaration (E/D) and the Gate-in-slip are furnished to the CY operator with the container. An E/R is also prepared at the time of receiving the container at the CY.

Free charge time for FCL cargo is generally allowed by the Carrier, for instance, within seven days including Saturdays, Sundays and legal holidays, and upon expiry of the above free time, Equipment Dentention Charges are paid to the Carrier.

In case of LCL, the Shipper delivers the cargo to the CFS with the D/R and E/D. The CFS operator loads the cargo together with other LCL cargo and draws up the CLP. Then, the container is carried to the CY.

For cargo received as LCL by the Carrier at the CFS, CFS Service Charges including a minimum charge per B/L are applied.

v) The CY/CFS operator surrenders the signed D/R to the Shipper at the

time of receiving cargo at the CY/CFS.

vi) Received containers are stacked at the CY based on such documents as the Booking List, Loading Prospect and Rough Stowage Plan sent from the Carrier in advance. The CY operator plans the final Stowage Plan and Sequence Check List for loading operation. The shipper must deliver cargo to the CFS by the cutoff time of the CFS and the loaded container to the CY by the cutoff time of the CY.

vii) The following documents are prepared by the CY operator and distributed to the sections and parties concerned:

(a) Stowage Plan

(b) Dangerous Cargo List

(c) Reefer Container List

(d) Exception List

(e) Container Loading List or Loading Sequence Check List

viii) The CY operator is generally entrusted such "Husbanding" works as arrangements of pilots, tugboat and mooring.

ix) When the vessel arrives at the berth, the CY operator discharges and loads containers froml to the vessel's hold using transtainers, tractors/trailers and gantry cranes based on the Loading Sequence List planned in advance.

(2) Import

i) After departure of the vessel from the port, such documents as copies of the D/R, CLP Stowage Plan, Dangerous Cargo List, Reefer Container List, Exception List, Cargo Manifest, Container List, Loading/Unloading Cargo List, Botanical Cargo List and Zoological Cargo List are sent to the Carrier at the loading place.

ii) Based on the above documents, the Cargo Manifest, Arrival Notice, Delivery Order (D/O) and Freight Bill are prepared by the Carrier, and distributed to the parties concerned.

iii) The Arrival Notice and Freight Bill are sent to the Consignee or other party to be notified.

iv) The Consignee receives the original B/L from a bank and surrenders it to the Carrier.

v) The Carrier issues the D/O to the Consignee in exchange for the B/L.

vi) Containers are discharged from the vessel and delivered to the CY. In the case of LCL, containers are delivered to the CFS and

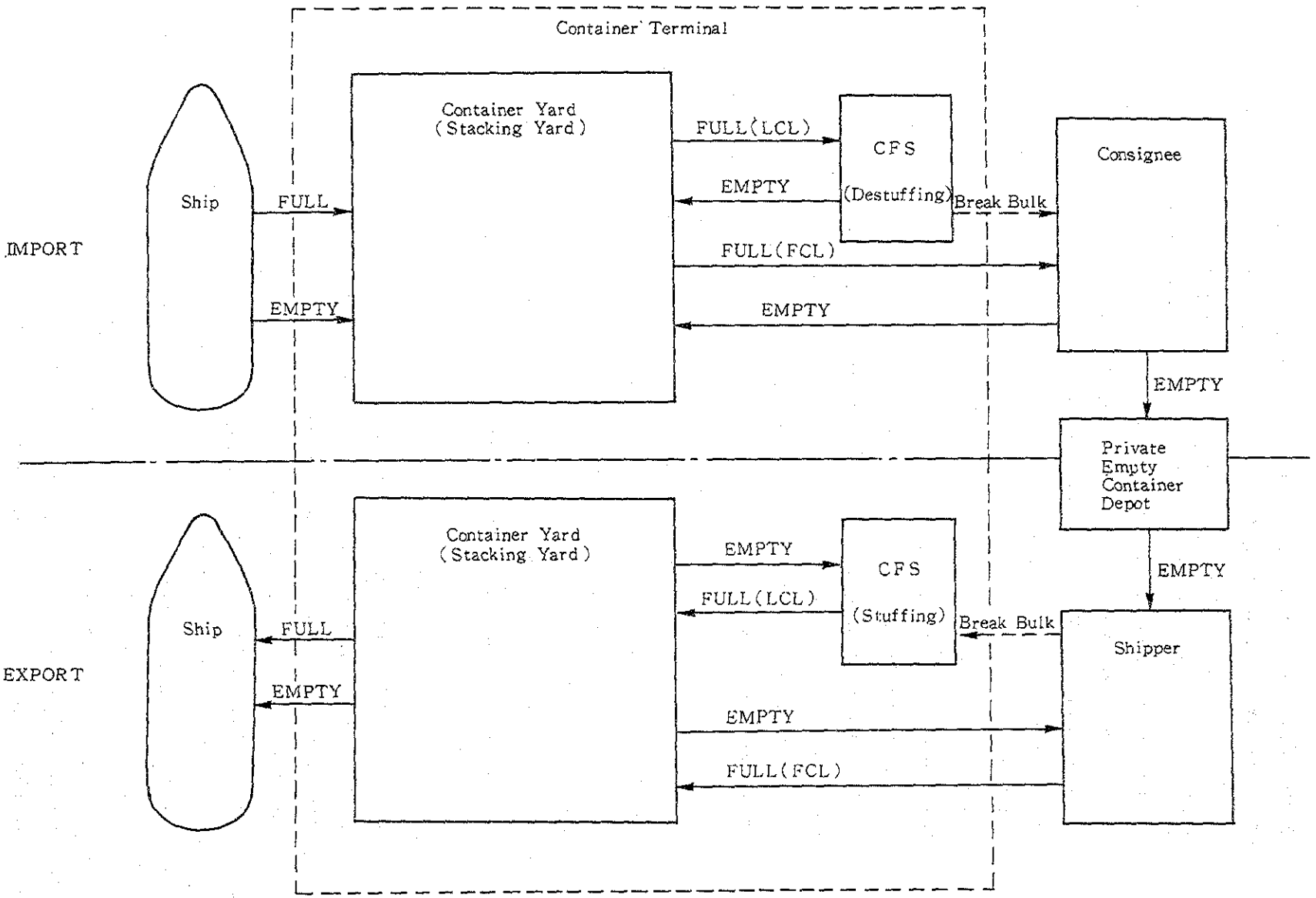


Fig. A-6-1-1 Container Transportation Flow

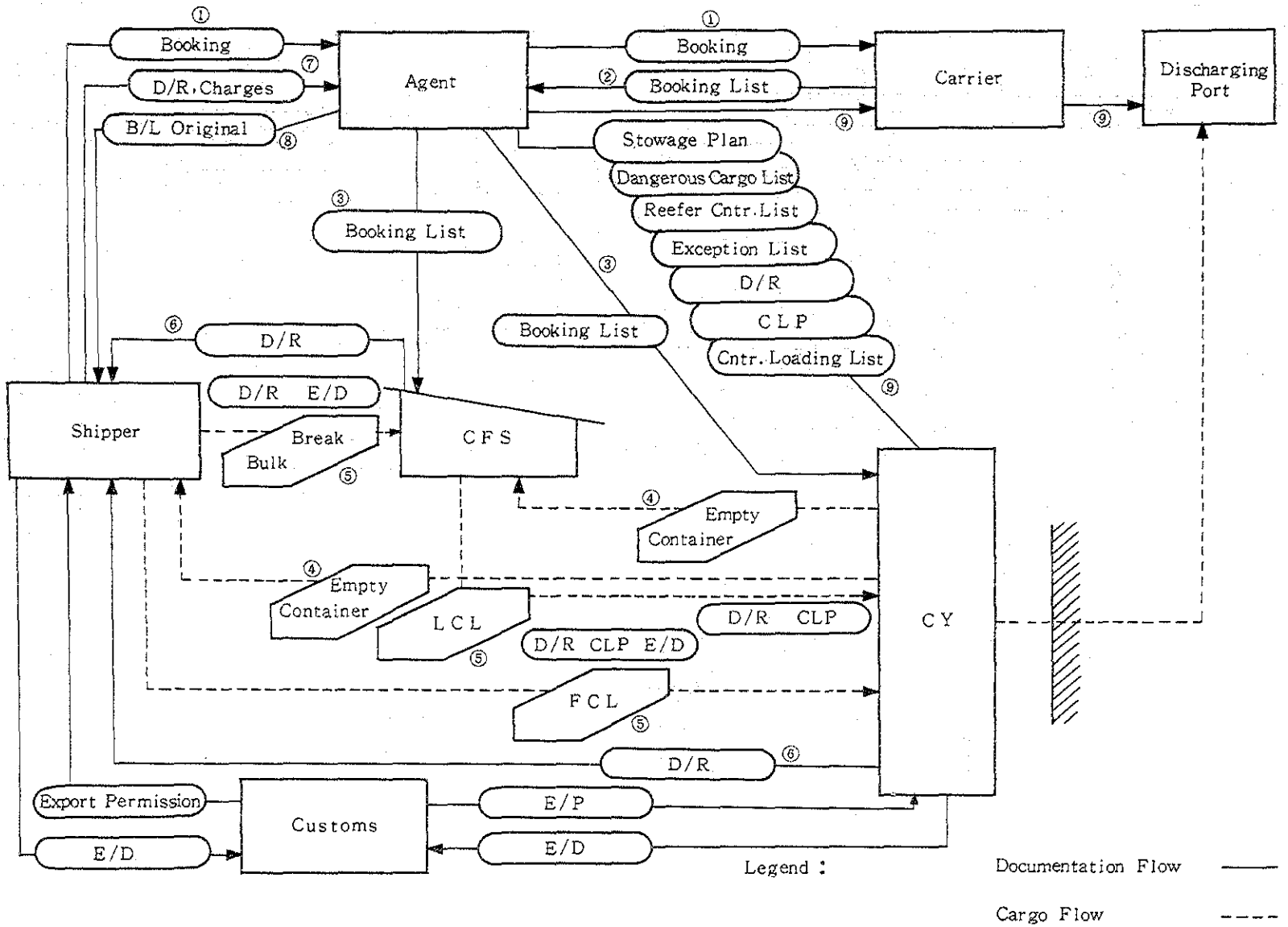


Fig. A-6-1-2 Container Documentation Flow (Export)

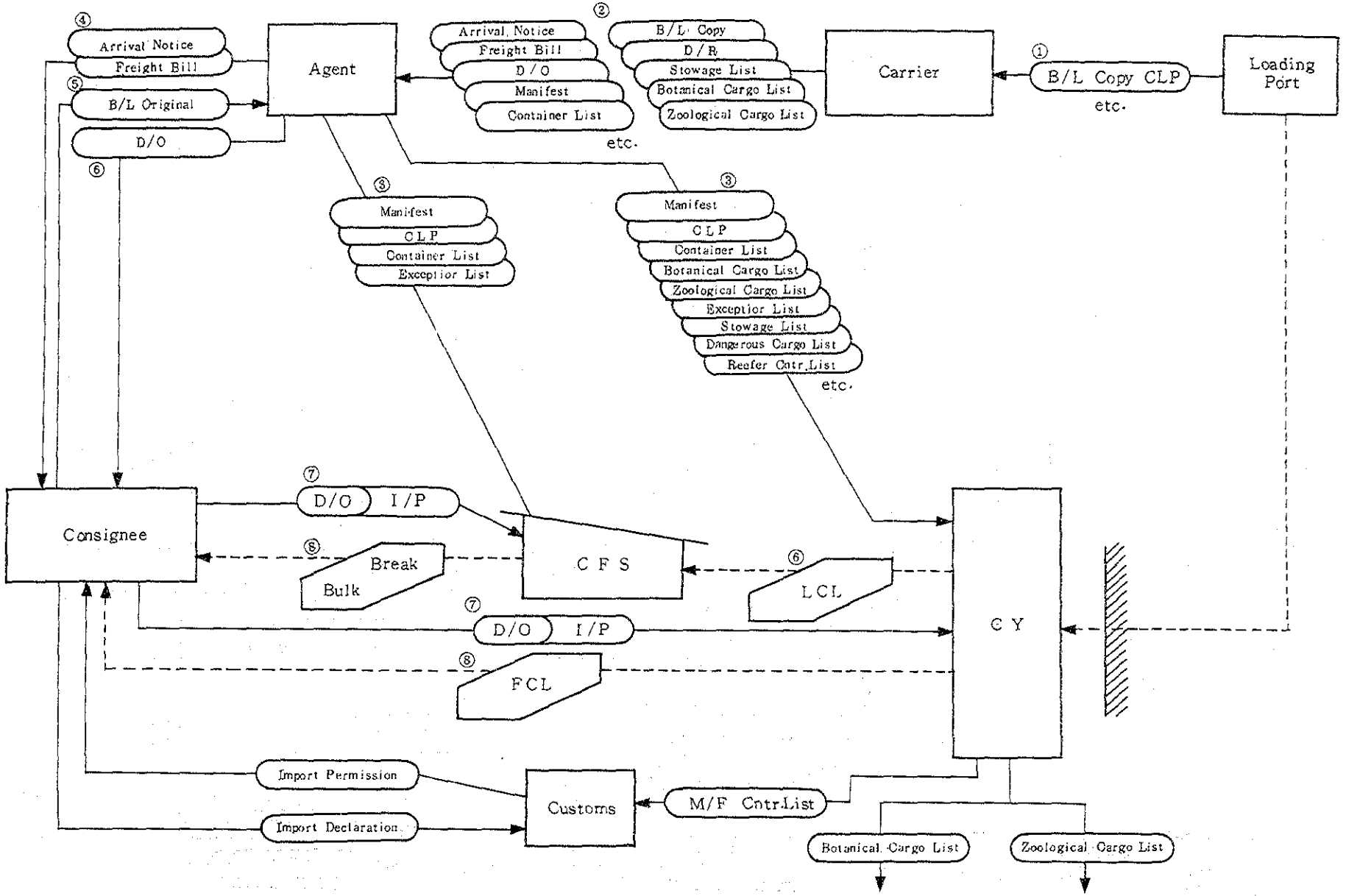


Fig. A-6-1-3 Container Documentation Flow (Import)

destuffed.

vii) The consignee which received the D/O furnishes it to the CY operator in the case of FCL and to the CFS operator in the case of LCL, and then receives the container. The E/R is made for the delivery of FCL cargo.

2. Function of Container Terminal

1) Discharging/Loading

It is essential for container terminal operation to minimize the berthing time of container vessels and for this purpose, a Stowage Plan is prepared before the vessel's arrival.

Stowage Plan should be established based on the information related to stowed containers on the vessel, the schedule of discharging at the port in question and the structure of the vessel as well as the number/weight of containers which will be loaded onto the vessel.

Responsibilities of Terminal Planner

Contents	Related Documents	Remarks
1. Exchange necessary information with former and latter ports	1. Loading Instructions of the Carrier	
2. Check the destination and weight of ctnrs.		
3. Decide the space of loading on board based on the stowage plan of former ports		3. Make Final Loading Plan based on the Loading Instructions
4. Make schematic plan	4. Schematic Plan (By bay, slot and tier)	
5. Make Working List based on the stowage plan and schematic plan	5. Working List	5. Take into account the operating conditions of the Yard
6. Make bay-wise loading plan		6. Pay attention to the specialized ctnrs.

7. Make Stowage Plan	7. Stowage Plan	7. Confirm the port, weight, number and service.
8. Calculate GM, trim and so on, make stowage plan summary	8. Stowage Plan Summary	
9. Make specialized ctnr. list	9. Dangerous Cargo List, Reefer Cargo List, Exception List	
10. Coordinate working schedule of whole operation		
11. Make daily report of handling work	11. Daily Report	

2) CY Operation

The yard planner of the yard control centre should assign some yard area to each group of containers before receiving the export containers. This procedure is called Yard Planning. The yard plan includes the yard area for import containers which are to be discharged from a vessel and empty containers which are received at the gate or destuffed at the CFS and discharged from a vessel and stacked in the yard.

Responsibilities of Yard Planner

Contents	Related Documents	Remarks
1. Make Yard Location Plan	1. Yard Location Plan (Name of vessel, destination, weight, individual number of ctnr.)	
2. Decide the location of receiving ctnrs.		

3. Make Sequence Check List based on the stowage plan	3. Sequence Check List (Seq. number, loading port, number of ctnr, weight, yard location, tractor number, stowage)	3. Loading and discharging shall be
4. Make Check List of shift/reload based on the working list	4. Rehandling List	
5. Collate Yard Location Plan with the stowage plan, plan the loading order		
6. Record the status of ctnr.		
7. Make Despatch Order	7. Despatch Order (Name of vessel, number of ctnr., consignee, B/L number, destination)	

Responsibilities of Gate Clerk

Contents	Related Documents	Remarks
1. Receive ctnr.		
2. Receive Gate Slip	2. Gate Slip (Name of vessel, number of ctnr., shipper, weight, destination, yard location)	
3. Receive and check the shipping documents (D/R, E/D, CLP)		
4. Receive D/O		

5. Maintain Gate Log	5. Gate Log (Number of ctnr., loading/empty, yard location destination shipper)	
6. Check number of ctnr., seal number, damage	6. Damage Report	
7. Weight loaded ctnr.		
8. Make E/R	8. Equipment Receipt	
9. Indicate yard location		
10. Control stacked empty ctnrs.	10. Empty container List	
11. Make Inventory Report	11. Inventory Report	

Appendix 6-2 Berth Allotment, CPT

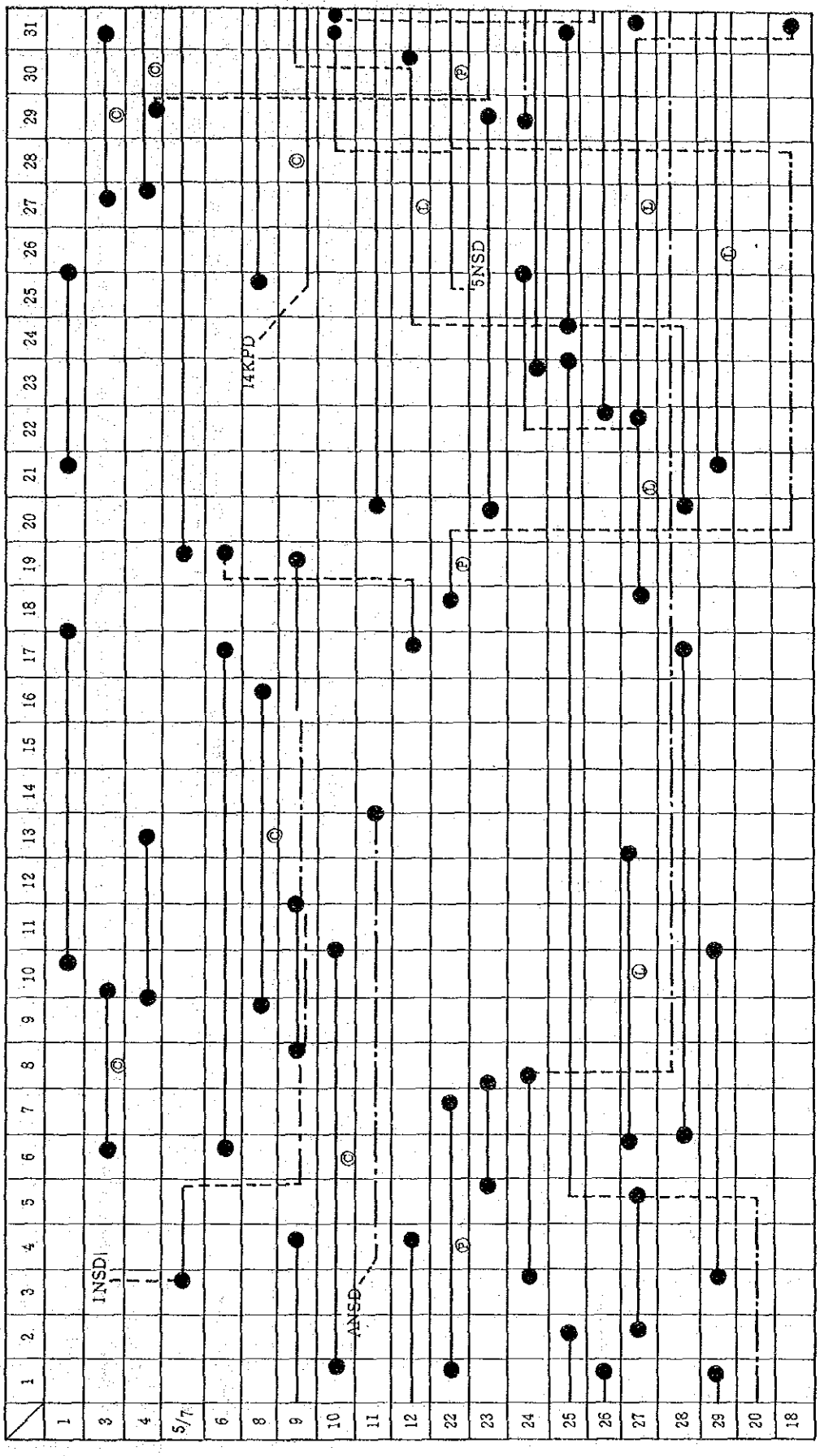


Fig. A-6-2-1 Berth Allotment at KPD or JAN., 1988

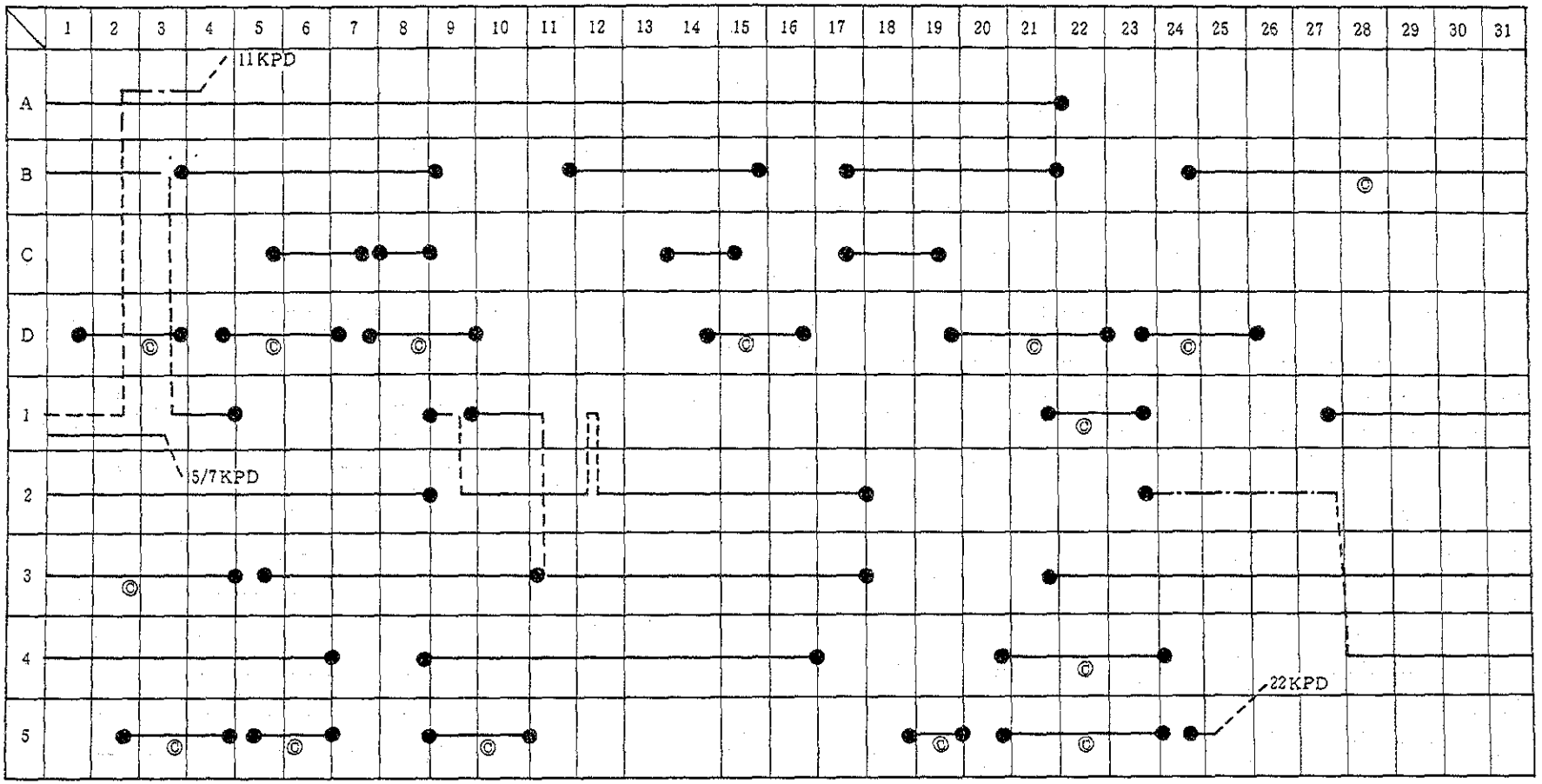


Fig. A-6-2-2 Berth Allotment at NSD or JAN., 1988

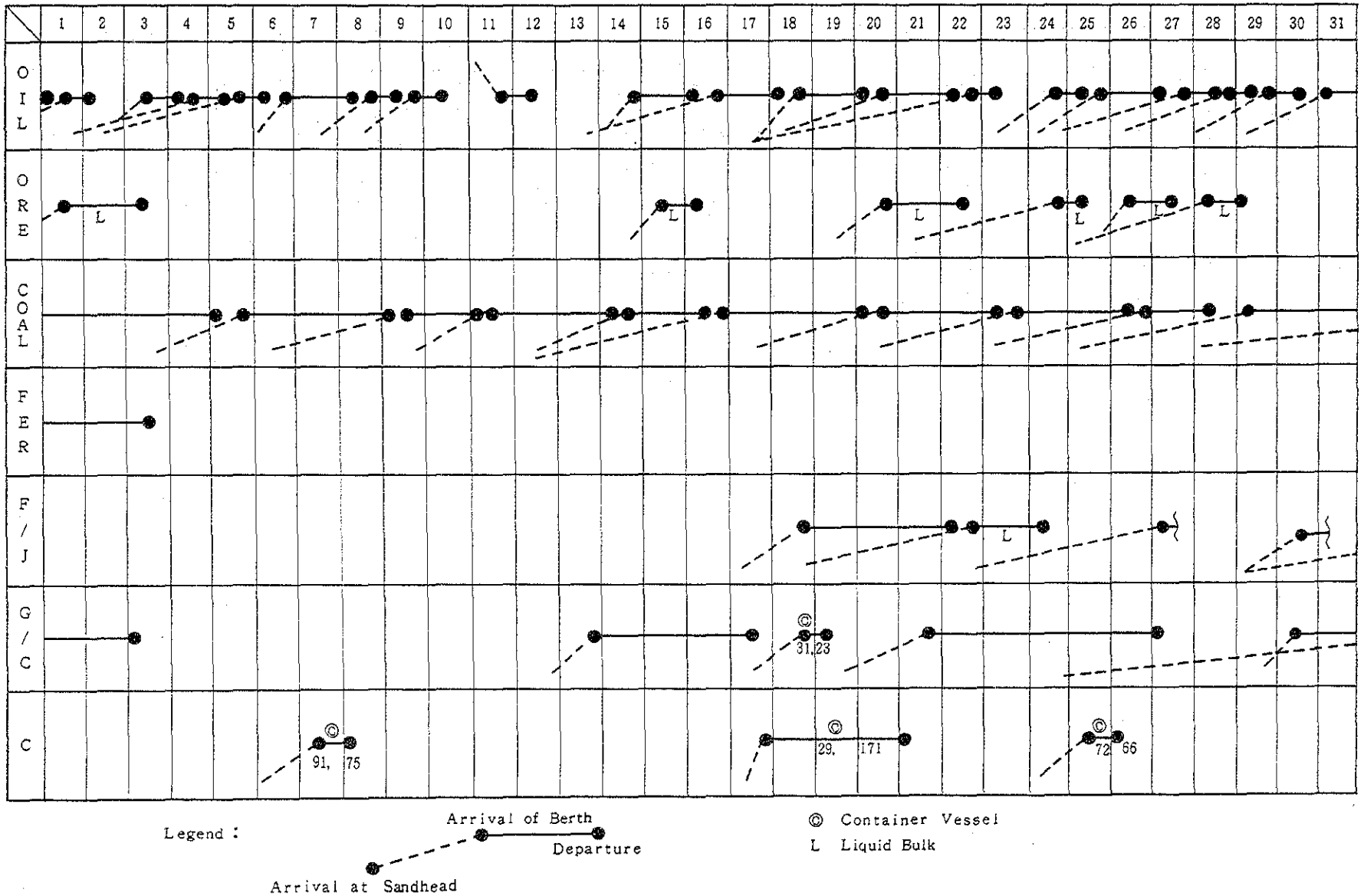


Fig. A-6-2-3 Berth Allotment at HDS or JAN., 1988

Appendix 8 Demand Forecast

Table A-8-1-1 Projections of Haldia POL Port Traffic by O.C.C.

(Unit: Million tonnes)

	1990/91	1991/92	1992/93	1993/94 (*)	1994/95	1999/2000
P.O.L (Crude)	2.61	2.61	2.61	2.61	2.61	2.61
P.O.L (Products)	3.84	4.48	5.88	5.17	5.42	6.39
Total	6.45	7.09	8.49	7.78	8.03	9.00

(*) Reduction in traffic at Haldia due to assumed commissioning of Paradeep Port

Table A-8-1-2 Haldia Port Traffic P.O.L. (Products) by O.C.C.

(Unit: '000 tonnes, %)

	Import		Export		Total	
		Share		Share		Share
1990/91	2,762	94.2	171	5.8	2,933	100
91/92	3,292	95.0	174	5.0	3,466	100
92/93	4,030	95.8	178	4.2	4,208	100
93/94	4,254	94.3	255	5.7	4,509	100
94/95	4,593	92.5	374	7.5	4,967	100
Average share		94.4		5.6		100

The volume of total cargo of P.O.L. (products) is different from the volume of P.O.L. (products) at Appendix 7-1-1. This is because the time frame is different. Since there is no projection of P.O.L. (products) by import and export, we used the above shares for our estimation.

Table A-8-1-3 Method of Estimation of Empty Containers

(Calcutta)

Table shows the container volume balance rate and the empty container rate.

Container Volume Balance Rate and Empty Container Rate

(Unit: '000 tonnes, %)

Year	(A) Volume of Import (Containers)	(B) Volume of Export (Containers)	(C)=(A)+(B) Total	(D)=½(A)-(B)½ Container Volume Balance	(E)=(D)/(C) Container Volume Balance Rate	(F) Empty Container Rate
1983/84	65.4	129.0	194.4	63.6	32.7	38.0
84/85	89.2	158.0	248.0	69.6	28.0	31.0
85/86	162.4	234.1	396.5	71.7	18.1	30.0
86/87	183.3	283.4	466.7	100.1	21.4	28.0
87/88	218.2	268.7	486.9	50.5	10.4	24.0
1995	580	530	1,110	50	4.5	(20.7)
2000	1,010	640	1,650	370	22.4	(30.2)
2005	1,460	775	2,235	685	30.6	(34.8)

The correction between the container volume balance rate and the empty container rate is as follows:

$$Y = 18.256 + 0.54x \quad (r = 0.914)$$

r : Correlation coefficient

x : Container volume balance rate

Y : Empty container rate

From the above equation we can estimate the future empty container rate as shown in parentheses in column (F). We estimate the total container cargo (TEUs) by loaded container cargo (TEUs) and the empty container rate.

We assumed that the volume of import and export container cargo (TEUs) is equal.

(Haldia)

The share of empty container cargo (TEUs) is stable for the last 5 years and the average share of empty container cargo is approximately 37 percent. We estimate the total container cargo (TEUs) by loaded container cargo (TEUs) and the empty container ratio.

We assume that the volume of import and export container cargo (TEUs) is equal.

Table A-8-1-4 Estimation of Containerization by CPT, IWT, Madras Port and Other Developing Containers

(Unit: %)

		1985	1995	2000	2005
JICA TEAM	Calcutta	12.1 (22.1)	41.7	51.2	54.3
	Haldia	43.7 (49.5)	57.4	63.7	65.4
	Calcutta /Haldia	14.3 (25.0)	44.8	54.2	57.0
CPT	Calcutta	12.1 (22.1)	27.9	37.3	-
	Haldia	43.7 (49.5)	50.7	50.6	-
	Calcutta /Haldia	14.3 (25.0)	31.5	46.4	-
IWT	Calcutta /Haldia	14.3 (25.0)	36.0	41.0	43.0
MADRAS PORT TRUST (Master Plan)	Madras Port	25	60	75	
PAKISTAN	Karachi /Qasim	42	69.5 (1992-93)	82.4 (1997-98)	90 (2005-06)
BANGLADESH	National Base	13	57	66	68
CHAINA	Dalian		65	73	-

Figures in parentheses are 1987-88.

Appendices 10 Navigation Safety and Navigation Aids

Appendix 10-1 Marine Traffic Control

(1) Vessel traffic services (VTS)

VTS are the services used to organize maritime traffic in those areas where it is necessary.

They include all the navigational facilities (material, personnel, procedures) placed at the disposal of vessels using the ports in order to improve the safety of navigation and the efficient flow of traffic.

Simultaneously, the VTS meets the requirements of the vessels and the port such as:

- safety of navigation and assistance to navigation in the port areas in the interest of both the port and the port users.

Normally, a ship is capable of avoiding collision and grounding through its own resources.

Nevertheless, experience has shown that in certain cases shore-based services are required to assist vessels, especially in areas with high traffic density, in channels, in circumstances where visibility is reduced and in difficult meteorological or hydrological conditions.

Thus to ensure a greater degree of safety, the VTS needs to keep all users informed to the fullest extent of meteological and tidal data, together with any appropriate advice gained from observation by shore surveillance (radar, etc.).

- if required, the regulation of movement to facilitate an efficient traffic flow in the port areas.

In addition under certain specific circumstances, the VTS center may need to issue detailed directives.

These are likely be of a general nature and to relate to local navigational regulations such as:

** a ship is in a one-way channel, thus prohibiting other vessels from sailing in the opposite direction

** movement is or is not permitted

** particular passing rules need to be complied with

- the handling of data relating to ships involved.
- if required, the coordination of actions in case of accidents.

And also the following shore-based services include:

- Aids to navigation
- Pilots
- Tugs and linesmen

(2) Equipment of VTS Center

To carry out all the tasks described in (1), a VTS center should comprise:

- a communications network
- data acquisition facilities
- data processing and dissemination facilities

The principal particulars of the traffic control system are as follows;

◉ Radar system

(A) The radar system is composed of antenna unit, transceiver, monitor display, C.P.U., graphic display and character display. The antenna unit is mounted at a reasonable height above sea-level to realize a good search area. The transceiver is installed at a suitable in the traffic control center, which contains the radar monitor display, graphic display, character display, C.P.U. and radio telephone control board.

(B) Performance of system

The radar antenna rotating continuously and automatically 360 degrees radiates the pulse-modulated radio wave produced in the transceiver. The returned echoes are amplified in the receiver and displayed on the monitor display. The output signals from the receiver are also transferred to the C.P.U., the output of which is displayed on the graphic display in the form of geometrical symbols such as targets with vector and past position, track mark, blind area, fairway line, map, etc. The targets are so indicated that the tips of the vectors show the ship's future position, and the operator can at a glance grasp the movement of targets. The alphanumeric information of the targets is also displayed on the character display.

(C) Specifications

1) Radar equipment

Transmitting frequency : 9,410 Mhz

Transmitting power : 40 KW

Range scale : 3/4, 1.5, 3, 6, 12, 24, 48 nautical miles

2) Monitor display : Square-type colored PPI

3) Graphic display :

CRT : Square-type colored CRT

Range scale : 3, 6, 12, 24 N.M.

Number of tracking targets : 20

Acquisition of targets : Manual or Automatic

Information to be displayed

Chart information
a) Coast line
b) Traffic lanes
c) Navigation aids (buoys, lightships)
d) Dangerous areas

Information of the ship subject to control

a) Ship symbol

b) Ship vector

Information of other targets

a) Target symbols

b) Target vectors

4) Character display

Information to be displayed :

Subject ships a) Speed

b) Course

Other targets a) Distance to the subject ship

b) Bearing

c) Speed

d) Course

e) Closest point of approach

◉ Communication system

(A) Middle-wave, middle-short wave, short-wave transmitter/receiver

Transmitting power : 800 W

(B) TELEX system

(C) International VHF radio telephone system

(D) UHF radio telephone system

Transmitting power : 50 W

Control center X 1

Pilot boat X 2

Pilot car X 1

(3) Views about vessel traffic control system

There are various views about vessel traffic service (VTS) as follows:

1) Ship masters and pilots would not accept orders and instructions from the VTS Center.
The control of the vessel should remain with those on board directly engaged in the movement of the vessel.

2) Pilots should support VTS in principle and a VTS center should be run by pilots.
It should be regarded as an aid to the navigation of vessels to facilitate safer and more efficient ship operations.

3) IMPA should first positively establish the need for VTS in their particular area, and IMO should formulate guidelines outlining the criteria of need for VTS.

4) Some user were associated with VTS for more than twenty years and were presently heavily involved. VTS should be implemented by competent authorities to improve the safety and efficiency of traffic and to protect the environment and it should be properly defined and be capable of giving information, advice and instructions to users.

5) VTS was widely used with the pilots taking an active role in the VTS center to supervise situations such as the regulation of movement to facilitate an efficient and safer traffic flow.

* IMPA: International Maritime Pilots Association
* IMO* International Maritime Organization

6) In spite of the various views of the users, experience has shown that in certain cases "shore-based services" are required, especially in areas with a high traffic density, in channels, in circumstances where visibility is reduced and in difficult meteorological or hydrological conditions.

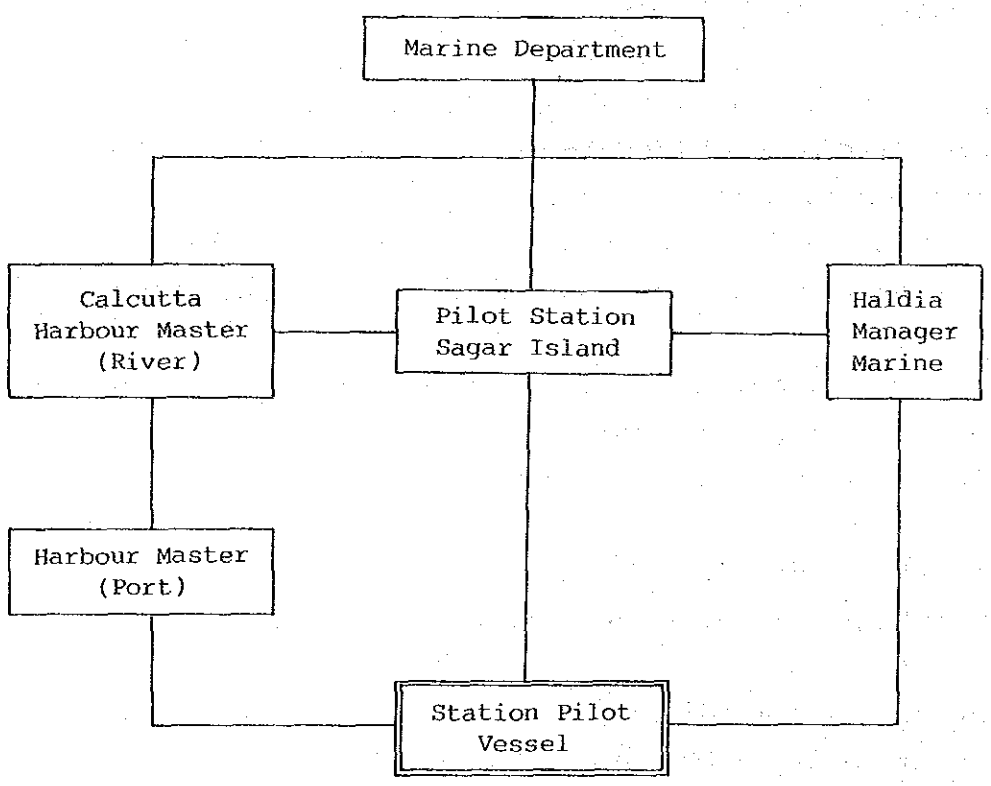
At this stage of pilot system no particular traffic control system will be introduces.

The station pilot vessel, using its radar and communications system, will stay in touch with inbound and outbound vessels and give instructions and exchange information to secure safety and cooperation with the pilot station on the Sagar Island.

(4) Organization

Until the establishment of a new marine traffic control system, traffic control shall be executed by the Harbour Master River in Calcutta and the Manager Marine in Haldia and also the Officer commanding the pilot vessel in collaboration with the Traffic Department.

Organization Chart of the Navigation Control



(5) Legislation

In case of a new pilotage system, it may be necessary to supplement or revise current rules such as by-laws and directions:

1) Taking pilots on board
2) Restrictions on overtaking
3) Notification of vessels' position
4) Steering and sailing rules
5) Restriction on vessels' speed
6) Restrictions on navigation under poor visibility
7) Procedures in case of emergency
8) Emergency anchorage, etc.

(6) Guide for Marine Traffic Safety in Tokyo Wan (extracts)

1) Taking pilot on board

The following vessels should take pilots on board;

(a) Any foreign flag vessel
(b) Any Japanese flag vessel commanded by a master not having sufficient experiences in entering Tokyo Bay.

2) Arrangement of Vessels for guarding the course.

A vessel should arrange vessels for guarding the course until she confirms her safe navigation even after leaving the traffic route.

3) Restrictions on using auto-pilot

When navigating Tokyo Bay, vessels should be maneuvered manualy.

4) Steering and sailing rules

(a) A vessel shall keep to the starboard side of the center line of the routes.
(b) A vessel shall not navigate at a speed exceeding 12 knots in the Uraga Suido Traffic Route.
(c) Obligation to navigate in traffic route is applied any vessel whose length is 50 m or more.
(d) Indication of destination.

5) Notification to be made by huge vessels and other particular vessels.

Those vessels should comply with the instructions given by the chief of Tokyo Bay Traffic Advisory Service Center.

6) Notification of navigation in Traffic Route and notification of changes.

7) Maintenance of communication with Tokyo Bay Traffic Advisory Service Center.

8) Information service provided by the Tokyo Bay Traffic Advisory Service Center.

(a) Regular service: from 00 - 15 min. and 30 - 45 min. every hour.

(b) Special broadcast service: To be provided whenever information is received.

(c) Indivisual information service: to be provided upon vessels' request.

(d) Special information service: To prevent accidents, the center calls the vessels concerned to provide information.

(e) Telephone service: Available anytime by ordinary or ship telephone.

Table-7 Navigation Control

1. Collection and adjustment of Informations in Advance	
1) Traffic Information	a. Receive information of ETA, ETD and adjust their time b. Verify with Harbour Master about the priority of the above vessel
2) Traffic Route	a. Traffic route and approach area b. Construction work plans c. Condition of fishing boats d. Meteorological and Hydrological conditions
2. Devise Control Plan and general instructions	
1) Control plan	a. Adjustment of time of sailing and entering port and control area b. Instructions/to maintain optimum distance between vessels c. Arrange meeting at pilot boarding area, etc. d. Adjust the time of construction and transit of vessels e. Enforce the time schedule strictly
2) Normal instructions	According to control plan, give instructions depending on ships type and cargo loaded a. Change of the transit time b. Change of ETA and ETD c. Restriction of speed d. Preservation of the UKC e. Arrangement of escort-boats, tug-boats, etc. f. Maintain communication with the control center through the triffic lane

3) Successive changes of the control plan	According to the alteration of ETA and ETD, the control plan will be changed successively and new instructions should be given accordingly
3. Collection and arrangement of information for the day	
1) Traffic information	a. Reception of position reports from vessels b. Sailing conditions and estimations c. Number of waiting vessels
2) Notice to mariners	a. Construction and dredging b. Marine casualties c. Condition of navigation aids d. Meteorological conditions and forecast e. Fishery conditions, etc.
4. Other navigation aids	Collected and arranged information will be informed to the vessels a. Movement of other vessels b. Warning of collision and grounding c. Estimation of traffic density d. Position of the vessel e. Weather conditions f. Condition of anchorage g. Construction works h. Conditions of fishing, obstacles and navigation aids
5. Overall judgements and special instructions	Based on an overall judgement of the collected information special instructions should be given as follows: a. Route and time b. Adjustment of speed c. Restrictions on overtaking d. Restrictions in poor visibility e. Arrangement of escort boats, etc.

(7) Navigation Aids at Pilot Station

1) Purpose

The equipment shall be established at the pilot station for the purpose of preventing collisions, groundings and for surveillance of vessels along the traffic route and available for the safety of navigation around the traffic route.

2) Composition of the Navigation Aids

The equipment shall be composed of the following units:

a) Radar System for traffic route surveillance

b) Communication system for vessel movement/notification of traffic route and other information

c) Racon shall be fitted to the light ship

d) An Antenna for the rader system, communication system, etc.

Note: The costs of the pilot station, additional public engineering, electric power equipment, electric supply and laying of electric wires etc. are not included.

3) Estimation of Traffic Control System Cost

The total approximate estimated cost of the Traffic control system as of Sept. 1988 is as follows:

Article	Set	Cost
1. Instrument		
(1) Radar equipment	1	465,400,000
(2) Communication equipment	1	87,080,000
(3) Racon equipment	1	26,000,000
(4) Antenna tower	1	9,800,000
		¥586,280,000
2. Transport		
(1) Radar equipment	1	4,800,000
(2) Communication equipment	1	2,000,000
(3) Racon equipment	1	2,000,000
(4) Antenna tower	1	500,000
		¥9,300,000
3. Construction		
(1) Radar equipment	1	323,900,000
(2) Communication equipment	1	119,300,000
(3) Racon equipment	1	17,160,000
(4) Antenna tower	1	52,960,000
		¥512,960,000

Note: (1) Delivery and construction in Japan.
(2) Construction of buildings, electric power supply equipment and power cable lay out construction etc. are not included.

Grand total ¥1,110,540,000

4) Communication System

The equipment shall be established on the pilot station for the purpose of communication between the pilot station and vessels inbound/outbound, pilots and other vessels around the coastal area for confirmation of traffic conditions, traffic information, meteorological information, navigation warnings, etc.

5) RACON Equipment

The RACON shall be installed on the light ship and utilized by vessels to confirm their position on the radar display.

6) Antenna Tower

A Steel Antenna tower shall be constructed for the use of Radar antenna and wireless telegraphy.

Appendix 10-2 : Summary of Pilotage Systems

ITEMS	CURRENT SYSTEM	PLAN-1 (Station vessel system)	PLAN-2 (Sagar Roads system)	PLAN-3 (Lower Middleton Ch.system)
Pilotage distance				
To Calcutta	126'	95'	80'	95'
To Haldia	70'	39'	24'	39'
Pilot boarding point	Sand Heads	Gasper Lt VSL (Approx. 21-25.6 N, 88-09.1 E)	Sagar Roads (Approx. 21-39.1 N, 88-01.0 E)	Same as plan-1
Pilot vessel/boat	Station vessel 2,000G/T x 2	Station vessel 1,000G/T x 2	Tug boat 200G/T x 2 or Tug boat x 2 Speed boat 40G/T x 1	Same as plan-2
Base of VSL/boat	Calcutta	Calcutta	Sagar Island	Sagar Island
Shore pilot station	None	None	Floor space abt 500m²	abt 500m²
Lower traffic lanes	None	abt 28 miles long	abt 28 miles long	abt. 28 miles long
Upper traffic lanes	None	None	abt 16 miles long	None
Navigation aids				
Light vessels		Racon x 4	Racon x 4	Racon x 4
Buoys on lower traffic lanes		High wave type x 12	Same as plan-1	ditto
Buoys on upper traffic lanes		None	Swift current type x 19	None
Buoys at anchorage		High wave type x 4	High wave type x 8	High wave type x 4
Traffic control system	None	None	* Radar system * Communication system	* Communication system

ITEMS	CURRENT SYSTEM	PLAN-1 (Station vessel system)	PLAN-2 (Sagar Roads system)	PLAN-3 (Lower Middleton Ch.system)
Advantages		* Shorter pilotage distance	* Shortest pilotage distance 35% less to Calcutta 65% less to Haldia	* Shorter pilotage distance
		* Easy approach to pilot boarding point		* Easy approach to pilot boarding point
			* Drastic improvement of pilots working conditions	* Improvement of pilots' working conditions
		* Similar to current system		
		* Less initial investment . Station VSL x 2 . Buoys on traffic lanes x 10 . Racon x 4		* Less initial investment . Tug boat x 2 . Buoys on traffic lanes x 12 . Racon x 4 . Basin & pontoon
				* Less running expenses . Abolishing station VSL . No traffic control system . No upper traffic lanes
Disadvantages		* Running expenses of station VSL	* Large amount of initial investment & running costs . Upper traffic lanes (Dredging & buoys) . Traffic control system	* Incomplete system
		* Poor pilot working conditions		* Embarkation/disembarkation of pilots in monsoon season

Appendix 10-3 Pilotage System in Calcutta

(1) Pilotage System

The safety of ships transiting the River Hooghly and the general efficiency of the operations in the port depend to a large degree on the capability of the pilots.

Pilotage is compulsory in the major ports of India under section 31 of the Indian Act, 1908 (Act XV of 1908).

In addition to this, Rules 4 and 5 of Calcutta Port Rules, 1944 also make pilotage compulsory for all vessels of 200 N.R.T. and over, and the pilotage area covers from Sandheads to Calcutta including kidderpore and N.S. Dock.

Usually a pilot vessel of about 2,000 G.R.T. cruises around Eastern Channel Lightship to serve pilots for the vessels in and out-bound.

In very strong winds and heavy seas she cruises about 4 miles South of this station. During the SW monsoon from March to October, the pilot vessel is in motion when supplying pilots and during the NE monsoon from December to February she is usually anchored near eastern Channel lightship or about 5 miles of the Lightship.

The pilot vessel is equipped with W/T, DF, radar, echo-sounder and other navigational equipment and maintains continuous watch on 500 Kc/s and receives the ETA messages of incoming vessels.

In Calcutta there are 3 ranks of pilot: river pilot, harbour pilot and dock pilot (berthing master).

River pilots take charge of vessels at Sandheads and proceed to Haldia/Garden Reach and then hand over to harbour pilots who maneuver vessels in the harbour or to river-side jetties, moorings, or the dock entrance lock at Calcutta, but in the port of Haldia river pilots serve as both river pilots and harbour pilots.

The movement of ships inside the dock from locks to berths is guided by dock pilots. There are 26 pilots in Calcutta and 14 pilots in Haldia.

In the port of Haldia, a candidate who wants to obtain a pilot license should have mariner's license (Master or First Mate) and experience on ocean-going vessels.

On the other hand, in Calcutta a candidate who wants to obtain a pilotage license should have 4-5 years of training and examination before receiving his license.

(2) New Pilotage System

In Interim Report-1, the JICA team proposed three types of new pilotage systems based on the results of the first field survey.

As the result of repeated discussions about the proposed plans in the second field survey, Plan-3 was selected as the most appropriate by the Indian Government.

But around the middle of January a letter (dated 12.1.1989) was transmitted by The director of the Planning and Research Department stating their final view that a "Station Type Pilot Vessel based at Sandheads is the best remedy and this should not be disturbed". Of course, the station pilot system is one of the best methods which has been carried out for a long time without any major marine casualties.

But there are still so many hazards which threaten safe navigation such as natural conditions and meteorological conditions, and there are other factors including navigation aids, the communications network, the system for lowering and hoisting motor boats, etc., which all affect safe navigation.

So, we would like to take this chance to consider the various technical and electronic advances which could be incorporated into a better system to improve the safety of navigation.

And thereafter the points raised by the DMD are quite useful for formulating a better alternative.

A lot of ports have changed their station pilot vessel systems to new systems after careful consideration about cost comparison, efficiency of the pilotage service, the working environment of pilots, safety aspects, etc. (refer to Table 10-2-1 & App. 10-6)

In the case of Calcutta Port, there are a lot of things which should be taken into consideration before a complete shift from the present station vessel system.

Taking into consideration the above, Plan-4 (combination system with the present station vessel system and Plan-3) is recommended as a phased plan. (refer to -- 10-3).

Appendix 10-4 New Pilotage System in Calcutta

10-4-1 Bay Pilotage System in Japan

A. Tokyo Bay

(1) Tug Boat Type Pilot Boat

This type of boat is used by Tokyo Bay Pilots for embarking and disembarking vessels. On the other hand, Osaka Bay Pilots and Irago Mikawa Bay Pilots are using fishing boat type pilot boats from the view point of safety.

Tokyo Bay Pilots generally prepare 13 tug boats for embarking/disembarking and escort service for transitting the Uraga Traffic Route. 4 tugs are prepared for the transport of pilots. The Principal items of the tug boats are as follows; Table-1

Table-1 Tug Boat Principal Items (YOKOSUKA)

OCT. 1988

	Name	Gross Tons	Propeller	Horse Power	Speed	Pulling	LOA	B
1	TOHO MARU	211	Z/P	2,900 PS	14.5 Kn	37.0 t	33.3 m	8.2 m
2	SADO MARU	238	Z/P	2,600	15.0	36.0	38.1	8.4
3	SHIMA MARU	236	Z/P	2,600	15.0	34.0	36.8	8.6
4	SATSUMA MARU	229	Z/P	2,600	15.0	34.0	36.3	8.6
5	SURUGA MARU	230	Z/P	2,600	15.0	34.5	36.3	8.6
6	NAGATO MARU	160	Z/P	3,000	15.5	37.6	37.7	8.4
7	URAGA MARU	162	Z/P	3,000	15.5	40.2	37.7	8.4
8	SAGAMI MARU	180	Z/P	3,000	15.5	35.0	35.0	8.6
9	AZUMA MARU	167	Z/P	3,000	15.5	44.0	34.2	8.4
10	TOA MARU NO.7	230	Z/P	2,600	15.0	34.0	36.3	8.6
11	TOA MARU NO.6	216	CPP	2,600	13.0	30.5	30.5	8.4
12	TOA MARU NO.5	194	CPP	2,400	11.0	23.9	29.2	8.4
13	TOA MARU NO.2	198	CPP	2,400	11.5	23.9	29.2	8.4

(2) Introduction of a new tug fitted with the Kort nozzlepeller

New devices for steering are now being developed which use varieties of new rudders and propeller mechanisms that give certain vessels improved handling qualities.

Z-pellers and Duck-pellers are tugs whose improved steering control, particularly when backing, is due to Kort nozzle-propellers.

1) Features of Kort nozzle-propellers

(a) Excellent maneuverability:

Tugs equipped with these propellers not only eliminate the rudder, but also are capable of executing pivot turns, moving side-ways and forward at dead-slow speeds or executing a crash astern at will.

The following table should help in comparing the available tugs with various systems.

(b) Powerful thrust

Since necessary provisions have been made for selecting the optimum propeller revolution, the Kort nozzlepeller can always deliver the maximum thrust per horsepower, further-more, there is no major difference in thrust between ahead and astern movement.

Propeller	Ahead Pull	Astern Pull
FPP	1.0 X	0.7 X
CPP	1.5 X	0.9 X
KORT	1.5 X	1.5 X

(c) Easy fitting and maintenance

Because of the all-in-one unit feature concerning propulsion and maneuvering, the Kort peller can be easily installed. In addition, since the propeller and driving unit which are submerged under water can be easily lifted onto the deck, maintenance of the Kort peller can be done without the ship entering into the dock.

(d) Advance and reliable operation

Single lever

The Kort peller is operated through remote control from the control stand placed in the wheel house, and its remote control system is of the single lever type.

From the standpoint of engineering psychology, the lever action perfectly coincides with the vessel's motion so that the vessel can be controlled to perform any desired maneuver at the mere touch of a single lever.

Twin lever

The twin lever type remote control stand which independently controls the port and starboard sides of the Kort peller by means of ahead and astern levers and the steering wheel can also be supplied in lieu of the said single lever type remote control stand if the client so requests.

2) Specification of 3,000 PS Duck-peller harbour Tug-boat

a) General Description:

The vessel is to be designed and built as a Zett drive screw propeller, diesel driven, single lever controlled harbour tug-boat.

The tug is to be equipped with two 360-degree steering propulsion systems (ISC Duckpeller).

b) Rules and Regulations:

The vessel, including its hull, machinery and equipment shall be built under a special survey and in accordance with the rules and regulations of Lloyd's Register of Shipping and upon completion shall be distinguished in the register by the symbols 100 AI (Indian Coastal Service and Tug-boat) and LMC.

The following Rules and Regulations shall be applied.

Classification Rules and Regulations, 1983

Indian Merchant Shipping Act.

c) Materials:

Materials, machinery and equipment are to be of Japanese make and type in accordance with the Japanese Industrial Standard (JIS) and/or Builder's Standard, and/or Sub-Constructor's Standard, except as specified.

d) Spare parts:

Spare parts are to be supplied in accordance with the requirements of the classification society.

e) Owner's Furnishing Equipment:

All hoses and mooring ropes other than those required by the rules.

Bosun's store other than as supplied by builder's practice.

All beddings (pillows, blankets, covers, etc.), naperies, chandleries and medical equipments.

All cook's and steward's utensils (silverware, dishes, glasses, pots, pans, etc.).

All charts and nautical books.

All consumable stores.

f) Standard and Building Practice:

The construction and outfitting of vessels is to be carried out in accordance with Japanese marine practice.

g) Inspection:

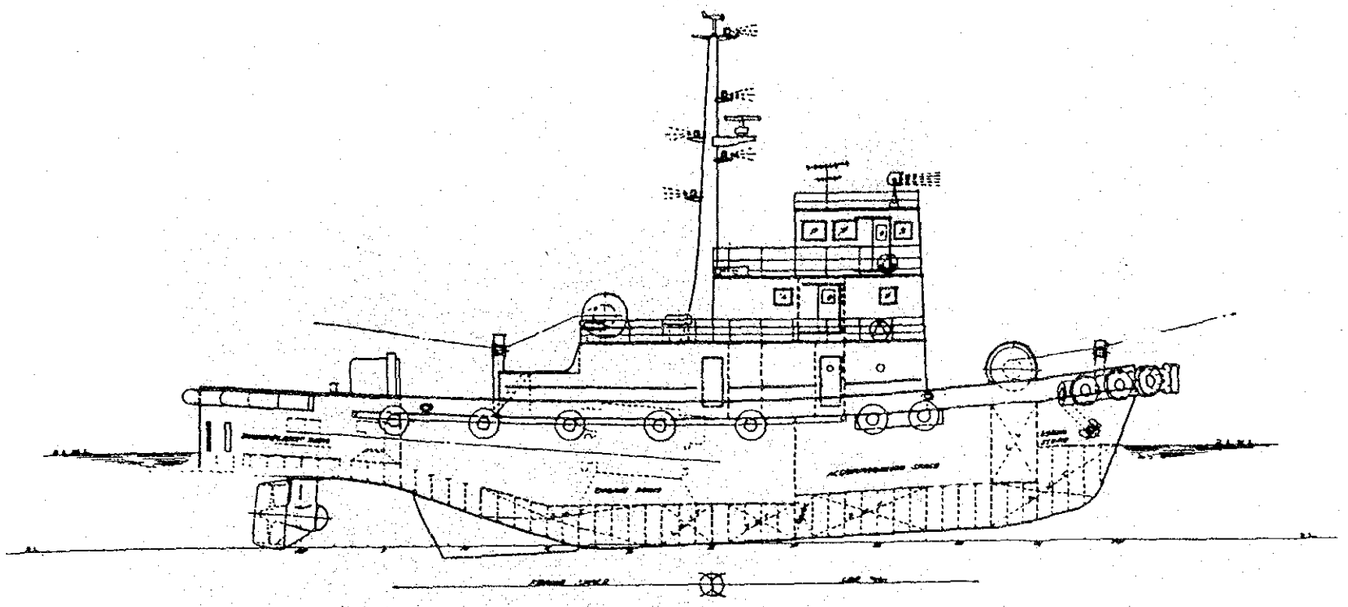
The inspection of the vessel is to be carried out in accordance with the standard rules.

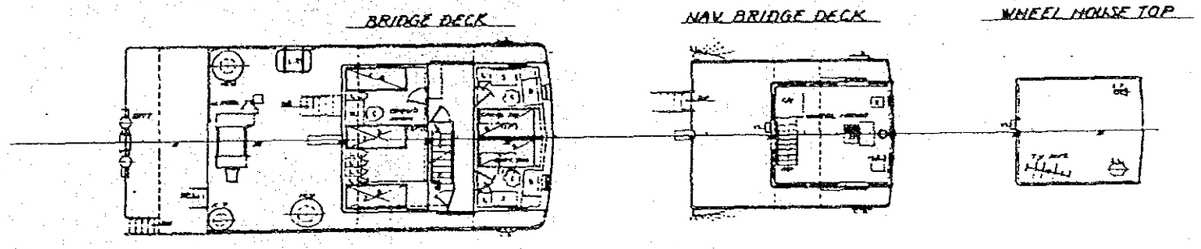
3) Principal Dimensions

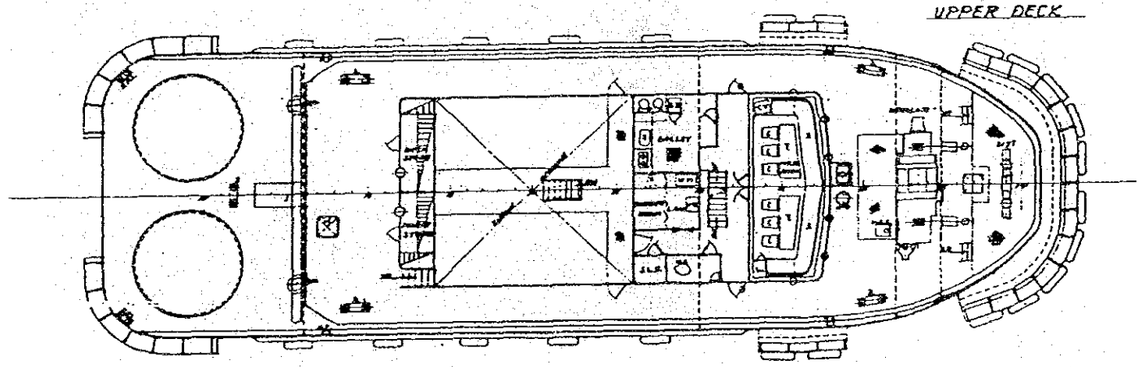
The principal dimensions of the tug-boats are as follows:

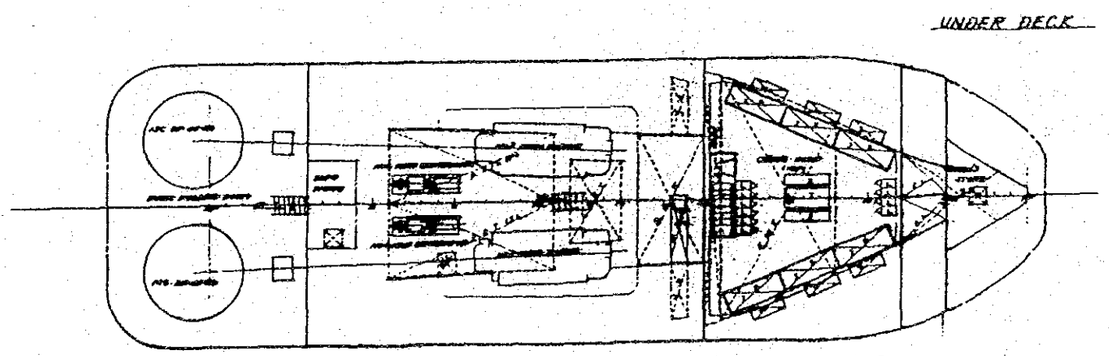
Principal Dimensions:

	3,000 ps Type
Length O.A	31.41 m
Length B.P	27.50 m
Breadth, mld.	9.50 m
Depth, mld.	4.20 m
Designed df.	3.20 m
Initial Trim	1.30 m
Gross tonnage	app. 320 t
Dead weight	app. 100 t
Diesel fuel	37 m3
Fresh water	24 m3
Speed, trial	13.0 knots
Speed, service	12.5 knots
Bollard pull	ahead max. 38 tons
Officer	2 p
Crew	17 p
Engine	Twin screw diesel propulsion sets and 360 degree steering propulsion system. 1,500 ps x 2
Generator	235V, A.C. 50 Hz





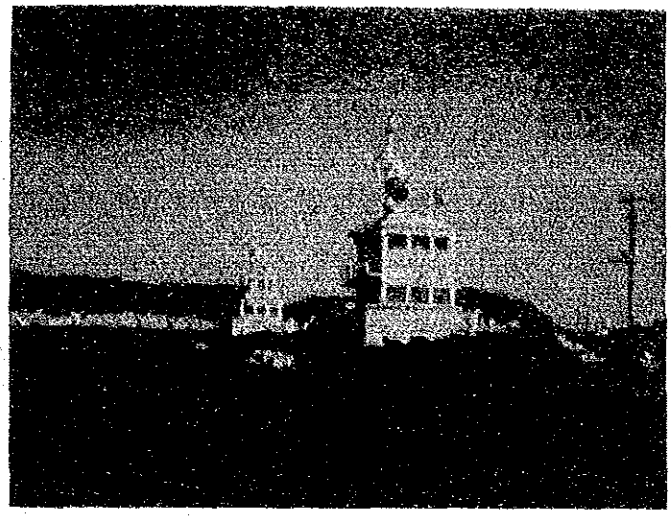


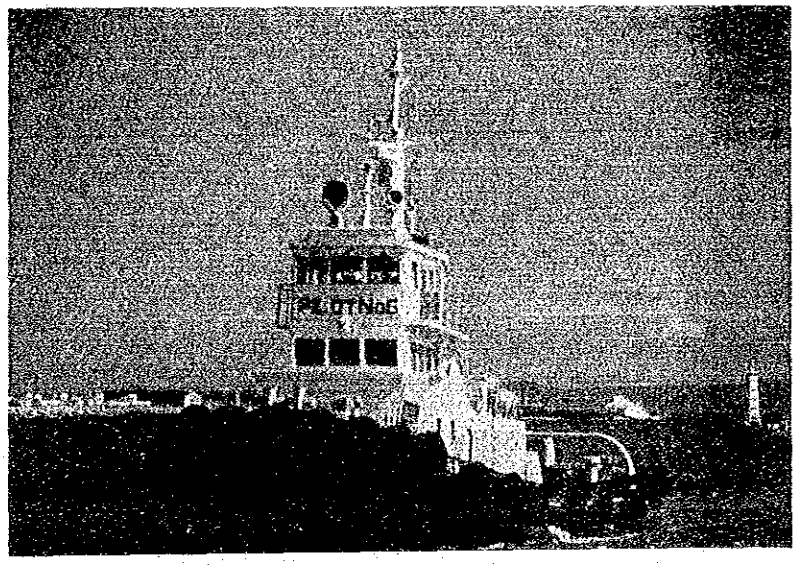


PRINCIPAL PARTICULARS

LENGTH	(O.A) (EXCEPT FENDER)	31.41 M
LENGTH	(L.B.P.)	30.80 M
LENGTH	(M.P.)	27.50 M
BREADTH	(MLD.)	9.50 M
DEPTH	(MLD.)	4.20 M
DRAUGHT	(MLD.)	3.70 M
GROSS TONNAGE		APPROX. 320 TON
MAIN ENGINE	DIESEL ENGINE	
	1500 PS × 330 RPM × 2 SETS	
PROPELLER :	I.S.C. CONTROLLABLE PITCH PROPELLER DP 40-E4 TYPE × 2 SETS	
COMPLEMENT	DECK	2 P
	CREW	17 P
	TOTAL	19 P
TRIAL SPEED		13 KTS
BOLLARD PULL	(AHEAD MAX.)	38 TON
CLASSIFICATION	NK	
	✠100 A1 (Inshore coastal service and Tug boat) strengthened ✠ LMC	

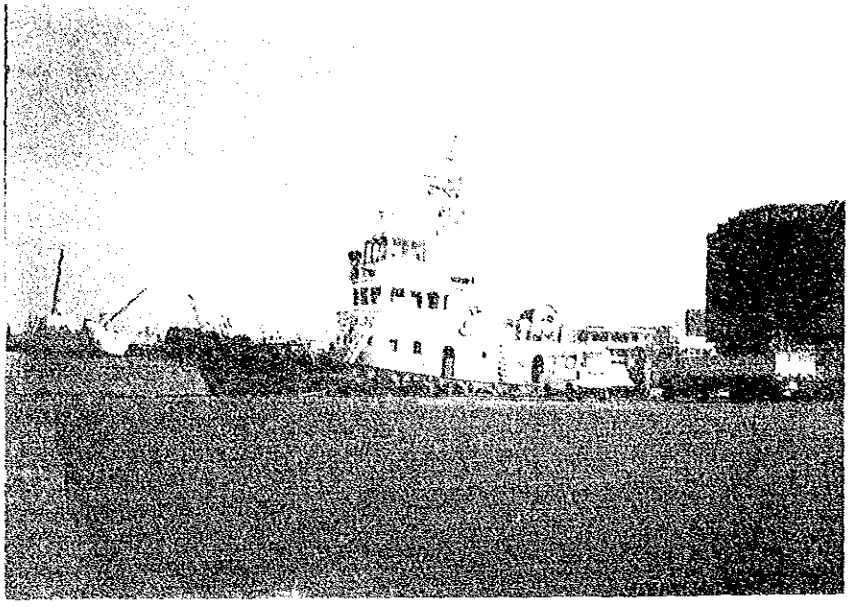
PROFILE OF TUG BOAT



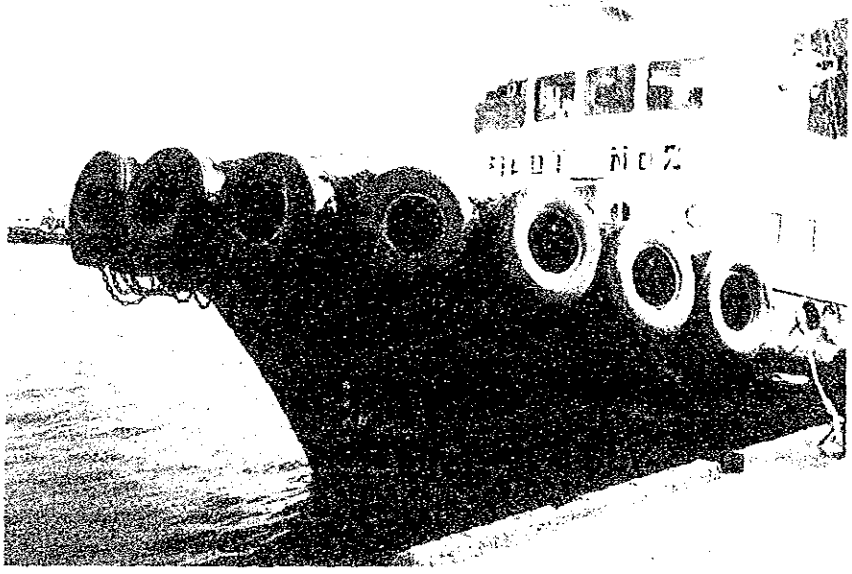


TOA MARU NO.6

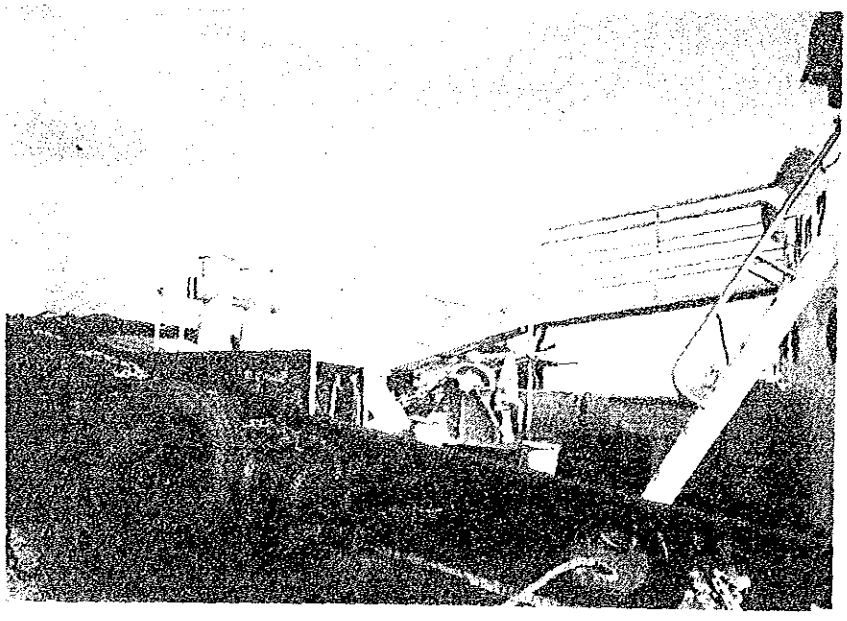
TOA MARU NO.2

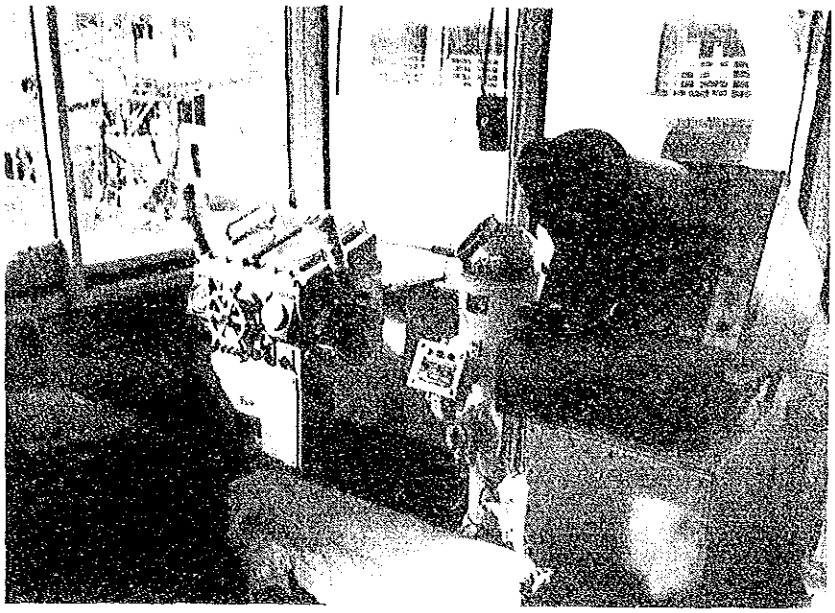


FOREPART



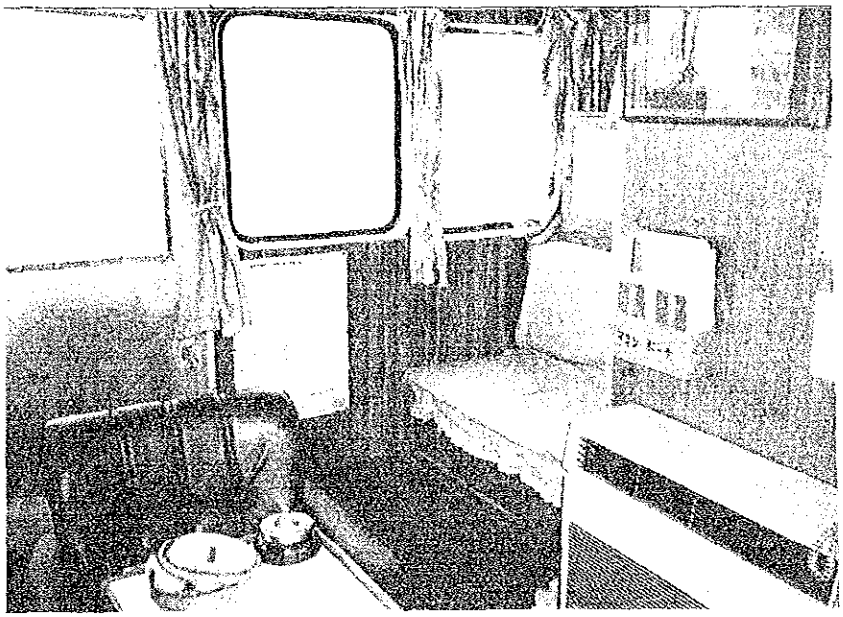
SAFETY HAND RAIL

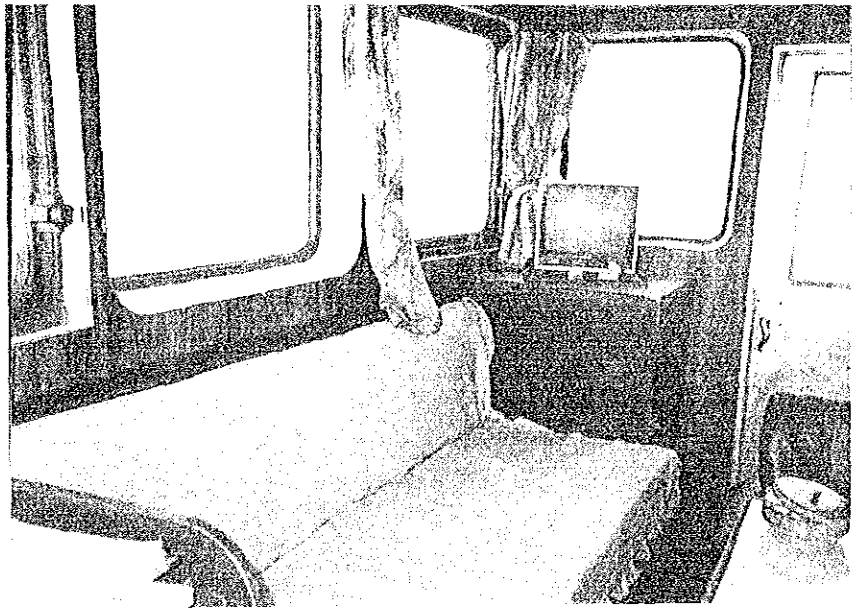




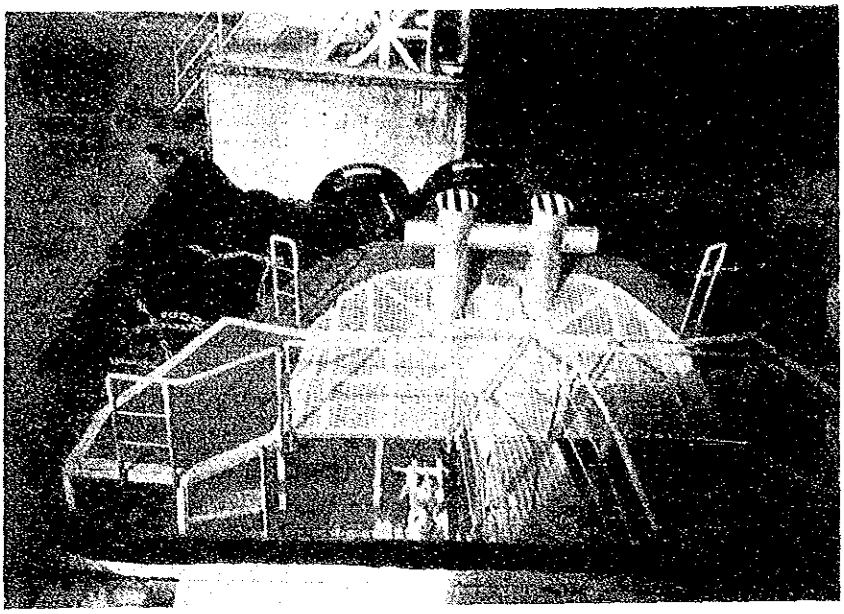
BRIDGE

PILOT WAITING ROOM



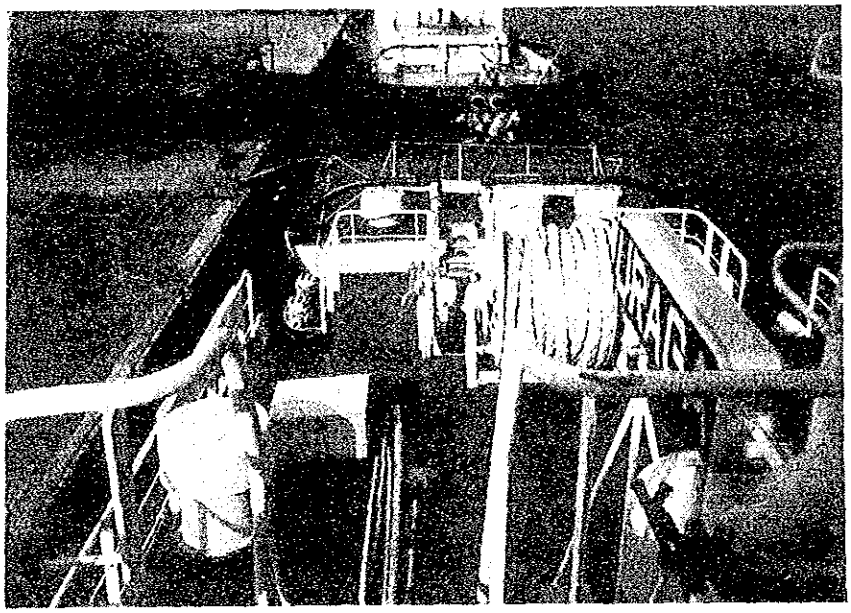


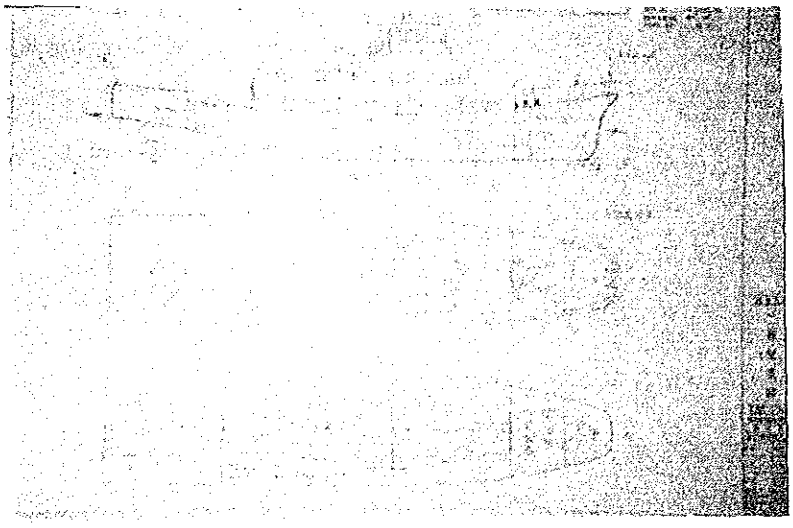
PILOT WAITING ROOM



FORECASTLE OF TOA NO.2

AFT. PART OF TOA NO.2





GENERAL PLAN OF URAGA