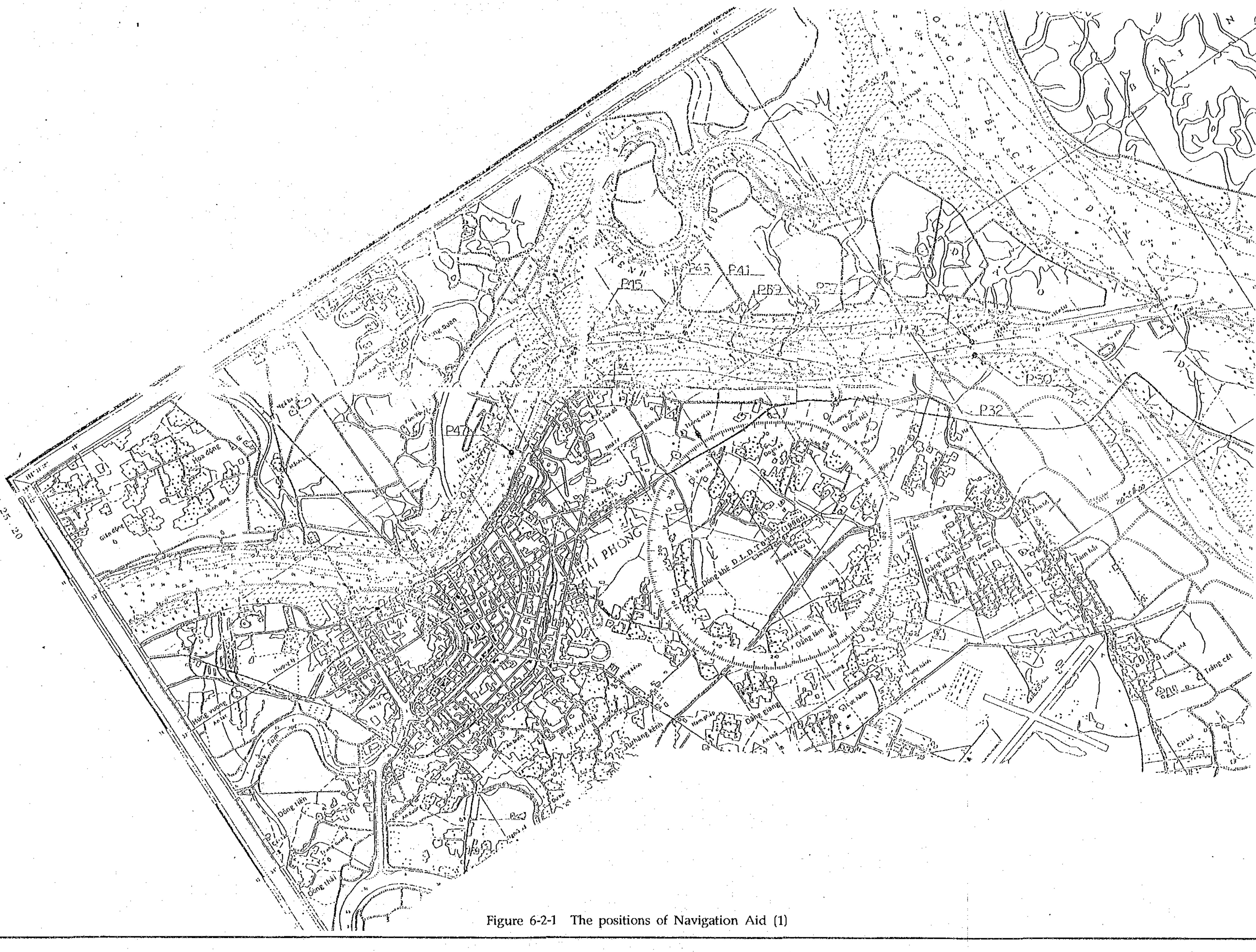


Figure 6-2-1 The positions of Navigation Aid (1)

Figure 6-2-1 The positions of Navigation Aid (2)

Figure 6-2-1 The positions of Navigation Aid (3)

(5) Official depth

'Official depth' means the access channel depth announced by the harbormaster based on the results of depth sounding carried out four to six times a year. An official depth is obtained by subtracting the underkeel clearance (0.3m) from the shallowest of sounding results. The months of depth sounding are shown in Table 6-2-1. (For official depths announced in the past, see Table 6-3-11.)

The harbormaster informs those listed in Table 6-2-2 of the official depth the day following his receipt of the depth sounding results.

In the case of the access channel where the rate of sedimentation will be changed daily, therefore the management of the access channel depth should be carried out at least once a month. Currently, the positioning method of sounding is carried out mainly by the used of transits.
In this sounding system, it is very difficult to obtain quick sounding result, because of a long distance sounding navigation line and its analysis of data manual method and also due to meteorological condition such as intense heat during day time had limited the time of conducting the sounding causing effect in obtaining the result.

Table 6-2-1 Record of Official Sounding 1991-1993

Year	Monthly Sounding	Times
1991	April, July, August, September, November	5 times
1992	January, March, June, August, October, December	6 times
1993	February, April, June	3 times

Source: Marine Safety

Before 1990, it has been confirmed that official sounding was carried out four times a year, by having from the Hai Phong port.

LIST OF OFFICAL DEPTH INFORMATION

- VINAMARINE
- CONSTRUCTING BOARD
- BASIC ENGINEERING
- VIETNAM OCEAN SHIPPING COMPANY
- VIETNAM OCEAN AGENCY
- VIETNAM SHIPPING COMPANY
- VIETNAM SEA TRANSPORT AND CHARTERING COMPANY
- TRANSPORT AND CHARTERING COOPERATION
- HAIPHONG SHIPPING COMPANY
- VIETNAM CONTAINER COMPANY
- PETRO LEUM PRODUCT COMPANY No.1
- SEA PRODUCT EXPORT COMPANY
- PETRO LEUM PRODUCT COMPANY No.3
- MARITIME ARBITRATION
- MARITIME SAFETY No.1
- PILOTAGE COMPANY No.2
- HAI PHONG PORT
- CUA CAM PORT
- FILE ADMINISTRATATIVE DAPARTMENT

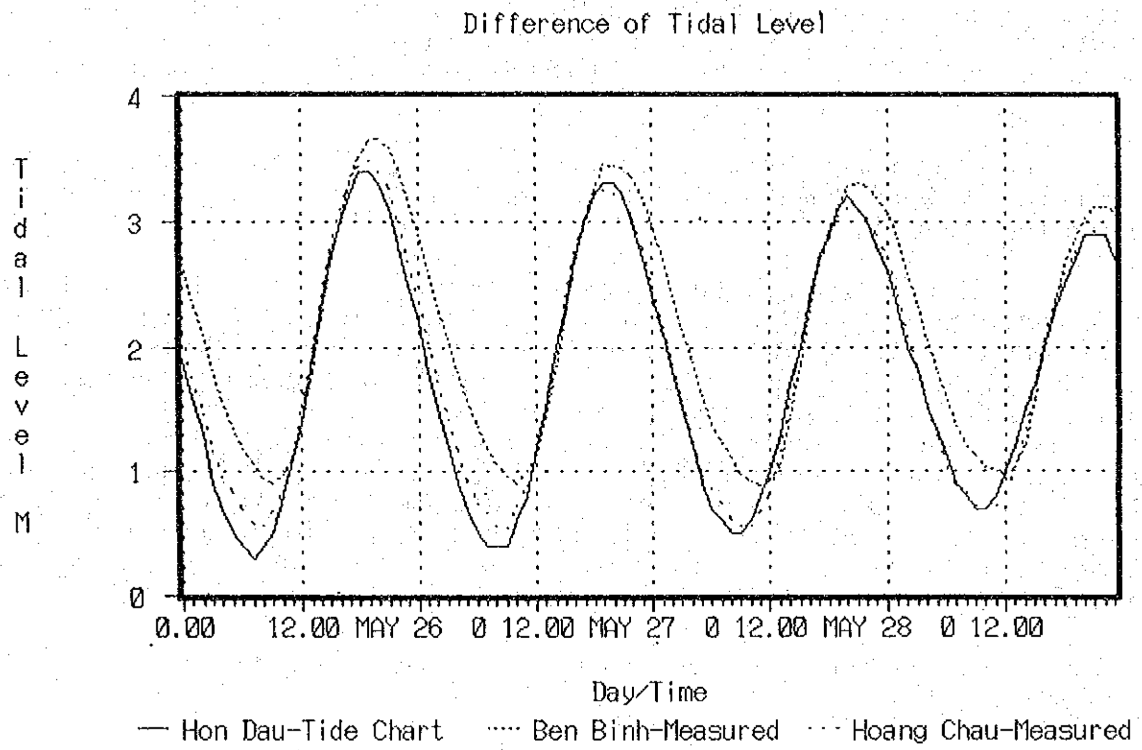


Figure 6-2-2 Timelag Between Hon Dau and Hai Phong Port

6-3 Dredging Volume and its Sedimentation Volume in Various Depths

6-3-1 Dredging volume in various depths (-5.0m, -6.0m, and -7.0m)

(1) The access channel

Based on latest the depth sounding carried out in June 1993, the volume of dredged earth was calculated at planned depth of -5.0m, -6.0m, and -7.0m. On the blueprinted alignment of access channel, normal line and the existing alignment obtained from the results of sounding, Nine dikes were constructed from 1991-1992 located between curve (ST.2) and curve (ST.3). After this construction, the alignment channel was moved by 20-30m toward the right bank and the radius of curvature was eased to reduce the distance between the two points by 60m.
However, the total distance from main port to the Dinh Vu channel still remained.

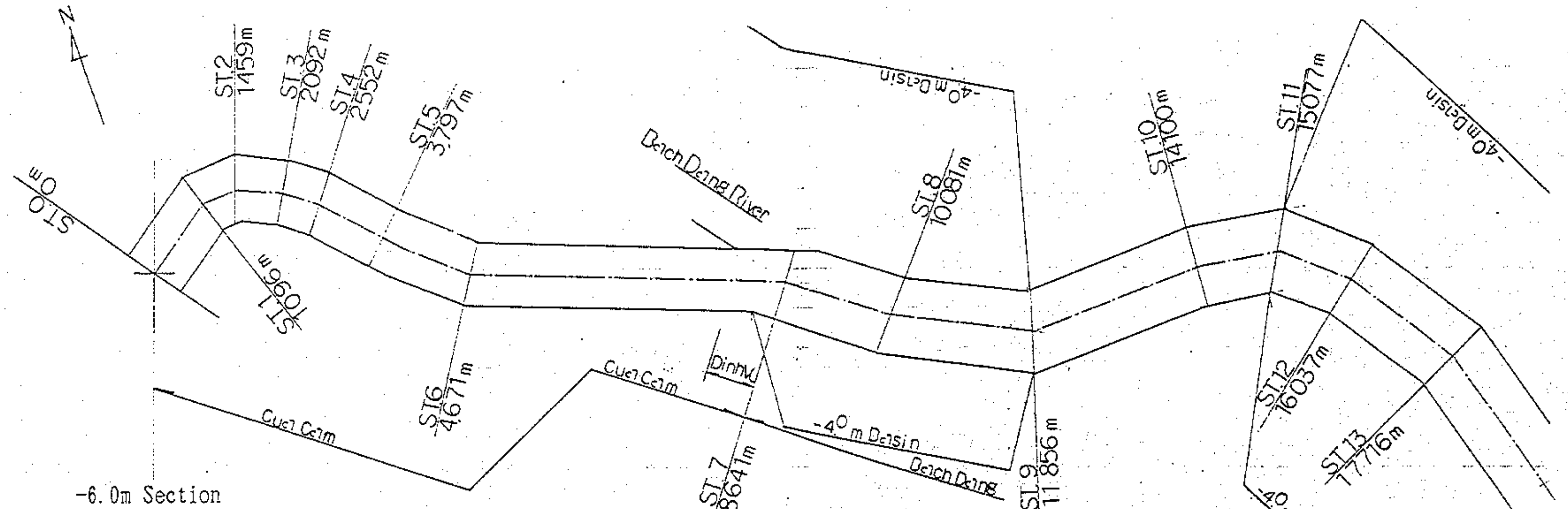
The cross section area were divided with 250m as the standard, and additional sections were divided in points on which a change in curvature were found, channel width, etc.
Measuring distances based on the center line of the channel (alignment). The areas without depth sounding record were used on the base of Bach Dang River in 1992 sounding record and marine chart of the Nam Trieu in 1992. The cross section area and their positions are shown in Figures 6-3-1 (I) and (II).

The alignment of the access channel stated in Chapter 2-3-4 was based on "existing condition of access channel and basin" and thereon volume of these cases (-5.0m, -6.0m and -7.0m) were calculated as shown in Table 6-3-1 to 6-3-3.

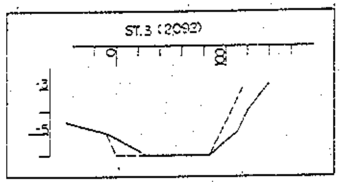
(2) Turning basin

For turning basin, calculation was based on February 1993 sounding record and by referring to typical section shown in Figure 6-3-2 as well as on the lay plan of Figure 6-3-3. The calculation results are shown in Table 6-3-4.

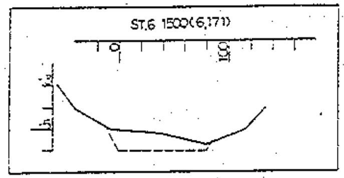
Both of them were calculated on the basis of the sounding results of June 1993, and its dredging volume are to be changed substantially by sedimentation and maintenance dredging work in the future. Therefore, finalization of depth sounding will be done in coming implementation stage.



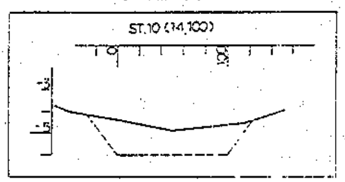
-6.0m Section



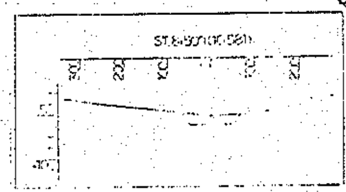
-6.0m Section



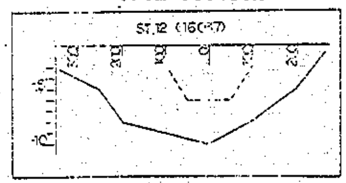
-6.0m Section



-6.0m Section

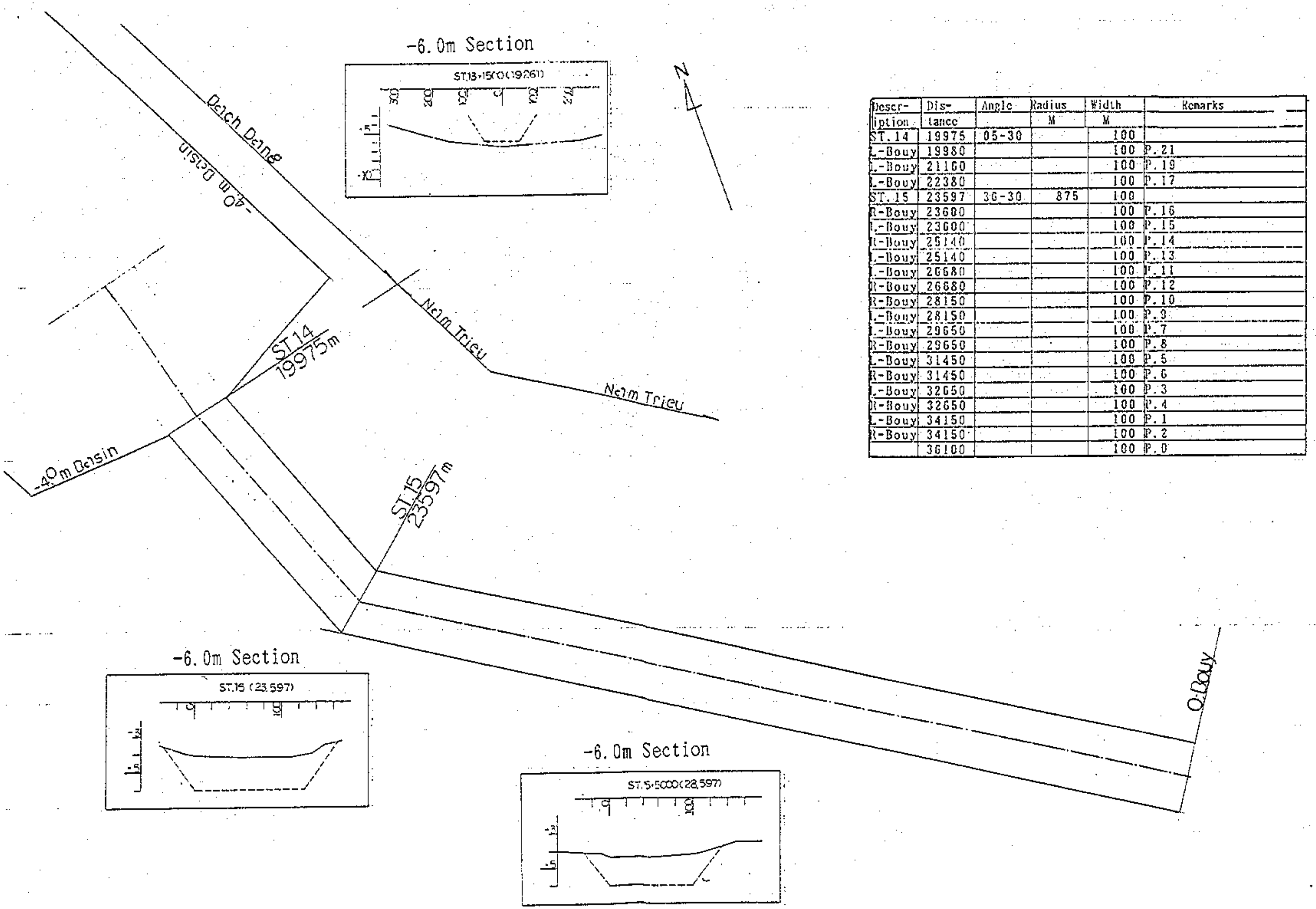


-6.0m Section



Description	Distance	Angle	Radius M	Width M	Remarks
L-Bouy	-20				P.47
ST.0	0	00-00		80	
ST.1	1096	34-02	675	80	
Lighti	1180			80	DEN TAY VANG CHAU
ST.2	1459	25-30	675	80	
L-Bouy	1560			80	P.45
ST.3	2092	11-12	675	80	
L-Bouy	2310			80	P.43
ST.4	2552	11-58	675	80	
Dike	2700			80	KE.1
L-Bouy	2730			80	P.41
Dike	3160			80	KE.2
L-Bouy	3250			80	P.39
Dike	3480			80	KE.3
Dike	3780			80	KE.4
ST.5	3797	06-11		80	
L-Bouy	3820			80	P.37
L-Bouy	4670			80	P.35
ST.6	4671	19-30	800	80	
L-Bouy	4800			80	P.32
R-Bouy	5970			80	P.30
L-Bouy	6110			80	P.33
Dike	6190			80	KE.5
Dike	6370			80	KE.6
Dike	6520			80	KE.7
Dike	6680			80	KE.8
Lighti	6840			80	DEN TAYDINHVU
Lighti	8190			80	DEN TRANG DDV
Lighti	8370			80	DEN DO DDV
ST.7	8641	16-30		80	
ST.8	10081	09-00	1000	Basin	
ST.9	11856	23-30	1000	100	
L-Bouy	11860			100	P.29
L-Bouy	12980			100	P.27
R-Bouy	12980			100	P.28
	13230			100	PTD
R-Bouy	14060			100	P.24
ST.10	14100	12-00	1000	100	
Lighti	14800			100	DEN ARIO
ST.11	15077	32-00	1000	100	
R-Bouy	15100			Basin	P.22
ST.12	16037	16-30		Basin	
ST.13	17716	17-00		Basin	

Figure 6-3-1 (1) The Access Channel Plan



Descr-iption	Dis-tance	Angle	Radius M	Width M	Remarks
ST.14	19975	05-30		100	
L-Bouy	19980			100	P.21
L-Bouy	21160			100	P.19
L-Bouy	22380			100	P.17
ST.15	23597	36-30	875	100	
R-Bouy	23600			100	P.16
L-Bouy	23600			100	P.15
R-Bouy	25140			100	P.14
L-Bouy	25140			100	P.13
L-Bouy	26680			100	P.11
R-Bouy	26680			100	P.12
R-Bouy	28150			100	P.10
L-Bouy	28150			100	P.9
L-Bouy	29650			100	P.7
R-Bouy	29650			100	P.8
L-Bouy	31450			100	P.5
R-Bouy	31450			100	P.6
L-Bouy	32650			100	P.3
R-Bouy	32650			100	P.4
L-Bouy	34150			100	P.1
R-Bouy	34150			100	P.2
	36100			100	P.0

Figure 6-3-1 (2) The Access Channel Plan

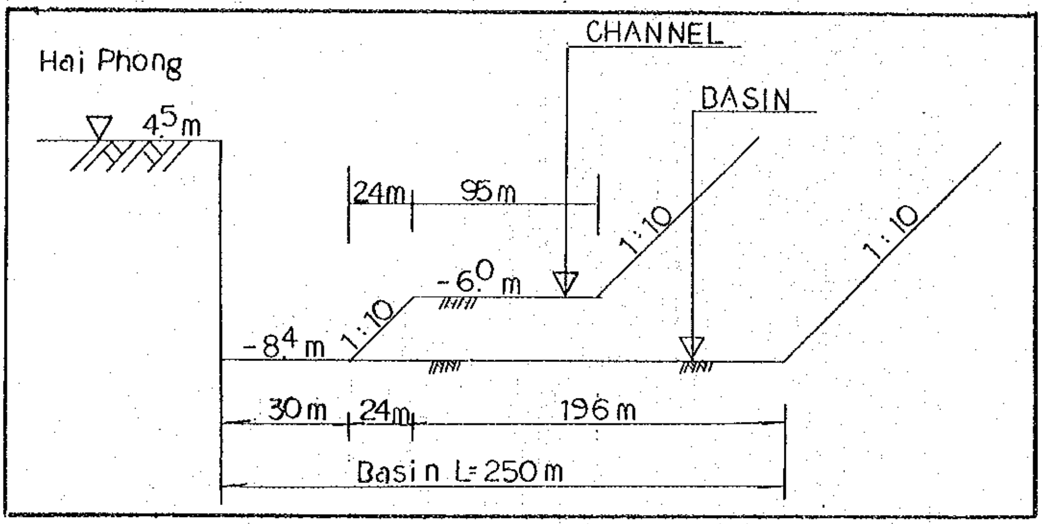


Figure 6-3-2 Typical Section of Turning Basin

(3) Summary of dredging volume

Summary of dredging volume shown of Table 6-3-5.

UNIT: 1,000M3

NET AREA	FROM TO	EXISTING -5.0 M	EXISTING -6.0 M	EXISTING -7.0 M
1. CHANNEL				
SONG CAM	ST0-ST 7	50	290	1,230
BACH DANG	ST7-ST14	80	770	1,460
NAM TREU	ST14-END	880	2,660	4,940
Sub Total		1,010	3,720	7,630
2. Basin				
Basin		920	920	920
TOTAL		1,930	4,640	8,550

Table 6-3-5 Summary of Dredging Volume

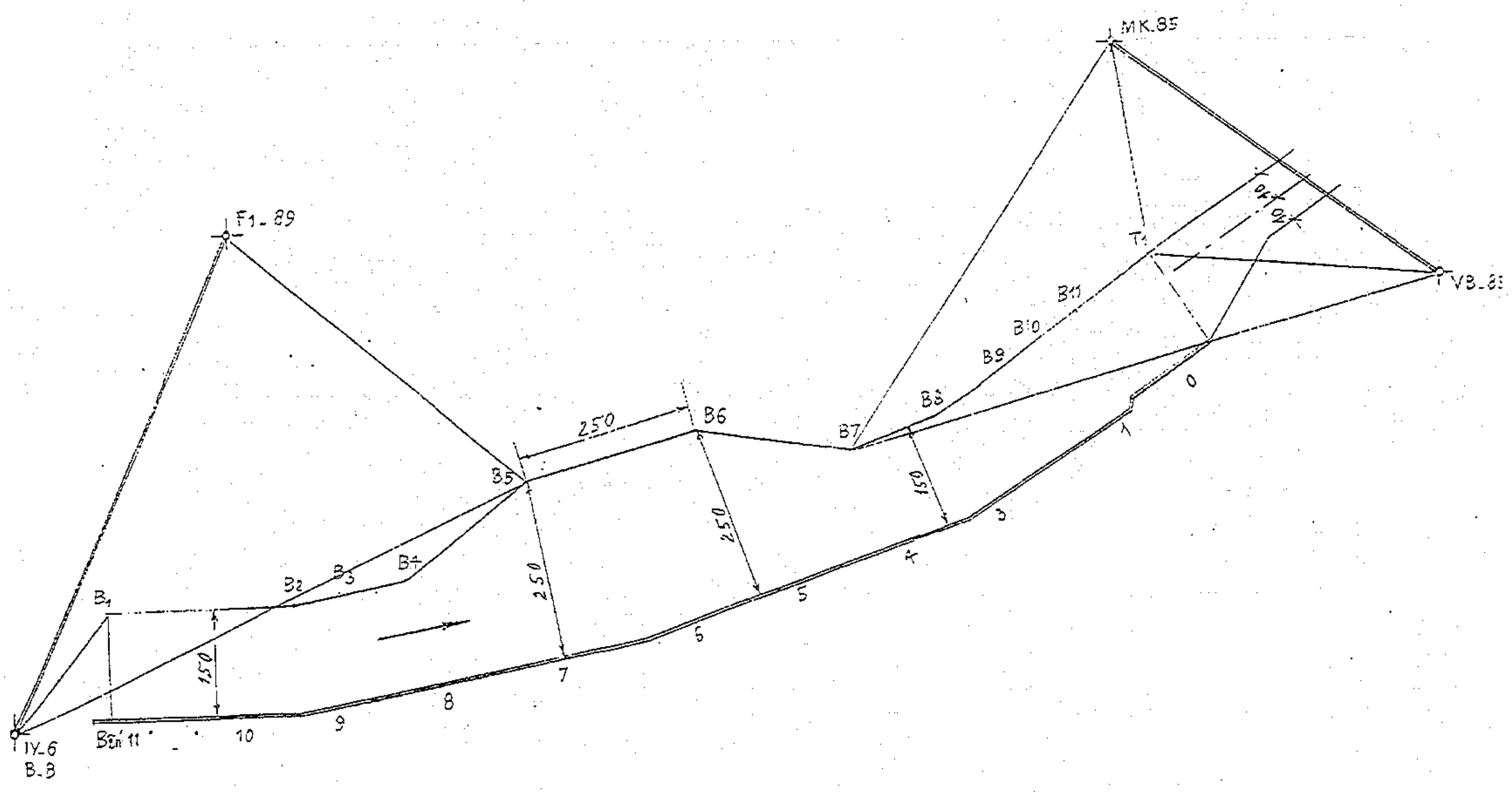


Figure 6-3-3 Lay Plan of Turning Basin

1993 JUNE -5.0 m
DREDGING VOLUME

Section	S Dist.	Distance	Area	AV.-Area	Volume	Remarks
	M	M	M2	M2	M3	Sub Total
ST.0	0	0	15.69	7.85	0.0	
500	500	500	0	7.85	3,922.5	
971	971	471	5.5	2.75	1,295.3	
ST.1	1096	125	3.77	4.64	579.4	5,797.1
110	1206	110	1.36	2.57	282.2	
220	1316	110	0	0.68	74.8	
303	1399	83	3.05	1.53	126.6	
ST.2	1459	60	3.25	3.15	189.0	672.5
250	1709	250	10.5	6.88	1,718.8	
500	1959	250	0	5.25	1,312.5	
ST.3	2092	133	0	0.00	0.0	3,031.3
ST.4	2552	460	14.21	7.11	3,268.3	3,268.3
500	3052	500	8.2	11.21	5,602.5	
1000	3552	500	13.02	10.61	5,305.0	
ST.5	3797	245	4.81	8.92	2,184.2	13,091.7
500	4297	500	15	9.91	4,952.5	
729	4526	229	7.22	11.11	2,544.2	
ST.6	4671	145	18.41	12.82	1,858.2	9,354.9
155	4826	155	7.5	12.96	2,008.0	
500	5171	345	24.38	15.94	5,499.3	
1000	5671	500	0	12.19	6,095.0	
1500	6171	500	0	0.00	0.0	
2000	6671	500	0	0.00	0.0	
2500	7171	500	1.29	0.65	322.5	
3000	7671	500	0	0.65	322.5	
3500	8171	500	0	0.00	0.0	
ST.7	8641	470	0	0.00	0.0	14,247.3
500	9141	500	0	0.00	0.0	
1000	9641	500	0	0.00	0.0	
ST.8	10081	440	0	0.00	0.0	0.0
500	10581	500	0	0.00	0.0	
1000	11081	500	0	0.00	0.0	
1500	11581	500	0	0.00	0.0	
2000	11701	120	34.21	17.11	2,052.6	
ST.9	11856	155	38.75	36.48	5,654.4	7,707.0
138	11994	138	14.68	26.72	3,686.7	
275	12131	137	39.77	27.23	3,729.8	
500	12356	225	8.65	24.21	5,447.3	
1000	12856	500	14.71	11.68	5,840.0	
1500	13356	500	10.83	12.77	6,385.0	
2080	13936	580	24.68	17.76	10,297.9	
ST.10	14100	164	25.26	24.97	4,095.1	35,795.1
152	14252	152	31.53	28.40	4,316.0	
500	14600	348	61.55	46.54	16,195.9	
885	14985	385	0	30.78	11,848.4	
ST.11	15077	92	0	0.00	0.0	32,360.3
250	15327	250	0	0.00	0.0	
500	15577	250	0	0.00	0.0	
ST.12	16037	460	0	0.00	0.0	0.0
500	16537	500	0	0.00	0.0	
1000	17037	500	0	0.00	0.0	

Table 6-3-1(1) Dredging Volume of -5.0 m

Section	S Dist.	Distance	Area	AV.-Area	Volume	Remarks
	M	M	M2	M2	M3	Sub Total
ST.13	17716	679	0	0.00	0.0	0.0
500	18216	500	0	0.00	0.0	
1000	18716	500	0	0.00	0.0	
1500	19216	500	0	0.00	0.0	
2000	19716	500	0	0.00	0.0	
ST.14	19975	259	0	0.00	0.0	0.0
500	20475	500	0	0.00	0.0	
1000	20975	500	0	0.00	0.0	
1500	21475	500	13.32	6.66	3,330.0	
2000	21975	500	57.58	35.45	17,725.0	
2500	22475	500	100.41	79.00	39,497.5	
3000	22975	500	104.18	102.30	51,147.5	
3178	23153	178	93.92	99.05	17,630.9	
3327	23302	149	87.67	90.80	13,528.5	
3473	23448	146	109.5	98.59	14,393.4	
ST.15	23597	149	119.63	114.57	17,070.2	174,323.0
144	23741	144	136.71	128.17	18,456.5	
280	23877	136	116.18	126.45	17,196.5	
432	24029	152	108.5	112.34	17,075.7	
1000	24597	568	107.48	107.99	61,338.3	
1500	25097	500	145	126.24	63,120.0	
2000	25597	500	125.55	135.28	67,637.5	
2500	26097	500	89.87	107.71	53,855.0	
3000	26597	500	116.57	103.22	51,610.0	
3500	27097	500	97.89	107.23	53,615.0	
4000	27597	500	74.25	86.07	43,035.0	
4500	28097	500	59.88	67.07	33,532.5	
5000	28597	500	78.28	69.08	34,540.0	
5500	29097	500	62.72	70.50	35,250.0	
6000	29597	500	46.09	54.41	27,202.5	
6500	30097	500	67.54	56.82	28,407.5	
7000	30597	500	77.35	72.45	36,222.5	
7500	31097	500	53.75	65.55	32,775.0	
8000	31597	500	21.05	37.40	18,700.0	
8500	32097	500	10.15	15.60	7,800.0	
9000	32597	500	0	5.08	2,537.5	
9500	33097	500		0.00	0.0	703,907.0
				TOTAL	1,007,242.1	

Table 6-3-1(2) Dredging Volume of -5.0 m

1993 JUNE -6.0 m
DREDGING VOLUME

Section	S Dist.	Distance	Area	AV.-Area	Volume	Remarks
	M	M	M2	M2	M3	Sub Total
ST.0	0	0	60.6	30.3	0.0	
500	500	500	27.7	44.2	22,077.5	
971	971	471	66.3	47.0	22,141.7	
ST.1	1096	125	47.4	56.9	7,108.8	51,328.0
110	1206	110	37.9	42.7	4,693.7	
220	1316	110	11.1	24.5	2,695.6	
303	1399	83	37.8	24.4	2,026.9	
ST.2	1459	60	29.9	33.8	2,028.6	11,444.7
250	1709	250	47.0	38.4	9,608.8	
500	1959	250	5.0	26.0	6,500.0	
ST.3	2092	133	14.6	9.8	1,301.4	17,410.2
ST.4	2552	460	77.6	46.1	21,189.9	21,189.9
500	3052	500	103.4	90.5	45,237.5	
1000	3552	500	108.8	106.1	53,035.0	
ST.5	3797	245	62.1	85.4	20,929.1	119,201.6
500	4297	500	88.6	75.4	37,680.0	
729	4526	229	63.1	75.9	17,370.8	
ST.6	4671	145	75.4	69.3	10,041.3	65,092.0
155	4826	155	69.7	72.5	11,243.7	
500	5171	345	93.1	81.4	28,079.6	
1000	5671	500	14.0	53.5	26,767.5	
1500	6171	500	54.4	34.2	17,080.0	
2000	6671	500	0.3	27.3	13,667.5	
2500	7171	500	53.8	27.1	13,525.0	
3000	7671	500	2.8	28.3	14,152.5	
3500	8171	500	0.0	1.4	705.0	
ST.7	8641	470	0.0	0.0	0.0	125,220.8
500	9141	500	0.0	0.0	0.0	
1000	9641	500	0.0	0.0	0.0	
ST.8	10081	440	60.0	30.0	13,200.0	13,200.0
500	10581	500	80.0	70.0	35,000.0	
1000	11081	500	90.0	85.0	42,500.0	
1500	11581	500	100.0	95.0	47,500.0	
2000	11701	120	169.9	135.0	16,194.6	
ST.9	11856	155	214.3	192.1	29,774.7	170,969.3
138	11994	138	145.2	179.7	24,804.8	
275	12131	137	143.7	144.5	19,789.7	
500	12356	225	133.0	138.4	31,129.9	
1000	12856	500	139.9	136.4	68,217.5	
1500	13356	500	132.2	136.0	68,000.0	
2080	13936	580	154.5	143.3	83,125.6	
ST.10	14100	164	162.9	158.7	26,023.5	296,286.1
152	14252	152	166.1	164.5	25,004.0	
500	14600	348	207.6	186.9	65,027.3	
885	14985	385	122.7	165.2	63,584.7	
ST.11	15077	92	60.9	91.8	8,447.4	162,063.4
250	15327	250	0.0	30.5	7,615.0	
500	15577	250	0.0	0.0	0.0	
ST.12	16037	460	0.0	0.0	0.0	7,615.0
500	16537	500	0.0	0.0	0.0	
1000	17037	500	0.0	0.0	0.0	

Table 6-3-2(1) Dredging Volume of -6.0 m

Section	S Dist.	Distance	Area	AV.-Area	Volume	Remarks
	M	M	M2	M2	M3	Sub Total
ST.13	17716	679	0.0	0.0	0.0	0.0
500	18216	500	0.0	0.0	0.0	
1000	18716	500	0.0	0.0	0.0	
1500	19216	500	0.0	0.0	0.0	
2000	19716	500	0.0	0.0	0.0	
ST.14	19975	259	0.0	0.0	0.0	0.0
500	20475	500	0.0	0.0	0.0	
1000	20975	500	60.1	30.1	15,035.0	
1500	21475	500	135.6	97.9	48,925.0	
2000	21975	500	193.0	164.3	82,130.0	
2500	22475	500	247.2	220.1	110,040.0	
3000	22975	500	255.3	251.2	125,620.0	
3178	23153	178	236.2	245.7	43,741.7	
3327	23302	149	241.9	239.1	35,619.9	
3473	23448	146	292.0	267.0	38,976.2	
ST.15	23597	149	303.3	297.6	44,349.1	544,436.9
144	23741	144	325.9	314.6	45,303.1	
280	23877	136	286.4	306.2	41,639.8	
432	24029	152	272.1	279.3	42,449.0	
1000	24597	568	287.1	279.6	158,821.3	
1500	25097	500	338.8	313.0	156,480.0	
2000	25597	500	313.5	326.1	163,067.5	
2500	26097	500	251.6	282.5	141,265.0	
3000	26597	500	291.8	271.7	135,837.5	
3500	27097	500	264.4	278.1	139,037.5	
4000	27597	500	231.0	247.7	123,855.0	
4500	28097	500	200.9	216.0	107,990.0	
5000	28597	500	223.8	212.4	106,187.5	
5500	29097	500	229.5	226.7	113,335.0	
6000	29597	500	180.8	205.2	102,575.0	
6500	30097	500	205.1	193.0	96,475.0	
7000	30597	500	213.4	209.2	104,617.5	
7500	31097	500	184.3	198.8	99,412.5	
8000	31597	500	142.9	163.6	81,787.5	
8500	32097	500	128.2	135.5	67,750.0	
9000	32597	500	102.1	115.1	57,552.5	
9500	33097	500	0.0	51.0	25,515.0	2,110,953.3
				TOTAL	3,715,701.0	

Table 6-3-2(2) Dredging Volume of -6.0 m

1993 JUNE -7.0 m
DREDGING VOLUME

Section	S Dist.	Distance	Area	AV.-Area	Volume	Remarks
	M	M	M2	M2	M3	Sub Total
ST.0	0	0	148.12	74.06	0.0	
500	500	500	126.55	137.34	68,667.5	
971	971	471	170.17	148.36	69,877.6	
ST.1	1096	125	127	148.59	18,573.1	157,118.2
110	1206	110	98.46	112.73	12,400.3	
220	1316	110	70.13	84.30	9,272.5	
303	1399	83	146.02	108.08	8,970.2	
ST.2	1459	60	153.25	149.64	8,978.1	39,621.1
250	1709	250	105	129.13	32,281.3	
500	1959	250	52.5	78.75	19,687.5	
ST.3	2092	133	125.5	89.00	11,837.0	63,805.8
ST.4	2552	460	267	196.25	90,275.0	90,275.0
500	3052	500	220.98	243.99	121,995.0	
1000	3552	500	220.52	220.75	110,375.0	
ST.5	3797	245	179.19	199.86	48,964.5	281,334.5
500	4297	500	204.31	191.75	95,875.0	
729	4526	229	177.09	190.70	43,670.3	
ST.6	4671	145	168	172.55	25,019.0	164,564.3
155	4826	155	184.94	176.47	27,352.9	
500	5171	345	212.49	198.72	68,556.7	
1000	5671	500	121.72	167.11	83,552.5	
1500	6171	500	162.84	142.28	71,140.0	
2000	6671	500	65.67	114.26	57,127.5	
2500	7171	500	164.07	114.87	57,435.0	
3000	7671	500	40.34	102.21	51,102.5	
3500	8171	500	13.27	26.81	13,402.5	
ST.7	8641	470	0	6.64	3,118.5	432,788.0
500	9141	500	0	0.00	0.0	
1000	9641	500	40	20.00	10,000.0	
ST.8	10081	440	160	100.00	44,000.0	54,000.0
500	10581	500	180	170.00	85,000.0	
1000	11081	500	190	185.00	92,500.0	
1500	11581	500	200	195.00	97,500.0	
2000	11701	120	339.46	269.73	32,367.6	
ST.9	11856	155	422.54	381.00	59,055.0	366,422.6
138	11994	138	309.38	365.96	50,502.5	
275	12131	137	302.41	305.90	41,907.6	
500	12356	225	291.89	297.15	66,858.8	
1000	12856	500	298.48	295.19	147,592.5	
1500	13356	500	289.16	293.82	146,910.0	
2080	13936	580	319.39	304.28	176,479.5	
ST.10	14100	164	337.74	328.57	53,884.7	633,633.0
152	14252	152	337.5	337.62	51,318.2	
500	14600	348	392.88	365.19	127,086.1	
885	14985	385	243.64	318.26	122,530.1	
ST.11	15077	92	0	121.82	11,207.4	312,141.9
250	15327	250	0	0.00	0.0	
500	15577	250	0	0.00	0.0	
ST.12	16037	460	0	0.00	0.0	0.0
500	16537	500	0	0.00	0.0	
1000	17037	500	0	0.00	0.0	

Table 6-3-3(1) Dredging Volume of -7.0 m

Section	S Dist.	Distance	Area	AV.-Area	Volume	Remarks
	M	M	M2	M2	M3	Sub Total
ST.13	17716	679	0	0.00	0.0	0.0
500	18216	500	0	0.00	0.0	
1000	18716	500	0	0.00	0.0	
1500	19216	500	40	20.00	10,000.0	
2000	19716	500	50	45.00	22,500.0	
ST.14	19975	259	60	55.00	14,245.0	46,745.0
500	20475	500	111.84	85.92	42,960.0	
1000	20975	500	201.35	156.60	78,297.5	
1500	21475	500	291.36	246.36	123,177.5	
2000	21975	500	362.19	326.78	163,387.5	
2500	22475	500	427.66	394.93	197,462.5	
3000	22975	500	443.8	435.73	217,865.0	
3178	23153	178	411.26	427.53	76,100.3	
3327	23302	149	437.01	424.14	63,196.1	
3473	23448	146	517	477.01	69,642.7	
ST.15	23597	149	523.35	520.18	77,506.1	1,109,595.3
144	23741	144	552.25	537.80	77,443.2	
280	23877	136	497.37	524.81	71,374.2	
432	24029	152	473	485.19	73,748.1	
1000	24597	568	510.66	491.83	279,359.4	
1500	25097	500	558.49	534.58	267,287.5	
2000	25597	500	539.76	549.13	274,562.5	
2500	26097	500	460.08	499.92	249,960.0	
3000	26597	500	507.81	483.95	241,972.5	
3500	27097	500	465.94	486.88	243,437.5	
4000	27597	500	423.97	444.96	222,477.5	
4500	28097	500	382.21	403.09	201,545.0	
5000	28597	500	404.11	393.16	196,580.0	
5500	29097	500	367.31	385.71	192,855.0	
6000	29597	500	350.42	358.87	179,432.5	
6500	30097	500	395.52	372.97	186,485.0	
7000	30597	500	379.35	387.44	193,717.5	
7500	31097	500	345.83	362.59	181,295.0	
8000	31597	500	295.4	320.62	160,307.5	
8500	32097	500	276.08	285.74	142,870.0	
9000	32597	500	243.75	259.92	129,957.5	
9500	33097	500	0	121.88	60,937.5	3,827,604.9
				TOTAL	7,630,152.0	

Table 6-3-3(2) Dredging Volume of -7.0 m

BASIN -6.0 M Dredging Volume

Section	Distance	Area	AV-Area	Volume
	M	M2	M2	M3
B.0	0	121.2	60.6	0
B.1	90	130.8	126.0	11,337
B.2	24	231.6	181.2	4,348
B.3	133	242.8	237.2	31,546
B.4	260	258.0	250.4	65,109
B.5	72	192.2	225.1	16,209
B.6	24	747.0	469.6	11,270
B.7	50	1034.1	890.5	44,526
B.8	35	1170.6	1102.3	38,582
B.9	135	1106.0	1138.3	153,674
B.10	164	1211.3	1158.7	190,022
B.11	104	1203.9	1207.6	125,592
B.12	80	1216.4	1210.2	96,813
B.13	29	1087.6	1152.0	33,408
B.14	54	584.0	835.8	45,132
B.15	24	85.7	334.9	8,036
B.16	60	11.0	48.4	2,901
B.17	127	41.9	26.4	3,356
B.18	150	192.0	116.9	17,541
B.19	160	82.3	137.1	21,942
B.20	24	82.3	82.3	1,974
Total				923,319

Table 6-3-4 Dredging Volume of Turning Basin -6.0 m

6-3-2 Sedimentation volume in various

1) General

In the past management, daily record of dredging work such as position, dredging volumes, operating hours, break hours, etc., have not been recorded.
This is because the promoting entity of a project and the contractor had no interest in anything but the contract volume (dredging volume) and final depth.
The orderer of dredging work had been changed from MOTAC in 1982-1988, to Hai Phong Port Authority in 1989-1992, and to Vinamarine from 1993. This is a result from the announcement of bylaws on February 1993 following Article 239-HDBT on June 1992. Sedimentation volumes at depths of -5.0m, -6.0m, and -7.0m were estimated from the limited collected data.

2) Problems in estimating sedimentation volumes

The mechanism of sedimentation in the channel including the Bay of Ha Long, Cua Cam River and Bach Dang River has already been discussed in section 6-1-1 'Flowing condition of the access channel'. In the past 60 years sedimentation volume was reviewed, particularly in two pocket areas of much deeper area in the Bach Dang river and it founds out that, the rate of sedimentation volume in the first 30 years is more higher than the latter 30 years. It is easy to assume that the completion of the Dinh Vu dam had been altered the river flow and its elements etc. then quickly decreased the depths of the pockets. This means that the natural function to mitigate sedimentation (pocket function) has been less and less.
The analysis of sedimentation volume using past record on dredged volumes and its depths do not reach the analyzed depths, which did not consider functions of pocket in deeper areas. Therefore, the analysis of sedimentation volumes might be exceeded accordingly as shown.

3) Records of dredging volumes and it depths

Table 6-3-6 shows the records of dredging volumes in various sections from 1955 to 1992.

4) Analysis of sedimentation volume

In analyzing the sedimentation volume, the channel was divided into two zones: the river zone including the Cua Cam and Bach Dang rivers and the Nam Trieu channel zone in Ha Long Bay.

In Table 6-3-6, records of maintenance dredging volume in the river areas and Nam Trieu area are in average ratio of 1:6. The Nam Trieu area shows greater sedimentation volume. Therefore, the analysis was put on the quantitative estimate of sedimentation volume in the Nam Trieu area. In Figure 6-3-4, shows the method of analyzing sedimentation volume obtained from;

(a) Based on the correlation between the dredged volume and it's depth,
(b) The rate of speed of sedimentation (I),
(c) Information record from TEDI Report (Channels of Present hai Phong Port 1993), and
(d) Using the rate of average speed of sedimentation (II) in river areas,

Table 6-3-6 The Records of Dredging Volumes in Various Section from 1955 to 1992

YEAR	TOTAL	NAMTRIEU				SONGCAM				BACHDANG			
		total	b(m)	h(m)	m(g:)	total	b(m)	h(m)	m(g:)	total	b(m)	h(m)	m(g:)
1955	2203	2177	100	-5	15	26	100	-4.5	15				
1956													
1957	3444	3145				299							
1958	2764	2644				120							
1959	1265	1165				100							
1960	2018	1674				344							
1961	2121	1630				491							
1962	1908	1430				478							
1963	349												
1964	2909	2655				304							
1974	3151	2640	100	-5	15	461	100	-5	15				
1975	1510	1100		-5.5		410		-5					
1976	435												
1977	1212	802		-5		410		-4.5					
1978	4310	3960	100	-6	15	350	100	-5	15				
1979	2476	2021		-5		465		-4.5					
1980	570	577				53							
1981	1110	1050				60							
1982	1540	1220				320							
1983	1630	1356	100	-5		274	100	-5					
1984	2730	2135	100	-4.8		595	100	-4.8					
1985	2485	1618	100	-5		767	100	-5					
1986	3508	2793	80	-4.8		715	80	-4.8					
1987	3011	2540	80	-4.5		471	80	-4.5					
1988	2648	2256	100	-4.5		392	100	-4.5					
1989	3100	2900		-4.8		100	80	-4.8	10	100	100	-4.8	15
1990	2700	2400		-4.5		170	80	-4.5	10	130	100	-4.5	15
1991	1100	1100	100	-4.1	15								
1992	1700	1700	100	-4.2	15								

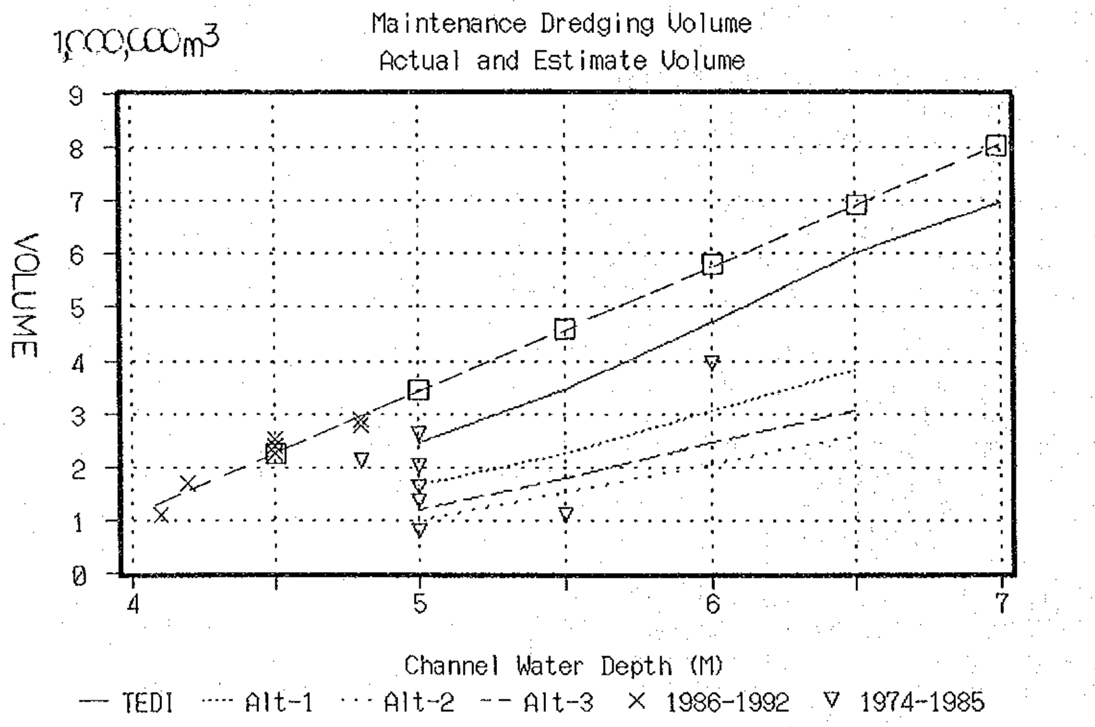
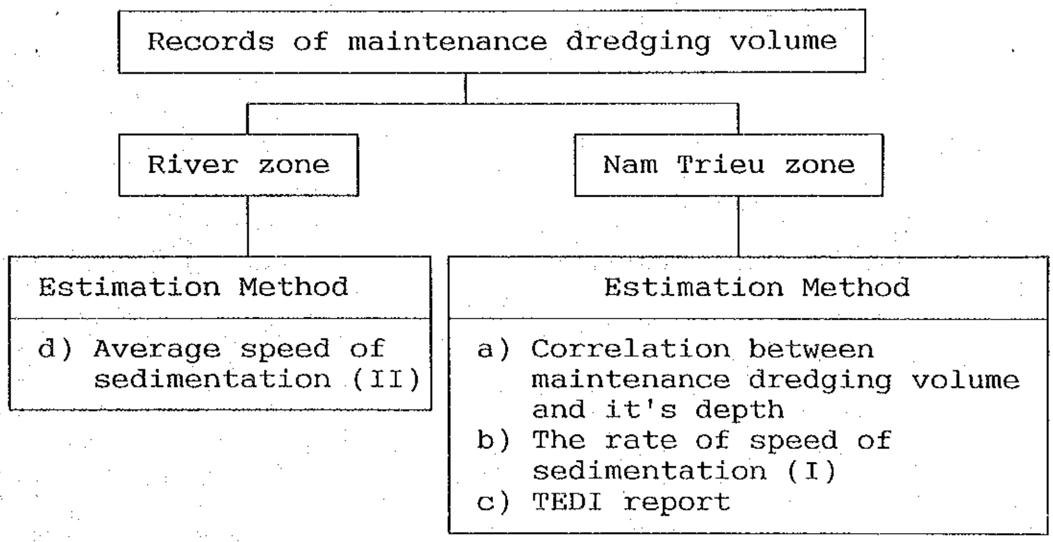


Figure 6-3-5 Trend of Dredged Volumes and its Depths

Fig. 6-3-4: Method of Analyzing Sedimentation Volume



a) Correlation between maintenance dredging volume and it's depth (Nam Trieu channel)

Assuming maintenance dredging volume equals sedimentation volume, the correlation between maintenance dredging volume and its depth was graphed mainly in regression analysis method and its rate of 0.96 forecasted as shown on Figure 6-3-5.

As detailed in Chapter 3-1-2 and 6-1-1. The sedimentation mechanism was altered changed by river flows after the completion of the Dinh Vu dam in 1982. Accordingly, unrelated previous records were not used till 1986, data (x), sedimentation conditions became similar to the present. As a result, of the regression analysis marked with (□) (coefficient of rate is 0.96). From this, the outcome of the sedimentation volumes can be obtained as listed in Table 6-3-7.

Table 6-3-7 Case (a) of Sedimentation Volumes

Depth	Analyzed Volume (m^3)
-4.5m	2,274,000
-5.0m	3,420,000
-5.5m	4,565,000
-6.0m	5,711,000
-6.5m	6,857,000
-7.0m	8,002,000

In Figure 6-3-5, Alt-1 line is the sedimentation volume estimated by TEDI and also Alt-2 and Alt-3 are new alignment one ('Channels of Present Hai Phong Port').

b) Estimation rate of speed of sedimentation (I) (Nam Trieu channel)

The basis for estimating sedimentation volume from the

method b), the dredging records such as position, period and its depth continuously recorded were used for analysis.
These records were only available after July 1989.

Sea bottom in the Nam Trieu channel were caused by waves reactions, flow current, ocean current, sailing speed of vessels, and other external factors. The first ridge is seen at the bending point (ST15), the next about 2km downstream, and the third one is 4.5km further downstream. The slope of the last bottom wave's slope connecting bottom of the sea.
The estimated sedimentation volume from the rate of speed of sedimentation has considered all of changing factors of the sea bed's conditions. The use of the average of dredged depth means including various external elements are represented by average values. The basic concept of the estimation method is the initial dredged depth of a certain period is shallowed by new coming sedimentation and next new dredging depth will be dredged then its result calls again for other initial dredged depth and continuously repeated again. The relation between dredged depth (dredged thickness) and sedimentation thickness is shown on Figure 6-3-6.

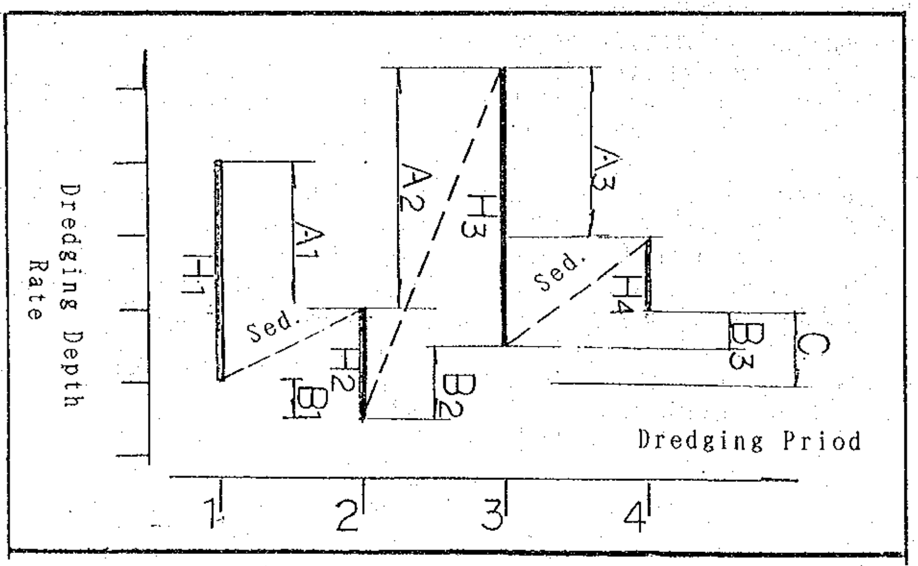


Figure 6-3-6 Diagram of Sedimentation Repeated Process

In the diagram, the relation between A and B is expressed as a change in water depth following a variation in dredged depth. C is the difference in depth between the last dredged depth and after the initial dredged depth.

The steps of estimation procedure is as follows;

(1) Average dredged thickness before the rainy season (January-April) and after the rainy season (October-December): Hi

(2) Comparison of dredged thicknesses = (Previous average dredged thickness) - (Last average dredged thickness): Hi+1-Hi

(3) Comparison of depths after dredging = (Previous average

dredged depth) - (Last average dredged depth): Bi

(4) The relation between (2) and (3) is represented graphically. (Figure 6-3-7)

(5) Graph (4) was corrected using average values and variations of water depth during the period covered.

(6) The sedimentation thicknesses at the various water depths were read from graph (5).

(7) The values of (6) are multiplied by sedimentation distance to obtain sedimentation volume.

In Figure 6-3-7, a sedimentation analysis line was hypothetically drawn as a trend of the line. In the figure, the origin of the X axis represents average dredged depth of H=-4.27m during analysis period, and the origin of the Y axis represents Average dredged thickness during same period (1.745m)+Total Change in dredged depth between the initial and the last (0.4m).

The analysis of sedimentation thicknesses can be read from Figure 6-3-7 as shown in Table 6-3-8.

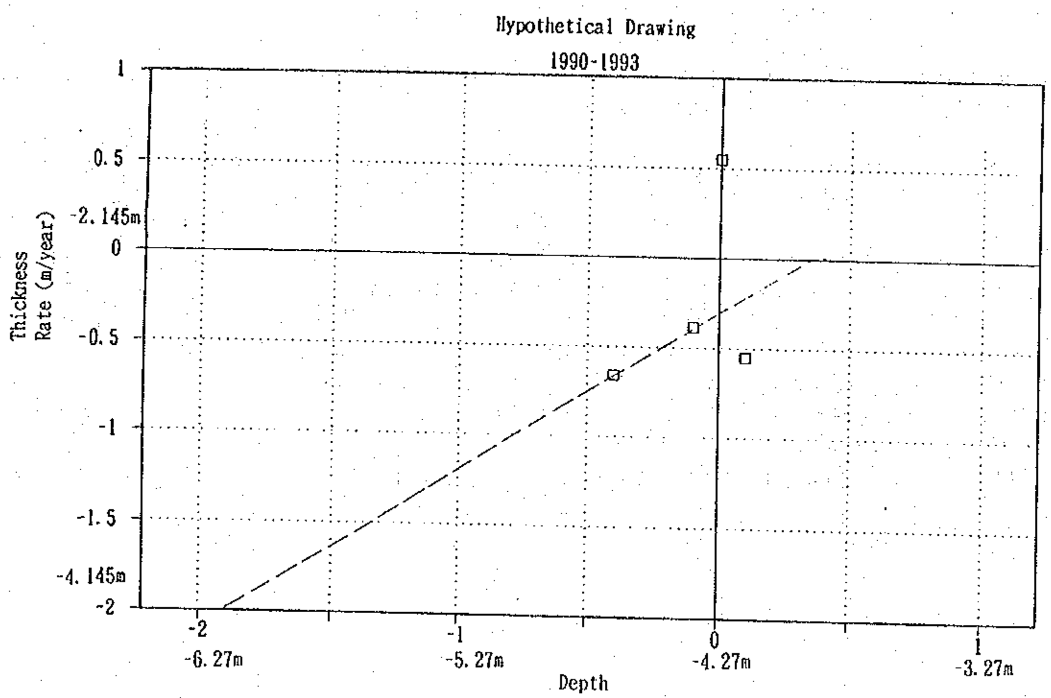


Figure 6-3-7 The Hypothetical Drawing of Sedimentation Analysis

Table 6-3-8 Analysis of Sedimentation Thickness

Depth	Thickness (m)
-4.0m	2.345m
-4.5m	2.745m
-5.0m	3.045m
-5.5m	3.395m
-6.5m	4.095m
-7.0m	4.445m

Table 6-3-9 shows analysis of sedimentation volumes obtained from multiplying the sedimentation thicknesses contained in Table 6-3-8 by sedimentation distance.

Table 6-3-9 Case (b) of Analysis of Sedimentation Volumes

Depth	Distance	Sedimenta-tion(m)	Sedimenta-tion(m3)	Analyzed Volume
-4.0m	8000	2.345	1,876,000	1,880,000
-4.5m	8750	2.745	2,401,875	2,400,000
-5.0m	10800	3.045	3,288,600	3,290,000
-5.5m	11950	3.395	4,057,025	4,060,000
-6.0m	13200	3.745	4,943,400	4,940,000
-6.5m	14850	4.095	6,081,075	6,080,000
-7.0m	16400	4.445	7,289,800	7,290,000

In the Nam Trieu channel zone, continuous records from 1990 to 1993 were used in the analysis as shown in Table 6-3-5. The average dredged thickness in 1990-1992 was 1.745m which were 0.441m before the raining reason and 1.304m after it.

Table 6-3-10 Dredged Volumes from 1990 to 1993 at Nam Trieu Channel

YEAR	NAM TRIEU DREDGING DISTANCE	DREDGING DISTANCE	DREDGING DEPTH		PRE-DREDGING	YEAR BALANCE
1990(I)	250.000		0.276	0	4.5	0
1990(II)	2.150.000		1.871	1.595	4.5	0
1991(I)	0		0		4.5	0
1991(II)	1.100.000		1.213	-0.658	4.1	-0.4
1992(I)	600.000		0.662	-0.551	4.2	-0.1
1992(II)	1.100.000		1.213	0.551	4.2	0
1993(I)	500.000		0.825	-0.388	4.1	-0.1
1993(II)			6.06			

The validity of the hypothetical trend line is calibrated by comparing with actual values.

Calibration-1 (dredged depth from 1990 to 1993)

The line of extension of hypothetical trend crosses with the X axis at +0.4m, hereby dredged depth is -3.87m calculated from -4.27m (average dredged depth)+0.4m (cross point).

The official survey records of channel depth as shown in Table 6-3-11 with average -3.7m to -3.9m without shallowest -2.9m in October 1992, corresponds to the value analyzed from the hypothetical trend line. Accordingly, the dredged volume is below the coming sedimentation volume and the depth of the channel was judged to be inadequate.

Table 6-3-11 Record of Offical Depths from 1982 to 1993

DEPTH OF THE CHANNEL OF HAIPHONG PORT FROM 1982-1993 UNIT:M

	NAMTRIEU			SONGCAM			BACHDANG			SLOPE		
	AVERAGE DEPTH	WIDTH	MINIMUM DEPTH	AVERAGE DEPTH	WIDTH	MINIMUM DEPTH	AVERAGE DEPTH	WIDTH	MINIMUM DEPTH	NAMTRIEU (M)	SONGCAM (M)	BACHDANG (M)
APR'82	-5.5	100										
JUL'82				-4.2	100					1/15	1/10	1/15
MAR'84				-4.3	100	-3.5						
						-3.7				1/15	1/10	1/15
APR'84	-5	100					-4.9	100				
APR'85	-4.8	80		-5	100	-4.3						
						-4.2						
						-3.9				1/15	1/10	1/15
AUG'85				-4.3	100							
OCT'85							-3.7	100	-3			
									-3.4			
NOV'85				3	100							
MAR'86				-4.1	100	-4.1						
APR'86	-4	80										
JUN'86				-4	100					1/15	1/10	1/15
AUG'86	-4	100		-3.6	100							
OCT'86				-3.5	100							
NOV'86	-3.2	100		-3.5	100	-3.6						
JUL'87				-3.6	100		-3.2	100				
SEP'87	-3.1	100		-4.1	100							
APR'88				-3.5	100		-3.9	100		1/15	1/10	1/15
MAY'88	-4.5	100	-4.4	-4.5	100							
AUG'88				-3.7	100		-3.7	100				
JAN'89				-4.4	100		-4.3	100	-4.2			
MAY'89	-4.7	100	-3.9	-4.6	100	-4.2				1/15	1/10	1/15
			-3.8									
FEB'90				-3.8	100		-4	100				
MAY'90	-3.9	100		-3.8	100					1/15	1/10	1/15
JUL'90	-3.4	100		-3.9	100							
OCT'90	-3	100		-3.1	100							
JAN'91	-4.2	100		-3.5	100		-3.9	100				
MAR'91				-3.5	100							
AUG'91				-3.6	80		-3.3	100		1/15	1/10	1/15
DEC'91							-4	100	-3.6			
							-4.1	60				
JAN'92				-3.6	80		-3.3	100				
				-4.2			-3.5	60		1/15	1/10	1/15
							-4					
MAR'92				-3.5	80	-3.5	-3.3	100				
				-3.7	60		-3.5	60				
				-4.2			-3.7					
APR'92				-3.5	80		-4.2	100				
							-4.2	60				
							-4.2					
JUN'92	-3.8			-4.2			-4.5					
	-3.5	60		-4	80		-4.1	100				
	-3.4	100										
OCT'92	-4	100		4.2			-4.4					
	-3.5	100		4	80		-4	100				
	-2.9	100										
	-3.2	60										
	-3.2	100										
	-4	100										
NOV'92	-3.7	100		3.7	100		-3.7	100				
DEC'92	-4.1	100		-4.4			-4.3					
				4	80		-4.1	100				
FEB'93	-4	100		-4.4			-4.6	100				
				-4.1	80		-4.2					
APR'93	-3.7	100	-3.1	-4.3			-4.6	100	-4.3			
	-3.2	80		-4.1	80							
JUL'93	-4.1	100		-4.3			-4.7	100	-4.1			
				-4.1	80							

Calibration-2 (Long-term dredged records)

In the Nam Trieu channel, a total of 25.2 million cubic meters was dredged during the 10-year period from 1983 to 1992, which brought the average dredged depth to -4.54m, a decrease of 0.7m from 10 years earlier.

Based on foregoing results, the following facts were calibrated.

Hereby;

Rate of speed of sedimentation = Average dredged depth (-4.54m)+0.4m (from calculated figure) = -4.14m, which correlated 0.3m of the trend line in the graphical diagram.

Inadequate dredged volume = (0.3m+0.4m) x 100m x 14,500m
= 1,015,000m3/yr

Analyzed sedimentation volume = (0.3m+0.4m+1.745m) x 100m x 14,500m
= 3,545,000m3/yr.

Hereby;

100m : channel width

14,500m: Nam Trieu channel average length indicated as shown in Fig. 6-3-8.

1,745m : Average dredged thickness in 1990 to 1992

Comparison of analyzed sedimentation volume with actual dredged volume in 1983-1992:

Analyzed sedimentation volume = 3,545,000m3/yr. x 10yrs.
= 35.5mil.m3

Actual Volume = Inadequate dredged volume x 10yrs. + Actual dredged volume
= 10.2mil. (1,015,000m3 x 10yrs.) m3 + 25.2mil.m3
= 35.4mil.m3

Base of the channel bottom for analyzed sedimentation volume was considered in a rectangular section with the channel width as its base, it could be assumed that the element of slope gradient (1:15) was included.

Since the above analyzed sedimentation volume coincided with the actual volume, the hypothetical trend line was assumed to be sufficient. As the actual resulting figures, the hypothetical trend line, reflect natural conditions such as ocean currents and typhoon were possibly included.

c) Information records from TEDI report

Sedimentation volumes in the Nam Trieu channel in TEDI's 'Channels of Present Hai Phong Port' are listed in Table 6-3-12. (For details, see the attached appendix.)

Table 6-3-12 Case (c) of Sedimentation Volumes Estimated by TEDI

Section	-5.0m	-5.5m	-6.0m	-6.5m	-7.0m
ST14-ST15	666m3	1,069m3	1,512m3	1,925m3	-----
ST15-END	1,793m3	2,371m3	3,215m3	4,071m3	-----
Total	2,459m3	3,440m3	4,727m3	5.996m3	6,965m3

d) Using the rate of average speed of sedimentation in the river areas (II)

The access channel in the river areas is about 20km long. In the past, dredging work has been done almost entirely in the Cua Cam River and the Bach Dang River was dredged only in 1989-1990. The total dredged volume in the river areas amounting to 770,000m3 is less than 25% of the Nam Trieu after 1983.

The rate of average sedimentation speed was calculated as follows.

The method of calculating the total sedimentation volume in the Cua Cam River from 1983 to 1986 was determined from sounding records between 1983 and 1986 adding the dredged volume during these periods, and the results dividing by 4 years.

Dredged volume in 983-1986: 2,351,000m3 (Table 6-3-6)
Sedimentation average thickness of Cua Cam River: 0.83cm (Table 6-3-13) and total sedimentation as shown in Figure 6-3-9
Average channel width calculated by (100mx3yrs. + 80mx1yr.) - 4yrs. = 95m
Cua Cam River length: 7,750m
Sedimentation volume between 1983 and 1986: 95mx7,750mx0.83m
= 611,000m3
Total sedimentation volume = Dredged volume + Sedimentation Volume
= 2,351,000m3 + 611,000,3
= 2,692,000m3
Therefore; Rate of average sedimentation volume/m: 2,692,000m3 - 4yrs. - 7,750m = 95m3/m (per 95m width)

Calculated sedimentation volumes in the river areas are shown in Table 6-3-14.

Table 6-3-14 Case (d) of Sedimentation Volumes

Area	Cua Cam			Bach Danh		
Depth	Distance	Width	Sedimenta.	Distance	Width	Sedimenta.
	(m)	(m)	(m3)	(m)	(m)	(m3)
-5.0m	2,100	80	168,000	300	100	30,000
-6.0m	7,600	80	608,000	5,600	100	560,000
-7.0m	8,100	80	648,000	7,000	100	700,000

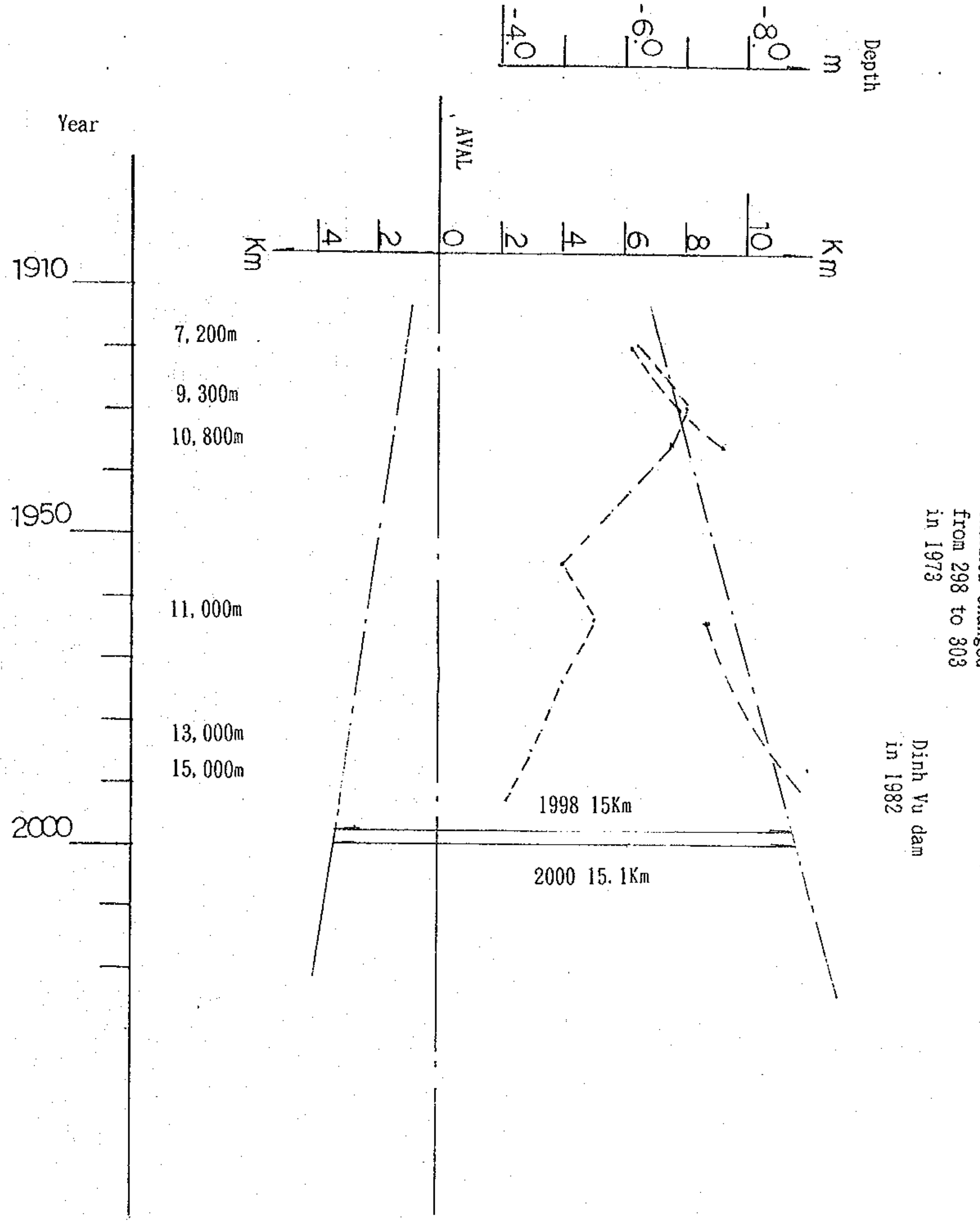


Figure 6-3-8 The Nam Trieu Channel Distance

Cua Cam

	Year	Year	UNIT: (M)
DISTANCE	1983	1986	BALANCE
0	5.7	5	-0.7
250	6.5	5.6	-0.9
500	7.2	6.5	-0.7
750	6.5	6	-0.5
1000	5.8	4.5	-1.3
1250	5.8	5	-0.8
1500	7	6	-1
1750	10.5	10.1	-0.4
2000	8.5	7	-1.5
2250	7	6	-1
2500	7	7	0
2750	6.8	4.5	-2.3
3000	6.5	4.5	-2
3250	5.8	3.9	-1.9
3500	5	4.1	-0.9
3750	4.8	4.5	-0.3
4000	4.2	4.6	0.4
4250	4.3	4.8	0.5
4500	5	5.3	0.3
4750	6.9	5.5	-1.4
5000	6.6	4	-2.6
5250	7	4	-3
5500	7	4.5	-2.5
5750	6.5	5.5	-1
6000	5.7	6.2	0.5
6250	5	5.5	0.5
6500	4.8	4.5	-0.3
6750	4.5	4.5	0
7000	5.1	5.5	0.4
7250	5.5	5	-0.5
7500	7.2	6	-1.2
7750	7.9	7.4	-0.5
TOTAL	199.6	173	-26.6
AV.	6.2375	5.40625	-0.83125

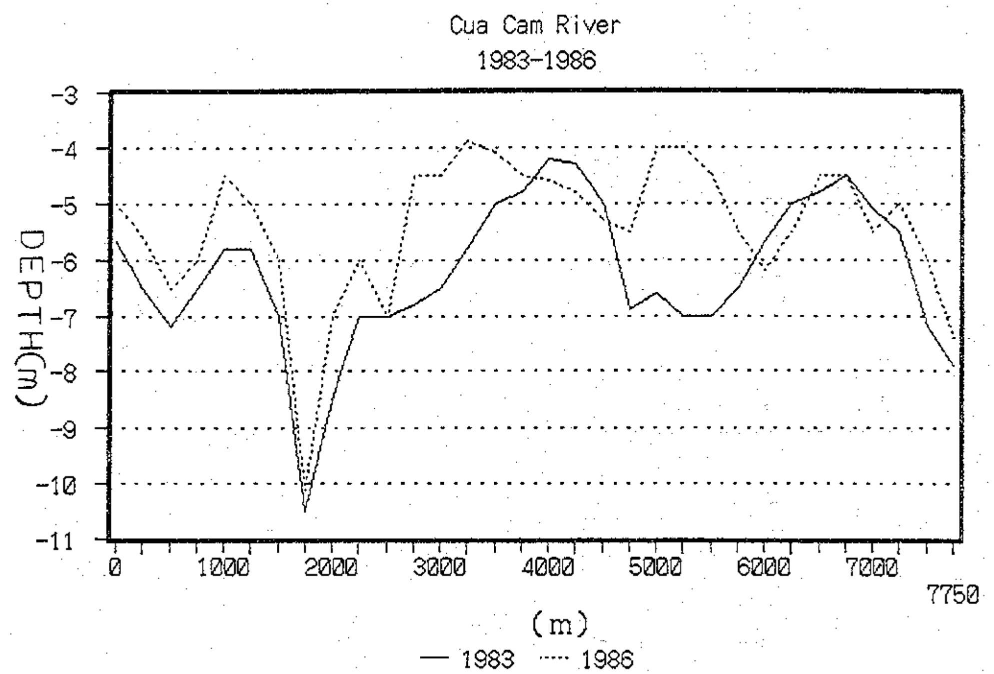


Figure 6-3-9 Sedimentation Volume of Cua Cam between 1983 to 1986

Table 6-3-13 Sedimentation Condition between 1983 and 1986

e) Turning basin

Calculation sedimentation volume based on same river areas rate.

Turning basin and berthing areas: 630m x 250m x 95m/95m = 157,500m3

Quay wall channel area: 580m x 50m x 95m/95m = 29,000m3

Hereby;

In the above, 630m is the length of the turning basin, including berthing area and its width is 250m while 580m is the length of the quay wall channel with 50m width that requiring dredging work at -6.0m. Areas other than the above have a depth of -6.0m or less at present due to non-sedimentation area by strong current speed.

5) Determining sedimentation volume

Analysis of the sedimentation volumes summarized from (a) to (d) as shown in Table 6-3-15.

Table 6-3-15 Summary of Analyzed Sedimentation Volumes

Unit:1000m3

Area	Nam Trieu	Nam Trieu	Nam Trieu	Cua Cam	Bach Danh
Method	(a)	(b)	(c)	(d)	(d)
Depth					
-5.0m	3,200	3,290	2,459	168	30
-5.5m	4,200	4,060	3,440		
-6.0m	5,100	4,940	4,727	608	560
-6.5m	6,000	6,080	5,996		
-7.0m	7,000	7,290	6,965	648	700

The above results induced us to determine sedimentation volumes with assumption at various case studies depths as follows.

Table 6-3-16 Determination of Sedimentation Volumes

Unit: 1,000 m3

Section	-5.0 m	-6.0 m	-7.0 m
Nam Trieu	3,290	4,940	7,290
Bach Dang	30	560	700
Cua Dam	168	608	648
Basin	0	190	Not Estimated

6-4 Improvement Plan

6-4-1 Determination of maintenance dredging depth

To provide improvement plan for access channel and basin is shown in Figure 6-4-1.

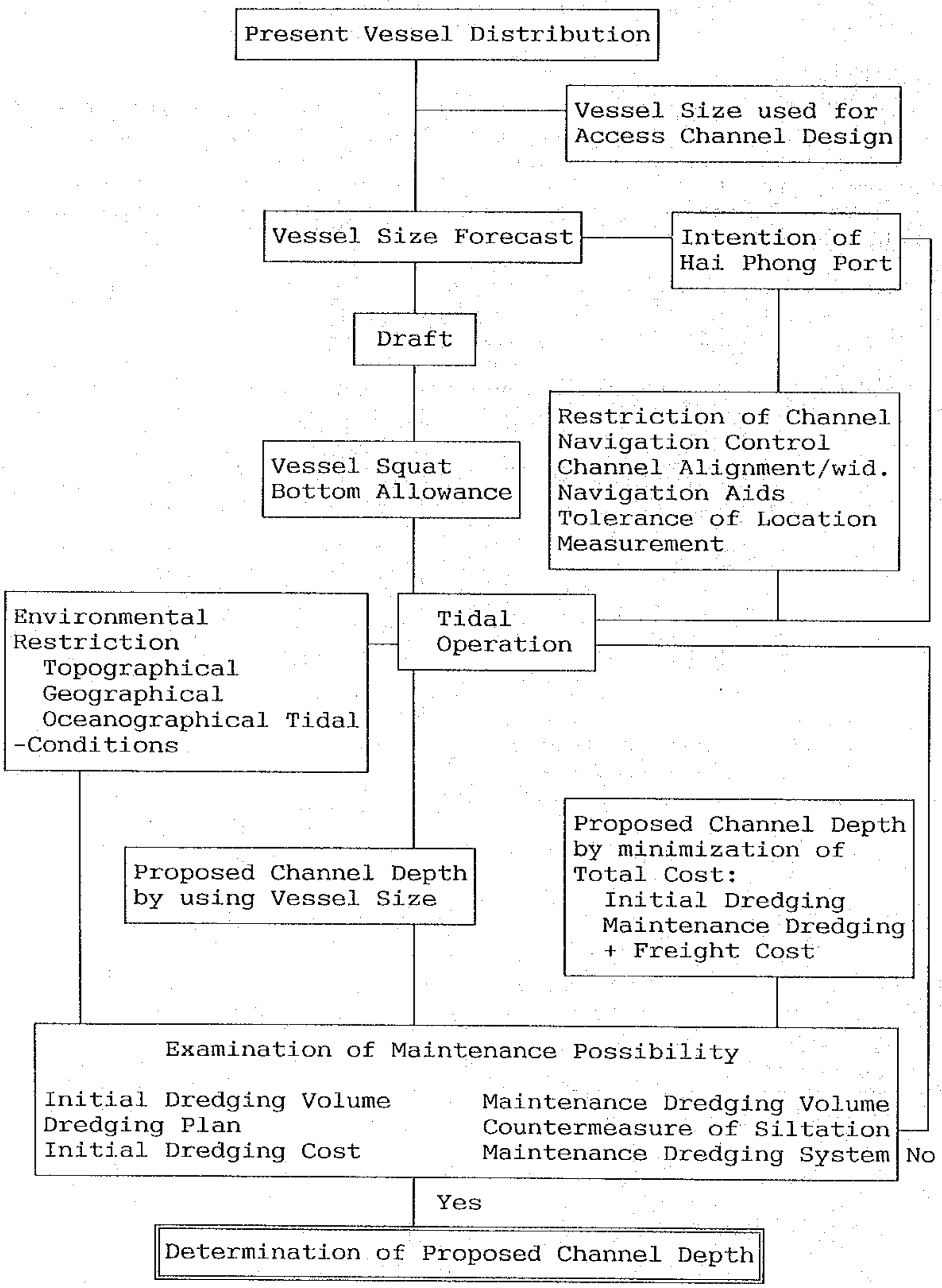


Figure 6-4-1 Decision Flows of Proposed Access Channel Depth

To provide a channel improvement plan, the vessel size and its draft described in chapter 4-3 were used. Bottom allowance (rate of squat and underkeel clearance) of navigation in the access channel was determined by present navigation figures and natural conditions.
Subsequent decisions on the frequency of the navigated vessels size, considering the tidal operations level, enabled to determine the channel depth required by the vessel size.

The channel depth required by vessel size was included in the study of initial dredging volume, dredging cost, and such questions as whether initial dredging depth could reach the depth determined and if its depth could be maintained each year.
If the above studies was not possible then the channel depth will be adjusted by changing the conditions for tidal operation level, the same procedure would have been repeated until a point the goal was reached wherein maintenance was possible.

On other hand, the optimum channel's depth considered on total minimum cost such as dredging cost, cargo transport charges fee.
Accordingly the goal point will be found out from comparing the above studies.

(1) Vessel size and its draft

As described in chapter 4-3, a 10,000 DWT, 8.3m draft and 140m-long vessel was regarded as the vessel size.

(2) Bottom allowance

Bottom allowance was determined into the following factors.

1) Rolling and pitching tolerance: DW

The effect of wind and waves was analyzed by referring to the natural conditions stated in chapter 6-1.
The frequency of strong winds (exceeded 10m/sec) was only about 3.3% and so the influence of wind assumed negligible. The wave frequency was, more than 82% exceeded 0.5m in height. Wherein, vessels were assumed to pitch and roll at half the height of the waves analyzed. Thus, DW=0.25m

2) Trim and squat tolerance: DR

The rate of squat calculated from the Froude number varies which on vessel's size and its speed as shown in Figure 6-4-2. The figure indicates that the higher the speed the larger the Froude number, and that the ratio between the rate of squatting and ship length also becomes larger.

In case the vessel speed navigated at about 8 knots in the access channel. Then,

$$\text{Froude number } Fn = \frac{V}{\sqrt{LPPG}} = \frac{4.1}{\sqrt{140 \times 9.8}} = 0.11$$

$$H/d = \frac{9.5m}{8.3m} = 1.1$$

Hereby;
V : Knots (8 knots)
LPP: Vessel length (140m)

G : Acceleration of gravity
H/d: Channel depth/draft

Reading from diagram, intersection of H/d bow line (1.10) and Froude number 0.11 its result is 0.33%.
Therefore; dr = 0.33% x LPP
= 0.33% x 140m
= 0.46m

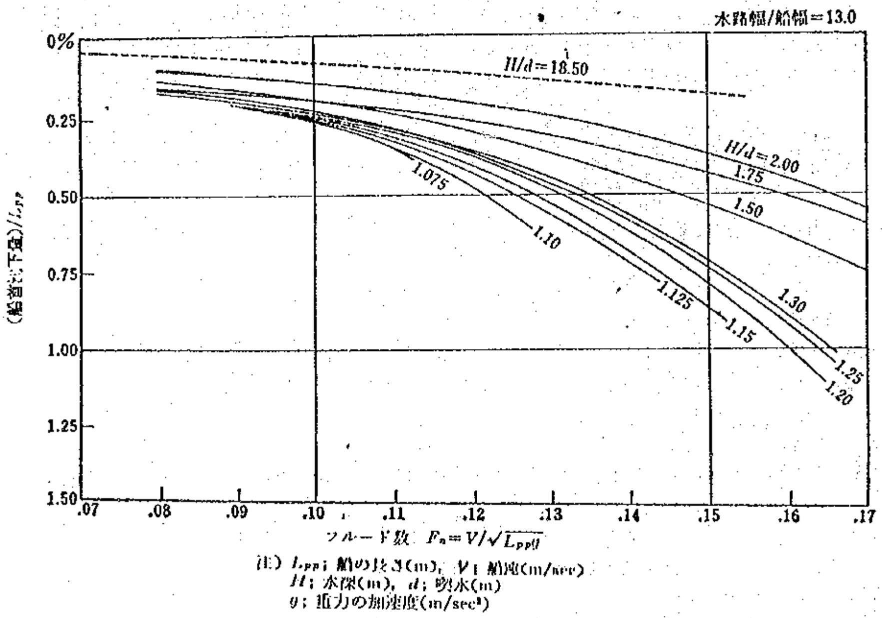


Figure 6-4-2 Navigation Speed and Rate of Squat

3) Marine geological tolerance: Gt
It can be concluded in Chapter 6, natural conditions and channel navigation, that the channel bottom is made up of light mud (its density: 0.12g/cc). Therefore, the bottom allowance does not include this factor figure.

4) Bottom allowance
Bottom allowance = Dw + Dr + Dt
= 0.25m + 0.46m + 0m
≑ 0.7m

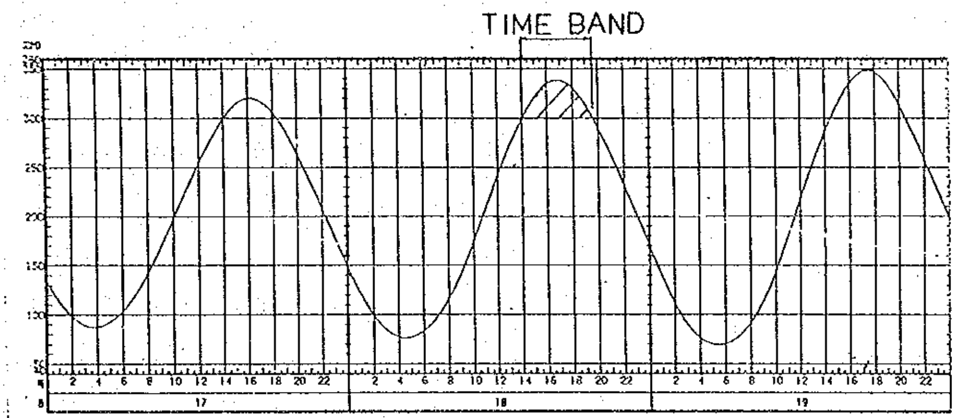
(3) Tidal operation
At detailed in Chapter 6-2, it is important to determine the movement of tidal level on vessel's sizes in deciding channel depth.
Tabular data on tidal levels, obtained through harmonic analysis, on Hai Phong port were sorted out to tabulate tide frequencies for a period of one year in relation to tidal levels and time bands (Table 6-4-1).

Table 6-4-1 Frequence of Tidal Levels and Time Bands

Tide Distribution Table by Tidal Level and Time Bands (1994)

Time Bands	Less 1 h		Over 1h		Over 1.5h		Over 2h		Over 2.5h		Over 3h	
	Freq.	T.hours	Freq.	T.hours	Freq.	T.hours	Freq.	T.hours	Freq.	T.hours	Freq.	T.hours
Tidal Level Over 350cm	2 0.5%	1.5 0.0%	12 3.3%	28 0.3%	11 3.0%	27 0.3%	9 2.5%	24 0.3%	6 1.6%	17 0.2%	1 0.3%	3 0.0%
Over 300cm	2 0.5%	1.9 0.0%	128 35.1%	591 6.7%	126 34.5%	588 6.7%	122 33.4%	581 6.6%	115 31.5%	566 6.5%	105 28.8%	538 6.1%
Over 250cm	0 0.0%	0 0.0%	243 66.6%	1816 20.7%	242 66.3%	1815 20.7%	242 66.3%	1815 20.7%	238 65.2%	1807 20.6%	236 64.7%	1801 20.6%
Over 200cm	0 0.0%	0 0.0%	344 94.2%	3789 43.3%	341 93.4%	3786 43.2%	341 93.4%	3786 43.2%	341 93.4%	3786 43.2%	341 93.4%	3786 43.2%

Source: These figures are obtained from the calculation by using a computed tidal analysis.



In the above table, figures under 'Freq' indicate number of times each tidal level occurred.
'T.hours' represent the total hours during which tides higher than that level occurred, and 'Time bands' are the lengths of time during which tides above that level occurred.

The length of the access channel and time lags (See Figure 6-2-2) of tidal levels are taken in 2.5 hours will be necessary for tidal operation.

To begin with, the tidal operation allowing port entry on most days was found to be above 2m (mean sea water level) (days/frequency 93.4%), by getting over 2.5 hours as time bands from the table.

(4) Determination of channel depth from vessel's size

From (1) to (3), channel depth determined by vessel's size as follows:

10,000 DWT vessel's draft	:	-8.3m
Bottom allowance	:	-0.7m
Tidal Operation	:	+2.0m
Proposed channel depth	:	-7.0m (Initial examination results)

(5) Initial examination of maintaining channel depth

Referring to Tables 6-3-5 and 6-3-16 in Chapter 6-3, the initial dredged volume is 8,550,000m3 in -7m channel depth, and its necessary to maintain dredged volume of 8,640,000m3. Therefore, total dredged volumes is the initial dredged volume plus maintenance volume because of the sediment transport has been continuous during a construction period.
Assuming that dredging work will take one year in minimized maintenance volume, the volume comes to 17,190,000m which is unrealistic in terms of construction period and its cost.
The dredging volume necessary to maintain the -7.0m channel depth is difficult as clear enough wherein comparing to the past maintenance dredged volumes (Table 6-3-6).

Following the flowchart of Figure 6-4-1, the tidal operation to be made used of was reconsidered. By reasoning that a planned vessel's size of 10,000 DWT would not enter the port each day, thus in future frequency of a 10,000 ton class vessel entering the port (about 316 times) was calculated at about 38%of the total (821 times). Therefore 3m (days/frequency 32%) was chosen as tidal operation.

Accordingly, the channel depth (final examination) determine by the vessel's size should be corrected as follows;

10,000DWT vessel's draft:	-8.3m	
Bottom allowance :	-0.7m	
Tidal operation :	+3.0m	
Proposed channel depth :	-6.0m	(Final examination)

If the maintenance dredging volume is at a channel depth of -6m, there is no problem with either initial dredging or maintenance dredging. In this case, vessel of 7,000DWT class (draft: 7.4m) enter the port most days as shown in Figure 4-3-7.

(6) Total minimum cost

In case of total costs were assumed for each channel depth. Total cost means the total of expenses incurred for initial dredging and maintenance dredging (one year) and freight cost of each vessel cargo demand volume in the target year.

For the sake of convenience, the following conditions and hypothesis were set.

a) One ship type was chosen for each channel depth and it was assumed that all cargoes were carried by this ship.
Conditions for entering the port were: full load; tidal operation; +2m; bottom allowance of 0.7m. The vessel's size for each channel depth were: 2,500 DWT for -4m (full draft 5.3m), 4,000 DWT for -5m (6.3m), 7,000 DWT for -6m (7.3m), and 10,000 DWT for -7m (8.3m), all taken from the Design Draft Diagram. Regarding the 1992 net freight volumes, 50% of the deadweight tonnage was assumed to be freight for transport.

b) The duration of each voyage was assumed to be 15 days.

c) Referring to Chapter 4, the freight was divided into 1.2 million tons of containers and 3.5 million tons of general goods.

d) Following demurrage rates were used as freight.

Table 6-4-2 Demurrage Rates by Vessel Types

Vessel Type (DWT)	3,000	5,000	7,000	10,000
Freight Cost ($/day)	4,000	5,080	6,200	7,800
Container ($/day)	5,000	6,500	8,100	10,500

The above rates were assumed for each of the representative sizes of general freighter on the basis of a Japanese shipping company's computation.

The results are shown in Figure 6-4-3. It is known that the total cost tends to rise when the depth deviates from -6m. This is interpreted as follows. The freight decrease as the ship size increases. Nevertheless, the freight ratio between the 7,000 and 10,000 DWT classes corresponds substantially to their tonnage ratio. There is thus not much sense in spending money on dredging to accommodate large vessels.
Although the above computation was made under certain conditions, again it was concluded that -6m was an adequate depth.

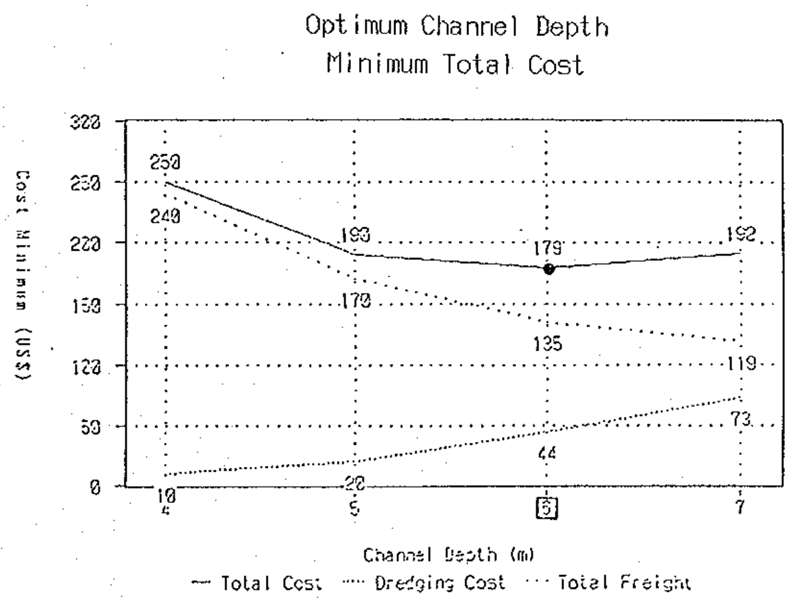


Figure 6-4-3 Optimum Channel Depth Minimum Total Cost

(7) Determining maintenance channel depth

Form the above, the maintenance water depth was determined at -6m.

In this channel depth, vessels can enter the port at the following frequencies.

Table 6-4-3 Frequency of Vessels Entry into Port with -6.0 m

Type	Full Draft	Tidal	Frequency
10,000 DWT	8.3 m	+3.0 m	32 %
7,000 DWT	7.3 m	+2.0 m	93 %

6-4-2 Dredging Method

(1) Present Condition

1) Dredging locations and its period

The places needing dredging at a channel depth of -4.1m are an approximately 15km long section in the Nam Trieu channel area and a 7km long section in the Cua Cam River.
The dredgers being used are a trailer suction hopper in the former and a grab dredger in the latter.

Dredging work was done before and after the rainy season, i.e., April to May and October to December. Thus, dredging work has been carried out twice every year from 1982, when the Dinh Vu dam was completed, until last year except in 1991.
Assuming the dredged volume before the rainy season, dredging work is believed to be necessary after the rainy season this year (1993). Since the above dredging system was established, a change has been seen in the sedimentation mechanism triggered by the construction of the dam, and the sedimentation volume has also increased.
Dredging work after the rainy season, indicates a conceptual shift from dealing with a change in natural conditions to just dealing with a change in sedimentation.

The first dredging (before rainy season) of this year, from May to June, ended with an average dredged volume of 250,000m3/month, resulting in a conspicuous decline in dredging efficiency.
Since the work was done immediately before the rainy season, it directly effect sedimentation volume corresponding to 100%.
This is desirable in this dredging method carried out in dealing with sedimentation.
Nevertheless, considering the occupancy of the channel (i.e., new dredgers to be engaged to maintain a certain level of dredging efficiency) and in view of safety navigation which threatened by unfavorable oceanic phenomena, dredging work should be finished before the beginning of the rainy season, or by the end of June at the latest, even if the largest trailer suction hopper engaged in this country up to this period.

In case of latest dredging work before rainy season contracted a load volume of 500,000m3 from May 5 to June 25.

2) Dredging method

The process methods for dredging work at the Nam Trieu channel section were as follows.

i) The dredging area was determined on the basis of Marine Safety's sounding results, and the amount of load to be dredged was also decided accordingly.
ii) Positioning of the dredger is only in the initial stages, by guiding with three transits on land.
iii) At that time, the captain confirmed the positions of navigation buoys in the neighboring areas and the dredging direction by means of a compass.
iv) After the position and angle of dredger confirmed, two ladders were lowered together to start carrying out dredging work. In this way, the process did not entail in determining the first ladder line as a guide throughout

dredging work.

v) The dredging depth was controlled by using a tidal table record (Hydrometeorological Service) indirectrly by actual readings of tide levels. (This information was obtained from an interview with the captain of a nationl dredging corporation's dredger on board.)

Figure 6-4-4 shows the cross section of the Nam Trieu channel in October 1992 to May 1993.
Although it is not a dredging work diagram immediately after the dredging, working conditions including positioning, dredged depths, etc., can be assumed to trace the captain's way of executing the work. It can hardly be called an efficient dredging operation.

3) Tide gauge

An automatic tide gauge installed by TEDI at Hoang Chau in 1992 has recorded tide levels of the channel, but the records have not been used for dredging work.

4) Inspection survey

In the inspection survey of the Nam Trieu area which was a particularly in difficult zone, two transits on land and one at sea (Aval) guided the dredger. the cutting line (positioning) was widthwise in the channel, on the basis of the preliminary reference angles calculated. The distance between the boat and the transits on land was about 10km. The angle to the breadth of the channel was reduced to less than 5 degrees at a point 500m away from Aval. These factors tend to produce an error exceeding a dredging tolerance of 2m on the crossing point of surveys.

In the other area, survey lines were also used by three transits on land.

After the dredging work has been completed, a pre-inspection survey was carried out by the dredging company. Then a inspection survey was conducted in the presence of the Port Bureau, and the load volume was calculated to check out its acceptance. When Hai Phong Port was in charge of execution management in the past, the dredging work was accepted in two days after the inspection survey. In case of this time, there was a onemonth delay between bringing the dredger and the carrying out the work period, and it is supposed that dredging work was still in progress immediately before bringing the dredger.

Because in the surveys by both parties, errors come out from this situation. Dredging work and inspection surveys were repeated without a clear conclusion up to the final acceptance.

The channel surveys conducted from four times to six in 1992 and its results were used as preliminary basis of measurements for dredging work. Therefore, comparing with above survey and dredging period it is not related with each other, despite sedimentation occurs in between. Volume of dredging to be added for the maintenance dredging work was excluded.

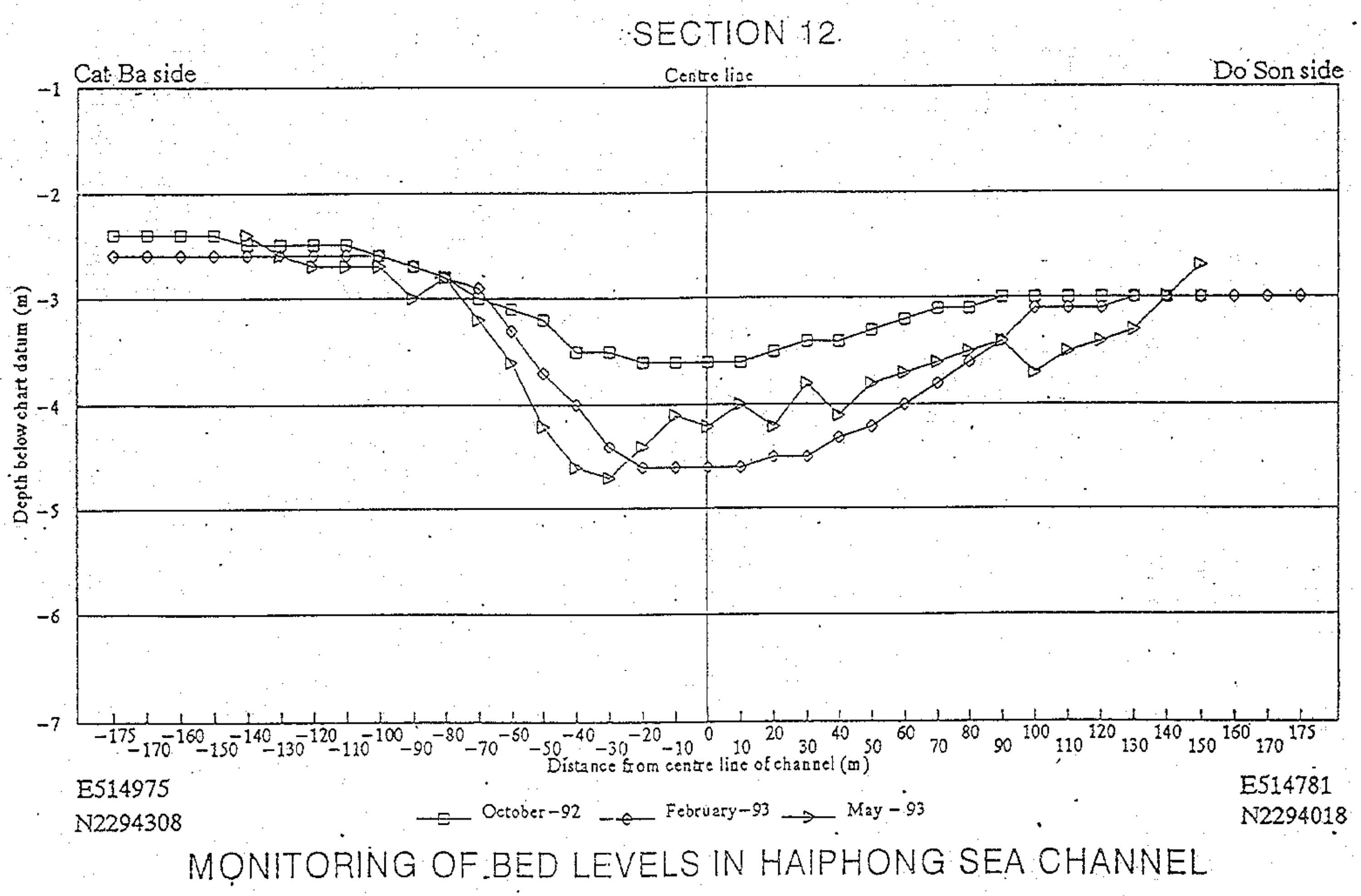


Figure 6-4-4 Cross Section of Nam Trieu Channel

5) Dumping area

Up to 1991, dredged materials were disposed of anywhere more than 500m away from the access channel. However, the study on sedimentation carried out by UNDP and TEDI revealed that dredged mud from disposed materials drifted back to the channel bottom. Due to this reason, the disposal area was decided to position 1km to the north of the No.0 buoy with a depth of -3.6m to -4.9m in 1992.

(2) Improvement plan for dredging method

1) Improvement of dredging efficiency

a) Dredger

Mechanical aspects such as the engines and pump capacity of individual dredgers are not covered in this report.

An improvement in the efficiency of the present dredging working conditions and its method is considred.

A direct impact to raise dredging efficiency is to decrease over-dredging volume. For this purpose, instead of existing positioning system of the dredger an automatic positioning system device is required, and dredging work should be done with an assured tide level.
Therefore it is necessary to;

i) Over-dredging should be decreased and an automatic positioning system should be installed.
ii) To improve the management of dredging depth, two tidal stations should be installed in the access channel instead of calculating from tide table book.

b) Starting location and boundaries

In the Nam Trieu channel, three big bottom waves are produced between the curved point (ST15) and the No.0 buoy. The distance are measured at around 2,000m and 5,000m as well as the curved point, although it remains unknown if there is any change in the former two positions before and after the rainy season. Accordingly, the dredging work should be from the curved point toward the No.0 buoy.
This method will reduce a change in the velocity of current caused by waves when dredging enlarges the dimensions of the section, so that the distance in which the velocity of current remains constant can be extended, the positions where waves are produced can move toward the No.0 buoy, and the occurrence of waves can be suppressed.

In the river area, fine silt are (sediment transport) moved by the river current speed and a flow caused by tide level difference. Near the curve (ST.7) of the Bach Dang River shown in Figure 6-4-6, the ratio of velocities between the fair and counter currents is 1:1 before the rainy season (April to June) according to TEDI's 1992 observation data.
During the rainy season, the fair current becomes three times faster than the countercurrent. As dredging work has not done during the rainy season, the movement of fine silt due to the river current speed and tidal level difference will be unchanged and will not affect dredging work.

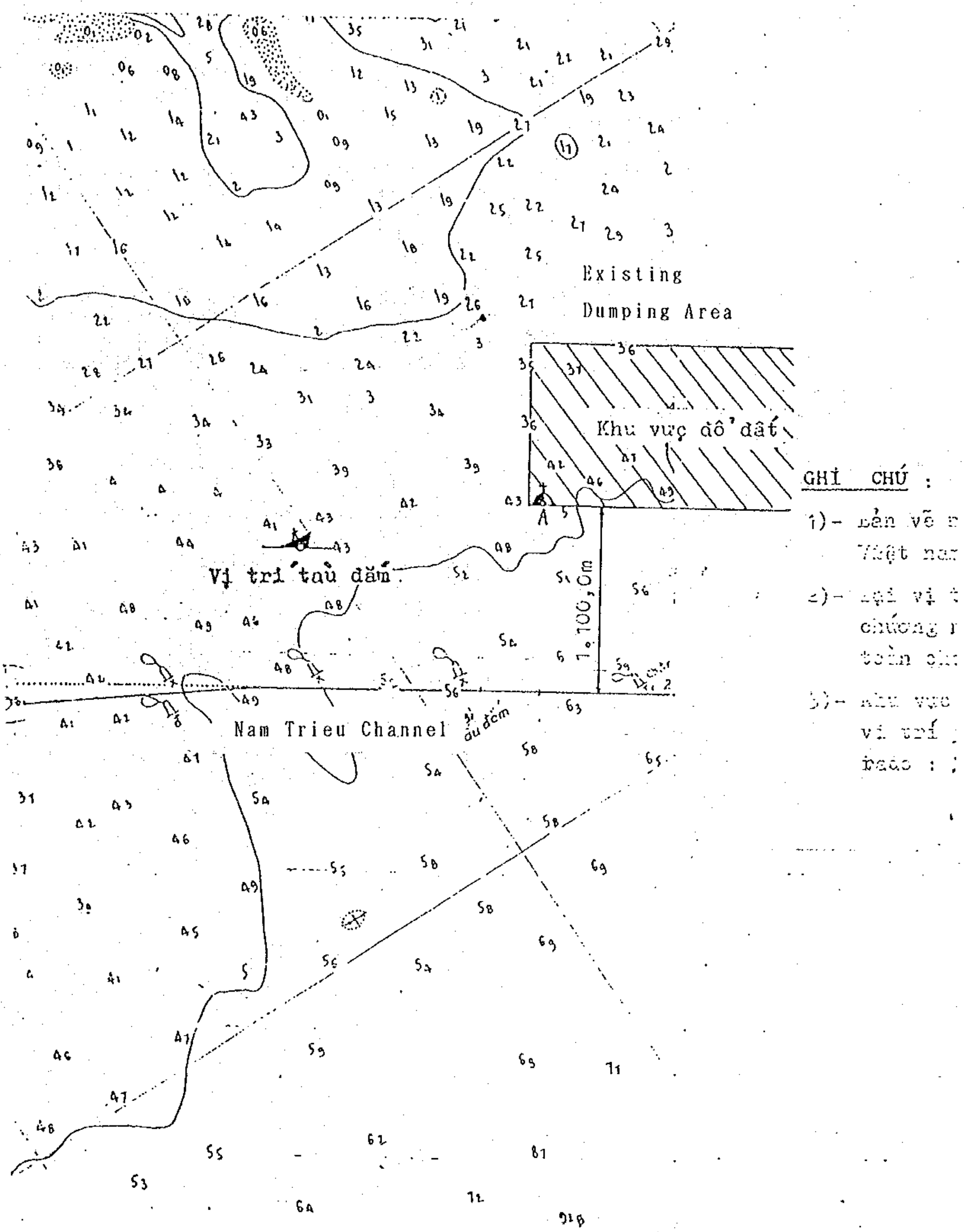


Figure 6-4-5 Dumping Area

c) Daily reports for dredging work

Daily reports concerning dredging and engines such as dredging position, dredging volume, operating hours, dredging hours, suspension hours, and operating hours of engines should be prepared. These reports are useful for identifying the soil condition and help increase dredging efficiency.

Data should also be accumulated to identify the characteristics of individual dredgers. This will eventually increase the amount of dredged materials.

2) Dredging schedule

For the period of this improvement channel plan (-6.0m dredging project), see the item (3) "Basic dredging plan" below. For the period of maintenance dredging after the completion of this project, see Chapter 6-5-1 "Maintenance Dredging System".

3) Establishment of actual reading of tidal level

Since no actual reading of tidal level for dredging work has been established yet, in the access channel it has to obtain two references levels, one for the Nam Trieu area to the Dinh Vu canal and the other for the rest of the channel, i.e., from the canal to Hai Phong Port. Both levels will be set based on the reference plane of Hon Dau. The reason for dividing the channel into two is that the data on average water level, current speed and flow rate at each observation point in and around the Dinh Vu section shows that the water levels on both sides of this topographically narrow section differ substantially during the rainy season as obtained by TEDI in 1992.

TEDI's 1992 observation on the stage, velocity of current and flow rate and shown in Figure 6-4-6 and its current speed continuously in schematic diagram in April and July as shown in Figures 6-4-7 (I) and (II).

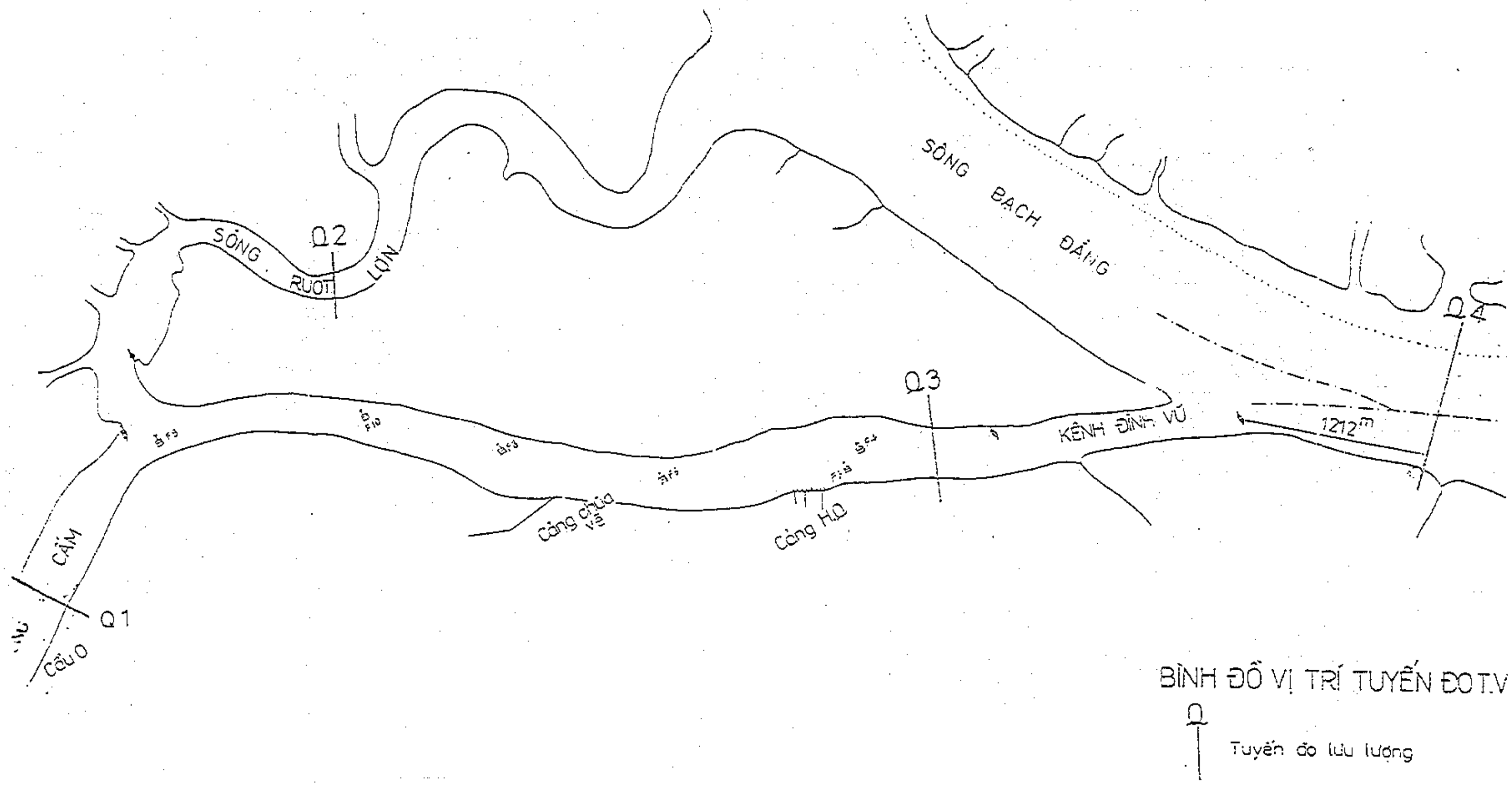


Figure 6-4-6 Survey Point of Current Speed and Flow Rate

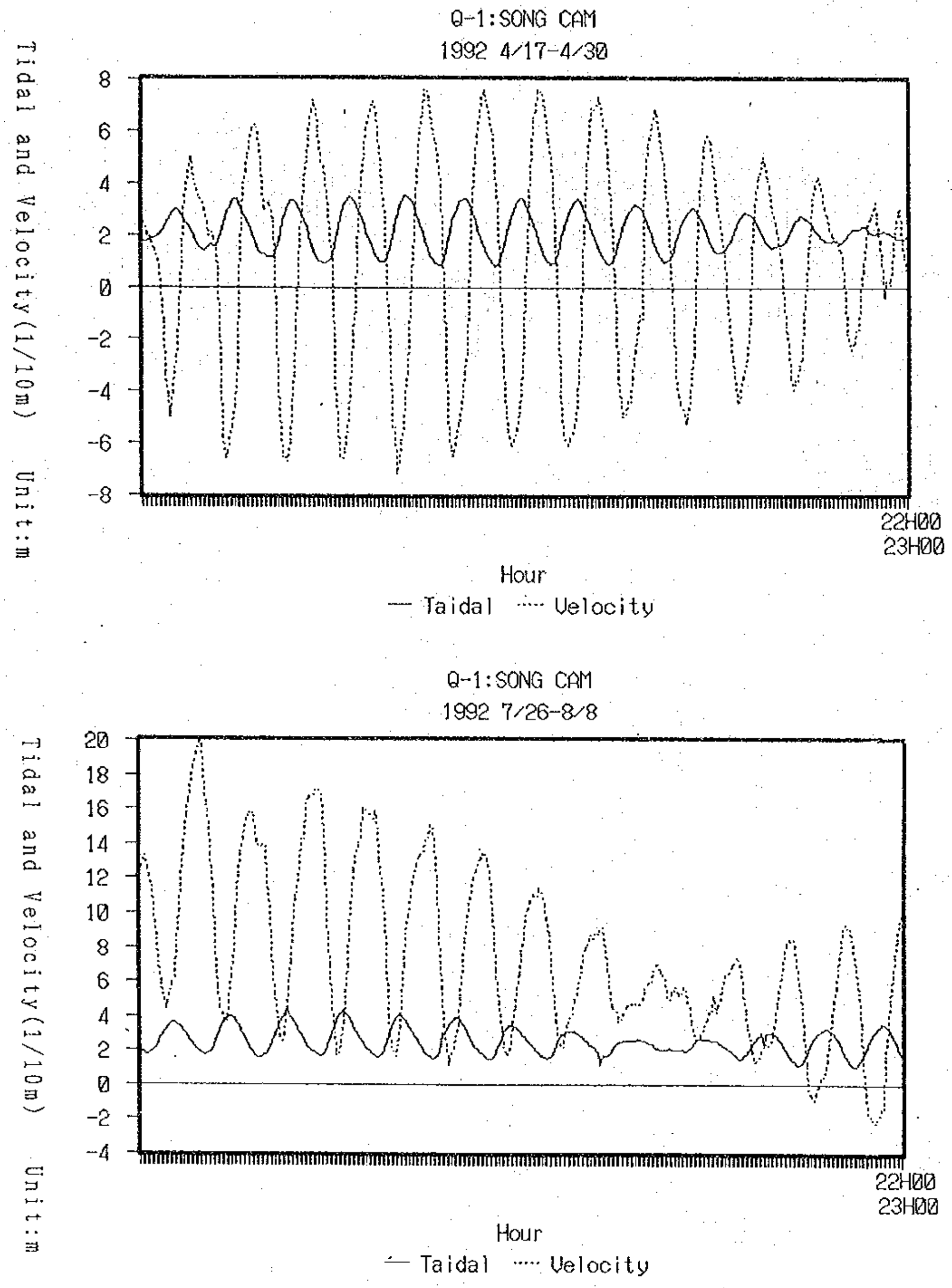


Figure 6-4-7(1) Q1 Current Speed and Flow Rate in April and July

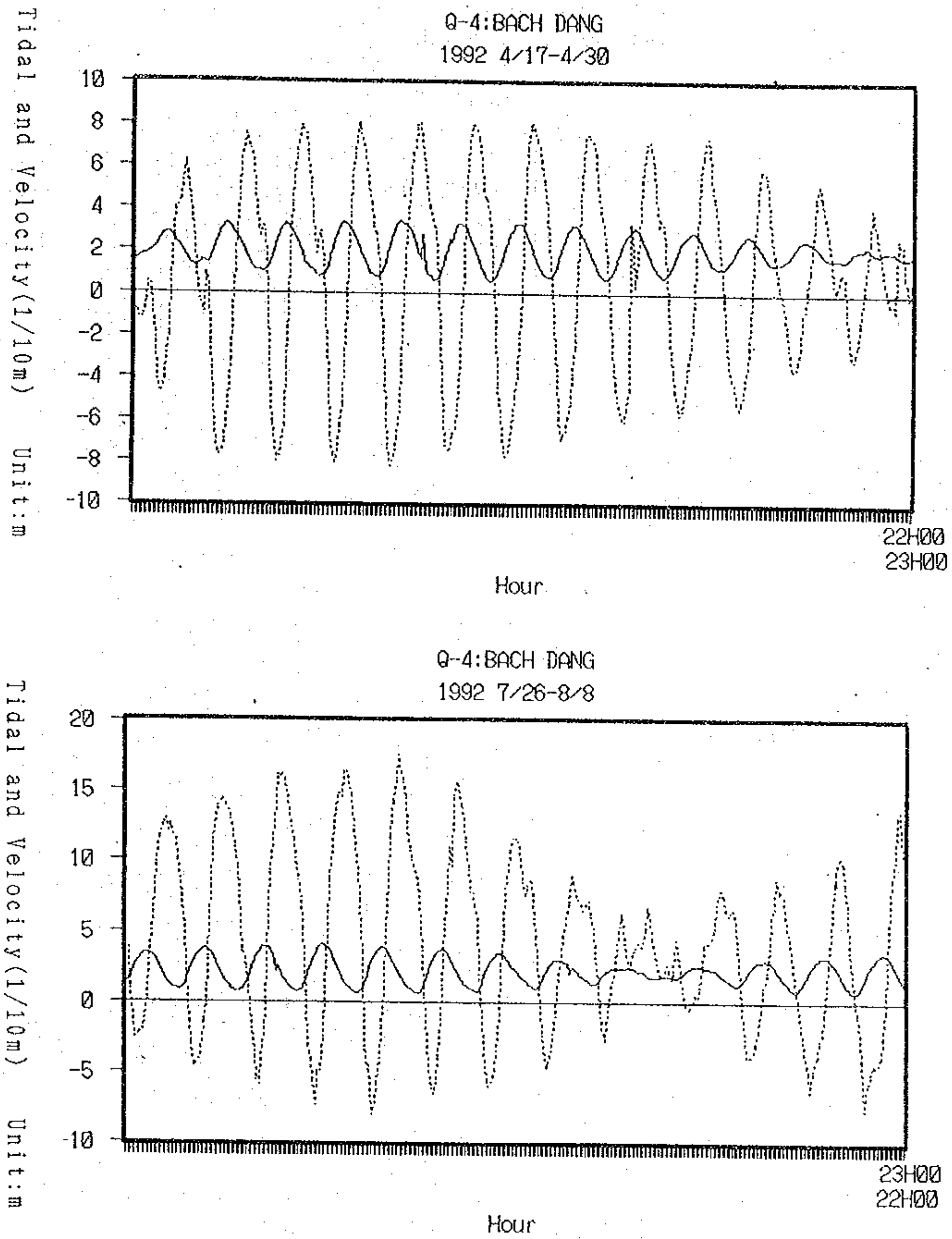


Figure 6-4-7(2) Q4 Current Speed and Flow Rate in April and July

Table 6-4-4 Referency Level for Dinh Vu Channel and Bach Dang River

Preiod of Obsevation	Cua Cam River	Dinh Vu Canal	Bach Dang River
4/17-4/30'92	2.12m	2.02m	1.99m
5/28-6/10'92	2.24m	2.12m	2.11m
7/26-8/ 8'92	2.52m	2.52m	2.13m

Source: TEDI

Table 6-4-5 Current Speed and Flow Rate

Preiod of Obsevation	Cua Cam River	Dinh Vu Canal	Bach Dang River
4/17-4/30'92 Flow Rate	0.09m/sec 174m3/sec	0.08m/sec 91m3/sec	0.07m/sec 271m3/sec
5/28-6/10'92 Flow Rate	0.23m/sec 471m3/sec	0.23m/sec 310m3/sec	0.11m/sec 1,151m3/sec
7/26-8/8 '92 Flow rate	0.75m/sec 1,570m3/sec	0.83m/sec 1,530m3/sec	0.42m/sec 2,166m3/sec

Source: TEDI

4) Systematization of inspection survey

a) Survey in general

i) In the pre and post surveys which serve as the source for measuring dredged volume, measurements are made in every 50m on the same survey line instead of existing from 70m to 100m.
In this process, it allows to observed the time rate series, of changes of sedimentation in each section. If a survey track deviates more than 2m from a planned survey line, this survey must be performed again.

Therefore above survey system, is propose by using an automatic positioning and diagrammatical device system are required.
To further increase the survey accuracy, a surveying ship (250HPx2) should be introduced. It should preferably be a dual propeller boat capable of maintaining a speed to 2m/sec. or above, enabling control of a slope survey, etc.

ii) The planned survey line should extend making a right angle with the channel alignment.

b) Inspection survey

i) A inspection survey is carried out immediately after the completion of dredging work and/or on a part of dredged area.

ii) An official channel survey follows. In addition, the entire channel is surveyed every month instead of existing numbers of survey and its resulting depth is announced. The official survey serves as the checking function of channel condition as well as the dredging work.

5) Dredging work management system

i) Daily dredging reports submitted by a dredging contractor are maintained and filed for later use in analyzing sedimentation, etc.

ii) To maintain channel depth, the dredging volume is analyzed and determined in advance.

iii) In the contract, the volume calculated in the same process including tolerance is followed.

(3) Basic dredging plan

In this project, initial dredging and its period of maintenance dredging work are planned to be carried out simultaneously.
If in case of dividing a two-step execution plan is adopted, it will lead to an increase in sedimentation volume that existed in separate period. Therefore optimum execution plan should match the rate of speed of sedimentation, considering suspension during the rainy season, and deal mainly with an increase in depth before the rainy season and increasing sedimentation after the rainy season, so as to reach the planned depth one year from the start of dredging work as minimum. (See Figure 6-4-9)

Basic dredging plan is discussed herein.

1) Conditions

i) the dredging volume includes initial dredging and sedimentation during the execution of dredging work.

ii) The dredging period is one year from the start.
iii)Over-dredging is not taken into calculation since initial dredging volume cannot be distinguished from volume of sedimentation.
iv) The dredging volume of -6.0m is shown in Figure 6-4-6.

Both of them were calculated on the basis of the sounding results of June 1993, and its dredging work are to be changed substantially by sedimentation and maintenance dredging work in the future. Therefore, finalization of depth sounding will be done in coming implementation stage.

Table 6-4-6 Dredging Volumes

Section	Initial DV. (m3)	Sedime. V (m3)	Total (m3)
Basin (Hai Phong)	920,000	190,000	1,110,000
Cua Cam	290,000	610,000	900,000
Bach Dang	770,000	1,720,000	2,490,000
Nam Trieu	2,660,000	3,780,000	6,440,000
Total	4,640,000	6,300,000	10,940,000

2) Implementation timing

The dredging work operation periods of 1990-1993 were divided into two before and after the rainy season. The coming rate of sedimentation volumes were sum up and dredged averages rate are expressed in percentage to obtain an average dredging volume of 2,140,000m3 in above period as shown in Figure 6-4-8.

The present dredging work period operates for four months, two months each before and after the rainy season. The figure 6-4-8 shows that throughout for one year, dredging volumes failed to reach the coming sedimentation.
Particularly, the channel depth could not be maintained during from July to September. (For reference, lines are drawn 23% above and below sedimentation of 500,000m3)

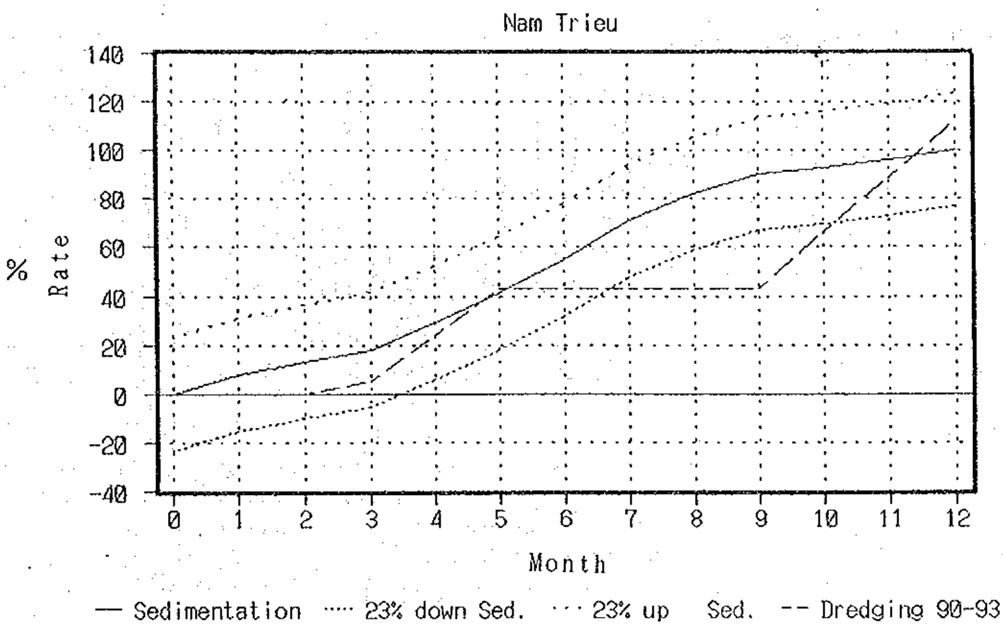


Figure 6-4-8 Relation Rate of Sedimentation and Dredged Volume

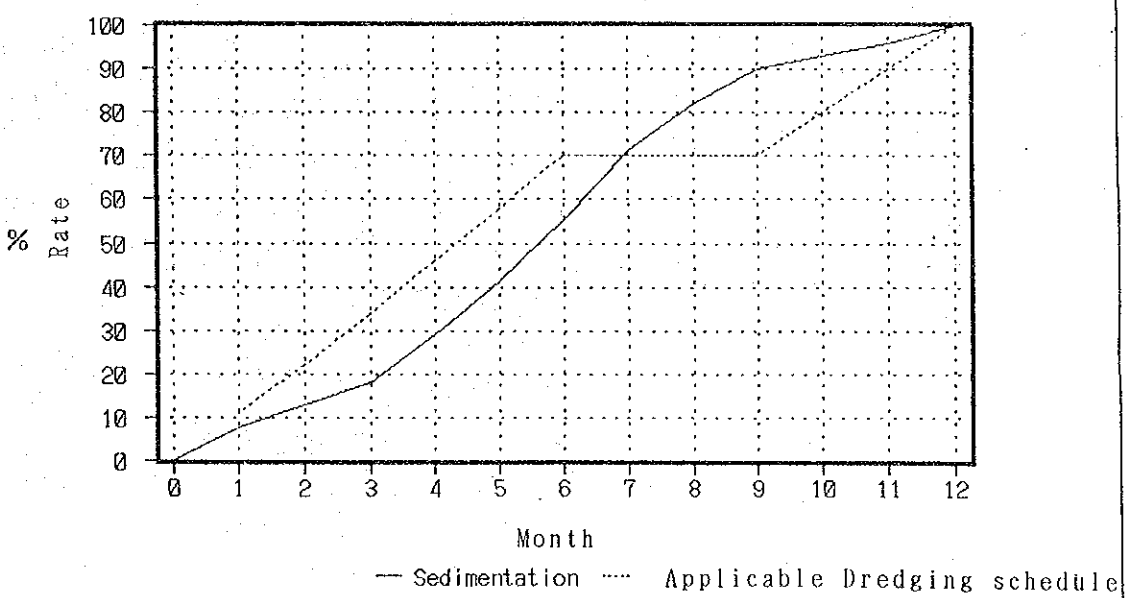


Figure 6-4-9 Applicable Relation Rate of Sedimentation and Dredging

Hence;

The channel depth should be maintained the following points as noted.

i) Dredging work should be carried out based on seasonal conditions.

ii) Basically in maintenance of dredging work, unless 90% of the coming sedimentation volume should be completely dredged by June (before the rainy season).
If not so, the channel depth can not possibly maintained (See Figure 6-5-1. 'Maintenance dredging system'.)
But in this implementation plan should be carried out matching the rate of speed of coming sedimentation as a minimum. (Figure 6-4-9)

iii)Dredging work should be carried out for a period of nine months, from January to June and October to December.

2) Dredging depth

The dredging depth before the rainy season is meant to compensate for the suspension during the rainy season, presumably requiring 20% of the annual sedimentation volume analyzed. (See Figure 6-4-9) The maintenance dredging depth in each area is shown in Table 6-4-7. The dredging depth after the rainy season is also 20%.

Table 6-4-7 Required Volume before Rainy Season

Area	Sedimentation Volume	Reading Percentage	Before Rainy Season	Distance
Basin Area	190,000m3	20 %	38,000m3	1,700m
Cua Cam Area	610,000	20	122,000	7,600
Bach Dang Area	1,720,000	20	344,000	5,600
Nam Trieu Area	3,780,000	20	756,000	13,200

Hereby;

Over dredging depth before rainy season
= Required volume
÷ Distance
÷ Channel width

The calculation results are shown in Table 6-4-8.

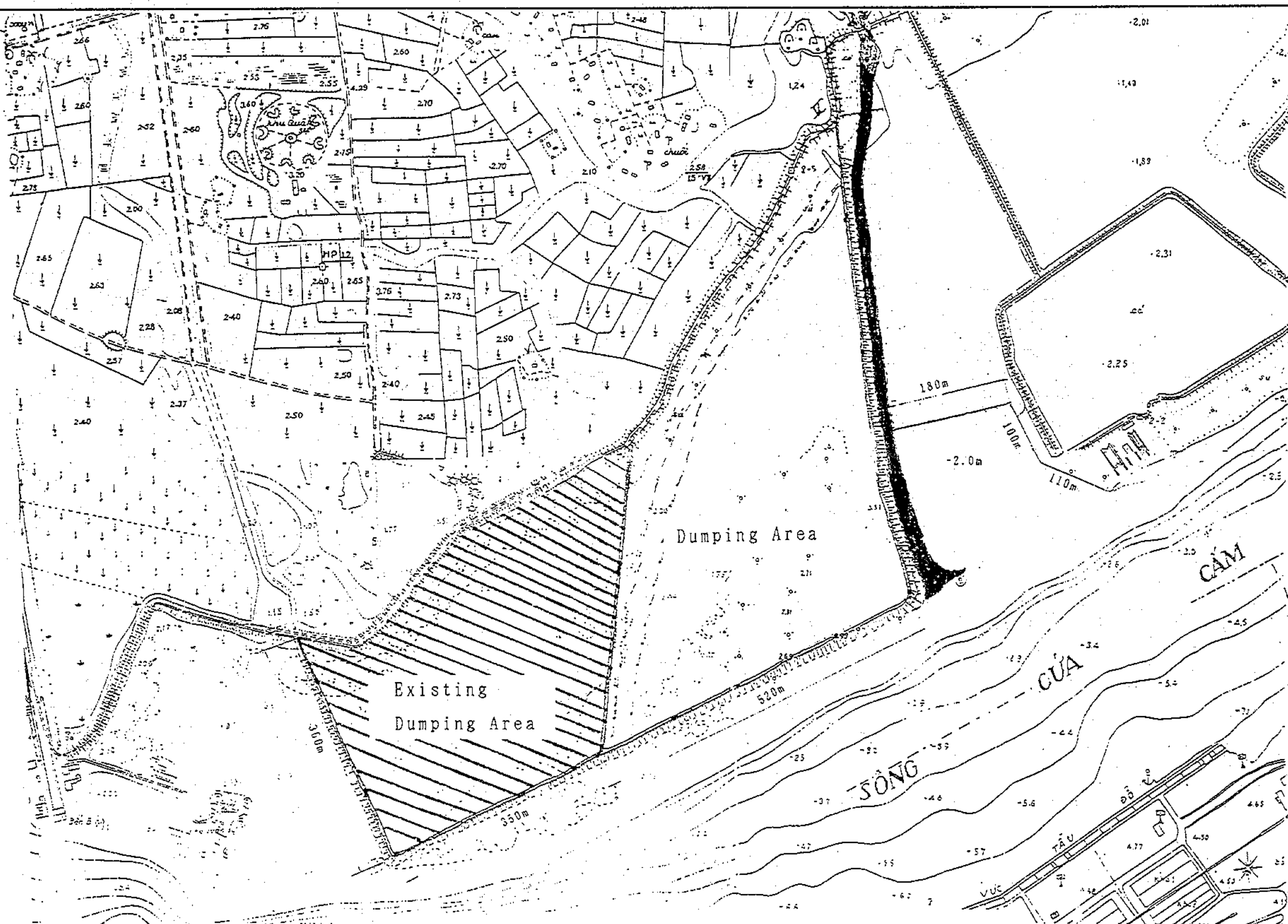


Figure 6-4-10(1) Dumping Area in Basin

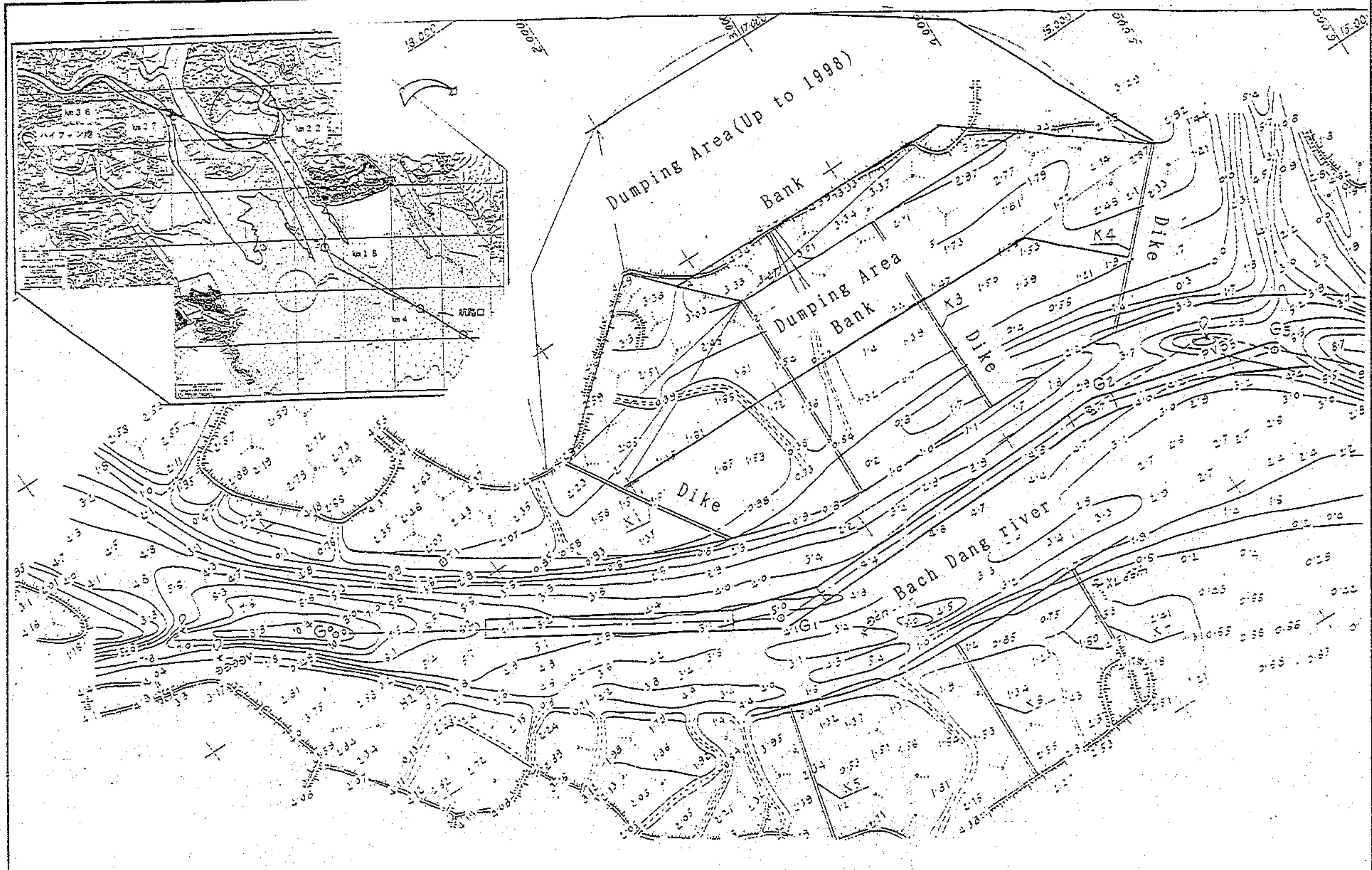


Figure 6-4-10(2) Dumping Area in Bach Dang River

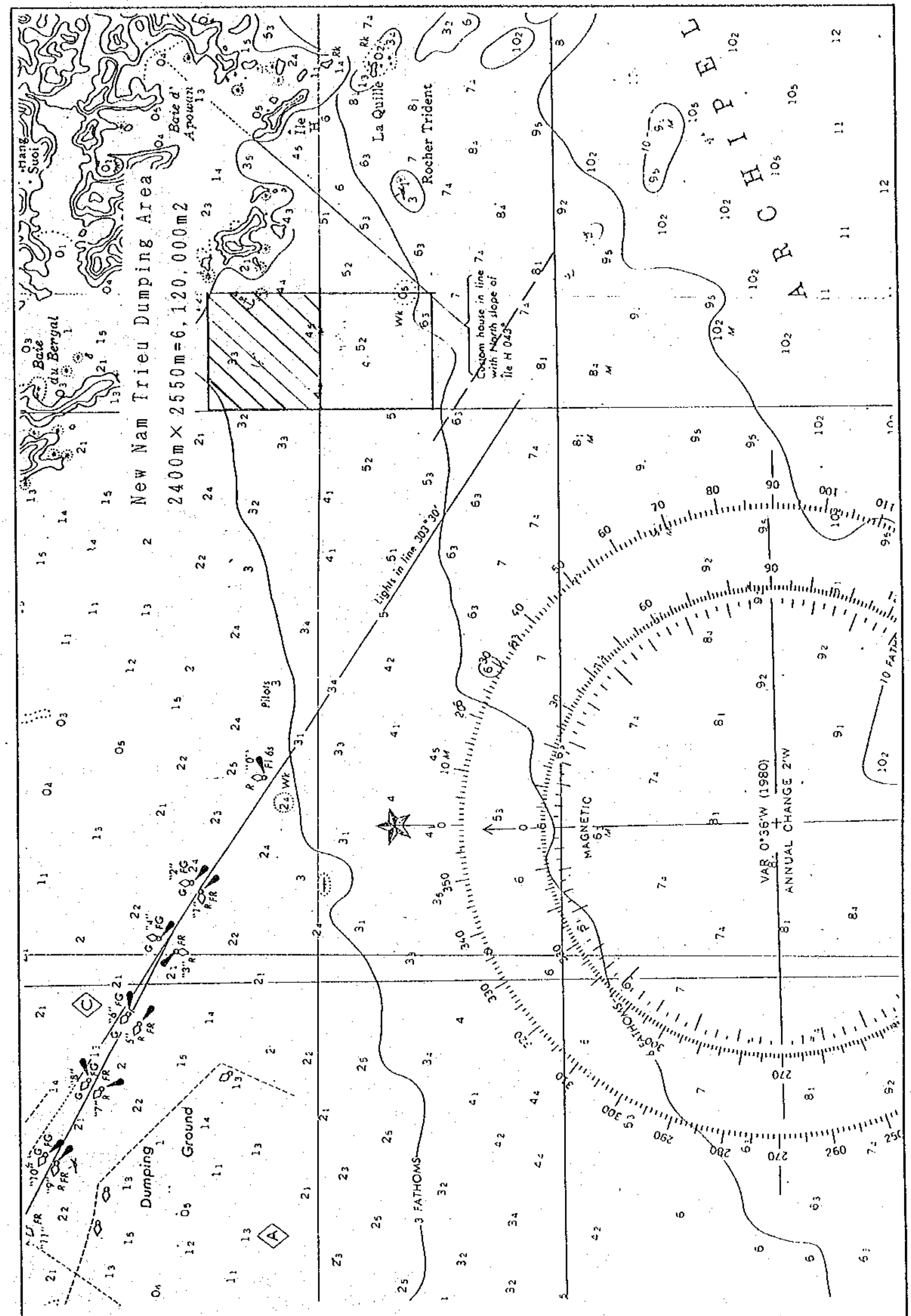


Figure 6-4-10(3) Dumping Area in Nam Trieu Channel

Table 6-4-8 Proposed Dredging Depth

	Cua Cam	Bach	Nam Trieu
Over Dredging	-0.2m	0.61m	-0.57m
Proposed Depth	6.2m	-6.61m	-6.57m

3) Dumping area

The indicated dumping areas do not have enough capacity to accommodate the dredged volume up to 1998. Hence, the dumping area shown in Figures 6-4-10 (1) and (2) have been added. Their capacities are listed in Table 6-4-9.

Table 6-4-9 Capacities of Dumping Area

Dumping Area	Spase 1000m2	Existing (m)	Bank (m)	Capacity (1000M3)	Allowable Capacity (1000m3)
Basin Area	235	+1.5~2.0	+5.0	728	600
Bach Dang Area	6,283	+2.0	+5.0	18,800	13,200
Nam Trieu Area	6,120	-4.5	-2.0	15,300	15,300
Total	12,638			34,828	29,100

4) Dredger fleets

The dredging working area is divided into the following four areas, and suitable fleets are assembled for each areas so as not to disturb channel traffic. After positioning in a good condition the work starts to carried out.

Turning basin: In this area, the safety of navigating vessels should be maintained during their turning and berthing operation. As a grab dredger is employed so that it can easily spot other ships' movements.
And discharge dredged materials on the river bottom and pumped up into the disposal area.

Cua Cam River: The dredging work extends over the entire river area and the dredged depth is rather shallow. In this case, trailing suction hopper dredger can be used efficiently and a dumping area is provided in the planned dike in the Bach Dang river which also for reinforcement of the zone. As the depth of dumping area is too shallow to enter a trailing suction hopper dredger a secondary transport (cutter suction dredger) is also used.

Bach Dang River: In this area, dredging areas can be defined to some extent and the channel depth (-4.0m) has a sufficient width of 300-500m. A cutter suction dredger can be used the above dumping area directly or indirectly will work out efficiently.

Nam Trieu channel: This area is limited due to dredging periods and natural conditions. In view of the safety of channel traffic and use of an offshore disposal area, a trailing suction hopper dredger or a cutter suction dredger is combined. The trailing suction hopper is considerable in this area.

The assembly of the above fleets is tabulated in Chapter 9, section 9-4-3.

(5) Schedule

Dredging schedule is shown in Table 6-4-10

Table 6-4-10 Dredging Schedule

Dredging Schedule For -6.0m

		1995						1995						1996	
Description	Quantity	1	2	3	4	5	6	7	8	9	10	11	12	1	2
Channel	×1000m3														
-6.0 m															
Mobilization		====	====												
Survey			====	====											
Nam Trieu -6.0m				====	====	====	====				====	====	====	====	====
Initial	2,660			400	400	400	400				400	400	260		
Sedimentation	3,780			200	400	400	600				600	600	600	200	180
Bach Dang				====	====	====	====				====	====	====	====	====
Initial	770			175	175	175	175				70				
Sedimentation	1,720										320	350	350	350	350
Song Cam						====	====					====	====	====	====
Initial	290					135	155								
Sedimentation	610											155	155	155	145
Basin				====	====	====	====				====	====	====	====	====
Initial	920			50	145	145	145				145	145	145		
Sedimentation	190													145	45
1120	10,940	0	0	825	1,120	1,255	1,475	0	0	0	1,535	1,650	1,510	850	720

6-4-3 Environment for Dredging Work

For the dumping area (Figure 6-4-10) in the basic dredging plan, the following environmental considerations have been made.

(1) Basin dumping area (in front of the main port)

This area is under the control of Hai Phong City. As seen in Figure 6-4-10, there are paddy fields, a lobster farm, etc., behind it, but they are separated from the dumping area by 2-3m high earth banks (stone-covered on the river side). The banks enclose the dumping area. Some part of it has already been reclaimed in the past which forming a piece of land of about +2m in height. The rest is marshy ground covered by weeds and trees.

No specific environmental problem has been encountered. But care should be taken to protect the neighboring areas from dredged material by the method of dredging work for a secondary transport (cutter suction dredger) in discharging material on the river bottom and pumped up into the disposal area. There is a intake feasibility located opposite the No.10 berth for using water to the farmland and nurseries behind the area. Another one is said to exist, although it was not found in the last survey. Even though they are far from the disposal area, precautions are necessary to prevent any problems.

(2) Dumping area in Bach Dang area

The area is administered by the Harbormaster, and the channel management and safety are the responsibility of Marine Safety. A dumping area needs authorization from both.

Fishermen's stationary nets were seen near the No.31 and No.25 buoys, but they were not large ones. As all fishing in the channel area has to be authorized by the Harbormaster and Marine Safety, and the handling of fishing in the area also needs to be authorized by both of them.

The silt pond is necessary to consider as much as possible in order to reduce area by over flowing from dumping area discharging to river.

(3) Dumping area in Nam Trieu channel

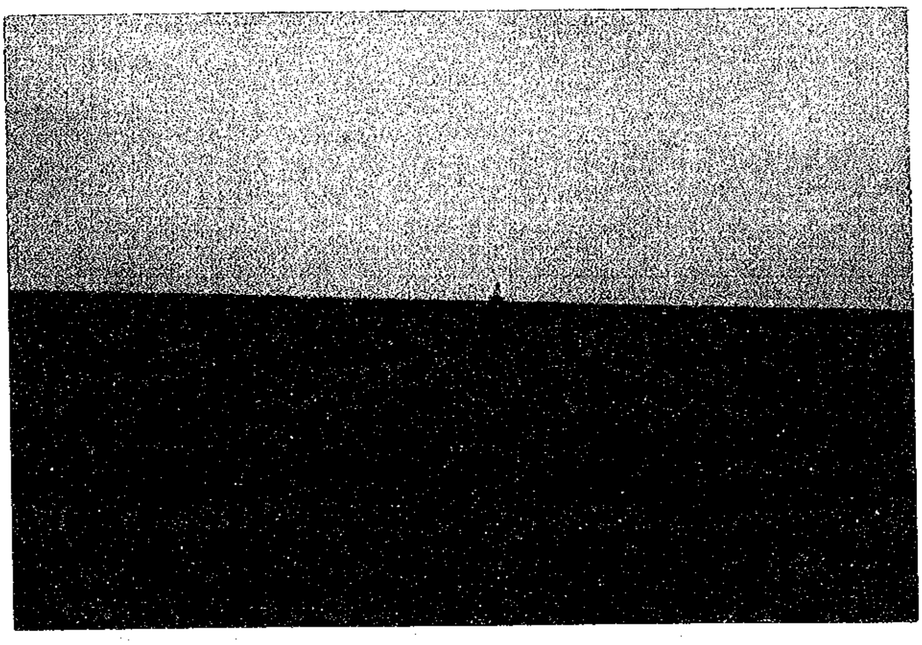
This area is at sea and is controlled by the Harbormaster. The dumped material should be prevented from drifting back to the access channel.

(4) Dredging work

Except water quality standards, there are practically no environmental standards concerning material dumping and dredging work. In view of such facts as no taking of water from the channel, the high rate of turbidity of rivers most of the year, and the dredging currently under way, authorities appear to be taking no noticeable measure against turbidity. No particular problem concerning turbidity is expected to arise from dredging work.

Dumping Arcas
Basin dumping area
Right: Existing dumping area
Left : Proposed dumping area

Bach Dang dumping area:
Dikes will be constructed to define disposal area.



Nam Trieu channel dumping area
Dumping area will be proposed at a point on the sea far to the left.

6-5 Study on Maintenance Dredging System

6-5-1 Maintenance Dredging

1) Maintenance dredging capacity

The improvement plan proposes to study whether the present dredging capacity can maintain the channel depth of the Nam Trieu particularly, in the maintaining the channel, and, if not, to introduce a new dredger.

Table 6-5-1 shows the dredgers owned since 1989 by Dredging Company No.1 (Hai Phong), the main entity carrying out channel dredger work on Hai Phong port, and their performance. The dredged volumes by the dredger Tau Long Chau are all from dredger the Nam Trieu channel.

Table 6-5-1 Dredging Volume by Dredging Company No.1

Unit:1000m3

Dredger Name	Capa.	1989	1990	1991	1992	Total
Tau Long Chau	5540HP	1,510	1,460	1,250	1,830	6,050
TC82	2060HP	380	550	640	990	2,560
HB88	1460HP	0	380	430	220	1,030
TC54	653HP	340	220	180	280	1,020
Total		2,230	2,610	2,500	3,320	10,660

The discrepancy between the above dredging volumes and those reported in Table 6-3-6 of Chapter 6 is ascribed to a deviation from the calculation method used in the inspection which provided in the contract (to take a 10% increased in contract volume and contract volume including an over-dredged volume under tolerance whichever is smaller).
The figures under Table 6-5-1 are obtain from later one.

The monthly average dredged volume is 490,000m3 is shown in Table 6-5-2. In view of the decrease in dredging volume in and after 1991 (supposedly due to a change of disposal area, and the dredged volume difference between before and after the wet season which assumed to have been caused by marine phenomena). Therefore, a monthly dredging volume analyzed is 440,000m3 considering the foregoing elements and its is used for the succeeding study.

Table 6-5-2 Monthly Dredging Volume by Tau Long Chau

Year	Contract Volume (m3)	Actual Dredged Volume (m3)	Period (Month)	Average Dredged Volume (m3)	Rainy Season
1989	1,000,000	1,510,000	3.0	503,000	After
1990	1,150,000	1,460,000	2.5	584,000	Before
1991	1,100,000	1,250,000	2.8	446,000	After
1992	600,000	(650,000)	1.5	446,000	Before
1992	1,100,000	(1,180,000)	2.6	446,000	After
Total	4,950,000	6,050,000	12.4	488,000	

Note: The numbers in parentheses denote the actual 1992 dredging volume of 1,830,000m3 distributed according to contract dredging ratios.

2) Maintenance dredging plan

Maintenance dredging plan during and after 1996 has been worked out on the basis of rate of sedimentation in Chapter 6-3-2 "Sedimentation volume in various depth". The dumping area in preceding 'Basic dredging plan' in the same chapter are useful until 1998. Therefore, such dumping areas will be used up to its maximum capacity. After that, the Nam Trieu dumping area will be utilized for all dumping. Based on earlier discussions, the dredging work with a maximum of nine months/year are considered as possible working months.

a) Dredger fleets

i) Nam Trieu area

This area required the dredging work before the rainy season to cope with the sedimentation volume during the rainy season. Unless dredging takes care of 35% of the analyzed sedimentation volume, the required channel depth cannot be maintained. The dredging volume is 900,000m3/month thus, the existing dredgers are inadequate and a new dredger has to be introduced.

The new dredger is a trailer suction hopper, whose dredging capacity is set at 90% that of the Tau Long Chau (440,000m3 x 90% = 420,000m3) in consideration of operating capacity during the training period and some other factors.

ii) Other areas (Ca Cam and Bach Dan Rivers)

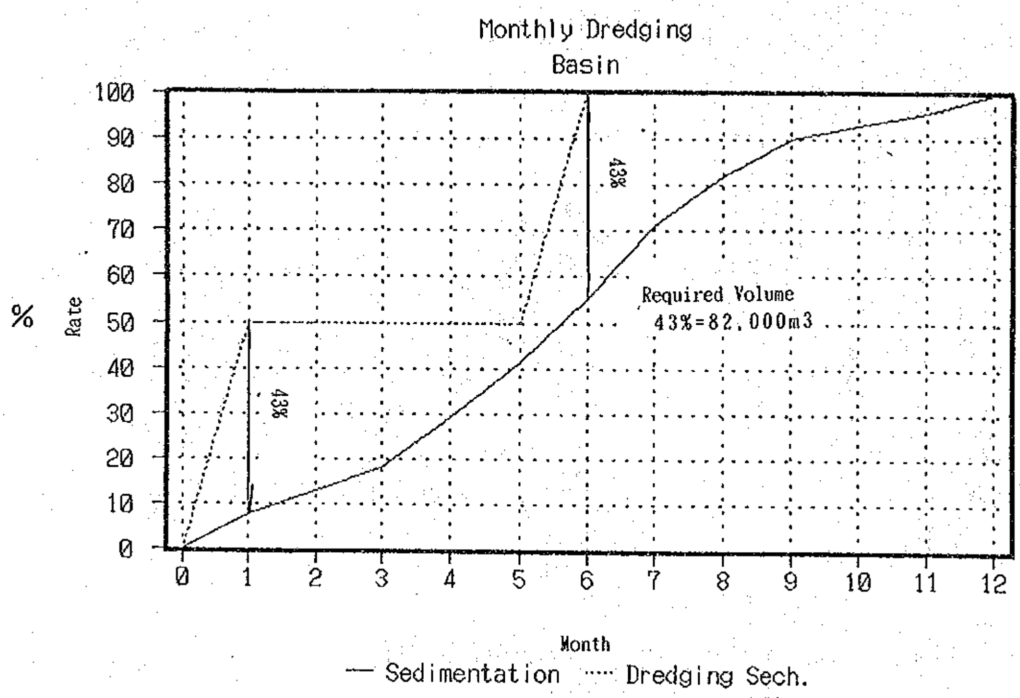
For the other areas, the assembly of a fleet described in 6-4-2 'Dredging method' is adopted. The dredging volume of the Tau Long Chau, the biggest dredger in Vietnam, is the upper limit of monthly dredging volumes for the member ships of the fleet. (Refer to table 6-5-3).

Table 6-5-3 Dredging Volumes and Dredgers Fleet's Member

Maintenance Dredging -6.0 m		1996 -1998						1996 -1998					
Description	Quantity	1	2	3	4	5	6	7	8	9	10	11	12
Nam Trieu	×1000m3												
Hop.Dredger 1	2,772	======	======	======	======	======	======				======		
Hop.Dredger 2	1,008				======	======	======						
Sub	3,780	294	420	420	860	860	548				378		
Bach Dang													
CSP.Dredger 1	943	======		======	======	======	======				======		
CSP.Dredger 2	777			======	======	======	======				======		
Sub	1,720	166		350	350	350	332				172		
Song Cam													
Hop.Dredger 1		====	======		======	======					==		
Sub	610	28	155		155	155	56				61		
Basin													
GRAB Dredger		==					======						
Sub	190	45					145						
Total	6,300	533	575	770	1,365	1,365	1,081	0	0	0	611	0	0

b) Channel depth to be attained by maintenance dredging

Optimum execution of the dredging plan before rainy season in each areas will produce turning points in March in the dry season and in June just before the rainy season, as seen in Figure 6-5-1. these turning points indicate the channel depth to be attained. When calculated inversely from the rate of sedimentation speed, Over dredging depth are required to be 10-50cm up to March and 50-110-cm up to June, as shown in Figure 6-5-4.



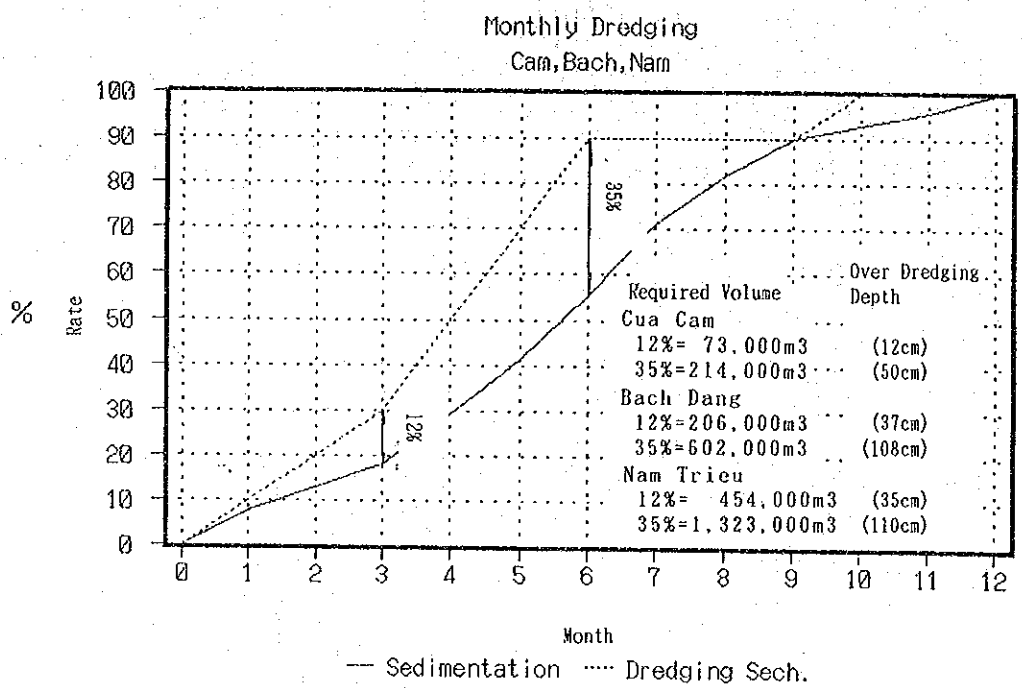


Figure 6-5-1 Applicable Relation Rate of Sedimentation and Dredging in Basin, Cua Cam, Bach Dang and Nam Trieu (Maintenance Dredging)

Table 6-5-4 Required Over Dredging before Rainy Season in March

Area	Analyzed Sedimentation	Reading Perce.	Required Volume	Distance
Basin Area	190,000 m3	43 %	82,000 m3	1,700 m
Cua Cam Area	610,000	12	73,000	7,600
Bach Dang Area	1,720,000	12	206,000	5,600
Nam Trieu Area	3,780,000	12	454,000	13,200

Table 6-5-5 Required Over Dredging before Rainy Season in June

Area	Analyzed Sedimentation	Reading Perce.	Required Volume	Distance
Basin Area	190,000 m3	43 %	82,000 m3	1,700 m
Cua Cam Area	610,000	35	214,000	7,600
Bach Dang Area	1,720,000	35	602,000	5,600
Nam Trieu Area	3,780,000	35	1,323,000	13,200

Hereby;

Over dredging depth = Required volume ÷ distance ÷ Channel width.

The calculation results are shown in Table 6-5-6.

Table 6-5-6 Proposed Dredging Depth

Dredging Depth	Basin Area	Cua Cam Area	Bach Dang Area	Nam Trieu Area	Remarks
Over-dredging	-0.51 m	-0.12 m	-0.37 m	-0.35 m	Before Rainy Season
Proposed	-6.51 m	-6.12 m	-6.37 m	-6.35 m	- " -
Over-dredging	-0.51 m	-0.35 m	-1.08 m	-1.00 m	After Rainy Season
Proposed	-6.51 m	-6.35 m	-7.08 m	-7.00 m	- " -

c) Schedule

Table 6-5-7 is the schedule of maintenance dredging work during and after 1996. If the dredging volume fails to reach 90% by the beginning of the rainy season (end of June), dredging work after the rainy season must be started in August. In the Nam Trieu section, particularly even if dredging is resumed in August or September, the planned maintenance dredging volume cannot be attained before the end of the year and it may not be possible to maintain the required channel depth.

Therefore, prior maintenance dredging should be 100%. (See figure 6-5-2)

Table 6-5-7 Schedule of Maintenance Dredging Work

Maintenance Dredging -6.0 m		1996 -1998						1996 -1998					
Description	Quantity	1	2	3	4	5	6	7	8	9	10	11	12
	×1000m3												
Nam Trieu		======	======	======	======	======	======				======		
Sedimentation	3,780	294	420	420	420	420	420				378		
					440	440	128						
Bach Dang		======		======	======	======	======				======		
Sedimentation	1,720	166		350	350	350	332				172		
Song Cam		====	====		======	======					==		
Sedimentation	610	28	155		155	155	56				61		
Basin		==					======						
Sedimentation	190	45					145						
Total	6,300	533	575	770	1,365	1,365	1,081	0	0	0	611	0	0

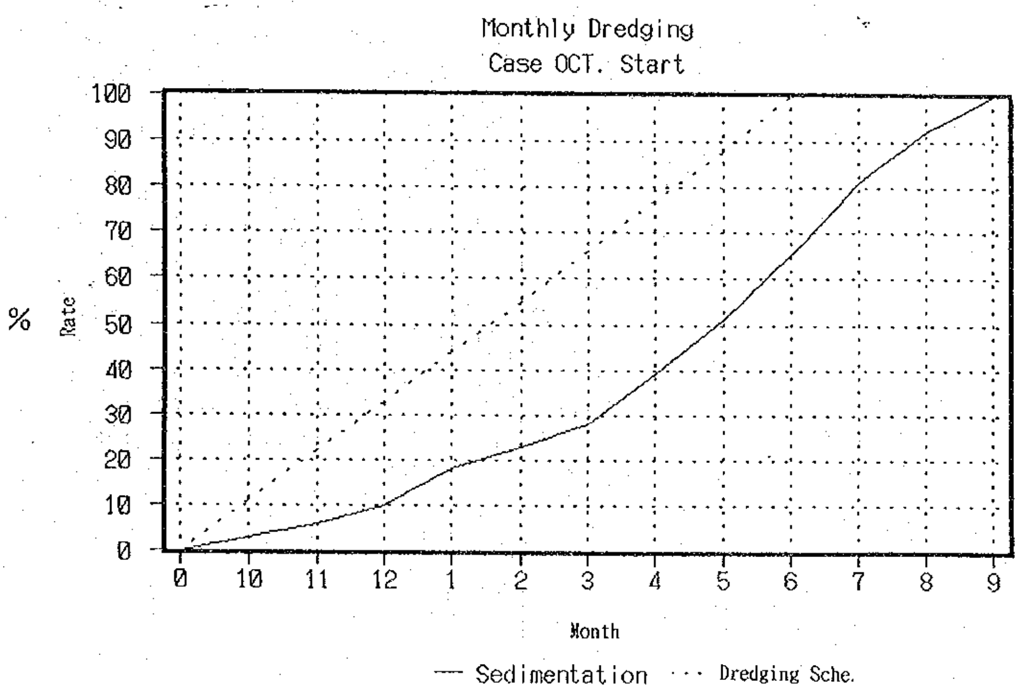


Figure 6-5-2 Applicable Relation rate of Sedimentation and Dredging if Starting September

6-5-2 Proposed Maintenance Dredging System

Figure 6-5-3 is a flow chart showing proposal for the maintenance dredging system. As mentioned in 'Analysis of malfunction factors' in Chapter 3-1 and 'Dredging method' in Chapter 6-4, various problems have been encountered.

Following are some proposals for the maintenance dredging system in dealing such problems. As for the proposal of setting up a new management division to take care of a new dredger, limited to the establishment of such a division without further organizing into details.

Analysis of Present State (See 'Analysis of Malfunction Factors')		
Implementation of Work	Management	Natural Conditions
Dredging capacity for present level Dredging method and frequency Inspection survey method Dumping Area	Contracting Inspection Budget allocation	Analyzed sedimentation Dredging period Operation rate

Identification of problems	Required maintenance dredging volume

Proposal for Improvement		
Implementation of Work	Management	Natural Conditions
Proposal for dredging capacity improvement - introducing a dredger - Training of crew Proposal related to dredging method - Positioning system, and equipment - Dredging volume measuring method Proposal for inspection survey - Surveying equipment, frequency Proposal for dumping area - Selection of suitable dumping area	Proposal for contracting process - Contract method - Management and operation - Budget allocation Official channel depth - Survey method	Measures to decrease sedimentation - Construction of new dikes Change of channel alignment

Figure 6-5-3 Flow Chart of Maintenance Dredging System

(1) Proposal for improvement

1) Proposal to introduce new dredger.

In the maintenance dredging plan, maintenance dredging volume has to cover 6,300,000m3 every year from now on in order to maintain a channel depth of -6m. this means that a maximum dredging volume of about 1,365,000m3/month is required for the four-month pre-dredging. If two dredgers in the same class as Vietnam's largest trailer suction hopper are used simultaneously, they can dredge 880,000m3/month a short of 485,000m3. Thus, another dredger of the same type has to be introduced or an order has to be placed with outsider for the work.

If such a dredger is introduced, it is appropriate for the Hai Phong Port Authority, the project implementing body of the dredging work between 1989 and 1992, to take charge of its management.

The "Old Chua Ve" port will be the mother port for the new dredger, and its crew will have to be employed and trained. In the training dredging period of this urgent improvement plan and at the time of introducing a dredger, two engineers (deck and engine) should be sent abroad for 24 man-months of training course to acquire the necessary technical knowledge.

In the case of the dredging work is given to an outsider, the following improvements are proposed.

2) Implementation of work

Since the details have been described in section 6-4-2 (2) 'Dredging method', only the key points will be repeated.

a) Proposals related to dredgers

i) To install an automatic positioning system to decrease over-dredging volume and improve dredging accuracy
ii) To provide two tide stations in the access channel for improving the accuracy of actual readings of dredging depth
iii) To file daily dredging reports, i.e., daily reports on matters concerning dredging and engines
iv) To collect and identify data for obtaining the characteristics of individual dredgers, so as to eventually increase the volume of dredged.

b) Proposals related to survey

i) the pitch of survey lines is in every 50m on same pre and post survey line.
ii) Introduction of automatic positioning survey and diagrammatic device systems.
iii) Introduction of a survey boat.
iv) The planned survey line should be extended making a right angle with channel alignment.
v) The channel depth should be surveyed each month.

c) Proposals related to inspection survey

i) For a inspection survey extend of the dredging area should be divided into areas. Thereafter the inspection survey immediately carried out upon its completion of dredging work.
ii) For the acceptance of contract volume, the same process

should be used including tolerance.

d) Proposal related to dumping area
See Chapter 6-4-3 (3) 'Basic dredging plan'.

3) Management

a) Proposals related to contract

i) The Hai Phong Port Authority should order and take charge of management and operation by forming a new division.

ii) To necessary dredged 90% of coming sedimentation volume by June, contract should be awarded at the beginning of each fiscal year.

iii) Before awarding, the volume of sedimentation should be analyzed from dredging reports and the access channel surveys.

iv) A budget should be allocated before articles number ii) and iii).

b) Proposals related to management and operation

i) Based on daily dredging reports submitted by the dredging contractor, pertinent data should be maintained and filed for use in analyzing sedimentation volume.

ii) To maintain a channel depth, the proposed depth is analyzed from the data of article i).
If necessary, its depth is to be readjusted in March-May.

iii) The acceptance of contract volume is done through same process including tolerance.

6-5-3 Proposal for Measures to Decrease Sedimentation

1) Construction of dikes

In 1912, 15 numbers of dikes were constructed in the Dinh Vu area. Since then, no dredging work has been carried out in the area. With the advantages being realized, nine dikes constructed in the Ca Cam River in 1991-1992. Two additional dikes are blueprinted to construct in the bends (ST.1 and ST.2) of the Ca Cam River for easing the curvature, and four more dikes in the bends (ST.9 and St.10) of the Bach Dan River for increasing the current speed.

2) Effect of dike

Details and advantages of a dike are as follows;

i) There are two kinds of constructing dikes: by the pile system and by the blockage system. each has different features.

A pile system of dike reduces depth by siltation and shifts the strong flow of the river. the other one also shifts the river flows and increases depth.

ii) Each has its own limitations depending on types of rivers. Their advantages on rivers with a fair current and/or a counter current are known from the dikes constructed in a fair current river in the city of Hanoi which suggest this effect.

iii) When the block type of dike is constructed in a fair and/or counter current river, cross sectional dimension is rather small and the average velocity of current does not change. However, there is a 1.2 to 1.5 fold increase in the velocity of bottom current, which forces loose material to flow.

iv) Structurally, dikes do not function alone. There are no restrictions on their placement and combination. Several of them are constructed on both sides where a change of river channel is intended. (The information has been obtained from an interview with Mr. Dao Nguyen Kim, former director of the TEDI investigations and design office.)

The study on the effect of dikes, to decrease the sedimentation volume in the river area. Thus, the dike project planned by the Vietnamese side will be promoted. (See Appendix 5)

3) Change of Nam Trieu channel
(New alignment)

The present alignment (N303) of the channel is planned to consider to N325-N335.

UNDP and TEDI have been studying the sedimentation of the access channel and Hai Long Bay since 1988. The results of these investigations have contributed to the concept of the sedimentation mechanism stated in this study.

The final report is scheduled to be published around March 1994. In the meantime, UNDP and TEDI are said to be collecting additional data. The change of the existing alignment might be referred to, and the simulation results for predicting sedimentation volume might be included.

Such being the situation, the draft plan for new alignment which under pre-studied by Vietnam side, is expected to be fully discussed in a next study. This study covers only some considerable points required in determining the direction of alignment as follows;

i) Data should be collected in a short period of time say, 1992 to 1993.
ii) The pocket function of the Bach Dan River must be taken into consideration.
iii) The necessity of the parallel dikes along the new alignment should be considered.
iv) A barrier dike should be considered to protect against the sediment transport caused by the coastal current of Cat Hai.
v) The feasibility of the above items in decreasing sedimentation efficiently, and introducing dredger capacity, should be considered.

The dredging volume at a depth of -6.0m near the new alignment (N328) and its sedimentation assumed by using the analyzed figures of Chapter 6-3-2 'Sedimentation Volume in Various Depth' and shown in Table 6-5-8.

Table 6-5-8 Balance Volumes of Existing and New Alignments

Existing Alignment

A -6.0 M	EXISTING		UNIT:	1,000M3
AREA		NET	SEDIMENTA	TOTAL(I)
Basin		920	190	1,110
SONG CAM	ST0-ST 7	290	610	900
BACH DANG	ST7-ST14	770	560	1,330
NAM TREU(I)	ST14-ST15	540	1,160	1,700
NAM TREU(II)	ST15-END	2,120	3,780	5,900
TOTAL		4,640	6,300	10,940

New Alignment

B -6.0 M	NEW CHANN		UNIT:	1,000M3
AREA		NET	SEDIMENTA	TOTAL(II)
Basin		920	190	1,110
SONG CAM	ST0-ST 7	290	610	900
BACH DANG	ST7-ST14	770	560	1,330
NAM TREU(I)	ST14-ST15	540	1,160	1,700
NAM TREU(II)	ST15-END	3,320	3,220	6,540
TOTAL		5,840	5,740	11,580

Initial Dredging
Balance Volume

C:B-A -6.0 M	BALANCE A-B		UNIT:	1,000M3
AREA		NET	SEDIMENTA	TOTAL(II)
Basin		0	0	0
SONG CAM	ST0-ST 7	0	0	0
BACH DANG	ST7-ST14	0	0	0
NAM TREU(I)	ST14-ST15	0	0	0
NAM TREU(II)	ST15-END	1,200	-560	640
TOTAL		1,200	-560	640

Chapter 7 Main Port Rehabilitation Plan

Chapter 7 Main Port Rehabilitation Plan

7-1 Premise of Planning

7-1-1 Cargo handling capacity

In order to make the cargo handling allocation plan of Hai Phong Port in 1998,it is necessary to estimate cargo handling capacity of Main Port without expansion case.
According to information from officials of Hai Phong Port Authority and calculation on the data provided, cargo handling capacity has been estimated as follows.

(1) The capacity announced by Hai Phong Port Authority

Annual throughput-----2,600 (in 1000 tons)
By rail ----- 874
By road -----1,910
By lighter ----- 367

Annual throughput of 2.6 million tons emerges using unit capacity by each berth. The unit capacity of rail and road is determined at the critical level of place and capacity such as wagon operating yard or bridge.

(2) The estimation based on actual cargo handling volume

Table 7-1-1 shows actual throughput and berthing records in Main Port and Chua Ve provided by Hai Phong Port Authority.
According to this data,total throughput was 1.78 million tons in 1990,1.75 million in 1991,and 1.9 million in 1992.Total annual berthing time was 3,772 hours in 1990,3,210 in 1991,and 3,403 in 1992.There is insufficient data to obtain total berth occupancy rate, so using above mentioned data and supposing one ship occupied one berth,total average berth occupancy rate can be estimated as follows.

Total average berth occupancy rate in 1992 is 0.44
3,403/322x24= 0.44 Here 322 is annual working day(322=<365-7(national holiday)>x0.9)
According to Hai Phong Port Authority,interrupted cargo handling mainly due to heavy rain averages 40 days per year.

Table 7-1-1 Actual Cargo Handling Data in Main Port(from 1991 includ.Chua Ve)

		1990		1991		1992	
Item	Unit	In	Out	In	Out	In	Out
Number of Ship	No	335	315	346	326	496	441
Cargo Volume	Thou.T	1,005	775	1,037	719	1,108	794
Berthing Time	Day/Ho	1903/22	1868/10	2051/01	1159/09	1989/01	1414/08
Operation Time	〃	1469/09	1523/13	1744/02	1034/23	1558/19	1253/17
Ave.Berth.Time/Sh	〃	5/16	5/22	5/22	3/13	4/00	3/05
Ave.Opera.Time/Sh	〃	4/09	4/20	5/01	3/04	3/03	2/20
Ave.Wait.Time/Sh.	〃	1/07	1/02	0/21	0/09	0/21	0/09
Ave.Cargo.H.Volu.	Ton/Da	527	414	505	620	557	561
Actu.Ave.Ca.H.Vo.	〃	683	508	594	694	711	633

Assuming berth occupancy will rise 0.75 and ship size distribution and loading ratio remain as same as at present, the cargo handling capacity increases as follows.
1902x0.75/0.44=3,242 thousand ton (this figure includes Chua Ve)

After the navigation channel is deepened, ship size distribution will correspondingly become larger and amount of cargo volume per ship will increase. Furthermore, the introduction of new cargo handling equipment should increase productivity.
Considering the above mentioned figure, it will be possible to handle more than 3,000,000 tons per year at Main Port.

Therefore the allocation plan of cargo handling volume in Main Port will be set at around 3 million tons annually.

c.f UNDP NATIONAL TRANSPORTATION SECTOR REPORT PORT proposed 4.6 million ton throughput for general cargo assuming a berth occupancy of 0.75.

7-1-2 Average ship size and loading volume and ratio

Average ship size and loading volume by commodity is tabulated as below, by abstracting and calculating from the existing description on ship berthing records provided by Hai Phong Port Authority.(cf. Appendix No) This data was limited to only 221 out of a total 947 ships in 1992 so that it does not represent true average figures. But except for container ship data, it seems to indicate some prevailing tendencies. Average ship size and cargo volume except container ship are calculated as 6,306 tons and 3,254 tons respectively. This means loading ratio is 0.51.

Table 7-1-2 Average Ship Size and Loading Cargo Volume in 1992

	Import				Export			
Cargo Type	No.	Ship DWT	Car.V.T	Load R.	No.	Ship DWT	Car.V.T	Load.R
Bulk Cargo	33	5,250	2,990	0.57	4	4,635	2,162	0.45
General Ca	76	4,833	1,078	0.22	22	4,614	1,705	0.37
Bagged Ca.	74	9,139	6,117	0.67	15	5,035	3,286	0.65
Container	38	4,414	722	0.16	36	4,553	459	0.10
Total	221	5,909	2,727	0.41	77	4,709	1,903	0.33

If 3,254 tons of cargo per ship is adopted in case of total throughput 3 million tons, number of ships berthing in Main Port