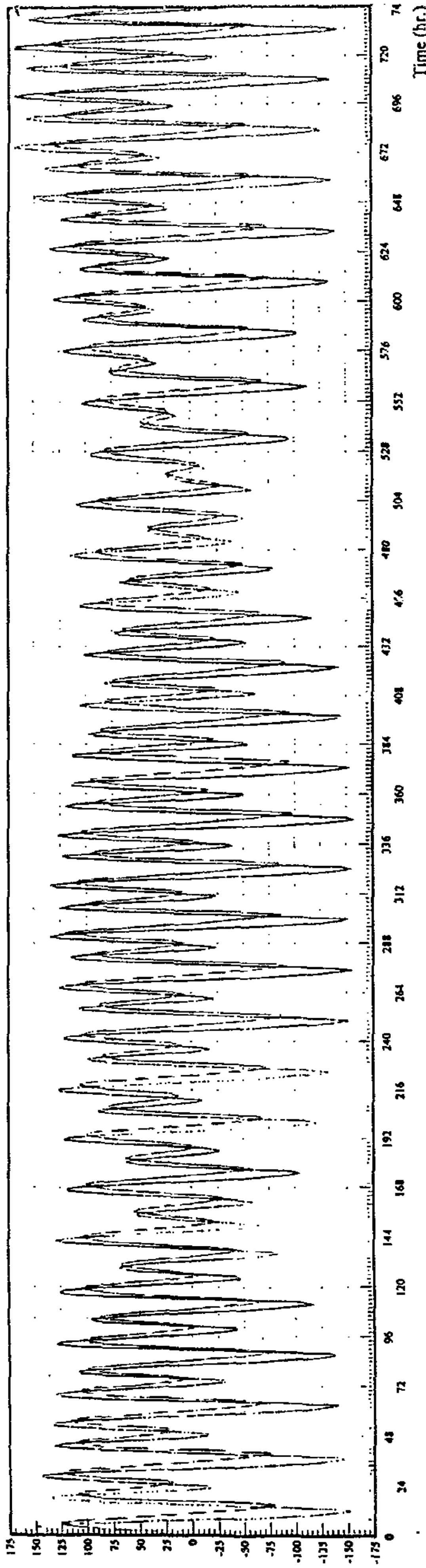
Appendix 2

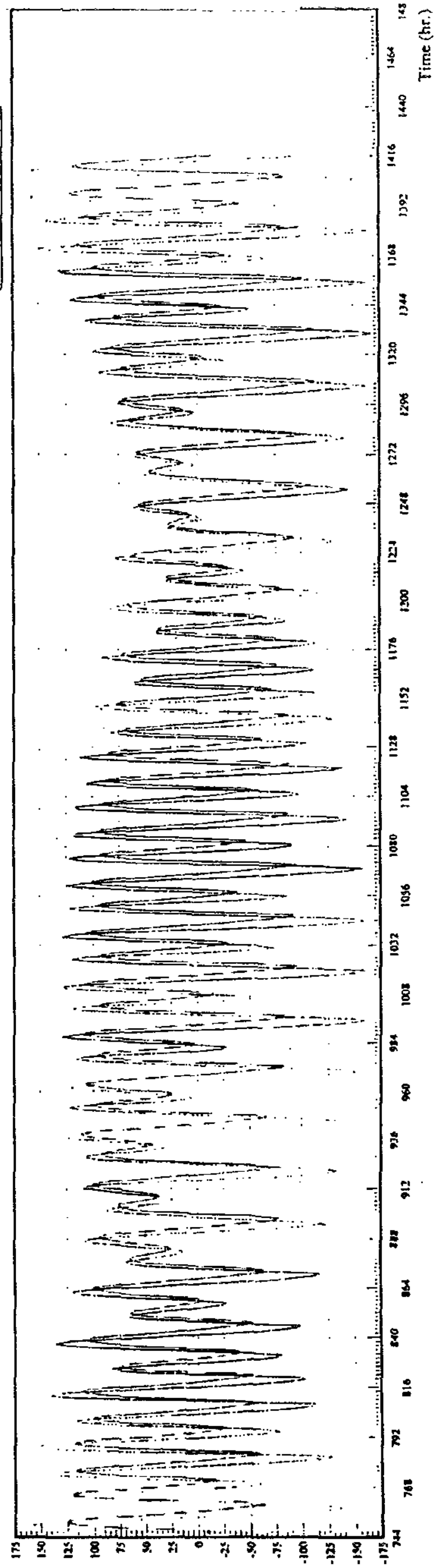
NATURAL CONDITION SURVEYS

2.1	*WATER SURFACE LEVEL IN CAN THO AND DAI NGAI OF THE HAU RIVER, JANUARY TO DECEMBER 1998*	*A2-1*
2.2	*YEARLY CHARACTERISTIC OF AIR TEMPERATURE, CAN THO STATION, 1978 ~ 1998*	*A2-7*
2.3	*YEARLY CHARACTERISTIC OF AIR TEMPERATURE, CAN THO STATION, 1978 ~ 1983, 1985 ~ 1992, 1995 ~ 1998*	*A2-8*
2.4	*YEARLY CHARACTERISTIC OF WIND, CAN THO STATION, 1978 ~ 1998*	*A2-9*
2.5	*MONTHLY PROBABILITY AND AVERAGE VELOCITY FOR EACH DIRECTION, CAN THO STATION*	*A2-10*
2.6	*OUTLINE OF THE TOPOGRAPHIC SURVEY*	*A2-13*

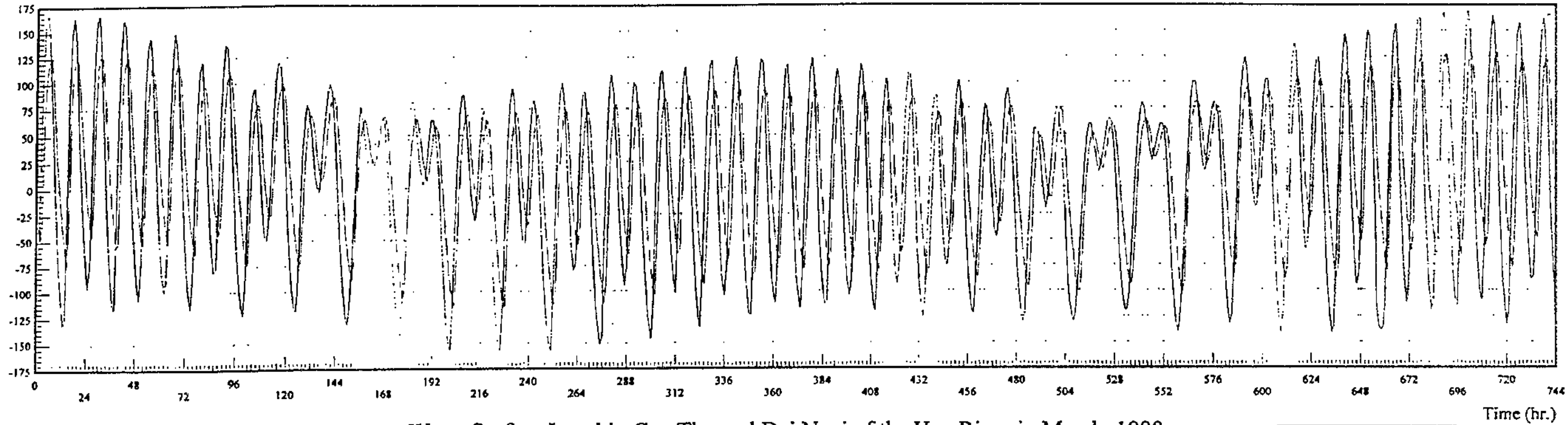
9. 2.1 Water Surface Level in Can Tho and Dai Ngai of the Hau River, January to December 1998



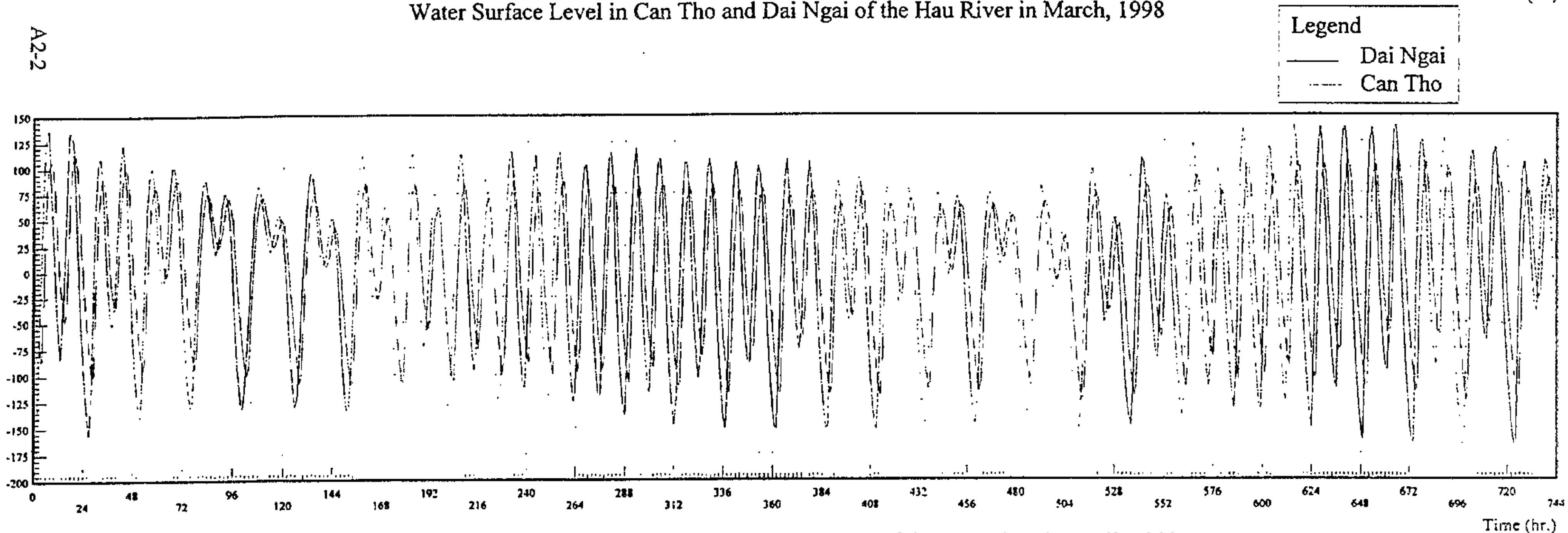
Water Surface Level in Can Tho and Dai Ngai of the Hau River in January, 1998



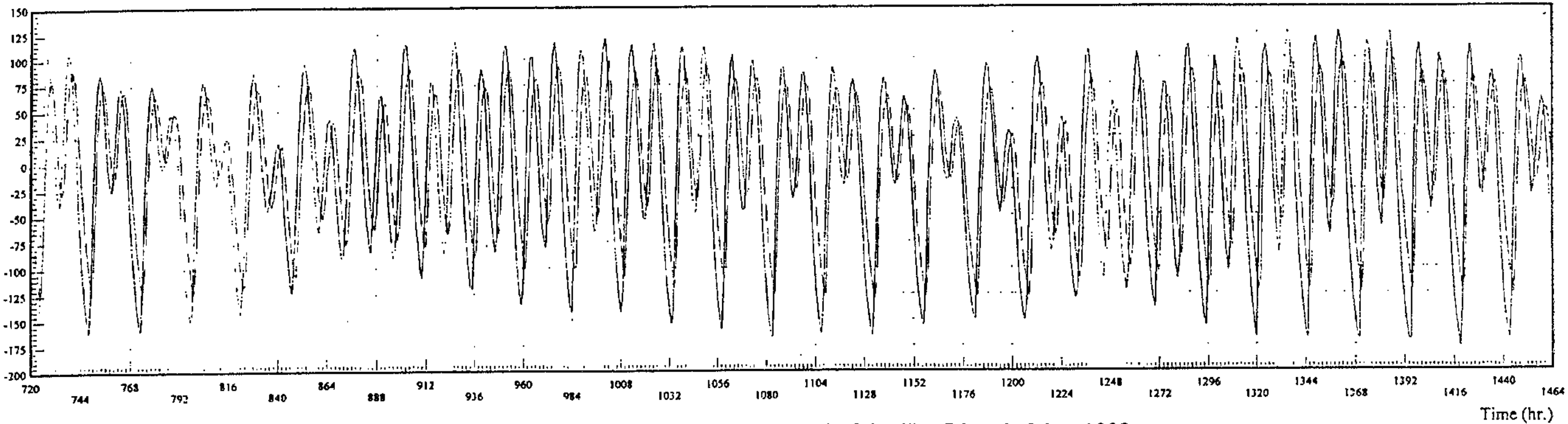
Water Surface Level in Can Tho and Dai Ngai of the Hau River in Febuary, 1998



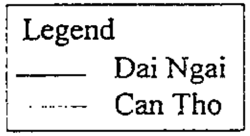
Water Surface Level in Can Tho and Dai Ngai of the Hau River in March, 1998

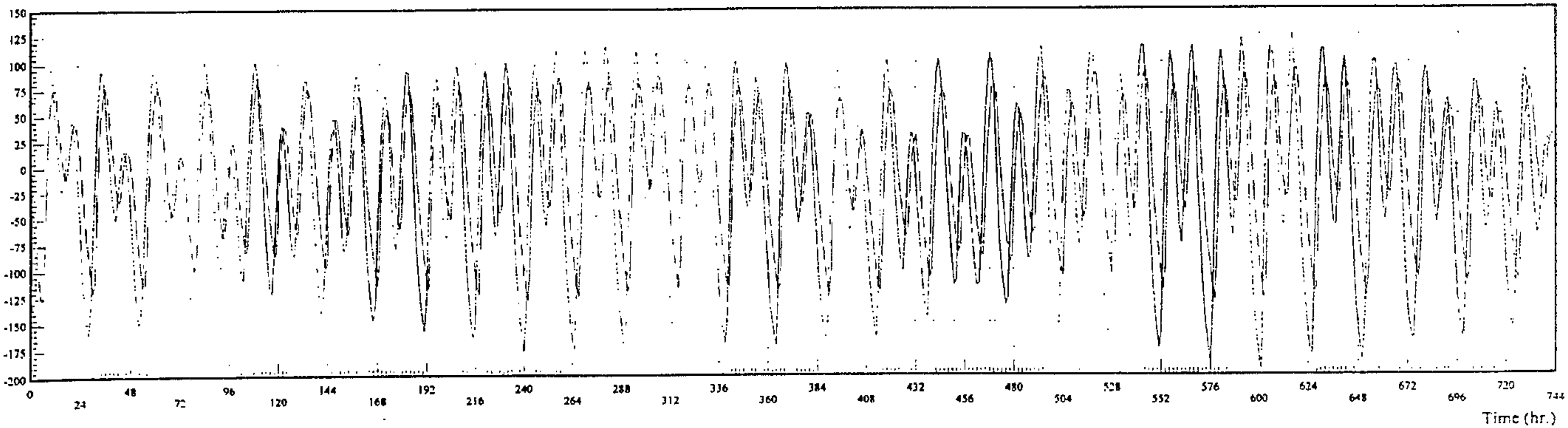


Water Surface Level in Can Tho and Dai Ngai of the Hau River in April, 1998

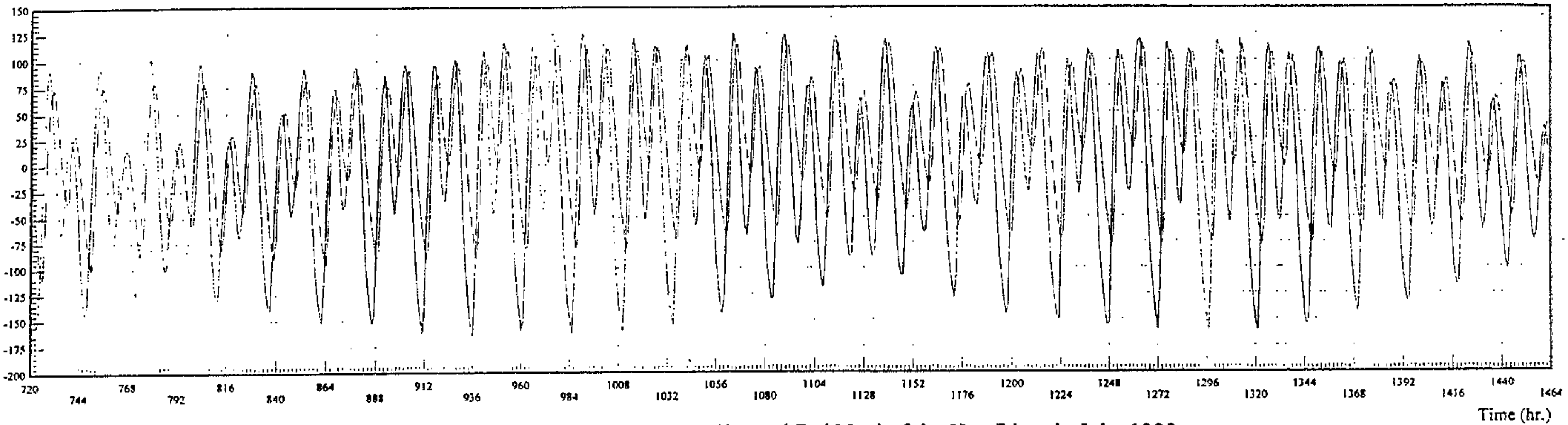


Water Surface Level in Can Tho and Dai Ngai of the Hau River in May, 1998



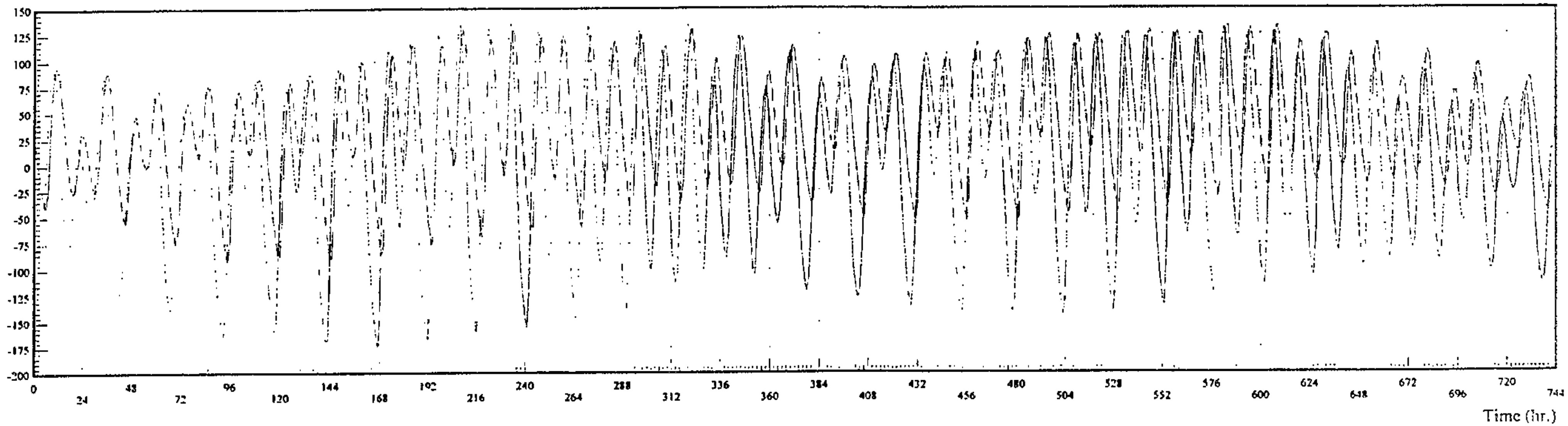


Water Surface Level in Can Tho and Dai Ngai of the Hau River in June, 1998

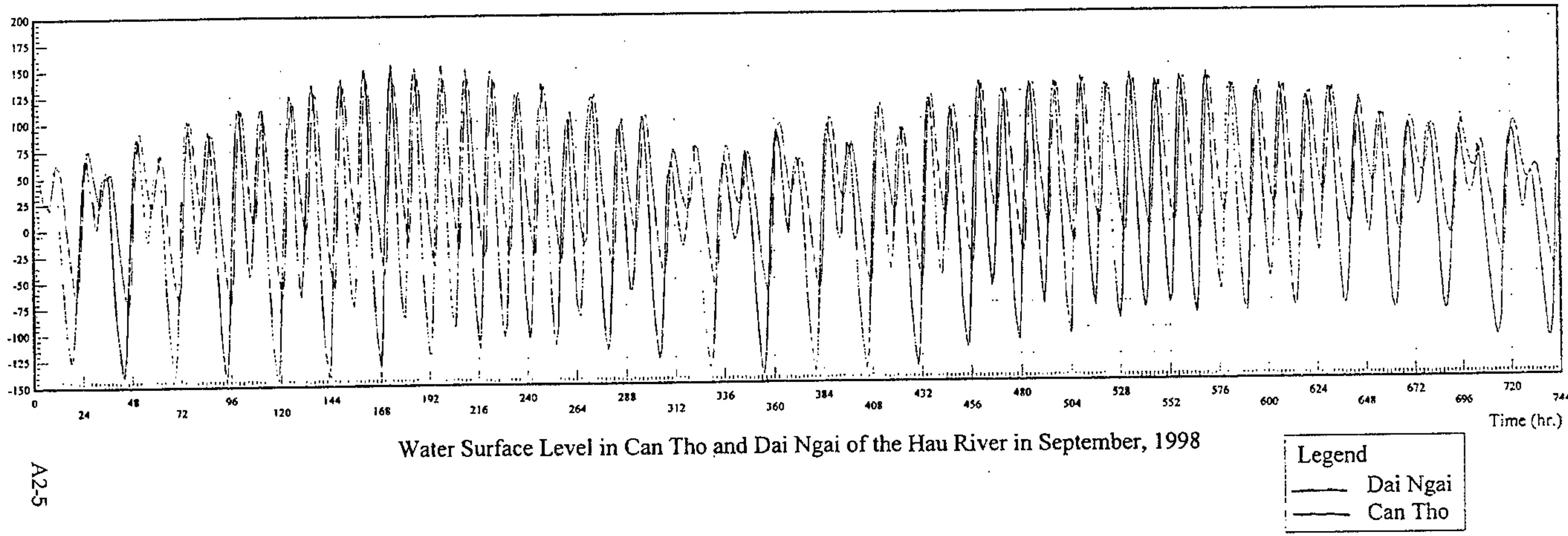


Water Surface Level in Can Tho and Dai Ngai of the Hau River in July, 1998

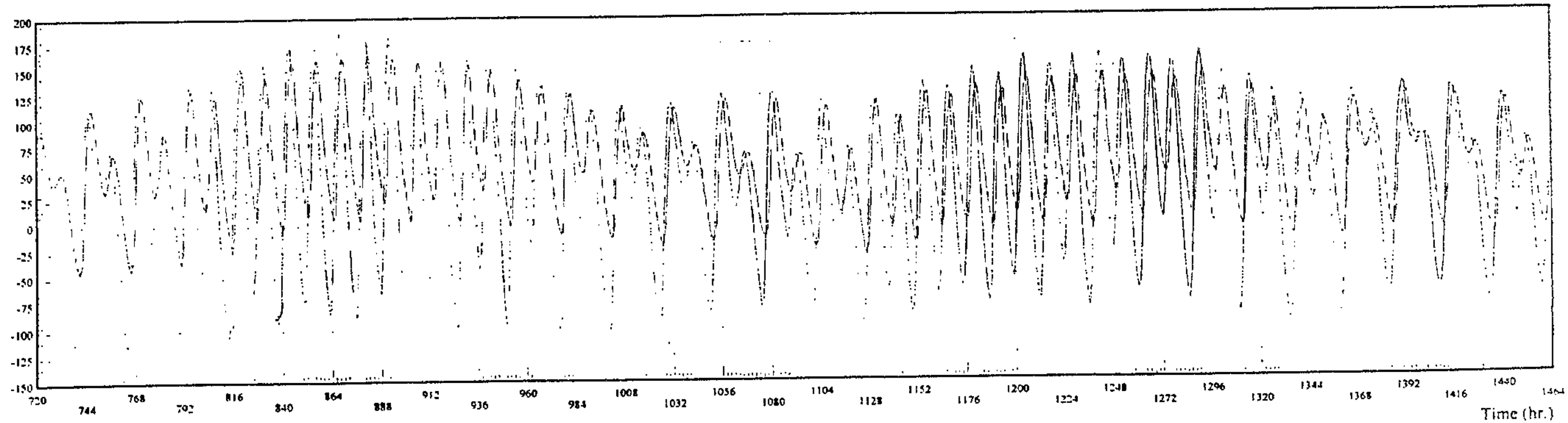
Legend
Dai Ngai
Can Tho



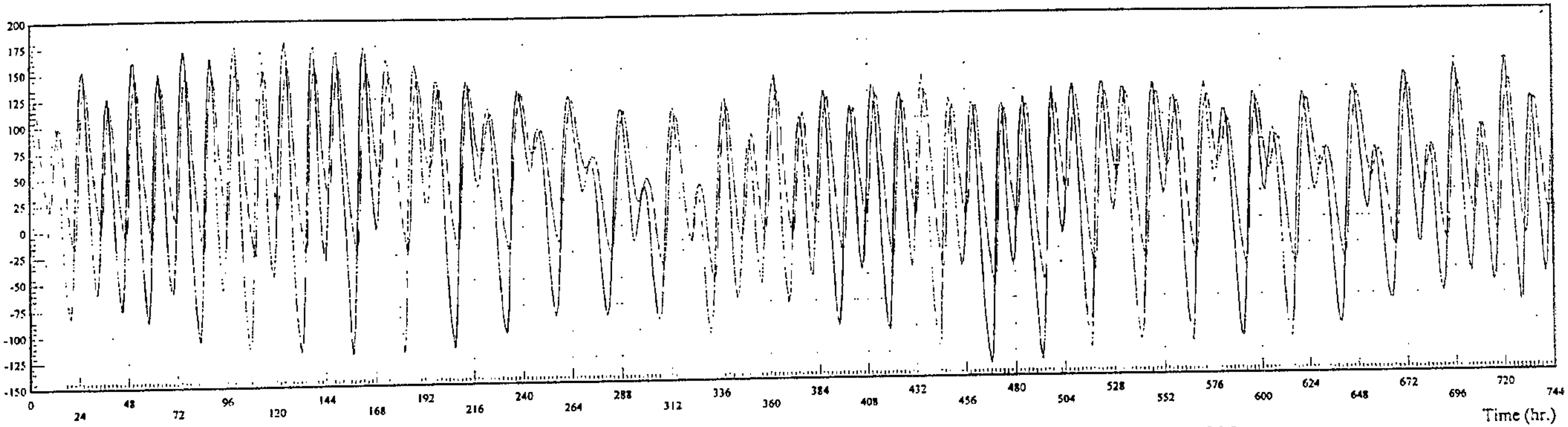
Water Surface Level in Can Tho and Dai Ngai of the Hau River in August, 1998



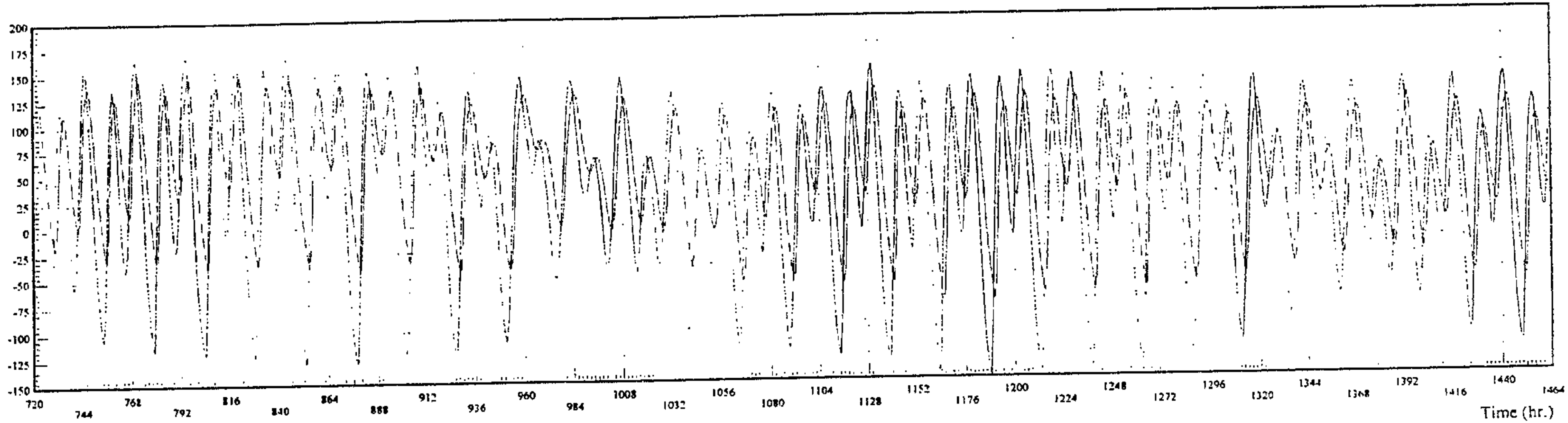
Water Surface Level in Can Tho and Dai Ngai of the Hau River in September, 1998



Water Surface Level in Can Tho and Dai Ngai of the Hau River in October, 1998



Water Surface Level in Can Tho and Dai Ngai of the Hau River in November, 1998



Water Surface Level in Can Tho and Dai Ngai of the Hau River in December, 1998

Legend
—— Dai Ngai
· · · Can Tho

2.2 Yearly Characteristic of Air Temperature, Can Tho Station, 1978 ~ 1998

SOUTHERN REGION HYDRO-METEOROLOGICAL CENTER
19 Nguyen Thi Minh Khai Str., Dist.1, HCMC
Tel: 8290092, 8242474 Fax: 8296091

YEARLY CHARACTERISTIC OF AIR TEMPERATURE
CAN THO STATION
YEAR: 1978 - 1998

Year	Temperature (°C)				
	Average	Maximum	Date	Minimum	Date
1978	26.6	36.2	21-Apr	20.1	23-Jan
1979	26.6	34.7	24-Feb	18.1	26-Dec
1980	26.7	35.3	4-May	18.6	24-Jan
1981	26.4	35.1	20-Apr	17.8	13-Jan
1982	26.4	35.5	1-May	18.6	21-Dec
1983	26.7	36.7	20-May	18.1	24-Jan
1984	26.4	34.8	20-Apr	18.0	9-Jan
1985	26.5	35.0	13-Apr	19.1	17-Dec
1986	26.4	34.8	21-Apr	17.7	4-Mar
1987	26.9	35.3	13-Apr	19.1	8-Dec
1988	26.7	36.1	22-Apr	19.0	15-Dec
1989	26.5	35.4	3-May	18.4	15-Feb
1990	26.9	35.9	19-Apr	20.5	29-Jan
1991	26.7	35.1	2-May	20.9	11-Jan
1992	26.7	35.4	12-Apr	19.2	19-Jan
1993	26.6	34.9	10-May	18.1	31-Jan
1994	26.8	35.0	2-May	19.3	25-Jan
1995	26.9	34.5	10-May	18.6	7-Jan
1996	26.6	34.5	31-Mar	19.5	29-Dec
1997	26.9	34.7	4-May	20.1	23-Jan
1998	27.4	36.0	23-Apr	18.7	16-Dec

2.3 Yearly Characteristic of Air Temperature, Can Tho Station, 1978 ~ 1983, 1985 ~ 1992, 1995 ~ 1998

SOUTHERN REGION HYDRO-METEOROLOGICAL CENTER
19 Nguyen Thi Minh Khai Str., Dist. 1, HCMC
Tel: 8290092, 8242474 Fax: 8296091

YEARLY CHARACTERISTIC OF RAINFALL
CAN THO STATION
YEAR:1978~1983, 1985~1992, 1995~1998

Year	Total of rainfall (mm)	Daily maximum rainfall (mm)	Date	Number of rainy day
1978	1739.8	91.2	20-Nov	153
1979	1479.2	48.4	2-Sep	157
1980	1688.9	90.4	9-Jun	140
1981	1630.0	69.7	11-May	142
1982	1720.2	83.6	28-Sep	163
1983	1799.3	117.8	16-Sep	155
1985	1648.0	77.5	4-Jun	169
1986	1831.5	116.4	2-Nov	152
1987	1465.5	67.3	7-Oct	153
1988	1716.9	73.4	22-Oct	157
1989	1336.8	82.2	15-Jul	152
1990	1160.2	67.3	4-Aug	134
1991	1516.3	64.0	30-Jun	148
1992	1300.8	67.2	28-Jul	145
1995	1704.3	131.8	18-Jun	157
1996	2134.6	112.0	15-May	185
1997	1700.1	94.6	2-Nov	143
1998	1952.0	104.8	24-Oct	149

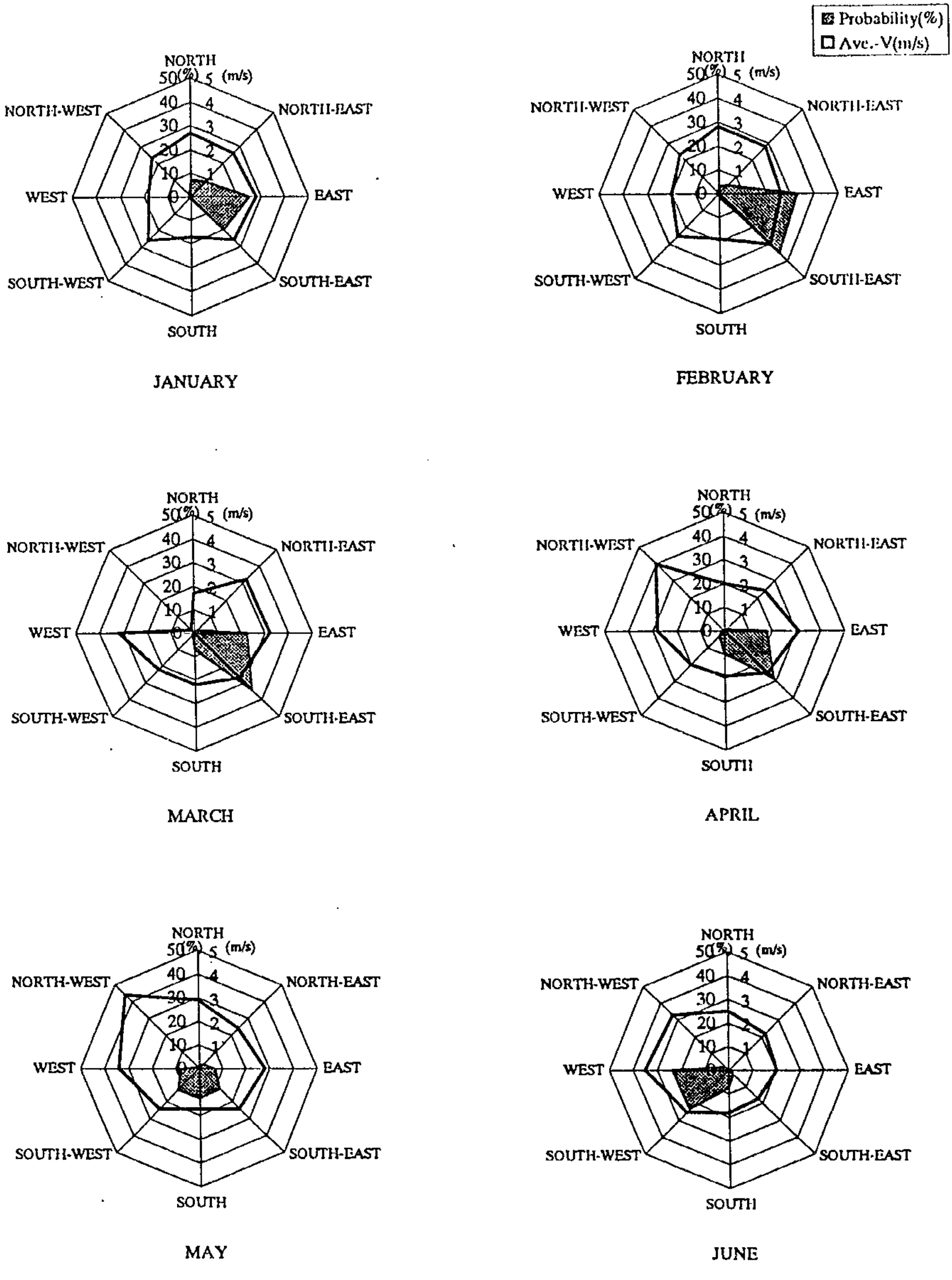
HYDROMETEOROLOGICAL CENTER
19 Nguyen Thi Minh Khai Str., Dist. 1, HCMC
Tel: 8290092, 8242474 Fax: 8296091

YEARLY CHARACTERISTIC OF WIND

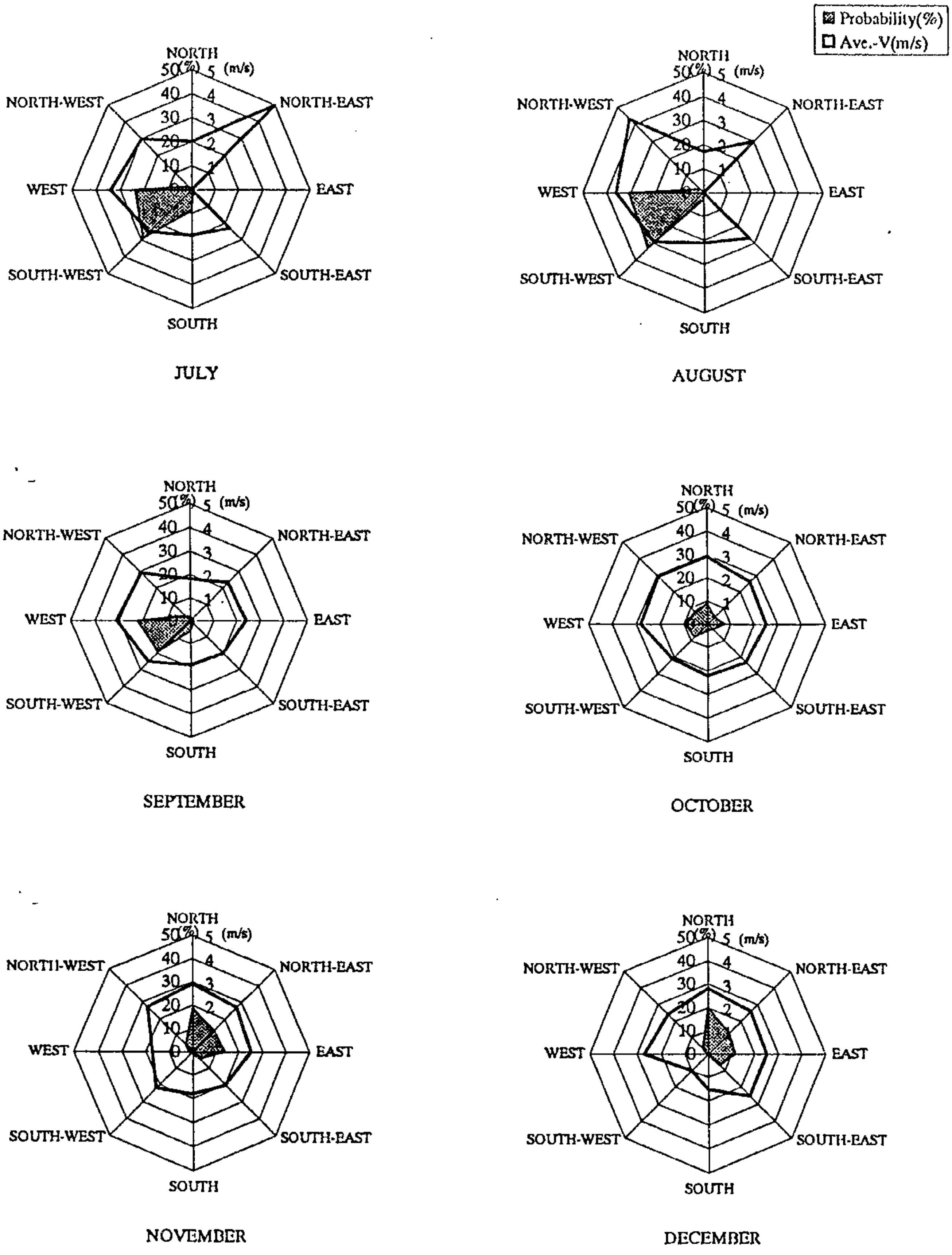
STATION: CAN THO - YEAR: 1978-1998

No.	Year	Average Wind Speed (m/s)	Maximum Wind Speed		
			Value (m/s)	Direction	Date
1	1978	2	30	W	10-Aug-78
2	1979	2	31	SW	9-Aug-79
3	1980	2	27	WSW	21-Jun-80
4	1981	2	30	W	10-Jun-81
5	1982	2	24	W	20-Jun-82
6	1983	2	28	SW	2-Sep-83
7	1984	2	20	W	13-Aug-84
8	1985	1	18	SW	20-Jun-85
9	1986	1	18	W	16-May-86
10	1987	1	18	SW	22-Aug-87
11	1988	1	20	N	26-Apr-88
12	1989	1	24	NW	23-May-89
13	1990	1	16	SW	16-Jul-90
14	1991	2	20	SW	7-Sep-91
15	1992	1	18	W	20-Aug-92
16	1993	1	16	W	8-Jul-93
17	1994	1	20	W, NW	10-Jul-94
18	1995	2	18	SW	23-May-95
19	1996	2	18	W	29-Jul-96
20	1997	2	20	W	22-May-97
21	1998	2	18	S	28-May-98

2.5 Monthly Probability and Average Velocity for Each Direction, Can Tho Station



(a) MONTHLY PROBABILITY AND AVERAGE VELOCITY EACH DIRECTION AT CAN THO (JAN – JUN)



(b) MONTHLY PROBABILITY AND AVERAGE VELOCITY EACH DIRECTION AT CAN THO (JUL – DEC)

MONTHLY PROBABILITY AND AVERAGE VELOCITY (speed) OF WIND EACH DIRECTION AT CAN THO

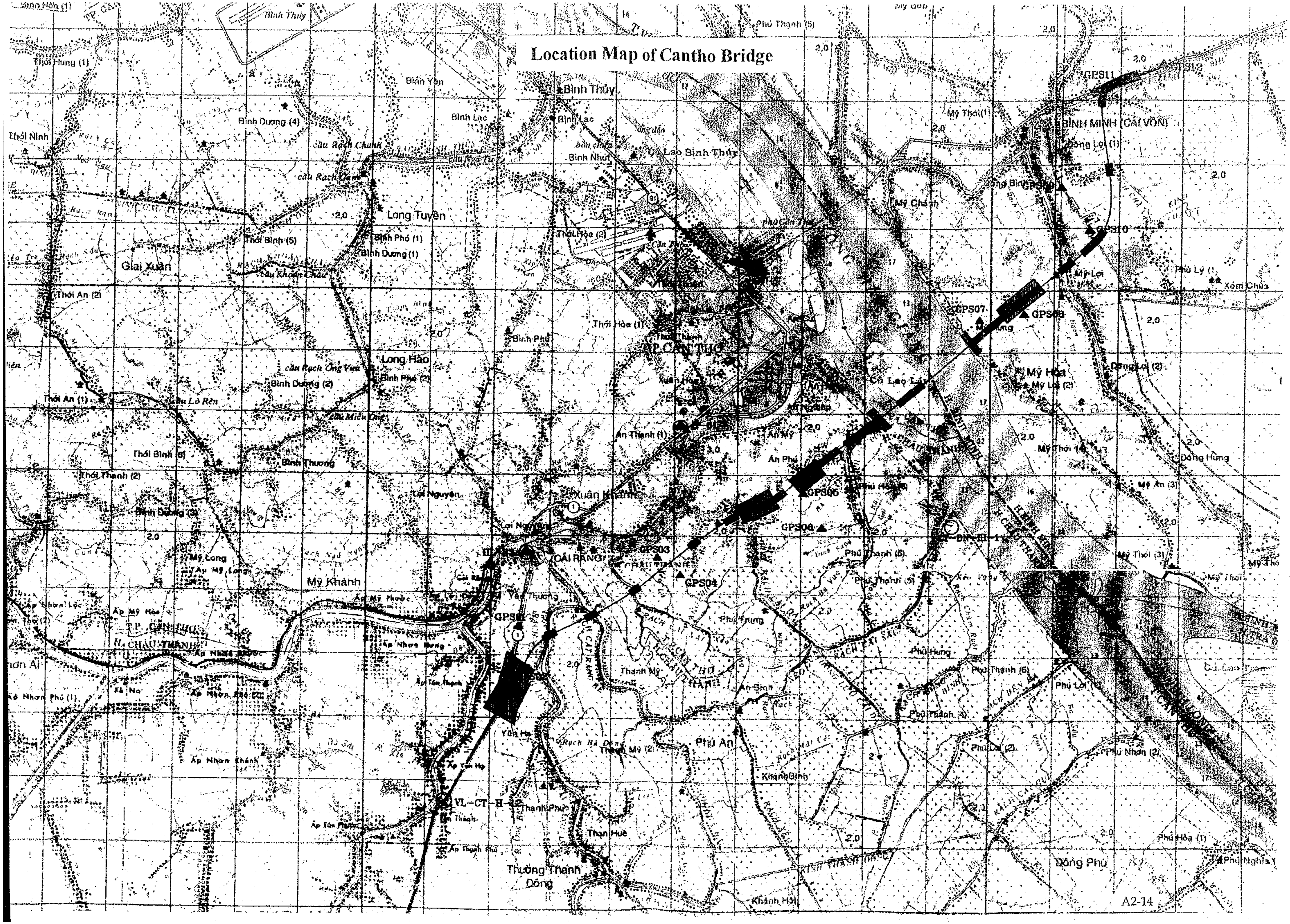
Month	1		2		3		4		5		6		7		8		9		10		11		12	
Direction	P(%)	V(m/s)	P(%)	V(m/s)	P(%)	V(m/s)	P(%)	V(m/s)	P(%)	V(m/s)	P(%)	V(m/s)	P(%)	V(m/s)	P(%)	V(m/s)	P(%)	V(m/s)	P(%)	V(m/s)	P(%)	V(m/s)	P(%)	V(m/s)
NORTH	7.3	2.7	3.0	2.8	0.3	1.7	0.4	2.0	1.3	2.9	0.6	2.5	0.5	2.0	0.3	1.7	1.6	1.8	9.0	2.9	18.7	2.9	19.9	2.8
NORTH-EAST	9.0	2.6	5.2	2.8	1.6	3.2	1.3	2.4	2.6	2.4	0.4	2.2	0.2	5.0	0.2	3.0	1.3	2.3	4.4	2.6	13.0	2.7	12.5	2.6
EAST	25.3	2.8	33.0	2.6	22.7	3.2	17.7	3.1	6.6	2.8	1.4	2.0		0.0		0.0	1.8	2.4	7.5	2.5	14.0	2.5	11.7	3.5
SOUTH-EAST	20.0	2.6	35.6	3.0	34.6	2.7	28.9	2.5	12.1	2.4	2.6	1.7	1.2	2.3	0.3	2.7	1.9	2.0	3.2	2.3	4.3	2.0	6.7	2.5
SOUTH	1.2	1.7	1.6	1.9	7.0	2.2	9.7	1.9	12.8	1.7	7.7	1.8	8.6	1.9	2.8	2.1	4.3	1.9	2.8	2.2	1.2	1.8	0.4	1.5
SOUTH-WEST	0.8	2.6	0.2	2.5	1.4	2.2	3.0	2.0	12.7	2.4	23.4	2.5	29.0	2.5	32.8	2.9	19.1	2.5	7.7	2.1	0.5	2.2	0.2	1.0
WEST	0.9	1.8	0.7	2.0	0.4	3.2	1.0	2.8	7.6	3.4	23.7	3.5	23.8	3.4	30.9	3.6	22.3	3.1	9.4	2.8	1.5	1.7	0.3	2.7
NORTH-WEST	0.9	2.3	0.4	2.3	0.4	0.2	0.1	4.0	0.8	4.4	2.3	3.3	2.0	3.0	2.3	4.3	2.8	2.9	7.6	2.9	4.4	2.7	3.6	2.4
WINDLESS	34.6		20.3		31.5		37.9		43.5		37.9		34.7		30.4		45.0		48.4		42.4		44.7	

APPENDIX

- Location Map of Can Tho Bridge
- Diagram of GPS Network

- Coordinate and Elevation of GPS points
- Diagram of Secondary Traverse and Levelling Network
- Coordinate and Elevation of Secondary Traverse points

Location Map of Cantho Bridge



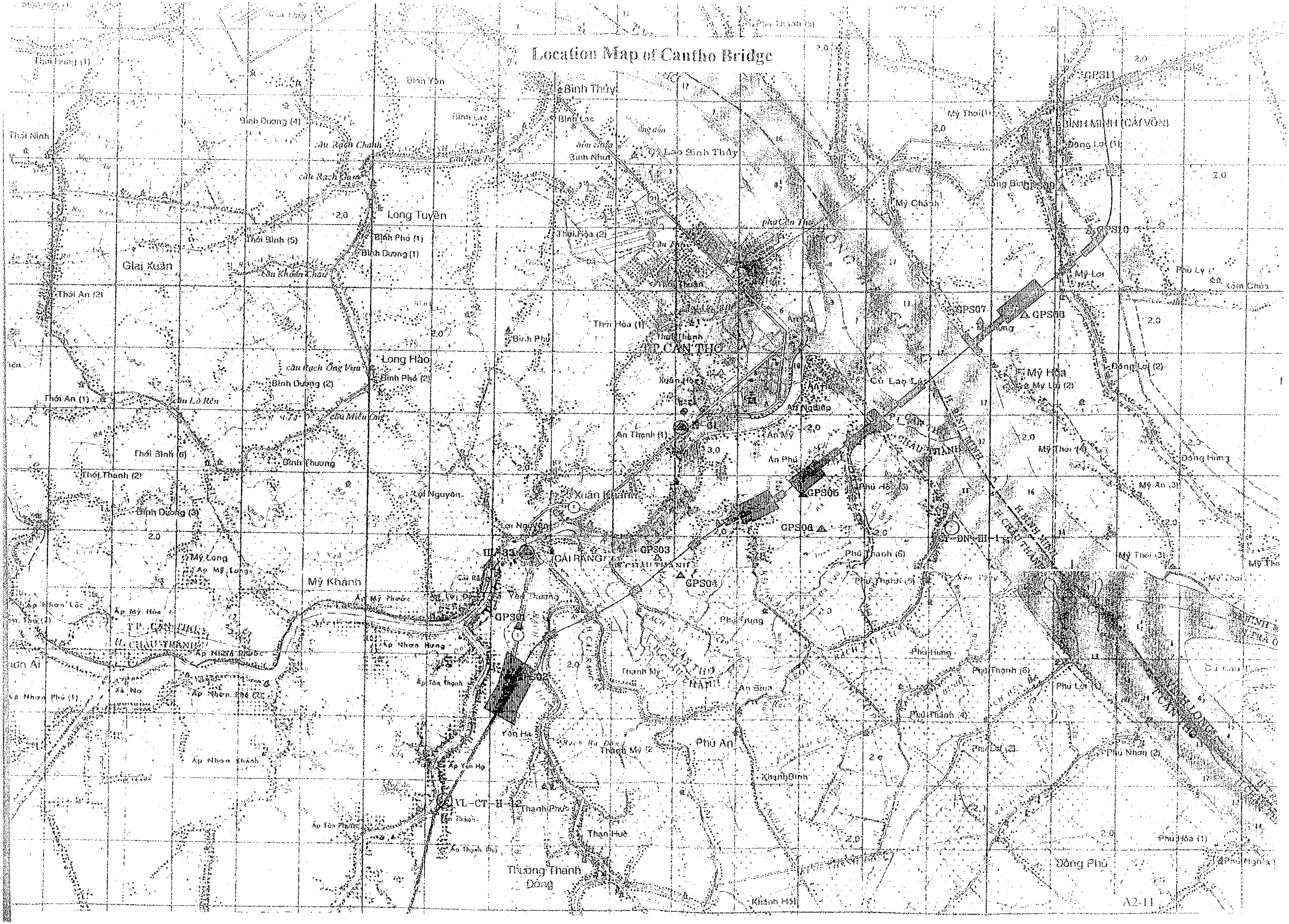
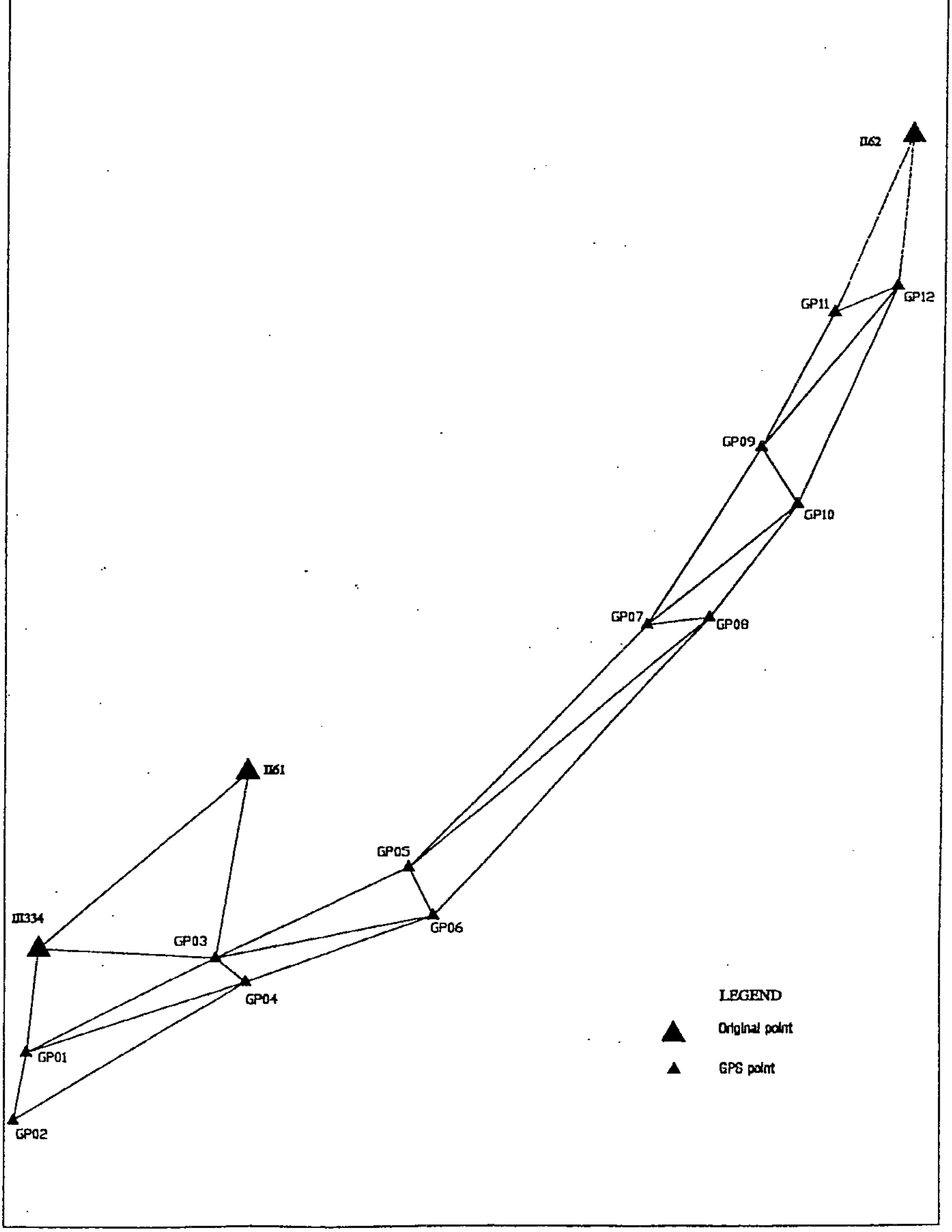

Location Map of Cantho Bridge
Bình Thủy
Lao Binh Thủy
Bình Minh (Cái Vồn)
GPS11
GPS10
GPS08
GPS07
GPS06
GPS05
GPS04
GPS03
GPS01
GPS02
Long Tuyền
Long Hào
Giai Xuân
Thới Ninh
Thới An (2)
Thới An (1)
Thới Bình (5)
Thới Bình (6)
Thới Thạnh (2)
Bình Dương (4)
Bình Dương (1)
Bình Dương (2)
Bình Dương (3)
Bình Phó (1)
Bình Thường
Lợi Nguyên
Mỹ Long
Mỹ Khánh
T.P. CẦN THƠ
H. CHÂU THÀNH
Thới Hòa (2)
Thới Hòa (1)
Thới Thạnh
Bình Phú
Xuân Hòa
Xuân Khánh
An Thạnh (1)
An Nghiệp
An Mỹ
An Phú
Cái Răng
Cù Lao Lớn
Mỹ Chánh
Mỹ Thới (1)
Mỹ Hòa
Mỹ Lợi
Mỹ Lợi (2)
Mỹ Hưng
Mỹ Thới (3)
Mỹ An (3)
Đông Lợi (1)
Đông Lợi (2)
Đông Hưng
Phú Ly
Xóm Chùa
Phú Hòa (3)
Phú Thạnh (6)
Phú Thạnh (5)
Phú Hưng
Phú Thạnh (4)
Phú Lợi (2)
Phú Nhơn (2)
Phú Hòa (1)
Phú An
Khánh Bình
Đông Phú
Thạnh Mỹ
Thạnh Phú
Thạnh Huệ
Thường Thạnh Đông
Yên Hạ
VL-CT-H-12
DN-III-1
Ấp Nhơn Khánh
Ấp Nhơn Hưng
Ấp Tân Thạnh
Ấp Mỹ Hòa
Ấp Nhơn Lộc
Ấp Mỹ Phước

DIAGRAM OF GPS NETWORK



COORDINATE AND ELEVATION OF GPS POINTS

No	Name	Coordinate		Elevation
		X (m)	Y (m)	(m)
1	GPS01	1105431.471	582098.996	2.015
2	GPS02	1104638.866	581943.126	1.880
3	GPS03	1106534.913	584312.627	1.477
4	GPS04	1106254.567	584671.564	1.324
5	GPS05	1107590.554	586594.355	1.409
6	GPS06	1107025.620	586877.035	1.516
7	GPS07	1110420.720	589379.969	1.591
8	GPS08	1110510.826	590096.639	1.468
9	GPS09	1112507.233	590687.774	1.318
10	GPS10	1111843.210	591109.838	1.519
11	GPS11	1114078.612	591519.564	1.538
12	GPS12	1114385.446	592257.998	1.513

DIAGRAM OF SECONDARY TRAVERSE AND LEVELING NETWORK

FROM : GPS10 TO GPS12

SCALE : 1/20,000.

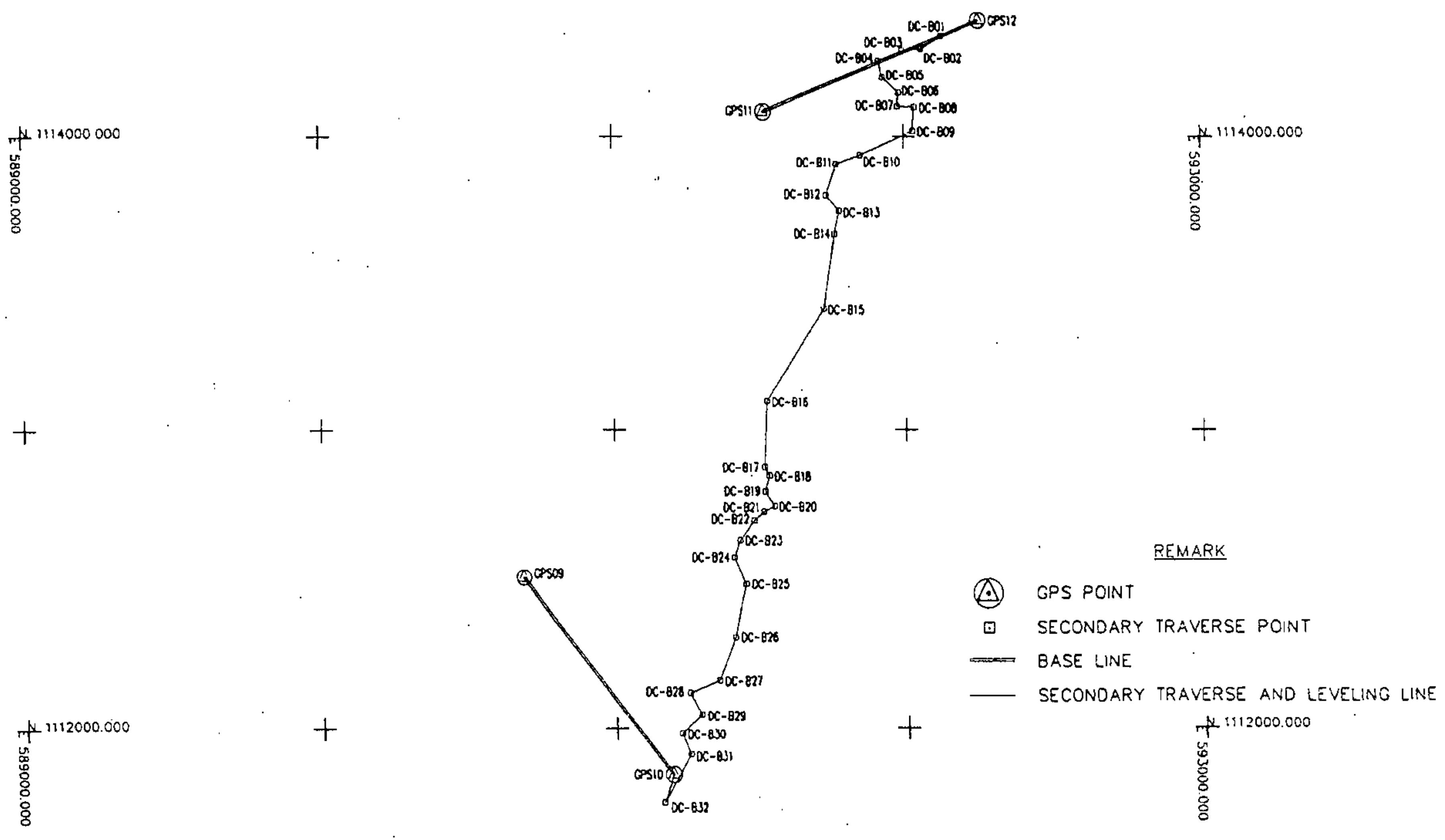


DIAGRAM OF SECONDARY TRAVERSE AND LEVELING NETWORK

FROM : GPS07 TO GPS10

SCALE : 1/20,000.

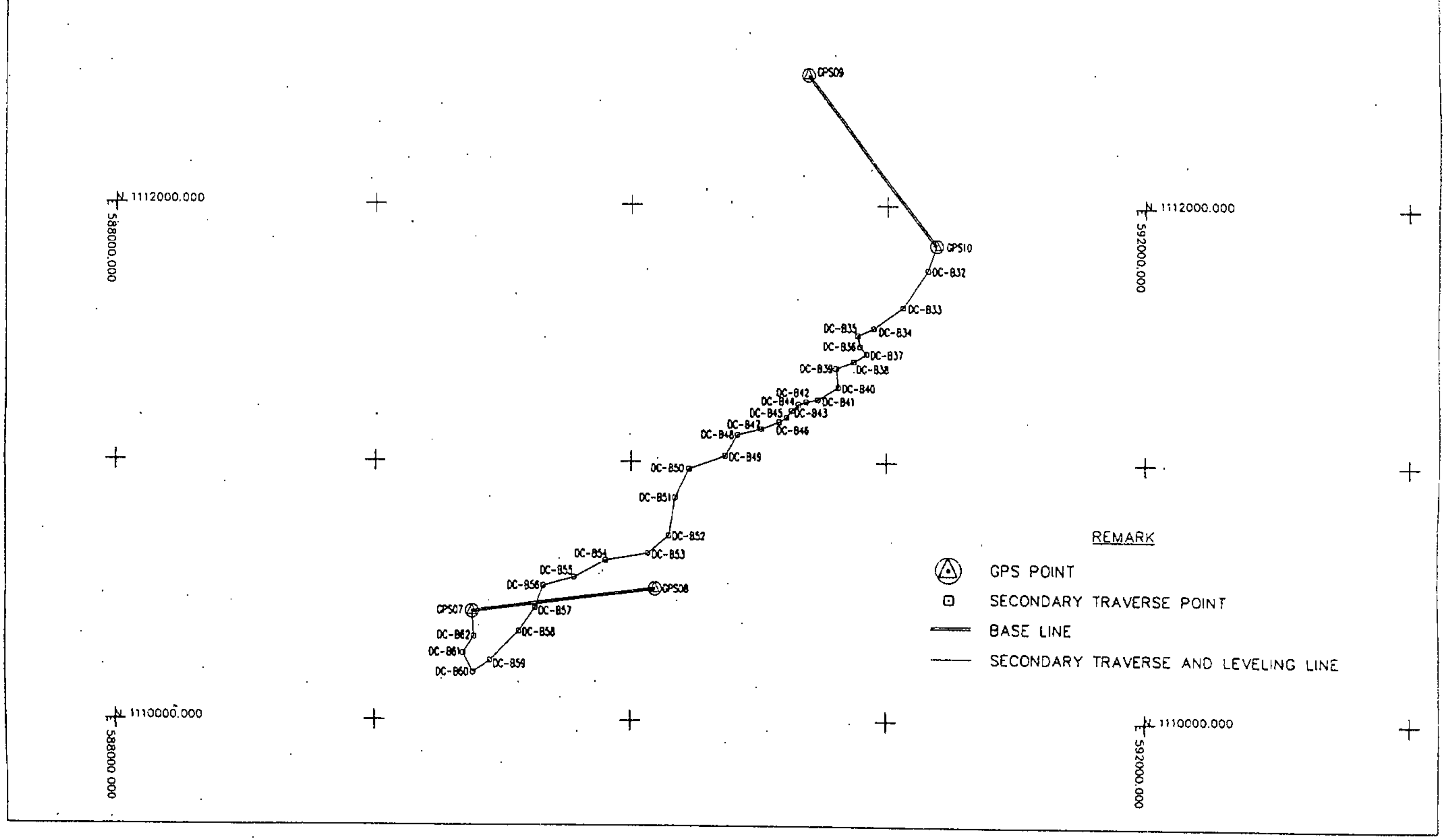


DIAGRAM OF SECONDARY TRAVERSE AND LEVELING NETWORK

FROM : GPS05 TO GPS06

SCALE : 1/20,000.

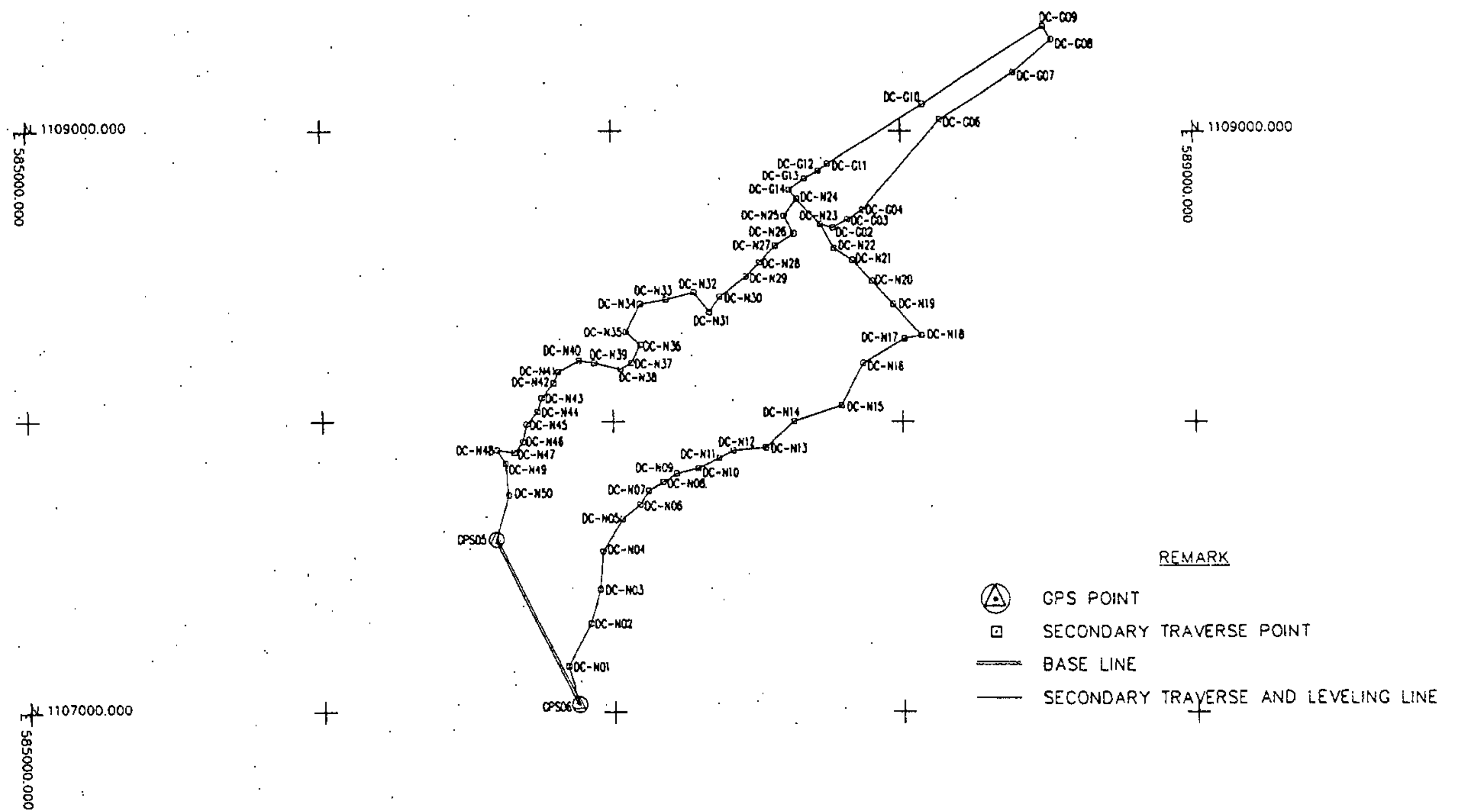


DIAGRAM OF SECONDARY TRAVERSE AND LEVELING NETWORK

FROM : GPS04 TO GPS05

SCALE : 1/20,000.

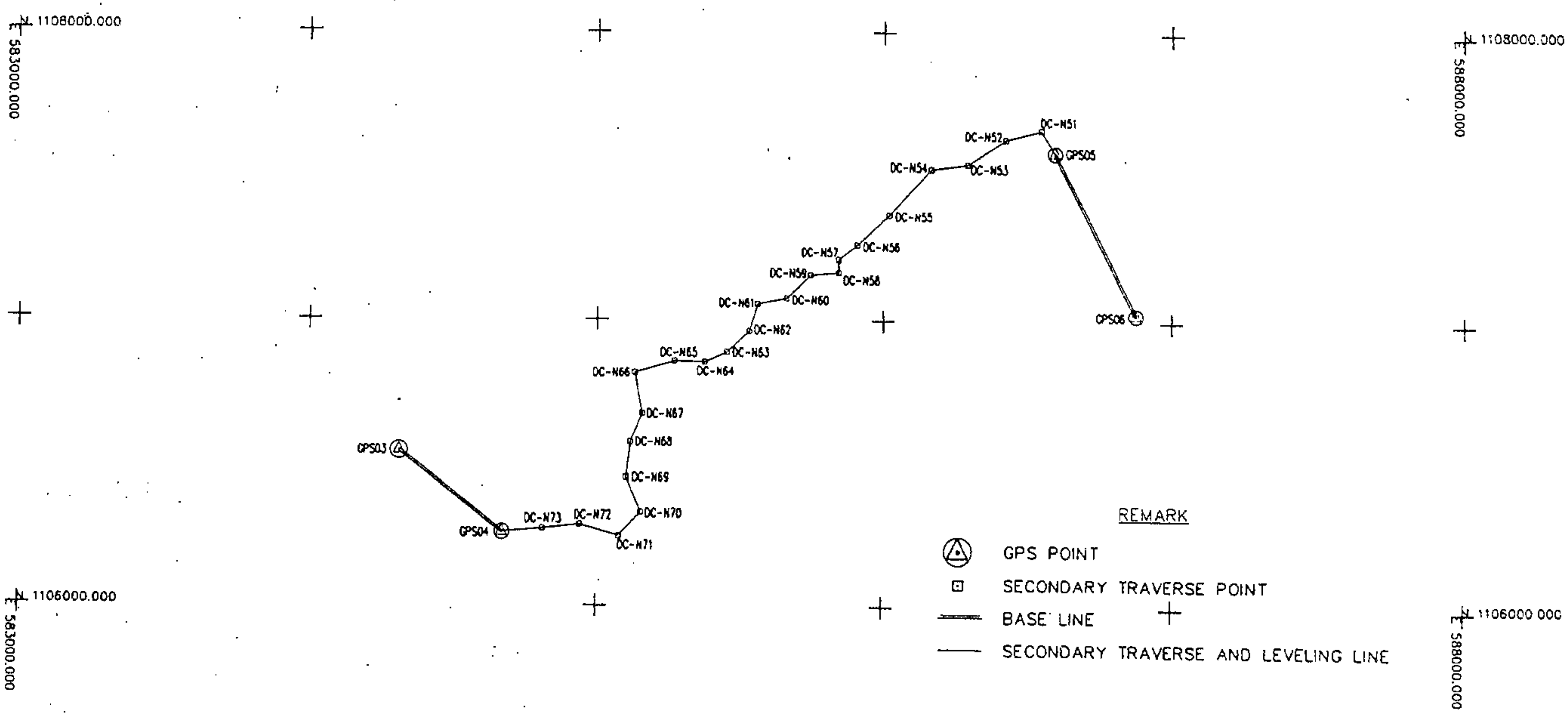
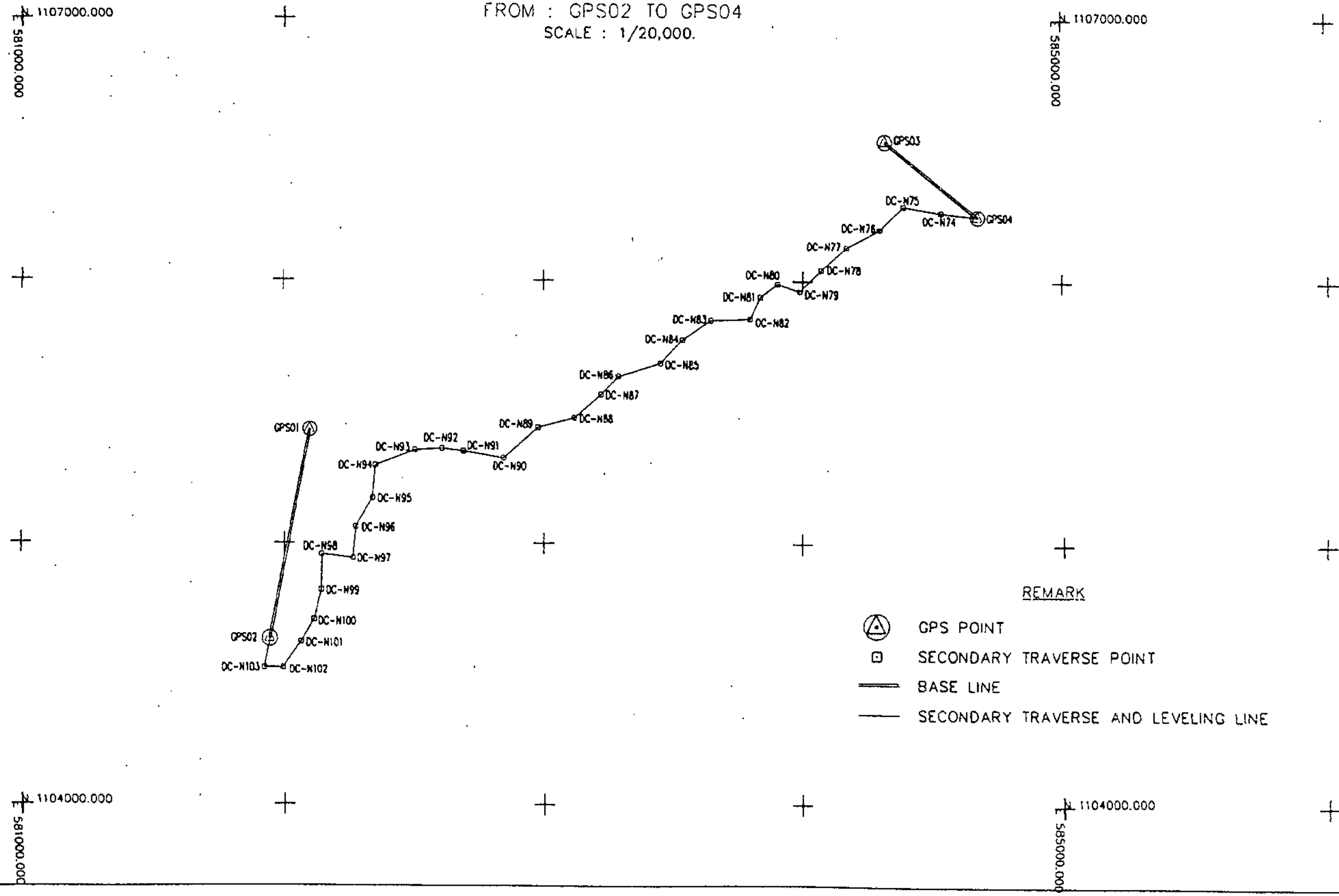


DIAGRAM OF SECONDARY TRAVERSE AND LEVELING NETWORK

FROM : GPS02 TO GPS04

SCALE : 1/20,000.



COORDINATE AND ELEVATION OF SECONDARY TRAVERSE POINTS

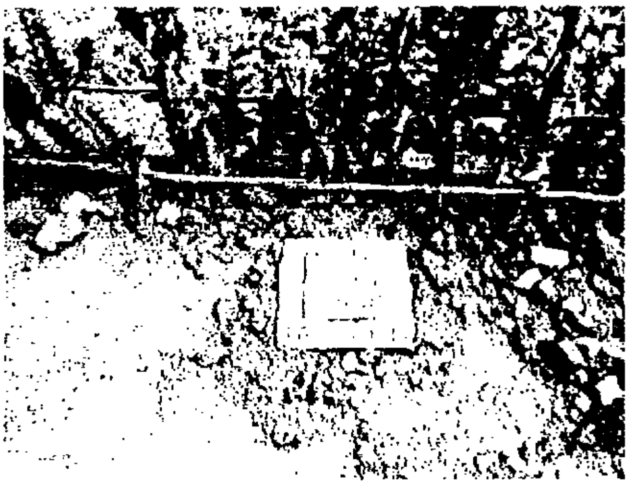
No	Name	Coordinate		Elevation
		X (m)	Y (m)	(m)
1	DC-B01	1114333.434	592131.164	1.582
2	DC-B02	1114290.104	592062.565	1.517
3	DC-B03	1114283.294	591997.175	1.462
4	DC-B04	1114248.826	591917.612	1.855
5	DC-B05	1114194.043	591930.960	2.708
6	DC-B06	1114142.362	591983.770	1.485
7	DC-B07	1114097.117	591979.964	1.514
8	DC-B08	1114094.264	592036.873	1.337
9	DC-B09	1114017.462	592030.394	1.242
10	DC-B10	1113935.946	591850.516	1.390
11	DC-B11	1113904.763	591767.360	1.187
12	DC-B12	1113796.856	591732.631	1.500
13	DC-B13	1113746.681	591776.512	1.453
14	DC-B14	1113669.522	591760.508	1.324
15	DC-B15.	1113415.052	591722.151	1.245
16	DC-B16	1113098.518	591523.362	1.174
17	DC-B17	1112873.507	591513.328	1.482
18	DC-B18	1112845.281	591528.814	1.217
19	DC-B19	1112793.019	591513.850	1.337
20	DC-B20	1112741.726	591546.743	1.327
21	DC-B21	1112723.207	591509.774	1.242
22	DC-B22	1112693.485	591475.140	1.239
23	DC-B23	1112629.070	591426.723	1.168
24	DC-B24	1112571.193	591406.322	1.254
25	DC-B25	1112482.530	591445.830	1.220
26	DC-B26	1112306.238	591408.763	1.354
27	DC-B27	1112160.384	591353.125	1.400
28	DC-B28	1112119.436	591251.057	1.334
29	DC-B29	1112045.255	591290.816	1.259
30	DC-B30	1111981.585	591222.175	1.350
31	DC-B31	1111910.180	591251.244	1.424
32	DC-B32	1111747.243	591158.105	1.606
33	DC-B33	1111603.612	591061.122	1.757
34	DC-B34	1111521.637	590946.779	1.556

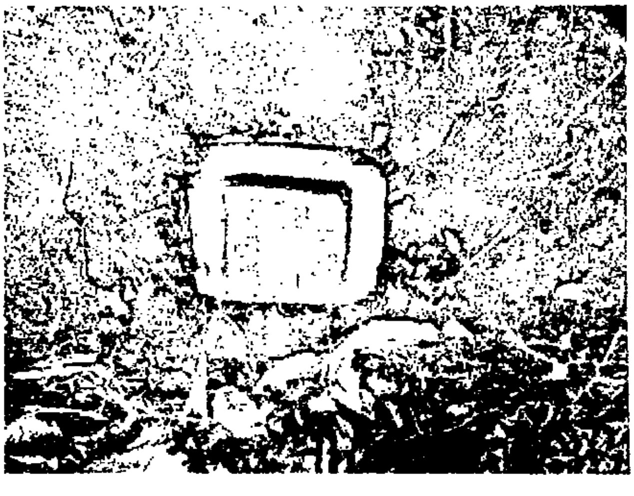
No	Name	Coordinate		Elevation
		X (m)	Y (m)	(m)
35	DC-B35	1111494.668	590883.825	1.646
36	DC-B36	1111451.250	590893.485	1.619
37	DC-B37	1111423.306	590918.389	1.668
38	DC-B38	1111393.448	590868.637	1.477
39	DC-B39	1111366.874	590800.119	1.586
40	DC-B40	1111292.144	590809.043	1.615
41	DC-B41	1111242.569	590728.560	1.563
42	DC-B42	1111234.126	590683.005	1.506
43	DC-B43	1111223.253	590653.237	1.464
44	DC-B44	1111199.769	590626.598	1.556
45	DC-B45	1111174.464	590608.248	1.448
46	DC-B46	1111156.337	590578.879	1.379
47	DC-B47	1111128.544	590509.206	1.612
48	DC-B48	1111105.537	590415.457	1.273
49	DC-B49	1111024.341	590368.566	1.580
50	DC-B50	1110972.149	590227.331	1.367
51	DC-B51	1110860.655	590174.094	1.285
52	DC-B52	1110712.995	590149.775	1.327
53	DC-B53	1110645.128	590068.140	1.435
54	DC-B54	1110617.304	589902.588	1.395
55	DC-B55	1110552.143	589778.699	1.493
56	DC-B56	1110520.291	589657.784	1.361
57	DC-B57	1110434.005	589626.749	1.241
58	DC-B58	1110343.276	589562.957	1.432
59	DC-B59	1110232.120	589448.814	1.660
60	DC-B60	1110186.987	589384.017	1.695
61	DC-B61	1110260.404	589344.548	1.606
62	DC-B62	1110323.000	589387.241	1.434
63	DC-G02	1108663.056	587763.290	1.611
64	DC-G03	1108691.843	587815.040	1.824
65	DC-G04	1108725.613	587866.949	1.648
66	DC-G06	1109038.649	588135.821	2.181
67	DC-G07	1109192.835	588388.910	1.769
68	DC-G08	1109303.794	588521.728	2.139
69	DC-G09	1109350.377	588493.396	2.188
70	DC-G10	1109090.467	588076.745	2.364

No	Name	Coordinate		Elevation (m)
		X (m)	Y (m)	
71	DC-G11	1108885.896	587747.447	1.832
72	DC-G12	1108861.591	587714.624	1.679
73	DC-G13	1108833.258	587666.707	1.601
74	DC-G14	1108793.458	587614.313	1.827
75	DC-N01	1107155.624	586840.705	1.478
76	DC-N02	1107305.453	586919.572	1.562
77	DC-N03	1107420.940	586952.452	1.327
78	DC-N04	1107550.046	586962.534	1.381
79	DC-N05	1107660.506	587030.609	1.335
80	DC-N06	1107710.148	587091.396	1.550
81	DC-N07	1107757.761	587121.294	1.587
82	DC-N08	1107788.305	587170.619	1.330
83	DC-N09	1107816.979	587216.106	1.340
84	DC-N10	1107835.831	587291.753	1.769
85	DC-N11	1107871.672	587365.308	1.850
86	DC-N12	1107897.508	587414.584	1.459
87	DC-N13	1107907.121	587526.772	1.414
88	DC-N14	1108000.392	587624.113	1.641
89	DC-N15	1108053.839	587788.823	1.533
90	DC-N16	1108202.689	587864.822	1.837
91	DC-N17	1108284.204	588008.211	1.525
92	DC-N18	1108296.604	588067.097	1.749
93	DC-N19	1108402.905	587970.859	1.601
94	DC-N20	1108480.720	587898.426	1.832
95	DC-N21	1108553.389	587829.616	1.867
96	DC-N22	1108593.048	587767.183	1.656
97	DC-N23	1108675.135	587720.397	1.684
98	DC-N24	1108762.785	587639.219	1.913
99	DC-N25	1108704.140	587595.522	1.745
100	DC-N26	1108642.250	587628.685	1.935
101	DC-N27	1108601.434	587565.413	1.912
102	DC-N28	1108543.781	587509.118	1.783
103	DC-N29	1108495.467	587462.803	1.875
104	DC-N30	1108427.235	587371.535	1.739
105	DC-N31	1108376.485	587334.266	1.709
106	DC-N32	1108442.224	587281.480	1.488

No	Name	Coordinate		Elevation
		X (m)	Y (m)	(m)
107	DC-N33	1108417.382	587185.189	1.374
108	DC-N34	1108402.565	587095.690	1.704
109	DC-N35	1108307.089	587046.058	1.977
110	DC-N36	1108263.490	587095.130	2.014
111	DC-N37	1108205.509	587064.170	1.906
112	DC-N38	1108183.586	587028.260	1.983
113	DC-N39	1108204.663	586937.127	1.581
114	DC-N40	1108212.750	586884.021	1.504
115	DC-N41	1108174.051	586813.581	1.510
116	DC-N42	1108132.722	586795.491	1.598
117	DC-N43	1108081.415	586754.187	1.581
118	DC-N44	1108033.533	586739.875	1.513
119	DC-N45	1107990.150	586700.497	1.434
120	DC-N46	1107927.505	586687.570	1.718
121	DC-N47	1107890.387	586656.820	1.559
122	DC-N48	1107899.095	586598.546	1.675
123	DC-N49	1107852.721	586626.672	1.643
124	DC-N50	1107743.602	586637.847	1.765
125	DC-N51	1107671.066	586546.409	1.506
126	DC-N52	1107637.494	586424.071	1.457
127	DC-N53	1107549.792	586290.744	1.217
128	DC-N54	1107531.903	586164.436	1.120
129	DC-N55	1107367.501	586019.914	1.425
130	DC-N56	1107262.592	585907.558	1.911
131	DC-N57	1107210.706	585842.650	1.371
132	DC-N58	1107165.485	585843.031	1.647
133	DC-N59	1107157.021	585745.188	1.610
134	DC-N60	1107075.466	585660.635	1.722
135	DC-N61	1107054.534	585559.761	1.716
136	DC-N62	1106961.468	585531.047	1.502
137	DC-N63	1106886.323	585453.473	1.562
138	DC-N64	1106851.102	585376.154	1.656
139	DC-N65	1106853.236	585269.218	1.465
140	DC-N66	1106811.153	585131.167	1.572
141	DC-N67	1106669.916	585158.100	1.411
142	DC-N68	1106569.163	585117.337	1.902

No	Name	Coordinate		Elevation
		X (m)	Y (m)	(m)
143	DC-N69	1106444.398	585104.029	1.534
144	DC-N70	1106323.214	585154.675	1.299
145	DC-N71	1106243.108	585078.093	1.403
146	DC-N72	1106281.749	584942.752	1.277
147	DC-N73	1106266.716	584812.474	1.268
148	DC-N74	1106269.963	584529.483	1.163
149	DC-N75	1106293.644	584383.516	1.551
150	DC-N76	1106204.074	584292.297	1.326
151	DC-N77	1106133.519	584166.927	1.294
152	DC-N78	1106042.637	584070.589	1.491
153	DC-N79	1105960.076	583989.167	1.633
154	DC-N80	1105988.462	583903.527	1.593
155	DC-N81	1105938.449	583836.264	1.347
156	DC-N82	1105856.030	583796.782	1.226
157	DC-N83	1105849.119	583645.437	1.370
158	DC-N84	1105773.465	583535.219	1.387
159	DC-N85	1105683.874	583449.914	1.294
160	DC-N86	1105634.457	583286.743	1.553
161	DC-N87	1105564.975	583219.330	2.325
162	DC-N88	1105477.456	583117.526	1.375
163	DC-N89	1105440.389	582977.182	1.378
164	DC-N90	1105323.909	582843.841	1.590
165	DC-N91	1105350.017	582688.187	1.397
166	DC-N92	1105359.931	582606.083	1.368
167	DC-N93	1105353.513	582502.603	1.397
168	DC-N94	1105294.320	582350.528	1.310
169	DC-N95	1105168.944	582338.537	1.397
170	DC-N96	1105060.872	582273.995	1.485
171	DC-N97	1104942.647	582262.409	1.377
172	DC-N98	1104957.407	582142.326	1.127
173	DC-N99	1104821.332	582140.713	1.239
174	DC-N100	1104711.148	582113.074	0.968
175	DC-N101	1104626.087	582063.323	1.169
176	DC-N102	1104528.727	581994.290	1.552
177	DC-N103	1104528.563	581921.151	1.514





Appendix 3

BASIC DESIGN

3.1	*REPORT ON THE REASONS OF ROUTE RE-ALIGNMENT AND WIDENING OF THE CENTRAL SPAN OF MAIN BRIDGE, 5 NOVEMBER 1999*	*A3-1*
3.2	*DESIGN VEHICLE LIVE LOAD*	*A3-6*
3.3	*DESIGN CRITERIA ON THE DETAILED DESIGN, SEPTEMBER 1999*	*A3-22*

3.1 Report on the Reasons of Route Re-Alignment and Widening of the Central Span of Main Bridge, 5 November 1999

NIPPON KOEI CO., LTD.
Consulting Engineers

The DETAILED DESIGN of The Can Tho Bridge Construction Project in Socialist Republic of Viet Nam, JICA.

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LETTER

Ref. No. FKOCO/052/99'

Date 05th November 1999

TO :	MR. LE LONG DINH	**FROM :**	MR. KOJI ENOMOTO
	Director General of PMU-My Thuan		Team Leader, JICA Study Team
COPY TO:	MR. NGUYEN XUAN HIEP		
	Manager, Bridge Projects Management Divs.		

Subject : **Report on the Reasons of Route Re-Alignment and Widening of the Central Span of Main Bridge**

Dear Sir,

Thank you for your all arrangements for the Basic Design Meeting (13rd October 1999) in Ha Noi.

Please find the attached report on the reasons for Route Re-Alignment and Widening the Central Span of Main Bridge for the Detailed Design of the Can Tho Bridge Construction, which were prepared following the conclusions at the above Meeting.

Yours sincerely,

榎本仰治

KOJI ENOMOTO
Team Leader
D/D of Can Tho Bridge Construction
in Socialist Republic of Viet Nam.

Attachment: - Report on the Reasons ...(English & Vietnamese version)
- Control Point of Final Centerline (No.1-No.3)
- Riverbed Change and Flow Velocity

Nippon Koei Co., Ltd. Consulting Engineers
Registered in England and Japan No. 958024

REPORT ON THE REASONS OF ROUTE RE-ALIGNMENT AND WIDENING THE CENTRAL SPAN OF MAIN BRIDGE

1. *Replacement project route*

The replacement route includes two intersections at the beginning and end of the route connecting to N.H No.1; two sides of approach bridges and main bridge parallel with the Feasibility Study (F/S) Route, but downstream 220m on the Hau River.

The main reasons for the change is that in the F/S Stage detailed topographic maps were not available except for major site locations. In F/S Stage, Route C was chosen (one of three routes A,B,C) primary for comparison and selection of the best route in this Detailed Design (D/D) Stage.

When implementing the Basic Design (in D/D Stage), the following problems need to be addressed:

- The beginning and end points of the route connecting to N.H No.1, should choose convenient locations with acceptable curve radius, with interchanges replacing intersections (F/S Stage) and avoiding removal housing of residents on both sides of NH.No.1.
- The route has been moved downstreams on both sides of the bridge to avoid 21 locations which can not be passed over (see the attached drawing of the two routes). The control areas to be avoided include: army areas, pagodas, graves, dense habitation ares, hospital, school, gasoline station, shipyard and especially the location of the new urban master plan of Binh Minh District (Vinh Long) and Can Tho City which were approved by the Government.
- The river cross-section on the re-located route has the same natural conditions such as geotechnical, riverbed form, hydraulic and hydrology; so it will not change the structure of the foundations and increase the construction cost. Moreover, it reduces the negative impacts to social and environmental aspects.

2. *Widening the span of main bridge.*

The central span length of main bridge in the F/S Stage was 500m. This should be widened to 550m for the following reasons:

- The tower pier on the Can Tho side is located in the river near the main flow section of the river channel. There are some disadvantages to this, as discussed following:

+ The tower pier in the F/S is located near the existing navigation channel for big vessels which will affect the navigable course of big vessels after construction of bridge. For guarantee of safety for navigable course of vessels, the bridge should be shifted toward the Can Tho side (see the map of this river section of South Marine Safety Company issued 1999). Therefore, the tower pier should be moved to the Can Tho side as far as possible from the channel.

+ The tower pier is located near the scour hole of the riverbed (see in cross section of riverbed) in the deep section with maximum flow velocity. Therefore, the tower pier should be moved as far as possible from the scour hole to the Can Tho side.

- There are two alternatives for achieving these requirements:

a) Keep the 500m span (F/S) and move the two tower piers towards the Can Tho side, unless this arrangement, the tower pier on the Vinh Long side would also be located in the river with higher scour velocities.

b) Keeping the location of the tower pier on the Vinh Long side on the river bank, and move the tower pier in the river toward the Can Tho side by lengthening the central span of bridge.

- If the pier on the Vinh Long side is moved into the river as alternative a), it would not be safe and construction in the river would be difficult. This would increased construction cost and require a longer construction period. Therefore, the Consultants suggest lengthening the central span length by 50m as alternative b), resulting in the central span length of 550m. This means that the length of the main span bridge of 550m is more suitable from the technical and economical aspects.

THUYẾT MINH VỀ LÝ DO DỊCH CHUYỂN TUYẾN VÀ MỞ RỘNG KHẨU ĐỘ NHỊP CẦU CHÍNH

1.-*Về dịch chuyển tuyến* .

Việc dịch chuyển tuyến bao gồm hai nút giao đầu và cuối tuyến nối với QL1; đoạn hai đầu cầu và cầu chính được dịch song song với tuyến của dự án khả thi xuống phía hạ lưu sông Hậu là 220m.

Lý do chủ yếu là ở bước Nghiên cứu khả thi (NCKT) chưa có bình đồ chi tiết, ngoài những điểm khống chế chính yếu, còn lại chưa được kiểm tra kỹ ở hiện trường như ở bước Thiết kế chi tiết. Ở bước NCKT tuyến được chọn là tuyến C (một trong 3 tuyến A,B,C) và chỉ là tuyến sơ bộ để so sánh chọn tuyến tối ưu trong bước này.

Đến nay, khi triển khai Thiết kế cơ bản (trong bước Thiết kế chi tiết) gặp một số điểm có tính chất khống chế sau đây cần phải dịch chuyển tuyến:

- Ở hai điểm đầu và cuối tuyến nối vào QL1 phải chọn vị trí thuận lợi về hướng tuyến ở điểm nối, với bán kính cong cho phép, nút giao thiết kế khác mức nên không còn đồng mức như ở bước NCKT và phải tránh khu nhà kiên cố của dân tập trung hai bên QL1.

- Ở hai đầu cầu, tuyến phải lui xuống phía hạ lưu để tránh tới 21 vị trí có khó khăn không thể vượt qua được (xin xem bản vẽ so sánh hai tuyến kèm theo). Các điểm khống chế đó là: doanh trại quân đội, đình, chùa, khu mồ mả tập trung, khu dân cư đông đúc, bệnh viện, trường học, bến xăng dầu, xưởng đóng thuyền và đặc biệt là phải nối với đường trong khu quy hoạch phát triển đô thị mới của huyện Bình Minh (Vĩnh Long) và của Thành phố Cần Thơ đã được Chính phủ phê duyệt.

Việc dịch chuyển tuyến này ở trên một đoạn sông đồng nhất về các điều kiện tự nhiên theo chiều dọc sông như về địa chất công trình, địa hình lòng sông, chế độ thủy văn, thủy lực; vì thế không làm thay đổi kết cấu nền móng và ảnh hưởng đến giá thành công trình mà còn giảm được chi phí đền bù và tránh được tác động xấu về mặt xã hội và môi trường.

2.-*Việc mở rộng khẩu độ nhịp cầu chính.*

Nhịp cầu chính ở NCKT có khẩu độ là 500m nay đề nghị mở rộng ra 550m vì những lý do sau:

- Trụ tháp phía Cần Thơ nằm ở dưới lòng sông gần giữa dòng chủ lưu. Ở vị trí đó có những bất lợi sau:

+ Trụ nằm ngay trên tim luồng tàu biển hiện tại và sẽ quá gần luồng trong tương lai (sau khi xây dựng cầu). Để tàu biển vận hành an toàn, cần phải dịch trụ về phía Cần Thơ càng xa luồng càng tốt (xin xem bình đồ luồng tàu đoạn sông này của C/ty Bảo đảm an toàn hàng hải phía Nam lập năm 1999 kèm theo),

+ Trụ nằm sát mép hố xói của lòng sông (xin xem mặt cắt ngang lòng sông ở đoạn này kèm theo) và đây cũng là điểm có lưu tốc dòng chảy lớn nhất phân bố theo chiều ngang, do đó cũng cần dịch về phía Cần Thơ càng xa hố xói càng tốt.

- Có hai giải pháp được chọn:

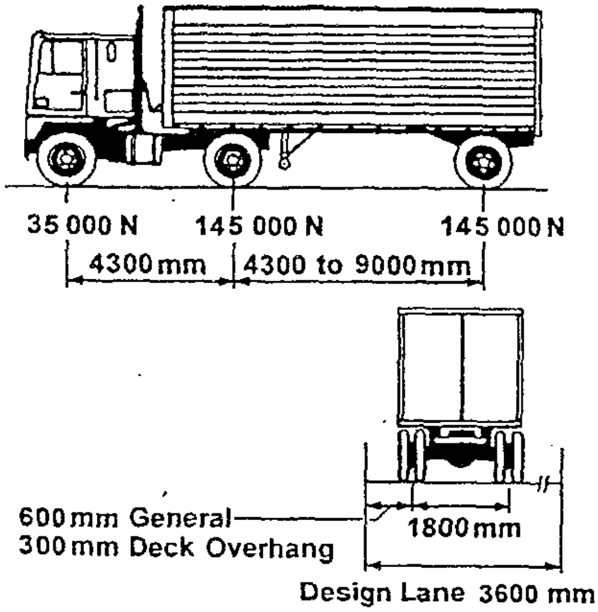
a) Giữ nguyên khẩu độ 500m như ở bước NCKT và dịch cả hai trụ về phía Cần Thơ, như vậy trụ trên bờ Vĩnh Long sẽ bị đưa xuống ngay lòng sông sâu và đang xói lở mạnh.

b) Giữ nguyên vị trí trụ trên bờ Vĩnh Long, dịch trụ dưới sông về phía Cần Thơ bằng cách mở rộng thêm khẩu độ cầu chính.

- Vì trụ trên bờ Vĩnh Long không nên đưa xuống sông sẽ không an toàn và khó thi công, tốn kém rất nhiều và kéo dài thời gian thi công giải pháp a). Do đó Tư vấn thiết kế đề nghị mở rộng khẩu độ nhịp cầu chính thêm 50m giải pháp b), do đó nhịp chính của cầu có chiều dài 550m và chiều dài đó có thể chấp nhận được về kỹ thuật và kinh tế.

3.2 Design Vehicle Live Load

a) AASHTO 1998(LRFD)
(AASHTO LRFD BRIDGE DESIGN SPECIFICATION 1998)



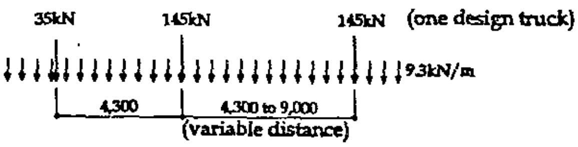
Dynamic Load Allowance

33% for Design Truck and Design Tandem

Multiple Presence of Live Load

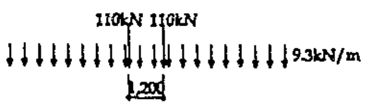
1 lane : 1.20
2 lanes : 1.00
3 lanes : 0.85
>3 lanes : 0.65

Design Truck(+ Impact 33%) + Design Lane Load(no Impact)



or

Design Tandem(+ Impact 33%) + Design Lane Load(no Impact)

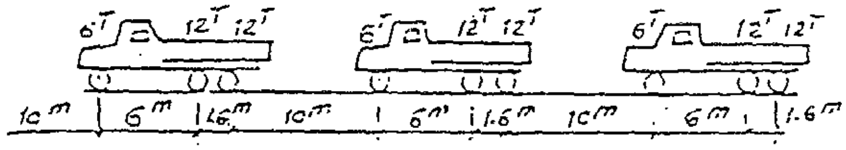


AASHTO LRFD DESIGN SPECIFICATION 1998	Design Vehicular Live Load (AASHTO 1998)
	(1)

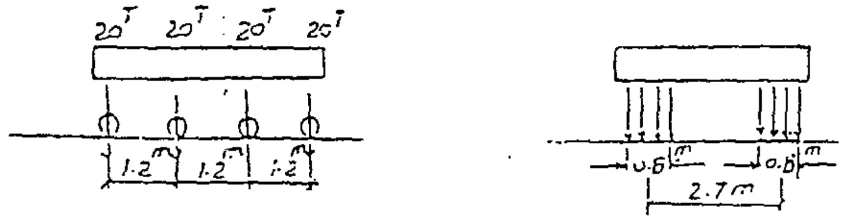
b) H-30,XB-80

(VIETNAMES BRIDGE DESIGN CODE SPECIFICATION 2057/QD-KT4-1979)

The H-30 loading consists of trucks with unlimited number, the weight of each truck is 30 tons and they are arrange as illustrated in figure below:



The XB-80 loading consists especial heavy truck-80 tons in weight as illustrated in figure below:



Whenever a special heavy truck is placed, no other normal trucks and pedestrians are allowed to be placed simultaneously.

Over Load Factor

H-30 : 1.4
XB-80 : 1.1

Dynamic Load Allowance

H-30

L =< 5 : 30%
L => 45 : 10%
5 < L < 45 : 10%-30%
(L : Length of Influence Line)

XB-80

0%

Multiple Presence of Live Load

H-30

L =< 25
K = 1

L > 25
K = 1 : 1 lane
K = 0.9 : 2 lanes
K = 0.8 : 3 lanes
K = 0.7 : =>4 lanes

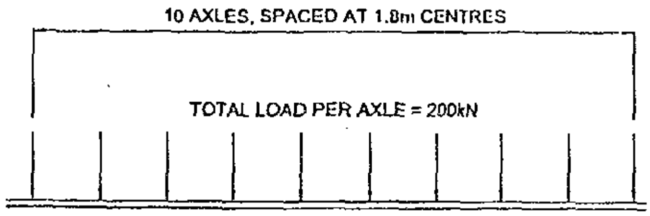
XB-80

1 car / span
K = 1

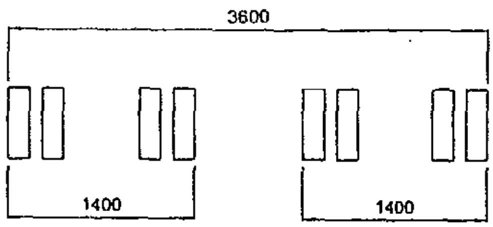
c)HLP200

(AUSTROADS Bridge Design Code 1992)

HLP200

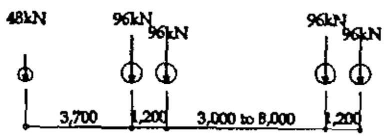


ELEVATION OF HLP VEHICLE

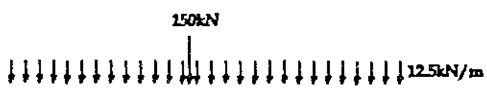


END VIEW OF HLP200 VEHICLE

T44



L44



Dynamic Load Allowance

HLP200

10%

T44 and L44

40%(22m) - 20%(60m)

Multiple Presence of Live Load

For T44 and L44

1 lane : 1.0
2 lanes : 0.9
3 lanes : 0.8
4 lanes : 0.7
=>5 lanes : 0.6

Appication of Design Live Load for My Thyan Bridge

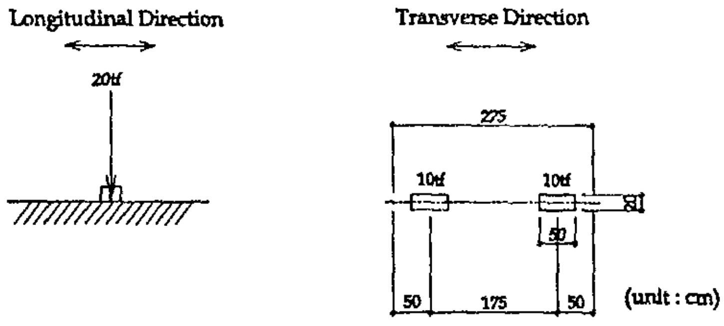
HLP200(1lane) + 50% x L44 x 2Lanes (2Lanes / 1direction) → (3Lanes / 1direction)

In case of Can Tho Bridge

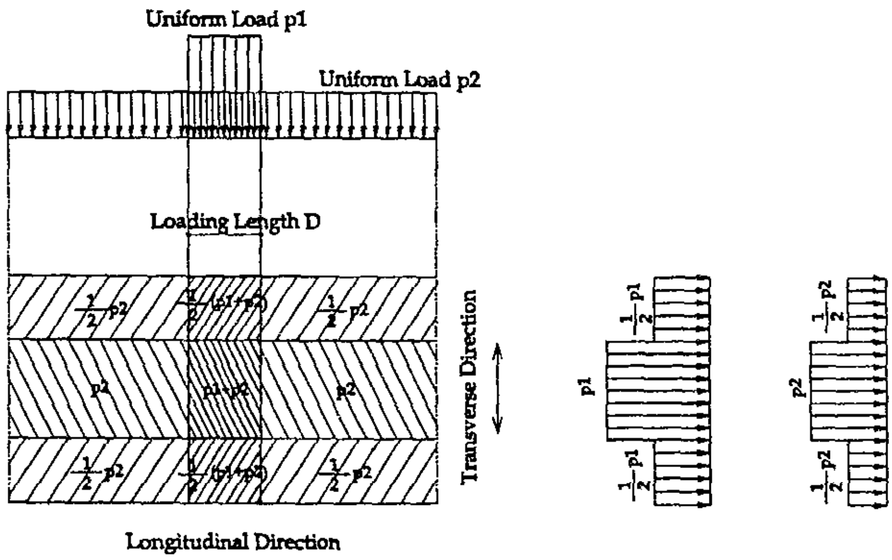
AUSTROADS Bridge Design Code 1992	Design Vehicular Live Load (MY THUAN BRIDGE Australian Code)
	(3)

d) B-LOAD

(SPECIFICATIONS FOR HIGHWAY BRIDGE 1996 JAPANESE STANDARD)



T-Loadings



L-Loadings

L-Loadings(B-Live Loads)

Main Loads (up to 5.5 meters in width)						Sub Loads
Uniform Load p1			Uniform Load p2			
Loading Length D(m)	Load(kgf/m2)		Load(kgf/m2)			
	For Moment	For Shear	L =< 80	80 < L =< 130	L > 130	
10	1,000	1,200	350	430-L	300	50% of Main Loads

L : Span Length(m)

Dynamic Load Allowance

$$\text{Impact} = \frac{10}{25 + L}$$ (For Prestressed Concrete Bridge)

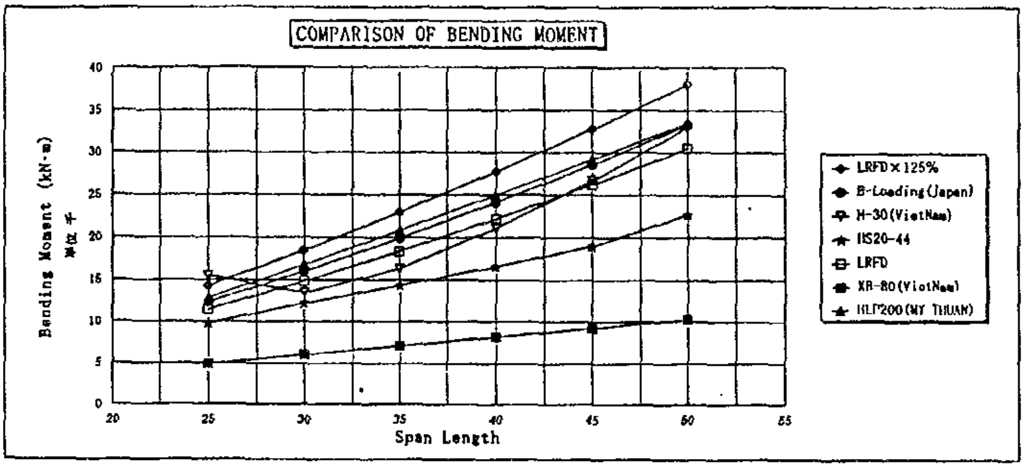
SPECIFICATIONS FOR HIGHWAY BRIDGES 1996 (JAPANESE STANDARD)

Design Vehicular Live Load (Japan)

(4)

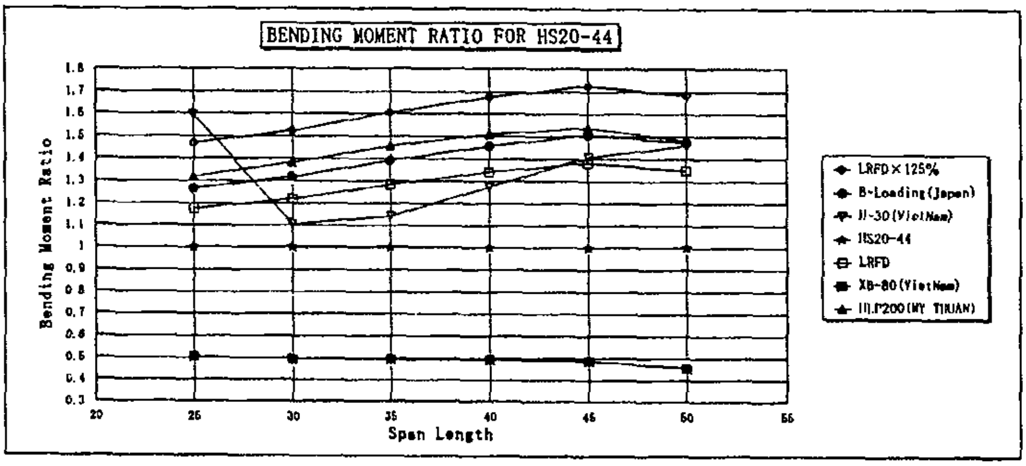
COMPARISON OF BENDING MOMENT — 6 lanes, except B-Loading, XB-80 and HLP200

Span Length (m) (Simple Beam)	(1) LRFD×125% (LRFD 1998) (kN・m)	(2) B-Loading (JAPAN) (kN・m)	(3) H-30 (VietNam) (kN・m)	(4) HS20-44 (AASHTO) (kN・m)	(5) LRFD (LRFD 1998) (kN・m)	(6) XB-80 (VietNam) (kN・m)	(7) HLP200 (MY THUAN) (kN・m)
25	14203	12261	15436	9700	11362	4873	12774
30	18397	15909	13345	12099	14718	5951	16706
35	22873	19827	16251	14281	18298	7029	20747
40	27631	24015	21004	16517	22105	8107	24880
45	32671	28484	26596	18949	26137	9185	29108
50	38001	33218	32904	22605	30401	10263	33416



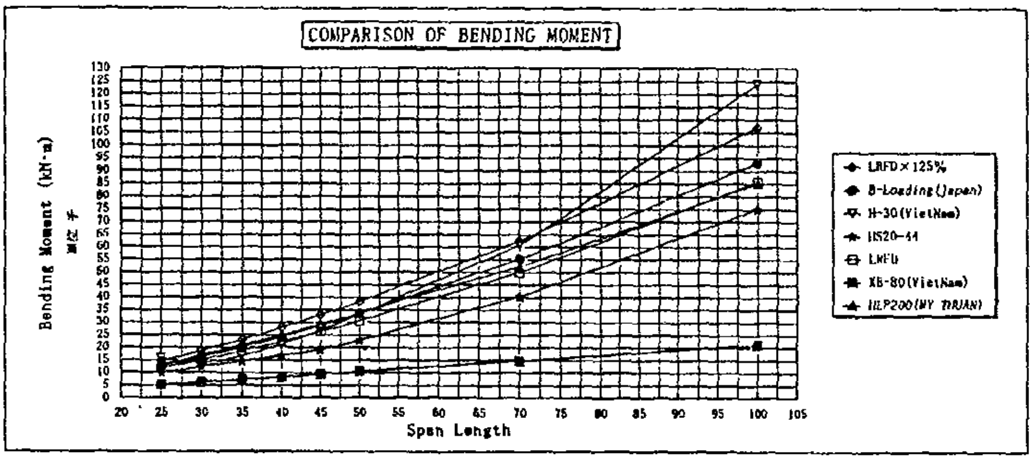
BENDING MOMENT RATIO FOR HS20-44 — 6 lanes, except B-Loading, XB-80 and HLP200

Span Length (m)	(1) LRFD×125% (LRFD 1998)	(2) B-Loading (JAPAN)	(3) H-30 (VietNam)	(4) HS20-44 (AASHTO)	(5) LRFD (LRFD 1998)	(6) XB-80 (VietNam)	(7) HLP200 (MY THUAN)
25	1.46	1.26	1.59	1	1.17	0.50	1.32
30	1.52	1.31	1.10	1	1.22	0.49	1.38
35	1.60	1.39	1.14	1	1.28	0.49	1.45
40	1.67	1.45	1.27	1	1.34	0.49	1.51
45	1.72	1.50	1.40	1	1.38	0.48	1.54
50	1.68	1.47	1.46	1	1.34	0.45	1.48



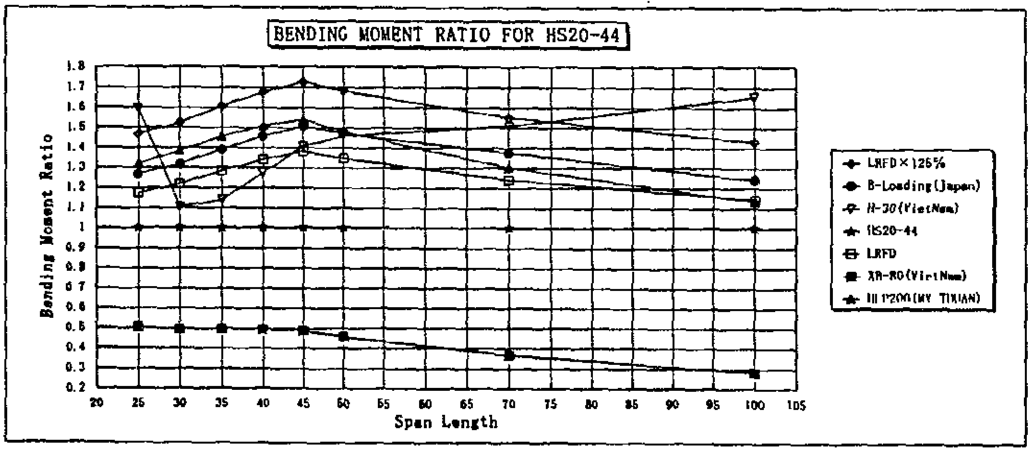
COMPARISON OF BENDING MOMENT 6 lanes , except B-Loading and XB-80

Span Length (m) (Simple Beam)	(1) LRFD×125% (LRFD 1998) (kN・m)	(2) B-Loading (JAPAN) (kN・m)	(3) H-30 (VietNam) (kN・m)	(4) HS20-44 (AASHTO) (kN・m)	(5) LRFD (LRFD 1998) (kN・m)	(6) XB-80 (VietNam) (kN・m)	(7) HLP200 (MY THUAN) (kN・m)
25	14203	12261	15436	9700	11362	4873	12774
30	18397	15909	13345	12099	14718	5951	16706
35	22873	19827	16251	14281	18298	7029	20747
40	27631	24015	21004	16517	22105	8107	24880
45	32671	28484	26596	18949	26137	9185	29108
50	38001	33218	32904	22605	30401	10263	33416
70	62138	55038	60393	40108	49710	14575	52056
100	106843	92853	123697	74924	85471	21013	8192[illegible]



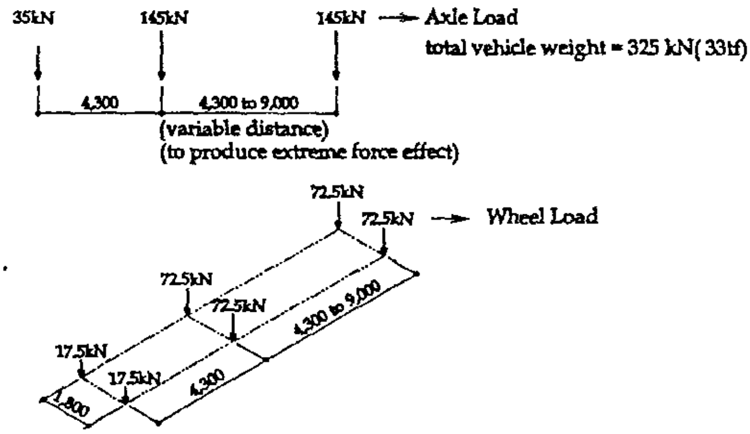
BENDING MOMENT RATIO FOR HS20-44 6 lanes , except B-Loading and XB-80

Span Length (m)	(1) LRFD×125% (LRFD 1998)	(2) B-Loading (JAPAN)	(3) H-30 (VietNam)	(4) HS20-44 (AASHTO)	(5) LRFD (LRFD 1998)	(6) XB-80 (VietNam)	(7) HLP200 (MY THUAN)
25	1.46	1.26	1.59	1	1.17	0.50	1.32
30	1.52	1.31	1.10	1	1.22	0.49	1.38
35	1.60	1.39	1.14	1	1.28	0.49	1.45
40	1.67	1.45	1.27	1	1.34	0.49	1.51
45	1.72	1.50	1.40	1	1.38	0.48	1.54
50	1.68	1.47	1.46	1	1.34	0.45	1.48
70	1.56	1.37	1.51	1	1.24	0.36	1.30
100	1.43	1.24	1.65	1	1.14	0.28	1.13

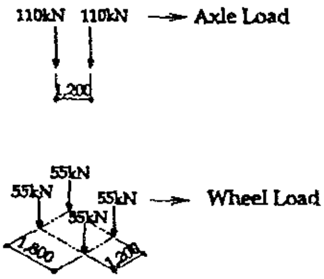


DESIGN VEHICULAR LIVE LOAD (AASHTO Article 3.6.1.2)

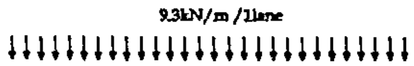
(1)Design Truck



(2)Design Tandem



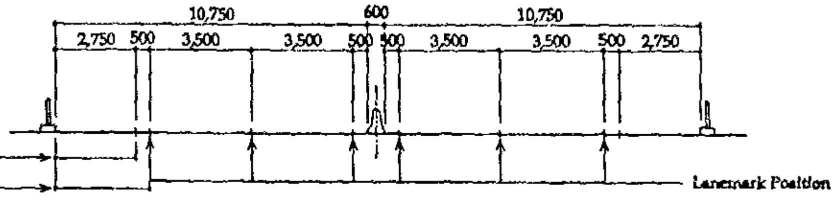
(3)Design Lane Load



THE DETAILED DESIGN OF THE CAN THO BRIDGE CONSTRUCTION IN SOCIALIST REPUBLIC OF VIET NAM	Figure Application of Design Live Load (AASHTO 1998) (1) JAPAN INTERNATIONAL COOPERATION AGENCY

A. DESIGN LOADS FOR GIRDER

Transverse Cross Section

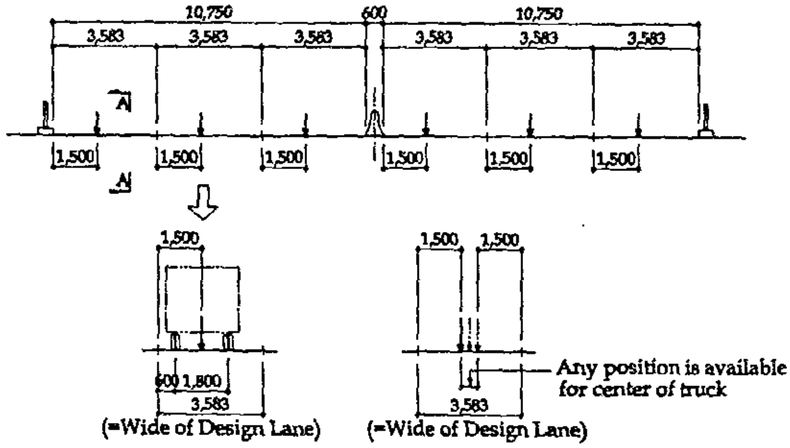


Vehicular Live Load is a case more critical than Pedestrian Load.
So we design Girder using Vehicular Live Load.

Design Lanes

Number of Design Lanes
n = 10750 / 3600 = 2.99 -> 3 Lanes/1direction

Wide of Design Lane
W = 10750 / 3 = 3583

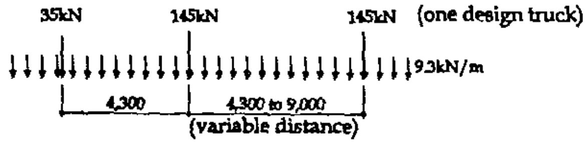


Loading of Design Vehicular Live Load (HL-93) A-A section (AASHTO Article 3.6.1.3.1)

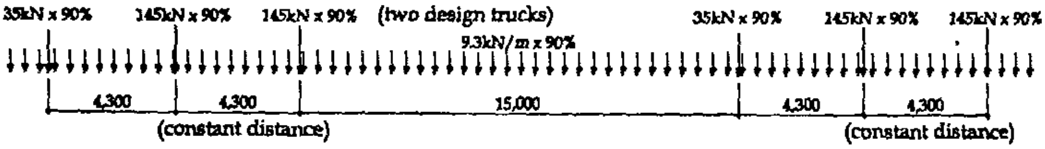
Vehicular live loading shall consist of a combination of the:
- Design truck or design tandem,and
- Design lane load.

Axles that do not contribute to the extreme force effect under consideration shall be neglected.

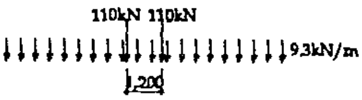
(1) Design Truck(+ Impact 33%) + Design Lane Load(no Impact)



Special Negative-moment Loading (For both negative moment and reaction at interior piers)



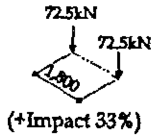
(2) Design Tandem(+ Impact 33%) + Design Lane Load(no Impact)



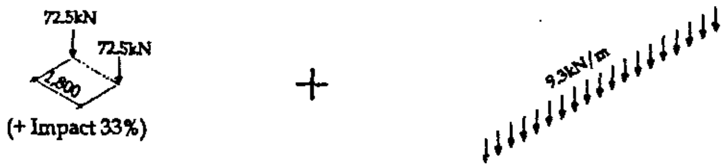
THE DETAILED DESIGN OF THE CAN THO BRIDGE CONSTRUCTION IN SOCIALIST REPUBLIC OF VIET NAM	Figure Application of Design Live Load (AASHTO 1998) (2) JAPAN INTERNATIONAL COOPERATION AGENCY

B. DESIGN LOADS FOR DECKS,DECK SYSTEMS (AASHTO Article 3.6.1.3.3)

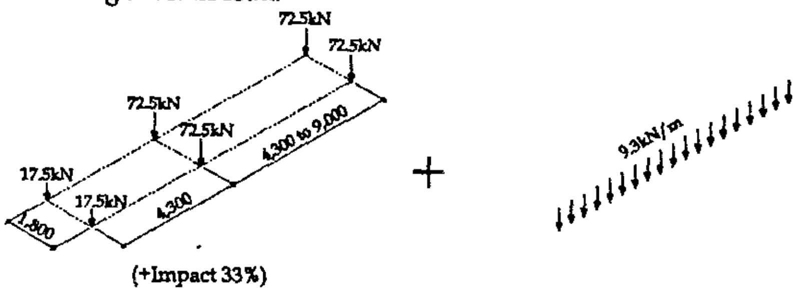
(1)Where primary strips are transverse and their span does not exceed 4600 mm - the transverse strips shall be designed for wheels of the 145kN axle.



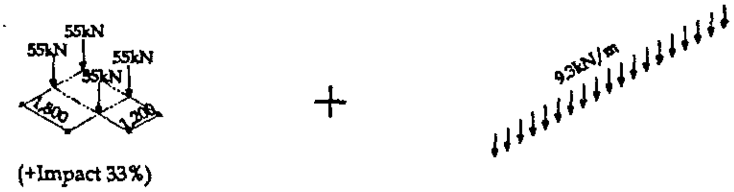
(2)Where primary strips are transverse and their span exceeds 4600 mm - the transverse strips shall be designed for the wheels of the 145 kN axle and the lane load.



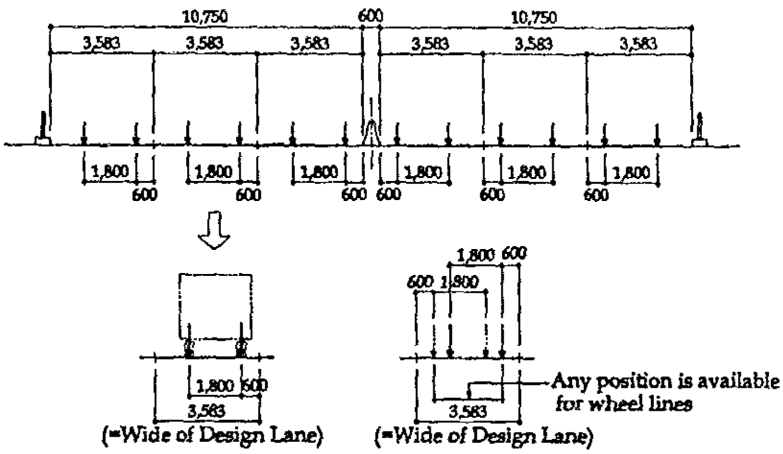
(3)Where primary strips are longitudinal - the transverse strips shall be designed for all loads including the lane load.



or

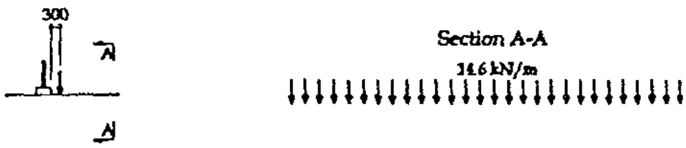


THE DETAILED DESIGN OF THE CAN THO BRIDGE CONSTRUCTION IN SOCIALIST REPUBLIC OF VIET NAM	Figure	Application of Design Live Load (AASHTO 1998) (3)
	JAPAN INTERNATIONAL COOPERATION AGENCY	



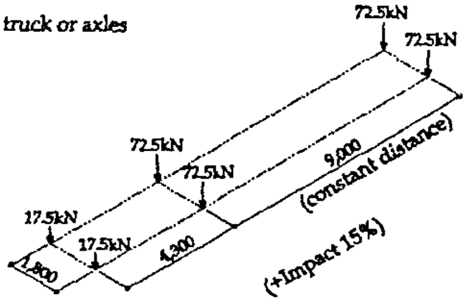
THE DETAILED DESIGN OF THE CAN THO BRIDGE CONSTRUCTION IN SOCIALIST REPUBLIC OF VIET NAM	Figure Application of Design Live Load (AASHTO 1998) (4) JAPAN INTERNATIONAL COOPERATION AGENCY

C. DESIGN LOAD FOR DECK OVERHANG (AASHTO Article 3.6.1.3.4)

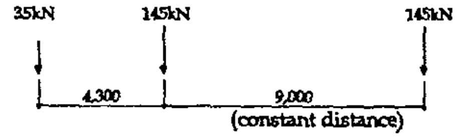


D. FATIGUE LOAD (AASHTO Article 3.6.1.4.1)

One design truck or axles

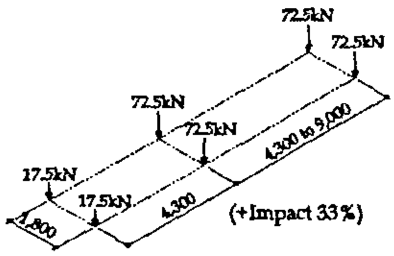


or



E. Loading for Optional Live Load Deflection Evaluation (AASHTO 3.6.1.3.2)

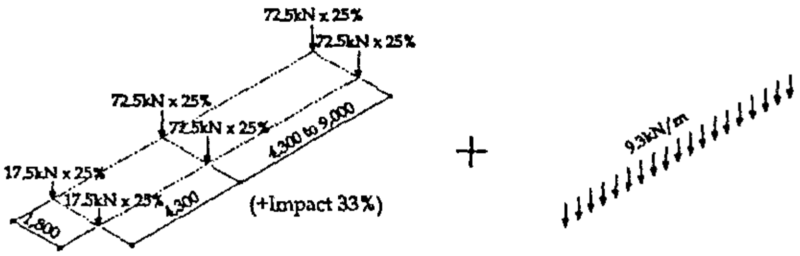
Live-load deflectin is checked using the live-load portion of the SERVICE I load combination including the appropriate dynamic load allowance.



The deflection should be taken as the larger of:

- That resulting from the design truck alone, or
- That resulting from 25 percent of the design truck taken together with the design lane load.

or



THE DETAILED DESIGN OF THE CAN THO BRIDGE CONSTRUCTION IN SOCIALIST REPUBLIC OF VIET NAM	Figure Application of Design Live Load (AASHTO 1998) (5)
	JAPAN INTERNATIONAL COOPERATION AGENCY

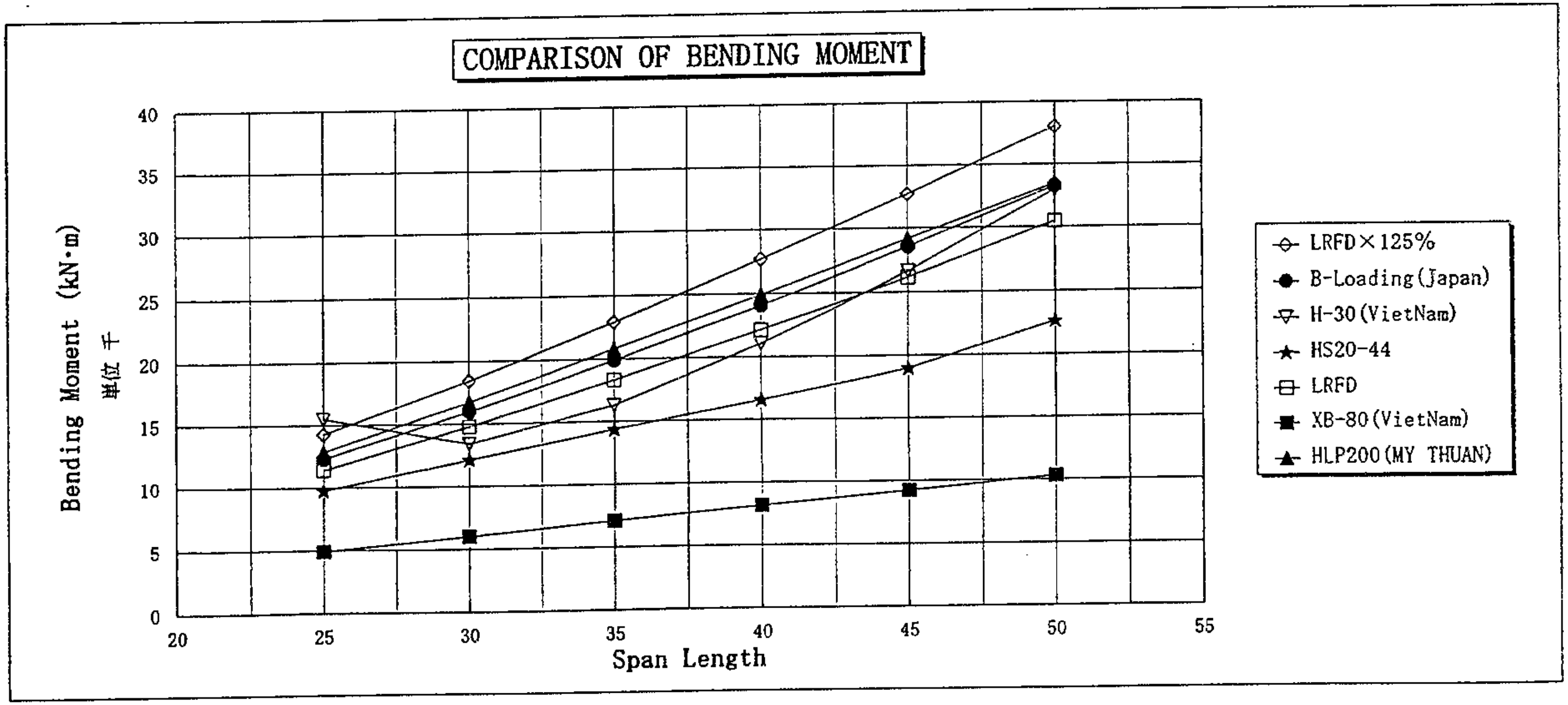
MULTIPLE PRESENCE OF LIVE LOAD (AASHTO Article 3.6.1.1.2)

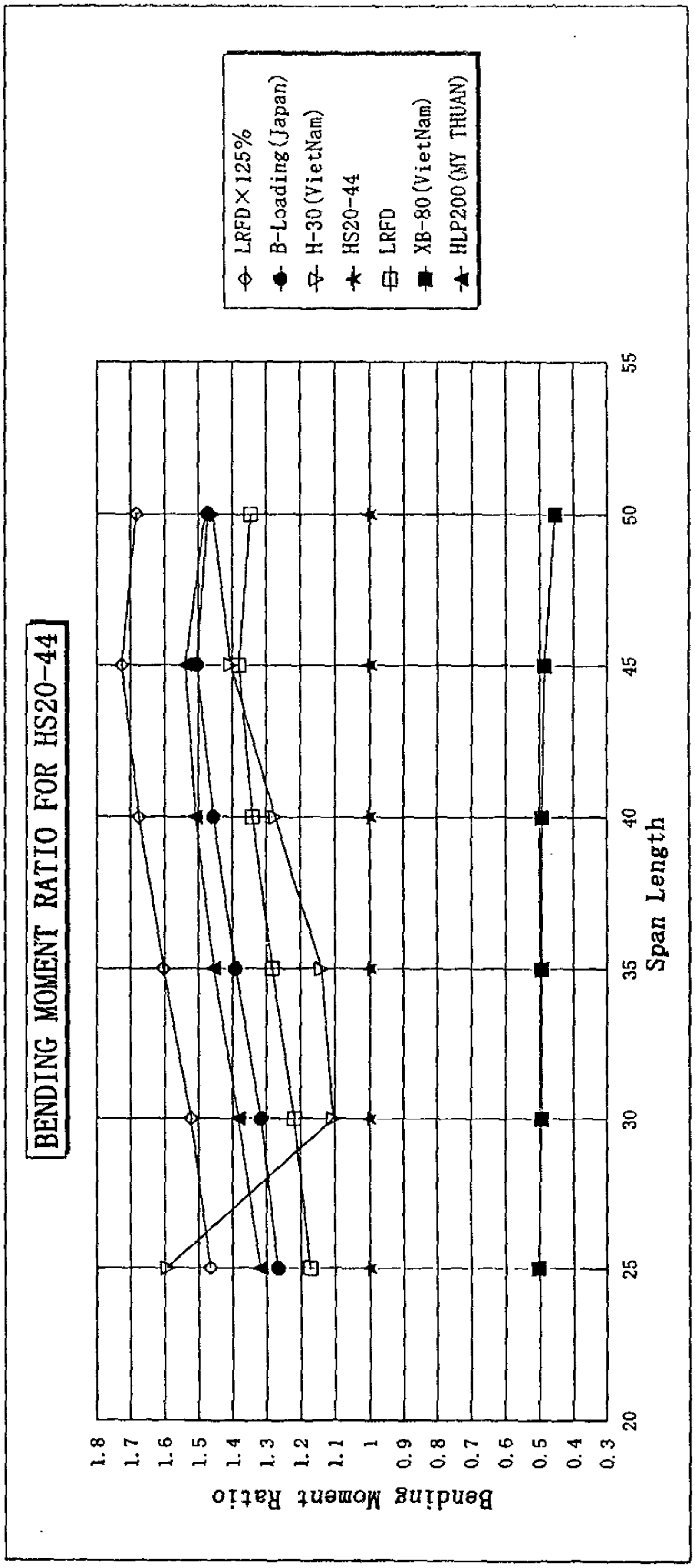
Number of Loaded Lanes	Multiple Presence Factors "m"
1	1.20
2	1.00
3	0.85
>3	0.65

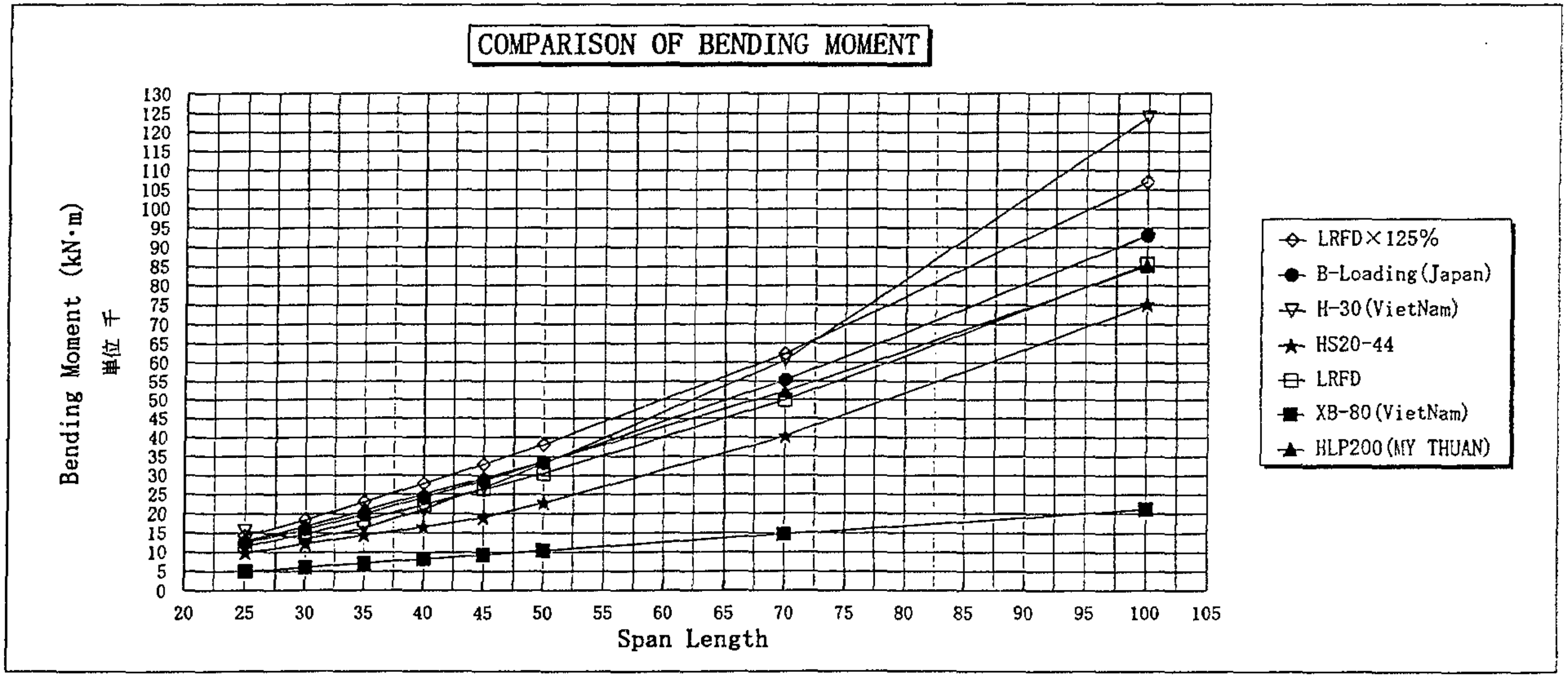
THE DETAILED DESIGN OF
THE CAN THO BRIDGE CONSTRUCTION
IN SOCIALIST REPUBLIC OF VIET NAM

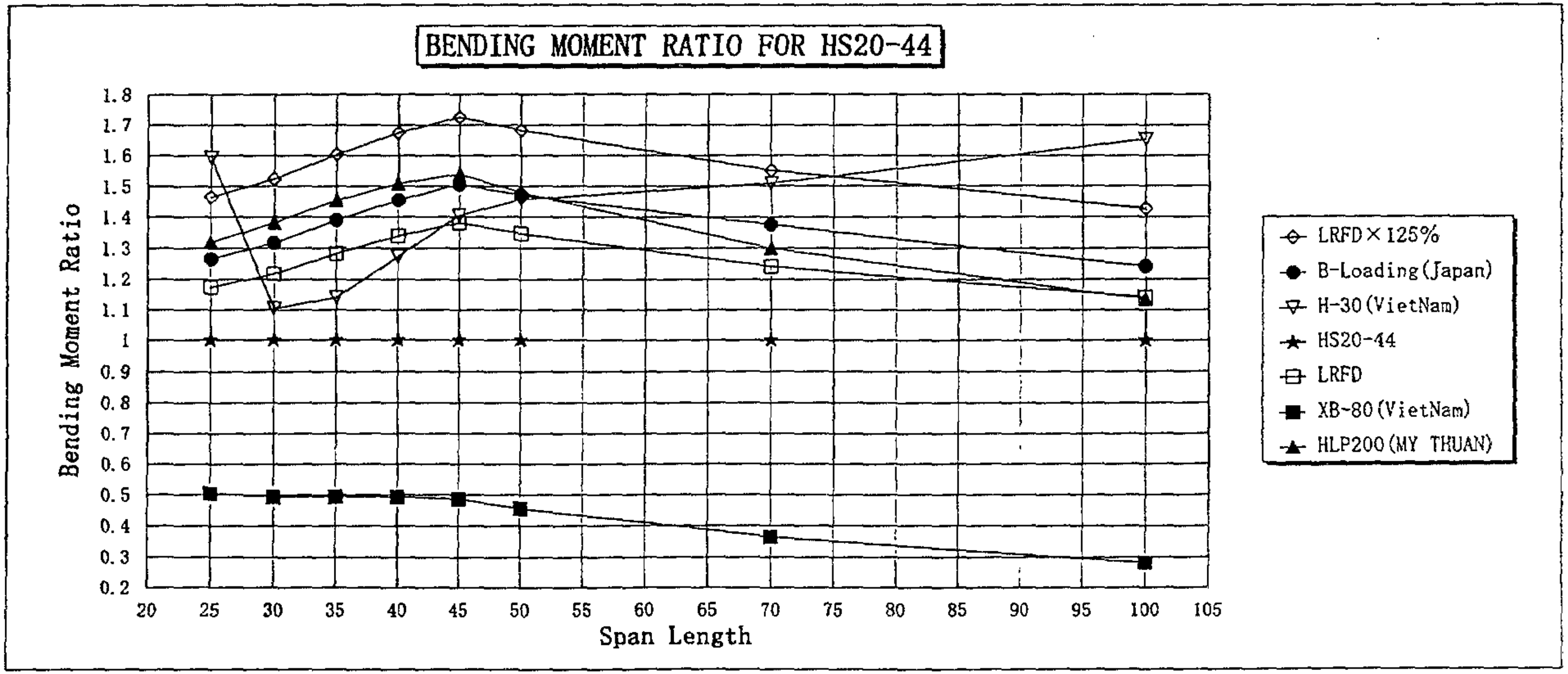
Figure Application of Design Live Load (AASHTO 1998) (6)

JAPAN INTERNATIONAL COOPERATION AGENCY


COMPARISON OF BENDING MOMENT
Bending Moment (kN·m)
単位 千
40
35
30
25
20
15
10
5
0
20
25
30
35
40
45
50
55
Span Length
LRFD×125%
B-Loading(Japan)
H-30(VietNam)
HS20-44
LRFD
XB-80(VietNam)
HLP200(MY THUAN)


BENDING MOMENT RATIO FOR HS20-44
LRFD×125%
B-Loading(Japan)
H-30(VietNam)
HS20-44
LRFD
XB-80(VietNam)
HLP200(MY THUAN)
Bending Moment Ratio
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
Span Length
20
25
30
35
40
45
50
55


COMPARISON OF BENDING MOMENT
Bending Moment (kN·m)
単位 千
130
125
120
115
110
105
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
105
Span Length
LRFD×125%
B-Loading(Japan)
H-30(VietNam)
HS20-44
LRFD
XB-80(VietNam)
HLP200(MY THUAN)


BENDING MOMENT RATIO FOR HS20-44
Bending Moment Ratio
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
105
Span Length
LRFD×125%
B-Loading(Japan)
H-30(VietNam)
HS20-44
LRFD
XB-80(VietNam)
HLP200(MY THUAN)

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

MINISTRY OF TRANSPORT
SOCIALIST REPUBLIC OF VIET NAM

DESIGN CRITERIA ON THE DETAILED DESIGN OF THE CAN THO BRIDGE CONSTRUCTION IN SOCIALIST REPUBLIC OF VIET NAM

I. HIGHWAY DESIGN
II. BRIDGE DESIGN

SEPTEMBER 1999

NIPPON KOEI CO., LTD.

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I. HIGHWAY DESIGN

1 DESIGN STANDARDS TO BE REFERRED

The Vietnamese geometric design standards to be applied for the project are the Highway Design Standards TCVN 4054-1998 (hereinafter referred to "TCVN4054").

Where no provisions exist in TCVN4054, the Consultant refers to the relevant standards of AASHTO (A Policy on Geometric Design of Highways and Streets, 1994) of United States, JRSO (Japan Road Structure Ordinance, 1983) of Japan.

2 HIGHWAY CLASSIFICATION

2.1 General

The TCVN4054 defines two highway classes, Administrative Class and Technical Class, as shown in Table 2-1, Table 2-2, and Table 2-3. The Administrative class is for the highway management, maintenance and operation works and the Technical Class is based on technical requirements for driver safety and comfort when vehicles operating at the design speed.

Table 2.1 Administrative Class of Highway Stipulated in TCVN4054

Administrative Class	Technical Class (TC)	Speed for Design (Km/h)	Lanes Required	Main Functions
I	80 or 60	80 or 60	6	Road connecting cultural, economic and politic centers
II			4	
III			2	
IV	60 or 40	60 or 40	2	Road connecting local cultural, economic and politic centers to highway or high speed
V	40 or 20	40 or 20	2 or 1	Road connecting places for commodity gathering and residence zones

Table 2.2 Technical Class of Highway Stipulated in TCVN4054

Technical Class	Speed for Design (Km/h)	Min. Traffic Volume (pcu)
80	80	≥ 3000
60	60	≥ 900
40	40	≥ 150
20	20	< 150

Table 2.3 Selection of Technical Class for a Highway according to its functions and topography

Functions Typical Natural Surface Slopes	Topography Plain <10%	 Hill 10-25%	 Mountain >25%
Highways that link big Economic, political, cultural centers together	80; 60	80; 60	60
Highways that link local economic, political, cultural centers and links with the main trunk road or expressway	80; 60	60; 40	40; 20
Highways that link with goods distribution Centers and Residential Sectors	40	40; 20	20

Note: Classification typical of existing ground as listed below:
Plain < 10% Hill 10 ÷ 25% Mountain > 25%

2.2 Classification for Highway Geometric Design

Administrative Class II is recommended for this project based on topographic condition, incorporation of the road in National Highway No.1 and also on the basis of the above Standard.

2.3 Design Speed

As the Can Tho Bridge will be incorporated in the re-alignment of National Highway No.1, it is recommended that a general design speed of 80 km/hr be adopted.

However, adoption of the design speed 80 km/hr on the confluence sections with the existing National Highway No.1 would relocate many houses, requiring significant amount of compensation. Therefore, it is recommended that the design speed be reduced from 80km/hr to 60km/hr at these locations.

Design speed for the interchange ramps are described in separate chapter.

3 GEOMETRIC DESIGN STANDARDS

Based on above concepts, understanding and study of the relevant data, the design standard for the highway was established and summarized in Table 3-1.

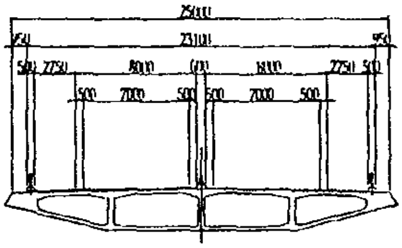
Table 3.1 Geometric Design Standard for Highway Design

Design Items			Unit	Type/Value		Reference
Basic Conditions	Class of Highway (Administrative -Technical)		-	II-80	II-60	TCVN4054
	Terrain		-	Plain		TCVN4054
	Design Speed		km/h	80	60	TCVN4054
	Design Vehicles		-	Truck with Trailer		TCVN4054
Cross Section Elements	Total Width		m	22.10 (23.10)		():*1
	Lane Number		-	4		
	Lane Width	Right side lane width	m	3.50		
		Left side lane width	m	3.50		
	Median Width	Total Width	m	1.60 (2.60)		
		Separator Width	m	0.60 (1.60)		
		Safety Portion	m	0.50		
	Sidewalk Width	Total Width	m	2.75		
		Separator Width	m	0.50		
	Shoulder Width	Paved Shoulder	m	0.50		
		Earthen Shoulder	m	0.50		
	Slop of Embankment		-	V:H=1:2.0		
Site Distance	Stopping Distance		m	100	75	TCVN4054
Horizontal Alignment	Minimum Radius	Super-elevation = 6%	m	250	125	TCVN4054
		Super-elevation = 4%	m	400	250	TCVN4054
	Minimum Curve Length	angular direction θ ≧7°	m	140	100	JRSO,AASHTO
		angular direction θ <7°	m	1000/ θ	700/ θ	JRSO
	Minimum Radius with Normal Cross Slope		m	1000	500	TCVN4054
	Transition Curve	Spiral Type	-	Clothoid		TCVN4054
		Minimum Length of Transition	m	50	40	AASHTO
		Minimum Radii w/o Transition	m	2,000	1,300	AASHTO
Vertical Alignment	Maximum Gradient		%	6.0	7.0	TCVN4054
	Minimum Radius of Vertical Curve	Crest	m	4,000	2,500	TCVN4054
		Sag	m	2,000	1,000	TCVN4054
	Minimum Length of Vertical Curve		m	50	40	AASHTO
	Critical Length of Grads	Less than 4.0%	m	No limit		TCVN4054
		For 4.0%	m	900	1,000	TCVN4054
		For 5.0%	m	700	800	TCVN4054
		For 6.0%	m	500	600	TCVN4054
		For 7.0%	m	-	400	TCVN4054
Cross Slope	Normal Cross Slope		%	2.0		TCVN4054
	Maximum Superelevation		%	6.0	6.0	TCVN4054
Clearance	Lateral Clearance		m	All paved width		TCVN4054
	Vertical Clearance		m	4.5		TCVN4054

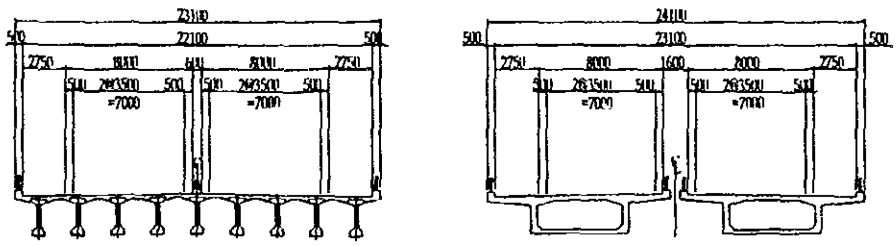
*1: ( )-See Chapter 4

4 TYPICAL CROSS SECTIONS

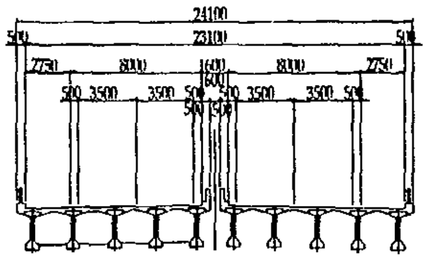
As a result of the review of the Feasibility Study and comparison with cross section of National Highway No.5, the Consultant proposes the cross sections shown in Figure 4.1.



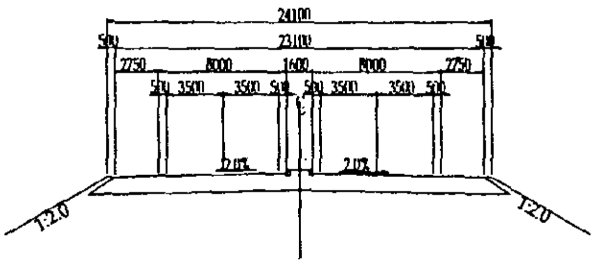
Main Bridge and Approach Span Bridge



(L ≧ 100m)
Minor Bridge in the Approach Road



(L < 100m)
Minor Bridge in the Approach Road



Road Embankment Section

Figure 4.1 Typical Cross Section

5 DETAILS OF DESIGN STANDARDS FOR HIGHWAY

5.1 Design Standards to be applied

The Vietnamese Highway Design Standards has been reviewed in comparison to AASHTO and JRSO.

TCVN4054 is proposed to be used as the basic highway design standard for the project. However, for some design elements the Consultant proposes to apply different values from AASHTO or JRSO as noted in Table 3-1.

5.2 Design Vehicles

The TCVN4054 has adopted design vehicles as shown in Table 5-1.

The Consultant proposes to apply the same design vehicles as stipulated in the TCVN4054.

Table 5.1 Dimension of Design Vehicles Stipulated in TCVN4054

Type	Length (m)	Width (m)	Height (m)	Front (m)	Rear (m)	2 axle distance (m)
Car	6	1.8	2	0.8	1.4	3.8
Truck	12	2.5	4	1.5	4	6.5
Trailer	16	2.5	4	1.2	2	4 - 8.8

5.3 Sight Distance

5.3.1 Criteria for Measuring Sight Distance

TCVN criteria for heights used in measurement of minimum sight distances are set out in Table 5-2, and the minimum sight distances are set out in Table 5-3.

However the highway for the project provides 2 lanes each way with a traffic separation barrier, hence the Consultant is proposing to adopt only the stopping sight distance recommendations from TCVN 4055

Table 5.2 Criteria for Measuring Sight Distance Stipulated in TCVN4054

(Unit: m)

Sight Distance	Driver's Eye Height	Height of Object
Stopping Sight Distance	1.20	0.10
Intermediate Sight Distance	1.20	1.20
Passing Sight Distance	1.20	1.20

Table 5.3 Minimum Sight Distance Stipulated in TCVN4054

(Unit: m)

Sight Distance	80 km/h	60 km/h
Stopping Sight Distance	100	75
Intermediate Sight Distance	200	150
Passing Sight Distance	550	350

5.4 Lateral and Vertical Clearances

According to the TCVN4054, the required clearances are shown in Figure 5-1.

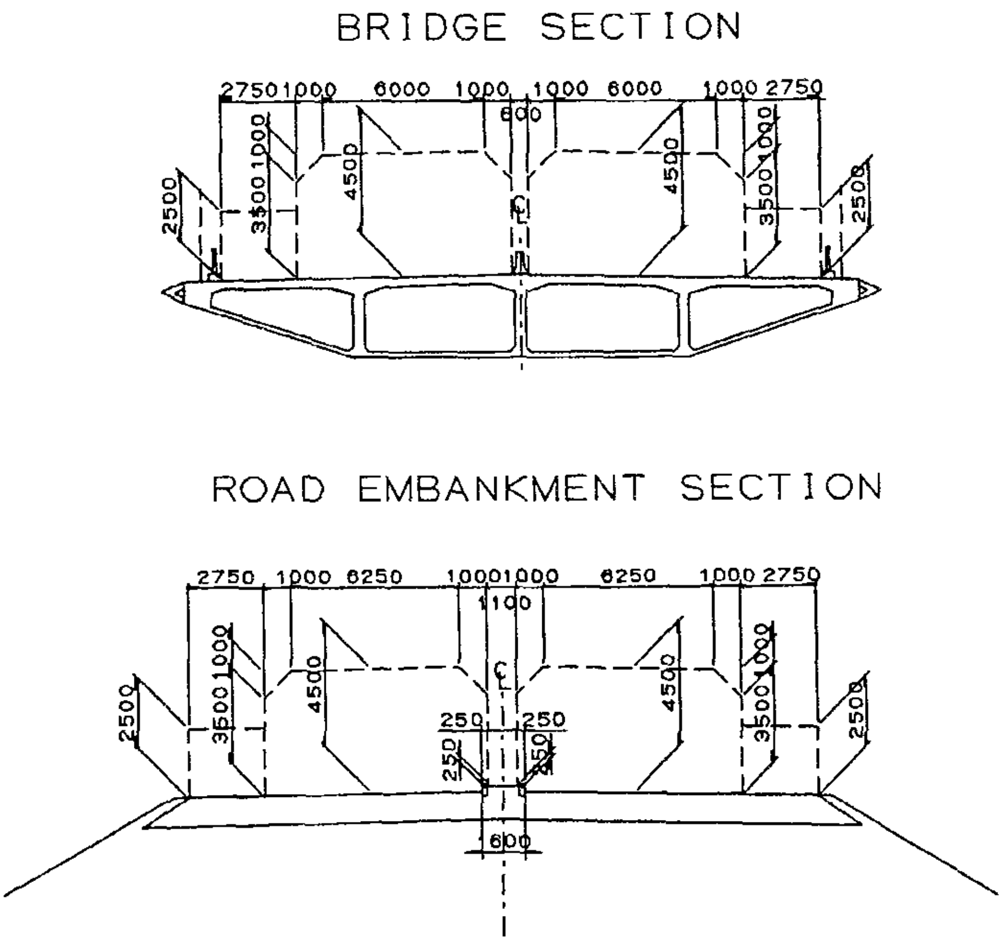


Figure 5.1 Lateral and Vertical Clearances

5.5 Horizontal Alignment

5.5.1 Minimum Radii of Horizontal Curves

TCVN4054 requirements for minimum radii of horizontal curves are set out in Table 5-4. The Consultant proposes to apply the same values of minimum radius of horizontal curves as stipulated in the TCVN 4054.

Table 5.4 Minimum Radii of Horizontal Curves Stipulated in TCVN4054

(Unit: m)

Design Elements	Technical Classification (TC)	
	60	80
Min. Curve Radius (Sup. e=6%)	125	250
Min. Basic Curve Radius (Sup. e=4%)	250	400
Min. Curve Radius use normal crossfall	500	1000

5.5.2 Superelevation

TCVN4054, relationships between radii of horizontal curves and superelevation are set out in Table 5-5.

The Consultant proposes to apply the same values of superelevation as stipulated in the TCVN 4054.

Table 5.5 Superelevation of Curves Stipulated in TCVN4054

Design Speed (km/h)	Superelevation (%)					Normal Crossfall	Remarks
	6	5	4	3	2		
80	≥250-275	>275-300	>300-350	>350-500	>500-1000	>1000	Radius
60	≥125-150	>150-175	>175-200	>200-250	>250-500	>500	(m)

5.5.3 Transition Curve

According to TCVN4054, the transition curves should conform to following standards:

- Set transition curve for the road design speed more than 60 km/h;
- Set transition curve as the connection of the tangent and circular curve;
- Clothoid spiral shall be used for the transition curve;
- Set transition curve coincided with the superelevation and/or widened section;
- Length of the transition curve is not shorter than that of the superelevation and/or widened section;
- Three degree parabola can be used instead of Clothoid; and
- Length of transition curve should be calculated based on following formula.

$$L = \frac{V^3}{23.5R}$$

Where

L	=	minimum length of transition curve, m;
V	=	speed, km/h;
R	=	curve radius, m; and

In addition to above, the Consultant proposes to place limits on lengths of transition curves in order to simplify the highway design as shown in Table 5-6, as recommended by AASHTO.

Table 5.6 Length of Transition Curves (Proposed)

(Unit: m)

Design Elements	Technical Classification (TC)	
	60	80
Min. Curve Length	40	50
Max. Curve Length	1300	2000

5.5.4 Widening of Traveled Way at Horizontal Curves

According to the TCVN4054, when radii smaller than 250 m is used, the road should be widened as shown in Table 5-7.

Table 5.7 Widening of 2-lane Traveled Way Stipulated in TCVN4054

Case	Distance from the rear axle to the front overhang (m)	Curve Radius (m)								
		250-200	200-150	150-100	100-70	70-50	50-30	30-25	<5-20	20-15
1	5	0.4	0.6	0.8	1.0	1.2	1.4	1.8	2.2	2.5
2	8	0.6	0.7	0.9	1.2	1.5	2.0	-	-	-
3	5.2-8.8	0.8	1.0	1.5	2.0	2.5	-	-	-	-
Case 1 applied for Design Speed ≥ 20 Km/h. Case 2 applied for Design Speed ≥ 60 Km/h. Case 3 applied for Highway where there are high traffic volumes of articulated trucks.										

The Consultant proposes to apply the same values of widening in the TCVN4054.

5.6 Vertical Alignment

5.6.1 Grades and Vertical Curves

TCVN4054 limits for vertical grades and vertical curves for each design speed are set out in Table 5-8.

Table 5.8 Vertical Grades and Curves Stipulated in TCVN4054

Design Elements	Technical Classification (TC)	
	60	80
Max. Grade of Vertical Alignment (%)	7	6
Min. Vertical Radius for Crest (m)	2500	4000
Min. Vertical Radius for Sag (m)	1000	2000

5.6.2 Critical Length of the Grades

Under TCVN4054, the maximum and minimum lengths of grades are set out in Table 5-9 and Table 5-10 respectively.

Table 5.9 Maximum Length of Grades Stipulated in TCVN4054

Grade (%)	Calculated Speed (km/h)	
	60	80
Less than 4	No limit	No limit
4	1000	900
5	800	700
6	600	500
7	400	Not applicable
8	Not applicable	—

Table 5.10 Minimum Length of Grades Stipulated in TCVN4054

	Calculated Speed (km/h)	
	60	80
Min Length (m)	150(100)	200(150)

The Consultant proposes to apply the same values of maximum and minimum as stipulated in the TCVN4054.

5.6.3 Minimum Length of Vertical Curves

In TCVN4054 there is no regulation for minimum vertical curve length, Under AASHTO, minimum lengths of vertical curves are expressed as about 0.6 times the design speed, or L_{min}=0.6V where V is in kilometers per hour and L is in meters resulting in. 50 m and a 40 m as the minimum vertical curve length for design speeds of 80 km/h and 60 km/h respectively.

The Consultant proposes the addition of the regulation shown in Table 5-11 which is based on the regulation of AASHTO.

Table 5.10 Minimum Length of Vertical Curves in AASHTO

	Calculated Speed (km/h)	
	60	80
Min Length (m)	40	50

5.6.4 Grades in Bridge Section

According to "Design Specification for Bridges and Culverts based on Limit States (TCVN PQ-79)", issued by Ministry of Transport in 1995, the maximum grade for bridge section stipulated three (3) percent for urban section and four (4) percent for rural section.

The Consultant proposes to apply four (4) percent and five (5) percent as the maximum grade for main bridge section and minor bridge section, respectively, in order to shorten bridge length and reduce construction cost.

5.7 Design Controls for Formation Height

According to TCVN4054, design elevation of roadbed should conform to following regulations;

Small-bridge section, crossing through flooding fields at riverside zones should have a design elevation of road bed at least 0.50m higher than flooding level frequencies given below, (including the height of overflow and the wave lapped against cross-fall).

The design flood frequency:

Vc ≥ 80km/h frequency is 2%

Vc ≤ 60km/h frequency is 4%

For minor bridges and culverts according to above standard.

For medium bridges and big bridges is 1%

There may be special requirement for large bridges

The elevation of the top of road pavement base layer should be higher than the groundwater level by the values given in Table 5-11.

Table 5.11 Minimum Height of Embankment above from Existing ground (seepage water under pavement to avoid Embankment section)

Types of embankment Material	Number of days subject to flooding per year	
	Over 20 days	Under 20 days
Fine sand, light clay-sand	50cm	30cm
Pumice clay sand	70cm	40cm
Dense clay-sand	80-120cm	50cm
Ponderous sandy clay, fat clay, ponderous clay	100-120cm	40cm

The Consultant proposes that the frequency be modified following the regulations based on Feasibility Study.

- Frequency of roadbed height design is 2% for embankment.
- Frequency of navigation clearance design is 5% for major bridges.

6 GEOMETRIC DESIGN STANDARDS FOR INTERCHANGES

6.1 Design Standards to be Applied

The Vietnamese geometric design standards to be applied for Interchanges in this project are the Highway Design Standards TCVN4054-1998.

Where no provisions exist in TCVN4054, the Consultant refers to the relevant standards of AASHTO (A Policy on Geometric Design of Highways and Streets, 1994) of United States, JRSO (Japan Road Structure Ordinance, 1983) of Japan.

6.2 Alignment of Throughway

The alignment of the throughway near the ramp terminal of the interchange should meet safety standards to suit the design speed.

As this is not stipulated in TCVN4054, the Consultant proposes to apply JSRO values as shown in Table 6-1.

Table 6.1 Alignment of Throughway

Design Speed of throughway(km/h)		80	60
Minimum Radii of Horizontal Alignment(m)		900(500)	450(200)
Maximum Gradient of Vertical(%)		4.0(5.0)	5.0(6.0)
Minimum Radius of Vertical Curves(m)	Crest	9000(4500)	4500(2500)
	Sag	6000(3000)	3000(1500)

6.3 Design Speed

The TCVN4054 stipulates the design speed of ramps as shown in Table 6-2.

Table 6.2 Design Speed of Rampways stipulated in TCVN4054

Design Speed of Throughway (km/h)	Design Speed of Rampways (km/h)	Ramp Terminal with Speed change lanes		Ramp Terminal without Speed change lanes	
		Desirable minimum	Absolute Minimum	Desirable minimum	Absolute Minimum
80	40	65	55	55	40
60	30	50	40	40	30

The Consultant proposes to apply the same values of design speed as stipulated in the TCVN4054.

6.4 Typical Cross Sections

According to the TCVN98, following conditions are indicated of the typical cross sections of rampways:

Cross sections of ramps are defined in article 4.2 of TCVN4054.

However, they shall also with conform the following minimum requirement provided:

- Designing one-lane for the ramp if the loop is less than 80m length
- For ramp over 80m length, it may be designed as one-lane the ramp's shoulders are widened to provide solve the case of safe passing of vehicle.

Consultant examines the entry contents of TCVN4054 and proposes the adoption of the typical cross sections as shown in Figure 6-1.

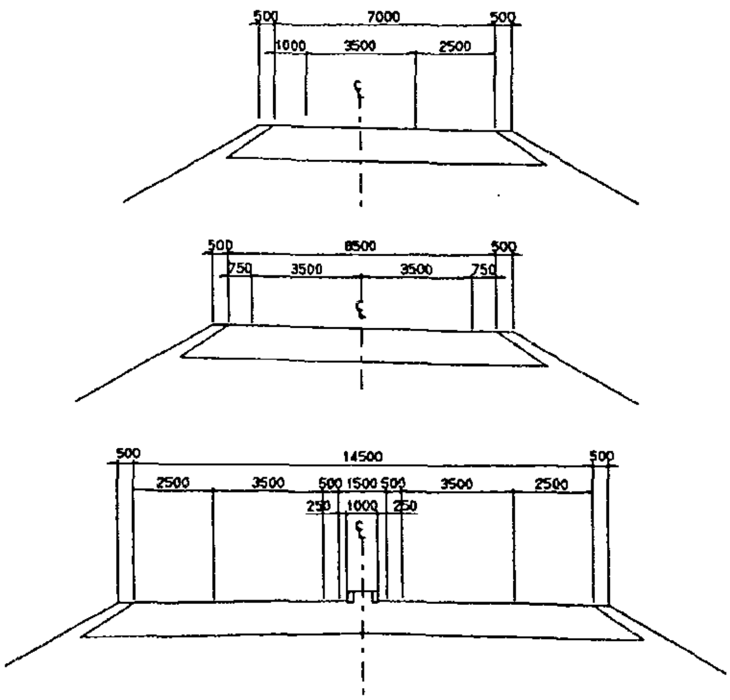


Figure 6.1 Typical Cross Section of Interchange Ramps

6.5 Geometric Design Standards

Based on above standards, understanding and study of the relevant data, the design standard for interchanges was established and summarized in Table 6-3.

Table 6.3 Geometric Design Standards of Interchange

Design Items			Unit	Value		Reference
Basic Condition	Design Speed of Highway		Km/h	80(60)		TCVN4054
	Design Speed of Rampways		Km/h	40	30	TCVN4054
Cross Section Elements	Lane Width		m	3.50		TCVN5729
	Left Shoulder Width		m	2.50		JRSO
	Right Shoulder Width		m	1.00		JRSO
Horizontal Alignment	Minimum Radius	On Rampway	m	50	30	JRSO
		On Nose	m	170(100)		JRSO
	Transition Curve	Minimum Parameter of Transition	m	35	20	JRSO
		Minimum Radius w/o Transition	m	140		JRSO
		Minimum Parameter on Nose	-	60	50	JRSO
Sight Distance	Stopping Distance		m	40	30	JRSO
Vertical Alignment	Maximum gradient		%	8.0	9.0	JRSO
	Minimum Radius of Vertical Curve on Rampway	Crest	m	450	250	JRSO
		Sag	m	450	250	JRSO
	Minimum Length of Vertical Curve		m	35	25	JRSO
	Minimum Radius of Vertical Curve on Nose	Crest	m	800(450)		JRSO
		Sag	m	700(450)		JRSO
Cross Slope	Normal Cross Slope		%	2.0		TCVN4054
	Maximum Superelevation		%	6.0		TCVN4054
	Superelevation (R: Radii of Horizontal Curve)	R<160	%	6.0		JRSO
		160≦R<210	%	5.0		JRSO
		210≦R<280	%	4.0		JRSO
		280≦R<400	%	3.0		JRSO
		400≦R<800	%	2.0		JRSO
	Minimum Radius with Normal Crossfall		m	800	500	JRSO
Speed Change Lane	Deceleration	Deceleration Lane Length	m	80(70)		TCVN5729
		Taper Length (Parallel Type)	m	50(40)		TCVN5729
	Acceleration	Acceleration Lane Length	m	160(120)		TCVN5729
		Taper Length (Parallel Type)	m	60 (50)		TCVN5729
Clearance	Lateral Clearance		m	All Paved Width		TCVN5729
	Vertical Clearance		m	4.50		TCVN5729