(Table 3.3.4-1: Ui-13 and Ui-14). This water originated formerly from small rivers inflowing into Ui Chong. However, both rivers are now covered and water is flowing into the intercepting pipe.

3.3.5 Water Quality and Flow-out Load at Freshet Time

The survey was started at 14:00 on August 31 and continued for 9 hours.

The precipitation on August 30 and 31 around Ui Chong were 8.0 and 63.0 mm, respectively.

Water levels showed a slight decrease along the sampling time at both of the stations (Tables 3.3.5-1 and 2, Fig. 3.3.5-1).

The mean of DO at U-St. 1 was quite lower at 4.5 mg/l than usual values. BOD and SS showed small two peaks at U-St. 1.

The values of pH, DO, COD and NH_4-N at U-St. 2, were higher than those measured at U-St. 1, and showed a decreasing tendency with the sampling time.

SS at U-St. 2 showed one peak of 85.5 mg/l, then decreased to 4.0 mg/l.

The highest values of COD, NH_4-N and coli-forms at U-St. 1 and U-St. 2 at freshet time were 1.6-4 times higher than those obtained on the clear day of August 25, 1990. BOD on freshet time was slightly higher by about 6-10 times. SS, on the other hand, was higher at this freshet time, 31 times at U-St. 1 and 34 times at U-St. 2, than those measured on a clear day, August 25.

The flow-out loads of selected items brought about during the freshet were calculated under several assumptions.

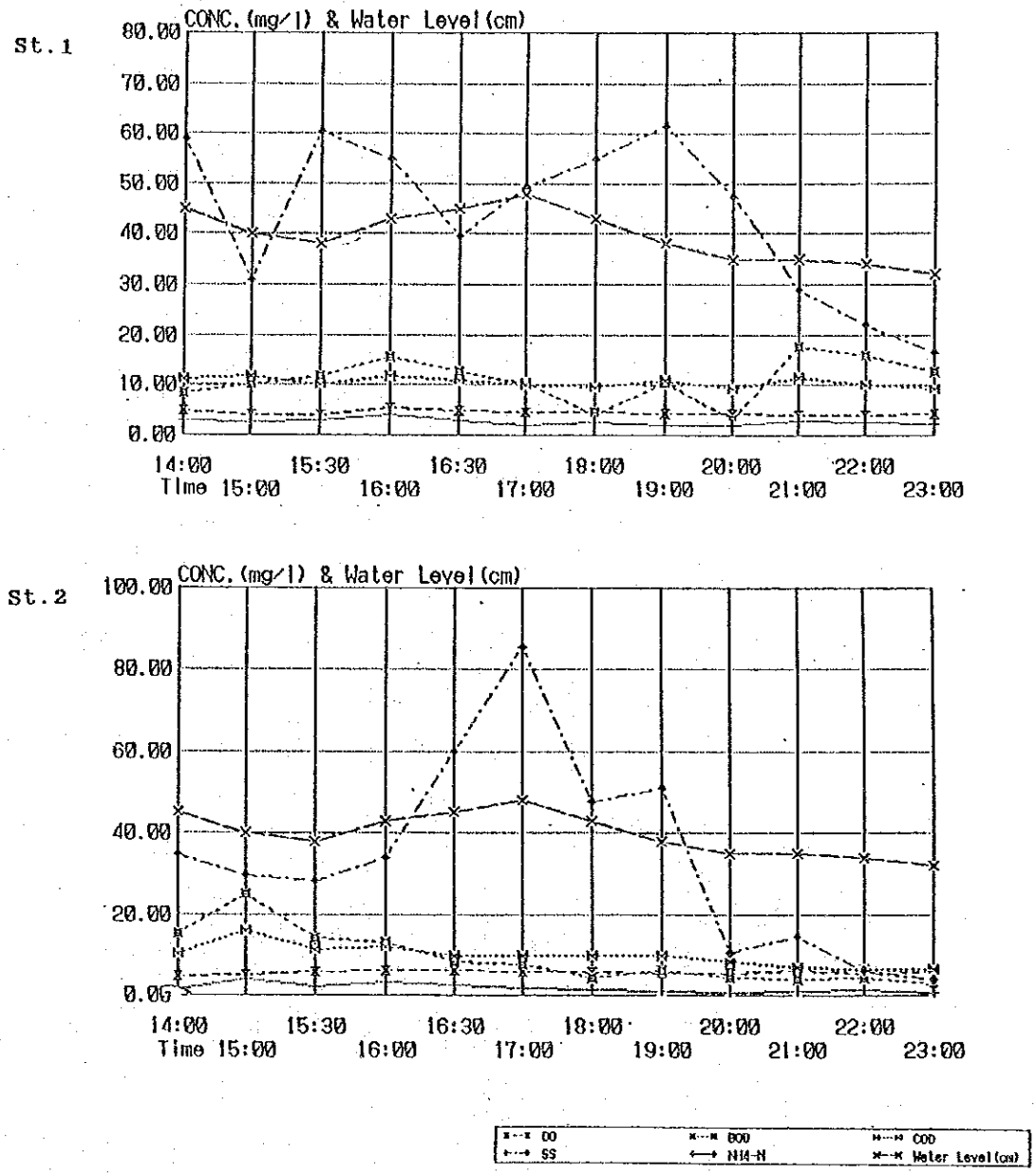


Fig. 3.3.5-1 Water Quality at Freshet Time of Ui Chong, August 31, 1990

Table 3.3.5-1 Water Quality of Ui Chong at Freshet Time, U-St.1, August 31, 1990
Precipitation: 8 mm(30th) and 63 mm (31st)

Item / Time	WT (°C)	DO (mg/l)	BOD (mg/l)	COD (mg/l)	SS (mg/l)	NH4-N (mg/l)	Coli-form (MPN/100ml)	Gauge (cm)	Water level(m)	Q (m3/s)	Interval (h)	BOD (t/h)		COD (t/h)		SS (t/h)		NH4-N (t/h)	
										7.825		0.0789		0.118		0.056		0.042	
14:00	22.8	4.8	8.3	11.4	59.0	2.78	180	45	16.855	29.953	5		0.408		2.777		15.764		0.644
												0.895		1.229		6.362		0.300	0.000
15:00	23.4	4.1	10.2	11.7	31.0	2.68	270	40	16.805	25.680	1		0.840		1.037		4.558		0.232
												0.943		1.082		2.866		0.248	0.000
15:30	23.5	4.0	11.7	10.1	60.5	2.90	100	38	16.785	24.063	0.5		0.450		0.430		1.999		0.104
												1.014		0.875	0.000	5.241	0.000	0.251	0.000
16:00	23.8	5.6	15.6	11.7	55.0	3.93	120	43	16.835	28.205	0.5		0.610		0.457		2.678		0.141
												1.584		1.188	0.000	5.585	0.000	0.399	0.000
16:30	23.5	5.0	12.6	11.0	39.5	2.90	80	45	16.855	29.953	0.5		0.696		0.534		2.433		0.157
												1.359		1.186	0.000	4.259	0.000	0.313	0.000
17:00	23.4	4.7	10.5	10.1	49.5	2.15	110	48	16.885	32.675	0.5		0.609		0.534		2.492		0.120
												1.235		1.188	0.000	5.823	0.000	0.253	0.000
18:00	23.3	4.5	4.1	9.5	55.0	2.54	210	43	16.835	28.205	1		0.747		0.958		5.647		0.213
												0.416		0.965	0.000	5.585	0.000	0.258	0.000
19:00	23.0	4.3	10.5	11.0	61.5	2.05	110	38	16.785	24.063	1		0.584		0.840		5.400		0.175
												0.910		0.953	0.000	5.328	0.000	0.178	0.000
20:00	23.0	4.2	3.3	9.2	47.5	2.12	100	35	16.755	21.736	1		0.505		0.718		4.466		0.129
												0.258		0.720	0.000	3.717	0.000	0.166	0.000
21:00	22.2	4.0	17.7	11.5	29.0	2.91	100	35	16.755	21.736	1		0.743		0.692		2.937		0.155
												1.385		0.900	0.000	2.269	0.000	0.228	0.000
22:00	22.1	4.1	15.9	10.1	22.0	2.46	210	34	16.745	20.986	1		1.214		0.713		1.909		0.165
												1.201		0.763	0.000	1.662	0.000	0.186	0.000
23:00	21.8	4.2	12.6	9.2	16.5	2.25	170	32	16.725	19.527	1		0.965		0.587		1.355		0.130
												0.885		0.647		1.160		0.158	0.000
											14		5.649		3.697		7.722		0.812
												0.079		0.118		0.056		0.0423	
Total(t/28h) on freshet													14.019		13.974		59.360		3.176
On clear day(t/28h)													2.209		3.313		1.578		1.183

Table 3.3.5-2 Water Quality of Ui Chong at Freshet Time, St. 2, August 31, 1990

Item	WT (°C)	DO (mg/l)	BOD (mg/l)	COD (mg/l)	SS (mg/l)	NH4-N (mg/l)	Coli- form (MPN/100ml)	Gauge (cm)	Water level (m)	Q (m3/s)		BOD (t/h)		COD (t/h)		SS (t/h)		NH4-N (t/h)	
									27.528	0.744		0.0067		0.01178		0.0067		0.003	
Time											5		0.361		0.222		0.851		0.026
14:00	23.9	4.8	15.0	10.0	34.5	1.34	280	6	27.648	2.796		0.151		0.101		0.347		0.013	
											1		0.195		0.119		0.315		0.024
15:00	23.7	4.9	25.0	16.0	29.5	4.06	320	6	27.648	2.796		0.252	0.000	0.161	0.000	0.297	0.000	0.041	0.000
											0.5		0.101		0.067		0.153		0.015
15:30	23.5	5.6	14.0	11.2	28.0	2.00	250	8	27.668	3.265		0.165	0.000	0.132	0.000	0.329	0.000	0.024	0.000
											0.5		0.091		0.077		0.220		0.017
16:00	23.4	6.1	12.9	12.0	34.0	3.07	160	13	27.718	4.598		0.214	0.000	0.199	0.000	0.563	0.000	0.051	0.000
											0.5		0.080		0.079		0.355		0.020
16:30	23.0	6.3	8.3	9.8	60.0	2.53	110	11	27.698	4.037		0.121	0.000	0.142	0.000	0.872	0.000	0.037	0.000
											0.5		0.052		0.062		0.505		0.013
17:00	22.9	5.8	7.5	9.6	85.5	1.71	180	10	27.688	3.771		0.102	0.000	0.130	0.000	1.161	0.000	0.023	0.000
											1		0.073		0.116		0.874		0.017
18:00	22.8	5.6	4.5	9.9	47.5	1.40	240	9	27.678	3.513		0.057	0.000	0.125	0.000	0.601	0.000	0.018	0.000
											1		0.058		0.108		0.593		0.012
19:00	22.6	5.5	6.2	9.7	51.0	0.98	100	8	27.668	3.265		0.073	0.000	0.114	0.000	0.599	0.000	0.012	0.000
											1		0.060		0.102		0.364		0.008
20:00	22.4	5.4	4.5	8.4	10.5	0.84	160	10	27.688	3.771		0.061	0.000	0.114	0.000	0.143	0.000	0.011	0.000
											1		0.046		0.086		0.150		0.009
21:00	22.3	6.0	3.8	7.0	14.5	1.06	210	8	27.668	3.265		0.045	0.000	0.082	0.000	0.170	0.000	0.012	0.000
											1		0.042		0.067		0.114		0.011
22:00	22.1	5.5	4.5	6.4	6.0	1.35	180	8	27.668	3.265		0.053	0.000	0.075	0.000	0.071	0.000	0.016	0.000
											1		0.038		0.066		0.054		0.010
23:00	22.0	5.7	2.9	6.4	4.0	0.84	160	9	27.678	3.513		0.037		0.081		0.051		0.011	
											14								
Total (t/28h) on freshet													1.197		1.173		4.549		0.184
On clear day (t/28h)													0.188		0.330		0.188		0.084

Assumptions:

* The water qualities obtained from the 24-hour survey on August 25 were considered the water qualities taken on the clear day in the same month because the levels of the water qualities and the water levels seemed to be representatives of the clear days around this freshet time.
* The starting and finishing times, which gave the flow-out loads of the freshet, were assumed comparing the curves between hourly precipitation and the flow-out load of BOD during the freshet. The duration estimated under assumption mentioned above was 28 hours.

Using these assumptions, the total flow-out load of selected items during the freshet time were below:

Table 3.3.5-3 Flow-out Load during the Freshet Time, August 31-September 1, 1990

	Item	BOD(ton)	COD(Mn)(ton)	SS(ton)	NH_4-N(ton)
U-St. 1	Freshet	14.0	14.0	59.4	3.2
	Clear	2.2	3.3	1.6	1.2
U-St. 2	Freshet	1.2	1.2	4.5	0.2
	Clear	0.2	0.3	0.2	0.08

The flow-out loads of SS at both stations were much higher than those on a clear day compared to the other items. And it is presumed that much of SS flowed out were inorganic based on the data obtained in May and June, 1991 (Table A-3.3-1). It was supposed that SS at freshet time were brought about by erosion of the river bed and accumulation of it at the lower stations.

3.3.6 Self-purification Capacity

Survey for the self-purification capacity of this river was once conducted on the two sections on September 19, 1990, between U-St. 1 and U-St. 2. The flow-down durations were 25 and 30 minutes,

respectively.

Very high self-purification coefficients based on TKN (8.15-12.48 1/day) and BOD (5.27 1/day) were recorded. But, on section 2, the self-purification regarding TKN was not observed. This may have been caused by some unknown reasons.
These extraordinary high values of self-purification coefficients are thought to be due to high DO and small velocity. However, this time lack of appropriate places to be surveyed and a too short period to completed the survey may have brought about these high coefficients.

There was not enough time this time to repeat the surveys either during the stay in Korea. The repetition of the survey will hopefully give more accurate values.

3.3.7 Correlation between Water Qualities

Fairly high positive correlation coefficients were seen between BOD and SS, and NH_4-N (r=0.769 and 0.752, respectively) at U-St. 1. The coefficients on other items were positive, but small (Table 3.3.7-1).

The correlation between BOD and COD(Mn) at U-St. 1 (R=0.645) was not quite high. They seemed to behave differently.

DO and other items showed negative values at U-St.1. In particular the values between BOD and SS were -0.409 and -0.472, which may be attributed to self-purification.

All coefficients at U-St. 2 were found lower than at U-St. 1.

Table 3.3.7-1 Correlation between Water Qualities obtained from Regular Monthly Survey, Ui Chong

U-St. 1

	DO	COD	BOD	SS	NH4-N
DO	1				
COD	-0.242	1			
BOD	-0.409	0.645	1		
SS	-0.472	0.463	0.769	1	
NH4-N	-0.062	0.533	0.752	0.521	1

U-St. 2

	DO	COD	BOD	SS	NH4-N
DO	1				
COD	-0.301	1			
BOD	-0.248	0.451	1		
SS	-0.162	0.486	0.434	1	
NH4-N	-0.029	0.196	0.307	-0.028	1

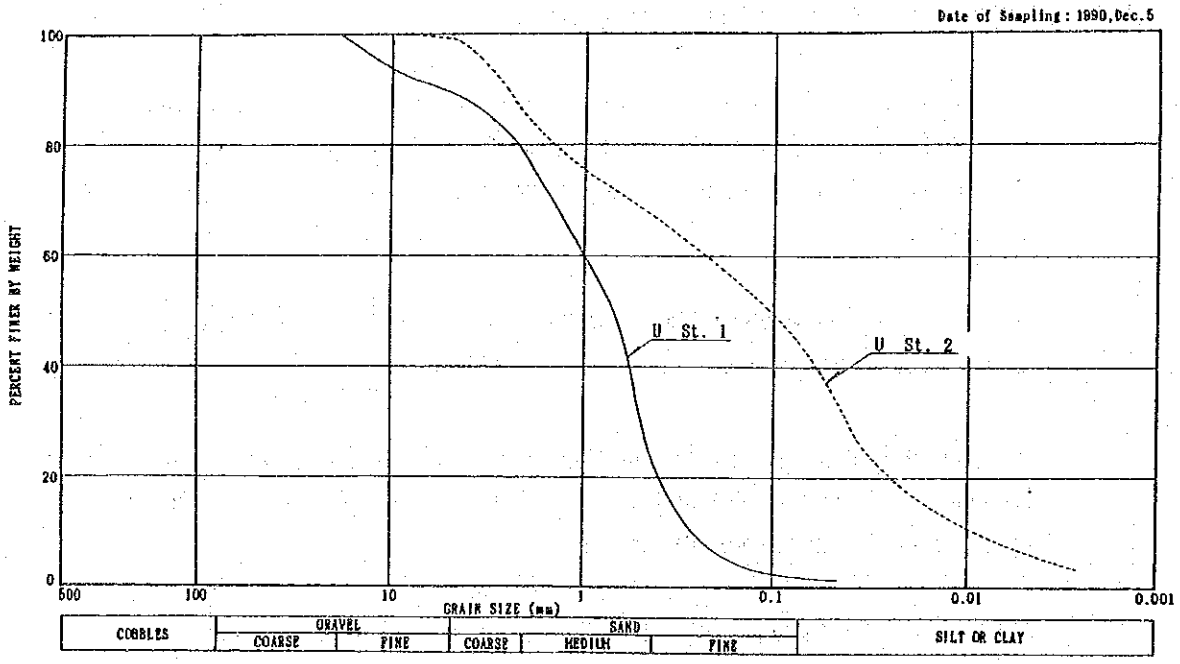


Fig. 3.3.8-1 Particle-size Distribution of Sediment of Ui Chong, December 5, 1990

3.3.8 Sediment Quality

(1) Particle-size distribution

Particle-size distributions at both stations were different. Sand fraction (greater than 0.074 mm) accounted for 87 % by weight of the total at U-St. 1, and on the other hand, at U-St. 2 silt and clay (smaller than 0,074 mm) accounted for 44 % of the total (Fig. 3.3.8-1, Table 3.3.8-1).
Drying Loss at U-St. 1 was 36 % and 59% at U-St. 2 , which reflect the qualities of the riverbed mentioned above.

(2) Chemical content

Particularly high Ignition Loss values at both stations showed the bottom of this river was organically polluted (38 % at u-St.1, 62 % at U-St. 2). It is said that the rivers of which Ignition Loss of sediment are higher than 5.03 % is defined organically strongly polluted, and usually heavy metal concentrations are also high in the sediment (Table 3.3.8-2).

Heavy metals, CN, As, PCB and Organic-P concentrations, however, in this river sediment were found in low values. It is thought that this river has not been polluted by industrial waste water, only few of which exist along Ui Chong, but by domestic waste water.

(3) Macro-benthos

Ui Chong showed the lower degree of pollution than other rivers by biological indicator, i.e. species and individual numbers this river were greater than those at other rivers (Table 3.3.8-3).

In particular, 5 species of benthos appeared at U-St. 2, which was the greatest number of all rivers. Chironomus yoshimatsu were found 43 individuals/m^2 at U-St. 1 and 23 individuals/m^2 at U-St. 2, of which numbers were not obtained in other rivers, either.

Table 3.3.8-1 Particle-size Distribution of Sediment of Ui Chong
(Accumulated Percent in Weight)

	Classification					
	Gravel	Sand			Silt	Clay
	Fine	Coarse	Medium	Fine		
Size(mm)	18.38-4.76	4.76-2.00	2.00-0.42	0.42-0.074	0.074-0.005	0.005>
Station						
U-St. 1	100.0	89.5	78.0	21.5	2.0	0.0
U-St. 2		100.0	99.0	66.0	43.5	6.5

Table 3.3.8-2 River Sediment Quality of Ui Chong, December 5, 1990

Weather on the day: Clear
Weather on the previous day: Clear
AT: 9°C (10:00)

Item	CN	As	THg	Cr(6+)	Cd	Pb	Sulfide	PCB	Org-P Malathion	PAP	DL	IL	Color	Odor
	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(%)	(%)		
Station														
U-St. 1	0.409	0.133	0.063	ND	0.100	1.133	5.68	ND	ND	ND	36.4	38.0	Dark brown	Non
U-St. 2	0.250	0.233	0.054	ND	0.183	1.960	6.45	ND	ND	ND	59.0	62.5	do.	do.

Table 3.3.8-3 Macro-benthos in Sediment of
Ui Chong (December 5, 1990)

Station / Species	U-St. 1	U-St. 2
Class Oligochaeta		
Order Haplotaxida		
Family Tubificidae		
Limnodrilus socialis		5
Class Hurudinea		
Order Pharyngobdellidae		
Family Erpobdellidae		
Erpobdella sp.	2	1
Class Gastropoda		
Order Lymnophila		
Family Phydidae		
Physella acuta		3
Class Insecta		
Order Diptera		
Family Chironomidae		
Chironomus yoshimatsui	43	23
Chironomus sp.		8
Total species number/m2	2	5
Total individual number/m2	45	40
Diversity Index	0.26	1.71
Biological Pollution Class	ps	alpha-m

ps: polysaprobic
alpha-m: alpha-mesosaprobic

U-St. 2 belongs to mesosaprobic water area and U-St. 1 to polysaprobic water area by classification of biological pollution class. However, degree of classification of these stations was reached in by the river bed material, where it is hard for benthos to habit.

3.4 Chungroung Chong

3.4.1 Hourly Change of Water Quality

A systematic hourly change on the water quality distribution of this river was not found. DBOD, DCOD and SS concentrations, however, tended to have higher values from 10:00 to 14:00 on the first sampling day, when the other items also showed great variances. The mean values, therefore, obtained from the 24-hour survey are supposed to be more accurate than the results taken from the once-a-day sampling.

The mean values of the same items as in the regular monthly surveys were included in the results from the regular monthly surveys to be discussed.

Data obtained from 24-hour surveys were sited in Tables A-4.1-1-18.

3.4.2 Monthly Variation of Water Quality

(1) Water quality variation obtained from the regular monthly survey

pH were in the small ranges from 6.6 to 8.2, usually showing neutral or weak alkaline (Tables 3.4.2-1-3).

DO concentrations were higher in July, August and September, and lower in December and January. In particular, it showed higher than 8 mg/l at all stations in February, 1991. The values at C-St. 3, which was located on the mouth of the sewer being covered, were constantly lower (3.2-8.4 mg/l) than the other two stations (C-St. 1: 3.7-9.4 mg/l, C-St. 2: 5.2-8.7 mg/l). It is supposed that the inflow from the upstream brought about these lower DO concentrations at C-St. 3. (Table 3.4.2-1-3, Fig. 3.4.2-1).

Table 3.4.2-1 Water Quality of Chungroung Chong, C-St. 1

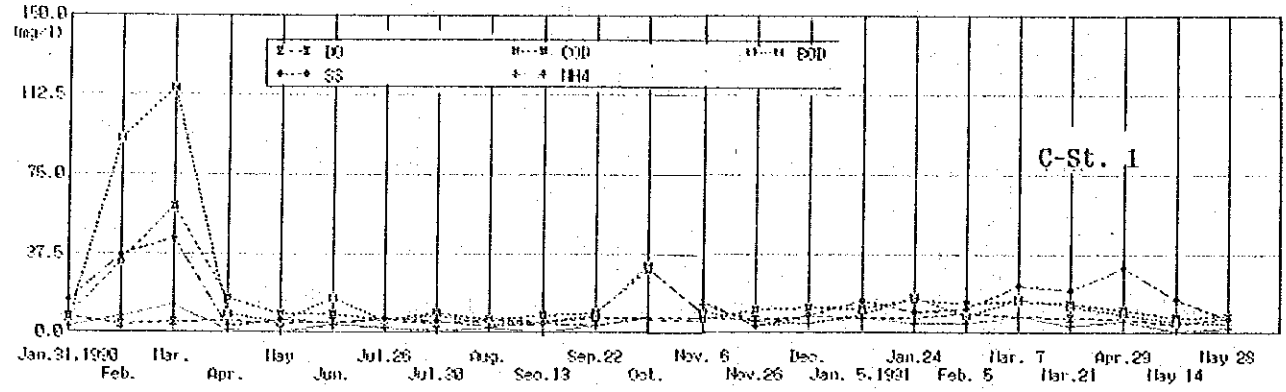
Item / Date	WT (°C)	pH	EC (mS/cm)	DO (mg/l)	COD(Mn) (mg/l)	BOD (mg/l)	SS (mg/l)	NH4-N (mg/l)	NO2-N (mg/l)	Coli-form (MPN/100ml)	CN (mg/l)	Hg (mg/l)	Gauge (cm)
Jan. 31, 1990	3.8	7.7	-	7.5	7.2	3.9	15.0	2.45	0.012	-	-	-	-3
Feb. 22, 1990	6.1	7.2	-	3.7	33.4	92.0	37.0	7.45	0.063	-	-	-	-2
Mar. 20, 1990	11.0	7.1	-	5.1	60.2	116.0	45.0	12.84	0.026	-	-	-	0
Apr. 20, 1990	19.2	7.9	-	5.2	16.0	8.4	2.8	1.07	0.143	-	-	-	1
May 28, 1990	23.8	7.8	-	4.2	8.8	5.0	6.0	0.22	0.368	-	-	-	1
Jun. 22, 1990	19.2	7.4	0.5	4.9	8.5	16.0	4.4	3.92	-	12	-	-	24
Jul. 26, 1990	23.0	6.9	-	5.5	6.1	5.4	6.7	2.16	0.063	-	-	-	15
Jul. 30, 1990	28.4	7.1	-	4.6	9.4	7.9	5.5	0.66	0.088	24	0.000	0.000	2
Aug. 25, 1990	28.0	7.5	-	5.7	6.0	3.6	2.5	2.03	0.091	200	0.000	0.000	1
Sep. 13, 1990	21.3	6.6	-	4.7	7.9	4.9	4.5	0.09	0.009	-	-	-	25
Sep. 22, 1990	24.1	7.4	-	6.8	9.2	8.0	3.4	3.30	0.159	180	-	-	24
Oct. 22, 1990	23.2	7.2	-	7.2	29.6	31.9	7.0	7.07	0.684	450	-	-	12
Nov. 6, 1990	12.9	7.2	-	5.9	10.4	14.8	12.9	4.61	0.204	-	-	-	12
Nov. 26, 1990	12.1	7.1	-	6.2	10.7	3.8	3.0	5.28	0.172	1400	0.000	0.000	7
Dec. 24, 1990	5.2	7.6	-	7.8	11.7	4.4	8.0	4.35	0.167	1100	-	-	5
Jan. 5, 1991	6.4	7.3	-	7.2	11.4	8.6	15.3	6.88	0.149	1200	0.000	0.000	14
Jan. 24, 1991	2.9	7.5	-	7.1	15.7	16.7	9.7	4.18	0.177	-	-	-	3
Feb. 5, 1991	1.7	7.4	-	9.4	13.5	7.8	11.5	4.08	0.000	1500	0.028	0.000	10
Mar. 7, 1991	6.2	7.3	-	7.7	15.2	15.9	22.3	7.78	0.049	-	-	-	7
Mar. 21, 1991	6.2	7.6	-	7.2	13.7	12.2	20.0	3.26	0.054	1200	0.000	0.000	7
Apr. 29, 1991	13.0	7.4	-	6.7	11.0	8.4	31.0	5.36	0.026	2000	0.000	0.000	6
May 14, 1991	24.1	7.7	-	3.9	6.8	4.8	15.8	0.26	0.596	-	-	-	0>
May 28, 1991	16.4	7.4	-	6.8	7.8	4.2	6.7	2.42	0.075	2800	0.000	0.000	0>

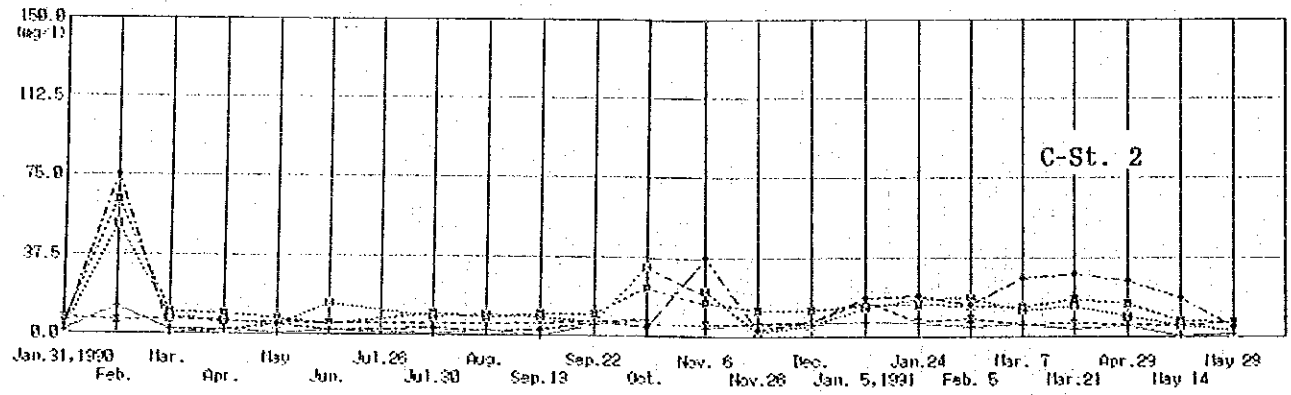
Table 3.4.2-2 Water Qality of Chungroung Chong, C-St. 2

Item / Date	WT (°C)	pH	EC (mS/cm)	DO (mg/l)	COD(Mn) (mg/)	BOD (mg/l)	SS (mg/l)	NH4-N (mg/l)	NO2-N (mg/l)	Coli-form (MPN/100ml)	CN (mg/l)	Hg (mg/l)	Gauge (cm)
Jan. 31, 1990	3.6	7.1	-	7.4	5.1	1.4	3.1	1.41	0.006	-	-	-	-7
Feb. 22, 1990	8.3	7.5	-	6.5	63.2	52.0	75.0	12.84	0.145	-	-	-	-2
Mar. 20, 1990	15.0	6.7	-	7.1	10.1	8.2	0.5	2.30	0.095	-	-	-	-5
Apr. 20, 1990	20.1	6.8	-	5.8	10.0	6.6	1.7	2.00	0.078	-	-	-	-2
May 28, 1990	24.1	7.4	-	5.7	7.8	4.2	5.0	0.45	0.300	-	-	-	0
Jun. 22, 1990	18.6	7.3	0.8	5.3	5.0	14.8	2.4	2.31	-	17	-	-	16
Jul. 26, 1990	22.1	6.9	-	6.6	6.0	5.4	3.8	2.61	0.069	-	-	-	17
Jul. 30, 1990	27.4	7.1	-	5.2	10.4	8.4	3.0	0.74	0.084	22	0.000	0.000	4
Aug. 25, 1990	26.6	7.2	-	5.5	8.8	9.9	2.0	2.76	0.093	310	0.000	0.000	6
Sep. 13, 1990	20.3	7.2	-	5.7	10.3	8.4	2.8	0.21	0.079	-	-	-	17
Sep. 22, 1990	23.7	7.2	-	7.2	10.2	6.7	6.6	5.44	0.128	220	-	-	28
Oct. 22, 1990	21.9	7.4	-	7.5	22.6	32.7	4.5	7.65	0.428	890	-	-	10
Nov. 6, 1990	13.4	7.1	-	6.0	16.0	21.5	37.5	4.37	0.048	-	-	-	14
Nov. 26, 1990	11.0	7.0	-	5.7	12.5	2.4	3.0	6.39	0.191	1400	0.000	0.000	11
Dec. 24, 1990	4.1	7.5	-	7.2	12.4	5.3	7.0	6.09	0.246	1000	-	-	10
Jan. 5, 1991	5.9	7.4	-	7.0	15.0	13.4	18.3	7.25	0.132	900	0.014	0.000	17
Jan. 24, 1991	4.6	7.3	-	6.9	15.1	17.8	19.5	6.44	0.294	-	-	-	7
Feb. 5, 1991	5.3	7.5	-	8.7	14.8	18.2	15.0	4.83	0.000	1200	0.093	0.000	11
Mar. 7, 1991	6.9	7.5	-	6.2	14.0	12.4	27.5	5.82	0.063	-	-	-	22
Mar. 21, 1991	5.3	7.4	-	6.7	17.7	14.5	30.0	4.03	0.039	1100	0.000	0.000	8
Apr. 29, 1991	12.0	7.0	-	5.8	15.6	9.8	26.5	5.22	0.039	1700	0.000	0.000	10
May 14, 1991	18.0	-	-	5.4	7.5	5.5	18.3	0.30	0.567	-	-	-	7
May 28, 1991	19.4	7.2	-	7.0	6.7	3.5	4.7	1.63	0.280	2100	0.000	0.000	6

Table 3.4.2-3 Water Quality of Chungroung Chong, C-St. 3

Item / Date	WT (°C)	pH	EC (mS/cm)	DO (mg/l)	COD(Mn) (mg/l)	BOD (mg/l)	SS (mg/l)	NH4-N (mg/l)	NO2-N (mg/l)	Coli-form (MPN/100ml)	CN (mg/l)	Hg (mg/l)	Gauge (cm)
Jan. 31, 1990	3.2	8.2	-	7.5	82.7	125.0	138.0	10.80	0.048	-	-	-	-
Feb. 22, 1990	6.8	7.6	-	5.2	50.1	106.5	82.0	15.49	0.007	-	-	-	-
Mar. 20, 1990	18.0	8.1	-	7.8	7.9	4.9	17.0	3.20	0.081	-	-	-	-
Apr. 20, 1990	20.0	6.8	-	5.9	6.4	3.7	7.2	2.33	0.071	-	-	-	-
May 28, 1990	22.5	7.2	-	5.3	7.5	12.4	2.0	3.18	0.921	-	-	-	11
Jun. 22, 1990	18.0	7.7	-	5.6	10.0	23.3	10.4	3.42	-	23	-	-	28
Jul. 26, 1990	22.2	7.2	-	6.3	6.2	6.0	4.1	2.35	0.060	-	-	-	22
Jul. 30, 1990	23.7	7.0	-	3.2	11.2	10.5	5.0	0.74	0.078	38	0.000	0.000	25
Aug. 25, 1990	23.2	7.4	-	4.2	8.6	11.0	2.8	1.39	0.066	310	0.000	0.000	21
Sep. 13, 1990	20.2	7.1	-	5.7	8.0	8.7	3.9	0.11	0.518	-	-	-	21
Sep. 22, 1990	19.2	7.1	-	6.0	8.6	6.0	3.6	3.59	0.054	190	-	-	30
Oct. 22, 1990	18.0	7.2	-	7.8	17.1	14.8	7.5	5.44	0.789	710	-	-	14
Nov. 6, 1990	13.2	7.2	-	6.5	10.4	11.1	6.9	4.42	0.060	-	-	-	17
Nov. 26, 1990	10.4	7.4	-	6.0	14.3	15.2	3.5	9.03	0.278	1800	0.000	0.000	16
Dec. 24, 1990	3.9	7.3	-	7.6	28.1	17.1	34.9	8.70	1.737	1500	-	-	14
Jan. 5, 1991	5.3	7.3	-	6.7	38.1	36.0	43.3	11.30	0.632	1100	0.004	0.000	20
Jan. 24, 1991	3.9	7.3	-	5.1	19.0	21.6	19.0	8.61	0.021	-	-	-	17
Feb. 5, 1991	4.4	7.8	-	8.4	24.5	52.0	21.5	7.00	0.021	1100	0.054	0.000	14
Mar. 7, 1991	6.7	7.6	-	6.3	24.4	31.3	30.4	6.73	0.054	-	-	-	17
Mar. 21, 1991	4.8	7.4	-	6.0	18.7	22.0	35.0	9.35	0.063	1200	0.000	0.000	12
Apr. 29, 1991	10.0	7.3	-	6.2	17.2	21.0	12.0	8.41	0.064	1900	0.000	0.000	14
May 14, 1991	17.3	7.4	-	6.2	11.5	14.7	6.7	3.56	1.183	-	-	-	17
May 28, 1991	21.2	7.2	-	5.9	11.0	12.2	5.3	2.90	0.487	2800	0.000	0.000	7





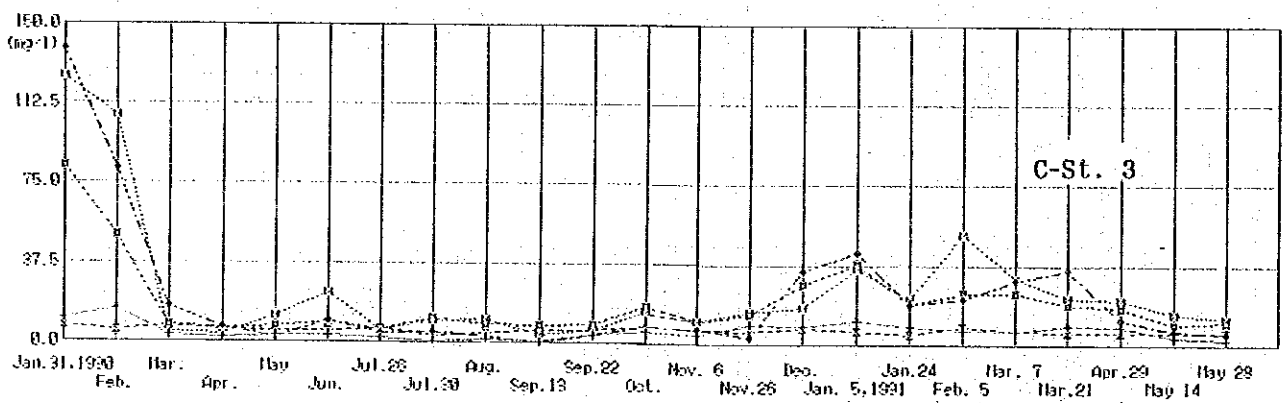


Fig. 3.4.2-1 Monthly Variation of Water Quality of Chungroung Chong, C-St. 1 to C-St. 3, from January, 1990, to May, 1991

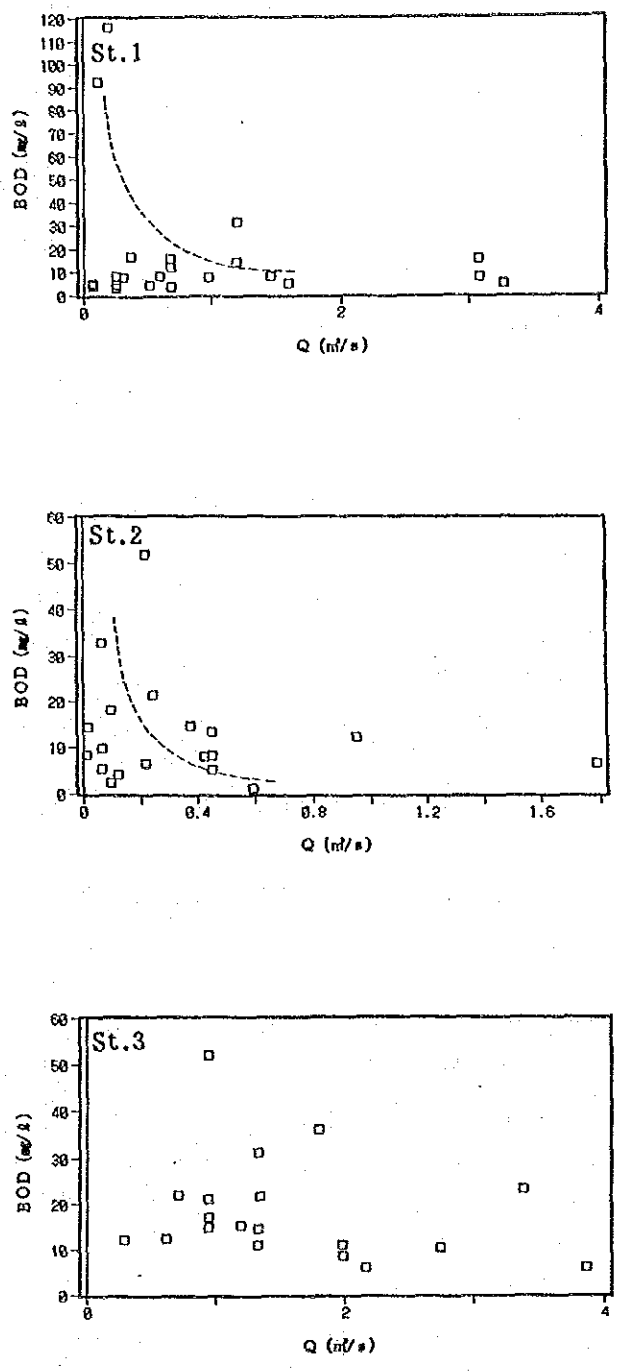


Fig. 3.4.2-2 Relation between Water Quality and Discharge of Chungroung Chong

COD(Mn), BOD, SS and NH_4-N, obtained with good correlation (as mentioned in 3.4.7), showed very similar distribution patterns, i.e. considerably high values were found in January, February and March, 1990, in particular the extraordinarily high values were obtained in February, 1990, at all stations. Then these concentrations of four items decreased suddenly, and kept the same levels until November, 1990. It is possible to say that low concentrations were obtained in the hotter months with higher discharge, and contrarily higher concentrations were found in colder months with lower discharges (Fig. 3.4.2-2).

NO_2-N showed extremely great monthly variations at all stations (0.000-1.737 mg/l), however usually with quite low values.

Coli-form bacterial numbers started in quite low values at 12 (C-St. 1), 17 (C-St. 2) and 23 (C-St. 3) MPN/100ml, respectively. Those numbers, however, increased at all stations until 2800 MPN/100ml at C-St. 1 and C-St. 3, and 2100 MPN/100ml at C-St. 2, in May, 1991. This increase still seems to be continuing. It may indicate the increase of waste water or human waste, recently.

THg was not detected at all stations throughout the sampling period.

CN was detected only two times in January and February, 1991, although the concentrations were quite low (0.004-0.093 mg/l) (Table 3.4.2-1-3). In these months, the discharges were small. Had then concentrations been higher than those when the discharges were greater in hotter months, it might have been detected.

(2) Variations of other water qualities

TN concentrations showed constantly high values at all stations, although with great variances (3.15-10.06 mg/l). TN is supposed to be distributed in lower values from May to September and then the increase peaking in March, as shown in the sign curves (Figs. 3.4.2-3-5, Tables 3.4.2-4-6).

Table 3.4.2-4 Water Quality Obtained from 24-hour Survey on Chungroung Chong, C-St. 1

C-St. 1, July 26-27, 1990

Item	DO (mg/l)	TN (mg/l)	TON (mg/l)	NO3-N (mg/l)	NO2-N (mg/l)	NH4-N (mg/l)	TP (mg/l)	TDP (mg/l)	PO4-P (mg/l)	BOD (mg/l)	DBOD (mg/l)	COD (mg/l)	DCOD (mg/l)	Sulfide (mg/l)	MBAS (mg/l)	SS (mg/l)	Settleable matter (mg/l)	(%)	Gauge (cm)
Mean	5.5	-	-	1.94	0.063	2.30	0.322	-	0.184	5.4	-	6.1	-	2.9	1.31	9.5	8.2	75	15
SD	0.7	-	-	0.21	0.009	0.58	0.101	-	0.057	0.7	-	0.9	-	0.5	0.46	12.0	11.4	17	4
						2.16			0.171						1.42	6.7	5.6	84	
						0.34			0.170						0.27	7.2	7.3		

C-St. 1, September 13-14, 1990

Item	DO (mg/l)	TN (mg/l)	TON (mg/l)	NO3-N (mg/l)	NO2-N (mg/l)	NH4-N (mg/l)	TP (mg/l)	TDP (mg/l)	PO4-P (mg/l)	BOD (mg/l)	DBOD (mg/l)	COD (mg/l)	DCOD (mg/l)	Sulfide (mg/l)	MBAS (mg/l)	SS (mg/l)	Settleable matter (mg/l)	(%)	Gauge (cm)
Mean	4.7	3.39	0.21	3.06	0.009	0.10	0.274	0.198	0.162	5.6	4.9	7.9	7.7	2.1	1.60	4.5	4.1	87	25
SD	0.5	0.14	0.01	0.13	0.013	0.03	0.080	0.059	0.054	1.2	1.7	1.4	2.6	0.7	0.51	2.7	2.6	7	3
						0.09									1.48				
						0.02									0.32				

St. 1, November 6-7, 1990

Item	DO (mg/l)	TN (mg/l)	TON (mg/l)	NO3-N (mg/l)	NO2-N (mg/l)	NH4-N (mg/l)	TP (mg/l)	TDP (mg/l)	PO4-P (mg/l)	BOD (mg/l)	DBOD (mg/l)	COD (mg/l)	DCOD (mg/l)	Sulfide (mg/l)	MBAS (mg/l)	SS (mg/l)	Settleable matter (mg/l)	(%)	Gauge (cm)
Mean	5.9	6.24	0.69	0.74	0.204	4.61	0.395	0.310	0.231	43.7	34.1	37.9	30.0	1.54	1.75	122.1	174.7	64	12
SD	0.5	0.97	0.39	0.61	0.162	1.24	0.052	0.059	0.060	50.1	47.8	47.6	37.3	1.22	1.26	281.6	336.0	15	1
				0.60										1.27		132.3			
				0.41						14.8	10.7	10.4	11.7	0.79		290.8	7.9	61	
										1.5	4.8	2.5	6.1				8.1		

C-St. 1, January 24-25, 1991

Item	DO (mg/l)	TN (mg/l)	TON (mg/l)	NO3-N (mg/l)	NO2-N (mg/l)	NH4-N (mg/l)	TP (mg/l)	TDP (mg/l)	PO4-P (mg/l)	BOD (mg/l)	DBOD (mg/l)	COD (mg/l)	DCOD (mg/l)	Sulfide (mg/l)	MBAS (mg/l)	SS (mg/l)	Settleable matter (mg/l)	(%)	Gauge (cm)
Mean	7.1	6.35	0.68	1.32	0.177	4.18	0.526	0.417	0.325	16.7	10.5	15.7	12.0	2.97	1.31	9.7	5.0	47	3
SD	0.3	0.75	0.20	0.38	0.061	0.61	0.064	0.084	0.092	8.9	4.9	6.0	2.5	0.15	0.44	5.7	4.5	10	1

C-St. 1, March 7-8, 1991

Item	DO (mg/l)	TN (mg/l)	TON (mg/l)	NO3-N (mg/l)	NO2-N (mg/l)	NH4-N (mg/l)	TP (mg/l)	TDP (mg/l)	PO4-P (mg/l)	BOD (mg/l)	DBOD (mg/l)	COD (mg/l)	DCOD (mg/l)	Sulfide (mg/l)	MBAS (mg/l)	SS (mg/l)	Settleable matter (mg/l)	(%)	Gauge (cm)
Mean	7.7	10.06	1.39	0.84	0.049	7.78	0.887	0.605	0.447	15.9	14.8	15.2	15.1	3.89	2.80	22.3	10.2	45	7
SD	0.3	1.19	0.28	0.25	0.004	1.52	0.238	0.182	0.088	6.2	4.9	2.4	2.7	0.26	0.79	10.0	5.5	8	1

C-St. 1, May 14-15, 1991

Item	DO (mg/l)	TN (mg/l)	TON (mg/l)	NO3-N (mg/l)	NO2-N (mg/l)	NH4-N (mg/l)	TP (mg/l)	TDP (mg/l)	PO4-P (mg/l)	BOD (mg/l)	DBOD (mg/l)	COD (mg/l)	DCOD (mg/l)	Sulfide (mg/l)	MBAS (mg/l)	SS (mg/l)	Settleable matter (mg/l)	(%)	Gauge (cm)
Mean	3.9	3.15	0.46	1.85	0.596	0.26	0.224	0.170	0.117	4.8	3.6	6.8	6.0	4.30	1.54	15.8	6.2	41	
SD	0.6	0.72	0.14	0.83	0.332	0.06	0.083	0.064	0.048	1.3	1.4	1.7	1.2	0.38	0.42	11.6	5.2	12	

Table 3.4.2-5 Water Quality Obtained from 24-hour Survey on Chungroung Chong, C-St. 2

C-St. 2, July 26-27, 1990

Item	DO (mg/l)	TN (mg/l)	TON (mg/l)	NO3-N (mg/l)	NO2-N (mg/l)	NH4-N (mg/l)	TP (mg/l)	TDP (mg/l)	PO4-P (mg/l)	BOD (mg/l)	DBOD (mg/l)	COD (mg/l)	DCOD (mg/l)	Sulfide (mg/l)	MBAS (mg/l)	SS (mg/l)	Settleable matter (ml/l)	(%)	Gauge (cm)
Mean	6.6	-	-	1.89	0.080	2.61	0.300	-	0.204	5.4	-	6.0	-	3.1	2.28	4.8	4.3	81	17
SD	0.4	-	-	0.21	0.040	0.90	0.069	-	0.071	0.8	-	0.8	-	0.5	0.68	4.5	4.4	12	4
					0.069											3.8	3.3		
					0.013											2.9	2.9		

St. 2, September 13-14, 1990

Item	DO (mg/l)	TN (mg/l)	TON (mg/l)	NO3-N (mg/l)	NO2-N (mg/l)	NH4-N (mg/l)	TP (mg/l)	TDP (mg/l)	PO4-P (mg/l)	BOD (mg/l)	DBOD (mg/l)	COD (mg/l)	DCOD (mg/l)	Sulfide (mg/l)	MBAS (mg/l)	SS (mg/l)	Settleable matter (ml/l)	(%)	Gauge (cm)
Mean	5.7	3.04	0.30	3.23	0.203	0.21	0.321	0.301	0.245	8.4	7.0	10.3	7.9	2.90	2.39	2.8	1.9	68	17
SD	0.5	0.55	0.11	0.12	0.493	0.12	0.114	0.073	0.064	2.9	2.9	1.5	3.1	0.50	0.69	1.3	1.1	13	3
		3.80			0.079		0.304												
		0.32			0.119		0.069												

St. 2, November 6-7, 1990

Item	DO (mg/l)	TN (mg/l)	TON (mg/l)	NO3-N (mg/l)	NO2-N (mg/l)	NH4-N (mg/l)	TP (mg/l)	TDP (mg/l)	PO4-P (mg/l)	BOD (mg/l)	DBOD (mg/l)	COD (mg/l)	DCOD (mg/l)	Sulfide (mg/l)	MBAS (mg/l)	SS (mg/l)	Settleable matter (ml/l)	(%)	Gauge (cm)
Mean	6.0	5.79	0.53	0.84	0.048	4.37	0.689	0.595	0.418	37.3	25.0	33.0	33.0	2.25	1.74	53.3	36.4	60	14
SD	0.6	1.44	0.26	1.09	0.040	2.12	0.588	0.526	0.408	27.4	18.7	32.1	32.1	1.24	1.17	73.4	54.8	16	1
											15.4		16.8			37.5	23.6		
										21.5	6.4	16.0	8.1			50.8	22.9		

C-St. 2, January 24-25, 1991

Item	DO (mg/l)	TN (mg/l)	TON (mg/l)	NO3-N (mg/l)	NO2-N (mg/l)	NH4-N (mg/l)	TP (mg/l)	TDP (mg/l)	PO4-P (mg/l)	BOD (mg/l)	DBOD (mg/l)	COD (mg/l)	DCOD (mg/l)	Sulfide (mg/l)	MBAS (mg/l)	SS (mg/l)	Settleable matter (ml/l)	(%)	Gauge (cm)
Mean	6.9	9.31	1.11	1.46	0.294	6.44	0.526	0.425	0.374	17.8	10.8	15.1	12.5	2.51	1.07	19.5	12.3	58	7
SD	0.8	1.22	0.24	0.62	0.165	1.30	0.108	0.077	0.085	10.4	5.6	4.7	2.3	0.76	0.23	14.4	11.7	12	0

C-St. 2, March 7-8, 1991

Item	DO (mg/l)	TN (mg/l)	TON (mg/l)	NO3-N (mg/l)	NO2-N (mg/l)	NH4-N (mg/l)	TP (mg/l)	TDP (mg/l)	PO4-P (mg/l)	BOD (mg/l)	DBOD (mg/l)	COD (mg/l)	DCOD (mg/l)	Sulfide (mg/l)	MBAS (mg/l)	SS (mg/l)	Settleable matter (ml/l)	(%)	Gauge (cm)
Mean	6.2	7.95	0.87	1.20	0.063	5.82	0.798	0.526	0.370	12.4	10.3	14.0	13.2	3.24	2.96	27.5	12.2	42	22
SD	1.0	1.32	0.35	0.26	0.025	1.25	0.110	0.112	0.072	6.9	4.9	1.6	1.9	0.90	0.66	13.0	7.3	7	0

C-St. 2, May 14-15, 1991

Item	DO (mg/l)	TN (mg/l)	TON (mg/l)	NO3-N (mg/l)	NO2-N (mg/l)	NH4-N (mg/l)	TP (mg/l)	TDP (mg/l)	PO4-P (mg/l)	BOD (mg/l)	DBOD (mg/l)	COD (mg/l)	DCOD (mg/l)	Sulfide (mg/l)	MBAS (mg/l)	SS (mg/l)	Settleable matter (ml/l)	(%)	Gauge (cm)
Mean	5.4	3.74	0.48	2.40	0.567	0.30	0.154	0.101	0.067	5.5	3.0	7.5	6.9	4.53	1.23	18.3	12.3	56	7
SD	0.8	1.20	0.13	1.37	0.420	0.11	0.069	0.041	0.026	1.9	1.5	1.9	3.0	0.15	0.17	18.4	14.0	16	0

Table 3.4.2-6 Water Quality Obtained from 24-hour Survey on Chungroung Chong, C-St. 3

St. 3, July 26-27, 1990

Item	DO (mg/l)	TN (mg/l)	TON (mg/l)	NO3-N (mg/l)	NO2-N (mg/l)	NH4-N (mg/l)	TP (mg/l)	TDP (mg/l)	PO4-P (mg/l)	BOD (mg/l)	DBOD (mg/l)	COD (mg/l)	DCOD (mg/l)	Sulfide (mg/l)	MBAS (mg/l)	SS (mg/l)	Settleable matter (mg/l)	(%)	Gauge (cm)
Mean	6.3	-	-	2.39	0.063	2.54	0.311	0.264	0.241	6.0	-	6.2	-	3.2	2.00	4.1	3.7	83	22
SD	0.7	-	-	0.23	0.013	0.82	0.107	0.085	0.089	1.1	-	1.3	-	0.6	0.40	2.7	2.6	14	5
					0.060	2.35	0.288	0.246	0.221										
					0.008	0.52	0.074	0.057	0.058										

St. 3, September 13-14, 1990

Item	DO (mg/l)	TN (mg/l)	TON (mg/l)	NO3-N (mg/l)	NO2-N (mg/l)	NH4-N (mg/l)	TP (mg/l)	TDP (mg/l)	PO4-P (mg/l)	BOD (mg/l)	DBOD (mg/l)	COD (mg/l)	DCOD (mg/l)	Sulfide (mg/l)	MBAS (mg/l)	SS (mg/l)	Settleable matter (mg/l)	(%)	Gauge (cm)
Mean	5.7	5.59	0.36	4.99	0.518	0.11	0.296	0.230	0.198	8.7	6.4	8.0	8.3	3.2	2.05	3.9	2.9	66	21
SD	0.3	0.48	0.12	0.43	0.391	0.07	0.050	0.041	0.034	2.1	2.5	2.6	2.8	0.5	0.41	1.2	1.3	16	2
													7.0						
													2.0						

St. 3, November 6-7, 1990

Item	DO (mg/l)	TN (mg/l)	TON (mg/l)	NO3-N (mg/l)	NO2-N (mg/l)	NH4-N (mg/l)	TP (mg/l)	TDP (mg/l)	PO4-P (mg/l)	BOD (mg/l)	DBOD (mg/l)	COD (mg/l)	DCOD (mg/l)	Sulfide (mg/l)	MBAS (mg/l)	SS (mg/l)	Settleable matter (mg/l)	(%)	Gauge (cm)
Mean	6.5	5.94	0.68	0.79	0.060	4.42	0.398	0.341	0.208	41.8	19.3	31.0	21.4	2.90	1.60	78.4	68.7	63	17
SD	0.5	0.86	0.28	0.54	0.041	1.01	0.104	0.066	0.059	53.1	25.3	35.6	24.9	1.00	0.60	174.9	160.0	18	1
							0.374			11.1	9.0	10.4	11.0			35.1	27.4		
							0.067			1.0	4.4	0.9	5.1			93.7	74.7		
																6.9	4.9		
																6.7	5.8		

C-St. 3, January 24-25, 1991

Item	DO (mg/l)	TN (mg/l)	TON (mg/l)	NO3-N (mg/l)	NO2-N (mg/l)	NH4-N (mg/l)	TP (mg/l)	TDP (mg/l)	PO4-P (mg/l)	BOD (mg/l)	DBOD (mg/l)	COD (mg/l)	DCOD (mg/l)	Sulfide (mg/l)	MBAS (mg/l)	SS (mg/l)	Settleable matter (mg/l)	(%)	Gauge (cm)
Mean	5.1	10.41	1.14	2.06	0.021	8.61	0.840	0.605	0.503	21.7	13.6	19.0	14.5	2.97	2.02	19.0	11.6	60	17
SD	1.3	2.33	0.33	0.28	0.011	2.79	0.510	0.254	0.244	5.8	4.9	4.3	3.8	0.81	2.46	13.8	9.3	10	2

C-St. 3, March 7-8, 1991

Item	DO (mg/l)	TN (mg/l)	TON (mg/l)	NO3-N (mg/l)	NO2-N (mg/l)	NH4-N (mg/l)	TP (mg/l)	TDP (mg/l)	PO4-P (mg/l)	BOD (mg/l)	DBOD (mg/l)	COD (mg/l)	DCOD (mg/l)	Sulfide (mg/l)	MBAS (mg/l)	SS (mg/l)	Settleable matter (mg/l)	(%)	Gauge (cm)
Mean	6.3	8.83	0.84	1.21	0.054	6.73	0.938	0.612	0.495	31.3	25.5	24.4	19.7	4.35	3.30	30.4	16.7	48	17
SD	0.5	1.03	0.29	0.62	0.02	0.81	0.483	0.320	0.291	19.3	16.9	15.9	11.3	0.26	1.19	19.7	14.5	13	1
																	13.7		
																	10.7		

C-St. 3, May 14-15, 1991

Item	DO (mg/l)	TN (mg/l)	TON (mg/l)	NO3-N (mg/l)	NO2-N (mg/l)	NH4-N (mg/l)	TP (mg/l)	TDP (mg/l)	PO4-P (mg/l)	BOD (mg/l)	DBOD (mg/l)	COD (mg/l)	DCOD (mg/l)	Sulfide (mg/l)	MBAS (mg/l)	SS (mg/l)	Settleable matter (mg/l)	(%)	Gauge (cm)
Mean	6.2	7.32	2.14	0.29	1.282	3.56	0.871	0.755	0.602	14.7	9.9	11.5	10.0	4.33	1.25	6.7	2.3	33	17
SD	0.5	1.01	1.01	0.33	0.700	1.2	0.174	0.198	0.146	4.6	5.7	1.7	1.8	0.15	0.15	2.4	0.9	2	1

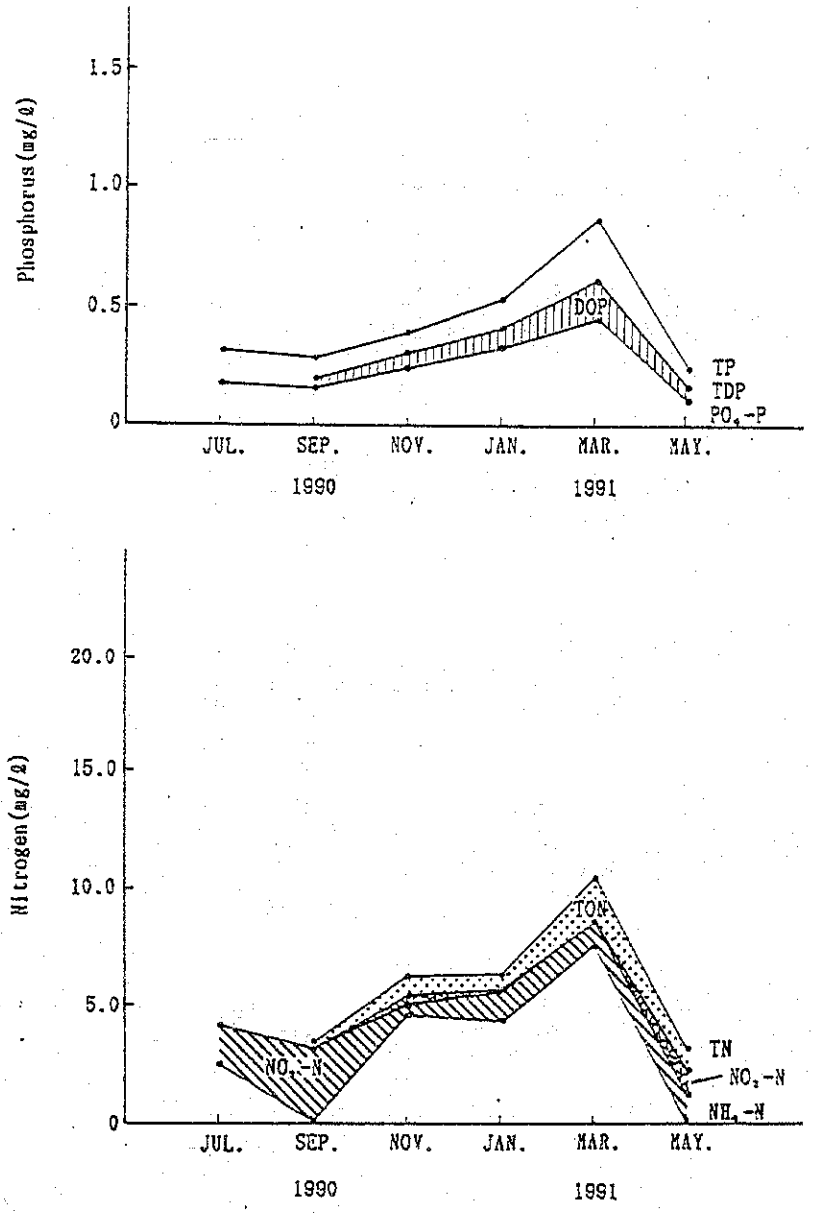


Fig. 3.4.2-3 Variation of Nitrogen and Phosphorus of Chungroung Chong at C-St. 1 from July, 1990 to May, 1991

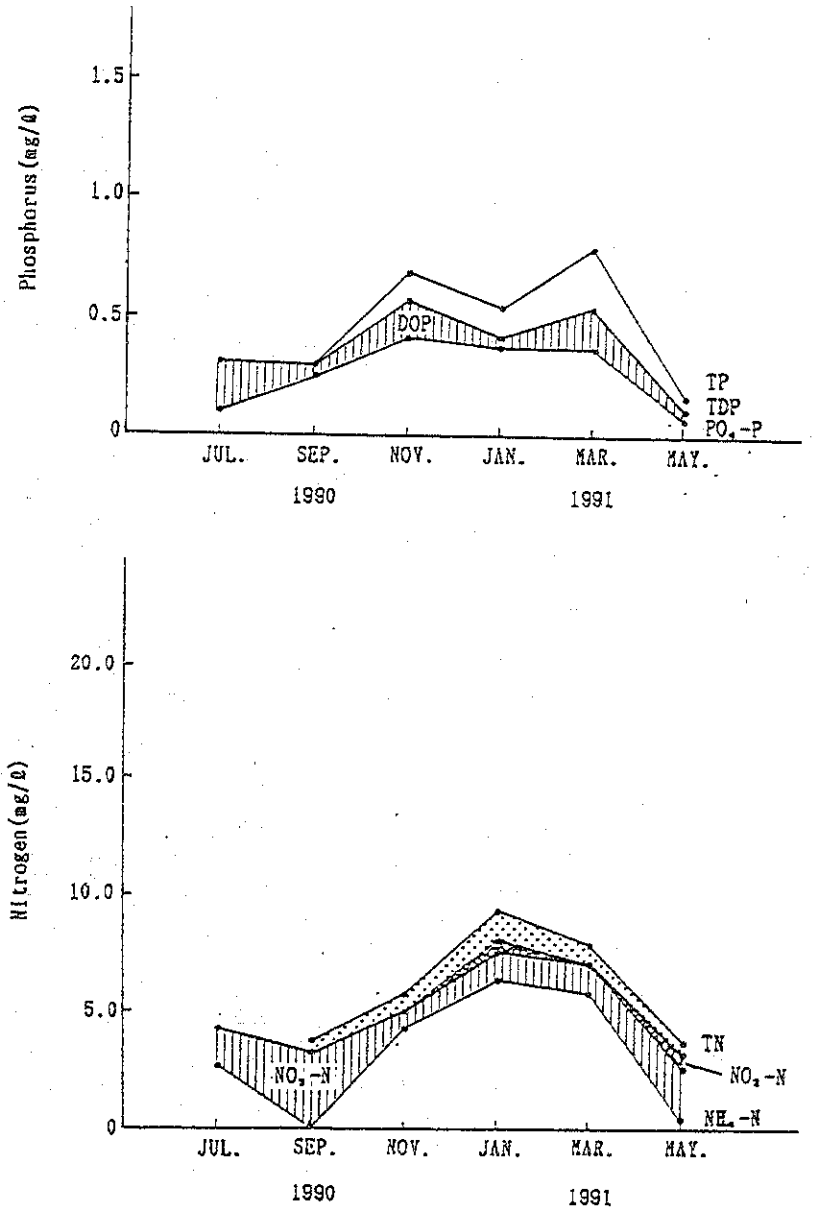


Fig. 3.4.2-4 Variation of Nitrogen and Phosphorus of Chungroung Chong at C-St. 2 from July, 1990 to May, 1991

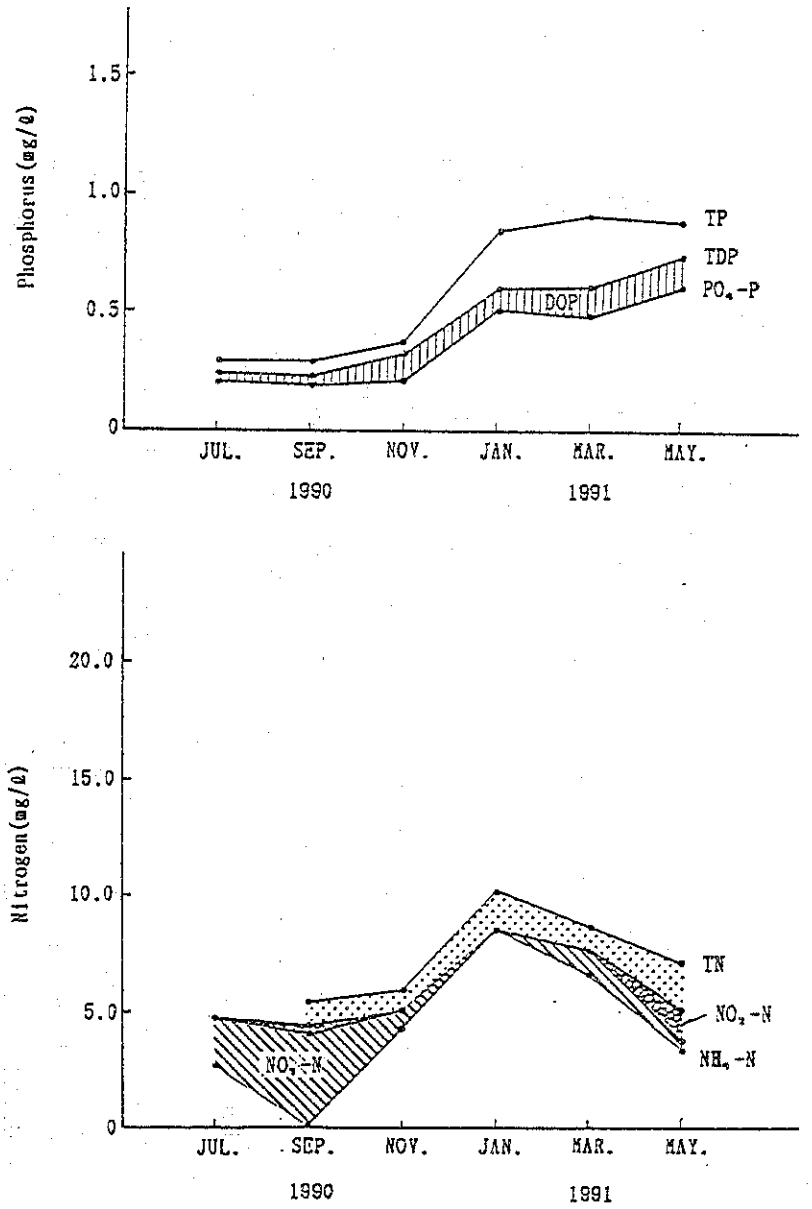


Fig. 3.4.2-5 Variation of Nitrogen and Phosphorus of Chungroung Chong at C-St. 3 from July, 1990 to May, 1991

TN at C-St. 2 showed a clear sign curve with the peak in January (3.74-9.31 mg/l).

Due to the location, TN at C-St. 3 was constantly higher (5.59-10.41 mg/l) than the other two stations with a similar curve at C-St. 2.

TON concentration at all stations was found in low values (0.21-1.39 mg/l) and the percentage to TN was usually from 6-15 %, with exception of 29 % at C-St. 3 in May. It means that TIN showed a similar distribution pattern to TN. Of TIN, the main part was usually NH_4-N (66-83 %), being displaced occasionally by NO_3-N (Table 3.4.2-7).

TP showed a similar distribution pattern to TN, lower concentrations from July to September, gradually increasing until the maximum is reached in March at all stations. The values at C-St. 1 (0.224-0.887 mg/l) and C-St. 2 (0.154-0.798 mg/l), however, decreased in May, contrasted to this, C-St. 3 kept the same level (0.288-0.938 mg/l) as the one of TN found the month before (Figs. 3.4.2-3-5, Tables 3.4.2-4-6).

PO_4-P concentration showed the great monthly variation (0.067-0.602 mg/l), however, its percentage to TP was in the narrow range from 44-77 %).

The distributions of N and P may indicate that the degree of pollution from up stream became greater after January, 1991. In May, however, with increase of temperature, it is supposed that self-purification occurred between C-St. 3 and C-St. 2, and C-St. 1, consequently the concentration at C-St. 1 and C-St. 2 were found in lower values.

Percentages of DBOD to BOD (55-93 %) were usually lower than DCOD(Mn) to TCOD(Mn) (77-99 %), as found on other rivers (Table 3.4.2-9).

Table 3.4.2-7 Each Form of Nirtogen in Chungroung Chong (24-hour)

		July (mg/l)	Ratio	September (mg/l)	(%)	November (mg/l)	(%)	January (mg/l	(%)	March (mg/l)	(%)	May (mg/l)	(%)
St. 1	TN	-		3.39		6.24		6.35		10.06		3.15	
	TON	-		0.21	6	0.69	11	0.68	11	1.39	14	0.46	15
	NO3-N	1.94	1	3.06	90	0.60	10	1.32	21	0.84	8	1.85	59
	NH4-N	2.30	1.2	0.09	3	4.61	74	4.18	66	7.78	77	0.26	8
St. 2	TN	-		3.80		5.79		9.31		7.95		3.74	
	TON	-		0.30	8	0.53	9	1.11	12	0.87	11	0.48	13
	NO3-N	1.89	1	3.23	85	0.84	15	1.46	16	1.20	15	2.40	64
	NH4-N	2.61	1.4	0.21	6	4.37	75	6.44	69	5.82	73	0.30	8
St. 3	TN	-		5.59		5.94		10.41		8.83		7.32	
	TON	-		0.36	6	0.68	11	1.14	11	0.84	10	2.14	29
	NO3-N	2.39	1	4.99	89	0.79	13	2.06	20	1.21	14	0.29	4
	NH4-N	2.35	1	0.11	2	4.42	74	8.61	83	6.73	76	3.56	49

Table 3.4.2-8 TP and PO4-P of Chungroung Chong (24-hour)

		July (mg/l)	(%)	September (mg/l)	(%)	November (mg/l)	(%)	January (mg/l)	(%)	March (mg/l)	(%)	May (mg/l)	(%)
St. 1	TP	0.322		0.274		0.395		0.526		0.887		0.224	
	PO4-P	0.184	57	0.162	59	0.231	58	0.417	79	0.447	50	0.117	52
St. 2	TP	0.300		0.321		0.689		0.526		0.798		0.154	
	PO4-P	0.204	68	0.245	76	0.418	61	0.374	71	0.370	46	0.067	44
St. 3	TP	0.288		0.296		0.374		0.840		0.938		0.871	
	PO4-P	0.221	77	0.198	67	0.208	56	0.503	60	0.495	53	0.602	69
Mean			67		67		58		70		50		55

Table 3.4.2-9 DBOD and DCOD(Mn) of Chungroung Chong (24-hour)

		July (mg/l)	Ratio	September (mg/l)	(%)	November (mg/l)	(%)	January (mg/l	(%)	March (mg/l)	(%)	May (mg/l)	(%)
St. 1	BOD	5.4	1	5.6	1	14.8	1	16.7	1	15.9	1	4.8	1
	DBOD	-		4.9	88	10.7	72	10.5	63	14.8	93	3.6	75
	COD	6.1	1.1	7.9	1	10.4	0.7	15.7	0.9	15.2	1	6.8	1.4
	DCOD	-		7.7	97	9.4	90	12.0	76	15.1	99	6.0	88
St. 2	BOD	5.4	1	8.4	1	21.5	1	17.8	1	12.4	1	5.5	1
	DBOD	-		7.0	83	15.4	72	10.8	61	10.3	83	3.0	55
	COD	6.0	1.2	10.3	1	16.0	0.7	15.1	0.8	14.0	1.1	7.5	1.4
	DCOD	-		7.9	77	13.6	85	12.5	83	13.2	94	6.9	92
St. 3	BOD	6.0	1	8.7	1	11.1	1	21.6	1	31.3	1	14.7	1
	DBOD	-		6.4	74	9.0	81	13.6	63	25.5	81	9.9	67
	COD	6.2	1	8.0	0.9	10.4	0.9	19.0	0.9	24.4	0.8	11.5	0.8
	DCOD	-		7.0	88	9.9	95	14.5	76	19.7	81	10.0	87

Table 3.4.2-10 SS and Settleable Matter of Chungroung Chong (24-hour)

		July (mg/l)	(%)	September (mg/l)	(%)	November (mg/l)	(%)	January (mg/l)	(%)	March (mg/l)	(%)	May (mg/l)	(%)
St. 1	SS	6.7		4.5		12.9		9.7		22.3		15.8	
	SM	5.6	84	4.1	87	7.9	61	5.0	47	10.2	45	6.2	45
St. 2	SS	3.8		2.8		15.4		19.5		27.5		18.3	
	SM	3.3	81	1.9	68	9.1	59	12.3	58	12.2	42	12.3	42
St. 3	SS	4.1		3.9		6.9		19.0		30.4		6.7	
	SM	3.7	83	2.9	66	4.9	63	11.6	60	16.7	48	2.3	48
Mean			83		74		61		55		45		45

Sulfide was constantly low at all stations, although the relatively lower values were found at St. 1 (1.54-4.30 mg/l) than on the other two stations (2.25-4.53 mg/l at C-St.2; 2.9-4.53 mg/l at C-St. 3). These gradually decreased from July to the lowest in November, then increased until the highest in May (Tables 3.4.2-4-6).

MBAS were found in values from 1.07 to 3.30 mg/l, showing higher values at C-St. 3. Because of the location, C-St. 3 may have easily been affected by the waste water from upper stream.

Whatever the concentrations were, the percentage of settleable SS matter to SS were in fairly narrow ranges from 42 to 87 %, showing a slight decrease from July, 1990, to May, 1991. The great part of SS being composed by larger particles make the treatment system of the works easier (Table 3.4.2-10).

3.4.3 Change of Water Quality and Pollution Load from the Upper to the Lower Stations

(1) Change in the short period

The results obtained from the four surveys conducted from May to June, 1991 are discussed below.

The bottom materials in this river are mainly composed of coarse sand (see Fig. 3.4.8-1). There may exist underground streams between C-St. 3 and C-St. 2, and C-St. 2 and C-St. 1, therefore, occasionally there was no discharge found at C-St. 1 and C-St. 2. Contrasted to these stations, due to the location on the mouth of a covered small river to which waste water are inflowing, the discharge at C-St. 3 was constantly higher than other two stations (Tables 3.4.3-1-3).

Discharges at all stations showed great variances, 0.00-0.03 m^3/s at C-St. 1, 0.010-0.082m^3/s at C-St. 2 and 0.143-0.230 m^3/s at C-St. 3, even in a short period.

Table 3.4.3-1 Water Quality of Chungroung Chong, C-St. 1, May-June, 1991
Discharge was practically measured on the same time.

Station	Date	COD(Mn) (mg/l)	COD(Cr) (mg/l)	SS-1 (mg/l)	SS-2 (mg/l)	SS-2(IL) (mg/l)	(IL)/ SS-2(%)	SS-2/ TR(%)	SS(IL)/ TR(%)	SS(IL)/ TR(IL)(%)	TR (mg/l)	TR(IL) (mg/l)	TR(IL)/ TR(%)	SM (mg/l)	SM(IL) (mg/l)	SM(IL)/ SM(%)	SM/TR (%)	SM/SS (%)	SM(IL)/ TR(IL)(%)	NH4-N (mg/l)	NO3-N (mg/l)	WT (°C)	DO (mg/l)	EC (mS/cm)	Discharge (m3/s)
C-St. 1-2	May 28	8.0	25	16	5.0	2.5	50	2	1	16	202	15.7	8	3.5	1.4	40	1.7	70	8.9	5.55	3.6	28.1	-	0.7	0.028
C-St. 1-2	Jun. 26	8.5	-	4	5.5	4.5	82	2	2	2	290	221.3	76	-	-	-	-	-	-	2.10	1.7	26.5	10.7	0.7	0.012
	Mean	8.3		5	11.0	2.3	66	2	2	9	246	119	42	-	-	-	-	-	-	3.83	2.7	27.3	5.4	0.7	

Table 3.4.3-2 Water Quality of Chungroung Chong, C-St. 2, May-June, 1991
Discharge was practically measured on the same time.

Station	Date	COD(Mn) (mg/l)	COD(Cr) (mg/l)	SS-1 (mg/l)	SS-2 (mg/l)	SS-2(IL) (mg/l)	(IL)/ SS-2(%)	SS-2/ TR(%)	SS(IL)/ TR(%)	SS(IL)/ TR(IL)(%)	TR (mg/l)	TR(IL) (mg/l)	TR(IL)/ TR(%)	SM (mg/l)	SM(IL) (mg/l)	SM(IL)/ SM(%)	SM/TR (%)	SM/SS (%)	SM(IL)/ TR(IL)(%)	NH4-N (mg/l)	NO3-N (mg/l)	WT (°C)	DO (mg/l)	EC (mS/cm)	Discharge (m3/s)
C-St. 2-2	May 28	6.7	43	5	7.0	4.0	57	4	2	17	185	23.3	13	2.3	0.9	39	1.2	33	4	3.58	2.5	25.3	-	0.8	0.082
C-St. 2-2	Jun. 5	7.3	21	5	19.5	14.5	74	4	3	10	480	141.0	29	5.5	4	73	1.1	28	2.8	0.34	3.5	26.2	-	0.7	0.017
C-St. 2-2	Jun. 10	6.1	30	5	20.0	8.4	42	4	2	8	476	103.0	22	7.7	2.0	26	1.6	39	1.9	0.85	2.3	26.2	12.4	0.7	0.013
C-St. 2-2	Jun. 26	5.8	(0	1	1.0	0.9	90	0.3	0.3	0.4	308	233.3	76	-	-	-	-	-	-	2.90	2.9	22.9	10.9	0.7	
	Mean	6.5	31	4	11.9	7.0	65.9	3.1	1.8	9.0	362	125.2	35	5.2	2.3	45.9	1.3	33	2.9	1.92	2.8	25.2	11.7	0.7	
	SD	0.6	9	2	8.2	5.1	18.0	1.6	1.0	6.0	124	75.5	24	2.2	1.3	19.7	0.2	4	0.8	1.36	0.5	1.4	0.8	0.0	

Table 3.4.3-3 Water Quality of Chungroung Chong, C-St. 3, May-June, 1991
Discharge was practically measured on the same time.

Station	Date	COD(Mn) (mg/l)	COD(Cr) (mg/l)	SS-1 (mg/l)	SS-2 (mg/l)	SS-2(IL) (mg/l)	(IL)/ SS-2(%)	SS-2/ TR(%)	SS(IL)/ TR(%)	SS(IL)/ TR(IL)(%)	TR (mg/l)	TR(IL) (mg/l)	TR(IL)/ TR(%)	SM (mg/l)	SM(IL) (mg/l)	SM(IL)/ SM(%)	SM/TR (%)	SM/SS (%)	SM(IL)/ TR(IL)(%)	NH4-N (mg/l)	NO3-N (mg/l)	WT (°C)	DO (mg/l)	EC (mS/cm)	Discharge (m3/s)
C-St. 3-2	May 28	13.0	45	4	17.5	12.5	71	5	4	34	354	36.7	10	7.9	4.8	61	2.2	45	13.1	5.29	1.4	21.1	-	0.8	0.230
C-St. 3-1	Jun. 5	11.3	23	4	9.5	6.5	68	3	2	4	360	166.7	46	1.5	1.0	67	0.4	16	0.6	10.14	1.4	23.0	17.0	0.8	0.143
C-St. 3-2	"	15.0	100	11	24.0	16.0	67	6	4	13	394	119.3	30	5.0	3.8	76	1.3	21	3.2	8.70	1.8	21.6	14.2	0.8	
C-St. 3-1	Jun. 10	14.3	58	9	16.8	12.7	76	4	3	4	406	324.7	80	2.0	1.3	65	0.5	12	0.4	12.25	0.5	23.2	5.7	0.8	0.188
C-St. 3-2	"	16.0	67	22	24.7	20.7	84	8	6	19	329	110.0	33	6.7	4.7	70	2.0	27	4.3	9.38	0.8	21.5	4.1	0.9	
C-St. 3-3	"	21.9	79	21	25.7	20.0	78	7	6	7	361	271.9	75	4.7	3.0	64	1.3	18	1.1	9.78	0.8	21.2	3.5	0.9	
C-St. 3-2	Jun. 26	-	19	17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10.10	0.9	24.1	4.4	0.9	
	Mean	15.3	56	13	19.7	14.7	74	5	4	14	367.3	171.6	46	4.6	3.1	67	1.3	23	3.8	9.38	1.1	22.2	8.2	0.8	
	SD	3.3	27	7	5.7	4.9	6	2	1	11	25.6	98.5	25	2.3	1.5	5	0.7	11	4.4	1.95	0.4	1.1	5.4	0.0	

The pollution load at C-St. 3 were estimated, and those values showed considerably higher values than other two stations, because of the high discharge and high water quality concentrations. Since the load at this station had a smaller range than the other two stations, it was thought that the water through the covered small sewer stream was not affected from outside, then the high and low variable pollution load at C-St. 3 was obtained.

The river water are filtrated before C-St. 2 and C-St. 1 by underground streaming. The concentrations of these stations, consequently, becomes lower and discharge also smaller, the load is inevitably calculated very low. SS, in particular, greatly decreased from C-St. 3 to C-St. 1 (Table 3.4.3-4).

Table 3.4.3-4 Pollution Load of Chungroung Chong in Short Period, May 28-June 26, 1991
Discharge: Actual measurement value

		COD(Mn) (kg/day)	BOD (kg/day)	SS (kg/day)	TR (t/day)	NH4-N (kg/day)	NO3-N (kg/day)
May 28, '91	C-St. 1	20.7	16.2	13.0	0.52	14.40	9.3
	C-St. 2	47.7	29.7	49.6	1.31	25.40	17.7
	C-St. 3	258.3	302.8	347.8	7.03	105.10	27.8
June 5, '91	C-St. 1	-	-	-	-	-	-
	C-St. 2	10.7	7.6	28.6	0.71	0.50	5.1
	C-St. 3	162.5	191.5	265.6	4.66	116.4	19.8
June 10, '91	C-St. 1	-	-	-	-	-	-
	C-St. 2	6.9	3.6	22.5	0.53	0.95	2.6
	C-St. 3	282.6	372.6	363.7	5.93	170.10	11.4
June 26, '91	C-St. 1	-	-	-	-	-	-
	C-St. 2	5	4.6	0.9	0.27	2.51	2.51
	C-St. 3	-	-	-	0.17	14.80	-

(2) Changes during the study period

There were two types of change of DO concentrations from the upper to the lower stations : One type was during the colder month in 1990, when DO values at all stations were being high, DO at C-St. 3 was higher than the lower stations and decreased gradually along downstream. The other type was that DO at C-St. 3 in the hotter months in 1990, from July to September and the whole survey period in 1991, January to May, was at its lowest and gradually increased along the stream (Fig. 3.4.3-1).

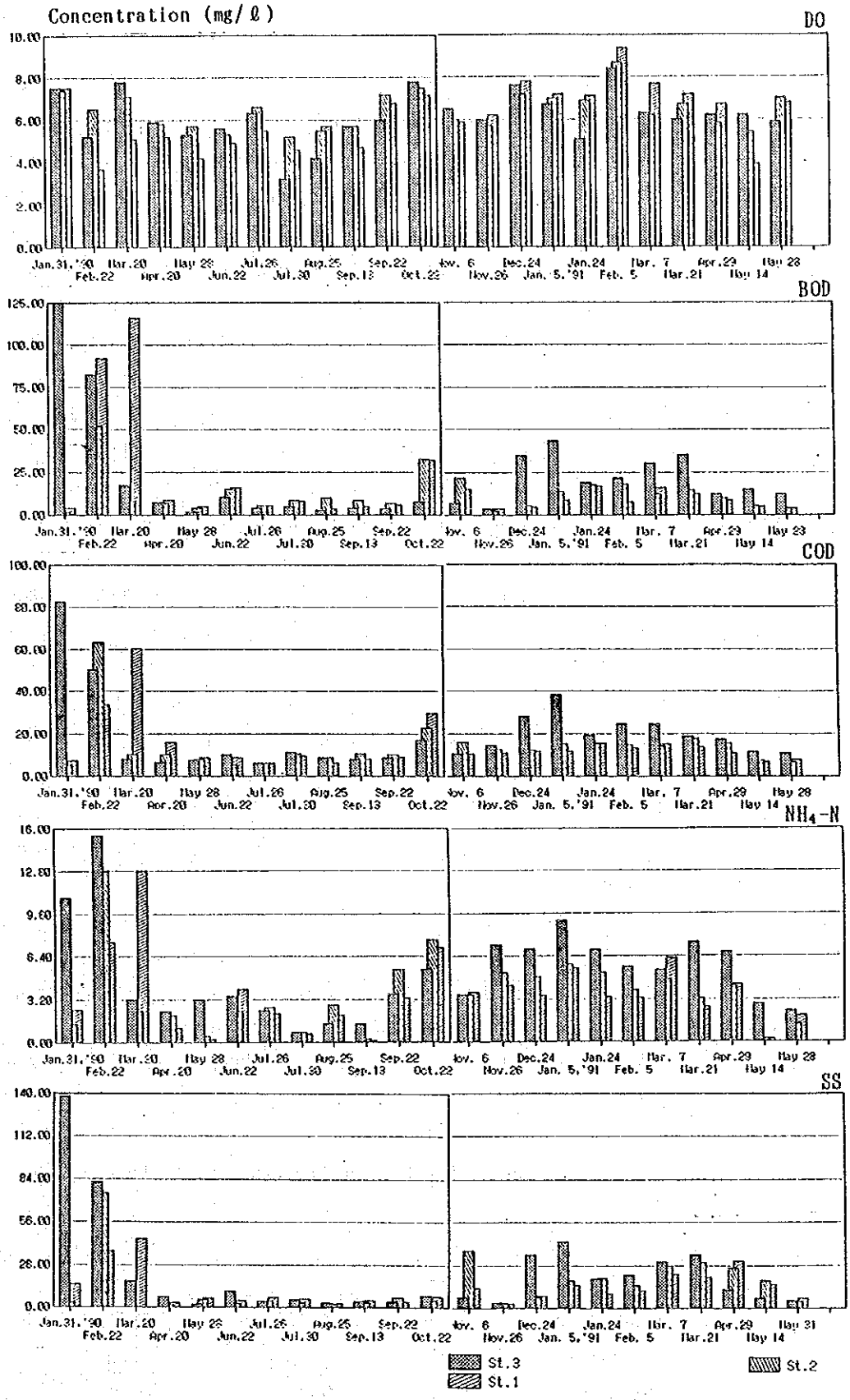


Fig. 3.4.3-1 Water Quality Change from the Upper to the Lower Stations of Chungroung Chong

Changes of the distribution patterns of COD(Mn), BOD , SS and NH_4-N concentrations were similar to one another showing three particular periods. One was that those values were extraordinarily high at all stations, in particular at C-St. 3, in January and February, 1990. Two was that the concentrations at all three stations were found with small differences from March to November, 1990. Three was that after November the concentrations at C-St. 3 were considerably higher than the other stations and decreased along the downstream.

The tendencies after November were clearly observed in the distributions of all items. It is supposed that after November unknown reason might have occur on the waste water which flowed through the sewer stream and appeared at C-St. 3 (Fig. 3.4.3-1).

Pollution loads were calculated using HQ curve and water quality data obtained by the monthly survey (Table 3.4.3-5). There were great monthly variances found in all values of loads on each station. The variances at C-St. 2 was largest, and at C-St. 3 the smallest. As found in the results obtained in the short period survey, the variance at C-St. 3 being the smallest was thought to be brought about by the waste water through the sewer stream a not affected from the outside, therefore constant distribution was found at C-St. 3.

No systematic monthly tendency of load was found on the same station. The mean pollution load showed the same tendencies among the three stations as found in the short period survey ; the load at C-St. 3 was the greatest it dropped at C-St. 2, while the lowest values were found at C-St. 1.

Table 3.4.3-5 Mean Pollution Load at Each Station

Item St.	St. 1	St. 2	St. 3
BOD(ton/day)	0.73	1.67	3.84
COD(ton/day)	0.73	1.76	2.75
SS(ton/day)	0.52	1.18	2.01
NH_4-N(ton/day)	0.22	0.57	0.80

These mean values were higher than those obtained during the short period. The extremely high values and those known to have been affected by the rainfall were omitted from the estimation of the mean values. However, the values obtained in September and November were quite higher than other months, and these might be due to after-effects of the rainfall. These may be the ones that gave the high mean values.

3.4.4 Side-inflow into Chungroung Chong

There are 17 side-inflows into Chungroung Chong (Fig. 3.4.4-1). Five of them were directly inflowing to this river, although the discharges were small except in Nos. 11 and 17 (Table 3.4.4-1). Generally, COD(Cr) and TKN values of these inflows were higher than those found on the Chungroung Chong water (Fig. 3.4.4-1 : A1-A4).

The upper part of Chungroung Chong is underdrained. Ryangkohu Chong (No. 15), the branch, is also underdrained and its water is now full of sewage. However, the water of this river does not directly flow into Chungroung Chong on clear days.

The water of indirect side-inflows are carried to the intercepting sewer pipe. It is, therefore, thought that the effects of these side-inflows on the water quality of this river is small on clear days.

It is, however, obvious that the water of this river is significantly polluted. A trial to find out where the pollutant was coming from was attempted with use the dye in December, 1990. The dye was placed in the sewer on the upper part of C-St. 3 from which sewer water must be carried to intercepting sewers. However, the dye was unfortunately discovered in the water of the river at the lower part of C-St. 3. It means that sewage is flowing directly into the river, although the degree of the total volume is still unknown.

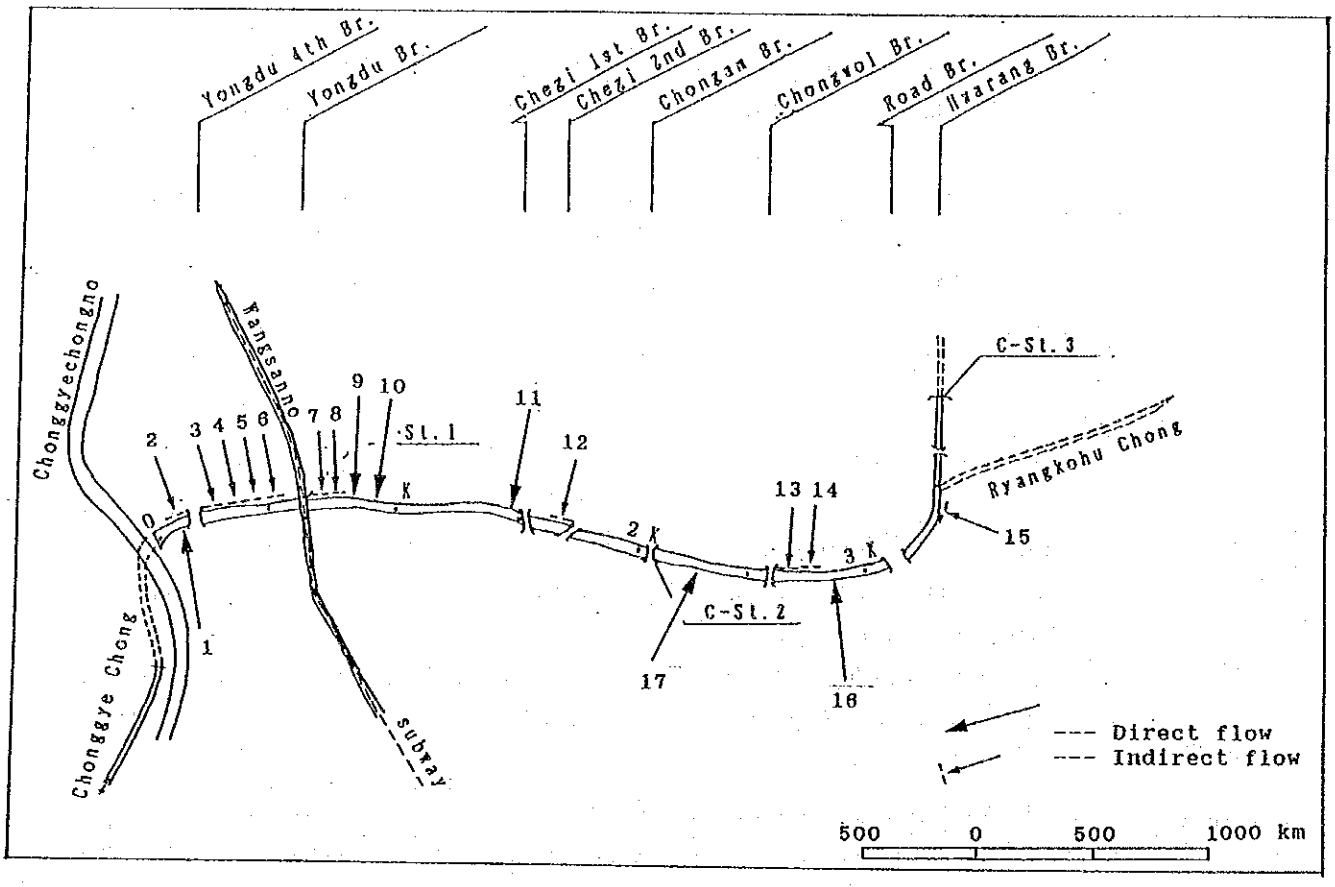


Fig. 3.4.4-1 Side-Inflow into Chungroung Chong

Table 3.4.4-1 Side Inflow into Chungroung Chong

Date: July 12, 1990
Weather on the day: Cloudy
Weather on the privious day: Rain
AT: 25°C

Item / Station	pH	WT (°C)	DO (mg/l)	EC (mg/l)	Turbid. (mg/l)	COD(Cr) (mg/l)	TKN (mg/l)	NO3-N (mg/l)	Discharge (m3/s)	Load COD(Cr) (t/day)
1	-	-	-	-	-	2	6.7	3.1	Very small	
2	-	-	-	-	-	19	11.7	2.3	-	
3	-	-	-	-	-	172	27.5	14.5	-	
4	-	-	-	-	-	81	12.5	4.0	-	
5	-	-	-	-	-	6	0.4	17.7	-	
6	7.6	24.8	4.9	0.8	18	96	15.8	5.2	-	
7	-	-	-	-	-	-	-	-	-	
8	-	-	-	-	-	174	-	10.9	(1.6 L)	
9	8.1	25.6	6.2	0.9	9	35	-	3.0	(12 L)	
10	7.4	23.6	5.9	0.7	0	4	-	17.3	2.2	0.00
11	7.5	24.7	4.6	0.5	40	172	-	14.7	-	
12	7.7	23.1	5.3	0.8	25	37	-	5.1	-	
13	7.9	23.1	5.5	0.9	30	47	-	3.3	-	
14	7.7	23.6	3.9	0.9	22	54	-	5.2	-	
15	7.5	23.4	3.4	0.8	24	48	-	4.1	-	
16	8.4	25.2	5.9	0.7	93	124	-	10.6	(48 L)	
17	7.6	22.5	7.2	0.9	6	11	-	3.9	9.9	9.41
A1	7.7	28.0	5.3	0.8	3	-	-	-	-	
A2	7.7	28.2	5.6	0.8	4	4	-	2.9	-	
A3	7.7	30.1	5.4	0.9	2	11	-	2.7	-	
A4	7.5	21.0	6.2	0.9	2	11	-	6.0	-	

1, 9, 10, 11, 16, 17: Direct Side-inflow
A1, A2, A3, A4: Water of Chungroung Chong

3.4.5 Water Quality and Pollution Load at Freshet Time

The survey was conducted at C-St. 1 on July 1-2, 1991. The precipitation was 6 mm.

The water level suddenly increased showing two peaks and it slowly decreased. The water level returned to the ordinary level in 19 and a half hours after the second peak (Fig. 3.4.5-1).

Distribution pattern of concentrations of water qualities during this freshet time were similar to that of the water level pattern, and the time of the peaks of both almost corresponded one another; the first peak was obtained within 2 hours after the water level started to go up and the second peak was found 6-7 hours after the first peak (Table 3.4.5-1).

Various forms of nitrogen flowed into this river by freshet, of these much of TON particularly inflowed (Table 3.4.5-2).

Table 3.4.5-2 Nitrogen during Freshet Time

TN(mg/l)	TON(mg/l)	NH_4-N(mg/l)
10.9-16.0	2.8-6.1	5.9-11.0

Much of SS, in particular the inorganic part of SS inflowed, even if the ratio of organic and inorganic parts of TR did not change even during freshet (TR(IL)/TR: 21-46%, SS(IL)/SS: 23-67 %) (Table 3.4.5-1).

Water quality concentrations were not recorded from the beginning of the time when the water level increased, therefore by means of assumption using the curves of both water level and water quality concentrations the flow-out load during the freshet (24 hours) were calculated (Table 3.4.5-4).

Table 3.4.5-1 Water Quality at Freshet Time of Chungroung Chong, C-St. 1, July 1, 1991

Date	Time	WT (°C)	pH	DO (mg/l)	EC (mS/cm)	Turbidi. (mg/l)	Water level (m)	Discharge (m3/s)	COD(Cr) (mg/l)	COD(Mn) (mg/l)	TN (mg/l)	TKN (mg/l)	TON (mg/l	TON/TN (%)	NO2-N (mg/l)	NO3-NO3-N/ (mg/lTN(%)		NH4-N (mg/l)	NH4-N/ TN(%)
July 1	11:50	23.6	6.2	5.3	0.8	96	13.342	4.903	58	18.0	16.0	13.8	2.8	17.5	0.190	2.0	12.5	11.0	68.8
	12:10	23.5	7.0	4.5	0.8	71	13.292	3.765	46	14.6	14.6	13.3	6.7	46.0	0.170	1.1	7.5	6.6	45.3
	12:50	23.4	7.5	3.7	0.8	25	13.262	3.154	29	14.0	13.9	12.9	4.7	33.9	0.175	0.8	5.8	8.2	59.1
	13:50	23.6	7.6	3.9	0.8	20	13.262	3.154	48	14.0	13.3	12.1	3.4	25.5	0.220	1.0	7.5	8.7	65.3
	14:00	23.7	7.8	4.4	0.9	40	13.312	4.202	45	15.0	12.9	11.7	3.7	28.8	0.155	1.0	7.8	8.0	62.2
	14:10	23.7	7.8	3.6	0.9	65	13.372	5.658	67	23.7	13.1	11.7	3.9	29.7	0.120	1.3	9.9	7.8	59.5
	14:20	23.8	7.7	3.2	0.9	60	13.392	6.191	60	24.0	14.8	13.3	6.1	41.3	0.180	1.3	8.8	7.2	48.7
	14:30	23.7	7.8	2.3	0.85	42	13.362	5.400	70	22.7	14.4	13.8	6.4	44.4	0.100	0.5	3.5	7.4	51.4
	15:00	23.6	7.7	2.9	0.85	25	13.302	3.981	42	15.2	14.4	12.9	5.6	38.8	0.235	1.3	9.0	7.3	50.6
	15:30	23.5	7.7	3.4	0.85	15	13.252	2.963	29	12.6	12.8	10.8	3.8	29.6	0.235	1.8	14.0	7.0	54.5
	16:00	23.6	7.7	4.0	0.85	12	13.212	2.256	31	10.8	11.7	10.0	4.1	35.1	0.180	1.5	12.8	5.9	50.5
	16:30	23.6	7.7	4.0	0.85	9	13.192	1.939	18	10.0	10.9	9.2	3.2	29.5	0.160	1.5	13.8	6.0	55.2
July 2	10:00						13.142	1.251											

Date	Time	TR (mg/l)	TR(IL) (mg/l)	TR(IL) /TR(%)	SS-1 (mg/l)	SS-2 (mg/l)	SS-2(IL) (mg/l)	SS-2(IL) /SS-2(%)	SS-2/ TR(%)	SS(IL) /TR(IL)	Cl- (mg/l)	PO4-P (mg/l)	SS(IL) /TR(%)
July 1	11:50	290	70.0	24	206	159.3	36.0	23	55	51	18	1.49	12
	12:10	243	77.3	32	117	117.3	33.3	28	48	43	18	4.52	14
	12:50	206	45.3	22	45	52.7	25.3	48	26	56	30	4.57	12
	13:50	239	66.1	28	45	37.3	17.3	46	16	26	33	1.40	7
	14:00	272	87.7	32	88	80.7	26.0	32	30	30	28	1.65	10
	14:10	290	82.9	29	139	173.0	66.0	38	60	80	31	1.90	23
	14:20	360	130.0	36	108	164.0	48.0	29	46	37	28	1.66	13
	14:30	307	141.3	46	115	129.3	37.3	29	42	26	27	1.79	12
	15:00	259	54.7	21	-	53.3	22.5	42	21	41	29	-	9
	15:30	216	84.6	39	-	41.5	17.5	42	19	21	27	-	8
	16:00	186	46.0	25	-	22.0	10.5	48	12	23	25	-	6
	16:30	191	63.9	33	-	10.5	7.0	67	5	11	25	-	4
July 2	10:00												

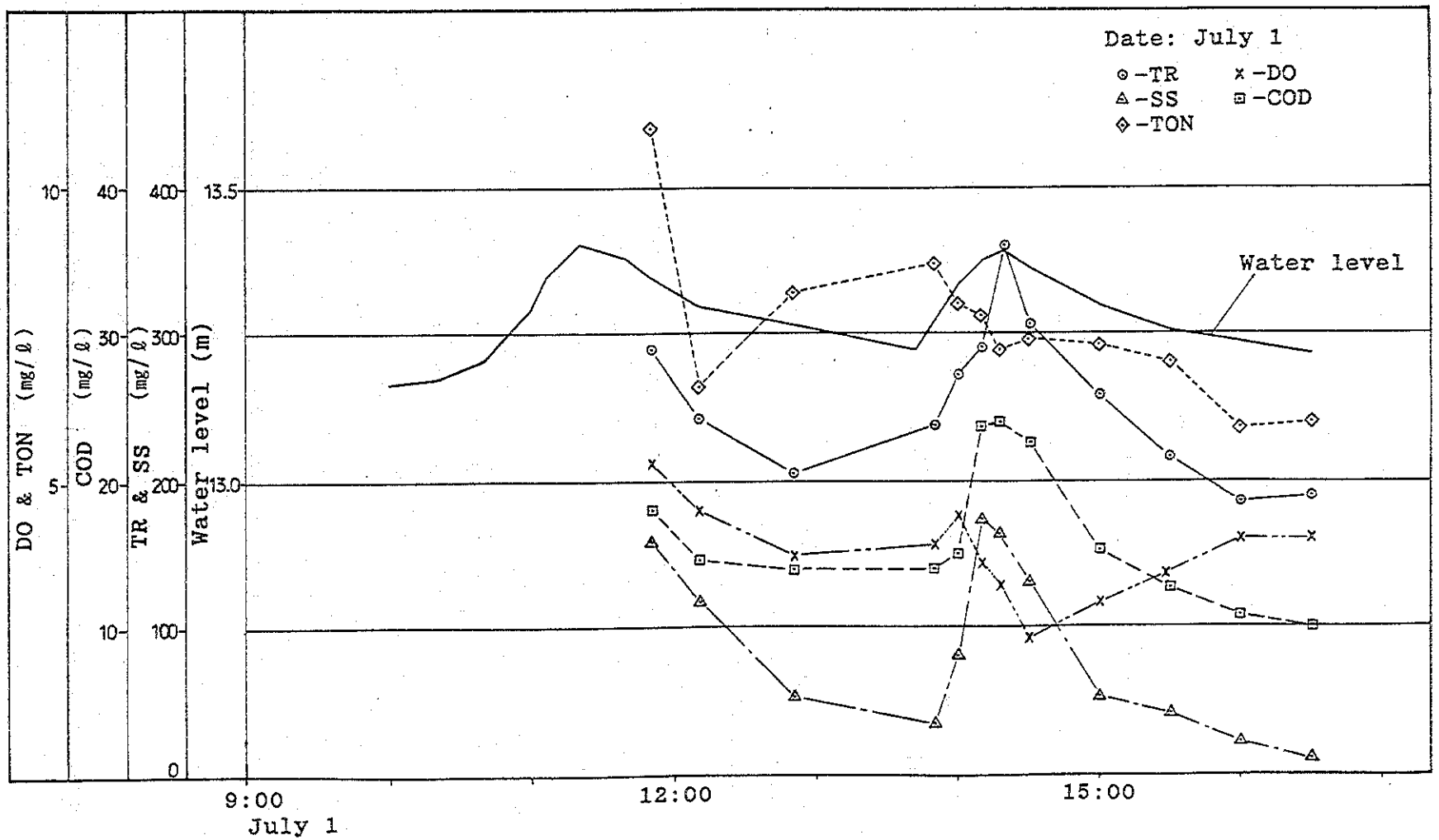


Fig. 3.4.5-1 Water Quality at Freshet Time of Chungroung Chong, July 1, 1991

Table 3.4.5-4 Total Flow-out Load during Freshet (ton/24 hours)

	COD(Cr)	COD(Mn)	TN	TON	NH_4-N	TR	SS
Freshet time	5.58	2.30	2.09	0.68	1.16	38.3	7.9
Ordinary time	3.25	0.95	-	-	0.44	26.3	0.8

Because of the low precipitation of only 6 mm, it is supposed the flow-out loads this time were obtained in low values.

The other result on freshet time on August 31, 1990 is mentioned below.

This survey was conducted 10 hours after the rain started, and continued for 11 hours. Rain stopped an hour after the survey started.

The rain period was too short to obtain the whole results of freshet which affects water quality, and to estimate of the flow-out load using it.

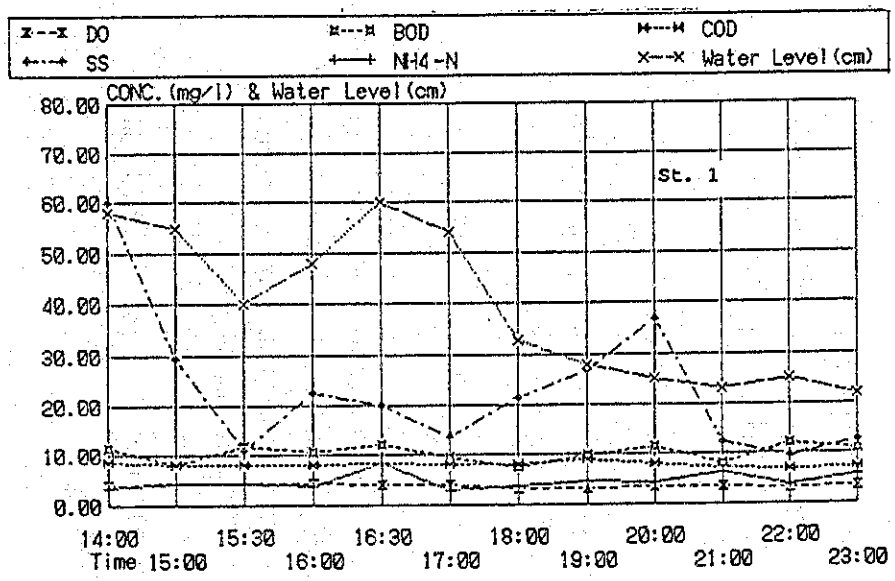
The water level at C-St. 1 decreased with the sampling time, but the decreasing of the water level was not found at C-St. 3 (Table 3.4.5-5 and 6, Fig. 3.4.5-2).

SS at C-St. 3 seemed to decrease with the time. The mean of SS was 22.1 mg/l (7.0-47.5 mg/l), which was much higher than that found on a clear day on August 25 (2.8 mg/l). The mean SS at C-St. 1 (23.1 mg/l) as also higher than the clear day value of 2.5 mg/l.

BOD and COD(Mn) values at C-St. 1 were slightly higher than the clear day values, while the NH_4-N value (3.00-8.42 mg/l) was quite higher than on the clear day (2.03 mg/l) as found as on SS.

3.4.6 Self-purification Capacity

Appropriate place for self-purification survey on this river was not



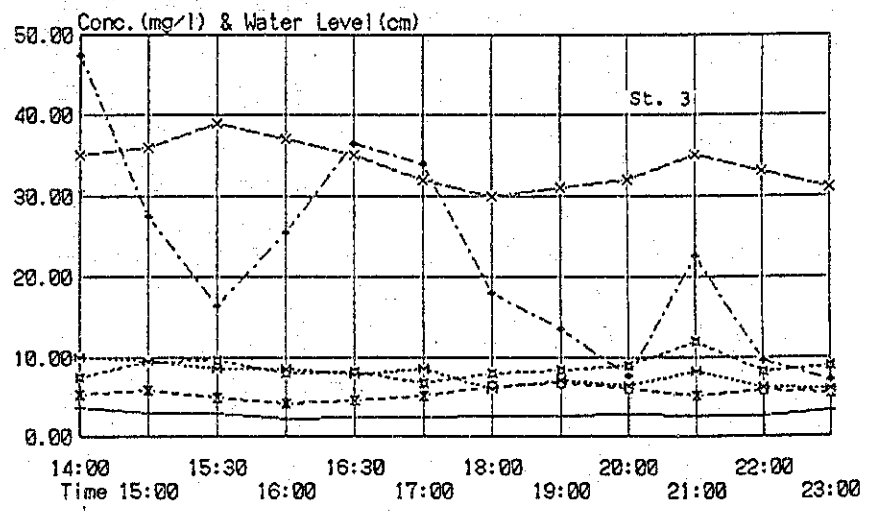


Fig. 3.4.5-2 Water Quality at Freshet Time of Chungroung Chong, August 31, 1990

Table 3.4.5-5 Water Quality of Chongroung Chong at Freshet Time, C-St. 1
August 31, 1990

Item Time	WT (°C)	DO (mg/l)	BOD (mg/l)	COD (mg/l)	SS (mg/l)	NH4-N (mg/l)	Coli- form (MPN/100ml)	Gauge (cm)	Discharge (m3/s)
14:00	23.8	4.0	11.6	8.6	60.0	3.48	240	58	13.071
15:00	23.7	4.2	8.1	8.2	29.5	4.28	200	55	12.120
15:30	23.7	4.2	11.8	8.0	11.0	4.26	160	40	7.941
16:00	23.8	4.3	10.6	8.2	22.5	3.78	320	48	10.050
16:30	23.6	4.0	12.2	8.4	20.0	8.42	180	60	13.744
17:00	23.3	4.1	9.6	8.0	13.5	3.00	180	54	11.811
18:00	23.3	3.2	7.5	8.0	21.5	3.87	140	33	6.320
19:00	22.9	3.1	9.8	9.0	27.0	4.50	250	28	5.292
20:00	22.9	3.5	11.5	8.2	37.0	4.22	230	25	4.726
21:00	22.2	3.5	8.2	7.2	12.5	6.21	370	23	4.370
22:00	22.0	3.3	12.0	7.0	9.6	3.75	280	25	4.726
23:00	22.1	3.5	11.0	7.1	12.8	5.85	190	22	4.198

Table 3.4.5-6 Water Quality of Chongroung Chong at Fresfet Time, C-St. 3
August 31, 1990

Item Time	WT (°C)	DO (mg/l)	BOD (mg/l)	COD (mg/l)	SS (mg/l)	NH4-N (mg/l)	Coli- form (MPN/100ml)	Gauge (cm)	Discharge (m3/s)
14:00	23.4	5.2	7.4	10.0	47.5	3.61	200	35	3.270
15:00	22.6	5.8	9.4	9.4	27.5	2.81	180	36	3.521
15:30	22.4	4.9	9.6	8.5	16.5	2.92	150	39	4.332
16:00	21.6	4.2	8.0	8.4	25.5	2.21	270	37	3.782
16:30	21.2	4.5	8.1	7.8	36.5	2.37	150	35	3.270
17:00	21.1	5.1	6.6	8.4	34.0	2.33	130	32	2.574
18:00	21.4	6.3	8.0	6.0	18.0	2.59	190	30	2.158
19:00	20.2	5.6	8.3	7.0	13.5	2.45	210	31	2.361
20:00	21.7	5.9	8.8	6.4	7.5	2.65	200	32	2.574
21:00	21.4	5.0	12.0	8.2	22.5	2.53	250	35	3.270
22:00	21.3	5.7	8.1	6.2	9.5	2.59	200	33	2.796
23:00	21.4	5.5	8.8	6.0	7.0	3.21	150	31	2.361

found. The survey, therefore, was not carried out.

3.4.7 Correlation between Water Qualities

Correlations between COD(Mn), BOD, SS and NH_4-N were significantly and positively high throughout the sampling period at all stations (Table 3.4.7-1). In particular, COD(Mn) showed high correlation with BOD (r= 0.896-0.940).

DO showed small correlations with other items at C-St. 1. However, positive but quite small correlations between DO and other items were found at C-St. 2 and C-St. 3.

3.4.8 Sediment quality

(1) Particle-size distribution

Particle-size at C-St. 1 was mainly composed by medium sized sand (52 %) and fine sized sand (41 %). On the other hand, at C-St. 2 it distributed in a narrower range, mainly medium sized sand at 91 % (Table 3.4.8-1, Fig. 3.4.8-1).

Due to these materials, the bottom of this river has poor preservation capacity for water and it occasionally brings about no discharge at C-St. 1 and C-St. 2 during the dry season.

(2) Chemical content

High values of Ignition Loss means the bottom of this river also has been heavily and organically polluted as found on the other river beds (C-St. 1: 35.0 %, C-St. 2: 51.5 %) even less than three months after the big flood in September, 1990 (Table 3.4.8-2).

Drying Loss at C-St.1 was lower(33.0 %) than at C-St. 2 (49.3 %) reflecting the particle-size distributions.

Table 3.4.7-1 Correlation between Water Qualities obtained from the Regular Monthly Survey, Chungroung Chong

C-St. 1

	DO	COD	BOD	SS	NH4-N
DO	1				
COD	-0.118	1			
BOD	-0.298	0.940	1		
SS	-0.078	0.715	0.779	1	
NH4-N	0.240	0.799	0.747	0.712	1

C-St. 2

	DO	COD	BOD	SS	NH4-N
DO	1				
COD	0.136	1			
BOD	0.187	0.896	1		
SS	0.032	0.849	0.757	1	
NH4-N	0.361	0.802	0.745	0.672	1

C-St. 3

	DO	COD	BOD	SS	NH4-N
DO	1				
COD	0.299	1			
BOD	0.210	0.937	1		
SS	0.287	0.974	0.932	1	
NH4-N	0.168	0.747	0.712	0.702	1

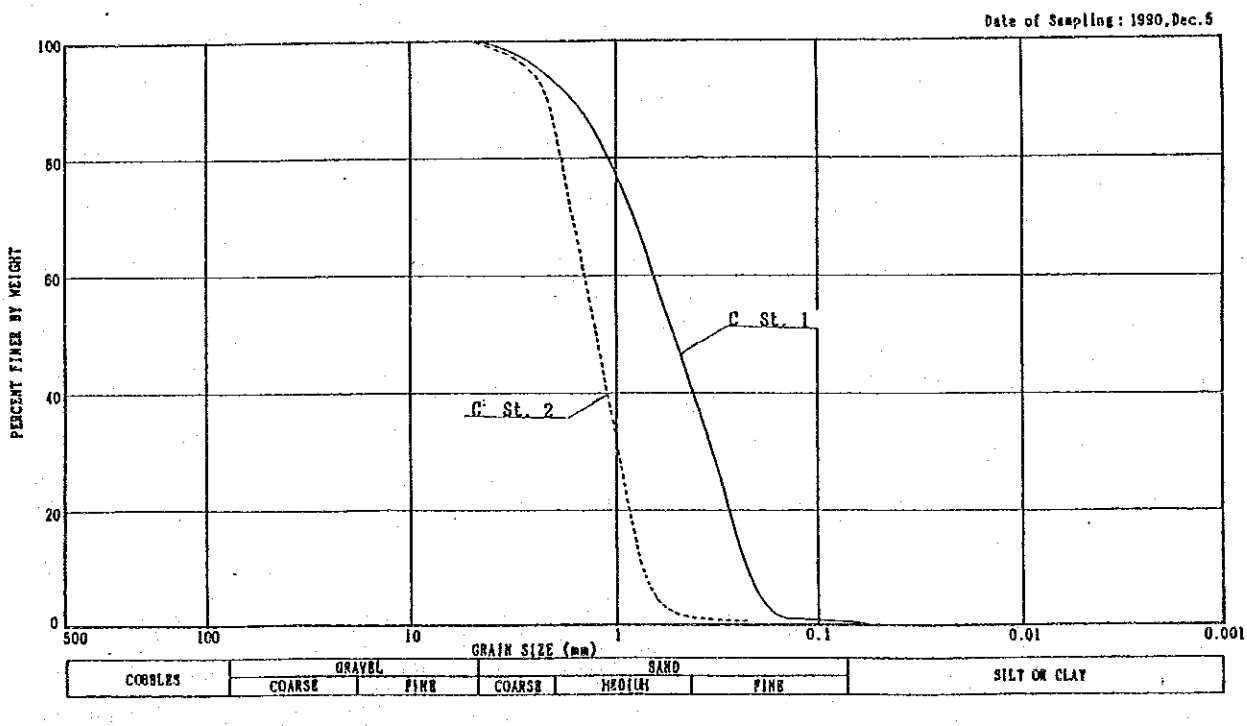


Fig. 3.4.8-1 Particle-size Distribution of Sediment of Chungroung Chong, December 5, 1990

Five items out of six, which were detected, THg, Pb, CN, As and Sulfide were slightly higher at C-St. 1 than at C-St. 2. However, those concentrations were not so high, as found on the other rivers.

The Cd value of this river was found to be the second lowest of the four rivers. Only THg was almost the same as those in Japan, as found on all stations of other rivers.

(3) Macro-benthos

Fauna in this river was also very poor, only Chironomous yoshimatsu. was found 1 individual/m^2 at C-St. 1 and 1 individual/m^2 of Physella acuta? was found at C-St.2 (Table 3.4.8-3).

By biological pollution class, this two stations were classified as polysaprobic water areas, however, this poor fauna may have been produced by the bottom material character of the sand.

Table 3.4.8-1 Particle-size Distribution of Sediment of Chungroung Chong (Accumulated Percent in Weight)

	Classification				
	Gravel	Sand			Silt
	Fine 18.38-4.76	Coarse 4.76-2.00	Medium 2.00-0.42	Fine 0.42-0.074	0.074-0.005
Station					
C-St.1		100.0	93.0	41.0	1.0
C-St.2		100.0	92.0	1.5	0.0

Table 3.4.8-2 River Sediment Quality of Chungroung Chong, December 5, 1990

Weahter on the day: Clear
Weather on the previous day: Clear
AT: 9 °C(10:00)

Item	CN (mg/kg)	As (mg/kg)	THg (mg/kg)	Cr(6+) (mg/kg)	Cd (mg/kg)	Pb (mg/kg)	Sulfide (mg/kg)	PCB (mg/kg)	Org-P Malathion (mg/kg)	PAP (mg/kg)	DL (%)	IL (%)
Station												
C-St. 1	0.386	0.187	0.029	ND	0.100	1.200	6.45	ND	ND	ND	33.0	35.0
C-St. 2	0.182	0.160	0.025	ND	0.110	0.793	5.46	ND	ND	ND	49.3	51.5

Table 3.4.8-3 Macro-benthos Appeared in Sediment of Chungroung Chong (December 5, 1990)

Station / Species	C-St. 1	C-St. 3
Class Gastropoda		
Order Lymnophila		
Family Phydidae		
Physella acuta		1
Class Insecta		
Order Diptera		
Family Chironomidae		
Chironomus yoshimatsui	1	
Total species number/m2	1	1
Total individual number/m2	1	1
Diversity Index	0	0
Biological Pollution Class	ps	ps

ps:polysaprobic

Chapter 4 Summary of Water Quality of the Four Rivers

Sumary of characteristics of water quality obtained during the study period for the four rivers are sited in Table 4.1.

Table 4.1 Summary of Characteristics of the Water Quality Obtained from the Four Rivers

River / Characteristics	Anyang Chong	Yangjae Chong	Ui Chong	Chungroung Chong
Hourly change	Not found	Not found	Not found	Not found
Monthly variation of water quality	Generally varied inversely with the discharge, the higher values in the colder season and the lower values in the hotter season	The same tendencies as Anyang Chong at Y-St. 1 and Y-St. 2. The lower concentrations at the upper stations, were increasing toward the lower stations	The higher concentration in the colder season, the lower in the hotter season, inversely proportional with the discharge. Concentrations higher at U-St. 1 than at U-St. 2	Extraordinarily high values from January to March, 1990. After March, the higher concentrations in the colder months, the lower in the hotter months. The values at C-St. 3 abruptly increased from November, 1990.
Concentration of quality item				Exclude extraordinary values
DO(mg/l)	0.0 - 6.6	3.0 - 8.8	3.9 - 9.7	3.2 - 9.4
pH	6.1 - 8.8	5.9 - 7.8	6.9 - 7.8	6.6 - 8.2
BOD(mg/l)	10.5 - 158.0	2.3 - 53.4	0.9 - 18.8	1.4 - 52.0
DBOD(mg/l)	8.1 - 63.6 (43 - 96 %)	2.2 - 25.7 (49 - 94 %)	1.2 - 9.1 (56 - 86 %)	3.0 - 25.5 (55 - 93 %)
COD(Mn)(mg/l)	17.3 - 76.0	5.0 - 48.7	1.5 - 15.3	5.1 - 38.1
DCOD(Mn)(mg/l)	9.6 - 58.0 (64 - 94 %)	5.4 - 28.8 (66 - 96 %)	3.9 - 13.9 (73 - 94 %)	6.0 - 19.7 (77 - 97 %)
SS(mg/l)	13.9 - 144.3	1.2 - 92.0	0.5 - 54.7	0.5 - 43.3
Settleable matter(mg/l)	5.3 - 81.0 (34 - 94 %)	2.2 - 76.1 (45 - 89)	1.0 - 16.3 (45 - 94)	1.9 - 15.7 (42 - 87)
SS(IL)(% of SS)	24 - 95	28 - 34	14 - 82	42 - 84
TR(mg/l)	109.7 - 1286.0	159 - 471	123 - 565	185 - 480
TR(IL)(% of TR)	12 - 53	9 - 75	7 - 62	8 - 80
TN(mg/l)	6.80 - 25.70	3.89 - 14.99	1.94 - 6.39	3.15 - 10.41
TON(mg/l)	0.69 - 2.91 (5 -15 %)	0.28 - 2.59 (7 -30 %)	0.23- 0.60 (5 -15 %)	0.21- 2.14 (6 - 29 %)
NH4-N(mg/l)	5.10 - 22.89 (85 - 92 %)	0.13 - 13.85 (5 - 94 %)	0.00 - 4.94 (0.5 -*79 %)	0.09 - 11.30 (3 - 83 %)
NO2-N(mg/l)	0.000 - 0.735	0.000 - 1.720 (0.820)	0.000 - 0.783	0.006 - 1.737
NO3-N(mg/l)	0.00 - 0.30	0.00 - 2.96	1.53 - 5.04 (67 - 94 %)	0.29 - 4.99 (4 - 89 %)
TP(mg/l)	0.718 - 2.720	0.318 - 1.183	0.050 - 0.469	0.154 - 0.338
PO4-P(mg/l)	0.148 - 1.878 (18 - 74 %)	0.081 - 1.159 (33 - 75 %)	0.013 - 0.210 (11 - 75 %)	0.067 - 0.602 (44 - 77 %)
Sulfide(mg/l)	2.8 - 5.36	2.6 - 4.23	2.14 - 4.62	1.54 - 4.53
MBAS(mg/l)	1.37 - 5.81	0.99 - 2.25	0.89 - 2.03	1.07 - 3.30
Coli-forms (MPN/100ml)	90 - 17000	72 - 9400	14 - 1700	12 - 2800
Pollution load	Increased from the upper stations to the lower stations, but lower at A-St. 1 than at A-St. 2	Increased from the upper to the lower stations. At Y-St. 3, quite small	The yearly mean at U-St. 1 was higher than at U-St. 2. COD(Mn), however, showed the inverse relation.	Great monthly variation, however, the yearly mean decreased in the lower stations
	Mean value except at A-St. 3 and A-St. 7			
Yearly mean				
BOD(ton/day)	16.99 - 43.12	7.04 - 18.18 (1.13)	0.43 - 0.54	0.73 - 3.84
COD(Mn)(ton/day)	16.28 - 35.48	7.40 - 17.38 (2.13)	0.41 - 0.45	0.73 - 2.75
SS(ton/day)	18.12 - 33.42	17.79 - 64.07 (3.21)	0.83 - 0.88	0.52 - 2.01
NH4-N(ton/day)	3.99 - 8.83	2.46 - 5.28 (0.55)	0.04 - 0.13	0.22 - 0.80
Side-inflow	15 direct side-inflows including those from pumping stations	5 main direct side-inflows on the right side	One direct side-inflow	5 out of 17 direct side-inflows with small discharges.
Total inflow load			COD(Cr) 0.30 (ton/day)	
COD(Mn)(ton/day)	11.7	0.54	TN 0.06 (ton/day)	COD(Cr) 10.17 (ton/day)
SS(ton/day)	38.7	0.37	TON 0.02 (ton/day)	
Water quality at freshet time and flow-out load	Height of the concentration on freshet time versus that on a clear day. September 10-11, 1990: BOD 0 - 2 times; COD(Mn) almost the same; SS 15 - 80 times	Height of the flow-out load versus that on a clear day. November 3, 1990: BOD 5.8 times; COD(Mn) 6.8 times; SS 33.1 times; NH4-N 2.5 times. Flow-out load June 10-14, 1991 at Y-St. 1 for 72.17 hours: COD(Mn) 10.0 ton (3.1); BOD 8.6 ton (-); TN 9.3 ton (3.6); SS 74.3 ton (17.0); NH4-N 4.9 ton (1.7); TKN 4.20 - 5.21 (1/day)	Concentration and flow-out load values on clear day in the parenthesis. August 31-September 1, 1991, for 28 hours. Conc. (times) Load(ton/day): COD(Mn) 1.6 - 4 1.2 -14.0 (0.3 - 3.3); BOD 6 - 10 1.2 - 14.0 (0.2 - 2.2); SS 31 - 34 4.5 - 59.4 (0.2 - 1.6); BOD 5.271 (1/day); TKN 8.15 - 12.48 (1/day)	The curve of concentrations was similar to that of the water level. Much of TON and SS were out. July 1-2, 1991, at C-St. 1 for 24 hours. Load (ton/day): Freshet / Clear day. COD(Cr) 5.58 / 3.25; COD(Mn) 2.30 / 0.95; TN 2.09 / -; TON 0.68 / -; NH4-N 1.16 / 0.44; SS 38.3 / 26.3; TR 7.9 / 0.8
Self-purification capacity	Not conducted			Not conducted
Correlation between quality				
Coefficients				
BOD - COD(Mn)	0.574 - 0.840	0.631 - 0.798	0.451 - 0.645	0.896 - 0.940
BOD - SS	-0.012 - 0.797	0.128 - 0.852	0.434 - 0.769	0.757 - 0.932
BOD - NH4-N	0.220 - 0.538	0.046 - 0.681	0.307 - 0.752	0.712 - 0.747
DO - NH4-N	-0.194 - 0.490	-0.087 - 0.247	-0.029 - -0.062	0.168 - 0.361
Sediment quality				
Particle-size	0.005> - 73.5 mm (mainly 0.074 - 4.76 mm)	0.005> - 18.38 mm (mainly 0.005 - 2.00 mm)	0.005> - 18.38 mm (mainly 0.005 - 4.76 mm)	0.005> - 4.76 mm (mainly 0.074 - 2.00 mm)
Chemical content				
IL(%)	27.0 - 44.5	43.2 - 63.0	38.0 - 62.5	35.0 - 51.5
CN (mg/kg)	0.00 - 0.477	0.000 - 0.114	0.250 - 0.409	0.182 - 0.386
As (mg/kg)	0.068 - 0.277	0.068 - 0.213	0.133 - 0.233	0.160 - 0.187
THg (mg/kg)	0.012 - 0.037	0.009 - 0.394	0.054 - 0.063	0.025 - 0.029
Cr(6+) (mg/kg)	Not detected	Not detedted	Not detedted	Not detedted
Cd (mg/kg)	0.150 - 0.200	0.149 - 0.177	0.100 - 0.183	0.100 - 0.110
Pb (mg/kg)	0.240 - 2.100	0.973 - 1.520	1.133 - 1.960	0.793 - 1200
Sulfide (mg/kg)	5.46 - 6.23	5.46 - 6.01	5.68 - 6.45	5.46 - 6.45
PCB (mg/kg)	0.000 - 4.038	Not detedted	Not detected	Not detected
Organic-P (mg/kg)	0.000 - 0.198	Not detedted	Not detected	Not detected
Macro-benthos				
Total species number/m2	0 - 2	2 - 5	0 - 2	1 - 1
Total individual number/m2	0 - 5	40 - 45	0 - 5	1 - 1
Biological pollution class	ps (A-St. 2 and A-St. 5)	ps at 3 stations	ps (U-St. 1), alpha-m (U-St. 2) (not by biological classification, but from riverbed materials)	ps (not by biological classification, but from riverbed materials)

*This was supposedly an extraordinary value. Normal range of values is 0.5 - 19 %.

Chapter 5 Recommendation for Continuing Survey and Sampling and Supplementary Survey

The time given for obtaining the whole and exact figures on water and sediment qualities of the four rivers this time was short. It is, therefore, recommended that further survey and sampling and supplementary survey be conducted in the future to complete the knowledge, which are quite helpful to progressing the measured relating the rivers.

Several recommendatory points on the surveys and samplings about water quality and sediment quality based on the results obtained this time are sited below.

5.1 Water Quality

5.1.1 Improvement on the regular sampling and survey station

(1) Anyang Chong

It is recommended that the stations on Anyang Chong be changed because of the reasons stated below:

* There was not set up automatic water level recorder on the A-St. 7 this time. Since, A-St. 7 is located on the mouth of Kaehwa Chong, which is seriously polluted, and it is necessary to detect the quality and quantity of the pollution from this river and its degree of contribution to the main river in future. We recommend that the water level recorder at A-St. 4 be moved to A-St. 7.

* Even after removing the water level recorder at A-St. 4, the balance of pollution load between A-St. 5 and A-St. 2 can still be determined with that from A-St. 7 and A-St. 3.

* A-St. 1 is not appropriate for the fixed station and it possible should be abolished, because of the strong effect of the back water from Hang Gang.

* Because a lot of inflow pollution load was observed upper stream rather than at A-St. 6, it is necessary to set up more sampling stations in this area in cooperation with the Anyang and Suwon Cities. Recommended places for stations:
  Front of Sokusu Public Corporation apartment house,
  Anyang Old Bridge,
  Yam-myong Bridge,
  Pesam Bridge,
  Kumpo Bridge,
  On the mouths of the branches, etc.

(2) Yangjae Chong
* Y-St. 1, (Y-St. 2), Y-St. 3 and Y-St. 4
  Y-St. 2 may be omitted.

(3) Ui Chong
* U-St. 1, U-St. 2 and Front of Green Hotel

(4) Chungroung Chong
* C-St.1, C-St. 2 and C-St. 3

5.1.2 Items of survey, sampling and analysis

The survey, sampling and analysis of water quality mentioned in Chapter 2 were carried out. It is, however, not necessary for all items. Further monitoring is necessary only for the following.

(1) For monthly variation of water quality
* Sampling stations: the regular stations on the three rivers of Yangjae Chong, Ui Chong and Chungroung Chong. On Anyang Chong the stations are mentioned in 3.4.1

* Times for sampling: once a month

* Analytical items: COD(Cr), TN, NH_4-N, PO_4-P, SS and BOD
  Analysis of BOD will be hopefully displaced

by the measurement of carbon, TOC.

(2) For hourly change of water quality

* Sampling stations: same as the regular monthly variation

* Times of sampling: four times a year (each season), every two hours for two days each time

* Analytical items: same as the regular monthly variation

(3) For analysis of toxic material

* Sampling stations: same as the regular monthly variation

* Times of sampling: four times a year (each season)

* Analytical items: CN

(4) For freshet time survey

* Sampling stations: same as the stations for freshet time sampling this survey period, 1990-1991. on Yangjae Chong, Ui Chong and Chungroung Chong. On Anyang Chong: A-St. 2, A-St. 3, A-St. 6, A-St. 7 and other several stations upstream

* Times of sampling: three times a year,

* Duration of survey: long enough to be able to obtain the whole figure of the freshet, start before rain and finish after rain

* Analytical items: same as the regular monthly survey

(5) For side-inflow survey

* Sampling places: all side-inflows existed on both sides of

the four rivers. Survey and sampling must be done on the fixed stations on the main rivers at the same time.

* Survey frequency: 4 times a year, twice on a clear day and twice on a rainy day

* Analytical items: same as the regular monthly survey

5.1.3 Points to consider in sampling

* To conduct survey and sampling efficiency, it is important to really understand their purpose, importance and methodology.

* The field records, records on weather, the time the rain starts and of ends, wind, air and water temperatures, sampling place, time of sampling, etc. are considerably important.

* The records and data of the survey and analyses should be checked after every sampling work. Caution is necessary so as not to repeat the same mistakes twice.

5.1.4 Points to consider in analysis

* The first point is the same as the first in sampling.

* Sampled water and sediment should be stored as soon as possible in place with low temperature and then analyzed.

* The data obtained should be treated the same way as the data obtained from the sampling shall be treated.

5.1.5 Treatment of data

All data obtained are very important, therefore, they should be

treated carefully.

The water quality distribution pattern often changes unexpectedly. This distribution pattern can be identified from the data obtained, and the rules that govern the changes, if there are any, shall be determined by using statistical methods.

5.2 Sediment Quality

5.2.1 Chemical analysis

The results obtained from the sediment of the four rivers showed that the river beds of all rivers were seriously polluted organically. Although the concentrations of CN, As, PCB, Organic-P and heavy metals except THg were low, we recommend that the survey for sediment quality should be continued to be conducted once or twice a year, particularly the survey on organic pollution.

5.2.2 Biological analysis

This time, both of numbers of individuals and species of benthos were very small, almost zero at all stations. It is, however, necessary to continue the survey on benthos, because it is an appropriate indicator of the degree of pollution.

5.2.3 Stations

Sampling stations on sediment quality are adequately mentioned below:

* Anyang Chong: A-St. 2, A-St. 3, A-St. 5, A-St. 6 and A-St. 7
* Yangjae Chong: Y-St. 1, Y-St. 3 and Y-St. 4
* Ui Chong: U-St. 1 and U-St. 2
* Chungroung Chong: C-St. 1 and C-St. 3

Annex

Annex-1 Nitrification Capacity

A-1 Nitrification Capacity

Nitrification capacities were measured using the soil from Yangjae Chong (Y-St. 3 and Y-St. 4) and Chungroung CHong (C-St. 1, C-St. 2 and C-St. 3) on December 1, 1990.

100 mg of wet soil from each stations was put in. 1000 ml beaker with 500 ml of distilled water. 50 ml of NH_4-N solution (N: mg/l) was added and aerated sufficiently. The water was sampling every hour and the temperature, pH, DO, NH_4-N and NO_2-N were measured.

Control was treated as mentioned above without soil.

Because the preparatory test showed that nitrification capacity decreased with decrease of pH, and the practically measured pH natural conditions were always around neutral, ph of test solution were occasionally adjusted.

The results showed that significant increases of NO_3-N and NO_2-N were not found in the solution, however, abrupt decreases of NH_4-N was found, so it was supposed that there exists nitrobacteria in the soil of these rivers and NH_4-N would be oxidized to NH_X-N sufficient DO existed.

Table A-1-1 Nitrification Capacity of Sediment from Yangjae Chong

Control

Time	WT(°C)	pH	DO (mg/l)	NH4-N (mg/l)	NO2-N (mg/l)	NO3-N (mg/l)	Note
9:10	15.3	6.6	9.0	9.6	0.0	0.2	
10:10	14.4	6.6	9.3	9.6	0.0	0.3	pH adjuastment
11:10	14.3	6.3	9.4	9.6	0.0	0.3	pH adjuastment
12:10	14.4	6.6	9.0	9.3	0.0	0.4	pH adjuastment
13:10	14.3	8.7	9.1	9.2	0.0	0.4	
14:10	14.1	7.5	9.0	9.2	0.0	0.4	

Yangjae Chong, Y-St. 3 (December 12, 1990)

Time	WT(°C)	pH	DO (mg/l)	NH4-N (mg/l)	NO2-N (mg/l)	NO3-N (mg/l)	Note
10:30	16.3	7.6	8.7	10.0	0.0	1.3	
11:30	15.7	7.3	9.3	7.4	0.0	1.5	
12:30	14.9	7.7	9.2	6.4	0.0	1.4	
13:30	14.9	7.6	9.2	5.4	0.0	1.5	
14:30	14.8	7.6	8.8	5.1	0.0	1.4	
14:30	14.9	7.7	9.6	5.0	0.0	3.2	September 13

Yangjae Chong, Y-St. 4 (December 12, 1990)

Time	WT(°C)	pH	DO (mg/l)	NH4-N (mg/l)	NO2-N (mg/l)	NO3-N (mg/l)	Note
10:30	16.3	7.4	8.4	10.5	0.1	0.7	
11:30	15.8	7.3	9.0	9.2	0.0	0.8	
12:30	15.1	7.7	8.8	8.5	0.1	0.7	
13:30	15.1	7.7	8.9	8.1	0.1	0.5	
14:30	15.0	7.7	9.2	7.9	0.1	0.5	
14:30	14.9	7.9	9.1	8.8	0.3	1.3	September 13

Table A-1-2 Nitrification Capacity of Sediment from Chungroung Chor

Control

Time	WT(°C)	pH	DO (mg/l)	NH4-N (mg/l)	NO2-N (mg/l)	NO3-N (mg/l)	Note
9:10	15.3	6.6	9.0	9.6	0.0	0.2	
10:10	14.4	6.6	9.3	9.6	0.0	0.3	pH adjuastment
11:10	14.3	6.3	9.4	9.6	0.0	0.3	pH adjuastment
12:10	14.4	6.6	9.0	9.3	0.0	0.4	pH adjuastment
13:10	14.3	8.7	9.1	9.2	0.0	0.4	
14:10	14.1	7.5	9.0	9.2	0.0	0.4	

Table A-1-2 Nitrification Capacity of Sediment from Chungroung Chong

Control

Time	WT(°C)	pH	DO (mg/l)	NH4-N (mg/l)	NO2-N (mg/l)	NO3-N (mg/l)	Note
9:10	15.3	6.6	9.0	9.6	0.0	0.2	
10:10	14.4	6.6	9.3	9.6	0.0	0.3	pH adjuastment
11:10	14.3	6.3	9.4	9.6	0.0	0.3	pH adjuastment
12:10	14.4	6.6	9.0	9.3	0.0	0.4	pH adjuastment
13:10	14.3	8.7	9.1	9.2	0.0	0.4	
14:10	14.1	7.5	9.0	9.2	0.0	0.4	

Chungroung Chong, C-St. 1 (December 3, 1990)

Time	WT(°C)	pH	DO (mg/l)	NH4-N (mg/l)	NO2-N (mg/l)	NO3-N (mg/l)	Note
9:10	14.7	6.6	9.1	10.9	0.03	0.8	
10:10	14.2	6.4	9.1	10.6	0.02	0.7	pH adjuatment
11:10	14.3	6.0	9.4	9.1	0.03	0.6	pH adjuatment
12:10	14.5	6.2	9.3	8.1	0.02	0.5	pH adjuatment
13:10	14.1	8.7	9.1	8.4	0.05	0.9	
14:10	14.2	7.4	8.5	7.8	0.08	0.6	

Chungroung Chong, C-St. 2 (December 3, 1990)

Time	WT(°C)	pH	DO (mg/l)	NH4-N (mg/l)	NO2-N (mg/l)	NO3-N (mg/l)	Note
15:00	16.7	8.8	8.2	9.3	0.04	1.2	
16:00	16.1	7.2	8.8	8.2	0.06	0.8	
17:00	15.5	7.3	8.6	8.9	0.09	0.5	
18:00	15.4	7.3	8.6	8.7	0.16	0.5	
19:00	15.1	7.1	8.7	7.8	0.20	0.8	
20:00	15.0	8.1	9.0	7.8	0.25	0.9	
15:00	14.4	7.3	8.0	7.8	1.51	3.9	September 4

Chungroung Chong, C-St. 3 (December 3, 1990)

Time	WT(°C)	pH	DO (mg/l)	NH4-N (mg/l)	NO2-N (mg/l)	NO3-N (mg/l)	Note
15:00	16.8	8.6	8.2	10.8	0.15	6.5	
16:00	16.1	7.2	9.1	9.5	0.16	5.2	
17:00	15.4	7.3	8.5	10.4	0.21	6.0	
18:00	15.3	7.4	8.6	9.3	0.33	5.6	
19:00	14.9	7.4	8.6	8.6	0.40	5.1	
20:00	15.0	7.7	8.7	9.3	0.47	6.3	
15:00	14.4	7.6	8.7	8.7	2.11	7.2	September 4