2.1.2 Yangjae Chong

(1) Generation Load Discharged by the Inhabitants of the basin

1) Settled Population within the basin

The population in the basin was calculated using the data of don-districts in 1988. These data were summed up at every observation station.
The future population was estimated on the basis of the Basic Town Plan of Seoul Metropolitan. The population in 1990 and 2002 were estimated using the data in 1988, 2001 and 2010 by quota allotment. The result is indicated in Table 2.1.2-1

Table 2.1.2-1 Population in Yanjgae Chong Basin
unit:person

	St.1 to 2	St.2 to 4	St.3	Total
1988	130,440	19,543	67,147	217,130
1990	140,275	21,017	72,210	233,502
2002	291,735	48,618	152,981	493,334
2010	317,196	47,525	163,284	528,005

2) Generation Load discharged by the Population

The generation Load discharged by the settled population was calculated using the generation unit load adopted in the Basic Sewage Plan of SMG published in 1984.

Table 2.1.2-2 Adopted Pollution Load Factor by Basic Sewage Plan of SMG

Treatment District	Item	Pollution Load of Population			Pollution Load of Commercial Use	Total
		Domest	Night Soil	Sub-total		
Anyang	BOD	29	19	48	14.2	62.2
	S S	29.3	25	54	14.3	68.3
Tan	BOD	29	19	48	12.8	60.8
	S S	29.3	25	54	12.9	66.9
Joongnang	BOD	29	19	48	18.9	66.9
	S S	29.3	25	54	19.0	73.0

cf:converted figures 1990

Table 2.1.2-3 Pollution Load Amount of Yangjae Chong Basin(1990)

	St.1 to 2	St.2 to 4	St.3	Total
Population	140,275	21,017	72,210	233,502
BOD(kg/day)	8,529	1,278	4,390	14,197
S S(kg/day)	9,384	1,406	4,831	15,621

(2) Estimate of Generation Load discharged by Industry

1) Industrial Classification and Production Amount within the basin

The data on the factories in the basin were offered by Seoul Metropolitan. These data include the industries in the basin and the number of workers in each unit of the district. Textile, chemistry, and others are listed as the major industries of this area.
The production amount by each factory classification within the basin was calculated by multiplication -- population amount per employee number multiplied by employee number -- using the results from the Reserch on the load Factor Discharge from Factories compiled by the Ministry of Commerce in 1984.
The production amounts of the year 1990 was arrived at based on the assumption that the annual growth rate was 10% from 1984 to 1990.

Table 2.1.2-4 Production Amount per Employee
unit:million won per year

	Textile	Chemistry	Machinery	Others
1984	16.4	55.3	21.3	10.8
1990	29.1	98.0	37.7	19.1

Table 2.1.2-5 Employee Numbers & Yearly Production Amount

unit:persons,mlion won per year

		St.1 to 2	St.2 to 4	St.4 to	St.3 to
Textil	Employee nos	9	0	0	0
	Production Amount	262	0	0	0
Chemistry	Employee nos	0	0	0	0
	Production Amount	0	0	0	0
Machinery	Employee nos	0	20	0	0
	Production Amount	0	754	0	0
Others	Employee nos	133	71	0	0
	Production Amount	2,540	1,356	0	0
Total	Employee nos	142	91	0	0
	Production Amount	2,802	2,110	0	0

2) Estimation of Generation Load Discharged by Industry

The industries in Korea are classified broadly into four categories, textile, chemistry, machinery and others. Machinery is further divided into three and others into four sub-categories.
The pollutant load factor per production has not been determined in Korea, because there was no Industry Pollution Factor included in the data. The pollutant load factor was therefore estimated using thedata in the Pollution Load Factor from the Japanese Design Criteria of Sewerage Facilities.
The industry discharge factor was estimated using the results of Reserch on the Load Factor Discharged from Factories compiled by the Ministry of Korea in 1984.
The estimate was arrived at using the following formulas.

Industry Discharge Factor

= discharge from the Factor

Industry Pollution Load Factor

= discharge from the factories / pollution amount

a. Industry Discharge Factor and Discharge by Factory Classification per Production Amount

i. Industry Discharge Factor per Production Amount

The industry discharge factors is indicated as follows.

Table 2.1.2-6 Industry Discharge Factor

unit:m3/million won

	Industry Discharge Factor
Textile	17.7
Chemistry	28.3
Machinery	7.1
Others	4.8

ii. Discharge of Each Factory Classification

The discharge of Each Factory classification, which was estimated using the production amount and discharge factor, is indicated as follows.

Table 2.1.2-7 Industry Discharge

Unit:m^3/day

	St.1 to 2	St.2 to 4	St.4 to	St.3 to
Textil	13	0	0	0
Chemistry	0	0	0	0
Machinery	0	15	0	0
Others	33	18	0	0
Total	46	33	0	0

b. Estimatite of the Production Amount

The production amounts were estimated using the ratio of the production amount to each factory sort and the calculated total.

Table 2.1.2-8 Industry Production Breakdown(Seoul Area)

		Production per year	Ratio
Textile		1,164 (billion won)	1.00000
Chemistry		1,182	1.00000
Machinery		2,462	1.00000
	Casting & Nonferrousmetal	256	0.10398
	Primary Metals	386	0.15678
	Machinery&Instrumentation	1,820	0.73924
Others		2,515	1.00000
	Foods	1,673	0.66521
	Wooden	65	0.02584
	Printing	599	0.23817
	Others	178	0.07078
Total		7,323	-

c. Pollution Load Factor per Industry Discharge

Pollution load fcator per industry discharge was estimated using the data of the Japanese Design Criteria of Sewerage Facility because the data obtained from Korea were insufficient.

Table 2.1.2-9 Industry Pollution Load Factor

	BOD (g/m^3)	S S (g/m^3)
Textile	15.0	22.5
Textil Industry	20.0	15.0
Clothing	10.0	30.0
Chemistry	633.0	233.0
Resin acid & Glycerin	600.0	500.0
Crude Drugs	1,000.0	100.0
Petroleum	300.0	100.0
Casting & Nonferrousmetal	50.0	100.0
Primary Metals	360.0	230.5
Machinery & Instrumentation	25.0	20.0
Machinery	40.0	30.0
Instrumentation	10.0	100.0
Foods	2,400.0	1,200.0
Wooden	10.0	40.0
Printing	200.0	60.0
Others	10.0	100.0

d. Industry Discharge

The industry discharge of the nine categories was calculated using the ratio presented above.

Table 2.1.2-10 Industry Discharge of Yangjae Chong Basin

unit: m^3/day

Item	St.1 to 2	St.2 to 4	St.4 to	St.3 to
Textile	13	0	0	0
Chemistry	0	0	0	0
Machinery	0	15	0	0
Casting & Nonferrou	0	1.6	0	0
Primary Metals	0	2.4	0	0
Machin & Inst	0	11.1	0	0
Other	33	18	0	0
Foods	21.9	12.0	0	0
Wooden	0.9	0.4	0	0
Printing	7.9	4.3	0	0
Others	2.3	1.3	0	0

e. Generation Load by Industry

The generation load by industry based on the industry pollution load factor and the industry discharge is presented in the Table 2.1.2-11.

Table 2.1.2-11 Industry Input Load of Yangjae Chong Basin unit:kg/day

Item		St.1 to 2	St.2 to 4	St.4 to	St.3 to
Textile	BOD	0.2	0	-	0
	S S	0.3	0	-	0
Chemistry	BOD	0	0	-	0
	S S	0	0	-	0
Casting & Nonfer	BOD	0	0.1	-	0
	S S	0	0.2	-	0
Primary Metals	BOD	0	0.9	-	0
	S S	0	0.6	-	0
Machin & Inst	BOD	0	0.3	-	0
	S S	0	0.2	-	0
Foods	BOD	52.6	28.8	-	0
	S S	26.3	14.4	-	0
Wooden	BOD	0	0	-	0
	S S	0	0	-	0
Printing	BOD	1.6	0.9	-	0
	S S	0.5	0.3	-	0
Others	BOD	0	0	-	0
	S S	0.2	0.1	-	0
Total	BOD	54.4	31.0	-	0
	S S	27.3	15.8	-	0

(3) Generation Load by Land Utilization

1) Present Land Utilization conditions

The present land utilization condition and the land utilization plan for Seoul Metropolitan have not been compiled. Therefore in order to grasp the present state of land utilization at each observation station, the condition of the land utilization was studied at each river basin based on the Town Plan of Seoul Metropolitan published in 1989, 1/25,000 in scale. However, this method includes the areas of the productive green zone, development restricted zone, the agricultural farm zone, the bush zone and the green zone combined.
The land area formation ratio of the farms, paddy fields including orchards and forest, were determined using the land utilization area survey of the smallest district. Each of the land utilization area was obtained by using the determined land area formation ratio. The green zone area includes the development restricted zone, the natural green zone, reductive green zone and the scenic zone.

Table 2.1.2-12 Land Use Area by Each Observation Station

unit:km^2

	Farm	Paddy	Forest	Residence	Others	Total
St.1 to 2	0.183	0.129	2.820	3.913	0.335	7.380
St.2 to 4	0.078	0	0.897	1.569	0.666	3.210
St.3 to	1.076	0	10.381	0.406	0.317	12.180
St.4 to	2.163	0	29.679	2.200	2.308	36.350
Total	3.500	0.129	43.777	8.088	3.626	59.120

2) Generation Load by Utilization

a. Generation Unit Load

The generation unit load of the land utilization was adopted from the basic study result for principal rivers in Korea which was summarized in the Basic Plan and the Detailed Plan of the Water Purification Project for Anyang Chong.

The park is classified under the forest category. While the residential zone, the quasi-industrial zone, the quasi-residential zone and the commercial zone fall under the residential area category.

Table 2.1.2-13 Pollution Load Factor by Land Use

unit:kg/km^2·day

	Farm	Paddy	Forest	Residence	Others
BOD	7.10	5.12	0.96	87.59	0.96
S S	7.59	4.41	1.26	227.73	1.26

b. Generation Load by Land Utilization

The generation load by Land Utilization was calculated using the size of the land and the generation unit load.

Table 2.1.2-14 Input Load by Land Use unit:kg/day

		Farm	Paddy	Forest	Residence	Others	Total
St.1 to 2	BOD	1.3	0.7	2.7	342.7	0.3	347.7
	S S	1.4	0.6	3.6	891.1	0.4	897.1
St.2 to 4	BOD	0.6	0	0.9	137.4	0.6	139.5
	S S	0.6	0	1.1	357.3	0.8	359.8
St.3 to	BOD	7.6	0	10.0	35.6	0.3	53.5
	S S	8.2	0	13.1	92.5	0.4	114.2
St.4 to	BOD	0.9	0	2.9	3,298.8	2.2	3,304.8
	S S	16.4	0	37.4	501.0	2.9	557.7
Total	BOD	10.4	0.7	16.5	3,814.5	3.4	3,845.5
	S S	26.6	0.6	55.2	1,841.9	4.5	1,928.8

(4) Generation Load by Livestock

1) Present Condition of Livestock

The present condition of the livestock within the basin is shown in the following.

Table 2.1.2-15 Livestok Amount of Yangjae Chong

unit:head

	St.1 to 2	St.2 to 4	St.4 to	St.3 to
Cow	-	117	728	383
Pig	-	205	1,675	152
Chicken	-	1,019	4,480	-
Toal	-	1,341	6,883	535

2) Generation Load by Livestock

a. Generation Unit Load factor of Livestock

The generation unit load of the livestock was estimated on the basis of the investigative study by Seoul Metropolitan. The result is indicated in Table 2.1.2-16.

Table 2.1.2-16 Livestock Pollution Load Factor

	BOD (g/head)	S S (g/head)
Cow	640	3,800
Pig	125	356
Chicken	12.5	18

b. Generation Load by Livestock

The generation load by livestock was estimated using the number of the livestock (Table 2.1.2-16) and the generation unit load.

Table 2.1.2-17 Livestock Input Load unit:kg/day

		St.1 to 2	St.2 to 4	St.4 to	St.3 to
Cow	BOD	-	74.9	465.9	245.1
	S S	-	444.6	2,766.4	1,455.4
Pig	BOD	-	25.6	209.4	19.0
	S S	-	73.0	596.6	54.1
Chicken	BOD	-	12.7	56.0	0.0
	S S	-	18.3	80.6	0.0
Total	BOD	-	113.2	731.3	264.1
	S S	-	535.9	3,443.6	1,509.5

(5) Result

The generation load obtained by the method described above is summarized in Table 2.1.2-18 & 19.

Table 2.1.2-18 Continuous Input Load (BOD) unit:kg/day

	St.1 to 2	St.2 to 4	St.4 to	St.3 to
Poulation	8,529	1,278	Kwachon-shi	4,390
Industry	54	31	Kwachon-shi	0
Land Use	348	140	Kwachon-shi	54
Livestock	0	113	Kwachon-shi	264
Total	8,931	1,562	-	4,708

Table 2.1.2-19 Continuous Input Load (S S) unit:kg/day

	St.1 to 2	St.2 to 4	St.4 to	St.3 to
Poulation	9,384	1,406	Kwachon-shi	4,831
Industry	27	16	Kwachon-shi	0
Land Use	897	360	Kwachon-shi	114
Livestock	0	536	Kwachon-shi	1,510
Total	10,308	2,318	-	6,455

2.1.3 Ui Chong

(1) Generation Load Discharged by the Inhabitants of the basin

1) Settled Population within the basin

The population in the basin was calculated using the data of don-districts in 1988. These data were summed up at every observation station.

The future population was estimated on the basis of the Basic Town Plan of Seoul Metropolitan. The population in 1990 and 2002 were estimated using the data in 1988, 2001 and 2010 by quota allotment. The result is indicated in Table 2.1.3-1

Table 2.1.3-1 Population in Ui Chong Basin

unit:person

	St.1 to 2	St.2 to	Total
1988	199,971	154,529	354,500
1990	182,494	141,024	323,518
2002	209,085	160,283	369,368
2010	217,524	168,093	385,617

2) Generation Load discharged by the Population

The generation Load discharged by the settled population was calculated using the generation unit load adopted in the Basic Sewage Plan of SMG published in 1984.

Table 2.1.3-2 Pollution Load Amount of Ui Chong Basin (SS)

unit:g/person/day

Treatment District	Item	Pollution Load of Population			Pollution Load of Commercial Use	Total
		Domest	Night Soil	Sub-total		
Anyang	BOD	29	19	48	14.2	62.2
	S S	29.3	25	54	14.3	68.3
Tan	BOD	29	19	48	12.8	60.8
	S S	29.3	25	54	12.9	66.9
Joongnang	BOD	29	19	48	18.9	66.9
	S S	29.3	25	54	19.0	73.0

cf:converted figures 1990

Table 2.1.3-3 Pollution Loading Amount of Ui Chong Basin(1990)

	St.1 to 2	St.2 to 3	Total
Population	182,494	141,024	323,518
BOD(kg/day)	12,209	9,435	21,644
S S(kg/day)	13,322	10,295	23,617

(2) Estimate of Generation Load discharged by Industry

1) Industrial Classification and Production Amount within the basin

The data on the factories in the basin were offered by Seoul Metropolitan. These data include the industries in the basin and the number of workers in each unit of the district. Textile, chemistry, and others are listed as the major industries of this area.

The production amount by each factory classification within the basin was calculated by multiplication -- population amount per employee number multiplied by employee number -- using the results from the Reserch on the load Factor Discharge from Factories compiled by the Ministry of Commerce in 1984.

The production amounts of the year 1990 was arrived at based on the assumption that the annual growth rate was 10% from 1984 to 1990.

Table 2.1.3-4 Production Amount per Employee
unit:million won per year

	Textile	Chemistry	Machinery	Others
1984	16.4	55.3	21.3	10.8
1990	29.1	98.0	37.7	19.1

Table 2.1.3-5 Employee Numbers & Yearly Production Amount
unit:plion per year

		St.1 to 2	St.3 to
Textil	Employee nos	4,391	5,345
	Production Amount	127,778	155,540
Chemistry	Employee nos	978	978
	Production Amount	95,844	95,844
Machinery	Employee nos	795	787
	Production Amount	29,972	29,670
Others	Employee nos	1,735	1,834
	Production Amount	33,139	35,029
Total	Employee nos	7,899	8,944
	Production Amount	286,733	316,083

2) Estimation of Generation Load Discharged by Industry

The industries in Korea are classified broadiy into four categories, textile, chemistry, machinery and others. Machinery is further divided into three and others into four sub-categories.
The pollutant load factor per production has not been determined in Korea, because there was no Industry Pollution Factor included in the data. The pollutant load factor was therefore estimated using thedata in the Pollution Load Factor from the Japanese Design Criteria of Sewerage Facilities.
The industry discharge factor was estimated using the results of Reserch on the Load Factor Discharged from Factories compiled by the Ministry of Korea in 1984.
The estimate was arrived at using the following formulas.

Industry Discharge Factor

= discharge from the Factor

Industry Pollution Load Factor

= discharge from the factories / pollution amount

a. Industry Discharge Factor and Discharge by Factory Classification per Production Amount

i. Industry Discharge Factor per Production Amount

The industry discharge factors is indicated as follows.

Table 2.1.3-6 Industry Discharge Factor

unit:m3/million won

	Industry Discharge Factor
Textile	17.7
Chemistry	28.3
Machinery	7.1
Others	4.8

ii. Discharge of Each Factory Classification

The discharge of Each Factory classification, which was estimated using the production amount and discharge factor, is indicated as follows.

Table 2.1.3-7 Industry Discharge

Unit:m^3/day

	St.1 to 2	St.3 to
Texitile	6,196	7,543
Chemistry	7,431	7,431
Machinery	583	577
Others	436	461
Total	14,646	16,012

b. Estimatite of the Production Amount

The production amounts were estimated using the ratio of the production amount to each factory sort and the calculated total.

Table 2.1.3-8 Industry Production Breakdown(Seoul Area)

	Production per year	Ratio
Textile	1,164 (billion won)	1.00000
Chemistry	1,182	1.00000
Machinery	2,462	1.00000
Casting & Nonferrousmetal	256	0.10398
Primary Metals	386	0.15678
Machinery&Instrumentation	1,820	0.73924
Others	2,515	1.00000
Foods	1,673	0.66521
Wooden	65	0.02584
Printing	599	0.23817
Others	178	0.07078
Total	7,323	-

c. Pollution Load Factor per Industry Discharge

Pollution load fcator per industry discharge was estimated using the data of the Japanese Design Criteria of Sewerage Facility because the data obtained from Korea were insufficient.

Table 2.1.3-9 Industry Pollution Load Factor

	BOD (g/m^3)	S S (g/m^3)
Textile	15.0	22.5
Textil Industry	20.0	15.0
Clothing	10.0	30.0
Chemistry	633.0	233.0
Resin acid & Glycerin	600.0	500.0
Crude Drugs	1,000.0	100.0
Petroleum	300.0	100.0
Casting & Nonferrousmetal	50.0	100.0
Primary Metals	360.0	230.5
Machinery & Instrumentation	25.0	20.0
Machinery	40.0	30.0
Instrumentation	10.0	100.0
Foods	2,400.0	1,200.0
Wooden	10.0	40.0
Printing	200.0	60.0
Others	10.0	100.0

d. Industry Discharge

The industry discharge of the nine categories was calculated using the ratio presented above.

Table 2.1.3-10 Industry Discharge of Ui Chong Basin

unit:m^3/day

Item	St.1 to 2	St.3 to
Texitile	6,196	7,543
Chemistry	7,431	7,431
Machinery	583	577
Casting & Nonferrou	60.6	60.0
Primary Metals	91.4	90.5
Machin & Inst	431.0	426.5
Others	436	461
Foods	290.0	306.7
Wooden	11.3	11.9
Printing	103.8	109.8
Others	30.9	32.6

e. Generation Load by Industry

The generation load by industry based on the industry pollution load factor and the industry discharge is presented in the Table 2.1.3-11.

Table 2.1.3-11 Industry Input Load of Ui Chong Basin
unit:kg/day

Item		St.1 to 2	St.3 to
Textile	BOD	92.9	113.1
	S S	139.4	169.7
Chemistry	BOD	4,703.8	4,703.8
	S S	1,731.4	1,731.4
Casting & Nonfer	BOD	3.0	3.0
	S S	6.1	6.0
Primary Metals	BOD	32.9	32.6
	S S	21.1	20.9
Machin & Inst	BOD	10.8	10.7
	S S	8.6	8.5
Foods	BOD	696.0	736.1
	S S	348.0	368.0
Wooden	BOD	0.1	0.1
	S S	0.5	0.5
Printing	BOD	20.8	22.0
	S S	6.2	6.6
Others	BOD	0.3	0.3
	S S	3.1	3.3
Total	BOD	5,560.6	5,621.7
	S S	2,264.4	2,314.9

(3) Generation Load by Land Utilization

1) Present Land Utilization conditions

The present land utilization condition and the land utilization plan for Seoul Metropolitan have not been compiled. Therefore in order to grasp the present state of land utilization at each observation station, the condition of the land utilization was studied at each river basin based on the Town Plan of Seoul Metropolitan published in 1989, 1/25,000 in scale. However, this method includes the areas of the productive green zone, development restricted zone, the agricultural farm zone, the bush zone and the green zone combined.
The land area formation ratio of the farms, paddy fields including orchards and forest, were determined using the land utilization area survey of the smallest district. Each of the land utilization area was obtained by using the determined land area formation ratio. The green zone area includes the development restricted zone, the natural green zone, reductive green zone and the scenic zone.

Table 2.1.3-12 Land Use Area by Each Observation Station

unit:km^2

	Farm	Paddy	Forest	Residence	Others	Total
St.1 to 2	0.074	0.044	3.976	4.244	0.982	9.320
St.2 to	0.236	0.088	15.650	0.054	0.832	16.860
Total	0.310	0.132	19.626	4.298	1.814	26.180

2) Generation Load by Utilization

a. Generation Unit Load

The generation unit load of the land utilization was adopted from the basic study result for principal rivers in Korea which was summarized in the Basic Plan and the Detailed Plan of the Water Purification Project for Anyang Chong.
The park is classified under the forest category. While the residen-

tial zone, the quasi-industrial zone, the quasi-residential zone and the commercial zone fall under the residential area category.

Table 2.1.3-13 Pollution Load Factor by Land Use

unit:kg/km²·day

	Farm	Paddy	Forest	Residence	Others
BOD	7.10	5.12	0.96	87.59	0.96
S S	7.59	4.41	1.26	227.73	1.26

b. Generation Load by Land Utilization

The generation load by Land Utilization was calculated using the size of the land and the generation unit load.

Table 2.1.3-14 Input Load by Land Use unit:kg/day

		Farm	Paddy	Forest	Residence	Others	Total
St.1 to 2	BOD	0.5	0.2	3.8	371.7	0.9	377.1
	S S	0.6	0.2	5.0	966.5	1.2	973.5
St.2 to	BOD	1.7	1.2	15.0	4.7	0.8	23.4
	S S	1.8	1.0	19.7	12.3	1.0	35.8
Total	BOD	2.2	1.4	18.8	376.4	1.7	400.5
	S S	2.4	1.2	24.7	978.8	2.2	1,009.3

(4) Generation Load by Livestock

1) Present Condition of Livestock

The present condition of the livestock within the basin is shown in the following.

Table 2.1.3-15 Livestok Amount of Yangjae Chong
unit:head

	St.1 to 2	St.2 to
Cow	0	0
Pig	0	0
Chicken	0	74
Toal	0	74

2) Generation Load by Livestock

a. Generation Unit Load factor of Livestock

The generation unit load of the livestock was estimated on the basis of the investigative study by Seoul Metropolitan. The result is indicated in Table 2.1.3-16.

Table 2.1.3-16 Livestock Pollution Load Factor

	BOD (g/head)	S S (g/head)
Cow	640	3,800
Pig	125	356
Chicken	12.5	18

b. Generation Load by Livestock

The generation load by livestock was estimated using the number of the livestock (Table 2.1.3-16) and the generation unit load.

Table 2.1.3-17 Livestock Input Load unit:kg/day

		St.1 to 2	St.2 to
Cow	BOD	0	0
	S S	0	0
Pig	BOD	0	0
	S S	0	0
Chicken	BOD	0	0.9
	S S	0	1.3
Total	BOD	0	0.9
	S S	0	1.3

(5) Result

The generation load obtained by the method described above is summarized in Table 2.1.3-18 and 19.

Table 2.1.3-18 Continuous Input Load (BOD) unit:kg/day

	St.1 to 2	St.2 to
Poulation	12,209	9,435
Industry	5,561	5,622
Land Use	377	23
Livestock	0	1
Total	18,147	15,081

Table 2.1.3-19 Continuous Input Load (S S) unit:kg/day

	St.1 to 2	St.2 to
Poulation	13,322	10,295
Industry	2,264	2,315
Land Use	974	36
Livestock	0	1
Total	16,560	12,647

2.1.4 Chungroung Chong

(1) Generation Load Discharged by the Inhabitants of the basin

1) Settled Population within the basin

The population in the basin was calculated using the data of don-districts in 1988. These data were summed up at every observation station.
The future population was estimated on the basis of the Basic Town Plan of Seoul Metropolitan. The population in 1990 and 2002 were estimated using the data in 1988, 2001 and 2010 by quota allotment. The result is indicated in Table 2.1.4-1

Table 2.1.4-1 Population in Chungroung Chong Basin
unit:person

	St.1 to 2	St.2 to 3	St.3 to	Total
1988	76,002	326,312	16,202	418,516
1990	69,359	297,792	14,786	381,937
2002	101,910	432,055	23,035	557,000
2010	102,967	442,084	21,949	567,000

2) Generation Load discharged by the Population

The generation Load discharged by the settled population was calculated using the generation unit load adopted in the Basic Sewage Plan of SMG published in 1984.

Table 2.1.4-2 Adopted Pollution Load Factor by Basic Sewage Plan of SMG

unit:g/person/day

Treatment District	Item	Pollution Load of Population			Pollution Load of Commercial Use	Total
		Domest	Night Soil	Sub-total		
Anyang	BOD	29	19	48	14.2	62.2
	S S	29.3	25	54	14.3	68.3
Tan	BOD	29	19	48	12.8	60.8
	S S	29.3	25	54	12.9	66.9
Joongnang	BOD	29	19	48	18.9	66.9
	S S	29.3	25	54	19.0	73.0

cf:converted figures 1990

Table 2.1.4-3 Pollution Load Amount of Chungroung Chong Basin(1990)

	St.1 to 2	St.2 to 3	St.3	Total
Population	69,359	297,792	14,786	381,937
BOD(kg/day)	4,640	19,922	989	25,551
S S(kg/day)	5,063	21,739	1,079	27,881

(2) Estimate of Generation Load discharged by Industry

1) Industrial Classification and Production Amount within the basin

The data on the factories in the basin were offered by Seoul Metropolitan. These data include the industries in the basin and the number of workers in each unit of the district. Textile, chemistry, and others are listed as the major industries of this area.

The production amount by each factory classification within the basin was calculated by multiplication -- population amount per employee number multiplied by employee number -- using the results from the Reserch on the load Factor Discharge from Factories compiled by the Ministry of Commerce in 1984.

The production amounts of the year 1990 was arrived at based on the assumption that the annual growth rate was 10% from 1984 to 1990.

Table 2.1.4-4 Production Amount per Employee

unit:million won per year

	Textile	Chemistry	Machinery	Others
1984	16.4	55.3	21.3	10.8
1990	29.1	98.0	37.7	19.1

Table 2.1.4-5 Employee Numbers & Yearly Production Amount

unit:persons,mlion won per year

		St.1 to 2	St.2 to 3	St.3 to
Textil	Employee nos	407	3,287	4,491
	Production Amount	11,844	95,652	130,688
Chemistry	Employee nos	58	128	277
	Production Amount	5,684	12,544	27,146
Machinery	Employee nos	71	144	323
	Production Amount	2,677	5,429	12,177
Others	Employee nos	59	331	537
	Production Amount	1,127	6,322	10,257
Total	Employee nos	595	3,890	5,628
	Production Amount	21,332	119,947	180,268

2) Estimation of Generation Load Discharged by Industry

The industries in Korea are classified broadly into four categories, textile, chemistry, machinery and others. Machinery is further divided into three and others into four sub-categories.

The pollutant load factor per production has not been determined in Korea, because there was no Industry Pollution Factor included in the data. The pollutant load factor was therefore estimated using thedata in the Pollution Load Factor from the Japanese Design Criteria of Sewerage Facilities.

The industry discharge factor was estimated using the results of

Reserch on the Load Factor Discharged from Factories compiled by the Ministry of Korea in 1984.

The estimate was arrived at using the following formulas.

Industry Discharge Factor

= discharge from the Factor

Industry Pollution Load Factor

= discharge from the factories / pollution amount

a. Industry Discharge Factor and Discharge by Factory Classification per Production Amount

i. Industry Discharge Factor per Production Amount

The industry discharge factors is indicated as follows.

Table 2.1.4-6 Industry Discharge Factor

unit:m3/million won

	Industry Discharge Factor
Textile	17.7
Chemistry	28.3
Machinery	7.1
Others	4.8

ii. Discharge of Each Factory Classification

The discharge of Each Factory classification, which was estimated using the production amount and discharge factor, is indicated as follows.

Table 2.1.4-7 Industry Discharge

Unit:m^3/day

	St.1 to 2	St.2 to 3	St.3 to
Texitile	574	4,638	6,337
Chemistry	441	973	2,105
Machinery	52	106	237
Others	15	83	135
Total	1,082	5,800	8,814

b. Estimatite of the Production Amount

The production amounts were estimated using the ratio of the production amount to each factory sort and the calculated total.

Table 2.1.4-8 Industry Production Breakdown(Seoul Area)

	Production per year	Ratio
Textile	1,164 (billion won)	1.00000
Chemistry	1,182	1.00000
Machinery	2,462	1.00000
Casting & Nonferrousmetal	256	0.10398
Primary Metals	386	0.15678
Machinery&Instrumentation	1,820	0.73924
Others	2,515	1.00000
Foods	1,673	0.66521
Wooden	65	0.02584
Printing	599	0.23817
Others	178	0.07078
Total	7,323	-

c. Pollution Load Factor per Industry Discharge

Pollution load fcator per industry discharge was estimated using the data of the Japanese Design Criteria of Sewerage Facility because the data obtained from Korea were insufficient.

Table 2.1.4-9 Industry Pollution Load Factor

	BOD (g/m^3)	S S (g/m^3)
Textile	15.0	22.5
Textil Industry	20.0	15.0
Clothing	10.0	30.0
Chemistry	633.0	233.0
Resin acid & Glycerin	600.0	500.0
Crude Drugs	1,000.0	100.0
Petroleum	300.0	100.0
Casting & Nonferrousmetal	50.0	100.0
Primary Metals	360.0	230.5
Machinery & Instrumentation	25.0	20.0
Machinery	40.0	30.0
Instrumentation	10.0	100.0
Foods	2,400.0	1,200.0
Wooden	10.0	40.0
Printing	200.0	60.0
Others	10.0	100.0

d. Industry Discharge

The industry discharge of the nine categories was calculated using the ratio presented above.

Table 2.1.4-10 Industry Discharge of Yangjae Chong Basin

unit:m³/day

Item	St.1 to 2	St.2 to 3	St.3 to
Texitile	574	4,638	6,337
Chemistry	441	973	2,105
Machinery	52	106	237
Casting & Nonferrou	5.4	11.0	24.6
Primary Metals	8.2	16.6	37.2
Machin & Inst	38.4	78.4	175.2
Others	15	83	135
Foods	10.0	55.2	89.8
Wooden	0.4	2.1	3.5
Printing	3.6	19.8	32.2
Others	1.1	5.9	9.6

e. Generation Load by Industry

The generation load by industry based on the industry pollution load factor and the industry discharge is presented in the Table 2.1.4-11.

Table 2.1.4-11 Industry Input Load of Chungroung Chong Basin

unit:kg/day

Item		St.1 to 2	St.2 to 3	St.3 to
Textile	BOD	8.6	69.6	95.1
	S S	12.9	104.4	142.6
Chemistry	BOD	279.2	615.9	1,332.5
	S S	102.8	226.7	490.5
Casting & Nonfer	BOD	0.3	0.6	1.2
	S S	0.5	1.1	2.5
Primary Metals	BOD	3.0	6.0	13.4
	S S	1.9	3.8	8.6
Machin & Inst	BOD	1.0	2.0	4.4
	S S	0.8	1.6	3.5
Foods	BOD	24.0	132.5	215.5
	S S	12.0	66.2	107.8
Wooden	BOD	0.0	0.0	0.0
	S S	0.0	0.1	0.1
Printing	BOD	0.7	4.0	6.4
	S S	0.2	1.2	1.9
Others	BOD	0.0	0.1	0.1
	S S	0.1	0.6	1.0
Total	BOD	316.8	830.7	1,668.6
	S S	131.2	405.7	758.5

(3) Generation Load by Land Utilization

1) Present Land Utilization conditions

The present land utilization condition and the land utilization plan for Seoul Metropolitan have not been compiled. Therefore in order to grasp the present state of land utilization at each observation station, the condition of the land utilization was studied at each river basin based on the Town Plan of Seoul Metropolitan published in 1989, 1/25,000 in scale. However, this method includes the areas of the productive green zone, development restricted zone, the agricultural farm zone, the bush zone and the green zone combined.

The land area formation ratio of the farms, paddy fields including orchards and forest, were determined using the land utilization area survey of the smallest district. Each of the land utilization area was obtained by using the determined land area formation ratio. The green zone area includes the development restricted zone, the natural green zone, reductive green zone and the scenic zone.

Table 2.1.4-12 Land Use Area by Each Observation Station

unit:km^2

	Farm	Paddy	Forest	Residence	Others	Total
St. 1 to 2	0.008	0.009	0.198	1.216	0.049	1.480
St. 2 to 3	0.046	0.024	2.287	5.274	0.259	7.890
St. 3 to	0.011	0.010	6.392	3.213	0.404	10.030
Total	0.065	0.043	8.877	9.703	0.712	19.400

2) Generation Load by Utilization

a. Generation Unit Load

The generation unit load of the land utilization was adopted from the basic study result for principal rivers in Korea which was summarized in the Basic Plan and the Detailed Plan of the Water Purification Project for Anyang Chong.

The park is classified under the forest category. While the residential zone, the quasi-industrial zone, the quasi-residential zone and the commercial zone fall under the residential area category.

Table 2.1.4-13 Pollution Load Factor by Land Use

unit:kg/km²·day

	Farm	Paddy	Forest	Residence	Others
BOD	7.10	5.12	0.96	87.59	0.96
S S	7.59	4.41	1.26	227.73	1.26

b. Generation Load by Land Utilization

The generation load by Land Utilization was calculated using the size of the land and the generation unit load.

Table 2.1.4-14 Input Load by Land Use

unit:kg/day

		Farm	Paddy	Forest	Residence	Others	Total
St.1 to 2	BOD	0.1	0	0.2	106.5	0	106.8
	S S	0.1	0	0.2	276.3	0.1	277.3
St.2 to 3	BOD	0.3	0.1	2.2	461.9	0.2	464.7
	S S	0.3	0.1	2.9	1,201.0	0.3	1,204.6
St.3 to	BOD	0.1	0.1	6.1	281.4	0.4	288.1
	S S	0.1	0	8.1	731.7	0.5	740.4
Total	BOD	0.5	0.2	8.5	849.8	0.6	859.6
	S S	0.5	0.1	11.2	2,209.6	0.9	2,222.3

(4) Generation Load by Livestock

1) Present Condition of Livestock

The present condition of the livestock within the basin is shown in the following.

Table 2.1.4-15 Livestok Amount of Chungroung Chong

unit:head

	St.1 to 2	St.2 to 3	St.3 to
Cow	0	0	0
Pig	0	0	0
Chicken	38	0	98
Toal	38	0	98

2) Generation Load by Livestock

a. Generation Unit Load factor of Livestock

The generation unit load of the livestock was estimated on the basis of the investigative study by Seoul Metropolitan. The result is indicated in Table 2.1.4-16.

Table 2.1.4-16 Livestock Pollution Load Factor

	BOD (g/head)	S S (g/head)
Cow	640	3,800
Pig	125	356
Chicken	12.5	18

b. Generation Load by Livestock

The generation load by livestock was estimated using the number of the livestock (Table 2.1.4-16) and the generation unit load.

Table 2.1.4-17 Livestock Input Load unit:kg/day

		St.1 to 2	St.2 to 3	St.3 to
Cow	BOD	0	0	0
	S S	0	0	0
Pig	BOD	0	0	0
	S S	0	0	0
Chicken	BOD	0.5	0	1.2
	S S	0.7	0	1.8
Total	BOD	0.5	0	1.2
	S S	0.7	0	1.8

(5) Result

The generation load obtained by the method described above is summarized in Table 2.1.2-18 & 19.

Table 2.1.4-18 Continuous Input Load (BOD)
unit:kg/day

	St.1 to 2	St.2 to 3	St.3 to
Poulation	4,640	19,922	989
Industry	317	831	1,669
Land Use	107	465	288
Livestock	1	0	1
Total	5,065	21,218	2,947

Table 2.1.4-19 Continuous Input Load (SS)

unit:kg/day

	St.1 to 2	St.2 to 3	St.3 to
Poulation	5,063	21,739	1,079
Industry	131	406	759
Land Use	277	1,205	740
Livestock	1	0	2
Total	5,472	23,350	2,580

2.2 Future Generation Load

Generation load in the future was estimated taking into consideration the following matters.

1) The population in the basin is considered to increase in the future due to the town re-development.
2) The future production amounts are expected to increase in view of the annual growth rate.
3) The future land utilization is not variable in the estimate, because except for highly dense development, new land development will not be carried out according to the Basic Town Plan of Seoul Metropolitan.
4) The number of livestock will be a calculated increase of generation load in future.

In general, with the estimates of the population and industrial variable there will be a calculated increase of generation load in future.

2.2.1 Anyang Chong

(1) Generation Load Discharged by the Population of the Basin

1) Settled Population within the Basin

Seoul
The population was calculated using the data don-districts in 1988.
The population of each don-district was summed up at every basin, where the water quality and discharge observation station were installed.

Kwangmyong-shi
The population was calculated using the data indicated in the Sewrage Service Basic Plan of Kwangmyong-shi.
The future population estimate was based on the Basic Town Plan of Seoul Metropolitan and the Sewerage Service Basic Plan of Kwangmyong-shi. The

population in 1990 and 2002 were estimated by quota allotment. The result is indicated in Table 2.2.2-1.

Table 2.2.1-1 Population in Anyang Chong Basin

unit:person

	St.1to2	St.2to4	St.4 to 5 Seoul/Kwangmyong	St.5to6	St.3 to	Total
1988	243,162	151,809	230,787/230,200	267,483	996,569	2,120,010
1990	262,031	163,589	248,695/248,061	288,240	1,073,903	2,284,519
2001	283,973	177,288	269,530/300,000	312,377	1,163,832	2,507,000
2002	302,641	195,956	288,198/305,000	331,045	1,182,500	2,605,340
2010	305,591	190,784	290,038/345,000	336,157	1,252,430	2,720,000

2) Generation Load Discharged by the Population

a. Generation Unit Load of the Population

The future generation load of the settled population was calculated the estimated future generation unit load adopted in the Basic Sewerage Plan of SMG published in 1984. The estimated future generation load is as follows.

Table 2.2.1-2 Future Generation Unit Load by Basic Sewage Plan of SMG in Anyang Chong Treatment District

	BOD(g/person)	S S(g/person)	Remarks
1990	62.2	68.3	
2001	78.6	80.1	
2002	80.9	81.1	
2010	92.0	89.5	

b. Generation Load Discharged by the Population

As described above, the future generation load discharged was determined using the estimated future population and the generation unit load. the result is represented in Table 2.2.1-3.

Table 2.2.1-3 Future Generation Load (BOD) of Poulation in Anyang Chong Basin

	St.1 to 2	St.2 to 4	St.4 to 5	St.5 to 6	St.3 to
1990	16,298	10,175	30,898	17,929	66,797
2001	22,320	13,935	44,765	24,553	91,477
2002	24,484	15,853	47,990	26,782	95,664
2010	28,114	17,552	58,423	30,926	115,224

Table 2.2.1-4 Future Generation Load (S S) of Poulation in Anyang Chong Basin

	St.1 to 2	St.2 to 4	St.4 to 5	St.5 to 6	St.3 to
1990	17,897	11,173	33,928	19,687	73,348
2001	22,746	14,201	45,619	25,021	93,223
2002	24,544	15,892	48,108	26,848	95,901
2010	27,350	17,075	56,836	30,086	112,092

(2) Generation Load discharged by Industry

The future generation load, discharged by the industry, was estimated based on the future production figures, assuming that these figures increase 5% annually from the year 1990.

1) Future Production Amounts

Table 2.2.1-5 Yearly Production Amount of Anyang Chong Basin in 2002
unit:million per won

	St.1 to 2	St.2 to 4	St.4 to 5	St.5 to 6	St.3 to
Textile	165,036	314,498	45,622	2,244,490	470,020
Chemistry	1,932,413	391,234	495,247	5,020,227	411,826
Machinery	1,616,292	731,607	989,287	6,072,555	1,356,784
Others	615,734	159,499	255,714	1,641,775	379,574
Total	4,329,475	1,596,838	1,785,047	14,979,047	2,618,204

Table 2.2.1-6 Yearly Production Amount of Anyang Chong Basin in 2010

unit:million per won

	St.1 to 2	St.2 to 4	St.4 to 5	St.5 to 6	St.3 to
Textile	243,833	464,656	67,404	3,316,134	694,434
Chemistry	2,855,054	578,032	731,705	7,417,161	608,454
Machinery	2,388,000	1,080,916	1,461,627	8,971,930	2,004,588
Others	909,720	235,653	377,806	2,425,650	560,804
Total	6,396,607	2,359,257	2,638,542	22,130,875	3,868,280

2) Future Generation Load

The future generation load, calculated using the future production amounts and the generation unit load of each kind of industry, is represented in Table 2.2.1-7 & 8.

Table 2.2.1-7 Industry Generation Load of Anyang Chong Basin(2002)

unit:kg/day

Item		St.1to 2	St.2to 4	St.4to 5	St.5to 6	St.3 to
Textile	BOD	120.0	228.8	33.2	177.8	341.9
	S S	180.1	343.1	49.8	266.8	512.8
Chemistry	BOD	94,841.1	19,201.4	24,543.3	246,388.9	20,212.3
	S S	34,909.9	7,067.8	9,034.1	90,692.9	7,439.9
Casting & Nonfer	BOD	163.9	74.2	217.9	615.8	137.6
	S S	327.8	148.4	435.7	1,231.6	275.2
Primary Metals	BOD	1,779.5	805.3	1,089.0	6,685.2	1,493.6
	S S	1,139.4	515.6	697.3	4,280.4	956.3
Machin & Inst	BOD	582.7	263.7	356.6	2,189.0	489.1
	S S	466.1	211.0	285.3	1,751.2	391.3
Foods	BOD	12,926.4	3,350.4	6,153.6	34,468.8	7,970.4
	S S	6,463.2	1,675.2	3,076.8	17,234.4	3,985.2
Wooden	BOD	2.1	0.5	0.9	5.6	1.3
	S S	8.4	2.2	3.5	22.3	5.2
Printing	BOD	385.6	100.0	160.2	1,028.4	237.8
	S S	115.7	30.0	48.1	308.5	71.3
Others	BOD	5.7	1.5	2.4	15.3	3.5
	S S	5.7	1.5	2.4	15.3	3.5
Total	BOD	11,080.0	24,025.8	32,557.1	291,574.8	30,887.5
	S S	43,616.3	9,994.8	13,633.0	115,803.4	13,640.7

Table 2.2.1-8 Industry Generation Load of Anyang Chong Basin(2010)

unit:kg/day

Item		St.1to 2	St.2to 4	St.4to 5	St.5to 6	St.3 to
Textile	BOD	177.4	338.0	49.0	2,412.2	505.1
	S S	266.0	507.0	73.6	3,618.2	757.7
Chemistry	BOD	14,012.4	28,369.2	36,148.1	364,028.2	29,862.4
	S S	51,577.8	10,442.4	13,305.7	133,994.6	10,992.0
Casting & Nonfer	BOD	242.2	109.6	265.7	909.9	203.3
	S S	484.3	219.2	531.4	1,819.7	406.0
Primary Metals	BOD	2,629.1	1,190.2	1,609.2	9,877.3	2,206.8
	S S	1,683.3	762.0	1,030.3	6,324.2	1,413.0
Machin & Inst	BOD	860.8	389.7	526.9	3,234.2	722.6
	S S	688.7	311.7	421.5	2,587.4	578.1
Foods	BOD	19,099.2	4,946.4	8,716.8	50,928.0	11,774.4
	S S	9,549.6	2,473.2	4,358.4	25,464.0	5,887.2
Wooden	BOD	3.1	0.8	1.3	8.2	1.9
	S S	12.4	3.2	5.1	33.0	7.6
Printing	BOD	569.8	147.6	236.6	1,519.4	351.4
	S S	170.9	44.3	71.0	455.8	105.4
Others	BOD	8.5	2.2	3.5	22.6	5.2
	S S	8.5	2.2	3.5	22.6	5.2
Total	BOD	16,371.5	35,493.7	47,557.1	432,940.0	45,633.1
	S S	64,441.5	14,765.2	19,800.5	174,319.5	20,152.8

(3) Results of Estimation

The estimated future generation loads are summarized in Table 2.2.1-9 to 12.

Table 2.2.1-9 Futurte(2002) Continuous Generation Load (BOD)

unit:kg/day

	St.1 to 2	St.2 to 4	St.4 to 5	St.5 to 6	St.3 to
Poulation	24,484	15,853	47,990	26,782	95,664
Industry	110,807	24,026	32,557	291,575	30,888
Land Use	1,301	147	1,664	1,188	2,123
Livestock	7	667	2,835	5,830	27
Total	136,599	40,693	85,046	325,375	128,702

Table 2.2.1-10 Future(2002) Continuous Generation Load (S S)

unit:kg/day

	St.1 to 2	St.2 to 4	St.4 to 5	St.5 to 6	St.3 to
Poulation	17,897	11,173	33,928	19,687	73,348
Industry	43,616	9,995	13,633	115,803	13,641
Land Use	3,367	364	4,144	3,059	5,497
Livestock	38	3,515	12,186	29,962	123
Total	64,918	25,047	63,891	168,511	92,609

Table 2.2.1-11 Futurte(2010) Continuous Generation Load (BOD)

unit:kg/day

	St.1 to 2	St.2 to 4	St.4 to 5	St.5 to 6	St.3 to
Poulation	28,114	17,552	58,423	30,296	115,224
Industry	163,714	35,494	47,557	432,940	45,633
Land Use	1,301	147	1,664	1,188	2,123
Livestock	7	667	2,835	5,830	27
Total	193,136	53,860	110,479	470,254	163,007

Table 2.2.1-12 Future(2010) Continuous Generation Load (S S)

unit:kg/day

	St.1 to 2	St.2 to 4	St.4 to 5	St.5 to 6	St.3 to
Poulation	27,350	17,075	56,836	30,086	112,092
Industry	64,442	14,765	19,801	174,320	20,153
Land Use	3,367	364	4,144	3,059	5,497
Livestock	38	3,515	12,186	29,962	123
Total	95,197	35,719	92,967	237,427	137,865

2.2.2 Yangjae Chong

(1) Generation Load Discharged by the Population of the Basin

1) Settled Population within the Basin

The population in the basin was calculated using the data of don-districts in 1988, totaled at every observation station.
The future population estimate was based on the Basic Town Plan of Seoul Metropolitan. The population in 1990 and 2002 were estimated using the data in 1988, while the population in 2001 and 2010 were estimated by quota allotment. The result is indicated in Table 2.2.2-1.

Table 2.2.2-1 Population in Yangjae Chong Basin

unit:person

	St.1 to 2	St.2 to 4	St.3	Total
1988	130,440	19,543	67,147	217,130
1990	140,275	21,017	72,210	233,502
2002	291,735	48,618	152,981	493,334
2010	317,196	47,525	163,284	528,005

2) Generation Load Discharged by the Population

a. Generation Unit Load of the Population

The future generation load of the settled population was calculated the estimated future generation unit load adopted in the Basic Sewerage Plan of SMG published in 1984. The estimated future generation load is as follows.

Table 2.2.2-2 Future Generation Unit Load by Basic Sewage Plan of SMG in Tan Chong Treatment District

	BOD(g/person)	S S(g/person)	Remarks
1990	60.8	66.9	
2001	76.6	78.3	
2002	78.0	79.3	
2010	89.6	87.4	

b. Generation Load Discharged by the Population

As described above, the future generation load discharged was determined using the estimated future population and the generation unit load. the result is represented in Table 2.2.2-3.

Table 2.2.2-3 Future Generation Load (BOD) of Poulation in Yangjae Chong Basin

	St.1 to 2	St.2 to 4	St.4 to	St.3 to
1990	8,529	1,278	-	4,390
2001	21,904	3,282	-	11,276
2002	22,755	3,792	-	11,933
2010	28,421	4,258	-	14,630

Table 2.2.2-4 Future Generation Load (S S) of Poulation in Yangjae Chong Basin

	St.1 to 2	St.2 to 4	St.4 to	St.3 to
1990	9,384	1,406	-	4,831
2001	22,390	3,354	-	11,526
2002	23,135	3,855	-	12,131
2010	27,723	4,154	-	14,271

(2) Generation Load discharged by Industry

The future generation load, discharged by the industry, was estimated based on the future production figures, assuming that these figures increase 5% annually from the year 1990.

1) Future Production Amounts

Table 2.2.2-5 Yearly Production Amount of Yangjae Chong Basin in 2002
unit:million per won

	St.1 to 2	St.2 to 4	St.4 to	St.3 to
Textile	471	0	-	0
Chemistry	0	0	-	0
Machinery	0	1,354	-	0
Others	4,561	2,435	-	0
Total	5,032	3,789	-	0

Table 2.2.2-6 Yearly Production Amount of Yangjae Chong Basin in 2010
unit:million per won

	St.1 to 2	St.2 to 4	St.4 to	St.3 to
Textile	695	0	-	0
Chemistry	0	0	-	0
Machinery	0	2,001	-	0
Others	6,739	3,598	-	0
Total	7,434	5,599	-	0

2) Future Generation Load

The future generation load, calculated using the future production amounts and the generation unit load of each kind of industry, is represented in Table 2.2.2-7 & 8.

Table 2.2.2-7 Industry Generation Load of Yangjae Chong Basin(2002)

unit:kg/day

Item		St.1to 2	St.2to 4	St.5 to	St.3 to
Textile	BOD	0.3	0	-	0
	S S	0.5	0	-	0
Chemistry	BOD	0	0	-	0
	S S	0	0	-	0
Casting & Nonfer	BOD	0	0.2	-	0
	S S	0	0.3	-	0
Primary Metals	BOD	0	1.4	-	0
	S S	0	0.9	-	0
Machin & Inst	BOD	0	0.5	-	0
	S S	0	0.4	-	0
Foods	BOD	96.0	50.4	-	0
	S S	48.0	25.2	-	0
Wooden	BOD	0	0	-	0
	S S	0.1	0	-	0
Printing	BOD	2.8	1.6	-	0
	S S	0.8	0.5	-	0
Others	BOD	0	0	-	0
	S S	0	0	-	0
Total	BOD	99.1	54.1	-	0
	S S	49.4	27.3	-	0

Table 2.2.2-8 Industry Generation Load of Yangjae Chong Basin(2010)

unit:kg/day

Item		St.1to 2	St.2to 4	St.5 to	St.3 to
Textile	BOD	0.5	0	-	0
	S S	0.8	0	-	0
Chemistry	BOD	0	0	-	0
	S S	0	0	-	0
Casting & Nonfer	BOD	0	0.2	-	0
	S S	0	0.4	-	0
Primary Metals	BOD	0	2.2	-	0
	S S	0	1.4	-	0
Machin & Inst	BOD	0	0.7	-	0
	S S	0	0.6	-	0
Foods	BOD	70.8	74.4	-	0
	S S	48.0	37.2	-	0
Wooden	BOD	0	0	-	0
	S S	0.1	0	-	0
Printing	BOD	4.2	2.2	-	0
	S S	1.3	0.7	-	0
Others	BOD	0.1	0	-	0
	S S	0.1	0	-	0
Total	BOD	146.4	79.7	-	0
	S S	73.1	40.3	-	0

(3) Results of Estimation

The estimated future generation loads are summarized in Table 2.2.2-9 to 12.

Table 2.2.2-9 Futurte(2002) Continuous Generation Load (BOD)

unit:kg/day

	St.1 to 2	St.2 to 4	St.4 to	St.3 to
Poulation	22,755	3,792	Kwachon-shi	11,933
Industry	99	54	Kwachon-shi	0
Land Use	348	140	Kwachon-shi	54
Livestock	0	113	Kwachon-shi	264
Total	23,202	4,099	-	12,251

Table 2.2.2-10 Future(2002) Continuous Generation Load (S S)

unit:kg/day

	St.1 to 2	St.2 to 4	St.4 to	St.3 to
Poulation	23,135	3,855	Kwachon-shi	12,131
Industry	49	27	Kwachon-shi	0
Land Use	897	360	Kwachon-shi	114
Livestock	0	536	Kwachon-shi	1,510
Total	24,081	4,778	-	13,755

Table 2.2.2-11 Futurte(2010) Continuous Generation Load (BOD)

unit:kg/day

	St.1 to 2	St.2 to 4	St.4 to	St.3 to
Poulation	28,421	4,258	Kwachon-shi	14,360
Industry	146	80	Kwachon-shi	0
Land Use	348	140	Kwachon-shi	54
Livestock	0	113	Kwachon-shi	264
Total	28,915	4,591	-	14,678

Table 2.2.2-12 Future(2010) Continuous Generation Load (S S)

unit:kg/day

	St.1 to 2	St.2 to 4	St.4 to	St.3 to
Poulation	27,723	4,154	Kwachon-shi	14,271
Industry	73	40	Kwachon-shi	0
Land Use	897	360	Kwachon-shi	114
Livestock	0	536	Kwachon-shi	1,510
Total	28,693	5,090	-	15,895

2.2.3 Ui Chong

(1) Generation Load Discharged by the Population of the Basin

1) Settled Population within the Basin

The population in the basin was calculated using the data of don-districts in 1988, totaled at every observation station.
The future population estimate was based on the Basic Town Plan of Seoul Metropolitan. The population in 1990 and 2002 were estimated using the data in 1988, while the population in 2001 and 2010 were estimated by quota allotment. The result is indicated in Table 2.2.3-1.

Table 2.2.3-1 Population in Ui Chong Basin

unit:person

	St.1 to 2	St.2 to	Total
1988	199,971	154,529	354,500
1990	182,494	141,024	323,518
2002	209,085	160,283	369,368
2010	217,524	168,093	385,617

2) Generation Load Discharged by the Population

a. Generation Unit Load of the Population

The future generation load of the settled population was calculated the estimated future generation unit load adopted in the Basic Sewerage Plan of SMG published in 1984. The estimated future generation load is as follows.

Table 2.2.3-2 Future Generation Unit Load by Basic Sewage Plan of SMG in Joongnang Chong Treatment District

	BOD(g/person)	S S(g/person)	Remarks
1990	66.9	73.0	
2001	85.0	86.1	
2002	86.7	87.3	
2010	99.9	99.9	

b. Generation Load Discharged by the Population

As described above, the future generation load discharged was determined using the estimated future population and the generation unit load. the result is represented in Table 2.2.3-3.

Table 2.2.3-3 Future Generation Load (BOD) of Poulation in Ui Chong Basin

	St.1 to 2	St.2 to
1990	12,209	9,435
2001	17,631	13,624
2002	18,128	14,041
2010	21,731	16,793

Table 2.2.3-4 Future Generation Load (S S) of Poulation in Ui Chong Basin

	St.1 to 2	St.2 to
1990	13,322	10,295
2001	17,859	13,800
2002	18,253	14,138
2010	21,731	16,793

(2) Generation Load discharged by Industry

The future generation load, discharged by the industry, was estimated based on the future production figures, assuming that these figures increase 5% annually from the year 1990.

1) Future Production Amounts

Table 2.2.3-5 Yearly Production Amount of Ui Chong Basin in 2002
unit:million per won

	St.1 to 2	St.2 to 4
Textile	229,471	279,327
Chemistry	172,122	172,122
Machinery	53,825	53,283
Others	59,513	62,907
Total	514,931	567,639

Table 2.2.3-6 Yearly Production Amount of Ui Chong Basin in 2010
unit:million per won

	St.1 to 2	St.2 to 4
Textile	339,033	412,694
Chemistry	254,303	254,303
Machinery	79,525	78,723
Others	87,928	92,942
Total	760,789	838,662

2) Future Generation Load

The future generation load, calculated using the future production amounts and the generation unit load of each kind of industry, is represented in Table 2.2.3-7 & 8.

Table 2.2.3-7 Industry Generation Load of Ui Chong Basin (2002)

unit:kg/day

Item		St.1to 2	St.2to
Textile	BOD	166.9	203.2
	S S	250.4	304.8
Chemistry	BOD	8,451.4	9,451.4
	S S	3,113.4	3,113.4
Casting & Nonfer	BOD	5.5	5.4
	S S	10.9	10.8
Primary Metals	BOD	59.4	58.7
	S S	38.0	37.6
Machin & Inst	BOD	19.4	19.2
	S S	15.5	15.4
Foods	BOD	1,250.4	1,320.0
	S S	625.2	660.0
Wooden	BOD	0.2	0.2
	S S	0.8	0.8
Printing	BOD	37.2	39.4
	S S	11.2	11.8
Others	BOD	0.6	0.6
	S S	0.6	0.6
Total	BOD	9,991.0	10,098.1
	S S	4,066.0	4,155.2

Table 2.2.3-8 Industry Generation Load of Ui Chong Basin(2010)

unit:kg/day

Item		St.1to 2	St.2to
Textile	BOD	246.6	300.2
	S S	369.9	450.3
Chemistry	BOD	12,486.8	12,486.8
	S S	4,600.0	4,600.0
Casting & Nonfer	BOD	8.1	8.0
	S S	16.1	16.0
Primary Metals	BOD	87.5	86.8
	S S	56.0	55.6
Machin & Inst	BOD	28.7	28.4
	S S	22.9	22.7
Foods	BOD	1,845.6	1,951.2
	S S	922.8	975.6
Wooden	BOD	0.3	0.3
	S S	1.2	1.3
Printing	BOD	55.0	58.2
	S S	16.5	17.5
Others	BOD	0.8	0.9
	S S	0.8	0.9
Total	BOD	14,759.4	14,920.8
	S S	6,006.2	6,139.9

(3) Results of Estimation

The estimated future generation loads are summarized in Table 2.2.3-9 to 12.

Table 2.2.3-9 Futurte(2002) Continuous Generation Load (BOD)

unit:kg/day

	St.1 to 2	St.2 to
Poulation	18,128	14,041
Industry	9,991	10,098
Land Use	377	23
Livestock	0	1
Total	28,496	24,163

Table 2.2.3-10 Future(2002) Continuous Generation Load (S S)

unit:kg/day

	St.1 to 2	St.2 to
Poulation	21,731	16,793
Industry	4,066	4,155
Land Use	974	36
Livestock	0	1
Total	26,771	20,985

Table 2.2.3-11 Futurte(2010) Continuous Generation Load (BOD)

unit:kg/day

	St.1 to 2	St.2 to
Poulation	21,731	16,793
Industry	14,759	14,921
Land Use	377	23
Livestock	0	1
Total	36,867	31,738

Table 2.2.3-12 Future(2010) Continuous Generation Load (S S)

unit:kg/day

	St.1 to 2	St.2 to
Poulation	21,731	16,793
Industry	6,006	6,140
Land Use	974	36
Livestock	0	1
Total	28,711	22,970

2.2.4 Chungroung Chong

(1) Generation Load Discharged by the Population of the Basin

1) Settled Population within the Basin

The population in the basin was calculated using the data of don-districts in 1988, totaled at every observation station.
The future population estimate was based on the Basic Town Plan of Seoul Metropolitan. The population in 1990 and 2002 were estimated using the data in 1988, while the population in 2001 and 2010 were estimated by quota allotment. The result is indicated in Table 2.2.4-1.

Table 2.2.4-1 Population in Chungroung Chong Basin
unit:person

	St.1 to 2	St.2 to 3	St.3 to	Total
1988	76,002	326,312	16,202	418,516
1990	69,359	297,792	14,786	381,937
2002	101,910	432,055	23,035	557,000
2010	102,967	442,084	21,949	567,000

2) Generation Load Discharged by the Population

a. Generation Unit Load of the Population

The future generation load of the settled population was calculated the estimated future generation unit load adopted in the Basic Sewerage Plan of SMG published in 1984. The estimated future generation load is as follows.

Table 2.2.4-2 Future Generation Unit Load by Basic Sewage Plan of SMG in Joongnang Chong Treatment District

	BOD(g/person)	S S(g/person)	Remarks
1990	66.9	73.0	
2001	85.0	86.1	
2002	86.7	87.3	
2010	99.9	99.9	

b. Generation Load Discharged by the Population

As described above, the future generation load discharged was determined using the estimated future population and the generation unit load. the result is represented in Table 2.2.4-3.

Table 2.2.4-3 Future Generation Load (BOD) of Population in Chungroung Chong Basin unit:kg/day

	St.1 to 2	St.2 to 3	St.3 to
1990	4,640	19,922	19,922
2001	8,521	36,583	36,583
2002	8,836	37,459	37,459
2010	10,286	44,164	44,164

Table 2.2.4-4 Future Generation Load (SS) of Population in Chungroung Chong Basin unit:kg/day

	St.1 to 2	St.2 to 3	St.3 to
1990	5,063	21,739	1,079
2001	8,631	37,056	1,840
2002	8,897	37,718	2,011
2010	9,936	42,661	2,118

(2) Generation Load discharged by Industry

The future generation load, discharged by the industry, was estimated based on the future production figures, assuming that these figures increase 5% annually from the year 1990.

1) Future Production Amounts

Table 2.2.4-5 Yearly Production Amount of Chungroung Chong Basin in 2002
unit:million per won

	St.1 to 2	St.2 to 3	St.3 to
Texitile	21,270	171,777	234,697
Chemistry	10,208	22,527	48,750
Machinery	4,808	9,750	21,868
Others	2,024	11,353	18,420
Total	38,310	215,407	323,735

Table 2.2.4-6 Yearly Production Amount of Chungroug Chong Basin in 2010
unit:million per won

	St.1 to 2	St.2 to 3	St.3 to
Texitile	31,426	253,793	346,754
Chemistry	15,081	33,283	72,026
Machinery	7,103	14,405	32,309
Others	2,990	16,774	27,215
Total	56,600	318,255	478,304

2) Future Generation Load

The future generation load, calculated using the future production amounts and the generation unit load of each kind of industry, is represented in Table 2.2.4-7 & 8.

Table 2.2.4-7 Industry Generation Load of Chungroung Chong Basin (2002) unit:kg/day

Item		St.1 to 2	St.2 to 3	St.3 to
Textile	BOD	15.5	125.0	170.7
	S S	23.2	187.4	256.1
Chemistry	BOD	500.9	1,106.4	2,393.9
	S S	184.5	407.6	881.9
Casting & Nonfer	BOD	0.5	1.0	2.2
	S S	1.0	2.0	4.4
Primary Metals	BOD	5.4	10.8	24.1
	S S	3.5	6.9	15.4
Machin & Inst	BOD	1.7	3.5	7.9
	S S	1.4	2.8	6.3
Foods	BOD	43.2	237.6	386.4
	S S	21.6	118.8	193.2
Wooden	BOD	0	0	0.1
	S S	0	0.2	0.2
Printing	BOD	1.2	7.0	11.6
	S S	0.4	2.1	3.5
Others	BOD	0	0.1	0.2
	S S	0	0.1	0.2
Total	BOD	568.4	1,491.4	2,997.1
	S S	235.6	727.9	1,361.2

Table 2.2.4-8 Industry Generation Load of Chungroung Chong Basin(2010)

unit:kg/day

Item		St.1 to 2	St.2 to 3	St.3 to
Textile	BOD	22.9	184.6	252.2
	S S	34.3	276.9	378.3
Chemistry	BOD	740.3	1,634.5	3,536.3
	S S	272.7	602.1	1,302.7
Casting & Nonfer	BOD	0.7	1.5	3.3
	S S	1.4	2.9	6.6
Primary Metals	BOD	7.9	15.8	35.6
	S S	5.1	10.1	22.8
Machin & Inst	BOD	2.6	5.2	11.7
	S S	2.1	4.2	9.3
Foods	BOD	62.4	352.8	571.2
	S S	31.2	176.4	285.6
Wooden	BOD	0	0.1	0.1
	S S	0	0.2	0.4
Printing	BOD	1.8	10.6	17.0
	S S	0.5	3.2	5.1
Others	BOD	0	0.2	0.3
	S S	0	0.2	0.3
Total	BOD	836.6	2,205.3	4,427.7
	S S	347.3	1,076.2	2,011.1

(3) Results of Estimation

The estimated future generation loads are summarized in Table 2.2.4-9 to 12.

Table 2.2.4-9 Futurte(2002) Continuous Generation Load (BOD)
unit:kg/day

	St.1 to 2	St.2 to 3	St.3 to
Poulation	8,836	37,459	1,997
Industry	568	1,491	2,997
Land Use	107	465	288
Livestock	1	0	1
Total	9,512	39,415	5,283

Table 2.2.4-10 Future(2002) Continuous Generation Load (S S)
unit:kg/day

	St.1 to 2	St.2 to 3	St.3 to
Poulation	8,897	37,718	2,011
Industry	236	728	1,361
Land Use	277	1,205	740
Livestock	1	0	2
Total	9,411	39,651	4,114

Table 2.2.4-11 Futurte(2010) Continuous Generation Load (BOD)
unit:kg/day

	St.1 to 2	St.2 to 3	St.3 to
Poulation	10,286	44,164	2,193
Industry	839	2,205	4,428
Land Use	107	465	288
Livestock	1	0	1
Total	11,233	46,834	6,910

Table 2.2.4-12 Future(2010) Continuous Generation Load (S S)

unit:kg/day

	St.1 to 2	St.2 to 3	St.3 to
Poulation	9,936	42,661	2,118
Industry	347	1,076	2,011
Land Use	277	1,205	740
Livestock	1	0	2
Total	10,561	44,942	4,871

Chapter 3 Measured Pollution Load along the Rivers

The water quality and the discharge measurements were carried out at each observation station every month from January 1990 to May 1991. BOD and SS at each station.
This survey was forcused on the average conditions, rather than on seasonal and temporal dynamics. Therefore, the average data during the observation period were taken as the measured pollution load, excluding maximum data in the calculation.

3.1 Anyang Chong

The aberage measured pollution load of Anyang Chong is represented in Table 3.1-1. (St.3-1 shows the period of unusual condition, i.e., February 1990 to December 1991, when the wastewater was flowed into the river because of the destruction of the intercepting sewer located beneath the road under construction. St.3-2 shows the period after its repair work.)

Table 3.1-1 Measuered Pollutoin Load of Anyang Chong

unit: kg/day

	St.1	St.2	St.4	St.5	St.6	St.3-1	St.3-2
BOD	32,119.3	41,009.8	18,678.3	31,807.1	22,406.3	25,364.9	154.2
S S	32,680.4	37,112.1	23,827.0	24,533.7	18,943.2	19,003.5	280.9

3.2 Yangjae Chong

The average measured pollution load of Yangjae Chong is represented in Table 3.2-1.

Table 3.2-1 Measuered Pollutoin Load of Yangjae Chong

unit: kg/day

	St.1	St.2	St.3	St.4
BOD	1,800.6	438.9	425.8	1,471.5
S S	4,539.7	1,712.9	6,222.4	2,247.3

3.3 Ui Chong

The average measured pollution load of Ui Chong is represented in Table 3.3-1.

Table 3.3-1 Measuered Pollutoin Load of Ui Chong
unit: kg/day

	St.1	St.2
BOD	1,326.6	264.3
S S	2,358.5	888.0

3.4 Chungroung Chong

The average measured pollution load of Chungroung Chong is represented in Table 3.4-1.

Table 3.4-1 Measuered Pollutoin Load of Chungroung Chong
unit: kg/day

	St.1	St.2	St.3
BOD	683.4	450.0	1,844.6
S S	453.4	226.2	1,105.9

3.5 Measured Pollution Load of Each River

Table 3.5-1 Measuered Pollutoin Load of Anyang Chong

unit:BOD kg/day

Date	St. 1-1	St. 1-2	St. 2	St. 2	St. 4
Jan. 31, 1990		7,612.6		38,019.8	17,761.4
Feb. 22	11,199.3		61,198.3		20,710.6
Mar. 20	-		114,629.1		27,039.4
Apr. 20	10,121.9		117,942.7		44,851.3
May, 28	39,680.4		56,084.7		11,302.4
Jun. 22	-		-		-
Jul. 30	98,579.5		49,127.7		51,353.2
Aug. 25	6,485.2		8,840.7		7,347.8
Sep. 22	23,242.5		25,297.5		11,007.6
Oct. 22	10,137.4		-		5,815.8
Nov. 26	20,507.9		21,679.3		11,812.2
Dec. 25	16,711.3		15,088.6		17,227.5
Jan. 5, 1991		41,075.5		48,956.7	12,755.2
Feb. 5		34,799.2		49,708.1	16,760.3
Mar. 5		37,477.4		49,575.5	13,455.8
Apr. 29		59,788.7		41,556.0	10,974.1
May. 28		11,962.1		18,242.7	-
Mean	26,296.2	32,119.3	52,209.5	41,009.8	18,678.3

Table 3.5-2 Measuered Pollutoin Load of Anyang Chong

unit:BOD kg/day

Date	St.5	St.6	St.3-1	St.3-1
Jan.31,1990	33,530.5	11,203.9		57.7
Feb.22	115,786.4	57,558.9	54,028.7	
Mar.20	73,093.4	28,327.8	71,165.5	
Apr.20	43,181.9	18,535.1	22,272.7	
May.28	11,042.3	18,960.5	29,889.5	
Jun.22	-	-	-	
Jul.30	63,428.4	47,365.2	24,191.1	
Aug.25	6,153.9	16,423.9	13,803.2	
Sep.22	8,582.8	4,745.0	3,458.9	
Oct.22	-	-	-	
Nov.26	6,420.3	4,996.8	4,686.0	
Dec.25	30,496.6	12,862.9	4,788.6	
Jan. 5,1991	24,072.4	18,127.4		309.4
Feb. 5	13,107.5	29,544.1		-
Mar. 5	28,647.9	42,033.2		123.0
Apr.29	11,314.3	12,894.2		126.7
May.28	8,248.3	12,515.5		-
Mean	31,807.1	22,406.3	25,364.9	154.2

Table 3.5-3 Measuered Pollutoin Load of Anyang Chong

unit:S S kg/day

Date	St.1-1	St.1-2	St.2-1	St.2-1	St.4
Jan. 31, 1990		5,356.2		43,015.1	19,681.6
Feb. 22	17,384.5		37,326.6		18,025.9
Mar. 20	-		103,021.1		39,571.9
Apr. 20	3,038.5		476,967.0		139,599.6
May, 28	26,708.0		54,568.9		15,823.4
Jun. 22	-		-		-
Jul. 30	41,074.8		67,038.9		13,365.9
Aug. 25	9,127.3		21,049.2		12,858.7
Sep. 22	72,902.6		57,451.3		24,387.5
Oct. 22	7,241.0		-		5,410.0
Nov. 26	11,535.7		14,320.3		14,046.9
Dec. 25	10,439.3		9,778.2		9,169.5
Jan. 5, 1991		34,086.8		42,003.4	14,344.0
Feb. 5		27,066.0		49,045.3	11,941.2
Mar. 5		22,148.1		21,937.8	6,048.0
Apr. 29		72,152.4		35,524.7	13,131.4
May. 28		35,272.8		31,146.0	-
Mean	22,161.3	32,680.4	93,502.4	37,112.1	23,827.0

Table 3.5-4 Measuered Pollutoin Load of Anyang Chong

unit:S S kg/day

Date	St.5	St.6	St.3-1	St.3-2
Jan. 31, 1990	42,033.7	10,734.4		467.1
Feb. 22	83,959.8	70,516.2	40,851.0	
Mar. 20	50,409.2	11,100.2	47,241.8	
Apr. 20	19,747.8	4,808.3	13,126.3	
May, 28	8,868.2	12,387.5	12,718.9	
Jun. 22	-	-	-	
Jul. 30	17,017.4	22,202.4	12,332.7	
Aug. 25	9,330.1	20,178.0	28,223.0	
Sep. 22	15,311.6	7,851.9	9,423.3	
Oct. 22	-	-	-	
Nov. 26	8,083.2	4,654.8	3,962.6	
Dec. 25	22,628.6	5,283.5	3,151.9	
Jan. 5, 1991	16,901.9	17,372.1		313.3
Feb. 5	18,622.7	36,706.3		-
Mar. 5	11,302.1	12,892.0		194.5
Apr. 29	13,427.6	21,133.3		148.7
May. 28	30,361.5	26,327.6		-
Mean	24,533.7	18,943.2	19,003.5	280.9

Table 3.5-5 Measureered Pollution Load of Yangjae Chong

unit: BOD kg/day

Date	St. 1	St. 2	St. 3	St. 4
Jan. 31, 1990	4,084.0	516.7	48.4	35.5
Feb. 22	2,250.6	446.9	1,942.4	-
Mar. 20	-	-	56.4	290.0
Apr. 20	274.8	172.7	45.7	201.7
May. 28	1,610.9	834.6	-	-
Jun. 22	254.4	267.5	166.3	610.0
Jul. 30	3,883.5	-	262.8	561.9
Aug. 25	1,295.8	678.2	177.2	438.5
Sep. 22	901.7	682.2	177.4	289.9
Oct. 22	453.7	291.9	38.7	150.6
Nov. 26	1,747.6	136.6	31.6	143.9
Dec. 25	-	361.8	78.4	89.3
Jan. 5, 1991	862.2	-	-	-
Feb. 5	633.4	-	-	-
Mar. 5	3,472.1	-	1,363.7	14,867.7
Apr. 29	1,674.6	-	1,146.3	1,051.1
May. 28	3,610.3	-	-	399.9
Mean	1,800.6	438.9	425.8	1,471.5

Table 3.5-6 Measureered Pollution Load of Yangjae Chong

S Skg/day

Date	St.1	St.2	St.3	St.4
Jan.31,1990	9,313.7	1,391.0	151.4	111.3
Feb.22	2,914.4	1,383.2	-	4,451.0
Mar.20	-	-	23.8	106.5
Apr.20	431.6	142.2	37.0	193.0
May.28	1,724.3	1,550.0	-	-
Jun.22	127.2	1,805.6	1,140.5	2,837.4
Jul.30	7,166.1	-	728.0	4,982.6
Aug.25	7,901.3	996.6	151.9	151.2
Sep.22	2,623.2	1,472.2	498.5	1,172.3
Oct.22	662.9	470.2	183.9	208.7
Nov.26	2,496.6	2,527.1	163.4	143.9
Dec.25	7,448.0	5,391.0	153.4	333.6
Jan. 5,1991	1,943.9	-	-	-
Feb.5	1,414.2	-	-	-
Mar.5	4,088.2	-	1,431.9	11,507.7
Apr.29	-	-	2,057.5	4,624.6
May.28	17,839.2	-	74,170.1	637.9
Mean	4,539.7	1,712.9	6,222.4	2,247.3

Table 3.5-7 Measuered Pollution Load of Ui Choung

Date	BOD(kg/day)		S S(kg/day)	
	St.1	St.2	St.1	St.2
Jan.31,1990	-	74.7	991.4	89.7
Feb.22	718.9	434.0	3,993.8	591.8
Mar.20	1,202.0	337.1	2,404.0	80.3
Apr.20	2,260.7	529.8	3,875.6	3,411.3
May.28	756.0	169.5	-	154.4
Jun.22	-	-	-	-
Jul.30	1,757.8	221.5	4,394.5	332.3
Aug.25	1,893.0	160.7	1,352.2	160.7
Sep.22	399.6	277.2	522.6	653.5
Oct.22	486.0	176.4	1,166.4	98.0
Nov.26	2,119.0	147.8	4,276.8	1,157.1
Dec.24	1,237.2	521.0	2,984.9	1,060.4
Jan. 5,1991	-	-	-	-
Feb. 5	-	-	-	-
Mar. 7	-	246.8	-	2,500.1
Apr.29	1,885.9	179.4	1,694.9	1,980.5
May.28	1,202.8	223.8	644.4	161.6
Mean	1,326.6	264.3	2,358.5	888.0

Table 3.5-8 Measuered Pollution Load of Chungroung Chong

Date	BOD(kg/day)			S S(kg/day)		
	St. 1	St. 2	St. 3	St. 1	St. 2	St. 3
Jan. 31, 1990	25.6	-	248.4	98.5	11.0	274.2
Feb. 22	866.4	1,136.7	1,306.6	348.5	-	1,006.0
Mar. 20	1,934.3	60.2	-	750.4	-	70.5
Apr. 20	177.1	144.3	45.4	59.0	37.2	88.3
May. 28	105.4	141.2	661.0	126.5	168.0	106.6
Jun. 22	-	-	6,840.6	1,169.8	522.3	3,053.3
Jul. 30	205.5	505.1	2,490.3	143.0	180.4	1,185.8
Aug. 25	75.9	934.1	1,883.7	52.7	188.7	479.5
Sep. 22	1,634.7	1,264.9	634.0	694.7	1,246.0	380.4
Oct. 22	1,157.6	1,096.2	277.5	254.0	150.9	140.6
Nov. 26	65.0	9.5	34.1	51.3	11.9	-
Dec. 24	-	51.3	93.1	-	67.7	190.0
Jan. 5, 1991	-	-	3,956.4	-	-	-
Feb. 5	312.0	-	-	460.0	-	2,912.7
Mar. 7	2,261.2	49.3	4,240.4	-	109.3	4,118.4
Apr. 29	452.9	7.6	3,135.3	1,671.3	20.6	1,791.6
May. 28	293.6	-	1,821.5	468.3	-	791.3
Mean	683.4	450.0	1,844.6	453.4	226.2	1,105.9

Chapter 4 Run-off Ratio of Pollution Load

Contaminants discharged from a pollution source flow into a river through a waterway. Run-off ratio of pollution load is the proportion of the pollution load which is just short of falling into a river, to the pollution load which is discharged from a waterway mixing treated and untreated water.
Therefore, in this study estimated pollution load of pollution source was used in calculation, instead of the pollution load which was discharged from a waterway. The calculation is indicated as follows.

Run-off Ratio of Pollution Load in this study
= Measured Pollution Load / Estimated Generation Load

The ratio obtained through the calculation presented above was regarded as the run-off ratio.

4.1 Anyang Chong

Generation load, measured pollution load and the run-off ratio of Anyang Chong at each observation station are indicated in Table 4.1-1.
According to these data, the measured pollution load at St.1 is lower than at the upstream stations. This is probably due to infiltration of river water. However it does not reflect the true state accurately in case of this because the apearant run-off ration is negative. Discharge was thereby corrected with the basin area and data before and after this station.

Table 4.1-1 Measuered and Estimate Pollutoin Load Amount unit:BOD kg/day

		St.1	St.2	St.4	St.5	St.6	St.3
Estimate Load		79,237	24,237	52,872	187,193	-	85,952
Discharge(m^3/s)	Measuered	6.703	7.973	4.117	6.615	5.336	0.078
	Revised	8.564	-	7.771	-	-	-
Load	Measuered	32,119.3	41,009.8	18,678.3	31,807.1	22,406.3	154.2
	Revised	41,066.1	-	35,249.3	-	-	-
Section Load		56.3	5,606.3	3,442.2	31,807.1	-	154.2
Run-off Ratio		0.001	0.231	0.065	0.170	-	0.002

Table 4.1-2 Measuered and Estimate Pollutoin Load Amount unit:S S kg/day

		St.1	St.2	St.4	St.5	St.6	St.3
Estimate Load		45,615	20,623	57,462	118,472	-	86,579
Discharge(m^3/s)	Measuered	6.703	7.973	4.117	6.615	5.336	0.078
	Revised	8.564	-	7.771	-	-	-
Load	Measuered	32,680.4	37,112.1	23,827.0	24,533.7	18,943.2	280.9
	Revised	41,732.0	-	44,987.8	-	-	-
Setion Load		4,602.1	-8,135.8	13,150.2	31,834.6	-	280.9
Run-off Ratio		0.101	-0.395	0.229	0.269	-	0.003

4.2 Yangjae Chong

The run-off ratio of Yangjae Chong at each observation station is indicated in Table 4.2-1.

Table 4.2-1 Measuered and Estimate Pollutoin Load Amount unit:BOD kg/day

	St.1	St.2	St.3	St.4
Estimate Load	8,931	1,562	4,708	-
Discharge(m^3/s)	1.548	0.929	0.284	0.634
Measuered Load	1,800.6	438.9	275.0	281.1
Section Load	1,917.8	-117.2	275.0	281.1
Run-off Ratio	0.215	-0.075	0.058	-

Table 4.2-2 Measuered and Estimate Pollutoin Load Amount unit:S S kg/day

	St.1	St.2	St.3	St.4
Estimate Load	10,308	2,318	6,455	-
Discharge(m^3/s)	1.548	0.929	0.284	0.634
Measuered Load	4,539.7	1,712.9	323.2	1,335.6
Section Load	4,485.5	54.1	323.2	
Run-off Ratio	0.435	0.023	0.050	-

4.3 Ui Chong

The run-off ratio of Ui Chong at each observation station is indicated in Table 4.3-1.

Table 4.3-1 Measuered and Estimate Pollutoin Load Amount
unit:BOD kg/day

	St.1	St.2
Estimate Load	18,147	15,081
Discharge(m^3/s)	4.335	0.935
Measuered Load	1,326.6	264.3
Section Load	1,062.3	264.3
Run-off Ratio	0.059	0.018

Table 4.3-2 Measuered and Estimate Pollutoin Load Amount
unit:S S kg/day

	St.1	St.2
Estimate Load	16,560	12,647
Discharge(m^3/s)	4.335	0.935
Meausered Load	2,358.5	888.0
Section Load	1,470.5	888.0
Run-off Ratio	0.089	0.070

4.4 Chungroung Chong

Generation load, measured pollution load and the run-off ratio of Chungroung Chong at each observation station are indicated in Table 4.4-1.

BOD and SS decrease between St.3 and St.2. This is considered to be due to decrease of discharge, decreasing to 40%. The cause of discharge decrease is considered to be infiltration or interception with an intercepting sewer. This was corrected by the same way as Anyang Chong.

Table 4.4-1 Measuered and Estimate Pollutoin Load unit:BOD kg/day

		St.1	St.2	St.3
Estimate Load		5,065	21,218	2,947
Discharge(m^3/s)	Measuered	0.567	0.463	1.125
	Revised	2.176	2.010	-
Load	Measuered	683.4	450.0	1,844.6
	Revised	2,632.1	1,945.0	1,844.6
Section Laod		687.1	100.4	1,844.6
Run-off Ratio		0.136	0.005	0.626

Table 4.4-2 Measuered and Estimate Pollutoin Load   unit:S S kg/day

		St.1	St.2	St.3
Estimate Load		5,472	23,350	2,580
Discharge(m^3/s)	Measuered	0.567	0.463	1.125
	Revised	2.176	2.010	–
Load	Measuered	453.4	226.2	1,105.9
	Revised	1,748.5	989.9	–
Section Load		758.6	-118.2	1,105.9
Run-off Ratio		0.139	-0.005	0.429

Chapter 5 Prediction of water Quality

5.1 Prediction of Water Quality

In order to predict future water quality, the rivers without specified water quality improvement facilities require the investigation of various factors which restrict the discharge and inflow load. In this study, however, the dischage and the inflow load are largely influenced by the conditions of the existing drainage systems. In addition to this, the actual conditions of the pollution source and the emission load have not been completely grasped, therefore, it is extremely difficult to make an accurate prediction.
Future water quality was estimated on the basis of BOD and SS by calculation of annual average value at each observation station under the following conditions.

(1) The average pollution load, excluding the maximum and the minimum data in calculation, was adopted in this study as the measured pollution load at each observation station. This load was calculated from the results of discharge observation and water quality analysis carried out every month during the observation period of this survey.

(2) The generation load was estimated by multiplying. The generation unit load and the data related to the pollution source is based on the systems described below.

* life system based on the settled population
* natural system based on the area of the classified land utilization
* industrial system based on the production amounts for each factory classification
* stock farm system based on the number of livestock

(3) Scientifically, run-off ratio is calculated as follows.

Run-off ratio
= measured generation load/emission load

However, since it was impossible to measure the emission load in this survey, "rete of pratically measured load and estimated generation load" was used as an alternative. Thus, the result of this calculation was regarded as the run-off ratio in this study.

(4) If existing sewerage system are not repaired, run-off ratio in the future will remain the same.
Yangjae Chong and Chungroung Chong, show negative existing run-off ratios. With their BOD and SS estimated at 0.02 and 0.07.
If existing sewerage systems are repaired, BOD and SS in the future are estimated to be 0.02 and 0.07 adopting the data of Ui Chong.
However, if the present run-off ratio is below these 0.02 and 0.07 will be adopted.

(5) Future inflow load is calculated as follows.

Future Generation Load multiplied by Run-off Ratio

(6) The river water under current conditions has been the mixture of river water itself and polluted water from the sewerage systems. Therepair work is undertaken the discharge from the river will change in the future.
In this respect, the discharge used for water quality prediction was calculated in consideration of not only estimated water quality of the river itself but also of the water quality of the sewage.

(7) Future water quality is calculated as follows.

Inflow Load divided by Discharge

(8) It is not necessary to consider self-purification of the rivers in this study.

5.2 Existing Generation Load and Future generation Load

Both the existing generation load and future generation load, which were calculated so far, are represented in tables below.

5.2.1 Anyang Chong

Table 5.2.1-1 Continuous Generation Load (BOD) unit:kg/day

		St.1 to 2	St.2 to 4	St.4 to 5	St.5 to 6	St.3 to
1990	Loading	79,237	24,237	52,872	187,193	85,952
2002	Loading	136,599	40,693	85,046	325,375	128,702
	2002/1990	1.724	1.679	1.609	1.738	1.497
2010	Loading	193,136	53,860	110,479	470,254	163,007
	2010/1990	2.437	2.222	2.090	2.512	1.896

Table 5.2.1-2 Continuous Generation Load (S S) unit:kg/day

		St.1 to 2	St.2 to 4	St.4 to 5	St.5 to 6	St.3 to
1990	Loading	45,615	20,623	57,462	118,472	86,579
2002	Loading	64,918	25,047	63,891	168,511	92,609
	2002/1990	1.423	1.215	1.112	1.422	1.070
2010	Loading	95,197	35,719	92,967	237,427	137,865
	2010/1990	2.087	1.732	1.618	2.004	1.592

5.2.2 Yangjae Chong

Table 5.2.2-1 Continuous Generation Loadit(BOD) unit:kg/day

		St.1 to 2	St.2 to 4	St.4 to	St.3 to
1990	Loading	8,931	1,562	Kwachon-shi	4,708
2002	Loading	23,202	4,099	Kwachon-shi	12,251
	2002/1990	2.598	2.624	-	2.602
2010	Loading	28,915	4,591	Kwachon-shi	14,678
	2010/1990	3.238	2.939	-	3.118

Table 5.2.2-2 Continuous Generation Loadit(S S) unit:kg/day

		St.1 to 2	St.2 to 4	St.4 to	St.3 to
1990	Loading	10,308	2,318	Kwachon-shi	6,455
2002	Loading	24,081	4,778	Kwachon-shi	13,755
	2002/1990	2.336	2.061	-	2.131
2010	Loading	28,693	5,090	Kwachon-shi	15,895
	2010/1990	2.784	2.196	-	2.462

5.2.3 Ui Chong

Table 5.2.3-1 Continuous Generation Load (BOD) unit:kg/day

		St.1 to 2	St.2 to
1990	Loading	18,147	15,081
2002	Loading	28,496	24,163
	2002/1990	1.570	1.602
2010	Loading	36,867	31,738
	2010/1990	2.032	2.105

Table 5.2.3-2 Continuous Generation Load (S S) unit:kg/day

		St.1 to 2	St.2 to
1990	Loading	16,560	12,647
2002	Loading	26,771	20,985
	2002/1990	1.617	1.659
2010	Loading	28,711	22,970
	2010/1990	1.734	1.816

5.2.4 Chungroung Chong

Table 5.2.4-1 Continuous Generation Load(BOD) unit:kg/day

		St.1 to 2	St.2 to 3	St.3 to
1990	Loading	5,065	21,218	2,947
2002	Loading	9,512	39,415	5,283
	2002/1990	1.878	1.858	1.793
2010	Loading	11,233	46,834	6,910
	2010/1990	2.218	2.207	2.345

Table 5.2.4-2 Continuous Generation Load(S S) unit:kg/day

		St.1 to 2	St.2 to 3	St.3 to
1990	Loading	5,472	23,350	2,580
2002	Loading	9,411	39,651	4,114
	2002/1990	1.720	1.698	1.595
2010	Loading	10,561	44,942	4,871
	2010/1990	1.930	1.925	1.888

5.3 Pollution Load Run-off Ratio

Tables below represent run-off ratio from each river, calculated with the method previously described, and the ratio to be adopted after the repair work.

5.3.1 Anyang Chong

Table 5.3.1-1 Pollutoin Load Run-off Ratio(BOD)

	St.1	St.2	St.4	St.5	St.6	St.3
Measuered(1990)	0.001	0.231	0.065	0.170	-	0.002
Sewer Repair	0.020	0.020	0.020	0.020	-	0.002

Table 5.3.1-2　Pollutoin Load Run-off Ratio(S S)

	St.1	St.2	St.4	St.5	St.6	St.3
Measuered(1990)	0.101	-0.395	0.229	0.269	-	0.003
Sewer Repair	0.070	0.070	0.070	0.070	-	0.003

5.3.2 Chungroung Chong

Table 5.3.2-1　Pollutoin Load Run-off Ratio(BOD)

	St.1	St.2	St.3	St.4
Measuered(1990)	0.215	-0.075	0.058	-
Sewer Repair	0.020	0.020	0.020	-

Table 5.3.2-2　Pollutoin Load Run-off Ratio(S S)

	St.1	St.2	St.3	St.4
Measuered(1990)	0.435	0.023	0.050	-
Sewer Repair	0.070	0.023	0.050	-

5.3.3 Ui choung

Table 5.3.3-1　Pollutoin Load Run-off Ratio(BOD)

	St.1	St.2
Measuered(1990)	0.059	0.018

Table 5.3.3-2　Pollutoin Load Run-off Ratio(S S)

	St.1	St.2
Measuered(1990)	0.089	0.070

5.3.4　Coungroung Chong

Table 5.3.4-1　Pollutoin Load Run-off Ratio(BOD)

	St.1	St.2	St.3
Measuered(1990)	0.136	0.005	0.626
Sewer Repair	0.020	0.020	0.020

Table 5.3.4-2 Pollutoin Load Run-off Ratio(S S)

	St.1	St.2	St.3
Measuered(1990)	0.139	-0.005	0.429
Sewer Repair	0.070	0.070	0.070

5.4 Water Quality Prediction

The water quality prediction result based on the aforesaid data are represented below.

5.4.1 Anyang Chong

The water quality predictions were conducted for the following four cases.

Case 1 : Sewerage system will not be improved in future.

Case 2 : BOD will be attained to 23.7 mg/l at St.6 due to the sewerage projects in the upstream basin, and the condition within Seoul won't change.

Case 3 : The sewerage system within Seoul will be improved but it in the upstream basin won't be improved.

Case 4 : The sewerage system within the basin will be all improved.

Table 5.4.1-1 Future Water Quality of Anyang Chong(Case1) unit:mg/l

		St.1	St.2	St.4	St.5	St.6	St.3
1990	BOD	55.5	59.5	52.5	55.7	48.6	22.9
	S S	56.4	53.9	67.0	42.9	41.1	42.0
2002	BOD	148.1	158.9	148.6	164.9	84.5	38.2
	S S	120.0	119.3	136.8	135.1	69.1	41.2
2010	BOD	211.3	226.7	213.6	238.4	122.1	48.4
	S S	170.3	168.9	197.7	190.3	97.4	61.4

Table 5.4.1-2 Future Water Quality of Anyang Chong(Case2) unit:mg/l

		St.1	St.2	St.4	St.5	St.6	St.3
1990	BOD	55.5	59.5	52.5	55.7	48.6	22.9
	S S	56.4	53.9	67.0	42.9	41.1	42.0
2002	BOD	110.2	118.2	106.9	115.9	23.7	38.2
	S S	106.4	104.8	121.9	117.5	47.4	41.2
2010	BOD	150.0	160.9	146.0	159.0	23.7	48.4
	S S	139.1	135.5	159.4	150.0	47.4	61.4

Table 5.4.1-3 Future Water Quality of Anyang Chong(Case3) unit:mg/l

		St.1	St.2	St.4	St.5	St.6	St.3
1990	BOD	55.5	59.5	52.5	55.7	48.6	22.9
	S S	56.4	53.9	67.0	42.9	41.1	42.0
2002	BOD	86.7	90.0	83.2	92.0	84.5	38.2
	S S	84.7	84.4	76.2	78.5	58.4	41.2
2010	BOD	124.5	129.3	119.7	133.0	122.1	48.4
	S S	120.3	119.5	107.8	110.6	82.4	61.4

Table 5.4.1-4 Future Water Quality of Anyang Chong(Case4) unit:mg/l

		St.1	St.2	St.4	St.5	St.6	St.3
1990	BOD	55.5	59.5	52.5	55.7	48.6	22.9
	S S	56.4	53.9	67.0	42.9	41.1	42.0
2002	BOD	39.0	37.7	33.7	35.3	23.7	38.2
	S S	76.1	74.9	67.2	68.1	47.4	41.2
2010	BOD	47.3	44.7	39.8	41.2	23.7	48.4
	S S	92.8	89.4	79.3	77.9	47.4	61.4

5.4.2 Yangjae Chong

Case1 : Without the sewerage system improvement

Case2 : With the sewerage system improvement

Table 5.4.2-1 Future Water Quality of Yangjae Chong(Case1) unit:mg/l

		St.1	St.2	St.3	St.4
1990	BOD	13.5	5.5	11.2	5.1
	S S	33.9	21.3	13.2	24.4
2002	BOD	45.3	13.4	29.0	5.1
	S S	94.3	26.6	28.0	24.4
2010	BOD	55.6	15.3	34.7	5.1
	S S	110.1	28.0	32.4	24.4

Table 5.4.2-2 Future Water Quality of Yangjae Chong(Case2) unit:mg/l

		St.1	St.2	St.3	St.4
1990	BOD	13.5	5.5	11.2	5.1
	S S	33.9	21.3	13.2	24.4
2002	BOD	8.8	7.7	10.7	5.1
	S S	35.5	33.5	42.2	24.4
2010	BOD	10.2	8.5	12.9	5.1
	S S	121.1	28.6	34.8	24.4

5.4.3 Ui Chong

Case1 : When maintein present condition.

Table 5.4.3-1 Future Water Quality of Ui Chong(Case1) unit:mg/l

		St.1	St.2
1990	BOD	3.5	3.3
	S S	6.3	11.0
2002	BOD	5.7	5.4
	S S	10.3	18.2
2010	BOD	7.3	7.1
	S S	11.1	19.9

5.4.4 Chungroung Chong

Case1 : Without the sewerage system improvement

Case2 : With the sewerage system improvement

Table 5.4.4-1 Future Water Quality of Chungroung Chong(Case1) unit:mg/l

		St.1	St.2	St.3
1990	BOD	14.0	11.2	19.0
	S S	9.3	5.7	11.4
2002	BOD	25.5	20.2	34.0
	S S	49.1	35.9	60.7
2010	BOD	32.4	26.3	44.5
	S S	57.3	41.3	70.2

Table 5.4.4-2 Future Water Quality of Chungroung Chong(Case2) unit:mg/l

		St.1	St.2	St.3
1990	BOD	14.0	11.2	19.0
	S S	9.3	5.7	11.4
2002	BOD	6.4	5.5	1.3
	S S	17.5	8.0	11.5
2010	BOD	7.6	6.7	1.6
	S S	20.4	9.1	13.3

Chapter 6 Applicable Water Quality Improvement Methods

6.1 Applicable Water Quality Improvement Methods

The applicable water quality improvement methods for the studied rivers are listed in Table 6.1-1, and the characteristics and the applicable conditions are described as follows.

Table 6.1-1 Water Quality Improvement Method

A. Countermeasure at Source
- A-1 Restriction of installation
- A-2 Restriction of discharge
- A-3 Install wastewater treatment plant

B. Countermeasure between river and pollution sources
- B-1 Sewerage improvement
- B-2 Repair of existing sewer pipes
- B-3 Removal of sludge in sewer pipes and retarding basins

C. Countermeasure at River Channel
- C-1 Removal of bed sediment in rivers
- C-2 Sediment pond
- C-3 Contact oxidation with cobble plant
- C-4 Groundsel
- C-5 Sheet flow channel
- C-6 Aeration facility
- C-7 Dilution with clean water

(1) Applicable technology to pollution sources

There are three sorts of available countermeasures at pollution sources as shown in Table 6.1-1.

A-1 Regulation on location of industry

Locations of factories are large in emitted pollution load and those which may discharge harmful matters are regulated by legislation, etc. The development limitation being applied by the Seoul Metropolitan Government is a kind of location regulation. However, it is difficult to applied this kind of regulation to the industrial area like Kuro Industrial Area, already established, because a large amount of expenses may be required for shifting many large-scale factories and compensating factories to be shifted for business suspension. In general, such regulation is applied to an area where its good environment must be maintained from now on by keeping the developed form of its urban zone.

A-2 Emission regulation

When the location regulation is impractical, the pollutant content and discharged quantity of waste water from a factory, etc. is to be regulated. In Korea, the wastewater emission standards settled by the Natural Environmental Preservation Act corresponds to this regulation.
No effective results can be expected from such regulation unless the regulation is supported by an executable monitoring system and fair monetary penalty system.

A-3 Installation of wastewater treatment plant

In order to control emission concentration of the wastewater in conformity with the regulation, the treatment plant can be installed in each factory or district. Generally, installation and operation cost must be spent by the owner company.
Its' competitive power will be down in comparison with other competitors who don't need to do so, because production cost must cover those treatment cost. In the result, there can be a case that factories shift its location to the unregulated area and pollutant sources spread.
Therefore, This kind of regulation shall be duties accompanied with a administrative support like a subsidy for its practical management.

(2) Applicable technology between pollution sources and river channels

B-1 Improvement of sewerage system

Improvement of sewerage is the most popular means for preventing rivers from being contaminated by domestic wastewater, human waste, industrial wastewater, etc, and this have been almost completed in Seoul.
While a high sewerage diffusion rate has been attained in a short period in the Seoul Metropolitan area due to intercepting sewers installed along rivers, the sewerage system thus installed causes water pollution and declines inflow to the rivers, because the main part of the system is combined system.

B-2 Rehabilitation of existing sewer pipes

When the sewer pipes are installed along a river channel in the Study Area, rehabilitation work of the damaged sewer pipes are very important because the damaged sewer pipes directly cause water pollution to the river. Leakage of sewage from aged sewer pipes was not observed in this investigation, but at some places it was found that sewage was flowing into rivers due to the design problem of intercepting sewers and due to wrong connection of sewer pipes to storm pipes in the separated system. Therefore, it is necessary to replace the wrongly connected sewer pipes and to review and modify of the design of defective intercepting ports.

B-3 Removal of deposited sludge from sewer and retarding basin

According to the investigations carried out by Public Works Research Institute, Ministry of Construction, Japan, the pollution load by the sludge deposited in sewers in an area equipped with the combined sewerage system corresponds to 56 - 66% of the emitted pollution load of river basin.

In the Study Area, many retarding basins and pumping stations are installed in the Seoul Metropolitan area to prevent inland water flooding, and the pollution load by the sludge deposited on the bottom of the basins is estimated to be equivalent to or more than the pollution load by the sludge deposited in the sewers. Therefore, removal of the sludge from such sewers and retarding basins will lead the reduction of pollution load flowing into rivers.

(3) Applicable technology to river channel

C-1 Dredging of deposited sludge in river channel

In the Anyang Chong, water quality is very close to that of sewage, it is considered that one reason of the water pollution may be attributed to the sludge deposited on the river channel in addition to the sludge deposit in sewers (The sludge described here means soft organic silts and clays).
Consequently, removal of the sludge deposited on the river channel by dredging may be considered to be one means for improving the quality of river water. However, since deposition of the sludge will be repeated unless the pollutants are prevented from flowing into the river, the dredging work should be carried out after pollution inflow decrease.

C-2 Sediment basin

Sediment basins are installed so as to remove precipitable pollutants by keeping waste water containing a large amount of pollutants in a stationary condition. The sediment basins can be divided into ordinal sediment basin where pollutants are precipitated by gravity only and chemical sediment basin where chemicals are added so that pollutants may settle by flocculate sedimentation. As for the operation and maintenance cost, that of chemical sediment basin will be costlier than ordinal sediment basin.

C-3 Contact oxidation plant by cobble

This plant purifies river water by passing the water through a tank filled with cobbles after a sufficient quantity of dissolved oxygen is added to the water and decomposing organic pollutants by means of microorganisms adhering to the surface of the cobbles in an oxidizing atmosphere.
This plant contributed after paying attention to the strong self-purifying action in mountainous streams where numerous cobbles are deposited and sufficient quantities of oxygen are supplied.

The advantage of this plant are as follows.
(a) Cobbles to be used for adhering microorganisms are abundant on river beds and can be obtained at low costs,
(b) Possibilities of producing secondary troubles is low, since the purifying process of this plant is the same as the self-purifying process of rivers,
(c) The plant may not be damaged easily even when a flood, etc., takes place, since the filler is cobbles having strong mechanical strengths.

On the other hand, this plant has such disadvantages as;
(a) Since sludge will be deposited in the cobble layers during the purification operation, removing sludge and cleaning cobble should be carried out every five years.
(b) The activity of the microorganisms decline and the treatment capacity is lowered when the treated water is 80 mg/l or higher in BOD content.
(c) When the SS content of the water to be treated is high, a large quantity of sludge deposits in a short period and it will lead decrease of the purification capacity due to the blockage of cobble layers.
(d) The activity also declines and the capacity is lowered when the water temperature becomes lower.

These advantages, however, can be eliminated to some extent by adding appropriate pretreatment facilities and controlling the water quality and water temperature.

C-4 Falling works

This facility forms a fall in a river channel and removes organic pollutants from the river water by utilizing the oxygen dissolving into the water when the water drops along the fall. Therefore, this work cannot be installed unless the river bed has a certain gradient in the longitudinal profile. The purifying capacity of this facility varies depending upon the fall, river width, oxygen demand of the river water, etc., and, therefore, quantitative evaluation of this facility is difficult.
For such a highly polluted river as the Anyang Chong, it may be possible that installation of a drop work may increase the offensive odor instead of reducing the odor.

C-5 Sheet flow channel

This facility not only supplies oxygen to the river water to which this facility is installed by spreading cobbles all over the river bed which is increased in width and reduced in depth, but also promotes decomposition of organic matters by means of microorganisms adhering to the surface of the cobbles.
Since the oxygen supplying method and water staying time are limited, this facility can only be applied to rivers, the water of which is not much contaminated. Moreover, since the flow passing through this channel becomes an eddy current, reduction of the SS contamination cannot be expected. At present, it is difficult to make quantitative evaluation on this facility, because test data are insufficient.

C-6 Installation of aeration system

This system forcibly supplies oxygen to river water by using machinery, such as blowers, etc., so as to promote decomposition of organic pollutants in an oxidizing atmosphere. Since the

river water must be aerated for about 35 hours to reduce the BOD content by about 50%, a wide facility area will be required when this facility is installed to a river with a large flow. For example, when the quantity of the water to be treated is 1.0 m3/sec, the aeration tank to be installed must have a capacity of about 140,000 m3, and, when the depth of the tank is 3 m, the required area becomes about 50,000 m2.
Consequently, this system is recognized to be impractical because the necessary land is too wide.

C-7 Dilution with clean water

This method is used for lowering the pollutant content of contaminated river water by adding river water or underground water having a good quality and, at the same time, for improving the self-purifying capacity of the river. This is an excellent method when a water source having a good water quality and a large water quantity is available, since the maintenance and management costs are inexpensive, but it must be noticed that at least the same amount of dilution water is required for reducing the pollutant content of the present river water quality to a half even when the dilution water is significantly clean.

(4) Evaluation on applicable water quality improvement technology in the river channel

The evaluation of each water quality improving countermeasure and technique, those which are applicable (executable measures as river improvement works) to the objective channels of this study are evaluated in the preceding paragraphs and the summary of the evaluated results is listed on Table 6.1-2.

Table 6.1-2 Evaluation of Applicable Water Quality Improving Technology within River Channel

	Type of Investment	Possibility of Enlargement	Equivalent Evaluation	Experience
Dredging of deposited sludge in river channel	I	○	△	△
Sediment basin	I+R	○	○	△
Contact oxidation plant by cobble	I+R	○	○	○
Falling works	I	○	×	○
Sheet flow channel	I	○	×	△
Installation of aeration system	I+R	△	△	△
Dilution with clean water	I+R	○	○	○

*"I" means "Initial Cost Type" and "R" means "Running Cost Type".

6.2 Quantitative Evaluation of the Applicable Technology within the River and its Effects

Of the above-mentioned water quality improving technologies, only the "Retarding basin" and "Contact oxidation with cobble plan" are evaluated quantitatively here.

(1) Sediment basin

The sediment basins used for water treatment can be divided into gravity and chemical treatment types as mentioned above and the selection of the basins must be made on the basis of the pollutant contamination of the water to be treated and the required water quality.

1) Gravity Treatment Type

In the case of the sediment basin, it is generally said that about 30% of the BOD content and 35% of the SS content can be removed at retention time of 3.0 hours and a water area load of 25 m^3/m^2/day (Japan Sewage Institute: Design Handbook for Sewerage Facilities), but the removal ratios vary depending upon the nature of the water to be treated. Especially, when the river to be treated is high in inorganic SS (sediments, etc.,) content like the Yangjae Chong, it is expected that the SS removal ratio may reach 35% or more.

2) Chemical Treatment Type

Since the pollutant removal ratio with the chemical settling basin varies depending upon the nature of the water to be treated and the chemical used for the treatment, it is desirable to decide the ratio by carrying out jar tests every time.

The jar tests carried out on the water sample (COD (Cr): 23 mg/l) collected from the Anyang Chong (at St. 6) in September, 1990, by varying the injecting concentration of chemicals, $FeCl_3$ and $Al_2(SO_4)_3$, from 50 mg/l to 1,000 mg/l give good results at injecting concentrations of 300 mg/l for both $FeCl_3$ and $Al_2(SO_4)_3$, with the COD (Cr) removal ratio being about 60%. However, the water treated with $FeCl_3$ was slightly colored in reddish black.
From the above-mentioned results, $Al_2(SO_4)_3$ and 300 mg/l will be selected as the chemical to be used and injecting concentration to be set when the chemical settling basin is used in this plan. Under such condition, the removal ratios of both BOD and SS can be set at 50%. The detention time and water area load are set to the same values as those used for the sediment basin.

(2) Contact oxidation treatment with cobble plant

The contact oxidation treatment with cobble plants can be divided into the pre-aerated contact oxidation treatment with cobble plants (a sufficient amount of dissolved oxygen is added to the water to be treated before the water is made to flow to the treatment tank) and the contact oxidation treatment with aerated cobble plants (the water to be treated is directly aerated in the treatment tank). The Ministry of Construction, Japan, recommends the latter when the BOD content of the water to be treated exceeds 25 mg/l on the basis of investigation results.

Since the contact oxidation treatment with cobble plants is a kind of biological treatment, the activity of the microorganisms and, accordingly, the BOD removal ratio decline when the water temperature becomes lower. In order to study the effect of the water temperature on the treatment function of this treatment method, the probability that the water temperature of the objective rivers becomes 1.5 - 22.0°C was calculated by using the water temperatures measured at the time of periodic water quality observations in 1990 (see Table 6.2-1) and, at the same time, the relation between the water temperature and BOD removal ratios was calculated by using Howland's equation to be used for the fixed type biological treatment(see Table 6.2-2).

Table 6.2-1 Non-Exceed probability of Water Temperature

Water Temp. (°C)	22.0	17.5	13.0	10.0	5.0	1.5
Non-exceed Probability(%)	83	58	35	25	10	5
Day	303	212	128	92	37	18

Table 6.2-2 Relation between Water Temperature and BOD Removal Ratio in Contact Oxidation Treatment with Cobble Plan

unit:removal ratio %

Time (hr)	Water Temperature(°C) 22.0	17.5	13.0	10.0	5.0	1.5
0.5	49.0	40.0	31.0	32.5	27.3	24.2
1.0	75.0	64.0	53.0	49.6	41.8	37.0
1.5	87.0	77.5	68.0	57.6	48.5	43.0
2.0	94.0	86.0	78.0	62.3	52.4	46.5
2.5	97.0	91.0	85.0	64.1	54.0	47.9
3.0	98.4	94.2	90.0	65.2	54.9	48.6
Ratio 1	1.1	1.0	0.91	0.72	0.61	0.54
Ratio 2	1.2	1.1	1.0	0.80	0.67	0.60

As far as the BOD removal ratio at detention time of 2.0 - 2.5 hours which are standards for the pre-aerated contact oxidation treatment with cobble plants, the ratio can be lowered at temperatures which are being used as design standards in Japan in such a way that the ratio can be lowered to about 90% at 13 C, about 70% at 10 C, about 60% at 5 C, and about 54% at 1.5 C.

When it is tried to secure the same removal ratios even when the design standard water temperatures are lowered, the required facility becomes excessively larger in size, because the detention time must be prolonged.

In this plan, therefore, the facility is designed so that the removal ratio at 17.5 C can be secured 100% against the water temperature (13 C) of 75% in annual frequency of occurrence and the removal ratio can be secured about 80% even when the water temperature drops to 10 C. However, it is necessary to carry out pilot tests to validate these figures and confirm the removal ratio before starting actual contact oxidation treatment with cobble plants.

6.3 Adopted Water Treatment System

The contact oxidation with cobble treatment system is basically adopted, adding pretreatment and post-treatment depending on the quality of the raw water.

(1) Removal Ratio

The pollutant removal ratios are determined by each treatment operation and total removal ratio is determined in case of the composite treatment system.

1) Sediment Treatment

Table 6.3-1 Removal Ratio

	BOD	SS
Sedimentation Method	30%	35%
Flocculent Settling	50%	50%

2) Contact Oxidation with Cobble Treatment

Table 6.3-2 Removal Ratio

	BOD	SS
Contact Oxidation with Cobble Method	75%	85%
Aeration Contact Oxidation with Cobble Method	90%	80%

(2) Treatment Flow and Total Removal Ratio

The composite treatment flows are shown below.

Type 1

Sand basin + Chemical settling basin + Contact oxidation with aerated cobble + Re-aeration

Type 2
Sand basin + Sediment basin + Contact oxidation with Aerated Cobble + Re-aeration

Type 3
Sand basin + Sediment basin + Pre-aerated Contact Oxidation with Cobble + Re-aeration

Type 4
Sand basin + Contact Oxidation with aerated Cobble + Re-aeration

Type 5
Sand Basin + Pre-aerated Contact Oxidation with Cobble + Re-aeration

Table 6.3-3 Water Treatment Unit Process and Removal Ratio

Item	Design Factor	Removal Ratio	Remarks
Sand Settler	Surface Loading: $1800m^3/m^2/day$ Detention Time:60sec	BOD: - S S: -	Removal Specific Gravity 2.65 (Sand & Soil) $0.02m^3/1,000m^3$
Flocculent Settling	Detention Time:3.0 hr Surface Loading: $25m^3/m^2/day$	BOD:50% S S:50%	$Al_2(SO_4)_3$ 300mg/l
Sedimentation Method	Detention Time:3.0 hr Surface Loading: $25m^3/m^2/day$	BOD:30% S S:35%	Sewage Densign Guide Line (Japan)
Aeration *C.O.C Method	Detention Time:3.0hr	BOD:90% S S:80%	Tama River (Japan)
Pre Aeration *C.O.C Method	Detention Time:2.0hr	BOD:75% S S:85%	Tama River (Japan)

*C.O.C Method:Contact Oxidation with Cobble Method

Table 6.3-4 Removal Ratio of Each Treatment System

Item	Settling	C.O.C Method	Toatl Removal Ratio
Type 1	Chemical	Aeration	
BOD	50%	90%	95%
S S	50%	80%	90%
Type2	Normal	Aeration	
BOD	30%	90%	93%
S S	35%	80%	87%
Type3	Normal	Pre Aeration	
BOD	30%	75%	82.5%
S S	35%	85%	90%
Type4		Aeration	
BOD	-	90%	90%
S S	-	80%	80%
Type5		Pre Aeration	
BOD	-	75%	75%
S S	-	85%	85%

6.4 Water Quality Improvement Plan for Anyang Chong

6.4.1 Basic Policy

The water quality improvement plan occupies mostly a part of the river environment improvement plan because the discharge quantity is sufficient for water familiarization function.

In order to improve the water quality of Anyang Chong fundamentally, it is necessary to improve sewer system in the basin of Kehwa and Oru Rivers and intercepting sewer running in the planning section in addition to the improvement of sewer in the upper basin beyond St. 6.

These measures are to be executed as a sewer project, however, the execution of which would takes considerable time while the improvement of the resident' living environment and the effective utilization of the river space could not be expected. Under such circumstances, any feasible measure shall be used, to execute as the river improvement works, so as to improve the water quality as early as possible.

The measures to be applied to the river shall be executed from upstream phase by phase while checking the water quality to maximize the investment effect.

6.4.2 Target Water Quality

Environmental Bureau determined that the water quality of this river should be Class V, however, the actual water quality is lowering " the limit that would not give any disconformity to the people's daily life (Class V)" greatly, and terribly stinky.

Therefore, tentative target of water quality on Class V (BOD concentration is below 10 mg/l)shall be set. This water quality is the limit of making no bad smell caused by the decomposition of organisms.

As stated previously, Anyang-shi's sewage treatment facility will be operated fully (100%) in 2001, and the water quality at St. 6 is expected to be improved by then to BOD concentrations of 23.7 mg/l, and the target mentioned above could be attained until 2002 by operating appropriate river purifying facility.

However, judging from the current load measured in the downstream past St. 6 and a possible increment of the load occurred hereafter, it appears to be very difficult to attain the target in the entire planning section by 2002, even if the arrangement of sewer were executed as per plan.

In order to clear the hurdle of Class V in the entire planning section, it is necessary to execute orderly arrangements and repair of sewage-related facilities in the downstream past St. 6 in parallel with the installation of water quality purification facilities.

6.4.3 Selection of Applicable Technology

The examined result on the applicability of technology are summarized below.

Table 6.4.3-1 Applicability of Water Quality Improvement Technology

Water Quality Improvement Technology			Applicable Condition
A	Restriction of installation	–	Conservation of green grass area and development restricted area
	Restriction of discharge	–	
	Install wastewater treatment plant	◎	This should be imposed for development restricted area.
B	Sewerage improvement	–	
	Repair of existing sewer pipes	○	Investigation of intercepting sewers is necessary.
	Install water preservation drainag	–	Intercepting sewers has been provided.
	Removal of sludge in sewer pipes	×	
C	Removal of bed sediment in rivers	○	It is executed from upstream after input loading decreases until certain level.
	Sedimentation pond	◎	
	Contact oxidation with cobble plan	◎	
	Ground sill	△	It accelerates sludge sediment on bed because of the present gentle invert.
	Sheet flow channel	○	It will be applicable after self purifing capacity of the river will be recovered.
	Direct aeration facility	△	It is expected to improve slightly based according to the present discharge and water quality.
	Dilution with clean water	△	It is not practical according to the present discharge and water quality.

Legend
- ◎ Most applicabe method
- ○ Applicable method subject to condition
- △ Low applicability method
- × Not necessary
- – Out of investigation scope

The technologies indicated in column C of Table 6.4.3-1 with ◎ and ○ marks are considered applicable as river projects for Anyang Chong. Among these technologies, the dredging of the bed sediment and the sheet flow channel will not be very effective, unless water quality has been improved to a certain level. It is considered wise to conduct dredging bed sediment while observing the water quality improved from the established grit chamber and the contact oxidation with cobble plant facilities.

6.4.4 Location and Function of Primary Facilities

(1) Design discharge

As regards the design discharge corresponding to them, ordinary discharge (Q185) which is approximate to 50% value, is adopted, however that in Table 6.4.4-1, the values of St. 1 and St. 4 are made smaller than that of the upstream being affected by the underground flow, so a supplementary correction was made, referring to specific discharge, etc. Prior to the implementation of the project this design discharge must be reviewed by the further observation data.

Table 6.4.4-1 Designed Discharge of Anyang Chong

unit:m^3/sec

	St.1	St.2	St.3	St.4	St.5	St.6
95days Discharge	11.074	11.070	4.333	6.472	9.108	6.478
185days Discharge	4.156	8.962	2.268	3.893	5.630	3.252
275days Discharge	2.639	6.562	0.520	3.039	4.048	2.187
365days Discharge	0.182	2.440	0.004	2.349	0.614	1.484
Design Discharge	9.632	8.962	2.268	7.494	5.630	3.252

(2) Design water quality

As for BOD concentration of the design water quality, estimated future water quality of each river is adopted. Incidentally, SS concentration shall be worked out from BOD concentration using SS/BOD ratio which were obtained from January, 1990 to May, 1991.

1) SS/BOD Ratio

The average rates of SS and BOD which were obtained in 1990 are summarized in Table 6.4.4-2.

Table 6.4.4-2 SS-BOD Ratio

River	Anyang	Yangjae	Ui	Chungroung
SS/BOD	1.50	4.00	2.50	1.10

2) Design water quality

It is too difficult to estimate accurately the design water quality because it varies depending on the sewerage improvement conditions in Seoul Metropolitan and the upstream cities. In this report, assuming the sewerage system will be improved in Seoul and the upstream cities, the design water quality is determined. In other words, we assumed as follows,

a. The apparent run-off ratio in Seoul is improved to that level of Ui Chong

b. BOD is attained to 23.7 mg/l at St.6 after the sewerage condition is improved in the upstream cites.

Table 6.4.4-3 Designed Water Quality of Anyang Chong

unit:mg/l

Year(Item)	St.1	St.2	St.4	St.5	St.6	St.3
1990(BOD)	55.5	59.5	52.5	55.7	48.6	23.0
(SS)	56.4	53.9	67.0	42.9	41.1	42.0
2002(BOD)	39.0	37.7	33.7	35.3	23.7	38.2
(SS)	58.5	56.6	50.6	53.0	35.6	57.3
2010(BOD)	47.3	44.7	39.8	14.2	23.7	38.2
(SS)	71.0	67.1	59.7	61.8	35.6	57.3

Table 6.4.4-5 Water Purification Facility Configuration and River Water Quality (2010)

		Water Quality (BOD mg/l)				
		St.1	St.2	St.4	St.5	St.6
Without Project	Load	39,362	34,612	25,770	20,041	6,659
	Conc.	47.3	44.7	39.8	41.2	23.7
St.6	Removal Load	3,682	3,862	3,862	3,862	3,862
	Concentration	42.7	39.7	33.8	33.3	10.0
St.5	Removal Load	11,325	11,325	11,325	11,325	-
	Concentration	29.1	25.1	16.3	10.0	-
St.4	Removal Load	4,127	4,127	4,127	-	-
	Concentration	24.1	19.8	10.0	-	-
St.2	Removal Load	7,573	7,573	-	-	-
	Concentration	15.0	10.0	-	-	-

(4) Facility Planning

The facility planning was selected among the five treatment flows described in 5.5, referring to the required removal ratio and the raw water quality shown in Table 6.4.4-6.
The treatment flow, and water quality and discharge of raw water, effluent and river water concerning the proposed plant at St.3 are summarized in Table 6.4.6-7.

Table 6.4.4-6 Treatment Discharge and River Water Quality (2002)

	River Discharg (m^3/sec)	Treatment Discharg (m^3/sec)	Raw Water Quality (BOD mg/l)	Treated Water Quality (BOD mg/l)	River Water Quality (BOD mg/l)	Flow Sheet
St.6	3.252	2.089	23.7	2.37	10	Type 4
St.5	5.630	3.972	27.4	2.74	10	Type 4
St.4	7.494	3.200	14.7	3.68	10	Type 5
St.2	8.962	5.278	17.9	4.48	10	Type 5

Table 6.4.6-7 Treatment Discharge and River Water Quality (2010)

	River Discharg (m^3/sec)	Treatment Discharg (m^3/sec)	Raw Water Quality (BOD mg/l)	Treated Water Quality (BOD mg/l)	River Water Quality (BOD mg/l)	Flow Sheet
St. 6	3.252	2.089	23.7	2.37	10	Type 4
St. 5	5.630	4.378	33.3	3.33	10	Type 4
St. 4	7.494	3.867	16.3	4.08	10	Type 5
St. 2	8.962	5.915	19.8	4.95	10	Type 5

6.4.5 Expected Water Quality Improvement Effect

As there is no effective alternate measure applicable to the water quality of this river, the estimation of future water quality was carried out for the purpose of finding the differences of effects depending on the facility locations assuming the following conditions.

1) Only data obtained after the intercepting sewer of Torim Chong was completed were used.
2) BOD concentration will attain 23.7 mg/l at St.6 in 2001 because the sewerage improvement achieve 100% in 2001.
3) The other conditions which affect the apparent run-off ratio will not change.
4) The water improvement facilities will be constructed from the upstream one by one and the treatment method is selected among the aforesaid several types in conformity with the inflow raw water quality.
5) The estimations were carried out for the year 2002 and 2010.

The estimation result are shown in Fig. 6.4.5-1. In order to attain the
target water quality in the entire planning section, it is

necessary to install a complex treatment facility comprising of the sediment pond and contact oxidation with cobble plant at St. 6, 4, 2. It is quite obvious that the effect of installing such facilities at St. 5 is great.

The improvement effect by dredging works is not able to be estimated at present. In addition, the improvement effect by the sheet flow channel is also not able to be estimated due to the insufficient data.

6.5 Water Quality Improvement Plan for Yangjae Chong

6.5.1 Basic Policy

It can be expected to attain high standard recreational zone with water familiarity by water quality improvement work which cannot be executed in other river section, since this river provides a relatively good water in quantity and quality except for some segments.
Therefore this river is proposed to be improved aiming the river environment improvement model in Korea.

In order to achieve such plan, repairing of erroneous connection of the sewage pipe and maintaining the present specified development restricted zone are required. In this report, only applicable plans within rivers were investigated.

The target of maintenance flow was not determined because the present discharge exceeds the required discharge to maintain the present environment and also because maintaining cleanness of water can be executed by the water quality improvement plan.

6.5.2 Water Quality Target

This river lacks the water quality standards established by Environmental Bureau because of a quasi-river. However, the water quality of Tan Chong joining this river is classified as Class II by Environmental Bureau.
This standard defines this river as a model river of the small-medium river environmental improvement project at such a level that is suitable to swimming and playing in the water and this concept is compatible with the basic policy of this scheme intending to create a quality recreation space possessing a great deal of hydrophile properties.

However it was estimated that the water quality would not be able to attain this target in the downstream of St.2 in the year 2002 even if the contact oxidation with cobble plant will be installed unless the inflow sewage is diverted. Therefore, the target water quality of this river is defined as Class III.

6.5.3 Selection of Applicable Technology

The examined result on the applicability of technology are summarized below.

Table 6.5.3-1 Applicability of Water Quality Improvement Technology

Water Quality Improvement Technology			Applicable Condition
A	Restriction of installation	—	Conservation of green grass area and development restricted area
	Restriction of discharge	—	
	Install wastewater treatment plant	◎	This should be imposed for development restricted area.
B	Sewerage improvement	—	
	Repair of existing sewer pipes	○	Misconnection of sewerage pipes must be repaired.
	Install water preservation drainag	○	In case sewerage repair work is impossibile.
	Removal of sludge in sewer pipes	×	
C	Removal of bed sediment in rivers	×	
	Sedimentation pond	◎	
	Contact oxidation with cobble plan	◎	
	Ground sill	×	DO is sufficient.
	Sheet flow channel	×	DO is sufficient.
	Direct aeration facility	×	DO is sufficient.
	Dilution with clean water	△	A large amount of clean water must be introduced because of large present discharge.

Legend
◎ Most applicabe method
○ Applicable method subject to condition
△ Low applicability method
× Not necessary
— Out of investigation scope

The technologies indicated in column C of Table 6.5.3-1 with and marks are considered applicable as river projects for Yangjae Chong.

6.5.4 Location and Function of Primary Facilities

(1) Design discharge

As regards the design discharge corresponding to them, ordinary discharge (Q185) which is approximate to 50% value, is adopted. Prior to the implementation of the project this design discharge must be reviewed by the further observation data.

Table 6.5.4-1 Designed Discharge of Yangjae Chong

unit:m^3/sec

	St.1	St.2	St.4	St.3
Q(95-day)	1.132	0.992	0.293	0.875
Q(185-day)	0.736	0.645	0.397	0.152
Q(275-day)>	0.341	0.299	0.079	0.170
Q(365-day)	0.008	0.007	0.013	0.057
Design Discharge	0.736	0.645	0.152	0.397

(2) Design water quality

As for BOD concentration of the design water quality, estimated future water quality of each river is adopted. Incidentally, SS concentration shall be worked out from BOD concentration using SS/BOD ratio which were obtained from January, 1990 to May, 1991.

1) SS/BOD Ratio

The average rates of SS and BOD which were obtained in 1990 are summarized in Table 6.4.4-2.

2) Design water quality

It is too difficult to estimate accurately the design water quality because it varies depending on the sewerage improvement conditions in Seoul Metropolitan and the upstream cities. In this report, assuming the sewerage system will not be improved.

Table 6.5.4-2 Designed Water Quality of Yangjae Chong

Year(Item)	St.1	St.2	St.4	St.3
1990(BOD)	13.5	5.5	5.1	11.2
(SS)	33.9	21.3	24.4	13.2
2002(BOD)	45.3	13.4	5.1	29.0
(SS)	181.2	53.6	20.4	116.0
2010(BOD)	155.6	15.3	5.1	34.7
(SS)	222.4	61.2	20.4	138.8

(3) Arrangement Plan of Facility

The result of the study on how to achieve the target water quality, 6 mg/l of BOD, based on the aforesaid total removal ratio is shown in Table 6.5.4-4.

Table 6.5.4-4 Water Purification Facility Configuration and River Water Quality (2002)

		Water Quality (BOD mg/l) & Removal Load(kg/day)		
		St.1	St.2	St.3
Without Project	Load	2,881	747	381
	Conc.	45.3	13.4	29
St.3	Removal Load	0	0	0
	Concentration	45.3	13.4	29
St.2	Removal Load	441	441	-
	Concentration	38.8	6.0	-
St.1	Removal Load	0	-	-
	Concentration	38.8	-	-

Table 6.5.4-5 Water Purification Facility Configuration and River Water Quality (2010)

		Water Quality (BOD mg/l) & Removal Load(kg/day)		
		St.1	St.2	St.3
Without Project	Load	3,536	853	456
	Conc.	55.6	15.3	34.7
St.3	Removal Load	0	0	0
	Concentration	55.6	15.3	34.7
St.2	Removal Load	520	520	-
	Concentration	47.4	6.0	-
St.1	Removal Load	0	-	-
	Concentration	47.4	-	-

(4) Facility Planning

The facility planning was selected among the five treatment flows described in 5.5, referring to the required removal ratio and the raw water quality shown in Table 6.5.4-6.
The treatment flow, and water quality and discharge of raw water, effluent and river water 3 are summarized in Table 6.5.6-7.

Table 6.5.4-6 Treatment Discharge and River Water Quality (2002)

	River Discharg (m^3/sec)	Treatment Discharg (m^3/sec)	Raw Water Quality (BOD mg/l)	Treated Water Quality (BOD mg/l)	River Water Quality (BOD mg/l)	Flow Sheet
St. 2	0.645	0.475	13.4	1.34	6	Type 3

Table 6.5.6-7 Treatment Discharge and River Water Quality (2010)

	River Discharg (m^3/sec)	Treatment Discharg (m^3/sec)	Raw Water Quality (BOD mg/l)	Treated Water Quality (BOD mg/l)	River Water Quality (BOD mg/l)	Flow Sheet
St. 2	0.645	0.523	15.3	1.53	6	Type 3

6.5.5 Expected Water Quality Improvement Effect

The primary pollution causes are Yoi Chong and the sewerage inflow from the storm water pipes between St.1 and St.2. The proposed plan is to install the facility near St.2 for the purpose of reducing pollution load from the main river and Yoi Chong. The expected water quality effect is shown in Fig.6.5.5-1.

This figure proves that water quality will be able to attain the target at St.2 in 2002 but not in the downstream of St.2 unless pollution load between St.1 and St.2.

In order to reduce the pollution load between St.1 and St.2, repairing the sewer pipes is most effective. The other measures are as follows,

a. Small contact oxidation with cobble plants are installed at

each outlet.
b. Diverting sewage from the outlets by intercepting sewer newly installed.

6.6 Water Quality Improvement Plan for Ui Chong

6.6.1 Basic Policy

Environmental Bureau has not established the water quality standard of this river, however, the water quality standard of the confluence of this river and Chungryang Chong is made Class III. The water quality improvement plan is not necessary to be established, because at present this standard is satisfied and also it is estimated to be satisfied in future.
However, it is necessary to conduct the flow-regime improvement plan due to insufficient river flow.

6.7 Water Quality Improvement Plan for Chungroung Chong

6.7.1 Basic Policy

The cause of deterioration of this river is greatly depending on the imperfect construction of the pipe intercepting sewer. Unless it is renovated, the water quality of the river would further deteriorated. Further, the occupation ratio of the river space by highway and parking lot would all the more increase and the construction conditions of facilities would become severer.

Under such circumstances, there is an opinion such that we should consider the effective utilization of the river space by covering the whole of river. However, we would improve the water quality on the precondition that we would leave the river space.

6.7.2 Water Quality Target

Environmental Bureau has not established the water quality standard of this river, however, Chungryang Chong which joins this river is classified as Class III. Accordingly, the target water quality of this river is defined as Class III.

6.7.3 Selection of Applicable Technology

The examined result on the applicability of technology are summarized below.

Table 6.7.3-1 Applicability of Water Quality Improvement Technology

Water Quality Improvement Technology			Applicable Condition
A	Restriction of installation	—	Conservation of green grass area and development restricted area
	Restriction of discharge	—	
	Install wastewater treatment plant	—	
B	Sewerage improvement	—	Sewerage service rate is 100%.
	Repair of existing sewer pipes	○	Investigation of intercepting sewers is necessary.
	Install water preservation drainag	×	
	Removal of sludge in sewer pipes	◎	It shoud be executed for open intercepting sewers.
C	Removal of bed sediment in rivers	○	It is not so effective unless existing sewer pipes is repaired.
	Contact oxidation with cobble plan	◎	
	Ground sill	×	DO is sufficient. dge sediment on bed because of
	Sheet flow channel	×	DO is sufficient. ble after self purifing capacity
	Direct aeration facility	×	DO is sufficient. improve slightly based according
	Dilution with clean water	○	It is possible to introduce water from Han River.

Legend
◎ Most applicabe method
○ Applicable method subject to condition
△ Low applicability method
× Not necessary
— Out of investigation scope

The technologies indicated in column C of Table 6.7.3-1 with ◎ and ○ marks are considered applicable as river projects for Chungroung Chong.

6.7.4 Location and Function of Primary Facilities

(1) Design discharge

As regards the design discharge corresponding to them, ordinary discharge (Q185) which is approximate to 50% value, is adopted. Prior to the implementation of the project this design discharge must be reviewed by the further observation data.

Table 6.7.4-1 Designed Discharge of Yangjae Chong

unit:m^3/sec

	St.1	St.2	St.4
Q(95-day)	0.434	0.715	1.107
Q(185-day)	0.244	0.300	0.168
Q(275-day)	0.109	0.075	0.042
Q(365-day)	0.012	0.020	0.011
Design Discharge	0.244	0.300	0.168

(2) Design water quality

As for BOD concentration of the design water quality, estimated future water quality of each river is adopted. Incidentally, SS concentration shall be worked out from BOD concentration using SS/BOD ratio which were obtained from January, 1990 to May, 1991.

1) SS/BOD Ratio

The average rates of SS and BOD which were obtained in 1990 are summarized in Table 6.4.4-2.

2) Design water quality

It is too difficult to estimate accurately the design water quality because it varies depending on the sewerage improvement conditions in Seoul Metropolitan and the upstream cities. In this report, assuming the sewerage system will not be improved.

Table 6.7.4-2 Designed Water Quality of Chungroung Chong

Year(Item)	St.1	St.2	St.3
1990(BOD)	14.0	11.2	19.0
(SS)	9.3	5.7	11.4
2002(BOD)	25.5	20.2	34.0
(SS)	28.1	22.2	37.4
2010(BOD)	32.4	26.3	44.5
(SS)	35.6	28.9	49.0

(3) Arrangement Plan of Facility

The result of the study on how to achieve the target water quality, 6 mg/l of BOD, based on the aforesaid total removal ratio is shown in Table 6.7.4-4. The water quality improvement facility is determined to be installed near St.3.

Table 6.7.4-3 Water Purification Facility Configuration and River Water Quality (2002)

		Water Quality (BOD mg/l) & Removal Load(kg/day)		
		St.1	St.2	St.3
Without Project	Load	538	524	494
	Conc.	25.5	20.2	34.0
St.3	Removal Load	407	407	407
	Concentration	5.9	4.7	6.0
St.2	Removal Load	0	0	-
	Concentration	5.9	4.7	-
St.1	Removal Load	0	-	-
	Concentration	5.9	-	-

Table 6.7.4-4 Water Purification Facility Configuration and River Water Quality (2010)

		Water Quality (BOD mg/l) & Removal Load(kg/day)		
		St.1	St.2	St.3
Without Project	Load	683	682	676
	Conc.	32.4	26.3	44.5
St.3	Removal Load	559	559	559
	Concentration	5.9	4.7	6.0
St.2	Removal Load	0	0	-
	Concentration	5.9	4.7	-
St.1	Removal Load	0	-	-
	Concentration	5.9	-	-

(4) Facility Planning

The facility planning was selected among the five treatment flows described in 5.5, referring to the required removal ratio and the raw water quality shown in Table 6.7.4-6.
The treatment flow, and water quality and discharge of raw water, effluent and river water are summarized in Table 6.7.6-7.

Table 6.7.4-5 Treatment Discharge and River Water Quality (2002)

	River Discharg (m^3/sec)	Treatment Discharg (m^3/sec)	Raw Water Quality (BOD mg/l)	Treated Water Quality (BOD mg/l)	River Water Quality (BOD mg/l)	Flow Sheet
St.3	0.168	0.153	34.0	3.40	6	Type 4

Table 6.7.4-6 Treatment Discharge and River Water Quality (2010)

	River Discharg (m^3/sec)	Treatment Discharg. (m^3/sec)	Raw Water Quality (BOD mg/l)	Treated Water Quality (BOD mg/l)	River Water Quality (BOD mg/l)	Flow Sheet
St.3	0.168	0.161	44.5	4.45	6	Type 4

6.7.5 Expected Water Quality Improvement Effect

The present primary cause of river water deterioration is deemed to be leakage of sewage, especially in the covered segment near St.3. The estimated water quality improvement effect is shown in Fig.6.7.5-1 in case of installing the pre-aeration contact oxidation with cobble plant near St.3.

Chapter 7. Investment amount in view of water quality level

7.1 Construction cost of each facility

Construction cost calculated with a view to the result described in the previous chapters is shown in Table 7.1-1.

Table 7.1-1 Expenses of Water Purification Facility

	Capcity (m^3/sec)	Flow Sheet	Expenses (million won)
Anyang Chong			
St. 6	2.089	Type 4	42,195
St. 5	4.378	Type 4	84,528
St. 4	3.867	Type 5	62,175
St. 2	5.915	Type 5	78,741
Yangjae Chong St. 2	0.523	Type 3	7,557
Chungroung Chong St. 3	0.168	Type 4'	3,066
Total			278,262

7.2 Investment amount in view of water quality level

Every sort of water quality purifying facilities designed in this study adopts mainly the biochemical treatment (contact oxidation with cobble plant). As elimination rate is constant in case of the biochemical treatment, manipulation of design parameter does not give a good result.

For example, in the facility of contact oxidation with cobble plant, water remains 3.0 hours and 90% of BOD is eliminated. On the assumption that water remains 2.0 hours there, elimination rate would not be variable in proportion to the time, and would be impossible to eliminate BOD sufficiently. Therefore, in this plan, the treatment ability of facility was determined by controlling the treatment water quantity and mixing both the treated and untreated water, for the purpose of maintaining the target water quality.

The construction cost per treatment water quality was calculated statistically in consideration of each treatment method using the

relationship between facility construction costs and treatment quality as mentioned above. It was recognized at each river quality level.
The forecasting water quality in 2010 and the commodity pri July, 1991 were used for calculation.

Table 7.2-1 River Water Quality & Purification Facility Expenses of Anyang Chong

River Water Quality(BOD mg/l)					Cost
St.6	St.5	St.4	St.2	St.1	(million won)
23.7	41.2	39.8	44.7	47.3	0
20.4	36.2	33.9	37.7	40.8	41,500
15.2	28.7	25.7	28.6	32.2	106,368
10.6	22.9	19.8	22.3	26.5	161,588
5.3	16.9	14.3	16.8	21.3	222,936
2.4	10.9	10.4	12.2	17.1	278,894
2.4	5.8	6.6	9.9	14.9	305,140
2.4	2.9	3.3	5.9	11.2	335,793
2.4	2.9	2.8	3.5	8.9	335,723

Table 7.2-2 River Water Quality Purification Facility Expenses of Yangjae Chong

River Water Quality(BOD mg/l)		Cost
St.2	St.1	(million won)
15.3	55.6	0
13.0	53.6	1,898
10.0	50.9	4,355
8.0	49.2	5,951
5.0	46.6	8,369
3.8	45.6	9,251

ANNEX 1

PREDICTION OF FUTURE WATER QUALITY

Case 1

	unit	St. 1	St. 2	St. 4	St. 5	St. 6	St. 3	
(1990)								
Total Discharge (Meausered)	m3/sec	6.703	7.973	4.117	6.615	5.336	0.078	
Area	km2	284.14	264.55	212.29	153.6	126.38	41.83	
Q/A	-	0.02359	0.03014	0.01939	0.04307	0.04222	0.00186	
Revised Discharge	m3/sec	8.564	7.973	7.771	6.615	5.336	0.078	
River Discharge	m3/sec							
Sewer Discharge	m3/sec							
Revised BOD Load (Meauser)	kg/day	41,066.1	41,009.8	35,249.3	31,807.1	22,406.3	154.2	
BOD Span Loading (Meauser)	kg/day	56.3	5606.3	3442.2	31807.1			
BOD Generation Loading	kg/day	79,237	24,237	52,872	187,193		85,952	
BOD Generation Loading	kg/day	451,897	372,660	262,471	209,599		85,952	
BOD Run-off Ratio	-	0.001	0.231	0.065	0.170		0.002	
BOD Loading (Meausered)	kg/day	32,119.3	41,009.8	18,678.3	31,807.1	22,406.3	154.2	
BOD Conc.	mg/l	55.5	59.5	52.5	55.7	48.5	22.9	
(2002)						1.738		←St. 6 Loading 2002/1990
Total Discharge	m3/sec	8.564	7.973	7.771	6.615	5.336	0.078	
River Discharge	m3/sec							
Sewer Discharge	m3/sec							
BOD Generation Loading	kg/day	136,599.0	40,693.0	85,046.0	325,375.0	-	128,702.0	
BOD Run-off Ratio	-	0.001	0.231	0.065	0.170	-	0.002	
BOD Loading	kg/day	109,578.0	109,441.4	99,783.9	94,255.9	38,942.1	257.4	
BOD Conc.	mg/l	148.1	158.9	148.6	164.9	84.5	38.2	
(2010)						2.512		←St. 6 Loading 2010/1990
Total Discharge	m3/sec	8.564	7.973	7.771	6.615	5.336	0.078	
River Discharge	m3/sec							
Sewer Discharge	m3/sec							
BOD Generation Loading	kg/day	193,136.0	53,860.0	110,479.0	470,254.0	-	163,007.0	
BOD Run-off Ratio	-	0.001	0.231	0.065	0.170	-	0.002	
BOD Loading	kg/day	156,369.7	156,176.6	143,408.9	136,227.8	56,284.6	326.0	
BOD Conc.	mg/l	211.3	226.7	213.6	238.4	122.1	48.4	

	unit	St. 1	St. 2	St. 4	St. 5	St. 6	St. 3	
(1990)								
Total Discharge (Meausered	m3/sec	6.703	7.973	4.117	6.615	5.336	0.078	
Area	km2	284.14	264.55	212.29	153.6	126.38	41.83	
Q/A	-	0.02359	0.03014	0.01939	0.04307	0.04222	0.00186	
Revised Discharge	m3/sec	8.564	7.973	7.771	6.615	5.336	0.078	
River Discharge	m3/sec							
Sewer Discharge	m3/sec							
Revised S S Load (Meauser)	kg/day	41,732.0	37,129.9	44,984.8	31,834.6	22,406.1	280.9	
S S Span Loading (Meauser)	kg/day	4602.1	-8135.8	13150.2	31834.6			
S S Generation Loading	kg/day	45,615	20,623	57,462	118,472		86,579	
S S Generation Loading	kg/day	351,157	305,542	198,340	140,878		86,579	
S S Run-off Ratio	-	0.101	-0.395	0.229	0.269		0.003	
S S Loading (Meausered)	kg/day	32,119.3	41,009.8	18,678.3	31,807.1	22,406.3	280.9	
S S Conc.	mg/l	56.4	53.9	67.0	55.7	48.6	42.0	
(2002)						1.422		←St. 6 Loading 2002/1990
Total Discharge	m3/sec	8.564	7.973	7.771	6.615	5.336	0.078	
River Discharge	m3/sec							
Sewer Discharge	m3/sec							
S S Generation Loading	kg/day	64,948.0	25,047.0	63,891.0	168,511.0	-	92,609.0	
S S Run-off Ratio	-	0.101	-0.395	0.229	0.269	-	0.003	
S S Loading	kg/day	88,766.2	82,206.5	91,822.3	77,191.3	31,861.8	277.8	
S S Conc.	mg/l	120.0	119.3	136.8	135.1	69.1	41.2	
(2010)						2.004		←St. 6 Loading 2010/1990
Total Discharge	m3/sec	8.564	7.973	7.771	6.615	5.336	0.078	
River Discharge	m3/sec							
Sewer Discharge	m3/sec							
S S Generation Loading	kg/day	95,197.0	35,719.0	92,967.0	237,427.0	-	137,865.0	
S S Run-off Ratio	-	0.101	-0.395	0.229	0.269	-	0.003	
S S Loading	kg/day	125,979.0	116,364.1	130,059.5	108,770.1	44,902.2	413.6	
S S Conc.	mg/l	170.3	168.9	193.7	190.3	97.4	61.4	

Case 2

	unit	St. 1	St. 2	St. 4	St. 5	St. 6	St. 3	
(1990)								
Total Discharge(Meausered)	m3/sec	6.703	7.973	4.117	6.615	5.336	0.078	
Area	km2	284.14	264.55	212.29	153.6	126.38	41.83	
Q/A	-	0.02359	0.03014	0.01939	0.04307	0.04222	0.00186	
Revised Discharge	m3/sec	8.564	7.973	7.771	6.615	5.336	0.078	
River Discharge	m3/sec							
Sewer Discharge	m3/sec							
Revised BOD Load(Meauser)	kg/day	41,066.1	41,009.8	35,249.3	31,807.1	22,406.3	154.2	
BOD Span Loading(Meauser)	kg/day	56.3	5606.3	3442.2	31807.1			
BOD Generation Loading	kg/day	79,237	24,237	52,872	187,193		85,952	
BOD Generation Loading	kg/day	451,897	372,660	262,471	209,599		85,952	
BOD Run-off Ratio	-	0.001	0.231	0.065	0.170		0.002	
BOD Loading(Meausered)	kg/day	32,119.3	41,009.8	18,678.3	31,807.1	22,406.3	154.2	
BOD Conc.	mg/l	55.5	59.5	52.5	55.7	48.6	22.9	
(2002)						1.738	←St. 6 Loading 2002/1990	
Total Discharge	m3/sec	8.564	7.973	7.771	6.615	5.336	0.078	
River Discharge	m3/sec							
Sewer Discharge	m3/sec							
BOD Generation Loading	kg/day	136,599.0	40,693.0	85,046.0	325,375.0	-	128,702.0	
BOD Run-off Ratio	-	0.001	0.231	0.065	0.170	-	0.002	
BOD Loading	kg/day	81,562.3	81,425.7	71,768.2	66,240.2	10,926.4	257.4	
BOD Conc.	mg/l	110.2	118.2	106.9	115.9	23.7	38.2	
(2010)						2.512	←St. 6 Loading 2010/1990	
Total Discharge	m3/sec	8.564	7.973	7.771	6.615	5.336	0.078	
River Discharge	m3/sec							
Sewer Discharge	m3/sec							
BOD Generation Loading	kg/day	193,136.0	53,860.0	110,479.0	470,254.0	-	163,007.0	
BOD Run-off Ratio	-	0.001	0.231	0.065	0.170	-	0.002	
BOD Loading	kg/day	111,011.5	110,818.4	98,050.7	90,869.6	10,926.4	326.0	
BOD Conc.	mg/l	150.0	160.9	146.0	159.0	23.7	48.4	

	unit	St. 1	St. 2	St. 4	St. 5	St. 6	St. 3	
(1990)								
Total Discharge (Meausered	m3/sec	6.703	7.973	4.117	6.615	5.336	0.078	
Area	km2	284.14	264.55	212.29	153.6	126.38	41.83	
Q/A	-	0.02359	0.03014	0.01939	0.04307	0.04222	0.00186	
Revised Discharge	m3/sec	8.564	7.973	7.771	6.615	5.336	0.078	
River Discharge	m3/sec							
Sewer Discharge	m3/sec							
Revised S S Load (Meauser)	kg/day	41,732.0	37,129.9	44,984.8	31,834.6	22,406.1	280.9	
S S Span Loading (Meauser)	kg/day	4602.1	-8135.8	13150.2	31834.6			
S S Generation Loading	kg/day	45,615	20,623	57,462	118,472		86,579	
S S Generation Loading	kg/day	351,157	305,542	198,340	140,878		86,579	
S S Run-off Ratio	-	0.101	-0.395	0.229	0.269		0.003	
S S Loading (Meausered)	kg/day	32,119.3	41,009.8	18,678.3	31,807.1	22,406.3	280.9	
S S Conc.	mg/l	56.4	53.9	67.0	55.7	48.6	42.0	
(2002)						1.422		←St. 6 Loading 2002/1990
Total Discharge	m3/sec	8.564	7.973	7.771	6.615	5.336	0.078	
River Discharge	m3/sec							
Sewer Discharge	m3/sec							
S S Generation Loading	kg/day	64,948.0	25,047.0	63,891.0	168,511.0	-	92,609.0	
S S Run-off Ratio	-	0.101	-0.395	0.229	0.269	-	0.003	
S S Loading	kg/day	78,757.2	72,197.5	81,813.3	67,182.3	21,852.8	277.8	
S S Conc.	mg/l	106.4	104.8	121.9	117.5	47.4	41.2	
(2010)						2.004		←St. 6 Loading 2010/1990
Total Discharge	m3/sec	8.564	7.973	7.771	6.615	5.336	0.078	
River Discharge	m3/sec							
Sewer Discharge	m3/sec							
S S Generation Loading	kg/day	95,197.0	35,719.0	92,967.0	237,427.0	-	137,865.0	
S S Run-off Ratio	-	0.101	-0.395	0.229	0.269	-	0.003	
S S Loading	kg/day	102,929.6	93,314.7	107,010.1	85,720.7	21,852.8	413.6	
S S Conc.	mg/l	139.1	135.5	159.4	150.0	47.4	61.4	

Case 3

	unit	St. 1	St. 2	St. 4	St. 5	St. 6	St. 3	
(1990)								
Total Discharge(Meausered)	m3/sec	6.703	7.973	4.117	6.615	5.336	0.078	
Area	km2	284.14	264.55	212.29	153.6	126.38	41.83	
Q/A	-	0.02359	0.03014	0.01939	0.04307	0.04222	0.00186	
Revised Discharge	m3/sec	8.564	7.973	7.771	6.615	5.336	0.078	
River Discharge	m3/sec	4.721	4.122	4.483	3.635	3.256	0.064	
Sewer Discharge	m3/sec	3.843	3.851	3.288	2.98	2.08	0.014	
Revised BOD Load	kg/day	41,066.1	41,009.8	35,249.3	31,807.1	22,406.3	154.2	
BOD Span Loading(Meauer)	kg/day	56.3	5606.3	3442.2	9400.8			
BOD Generation Loading	kg/day	79,237	24,237	52,872	187,193		85,952	
BOD Generation Loading	kg/day	451,897	372,660	262,471	209,599		85,952	
BOD Run-off Ratio	-	0.001	0.231	0.065	0.050		0.002	
BOD Loading(Meausered)	kg/day	32,119.3	41,009.8	18,678.3	31,807.1	22,406.3	154.2	
BOD Conc.	mg/l	55.5	59.5	52.5	55.7	48.6	22.9	
(2002)						1.738		←St.6 Loading 2002/1990
Total Discharge	m3/sec	8.564	7.973	7.771	6.615	5.336	0.078	
River Discharge	m3/sec	4.721	4.122	4.483	3.635	3.256	0.064	
Sewer Discharge	m3/sec	3.843	3.851	3.288	2.980	2.080	0.014	
SMG Sewer Discharge	m3/sec	1.763	1.771	1.208	0.900	-	-	
Total Discharge(2)	m3/sec	6.801	6.202	6.563	5.715	-	0.078	
BOD Generation Loading	kg/day	136,599.0	40,693.0	85,046.0	325,375.0	-	128,702.0	
BOD Run-off Ratio	-	0.020	0.020	0.020	0.020	-	0.002	
BOD Loading	kg/day	50,953.8	48,221.8	47,150.5	45,449.6	38,942.1	257.4	
BOD Conc.	mg/l	86.7	90.0	83.2	92.0	84.5	38.2	
(2010)						2.512		←St.6 Loading 2010/1990
Total Discharge	m3/sec	8.564	7.973	7.771	6.615	5.336	0.078	
River Discharge	m3/sec	4.721	4.122	4.483	3.635	3.256	0.064	
Sewer Discharge	m3/sec	3.843	3.851	3.288	2.980	2.080	0.014	
SMG Sewer Discharge	m3/sec	1.763	1.771	1.208	0.900	-	-	
Total Discharge(2)	m3/sec	6.801	6.202	6.563	5.715	-	0.078	
BOD Generation Loading	kg/day	193,136.0	53,860.0	110,479.0	470,254.0	-	163,007.0	
BOD Run-off Ratio	-	0.020	0.020	0.020	0.020	-	0.002	
BOD Loading	kg/day	73,165.2	69,302.5	67,899.3	65,689.7	56,284.6	326.0	
BOD Conc.	mg/l	124.5	129.3	119.7	133.0	122.1	48.4	

	unit	St. 1	St. 2	St. 4	St. 5	St. 6	St. 3	
(1990)								
Total Discharge(Meausered	m3/sec	6.703	7.973	4.117	6.615	5.336	0.078	
Area	km2	284.14	264.55	212.29	153.6	126.38	41.83	
Q/A	-	0.02359	0.03014	0.01939	0.04307	0.04222	0.00186	
Revised Discharge	m3/sec	8.564	7.973	7.771	6.615	5.336	0.078	
River Discharge	m3/sec	4.721	4.122	4.483	3.635	3.256	0.064	
Sewer Discharge	m3/sec	3.843	3.851	3.288	2.98	2.08	0.014	
Revised S S Load	kg/day	50,907.2	70,953.3	60,091.6	24,518.9	18,948.3	280.9	
S S Span Loading(Meauer)	kg/day	-20046.1	10580.8	35572.7	5570.6			
S S Generation Loading	kg/day	45,615	20,623	57,462	118,472		86,579	
S S Generation Loading	kg/day	347,694	302,079	194,877	137,415		86,579	
S S Run-off Ratio	-	-0.439	0.513	0.619	0.047	-	0.003	
S S Loading(Meausered)	kg/day	39,860.3	70,946.3	31,844.5	24,533.7	18,943.2	280.9	
S S Conc.	mg/l	68.8	103.0	89.5	42.9	41.1	41.7	
(2002)						1.422		←St. 6 Loading 2002/1990
Total Discharge	m3/sec	8.564	7.973	7.771	6.615	5.336	0.078	
River Discharge	m3/sec	4.721	4.122	4.483	3.635	3.256	0.064	
Sewer Discharge	m3/sec	3.843	3.851	3.288	2.98	2.08	0.014	
SMG Sewer Discharge	m3/sec	1.763	1.771	1.208	0.9	-	-	
Total Discharge(2)	m3/sec	6.801	6.202	6.563	5.715	-	0.078	
S S Generation Loading	kg/day	64,948.0	25,047.0	63,891.0	168,511.0	-	92,609.0	
S S Run-off Ratio	-	0.070	0.070	0.070	0.070	-	0.003	
S S Loading	kg/day	49,790.2	45,243.8	43,212.7	38,740.3	26,944.5	277.8	
S S Conc.	mg/l	84.7	84.4	76.2	78.5	58.4	41.2	
(2010)						2.004		←St. 6 Loading 2010/1990
Total Discharge	m3/sec	8.564	7.973	7.771	6.615	5.336	0.078	
River Discharge	m3/sec	4.721	4.122	4.483	3.635	3.256	0.064	
Sewer Discharge	m3/sec	3.843	3.851	3.288	2.98	2.08	0.014	
SMG Sewer Discharge	m3/sec	1.763	1.771	1.208	0.9	-	-	
Total Discharge(2)	m3/sec	6.801	6.202	6.563	5.715	-	0.078	
S S Generation Loading	kg/day	95,197.0	35,719.0	92,967.0	237,427.0	-	137,865.0	
S S Run-off Ratio	-	0.070	0.070	0.070	0.070	-	0.003	
S S Loading	kg/day	70,677.7	64,013.9	61,100.0	54,592.3	37,972.4	413.6	
S S Conc.	mg/l	120.3	119.5	107.8	110.6	82.4	61.4	

Case 4

	unit	St. 1	St. 2	St. 4	St. 5	St. 6	St. 3	
(1990)								
Total Discharge (Meausered)	m3/sec	6.703	7.973	4.117	6.615	5.336	0.078	
Area	km2	284.14	264.55	212.29	153.6	126.38	41.83	
Q/A	-	0.02359	0.03014	0.01939	0.04307	0.04222	0.00186	
Revised Discharge	m3/sec	8.564	7.973	7.771	6.615	5.336	0.078	
River Discharge	m3/sec	4.721	4.122	4.483	3.635	3.256	0.064	
Sewer Discharge	m3/sec	3.843	3.851	3.288	2.98	2.08	0.014	
Revised BOD Load	kg/day	41,066.1	41,009.8	35,249.3	31,807.1	22,406.3	154.2	
BOD Span Loading (Meauer)	kg/day	56.3	5606.3	3442.2	9400.8			
BOD Generation Loading	kg/day	79,237	24,237	52,872	187,193		85,952	
BOD Generation Loading	kg/day	451,897	372,660	262,471	209,599		85,952	
BOD Run-off Ratio	-	0.001	0.231	0.065	0.050		0.002	
BOD Loading (Meausered)	kg/day	32,119.3	41,009.8	18,678.3	31,807.1	22,406.3	154.2	
BOD Conc.	mg/l	55.5	59.5	52.5	55.7	48.6	22.9	
(2002)						1.738	←St. 6 Loading 2002/1990	
Total Discharge	m3/sec	8.564	7.973	7.771	6.615	5.336	0.078	
River Discharge	m3/sec	4.721	4.122	4.483	3.635	3.256	0.064	
Sewer Discharge	m3/sec	3.843	3.851	3.288	2.980	2.080	0.014	
SMG Sewer Discharge	m3/sec	1.763	1.771	1.208	0.900	-	-	
Total Discharge (2)	m3/sec	6.801	6.202	6.563	5.715	-	0.078	
BOD Generation Loading	kg/day	136,599.0	40,693.0	85,046.0	325,375.0	-	128,702.0	
BOD Run-off Ratio	-	0.020	0.020	0.020	0.020	-	0.002	
BOD Loading	kg/day	22,938.1	20,206.1	19,134.8	17,433.9	10,926.4	257.4	
BOD Conc.	mg/l	39.0	37.7	33.7	35.3	23.7	38.2	
(2010)						2.512	←St. 6 Loading 2010/1990	
Total Discharge	m3/sec	8.564	7.973	7.771	6.615	5.336	0.078	
River Discharge	m3/sec	4.721	4.122	4.483	3.635	3.256	0.064	
Sewer Discharge	m3/sec	3.843	3.851	3.288	2.980	2.080	0.014	
SMG Sewer Discharge	m3/sec	1.763	1.771	1.208	0.900	-	-	
Total Discharge (2)	m3/sec	6.801	6.202	6.563	5.715	-	0.078	
BOD Generation Loading	kg/day	193,136.0	53,860.0	110,479.0	470,254.0	-	163,007.0	
BOD Run-off Ratio	-	0.020	0.020	0.020	0.020	-	0.002	
BOD Loading	kg/day	27,807.0	23,944.3	22,541.1	20,331.5	10,926.4	326.0	
BOD Conc.	mg/l	47.3	44.7	39.8	41.2	23.7	48.4	

(1990)	unit	St. 1	St. 2	St. 4	St. 5	St. 6	St. 3
Total Discharge (Meausered	m3/sec	6.703	7.973	4.117	6.615	5.336	0.078
Area	km2	284.14	264.55	212.29	153.6	126.38	41.83
Q/A	-	0.02359	0.03014	0.01939	0.04307	0.04222	0.00186
Revised Discharge	m3/sec	8.564	7.973	7.771	6.615	5.336	0.078
River Discharge	m3/sec	4.721	4.122	4.483	3.635	3.256	0.064
Sewer Discharge	m3/sec	3.843	3.851	3.288	2.98	2.08	0.014
Revised S S Load	kg/day	50,907.2	70,953.3	60,091.6	24,518.9	18,948.3	280.9
S S Span Loading (Meauer)	kg/day	-20046.1	10580.8	35572.7	5570.6		
S S Generation Loading	kg/day	45,615	20,623	57,462	118,472		86,579
S S Generation Loading	kg/day	347,694	302,079	194,877	137,415		86,579
S S Run-off Ratio	-	-0.439	0.513	0.619	0.047	-	0.003
S S Loading (Meausered)	kg/day	39,860.3	70,946.3	31,844.5	24,533.7	18,943.2	280.9
S S Conc.	mg/l	68.8	103.0	89.5	42.9	41.1	41.7

(2002)	unit	St. 1	St. 2	St. 4	St. 5	St. 6	St. 3
						1.422	←St. 6 Loading 2002/1990
Total Discharge	m3/sec	8.564	7.973	7.771	6.615	5.336	0.078
River Discharge	m3/sec	4.721	4.122	4.483	3.635	3.256	0.064
Sewer Discharge	m3/sec	3.843	3.851	3.288	2.98	2.08	0.014
SMG Sewer Discharge	m3/sec	1.763	1.771	1.208	0.9	-	-
Total Discharge (2)	m3/sec	6.801	6.202	6.563	5.715	-	0.078
S S Generation Loading	kg/day	64,948.0	25,047.0	63,891.0	168,511.0	-	92,609.0
S S Run-off Ratio	-	0.070	0.070	0.070	0.070	-	0.003
S S Loading	kg/day	44,698.5	40,152.1	38,121.0	33,648.6	21,852.8	277.8
S S Conc.	mg/l	76.1	74.9	67.2	68.1	47.4	41.2

(2010)	unit	St. 1	St. 2	St. 4	St. 5	St. 6	St. 3
						2.004	←St. 6 Loading 2010/1990
Total Discharge	m3/sec	8.564	7.973	7.771	6.615	5.336	0.078
River Discharge	m3/sec	4.721	4.122	4.483	3.635	3.256	0.064
Sewer Discharge	m3/sec	3.843	3.851	3.288	2.98	2.08	0.014
SMG Sewer Discharge	m3/sec	1.763	1.771	1.208	0.9	-	-
Total Discharge (2)	m3/sec	6.801	6.202	6.563	5.715	-	0.078
S S Generation Loading	kg/day	95,197.0	35,719.0	92,967.0	237,427.0	-	137,865.0
S S Run-off Ratio	-	0.070	0.070	0.070	0.070	-	0.003
S S Loading	kg/day	54,558.1	47,894.3	44,980.4	38,472.7	21,852.8	413.6
S S Conc.	mg/l	92.8	89.4	79.3	77.9	47.4	61.4

Case 1

	unit	St.1	St.2	St.3	St.4	
(1990)						
Total Discharge	m3/sec	1.548	0.929	0.284	0.634	
River Discharge	m3/sec	1.408	0.910	0.264	0.622	
Sewer Discharge	m3/sec	0.140	0.019	0.020	0.012	
BOD Generation Loading	kg/day	8,931.0	1,562.0	4,708.0	-	
BOD Span Loading	kg/day	1917.8	-117.2	275		
BOD Run-off Ratio	-	0.215	-0.075	0.058		
BOD Loading	kg/day	1,800.6	438.9	275.0	281.1	
BOD Conc.	mg/l	13.5	5.5	11.2	5.1	
(2002)					1.000	←1990FIX
Total Discharge	m3/sec	1.548	0.929	0.284	0.634	
River Discharge	m3/sec	1.408	0.910	0.264	0.622	
Sewer Discharge	m3/sec	0.140	0.019	0.020	0.012	
BOD Generation Loading	kg/day	23,202.0	4,099.0	12,251.0		
BOD Run-off Ratio	-	0.215	0.020	0.058	-	
BOD Loading	kg/day	6,062.1	1,073.7	710.6	281.1	
BOD Conc.	mg/l	45.3	13.4	29.0	5.1	
(2010)					1.000	←1990FIX
Total Discharge	m3/sec	1.548	0.929	0.284	0.634	
River Discharge	m3/sec	1.408	0.910	0.264	0.622	
Sewer Discharge	m3/sec	0.140	0.019	0.020	0.012	
BOD Generation Loading	kg/day	28,915.0	4,591.0	14,678.0	-	
BOD Run-off Ratio	-	0.215	0.020	0.058	-	
BOD Loading	kg/day	7,440.9	1,224.2	851.3	281.1	
BOD Conc.	mg/l	55.6	15.3	34.7	5.1	

	unit	St.1	St.2	St.3	St.4	
(1990)						
Total Discharge	m3/sec	1.548	0.929	0.284	0.634	
River Discharge	m3/sec	1.408	0.910	0.264	0.622	
Sewer Discharge	m3/sec	0.140	0.019	0.020	0.012	
S S Generation Loading	kg/day	10,308.0	2,318.0	6,455.0		
S S Span Loading	kg/day	4485.6	54.1	323.2		
S S Run-off Ratio	-	0.435	0.023	0.050		
S S Loading	kg/day	4,539.7	1,712.9	323.2	1,335.6	
S S Conc.	mg/l	33.9	21.3	13.2	24.4	
(2002)					1.000	←1990FIX
Total Discharge	m3/sec	1.548	0.929	0.284	0.634	
River Discharge	m3/sec	1.408	0.910	0.264	0.622	
Sewer Discharge	m3/sec	0.140	0.019	0.020	0.012	
S S Generation Loading	kg/day	24,081.0	4,778.0	13,755.0	-	
S S Run-off Ratio	-	0.435	0.023	0.050	-	
S S Loading	kg/day	12,608.5	2,133.3	687.8	1,335.6	
S S Conc.	mg/l	94.3	26.6	28.0	24.4	
(2010)					1.000	←1990FIX
Total Discharge	m3/sec	1.548	0.929	0.284	0.634	
River Discharge	m3/sec	1.408	0.910	0.264	0.622	
Sewer Discharge	m3/sec	0.140	0.019	0.020	0.012	
S S Generation Loading	kg/day	28,693.0	5,090.0	15,895.0	-	
S S Run-off Ratio	-	0.435	0.023	0.050	-	
S S Loading	kg/day	14,729.0	2,247.5	794.8	1,335.6	
S S Conc.	mg/l	110.1	28.0	32.4	24.4	

Case 2

	unit	St.1	St.2	St.3	St.4
(1990)					
Total Discharge	m3/sec	1.548	0.929	0.284	0.634
River Discharge	m3/sec	1.408	0.910	0.264	0.622
Sewer Discharge	m3/sec	0.140	0.019	0.020	0.012
BOD Generation Loading	kg/day	8,931.0	1,562.0	4,708.0	-
BOD Span Loading	kg/day	1917.8	-117.2	275	
BOD Run-off Ratio	-	0.215	-0.075	0.058	
BOD Loading	kg/day	1,800.6	438.9	275.0	281.1
BOD Conc.	mg/l	13.5	5.5	11.2	5.1
(2002)					1.000 ←1990FIX
Total Discharge	m3/sec	1.548	0.929	0.284	0.634
River Discharge	m3/sec	1.408	0.910	0.264	0.622
Sewer Discharge	m3/sec	0.140	0.019	0.020	0.012
BOD Generation Loading	kg/day	23,202.0	4,099.0	12,251.0	
BOD Run-off Ratio	-	0.020	0.020	0.020	-
BOD Loading	kg/day	1,072.1	608.1	245.0	281.1
BOD Conc.	mg/l	8.8	7.7	10.7	5.1
(2010)					1.000 ←1990FIX
Total Discharge	m3/sec	1.548	0.929	0.284	0.634
River Discharge	m3/sec	1.408	0.910	0.264	0.622
Sewer Discharge	m3/sec	0.140	0.019	0.020	0.012
BOD Generation Loading	kg/day	28,915.0	4,591.0	14,678.0	-
BOD Run-off Ratio	-	0.020	0.020	0.020	-
BOD Loading	kg/day	1,244.8	666.5	293.6	281.1
BOD Conc.	mg/l	10.2	8.5	12.9	5.1

	unit	St.1	St.2	St.3	St.4
(1990)					
Total Discharge	m3/sec	1.548	0.929	0.284	0.634
River Discharge	m3/sec	1.408	0.910	0.264	0.622
Sewer Discharge	m3/sec	0.140	0.019	0.020	0.012
S S Generation Loading	kg/day	10,308.0	2,318.0	6,455.0	
S S Span Loading	kg/day	4485.6	54.1	323.2	
S S Run-off Ratio	-	0.435	0.023	0.050	
S S Loading	kg/day	4,539.7	1,712.9	323.2	1,335.6
S S Conc.	mg/l	33.9	21.3	13.2	24.4
(2002)					1.000 ←1990FIX
Total Discharge	m3/sec	1.548	0.929	0.284	0.634
River Discharge	m3/sec	1.408	0.910	0.264	0.622
Sewer Discharge	m3/sec	0.140	0.019	0.020	0.012
S S Generation Loading	kg/day	24,081.0	4,778.0	13,755.0	-
S S Run-off Ratio	-	0.070	0.070	0.070	-
S S Loading	kg/day	4,318.7	2,633.0	962.9	1,335.6
S S Conc.	mg/l	35.5	33.5	42.2	24.4
(2010)					1.000 ←1990FIX
Total Discharge	m3/sec	1.548	0.929	0.284	0.634
River Discharge	m3/sec	1.408	0.910	0.264	0.622
Sewer Discharge	m3/sec	0.140	0.019	0.020	0.012
S S Generation Loading	kg/day	28,593.0	5,090.0	15,895.0	-
S S Run-off Ratio	-	0.435	0.023	0.050	-
S S Loading	kg/day	14,729.0	2,247.5	794.8	1,335.6
S S Conc.	mg/l	121.1	28.6	34.8	24.4

Case 1

	unit	St. 1	St. 2
(1990)			
Total Discharge	m3/sec	4.335	0.935
River Discharge	m3/sec	4.317	0.933
Sewer Discharge	m3/sec	0.018	0.002
BOD Generation Loading	kg/day	18,147.0	15,081.0
BOD Span Loading	kg/day	1,062.3	264.3
BOD Run-off Ratio	-	0.059	0.018
BOD Loading	kg/day	1,326.6	264.3
BOD Conc.	mg/l	3.5	3.3
(2002)			
Total Discharge	m3/sec	4.335	0.935
River Discharge	m3/sec	4.317	0.933
Sewer Discharge	m3/sec	0.018	0.002
BOD Generation Loading	kg/day	28,496.0	24,163.0
BOD Run-off Ratio	-	0.059	0.018
BOD Loading	kg/day	2,116.2	434.9
BOD Conc.	mg/l	5.7	5.4
(2010)			
Total Discharge	m3/sec	4.335	0.935
River Discharge	m3/sec	4.317	0.933
Sewer Discharge	m3/sec	0.018	0.002
BOD Generation Loading	kg/day	36,897.0	31,738.0
BOD Run-off Ratio	-	0.059	0.018
BOD Loading	kg/day	2,748.2	571.3
BOD Conc.	mg/l	7.3	7.1

	unit	St. 1	St. 2	
(1990)				
Total Discharge	m3/sec	4.335	0.935	
River Discharge	m3/sec	4.317	0.933	
Sewer Discharge	m3/sec	0.018	0.002	
S S Generation Loading	kg/day	16,560.0	12,647.0	
S S Span Loading	kg/day	1,470.5	888.0	
S S Run-off Ratio	-	0.089	0.070	
S S Loading	kg/day	2,358.5	888.0	
S S Conc.	mg/l	6.3	11.0	
(2002)				←1990FIX
Total Discharge	m3/sec	4.335	0.935	
River Discharge	m3/sec	4.317	0.933	
Sewer Discharge	m3/sec	0.018	0.002	
S S Generation Loading	kg/day	26,771.0	20,985.0	
S S Run-off Ratio	-	0.089	0.070	
S S Loading	kg/day	3,851.6	1,469.0	
S S Conc.	mg/l	10.3	18.2	
(2010)				←1990FIX
Total Discharge	m3/sec	4.335	0.935	
River Discharge	m3/sec	4.317	0.933	
Sewer Discharge	m3/sec	0.018	0.002	
S S Generation Loading	kg/day	28,711.0	22,970.0	
S S Run-off Ratio	-	0.089	0.070	
S S Loading	kg/day	4,163.2	1,607.9	
S S Conc.	mg/l	11.1	19.9	

Case 1

(1990)	unit	St.1	St.2	St.3
Total Discharge	m3/sec	0.567	0.463	1.125
River Discharge	m3/sec	0.513	0.432	0.974
Sewer Discharge	m3/sec	0.054	0.031	0.151
Revsised Discharge	m3/sec	2.176	2.010	1.125
Revsied River Discharge	m3/sec			
Revsied Sewer Discharge	m3/sec			
Revsised BOD Load(Me)	kg/day	2,632.1	1,945.0	1,844.6
BOD Span Loading(Meuser)	kg/day	687.1	100.4	1844.6
BOD Generation Loading	kg/day	5065	21218	2947
BOD Generation Loading	kg/day	29,230	24,165	2,947
BOD Run-off Ratio	-	0.136	0.005	0.626
BOD Loading	kg/day	683.4	450.0	1,844.6
BOD Conc.	mg/l	14.0	11.2	19.0
(2002)			0	
Total Discharge	m3/sec	2.176	2.010	1.125
River Discharge	m3/sec			
Sewer Discharge	m3/sec			
BOD Generation Loading	kg/day	9,512.0	39,415.0	5,283.0
BOD Run-off Ratio	-	0.136	0.005	0.626
BOD Loading	kg/day	4,797.9	3,504.3	3,307.2
BOD Conc.	mg/l	25.5	20.2	34.0
(2010)			0	
Total Discharge	m3/sec	2.176	2.010	1.125
River Discharge	m3/sec			
Sewer Discharge	m3/sec			
BOD Generation Loading	kg/day	11,233.0	46,834.0	6,910.0
BOD Run-off Ratio	-	0.136	0.005	0.626
BOD Loading	kg/day	6,087.6	4,559.9	4,325.7
BOD Conc.	mg/l	32.4	26.3	44.5

(1990)	unit	St.1	St.2	St.3
Total Discharge	m3/sec	0.567	0.463	1.125
River Discharge	m3/sec	0.513	0.432	0.974
Sewer Discharge	m3/sec	0.054	0.031	0.151
Revsised Discharge	m3/sec	2.176	2.010	1.125
Revsied River Discharge	m3/sec			
Revsied Sewer Discharge	m3/sec			
Revsised SS Load	kg/day	1,748.5	989.9	1,108.1
S S Span Loading(Meuser)	kg/day	758.6	-118.2	1108.1
S S Generation Loading	kg/day	5472	23350	2580
S S Generation Loading	kg/day	31,402	25,930	2,580
S S Run-off Ratio	-	0.139	-0.005	0.429
S S Loading	kg/day	453.4	226.2	1,105.9
S S Conc.	mg/l	9.3	5.7	11.4
(2002)			0	
Total Discharge	m3/sec	2.176	2.010	1.125
River Discharge	m3/sec			
Sewer Discharge	m3/sec			
S S Generation Loading	kg/day	24,081.0	4,778.0	13,755.0
S S Run-off Ratio	-	0.139	0.070	0.429
S S Loading	kg/day	9,582.7	6,235.4	5,900.9
S S Conc.	mg/l	51.0	35.9	60.7
(2010)			0	
Total Discharge	m3/sec	2.176	2.010	1.125
River Discharge	m3/sec			
Sewer Discharge	m3/sec			
S S Generation Loading	kg/day	28,693.0	5,090.0	15,895.0
S S Run-off Ratio	-	0.139	0.070	0.429
S S Loading	kg/day	11,163.6	7,175.3	6,819.0
S S Conc.	mg/l	59.4	41.3	70.2

Case 2

(1990)	unit	St.1	St.2	St.3
Total Discharge	m3/sec	0.567	0.463	1.125
River Discharge	m3/sec	0.513	0.432	0.974
Sewer Discharge	m3/sec	0.054	0.031	0.151
Revsised Discharge	m3/sec	2.176	2.010	1.125
Revsied River Discharge	m3/sec	1.971	1.869	0.970
Revsied Sewer Discharge	m3/sec	0.205	0.141	0.155
Revsised BOD Load	kg/day	2,632.1	1,945.0	1,846.8
BOD Span Loading	kg/day	687.1	98.2	1846.8
BOD Generation Loading	kg/day	5065	21218	2947
BOD Generation Loading	kg/day	29,230	24,165	2,947
BOD Run-off Ratio	-	0.136	0.005	0.627
BOD Loading	kg/day	683.4	450.0	1,844.6
BOD Conc.	mg/l	14.0	11.2	19.0
(2002)			0	
Total Discharge	m3/sec	2.176	2.010	1.125
River Discharge	m3/sec	1.971	1.869	0.970
Sewer Discharge	m3/sec	0.205	0.141	0.155
BOD Generation Loading	kg/day	9,512.0	39,415.0	5,283.0
BOD Run-off Ratio	-	0.020	0.020	0.020
BOD Loading	kg/day	1,084.2	894.0	105.7
BOD Conc.	mg/l	6.4	5.5	1.3
(2010)			0	
Total Discharge	m3/sec	2.176	2.010	1.125
River Discharge	m3/sec	1.971	1.869	0.970
Sewer Discharge	m3/sec	0.205	0.141	0.155
BOD Generation Loading	kg/day	11,233.0	46,834.0	6,910.0
BOD Run-off Ratio	-	0.020	0.020	0.020
BOD Loading	kg/day	1,299.6	1,074.9	138.2
BOD Conc.	mg/l	7.6	6.7	1.6

(1990)	unit	St.1	St.2	St.3
Total Discharge	m3/sec	0.567	0.463	1.125
River Discharge	m3/sec	0.513	0.432	0.974
Sewer Discharge	m3/sec	0.054	0.031	0.151
Revsised Discharge	m3/sec	2.176	2.010	1.125
Revsied River Discharge	m3/sec			
Revsied Sewer Discharge	m3/sec			
Revsised SS Load	kg/day	1,748.5	989.9	1,108.1
S S Span Loading	kg/day	758.6	-118.2	1108.1
S S Generation Loading	kg/day	5472	23350	2580
S S Generation Loading	kg/day	31,402	25,930	2,580
S S Run-off Ratio	-	0.139	-0.005	0.429
S S Loading	kg/day	453.4	226.2	1,105.9
S S Conc.	mg/l	9.3	5.7	11.4
(2002)			0	
Total Discharge	m3/sec	2.176	2.010	1.125
River Discharge	m3/sec	1.971	1.869	0.970
Sewer Discharge	m3/sec	0.205	0.141	0.155
S S Generation Loading	kg/day	24,081.0	4,778.0	13,755.0
S S Run-off Ratio	-	0.070	0.070	0.070
S S Loading	kg/day	2,983.1	1,297.4	962.9
S S Conc.	mg/l	17.5	8.0	11.5
(2010)			0	
Total Discharge	m3/sec	2.176	2.010	1.125
River Discharge	m3/sec	1.971	1.869	0.970
Sewer Discharge	m3/sec	0.205	0.141	0.155
S S Generation Loading	kg/day	28,693.0	5,090.0	15,895.0
S S Run-off Ratio	-	0.070	0.070	0.070
S S Loading	kg/day	3,477.5	1,469.0	1,112.7
S S Conc.	mg/l	20.4	9.1	13.3