12. 1 Method of Calculation

The relations between direct costs and contracts price are assumed as follows.

The contract price will be divided into the following elements.

-	Direct Cost	72%	
-	Indirect Cost	5%	
-	Site-Overhead	8%	
-	General Overhead & Profit	12%	
-	Contingency	3%	
	Total	100%	(Contract price)

$72 \times 1.4 = 100$

It means Direct Cost $\times$ 1.4 = Contract price

Therefore the following expression, can be applied. The figure of calculated direct costs times 1.4 become contract prices or contract unit rates.

(Note: When the above expression is applied for temporary works cost, the coefficient of 1.35 instead of 1.4, will be taken because some costs are already included in the Indirect Cost sum)

12. 2 Breakdown of Temporary Works

12. 2. 1 Diversion Dam

			(Bath)
1)	Contractor's & Emplayer's Camp		(18,000,000)
	Land leveling	22,000 m^2	2,500,000
	Fence & Gate	600 m	300,000
	Road	6,000 m^2	600,000
	Building	3,300 m^2	12,500,000
	Working yard	2,000 m^2	200,000
	Septic Tanks	3 ea	300,000
	Water & Electric Supply	LS	1,600,000

2)	Labour's Camp			(3,000,000)
	Living Quarters	1,500	m^2	1,500,000
	Rest House & Toilet		LS	500,000
	Other Facilities		LS	1,000,000
3)	Electric Facilities & Telephone System			(6,000,000)
	Incoming Distribution Line		LS	2,500,000
	Substation		LS	650,000
	Site Distribution Line		LS	1,600,000
	Miscellaneous Works		LS	750,000
	Telephone System		LS	500,000
4)	Water supply			(1,500,000)
	Storage Tank	200	t	500,000
	Pumping Facilities from the River		LS	200,000
	Distribution System		LS	800,000
5)	Dewatering for Excavation			(20,000,000)
	Cut off wall L:12m sheetpile	1300	t	16,750,000
	Pump		LS	2,000,000
	Other Facilities		LS	1,250,000
6)	Slope Protection			(2,5000,000)
	Protection for Open Excavated Slope	42,000	m^2	2,100,000
	Miscellaneous Works		LS	400,000
7)	Concrete Plant			(2,000,000)
	Plant Establishment		LS	1,500,000
	Demolition Expense		LS	500,000

8)	Temporary Road for Works Site			(23,000,000)
	Access Roads to EL(-)9.0 Ground		3NOS	6,000,000
	Road for Dam site	40,000	m^2	6,000,000
	Road for O/M Building Area	50,000	m^2	7,500,000
	Other Road	16,000	m^2	2,000,000
	Drainage Facilities & Others		LS	1,500,000
9)	Scaffolding, Support & Bracing			(5,000,000)
	Scaffolding for Pier works	45,000	m^3	4,500,000
	Support & Bracing		LS	500,000
10)	Preparation for Mechanical Works Area			(1,000,000)
11)	Earth & Rock Loading Pier.	450	m^2	(2,000,000)
12)	Temporary Works for Road Bridge			(3,000,000)
	Access Road to Pier Works		LS	400,000
	Earth Removed before Pier & Abutmentworks		LS	100,000
	Scaffolding for Concrete Work	3,600	m^3	500,000
	Crane Road for Girder Setting	500	m	900,000
	Road for Concrete Hauling	500	m	300,000
	Staging for Pile Drive		LS	500,000
	Dewatering etc		LS	300,000
13)	Survey Works			(500,000)
	Transit Groups		2G	3,200,000
	Level Group		1G	1,400,000
	Consumerble Materials		LS	400,000
14)	Safty Facilities			(500,000)

15)	Security Service		(3,000,000)
	Guard Man	$3^{M} \times 2^{S} \times 42^{MTH}$	3,000,000
16)	Rock Embankment on the old River Course		(5,000,000)
	Dumped Rock	$10{,}000m^3$	5,000,000
17)	Sand Compaction Pile work Foot hold		(3,000,000)
18)	Final Site Clean Up		(1,500,000)
19)	Other's		(6,000,000)
	Total		111,000,000

111,000,000×1.35=150,000,000₿

12. 2. 2 Pumping Station

			(Bath)
1)	Coffer Dam		(11,600,000)
	Sheet Pile Type IV, L:15m	1,000t	9,000,000
	Fill Soil	13,000m^3	2,600,000
2)	Dewatering		(3,500,000)
	Cut off wall L : 10 m Sheet pile	310 t	3,100,000
	Pump etc		400,000
3)	Seaffolding for Concrete Work		(1,500,000)
4)	Foundation Treatment		(1,200,000)
	Remove Soft Soil and Refill Sand	6,000 m^3	1,200,000
5)	Misc Temporary Works		(200,000)
	Total		18,000,000

18,000,000 × 1.35 = 24,000,000 ฿

12. 3 Cost Breakdown of Major Construction Works

12. 3. 1 Diversion Dam

1) Bulk Excavation (per cu. m)

Volume 1,060,000 m^3

Dragline	$2m^3$	3unit	33unit · month × 360,000 ฿/M =	11,880,000
Backhoe	$1m^3$	3unit	33unit · month × 156,000 ฿/M =	5,148,000
Dump Truck	11t	20unit	244unit · month × 72,000 ฿/M =	17,568,000
Swamp Dozer	15t	5unit	65unit · month × 168,000 ฿/M =	10,920,000
Bulldozer	21t	2unit	26unit · month × 216,000 ฿/M =	5,616000
Foreman"A"	2 × 13M		26man · month × 18,000 ฿/M =	468,000
Foreman"B"	4 × 13M		52man · month × 12,000 ฿/M =	624,000
Labour	20 × 13M		260man · month × 4,500 ฿/M =	1,170,000
Misc.	LS			2,000,000
	Sub - Total			55,394,000

Diffusing expense at the O/M Building area.

Swamp Dozer	15t	2unit	26unit · month × 168,000 =	4,368,000
Bulldozer	21t	2unit	26unit · month × 216,000 =	5,616,000
Grader	3.4m	2unit	26unit · month × 150,000 =	3,900,000
Drain	LS			1,500,000
Labour	LS			500,000
	Sub - Total			15,884,000
	Total			71,278,000

$$71{,}278{,}000 \div 1{,}060{,}000 = 67\ ฿/m^3 \times 1.4 = 94\ ฿/m^3$$

2) Pile Work (per pcs)

i) P.C pile ø 400 × 10m

Material price	5,400
Driving expence	800
Total	6,200

× 1.4 = 8,700 ฿/pc

ii) P.C pile ø 600 × 10m

Material price	11,000
Driving expence	2,000
Total	13,000

× 1.4 = 18,200 ฿/pc

iii) Steel sheet pile Type II ℓ = 3m (per pes)

Material price	48 kg/m × 3m × 1.1 × 15฿/kg =	2,376
Driving expence		600
Total		2,976

× 1.4 = 4,200 ฿/pc

In Case of change in pile length, price are adjusted proportionally per linear meter.

3) Concrete (per cu. m)

i) Concrete (180 kg/cm^2)

Concrete Production	1,400
Loss 5%	70
Pouring By Pump	120
Vibrator & Curing etc	150
Total	1,740

ii) Concrete (210 kg/cm²)

Concrete Production	1,500
Loss 5%	75
others (same as above)	270
Total	1,845

iii) Concrete (240 kg/cm²)

Concrete Production	1,600
Loss 5%	80
others (same as above)	270
Total	1,950

iv) Reinforced Steel Bar (per ton)

Deformed Bar SD 30	13,000
Loss 12%	1,560
sleeper, Binding Wire 5%	650
Sub - Contractor Expence 12% of above	1,825
Labour LS	3,000
Equipment (crane etc) LS	600
Total	20,635

v) Form (per sq · m)

Base	Material	140
	Labour	160
Total		300

Pier Wall etc	Material	270
	Labour	230
	Equipment	100
Total		600

(Note ; Above price not include scaffolding)

4) River Bed Protection (cross concrete block) (per sq · m)

· Cross Block per 4m²

Concrete (210 kg/cm²)	1.03m³ × 1,845 =	1,900
Form Work (Base)	4.6m² × 300 =	1,380
Reinf. Bar	0.01t × 20,635 =	207
Sub - Total		3,487

3,487 ÷ 4 = 872 ฿/m²

· Steel Form for Casting ;

Prepared 60 sets

60 sets × 10,000 ฿/set = 600,000 ฿

Per 1m² of protection Work

600,000 ÷ 18,000 m² = 34 ฿/m²

· Handling & Setting 300 ฿/m²

Total 1,206 ฿/m²

× 1.4 = 1,700 ฿/m²

12. 3. 2 Closure Dam

1) Earth Embankment (per cu · m)

Total Volume	250,000 m³
By Bottom Dump Barge	150,000 m³
By end Tipping	100,000 m³

Embankment material will be taken from borrow pit apart approx 20km from the site

80 ฿/m³

Bottom Dump Barge	(200m³)	2unit × 2 M × 500,000 ฿/M =	2,000,000
Tag Boat	(250HP)	1unit × 2 M × 750,000 ฿/M =	1,500,000
Sub - Total			3,500,000
Bulldozer	(21t)	2unit × 2 M × 216,000 ฿/M =	864,000

Summery

Material	80฿/m³ × 250,000m³ × 1.2 =	24,000,000
Barge & Tag Boat		3,500,000
Bulldozer		864,000
Misc.	LS	1,136,000
Total		29,500,000

29,500,000 ÷ 250,000 = 118฿/m³ × 1.4 = 165฿/m³

2) Rock Zone Embankment (per cu m)

Volume 40,000m³

By Bottom Dump Barge

Bottom Dump Barge	(200m³)	2unit × 0.5M × 500,000฿/M =	500,000
Tag Boat	(250HP)	1unit × 0.5M × 750,000฿/M =	375,000
Sub - Total			875,000

Loading to Dump Truck at the Site (Double Hondling)

Loader (2.4m³)	40,000m³ ÷ 50m³ × 10 Hr × 24 D = 3.5 unit mounth
Dump Truck (11t)	10 unit mounth
Bulldozer (21t)	2 unit mounth

Loader	(2.4m³)	3.5 unit mounth × 105,000฿/M =	367,500
Dump Truck	(11t)	10 unit mounth × 72,000฿/M =	720,000
Bulldozer	(21t)	2 unit mounth × 216,000฿/M =	432,000
Sub - Total			1,519,500

Summery

Material	300฿/m³ × 40,000m³ × 1.4 =	16,800,000
Barge & Tag Boat		875,000
Bulldozer	handwork	1,519,500
Misc.	LS	805,500
Total		20,000,000

20,000,000 ÷ 40,000 = 500฿/m³ × 1.4 = 700฿/m³

3) Riprap (per cu. m)

Volume		15,000m³	
By crane Barge		5,000m³	
By crawler crane on the land		10,000m³	
Crane Barge (w/20t crane)	1 unit × 2 M × 250,000 =		500,000
Barge (50m³)	2 unit × 2 M × 200,000 =		800,000
Tag boat (100HP)	1 unit × 2 M × 350,000 =		700,000
Crawler crane (50t)	1 unit × 2 M × 240,000 =		480,000
Labour etc	LS		470,000
Material (rock)	300฿/m³ × 15,000 × 1.3 =		5,850,000
Total			8,800,000

8,800,000 ÷ 15,000 = 587฿/m³ × 1.4 = 820฿/m³

4) Sand Compaction pile (per cu. m)

One gang's one day progress is 10piles (40m³)

∴ 40m³ × 24 days = 960m³ / Mouth / gang

Material Cost

Sand	960 m³ × 1.3 × 150฿/m³	
Casing pipe & bucket	LS	50,000
Other Consumption	LS	20,000
Sub - Total		257,200

Labour Cost

Foreman "A"	1man × 1M × 18,000 =	18,000
Special Labour	2men × 1M × 9,000 =	18,000
Labour	3men × 1M×4,500=	13,500
Sub - Total		49,500

Equipment Cost

Base Machine		1unit × 1M × 300,000 =	300,000
Generator	120ps	1unit × 1M × 100,000 =	100,000
Compresser	50ps	1unit × 1M × 45,000 =	45,000
Crawler shovel	0.5m³	1unit × 1M × 120,000 =	120,000

Hummer	LS	20,000	=	20,000
Other tools	LS	10,000	=	10,000
Sub - Total				595,000
Site Preparation				50,000
Total				951,700

951,700 ÷ 960 ÷ 1,000 ps/m³ × 1.4 = 1,400฿/m³

12. 3. 3 Diversion Canal

1) Excaration (per cu. m)

By Pump Dredger	2,000,000 m³
By Backhoe & Dump Truck	300,000 m³
Total Volume	2,300,000 m³

° Pump Dredger ;

Pump Dredger	1,200ps	2unit × 8.5 M × 4,000,000฿/M =	68,000,000
Tag boat	250HP	2unit × 8.5 M × 900,000฿/M =	15,300,000
Motor Boat		1unit × 8.5 M × 150,000฿/M =	1,275,000
Archor barge		1unit × 8.5 M × 250,000฿/M =	2,125,000
Navigating expense for above		1,000,000 × 2 =	2,000,000
Delivery Pipe		LS	1,000,000
Foreman "A"		2men × 2 shift × 8.5 M × 18,000฿/M =	612,000
Foreman "B"		4men × 2 shift × 8.5 M × 12,000฿/M =	816,000
Labour		10men × 2 shift × 8.5 M × 4,500฿/M =	765,000
Site preparation & Night lightiny etc		LS	3,000,000
Sub - Total			94,893,000
Sub Contractor's overhead		16%	15,107,000
Total			110,000,000

110,000,000 ÷ 2,000,000 = 55฿/m³

° Backhoe & Dump Truck ; unit price 67 ฿/m³

$$\therefore \frac{(55\ ฿/m^3 \times 2{,}000{,}000\ m^3 + 67\ ฿/m^3 \times 300{,}000\ m^3)}{2{,}300{,}000\ m^3} = 56.60\ ฿/m^3$$

56.6฿/m³ × 1.4 = 80 ฿/m³

APPENDIX-13 : PART IV. ENVIRONMENTAL CONSIDERATION

APPENDIX - 13. PART IV. ENVIRONMENTAL CONSIDERATION

LIST OF CONTENTS

13. 1 New Organization of Ministry of Science, Technology and Environment (MOSTE)

The office of National Environment Board (ONEB) presided by the vice prime minister was upgraded to the National Environment Board (NEB) to be presided by the prime minister, and the Ministry of Science, Technology and Environment (MOSTE) of which organization was expanded on April 4, 1992. The new organization, offices and duties are shown on Figure 5-1 to 5-4.

The personnel training in the Environmental Research and Training Center with grant-in-aid by the Japanese Government started at the same time, is the NEB's main subject. Although their organization and rights are enlarged and expanded, they cannot be expected so much for the time being, because they have not yet equipped with personal and material conditions. Especially, the present situation of the water quality laboratory is far weak as compared with RID's laboratory.

13. 2 Designating Procedure of Specific Environmental Conservation Area (Pollution Control Area)

The concerned area upstream of the diversion damsite in this project will be designated as pollution control area for water quality conservation after the diversion dam completion. The designating procedure for it is shown on Figure 5-5, in accordance with the national ordinance for environment and environmental conservation.

13. 3 Procedure of Water Quality Analysis Method

Hand made sampler was used for taking the samples in the river. River water was collected not only from the surface but also the bottom, and cross sectional figures were checked at and near the pumping station. Sampling points are shown on Figure 5-1.

The following parameters were analyzed in the field;

Temperature (Temp.), pH, Electric Conductivity (EC), Transparency (Trans.), Dissolved Oxygen (DO).

Analyzing methods are;

1.	Temperature	:	Digital Temperature Meter
2.	pH	:	pH meter (Glass electrode)
3.	EC	:	EC meter
4.	Trans.	:	50 cm transparent meter
5.	Turbidity	:	Turbidity meter
6.	Total Dissolved Solid (TDS):		Calculated from EC μ s/cm $\times$ 0.64
7.	Suspended Solid (SS)	:	GFP method at 103 ~ 105°C
8.	Cℓ-	:	Argent metric method
9.	Salinity	:	Calculated from Cl-(g/ℓ) $\times$ 1.805 + 0.03
10.	COD	:	COD Cr, Dichromate reflex method COD_{Mn}, Permanganate method in case of low chloride used acid solution COD_{OH}, Permanganate method in case of high chloride used alkaline solution
11.	BOD	:	Winkler azide modification method Direct method : BOD < 7 mg/ℓ Dilution method : BOD > 7 mg/ℓ
12.	Total Nitrogen (TN)	:	Org. N + NH_3-N + NO_2-N + NO_3-N
13.	Ammonium Nitrogen (NH_3-N):		Distillation and titration method
14.	Nitrite Nitrogen (NO_2 - N):		Spectrophoto metric method by using N-Cl-Naphtyl-Ethylene diamine
15.	Nitrate Nitrogen (NU_3-N) :		Cadmium reduction method
16.	Organic Nitrogen (Org.-N):		Distillation and titration method
17.	Total Phosphorus (T-P)	:	Ascorbic method
18.	Dissolved Oxygen (D.O.)	:	DO meter

13. 4 Definitions of Analysis Data Sheets

All analysis data are shown on Table 5-1 to Table 5-14. Definition of the data sheet are the followings;

a) Unit

Temperature (°C), pH (-), EC (μ s/cm), Transparency (dig.), turbidity (NTU), Salinity (g/ℓ) other parameters (mg/ℓ).

b) Not Detective Value (N.D.)

N.D.	< 1	:	Turbidity, SS, Cℓ-
N.D.	< 0.5	:	COD, BOD
N.D.	< 0.01	:	T-N, NH_3-N, NO_2-N, NO_3-N, Org-N, Fe, Mn
N.D.	< 0.005	:	T-P
N.D.	< 0.001	:	Zn, As, Al, Cd, Cu, Cr, Pb

c) Effective Value

Temp. EC, Cl (3), 123,000 (1.23×10^5)
pH, SS, TOS, Transp. BOD, COD (2) 120,000 (1.2×10^5)

d) Remarks

CODCr	:	By potassium dichromate
COD_{Mn}	:	By potassium permanganate in acid solution
COD_{OH}	:	By potassium permanganate in alkaline solution

13. 5 Results of Pollution Source Survey

The pollution source survey, water sampling and water quality analysis were carried out twice in dry and wet season. (Table 5-1 and 5-4)

1) Noodle Factory (S-1W, 2W, 3W, 4D1, 4D2, and 4D3)

The water for the noodle factory is being taken from an irrigation canal constructed by RID.

Almost all the discharges are the water with which noodle was washed. In the factory, three settling tanks are set for precipitating suspended matters. Due to no draining of sludge, the water quality of the discharge after

matters. Due to no draining of sludge, the water quality of the discharge after passing through the tanks was rather worse than that of the water with which noodle has just been washed, before passing. The water quality of course, further over the water quality standard values of the Ministry of Industry (MOI). It will certainly be improved by draining the sludge from the tanks.

2) Old Paper Reproducing Factory (S-4W, 2'D, and 3'D)

Since this factory cannot take water from the river in a dry season, a chemical condensation and floating by pressure equipment was being operated as water treating facilities aiming at also re-cycle. SS of the treated water was pretty low indicating 150 mg/l in both the season, probably due to re-cycling, but BOD was far over the standard value.

3) Whisky Factory (S-6W and 6D)

The factory is classified as one of the semi-governmental firms with complete discharge treatment, particularly with an oxidation pond with aerators for the treatment of the water with which bottles are washed and miscellaneous drainages such as toilet wash water.

The treated water was so clean as usable water for miscellaneous purposes. Since this factory cannot take water from Bang Pakong river in a dry season owing to high salinity, it possesses a large reservoir. When the factory stores the water taken from the river, pH of the water gradually becomes extremely low (S5D2) because of the SO_4 from the soil.

4) Shrimp and Fish Ponds (S-7W, 8W, 9W, 7D and 8D)

As found out on the tables, the water in the ponds are qualitatively with no problem as a whole. There, however, are a little high values of nitrogen and phosphorus in the fish pond. Because the fish pond, over which 4,000 laying hens were being kept in a pen, could treat mostly well hen droppings.

5) Pig Farm (S-10W, 11W and 11D)

In case of S-10W, urine and dung and water with which pigs were washed, from piggeries, were not directly sampled form there but taken from

the canal just after passing a temporary storing tank. (not regarded as an oxidation pond.) The canal is situated 100 m inside of the river bank upstream of Bang Pakong diversion damsite, and the water quality has no problem, because a pig farmer said that even if water is taken from the irrigation canal it was hardly drained to it. As water was sampled form surface layer in the canal, it does not indicate water quality of piggery discharge, even though it is contaminated. It was expected, however, at the canal bottom layer, plenty of pig dung was deposited. During the dry season, water was more deteriorated, but not so much significant.

6) Fish Pond Supplied with Dung as Feed (S-12W)

Some pig farmers are using or selling dung as feed for fish for /to themselves or independent fish breeders.

Although BOD and SS values were somewhat high because of water sampling near the feeding spot, it does not seem that it contributes to a pollution of Bang Pakong river.

7) Ground Water On Left Bank Upstream of Diversion Damsite (S-13W, 13D1, 13D2, 13D3, and 13D4)

The survey was carried out so as to know whether the ground water in the area where many pig farms lie scattered, has been polluted or not.

It is said that all wells cannot be used at all owing to high salinity, with no necessity of the survey on pollution with pig urine and dung.

A sample of S-13W was taken from a deep well 70 m in depth. However, there are some items over the water quality standard values in drinking water supply ordinance. That is,

Cℓ	:	1,080mg/ℓ > 200 mg/ℓof standard value
TDS	:	2,500 mg/ℓ> 500 mg/ℓ ditto
Mn	:	204 mg/ ℓ> 0.3 mg/ℓ ditto

13. 6 Results of Water Quality Survey On Irrigation Canal Water Taken From Bang Pakong River (Table 5-6)

Sampling points are shown on Figure 5-6. Water was taken from the surface. There is not so much difference of the water qualities from left bank side to right bank side, and water is not so much polluted. It means that the waste water from the piggeries does not influence the river water quality.

13. 7 Survey on River Water

Since water sampling and water quality analysis are being performed at the sites shown on Figure 5-6 and water quality analysis data are shown on Table 5-7 to 5-14. Table 5-7 to 5-9 are on Nov. (Phase I), and Table 5-10 to 5-14 are on Mar. (Phase II).

1) Temperature

Water temperatures were around 26°C on November (Phase I), and around 30°C on March (Phase II).

There was less than one degree (°C) difference between surface and bottom in temperature measured at the every sampling station, and was no significant difference between upper stream and lower stream.

2) pH

The pH levels were also consistent through phase I and phase II, and in the most part, around 7.0.

3) Salinity

As mentioned, saline waters are denser than fresh water enevally. The result of this phenomenon in the estuarine river forms two-layer flows and "salinity wedge" in the transition zone between fresh and saline waters.

But there was no "salinity wedge" in phase II, there is no significant difference between surface water and bottom water. This phenomenon was called intensive mixing by tidal activity and it was assumed that there was a little fresh water inflow at the damsite during the dry season.

4) Water Clarify

Water clarify in the estuary is highly correlated with flow conditions and salinity.

Water clarify in the dry season was higher than in the wet season. During the wet season, clarify (Turbidity) was almost the same every sampling station and in the river cross section, but during the dry season, surface water was clearer than bottom water because of the co-agulation by the saline water.

5) Other Physical Features

There was no significant phenomenon worth to discuss.

13.8 Table and Figure

FIGURE 13-1 ORGANIZATION STRUCTURE O F MINISTRY OF SCIENCE, TECHNOLOGY AND ENVIRONMENT (MOSTE)

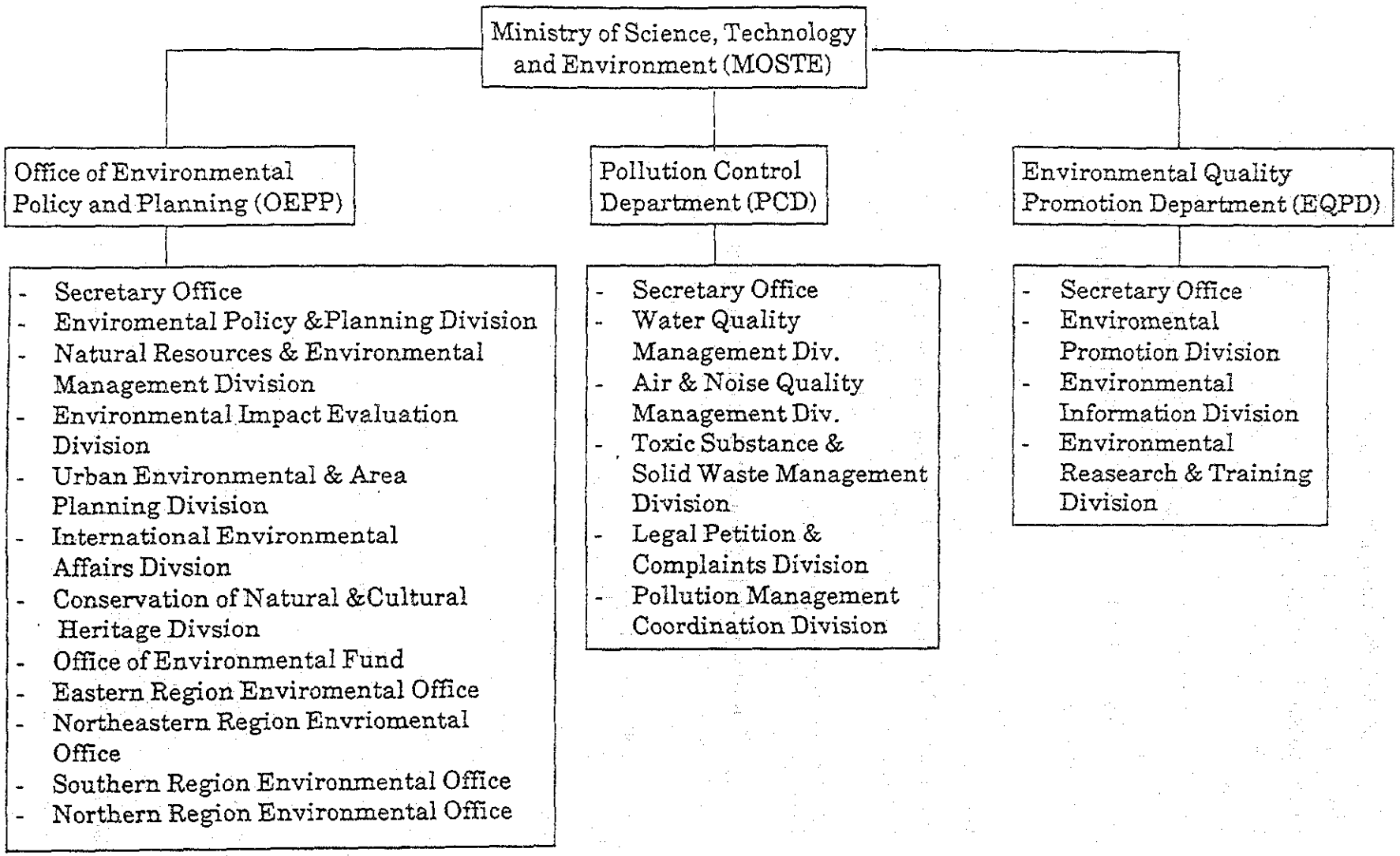


FIGURE 13-2 STRUCTURE OF OEPD

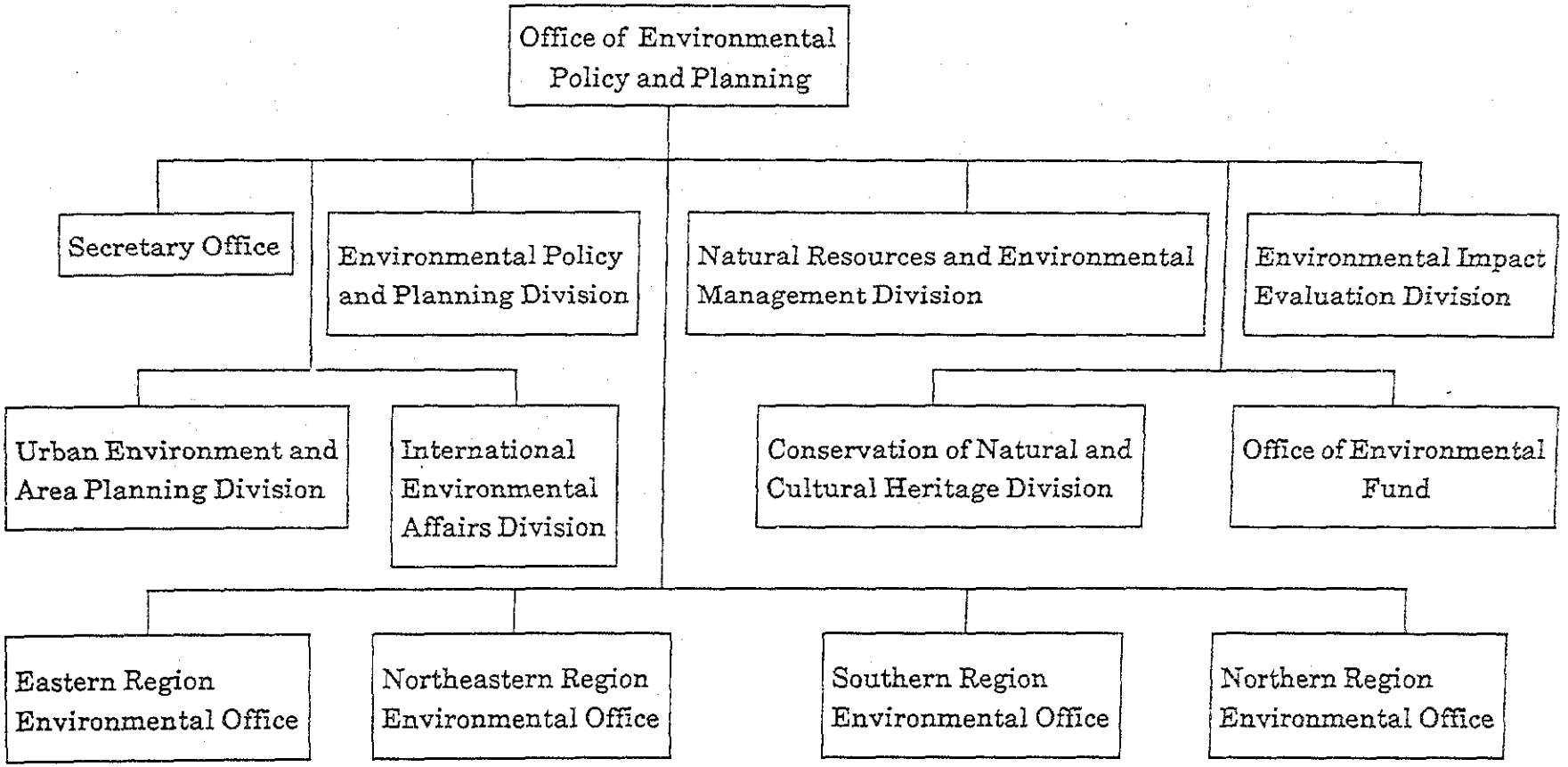


FIGURE 13-3 STRUCTURE OF PCD

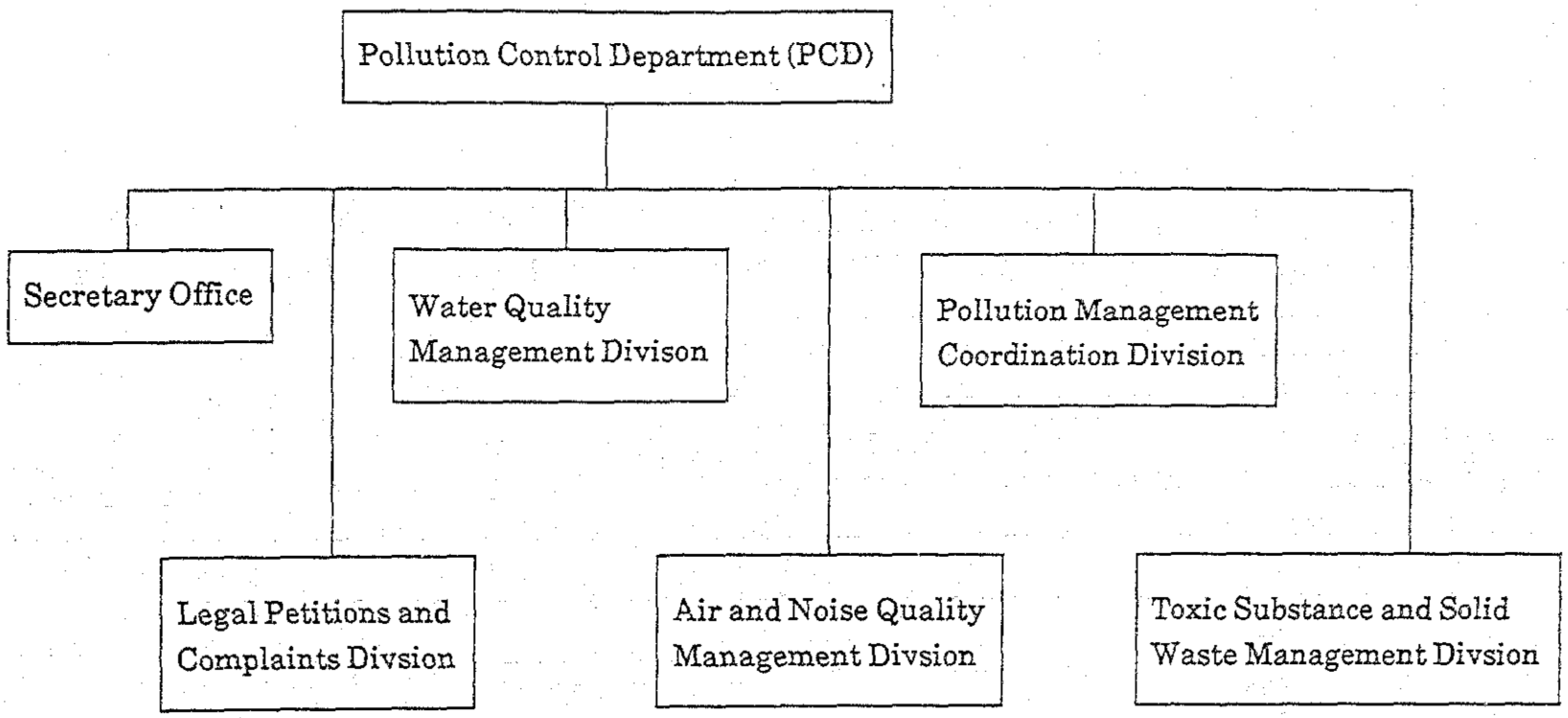


FIGURE 13-4 STRUCTURE OF EQPD

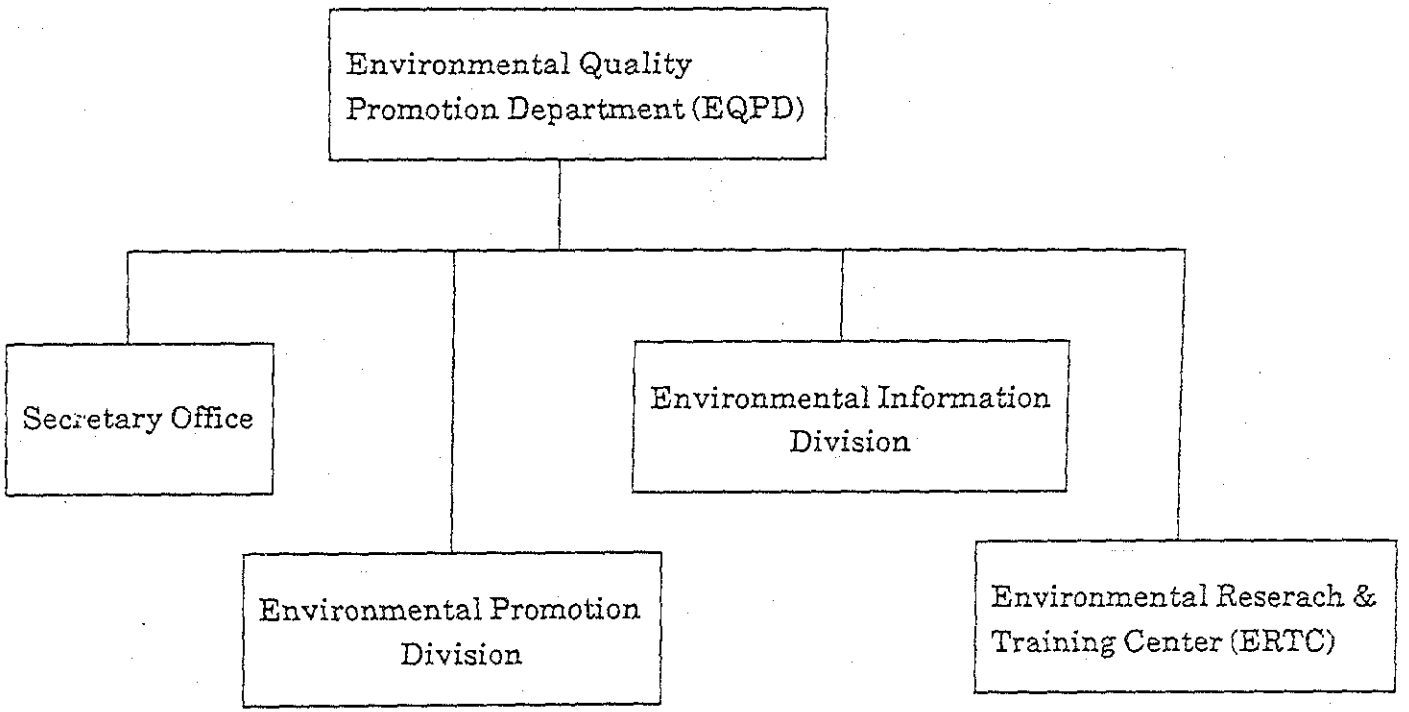


FIGURE 13-5 FLOW CHART OF ACTIONS WHICH WILL BE DONE AFTER THE DESIGNATING SUCH AREA AS THE POLLUTION CONTROL AREA

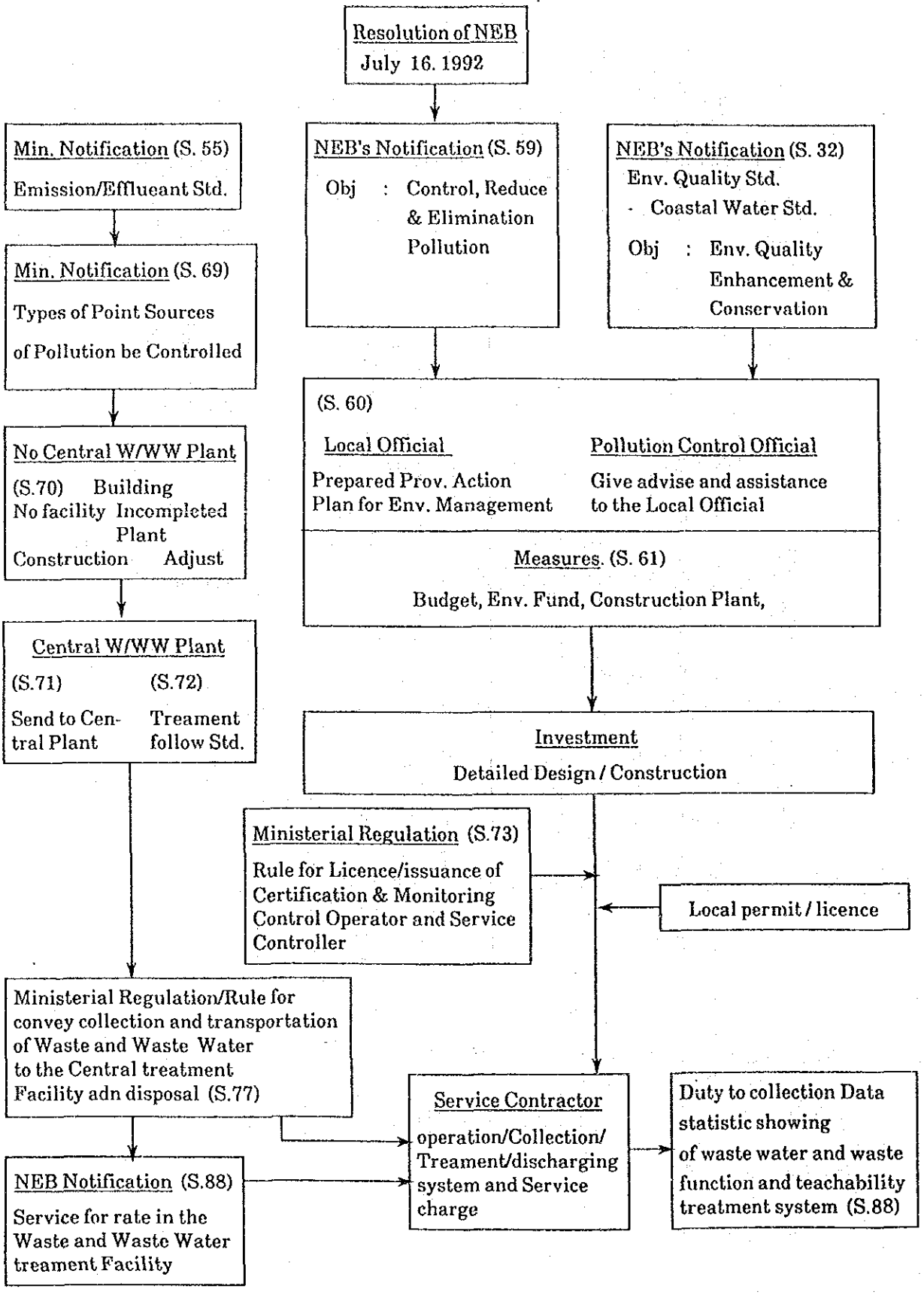
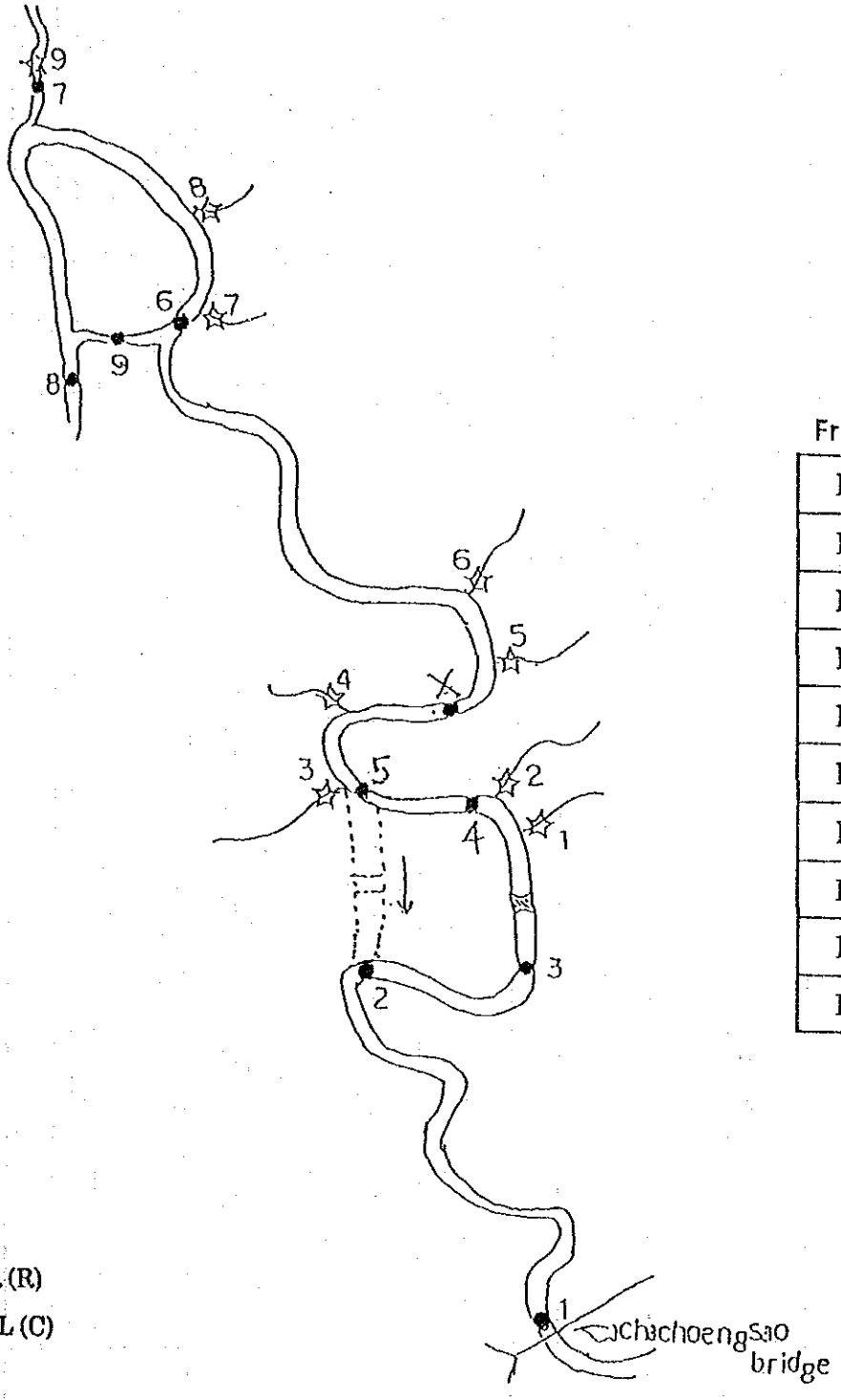


FIGURE 13-6 WATER SAMPLING POINT



From the sea (km)

R-1	57.3
R-2	65.0
R-3	66.8
R-4	68.8
R-5	69.8
R-X	71.8
R-6	78.8
R-8	84.3
R-9	79.3
R-7	81.8

● RIVER (R)

☆ CANAL (C)

TABLE 13-1 PROPERTIES OF WATER SAMPLES FROM FACTORIES AND PONDS AT CHACHOENGSAO ON OCTOBER, 1992

Sampling on Oct. '92

Item \ Sample	Noodle Factory Tap.W.	Noodle Factory Wash.W.	Noodle Factory Disch.W.	Paper mill Disch.W.	Whishky Factory Tap.W.	Whishky Factory Disch.W.	Shrimp/Fish Pond Shirimp A	Shrimp/Fish Pond Shrimp B	Shrimp/Fish Pond Fish
	Oct.27 S-1W	Oct.27 S-2W	Oct.27 S-3W	Oct.27 S-4W	Oct.26 S-5W	Oct.26 S-6W	Oct.27 S-7W	Oct.27 S-8W	Oct.20 S-9W
pH	6.2	4.2	3.1	6.4	6.2	7.5	7.0	7.8	8.3
EC	857	2,980	1,220	3,600	176	780	3,280	2,590	1,200
TDS	550	1,900	780	2,300	110	500	2,100	1,700	770
SS	18	390	260	150	18	20	24	45	99
COD_{Mn}	3.6	110	370	460	4.3	12	6.9	9.8	9.0
BOD	6.5	>140	>350	>350	2.2	9.9	8.3	15	11
Cl^-	127	737	233	393	28	39	953	637	282
Salinity	0.3	1.4	0.5	0.7	0.1	0.1	1.8	1.2	0.5
T-N	0.89	17.53	2.75	3.60	0.43	1.27	0.58	1.15	2.51
Org-N	0.76	8.75	2.52	2.59	0.28	1.19	0.56	0.56	1.17
NH_3-N	N.D.	7.84	0.21	N.D.	N.D.	N.D.	N.D.	0.56	1.15
NO_2-N	N.D.	N.D.	N.D.	N.D.	N.D.	0.07	N.D.	N.D.	0.08
NO_3-N	0.13	0.94	0.02	1.01	0.15	0.01	0.02	0.03	0.11
T-P	0.01	4.00	N.D.	0.10	0.02	0.10	0.03	0.10	0.06

TABLE 13-2 PROPERTIES OF WATER SAMPLES FROM PIG RAISING FARM, FISH POND AND GROUNDWATER AT CHACHOENGSAO ON NOV. 1992

Sampling on Nov.20. '92

Item / Sample	Pig Raising Farm Discharge (Pond)	Pig Raising Farm Discharge (Canal)	Fish Pond (Pig Feces Feed)	Ground Water (Deep Well 70m)
	S-10W	S-11W	S-12W	S-13W
pH	6.9	6.6	6.3	6.4
EC	1,400	606	265	3,910
TDS	900	390	170	2,500
SS	18	66	71	9.0
Cl^-	340	71	21	1,080
Salinity	0.6	0.2	0.1	2.0
COD_{cr}	31	200	55	6.4
BOD	23	88	37	1.0
T-N	14.57	27.47	1.51	1.07
Org-N	1.57	3.32	0.89	0.50
NH_3-N	11.80	24.15	0.50	0.50
NO_2-N	1.03	N.D.	N.D.	N.D.
NO_3-N	0.17	N.D.	0.12	0.07

※ All this samples were analyzed from three days after collection.
※ S-13, Heavy metal, Cd, Pd, As, Cu, Cr, (Not Detected)
Dissoved Fe = 0.01
Mn = 2.346
Zn = 0.026

TABLE 13-3 PROPERTIES OF WATER SAMPLES FROM FACTORIES AT CHACHOENGSAO ON MAR. 1993

Sampling on Mar. '93

Item \ Sample	Paper Mill Tap.W.	Paper Mill Wash.W.	Paper Mill Disch.W.	Noodle Factory Tap.W.	Noodle Factory Wash.W.	Noodle Factory Disch.W.	Whisky Factory Pond A	Whisky Factory Pond B	Whisky Factory Disch.W.
	Mar.18 S-1'D	Mar.18 S-2'D	Mar.18 S-3'D	Mar.18 S4D1	Mar.18 S4D2	Mar.18 S4D3	Mar.16 S5D1	Mar.16 S5D2	Mar.16 S6D
Temp.	35.0	36.5	36.5	30.0	31.5	31.5	30.4	29.5	28.5
pH	7.3	6.7	6.7	7.3	4.8	4.8	6.7	3.7	7.4
EC	1,600	9,390	9,440	594	1,200	2,760	253	732	1,180
TDS	1,000	6,000	6,000	380	770	1,800	160	470	750
SS	7	530	150	19	210	400	8.0	2.0	6.0
Cl-	173	1,710	1,750	81	257	691	32	122	93
Salinity	0.3	3.1	3.2	0.2	0.5	1.3	0.1	0.3	0.2
COD_{OH}	32	920	820	6.3	550	160	7.3	4.1	11.6
BOD	6.6	>1,400	>1,400	4.6	990	>1,400	2.7	1.3	7.6
T-N	-	-	-	1.48	3.71	16.75	0.75	0.94	0.64
Org-N	-	-	-	0.67	1.26	5.88	0.49	0.49	0.56
NH_3-N	-	-	-	0.81	2.45	10.78	N.D.	0.06	N.D.
NO_2-N	-	-	-	N.D.	N.D.	0.03	0.01	N.D.	0.01
NO_3-N	-	-	-	N.D.	N.D.	0.06	0.25	0.39	0.08
T-P	0.09	2.38	1.99	0.11	0.14	2.51	0.11	0.08	0.29

※ Heavy metal etc.

	SO_4	d-Fe	Mn	Zn	Al	Cd,Cu
S5D1	55.2	N.D.	N.D.	0.090	0.31	N.D.
S5D2	127.8	0.07	0.606	0.078	1.14	N.D.

TABLE 13-4 PROPERTIES OF WATER SAMPLES FROM PIG RAISING FARMS AT CHACHOENGSAO ON MAR. 1993

Sampling on Mar.16. '93

Item / Sample	Pig Raising Farm Discharge (Canal)	Shrimp Pond	Shrimp Pond
	S-11D	S-7D	S-8D
Temp.	29.3	28.9	29.9
pH	6.1	7.1	7.2
EC	23,000	23,600	23,500
TDS	15,000	15,000	15,000
SS	140	330	160
Cl^-	6,740	6,890	6,930
Salinity	12	12	13
COD_{OH}	86	13	32
BOD	179	12	14
T-N	37.86	16.92	18.86
Org-N	0.78	2.24	0.84
NH_3-N	36.96	12.49	17.78
NO_2-N	0.02	0.63	0.02
NO_3-N	0.10	1.56	0.22
T-P	6.72	1.00	0.23

TABLE 13-5 PROPERTIES OF WATER SAMPLES FROM GROUNDWATER AND RAIN POND AT CHACHOENGSAO ON MAR. 1993

Sampling on Mar.16. '93

Item \ Sample (m)	Ground Water				Rain Pond Water		
	S13D1 70	S13D2 70	S13D3 76	S13D4 114	S1D1	S1D2	S1D3
Temp.	29.1	29.7	29.2	30.7	27.6	29.3	29.2
pH	5.9	6.8	5.8	8.7	7.2	6.8	7.4
EC	9,130	3,200	10,200	2,410	142	6,580	925
TDS	5,800	2,100	6,500	1,500	91	4,200	590
SS	10.0	7.5	7.0	53	2.5	30	7
Cl^-	2,930	593	3,240	583	3	1,760	168
Salinity	5.3	1.1	5.9	1.1	0.1	3.2	0.3
COD_{OH}	1.3	2.5	2.0	11	5.0	11	8.6
BOD	1.8	1.4	1.6	6.5	3.1	4.8	3.4
T-N	0.71	0.63	2.61	0.73	1.39	0.79	0.87
Org-N	0.36	0.28	1.96	0.58	0.36	0.62	0.58
NH_3-N	0.20	N.D.	0.56	0.06	N.D.	N.D.	0.20
NO_2-N	N.D.	N.D.	N.D.	N.D.	0.50	0.01	0.01
NO_3-N	0.15	0.35	0.09	0.09	0.53	0.16	0.08
T-P	0.10	0.10	0.11	0.12	0.23	0.11	0.22

※ S13D2, Heavy metal
Mn = 3.51 , d-Fe = 0.07 , Zn = 0.192 , Al = 0.05 , Cu, Cr = N.D.

TABLE 13-6 PROPERTIES OF WATER SAMPLES FROM CANALS ON NOV. 1992

Sampling on Nov.3. '92

Item \ Sample (Time)	C-1	C-2	C-3	C-4	C-5	C-6	C-7	C-8	C-9
	9:20	9:25	9:35	9:45	9:55	10:05	10:25	10:35	10:50
pH	6.6	6.5	6.4	6.4	6.2	6.4	6.6	6.3	6.4
EC	970	374	200	195	296	829	184	217	109
TDS	620	240	130	130	190	530	120	140	70
SS	97	55	44	130	26	30	23	11	80
Cl-	206	60	23	23	39	139	18	27	10
Salinity	0.4	0.1	0.1	0.1	0.1	0.3	0.1	0.1	0.1
COD_{Mn}	24	5.6	5.6	6.7	9.3	8.3	3.8	7.9	6.0
BOD	17	3.9	2.8	2.7	4.4	2.9	2.0	1.6	2.4
T-N	8.74	2.24	2.55	0.83	2.50	2.87	1.01	0.69	0.85
Org-N	1.88	2.12	2.01	0.70	0.89	0.67	0.76	0.64	0.50
NH_3-N	6.86	N.D.	0.42	N.D.	1.57	2.10	0.14	N.D.	0.17
NO_2-N	N.D.	0.02	N.D.	N.D.	0.01	0.03	N.D.	N.D.	0.01
NO_3-N	N.D.	0.10	0.12	0.13	0.03	0.07	0.11	0.05	0.17
T-P	0.57	0.13	0.28	N.D.	0.10	0.14	0.55	0.01	0.23

TABLE 13-7 PROPERTIES OF WATER SAMPLES FROM BANG PAKONG RIVER (1)

Sampling on Nov.10. 1992
10:30~13:40

Item \ Sample (m)	R1B	R2B	R3B	R4B	R5B	RXB	R6B	R8B	R9B	R7B
	14.0	10.0	9.0	11.0	9.0	9.5	4.0	9.0	6.0	5.0
Temp.	26.8	26.5	26.7	26.6	26.6	26.5	26.7	26.5	26.6	26.2
pH	7.1	7.3	7.0	7.3	7.1	7.1	7.1	7.0	7.1	6.8
EC	225	231	209	216	210	204	202	210	201	179
TDS	140	150	130	140	130	130	130	130	130	120
SS	69	170	170	10	80	290	170	20	12	210
Cl-	33	27	23	22	21	20	18	20	18	20
Salinity	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
COD_{Mn}	6.0	8.3	8.8	6.6	6.8	11	9.0	5.6	5.7	9.2
BOD	1.7	2.8	2.2	2.0	2.2	2.0	2.3	1.1	2.9	2.1
T-N	0.65	0.59	0.57	0.59	0.41	0.62	0.55	0.38	0.40	1.00
Org-N	0.36	0.34	0.28	0.36	0.14	0.31	0.25	0.11	0.11	0.78
NH_3-N	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
NO_2-N	0.04	0.02	0.02	0.01	0.02	0.02	0.01	0.01	0.01	0.01
NO_3-N	0.25	0.23	0.27	0.22	0.25	0.29	0.29	0.26	0.28	0.21
T-P	0.092	0.080	0.078	0.086	0.080	0.078	0.084	0.066	0.077	0.070

TABLE 13-8 PROPERTIES OF WATER SAMPLES FROM BANG PAKONG RIVER (POINT 4) (2)

Sampling on Nov.10. 1992
10:30~13:40

Item \ Sample (m)	RLS	RLM	RLB	RCS	RCM	RCB	RRS	RRB
	0.0	5.0	10.0	0	5.5	11.0	0	2.0
Temp.	27.3	26.7	26.3	26.8	26.6	26.6	26.8	26.6
pH	7.4	7.5	7.5	7.1	7.2	7.3	7.1	7.1
EC	213	217	212	204	212	216	217	219
TDS	140	140	140	130	140	140	140	140
SS	2.0	5.0	21	4.0	9.0	10	6.0	190
Cl-	23	26	22	22	21	22	23	23
Salinity	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
COD_{Mn}	6.3	5.1	5.7	6.0	5.6	6.6	5.4	10
BOD	2.3	2.2	1.4	2.1	1.5	2.0	1.4	2.4
T-N	0.55	0.54	0.54	0.52	0.60	0.59	0.49	0.72
Org-N	0.28	0.28	0.28	0.27	0.37	0.36	0.27	0.45
NH_3-N	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
NO_2-N	0.02	0.02	0.02	0.01	0.02	0.01	0.01	0.01
NO_3-N	0.25	0.24	0.24	0.24	0.21	0.22	0.21	0.26
T-P	0.109	0.091	0.086	0.084	0.105	0.086	0.081	0.078

TABLE 13-9 PROPERTIES OF WATER SAMPLES FROM BANG PAKONG RIVER (3)

Sampling on Nov.10. 1992
10:30~13:40

Item \ Sample	Fe	Zn	As	Mn	Cr	Cu	Pb	Cd
R-1B	0.17	0.026	0.001	N.D.	↑	↑	↑	↑
R-2B	0.14	0.018	0.002	N.D.				
R-3B	0.23	0.066	N.D.	N.D.				
R-5B	0.18	0.003	0.001	N.D.				
R-XB	0.11	0.013	0.002	N.D.				
R-6B	0.13	0.025	0.002	N.D.				
R-8B	0.14	0.050	N.D.	0.01				
R-9B	0.15	0.071	N.D.	N.D.				
(R-7)	0.18	0.031	0.001	0.10	N.D.	N.D.	N.D.	N.D.
R4LS	0.18	0.024	0.001	0.01				
R4LM	0.18	0.028	0.001	N.D.				
R4LB	0.23	0.014	0.002	0.01				
R4CS	0.15	0.041	N.D.	N.D.				
R4CM	0.10	0.017	0.001	N.D.				
R4CB	0.17	0.041	0.001	N.D.				
R4RS	0.23	0.007	0.001	0.02				
R4RB	0.10	0.035	0.001	N.D.	↓	↓	↓	↓

TABLE 13-10 PROPERTIES OF WATER SAMPLES FROM BANG PAKONG RIVER (4)

Sampling on Mar.9. '93
11:00~13:30

Sample \ Item	Temp.	pH	EC	Transp.	DO
R1 S	30.1	7.0	44,800	5	2.3
B10m	29.8	7.1	45,200	2	2.7
R2 S	30.0	7.0	42,600	7	2.4
B9m	29.8	7.1	42,300	1	2.5
R3 S	31.0	7.1	-	23	2.6
B9m	30.0	7.1	41,300	5	2.6
R4 S	30.5	7.0	-	13	2.6
B10m	29.8	7.1	40,800	2	2.8
R5 S	30.3	7.1	-	23	2.5
B9m	29.8	7.1	39,700	1	2.8
RX S	30.2	7.0	38,700	20	2.4
B9m	29.8	7.1	39,400	2	2.8
R6 S	30.2	7.1	33,600	9	2.6
B4m	29.9	7.0	36,400	1	2.7
R8 S	30.1	7.1	32,000	14	2.6
B9m	29.8	7.1	34,200	4	2.6
R9 S	30.0	7.0	-	14	2.2
B6m	29.6	7.0	35,600	4	2.2
R7 S	30.0	7.1	-	15	2.7
B5.5m	29.7	7.1	31,700	2	2.7

TABLE 13-11 PROPERTIES OF WATER SAMPLES FROM BANG PAKONG RIVER (5)

Sampling on Mar.9. '93
11:00~13:30

Item \ Sample	R1B	R2B	R3B	R4B	R5B	RXB	R6B	R8B	R9B	R7B
(m)	10	9	9	10	9	9	4	9	6	5.5
Temp.	29.8	29.8	30.0	29.8	29.8	29.8	29.9	29.8	29.6	27.7
pH	7.1	7.1	7.1	7.1	7.0	7.1	7.0	7.1	7.0	7.1
EC	45,200	42,300	41,300	40,800	39,700	39,400	36,400	34,200	35,600	31,700
Transparency	2	1	5	2	1	2	1	4	4	2
TDS	29,000	27,000	26,000	26,100	25,000	25,000	23,000	22,000	23,000	20,000
SS	5,800	5,000	270	630	3,700	2,000	12,000	330	260	1,100
Cl-	13,800	13,300	12,700	12,500	12,100	11,900	10,700	10,200	10,700	9,320
Salinity	25	24	23	23	22	22	19	18	19	17
COD_{OH}	8.2	20.2	6.7	8.6	14.6	13.3	12.0	8.1	6.6	12.7
BOD	3.2	4.8	3.0	3.2	4.1	3.5	4.6	3.3	2.3	3.1
DO	2.7	2.5	2.6	2.8	2.8	2.8	2.7	2.6	2.2	2.7
T-N	1.58	6.13	2.49	2.27	2.74	2.85	3.95	2.20	2.17	2.26
Org-N	0.50	4.79	1.06	0.84	1.23	1.30	2.16	0.36	0.36	0.59
NH_3-N	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
NO_2-N	0.03	0.07	0.05	0.04	0.06	0.06	0.08	0.08	0.10	0.04
NO_3-N	1.05	1.27	1.38	0.39	1.45	1.49	1.71	1.76	1.71	1.63
T-P	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.

TABLE 13-12 PROPERTIES OF WATER SAMPLES FROM BANG PAKONG RIVER (6)

Sampling on Mar.9. '93
11:00~13:30

Item \ Sample	R1SR	R1S	R2S	RXS	R6S	R8S
Temp.	30.0	30.1	30.0	30.2	30.2	30.1
pH	7.1	7.0	7.0	7.0	7.1	7.1
EC	44,700	44,800	42,600	38,700	33,600	32,000
Transparency	6.0	4.5	6.5	20.0	8.5	14.0
TDS	27,000	29,000	27,000	24,800	22,000	21,000
SS	140	190	110	40	88	74
Cl^-	13,600	13,600	13,000	12,000	9,900	9,410
Salinity	25	25	24	22	18	17
COD_{OH}	4.6	5.2	4.7	4.7	6.2	5.3
BOD	2.6	2.7	2.9	1.6	1.7	2.1
DO	2.4	2.3	2.4	2.4	2.6	2.6
T-N	2.02	1.80	1.57	1.87	1.94	1.84
Org-N	0.76	0.73	0.31	0.18	0.20	0.17
NH_3-N	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
NO_2-N	0.05	0.04	0.05	0.10	0.05	0.03
NO_3-N	1.21	1.03	1.21	1.59	1.69	1.64
T-P	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.

TABLE 13-13 PROPERTIES OF WATER SAMPLES FROM BANG PAKONG RIVER (POINT X) (7)

Sampling on Mar.9. '93
11:00~13:30

Item \ Sample	RLS	RLB	RCS	RC5	RC7.5	RCB	RRS	RRB
	0	6	0	5	7.5	9	0	3
Temp.	30.1	30.0	30.2	29.9	29.8	29.8	30.1	29.9
pH	7.0	7.1	7.0	7.1	7.1	7.1	7.0	7.0
EC	-	37,900	38,700	39,600	39,400	39,400	-	39,300
Transparency	10	2	20	11	8	2	11	3
TDS		24,000	25,000	25,000	25,000	25,000		25,000
SS		1,000	40.0	82.0	130	2,000		850
Cl-		11,600	12,000	11,700	11,800	11,900		11,900
Salinity		21	22	21	21	21		21
COD_{OH}		8.7	4.7	5.5	6.0	13.3		8.7
BOD		2.1	1.6	1.6	1.9	3.5		2.4
DO	2.3	2.7	2.4	2.7	2.8	2.8	2.2	2.6
T-N		2.90	1.87	1.86	2.40	2.85		2.12
Org-N		1.27	0.18	0.31	0.78	1.30		0.49
NH_4-N		N.D.	N.D.	N.D.	N.D.	N.D.		N.D.
NO_2-N		0.10	0.10	0.08	0.08	0.06		0.07
NO_3-N		1.53	1.59	1.47	1.54	1.49		1.56
T-P		N.D.	N.D.	N.D.	N.D.	N.D.		N.D.

TABLE 13-14 PROPERTIES OF WATER SAMPLES FROM BANG PAKONG RIVER (8)

Sampling on Mar.9. '93
11:00~13:30

Item \ Sample	R9B	R6B	RXB	R2B	R1B
d-Fe	0.16	0.16	0.19	0.18	0.23
Mn	N.D.	N.D.	0.004	0.313	0.042
Zn	0.044	0.020	0.077	0.096	0.032
Cu	0.009	0.007	0.008	0.003	0.007
Cr	0.004	0.002	0.010	0.004	0.007