8. WATER POLLUTION ABATEMENT PLANS

8.1 General

As the result of the water quality projection in Peninsular Malaysia for 1990 and 2000, most rivers in the west coast especially, the southern half will be polluted. Therefore it is necessary to consider the water pollution abatement form the viewpoints of water use and environmental quality in river. The best method for water pollution abatement is that pollution sources control polluted effluent from sources by themselves. As mentioned in 7.3.2, BOD is the most suitable and common parameter of organic water pollution in river. Water pollution abatement is, therefore, the reduction of BOD load by some treatment method in pollution sources.

8.2 Setting of Water Quality Criteria

Water quality standards are of two kinds as follows:

(1) standards for drinking water which pertain to water delivered to consumers after treatment,

(2) standards for raw water which are classified depending upon the purpose of utilization, i.e., domemstic and industrial water supply, fishery, irrigation, bathing and conservation of environment.

International Standards for Drinking Water have been promulgated by the World Health Organization (WHO) as a worldwide guide to the improvement of water quality and treatment. In Malaysia Standards of Bacteriological Quality of Water and Standards for Toxic Substances derived from the WHO Standards have been carried out.

Standards for raw water in Malaysia have been promulgated as Toxicity Limits and Water Quality Criteria for 4 categories, i.e., (i) municipal water supply, (ii) recreation, propagation of fish and other aquatic wildlife, (iii) argicultural irrigation and (iv) industrial water supply. Adopted parameters are 74 parameters except BOD. Standards of raw water in some countries, Holland, U.S.A., U.S.S.R., Philippines and Japan have adopted several parameters including BOD. Concerns the living environment, river water quality is classified according to water usage, and environmental quality standards values for BOD, DO, SS, PH and Coliform are established for each class. Japanese Standards relating to living environment is shown in Table 44 and Philippines' water quality criteria is shown in Table 45. In the Study BOD is adopted in order to observe the river water quality. Some relationships between BOD concentration in a river and environmental quality, and river water quality standard in some countries are illustrated in Fig. 19.

As water quality criteria, two alternative targets for the water pollution abatement are proposed from the viewpoint of environmental quality in the Study. Alternative P1 sets BOD concentration in a river at less than 5 mg/lit in 1990 onwards. Alternative P2 limits BOD concentration in a river at less than 10 mg/lit in 1990 onwards.

8.3 Planning of Treatment Facilities

In case of the necessity of BOD concentration reduction for the proposed limit in a river, the improvement of treatment facility in pollution sources should be proposed.

First of all pollution sources, the improvement of purification methods in all palm oil mills and rubber factories is assumed. Improved purification methods are under investigation in Palm Oil Research Institute of Malaysia (PORIM) and Rubber Research Institute of Malaysia (RRIM) to attain to the limit of BOD concentration for watercourse discharge from palm oil mills and rubber factories. DOE proposed 50 ppm for the future limit. Present limits for watercourse discharge in palm oil mills and rubber factories are shown in Table 3 & 6.

If there still remains a river stretch of higher BOD concentration than the proposed limit, the construction of a sewerage system in the urban area immediately upstream of the river stretch is assumed.

Urban domestic and manufacturing wastewater is collected and treated in public sewerage treatment facilities. BOD concentration in the effluent from a sewerage system is estimated to be 30 mg/lit.

No purification measure is assumed for the effluent from rural area and animal husbandry.

For purification method of effluent from palm oil mills, anaerobic digestion with extended aeration or land disposal are proposed. As treatment method of effluent from rubber factories, aerobic and facultative pond for SMR and oxidation ditch for Latex Concentrate. The layout of the stabilization pond process, combining facultative pond with muturation pond, is shown in Fig. 20.

For public sewerage system, aerated lagoon process is proposed in the Study. This process is historically developed from stabilization pond. Floating aerator for surface aeration is commonly used to supply the necessary oxygen and arise reduction level of load. Maturation pond is necessary to reduce coliform after treating in the aerated lagoon. The layout of aerated lagoon process is shown in Fig. 21.

9. PLANNING MATERIALS

9.1 Financial Cost

9.1.1 Construction cost

Construction costs of purification facilities for palm oil mills, rubber factories and sewerage facilities for urban area composed of sewer, pumping station and treatment facilities are estimated, basing on the data from DOE and the previous studies available, i.e. Master Plan and Feasibility Study for Sewerage and Drainage System Project in Alor Setar and Its Urban Environs Malaysia Report. And construction cost of pretreatment facilities for domestic and industrial water supply are estimated using the data of the previous studies available.

Construction cost is estimated in the four categories, i.e. (1) direct construction cost, (2) engineering service & administration, (3) land acquisition, and (4) physical contingency. Engineering service and administration costs are assumed to be 10% of the direct cost. Physical contingency is assumed to be 30% of the total of the above (1) to (3).

For the sewerage facilities, direct construction costs by facility in reference of the data of Alor Setar Project are as follows;

$$C_s = 0.937Q$$
$$C_p = 0.279 + 0.0552Q$$
$$C_T = 1.02 + 0.153Q$$

Where C_s: Direct construction cost of sewer, M10^6
C_p: Direct construction cost of pumping station, M10^6
C_T: Direct construction cost of treatment facility, M10^6
Q : Treatment Capacity, $10^3 m^3/d$

Unit direct construction cost of sewerage facilities per 100 x $10^3 m^3/d$ of treatment capacity is M$115.8 x 10^6.

Land acquisition cost for sewerage facilities in reference of the data of Alor Seter Project are as follows;

$$C_{PL} = 0.0168 + 1.43 \times 10^{-3} \times Q$$
$$C_{TL} = 0.152 \times Q^{0.787}$$

Where C_{PL} = Land acquisition cost of pumping station, M10^6
C_{TL} = Land acquisition cost of treatment facility, M10^6
Q = Treatment capacity, $10^3 m^3/d$

Unit land acquisition cost of sewerage facilities per 100 x $10^3 m^3/d$ of treatment capacity is estimated to be M$5.9 x 10^6.

Construction and land acquisition costs of sewerage facilities are generally beared by the public and the private sector. Therefore calculation of costs for sewerage systems was carried out on the following assumptions;

(1) in the existing urban area, cost of house connection pipe is beared by the private,

(2) in the new development urban area, costs of branch sewer and house connection pipe are beared by the private.

Cost and sheare of branch sewer and house connection pipe to total costs of sewerage systems is shown in Table 46.

For the purification facilities for palm oil mills, direct construction costs are M$3,300 per m^3/d of treatment capacity for anaerobic digestion with extended aeration and M$2,200 per m^3/d of treatment capacity for anaerobic digestion with land disposal. In consideration of land disposal development; 50% in 1990 and 75% in 2000, direct construction costs in 1990 and 2000 are as follows;

$$Cp = (3.3 \times 0.5 + 2.2 \times 0.5) \times Q = 2.75 \times Q \text{ in } 1990$$
$$Cp = (3.3 \times 0.25 + 2.2 \times 0.75) \times Q = 2.48 \times Q \text{ in } 2000$$

Where Cp : Direct construction cost of purification facility, M$$10^3$

Q : Treatment capacity, m^3/d

Unit direct construction costs of purification facilities of palm oil mill are estimated to be M$2,750 per m^3/d of treatment capacity in 1990 and M$2,480 per m^3/d in 2000.

Purification facilities of palm oil mill is assumed to be constructed in the palm oil mill area, so no land acquisition cost is need.

For the purification facilities for rubber factories, direct construction costs are M$660 per m^3/d of treatment capacity for SMR production and M$1,980 per m^3/d of treatment capacity for Latex Concentrate production.

Percentage of rubber factories by type of rubber production in 1980 is as follows;

Type of Rubber Production	Number of Rubber Factory	Share
Conventional and SMR	146	70%
Latex Concentrate, Mixed and Others	60	30%

On the assumption of the same share in 1990 and 2000 as in 1980, direct construction cost in 1990 and 2000 is estimated as follows;

$$C_R = (0.66 \times 0.7 + 1.98 \times 0.3) \times Q = 1.06 \times Q$$

Where C_R: Direct construction cost of purification facility, $M\$10^3$
Q : Treatment capacity, m^3/d

Unit direct construction cost of purification facilities of rubber factory is estimated to be 1,060 per m^3/d of treatment capacity in 1990 and 2000.

No land acquisition cost of purification facility in rubber factory is need as the assumption of palm oil mill.

As the pretreatment facilities, two treatment methods are proposed. For BOD concentration in raw water between 2 mg/lit and 20 mg/lit, pretreatment is carried out by the rapid sand-filter and activated carbone absorption (Secondary treatment). For BOD concentration between 20 mg/lit and 200 mg/lit, an aerated lagoon process such as aerated lagoon or maturation pond (primary treatment) is further needed. The direct construction costs of the above-mentioned pretreatment facilities are estimated as follows:

$$Cpre1 = 3.48 \times 10^{-6} \times L^{2.9} \times (Q_D + Q_Z)$$

$$Cpre2 = 21.2 \times 10^{-6} \times L^{2.9} \times (Q_D + Q_Z)$$

where, Cpre1: Direct construction cost of primary pretreatment facility, $M\$10^6$
Cpre2: Direct construction cost of secondary pretreatment facility, $M\$10^6$
L : Reduction level of pretreatment facility, %
Q_D: Treatment capacity for domestic water supply, $10^3m^3/d$
Q_Z: Treatment capacity for industrial water supply, $10^3m^3/d$

Unit direct construction costs of pretreatment facility are estimated to be M\$29.4 x 10^6 per 100 x $10^3m^3/d$ of treatment capacity for primary pretreatment facility and M\$86.5 x 10^6 per 100 x $10^3m^3/d$ of treatment capacity for secondary pretreatment facility as 50% reduction level.

Pretreatment facilities is assumed to be constructed in the treatment plant area, so no land acquisition cost is need.

The unit construction costs by type of treatment facility are estimated as shown in Table 47 and summarized below.

Type of Treatment Facility		Unit Const. Cost ($M\$10^6/10^3m^3/d$)
Public sewerage system		173.3
Purification facilities of palm oil mill	in 1990	3.9
Purification facilities of palm oil mill	in 2000	3.6
Purification facilities of rubber factory	in 1990 & 2000	1.5
Primary pretreatment facility		42.0
Secondary pretreatment facility		123.7

9.1.2 O&M cost

The O&M costs include O&M cost of sewer, pumping station and aerated lagoon process for public sewerage system, O&M cost of ponding process for purification facilities in palm oil mills and rubber factories and O&M cost of aerated lagoon for primary pretreatment and rapid sandfilter bed for secondary pretreatment.

Relationship between construction cost and ratio of O&M cost and construction cost by city is shown in Fig. 22. The ratio has the range from 1% to 4%. In the study, the annual O&M cost is assumed to be 4% of the total construction cost for public sewerage system and 2% of the total construction cost for purification facilities of palm oil mills and rubber factories and pretreatment facilities.

9.2 Economic Benefit and Cost

Economic benefit for water pollution abatement is assumed to be composed with the sewerage benefit and the saving in pretreatment facility.

The sewerage benefit is the willingness-to-pay by served people and saving in the cost of purification of industrial waste-water. It is assumed to be 0.6% of real income of served people and gross value of manufacturing production of served industries in this Study.

Pretreatment facilities is necessary if BOD concentration in raw water is more than 2 mg/lit for domestic water supply or 5mg/lit for industrial water supply. Its cost can be saved, if the proposed water pollution abatement measures reduced BOD concentration in the riveracross this limit. This saving in cost is counted as a part of water pollution abatement benefit.

Economic cost for water pollution abatement is estimated to be 80% of the financial cost of public sewerage system, purification facilities of palm oil mills and rubber factories and pretreatment facilities for D & I water supply.

9.3 Manpower Requirement

9.3.1 Manpower requirement for construction

Manpower requirement for construction is estimated, basing on the data of Ministry of Local Government and Federal Territory. The staff in the Construction Division of Sewerage Department is composed with four categories as follows;

Staff Category	Number of Staff
Executive Engineer	1
Assistant Engineer	3
Technical Assistant	2
Technician	3
Total	9

In consideration of the above staff-requirement and construction schedule, manpower requirement is estimated for construction schedule of every 50 x $10^3m^3/d$ per year as follows,

Staff Category	Number of Staff	Share (%)
Engineer	2	25
Technical Assistant	2	25
Technician	2	25
Others	2	25
Total	8	100

9.3.2 Manpower requirement for O&M

Manpower requirement for O&M is estimated, basing on the data of the staff requirement of the Operation Division, Sewerage Department, Ministry of Local Government and Fedecal Territory as well as manpower requirement for construction. The staff in the Operation Division of Sewerage Department is composed with categories as follows;

Staff Category	Number of Staff
Treatment Plant	
- Laboratory Assistants	3
IMG Workers	18
Pumping Stations	
- Mechanical Supervisors	1
IMG Workers	11
- Sewer Inspectors	2
IMG Workers	29
Other Operations	
Works Manager	1
Chemist/Biologist	2
Technical Assistant (Electrical)	1
Supervisors (Works)	1
Assistant Clerk/Typist	2
Technicians (Sampling Meter Reader)	1
Security	3
IMG Workers	22
Driver	1
Total	98

In consideration of the above staff-requirement and staff required in the D&I water supply, manpower requirement is estimated for treatment capacity of every 200 x $10^3 m^3/d$ as follows,

Staff Category	Number of Staff	Share (%)
Engineer	2	1
Technical Assistant	3	1
Technician	18	7
Others	240	91
Total	263	100

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TABLES

Table 1 INVENTORY OF EXISTING SEWERAGE SYSTEM

Town	Population in 1980 (10^3) Total (Urban Area)	Served by Sewerage System	Purification System	Ultimate Effluent Receiving Watercourse
Kota Kinabalu	60	19	No Purification System	Likas Bay
		8	Stabilization Lagoons	The surface water drain along Penampang Road
Sandakan	70	26	No Purification System	Sandakan Harbour, Sulu Sea
Tawau	45	12	No Purification System	Cowie Bay
Labuan	12	Data Not Available	No Purification System	Labuan Harbour
Lahad Datu	17	Data Not Available	No Purification System	Celebes Sea
Kudat	11	Data Not Available	No Purification System	Marudu Bay

Remarks; Marine disposal without treatment is carried out in most cities.

Source; Public Works Department

Table 2 CHARACTERISTICS OF RUBBER FACTORY EFFLUENT

Unit: mg except pH

Parameter	Product Type: SMR & Conventional Grade	Latex Concentrate
pH	5.6	4.6
BOD_5	1,500	3,236
COD	2,295	6,976
SS	345	6,686
Ammoniacal Nitrogen	118	622
Total Nitrogen	161	858

Source; Ref 5

Table 3 RUBBER FACTORY EFFLUENT STANDARD FOR WATERCOURSE DISCHARGE

(1) *CONCENTRATED LATEX OR ITS ASSOCIATED PRODUCTS*

unit: mg/l except pH

Parameter	Limits According to Periods of Discharge 1.4.1980 - 31.3.1980	1.4.1981 - 31.3.1982	1.4.1982 - 31.3.1981	1.4.1983 - Thereafter
BOD_3	450	300	200	100 (50*)
COD	1,500	1,000	500	400
Total Solids	2,500	2,000	1,000	-
SS	1,000	800	250	150 (100)
Ammoniacal Nitrogen	350	300	300	300
Total Nitrogen	450	350	350	350
pH	6-9	6-9	6-9	6-9

(2) PRODUCTS OTHER THAN CONCENTRATED LATEX OR ITS ASSOCIATED PRODUCTS

unit: mg/l except pH

Parameter	Limits According to Periods of Discharge 1.4.1979 - 3.3.1980	1.4.1980 - 31.3.1981	1.4.1981 - Thereafter
BOD_3	300	200	100 (50*)
COD	750	500	250
Total Solids	1,000	1,000	-
SS	250	250	150 (100*)
Ammoniacal Nitrogen	70	70	40+
Total Nitrogen	100	100	60+
pH	6-9	6-9	6-9

Remarks; * This additional limit is the arithemetic mean value determined on the basis of a minimum of four samples taken at least once a week for four weeks consecutively.

\+ Value on filtered sample.

Source; Ref. 6

Table 4 INVENTORY OF PURIFICATION SYSTEM FOR RUBBER PROCESSING

Code No.	Name of Factory	State	Type of Production	Actual Production mt/day	Purification System	Quantity of Effluent m^3/year	BOD_3 & SS of Treated or Raw Effluent BOD_3(mg/l)	SS(mg/l)
201.	Ball Estates Sdn. Bhd. Rubber Factory	Sabah	RSS SMR	4.5 11	Rubber Trap, Anaerobic Pond, Facultative Pond	90,168	W: 19.81	W: 26
204.	Putatan Crumb Rubber Factory	Sabah	SMR5 BLOCK Rubber	22	No Treatment System	130,924.8	S: 50	S: 500
205.	Tenom SMR Factory	Sabah	SMR BLOCK Rubber	10	Rubber Trap, Anaerobic Pond, Facultative Pond	90,300	W: 25	W: 130
208.	Meradong SMR Factory	Sarawak	SMR BLOCK rubber	7	No Treatment System	54,588	W: 155.5	W: 287
209.	Skrang SMR Factory	Sarawak	SMR BLOCK rubber	5	No Treatment System	54,588	W: 98.5	W: 110
210.	Lim Liang Kee SMOKE House	Sarawak	SMR OFFGRADE SMOKE SHEET	4 8	Recycle Process	-	-	-

Remarks; W: Effluent into Watercourse, S: Effluent into Sea,

Source; DOE

Table 5 CHARACTERISTICS OF PALM OIL MILL EFFLUENT (RAW EFFLUENT)

Unit: mg/lit except pH

Parameter	Range	Mean
BOD_3	10,250 - 47,500	25,000
COD	15,500 - 106,360	53,630
Total Solids	11,450 - 164,950	43,635
SS	410 - 60,360	19,020
Ammoniacal Nitrogen	0 - 110	35
Total Nitrogen	180 - 1,820	770
pH	3.8 - 4.5	4.1

Source; Ref. 18

Table 6 PALM OIL MILL EFFLUENT STANDARD FOR WATERCOURSE DISCHARGE

unit: mg/l except pH

	Limits According to Periods of Discharge			
Parameter	1.7.1980 - 30.6.1981	1.7.1981 - 30.6.1981	1.7.1982 - 31.12.1983	1.1.1984 Thereafter
BOD_3	1,000	500	250	100 (50*)
COD	2,000	1,000	-	-
Total Solids	2,000	1,500	-	-
SS	600	400	400	400
Ammoniacal Nitrogen	15	10	150+	100+
Total Nitrogen	75	50	300+	200+
pH	5.0 - 9.0	5.0 - 9.0	5.0 - 9.0	5.0 - 9.0

Remarks; * This additional limit is the arithemetic mean value determined on the basis of a minimum of four samples taken at least once a week four weeks consecutively.

+ value on filtered sample

Source; Ref. 7

Table 7 INVENTORY OF PURIFICATION SYSTEM FOR PALM OIL PROCESSING

Code No.	Name of Factory	State	Average Production of FFB mt/day	Purification System	Average Quantity of Effluent m^3/year	BOD₃ & SS of Treated or Raw Effluent BOD₃(mg/l)	SS(mg/l)
202.	Bal Estate Palm Oil Mill	Sabah	341	Anaerobic pond, Aerobic pond	50,544	W: 113	W: 1,282
203.	Apas Balong Palm Oil Mill	Sabah	366	under construction	68,784	W:<300	W: 700
204.	Mostyn Kunak Palm Oil Mill	Sabah	270	Anaerobic pond, Facultative pond, Oxidation pond, Land Disposal	25,000	L: 500	L: 2,100
206.	Giram Palm Oil Mill	Sabah	100	Anaerobic pond, Aerobic pond, Land Disposal	18,000	L: 90	L: 501
205.	Sabah Agricultural Development Palm Oil Mill	Sabah	80	Anaerobic pond, Land Disposal	81	L: 1,000	-
207.	Silabukan Palm Oil Mill	Sabah	100	No Treatment System	15,000	S: 22,800	S: 35,400
209.	Tomanggong Palm Oil Mill	Sabah	150	Cooling Pond, Anaerobic Pond, Aerobic Pond	26,880	W: 100	W: 1,900
210.	Suan Lamba Palm Oil Mill	Sabah	50	No Treatment System	7,500	S: 4,800	-
212.	Sungai Majang Palm Oil Mill	Sabah	200	under construction	36,000	S: 5,700	S: 10,800
211.	Sungai Manila Palm Oil Mill	Sabah	316	No Treatment System	47,500	S: 10,200	S: 31,600
214.	Sabah Palm Oil Mill	Sabah	150	Anaerobic Pond, Digestion Pond, Land Disposal	4,800	L: <2,000	-
215.	Pamol Palm Oil Factory	Sabah	336	Anaerobic Pond, Anaerobic Ditch, Others Under Construction	46,800	W: 800	W: 2,488
217.	Beaufort Palm Oil Mill	Sabah	28	under construction	5,349.9	W: <300	W: 700
218.	Danau Palm Oil Mill	Sarawak	4.5	No Treatment System	376.8	W: 284.5	-
219.	Sarawak Oil Palm Sdn. Bhd.	Sarawak	220	Stabilisation Pond	62,400	W: 200	W: 204
220.	Niah Palm Oil Mill	Sarawak	450	Anaerobic Pond Facultative Oxidation Pond	100,000	W: <100	W: -
223.	Mukan Palm Oil Mill	Sarawak	100	Anaerobic Pond, Aerobic Pond or Facultative Oxidation Pond, Aerobic Pond	6,900	W: <500	W: -

Remarks; W: Effluent into Watercourse, S: Effluent into Sea, L: Effluent onto Land
Source; DOE

Table 8 CHARACTERISTICS OF WASHING FROM PIG FARMS

Unit: mg/l

Parameter	Analysis results
BOD_3	1,900 - 21,600
COD	4,800 - 39,000
Total Solids	3,690 - 22,300
Suspended Solids	636 - 15,900
Ammoniacal Nitrogen	75 - 950
Total Nitrogen	370 - 2,080
Organic-N (excluding NH_3)	140 - 1,370
Phosphate	160 - 1,600

Source; Ref. 9

Table 9 WATER QUALITY DATA AROUND MAMUT COPPER MINE MONITORED BY DOE IN 1980 (1/2)

Unit : mg/l except pH

Location of Sampling Point	pH Mean	pH Max	pH Min	SS Mean	SS Max	SS Min	Cu Mean	Cu Max	Cu Min	Cd Mean	Cd Max	Cd Min
1. Waste Discharge Channel No. 1	10.1	11.6	6.7	1123	2970	330	0.08	0.25	0.01	0.02	0.08	0.00
2. Water Intake Of Mamut River	7.6	9.7	6.5	187	755	20	0.02	0.08	0.00	0.00	0.00	0.00
3. 106 Thickener Discharge	8.1	10.8	4.1	81	140	15	0.03	0.15	0.00	0.00	0.00	0.00
4. Mamut River Affected by the Open Pit Mining	7.1	9.0	6.0	3661	6440	1100	0.56	4.00	0.01	0.01	0.04	0.00
5. 106 Thickener Discharge (Control) Before Lohan Tailing Dam	7.3	8.7	6.8	121867	248400	13970	0.04	0.11	0.01	0.00	0.01	0.00
6. Lohan Simpangan Road Bridge	7.7	8.6	7.2	1597	9850	195	0.08	0.50	0.01	0.00	0.01	0.00
7. Effluent Dischage At Spillway of Lohan Tailing Dam	7.1	8.4	4.1	876	8180	0	0.02	0.05	0.01	0.01	0.04	0.00
8. Effluent Discharge from Sillway into River Bongkud	7.3	8.3	6.7	70	160	0	0.01	0.04	0.00	0.00	0.01	0.00
9. Confluence of 8 & River Bongkud	7.6	8.2	7.1	51	85	5	0.01	0.02	0.00	0.00	0.01	0.00
10. River Bongkud At Vehicle Crossing Road	7.8	8.4	7.2	27	60	5	0.00	0.02	0.00	0.00	0.01	0.00
11. Sugui Mantukungan (Near the Road Before Poring)	7.6	8.4	7.3	15	45	0	0.01	0.04	0.00	0.00	0.01	0.00
12. Poring Rest House Bridge Crossing Over Mamut River to Poring Hot Spring	7.2	8.3	6.7	138	405	0	0.05	0.15	0.00	0.00	0.01	0.00
13. Ranau-Lohan Road Track Bridge Crossing Mensaban River	7.7	8.3	7.2	25	60	0	0.01	0.03	0.00	0.00	0.01	0.00
14. River Rakurit At Kg. Marakan Rd. Stop Near Takurik-Liwagu Confluenc	7.4	8.3	6.9	18	50	5	0.01	0.04	0.00	0.00	0.01	0.00
15. Sugui Liwagu Near Rest House	7.3	8.3	6.9	32	85	0	0.01	0.02	0.00	0.00	0.01	0.00
16. River Langunan At Kg. Togis near the Bridge	7.3	8.2	6.8	25	70	0	0.02	0.09	0.00	0.00	0.01	0.00
17. River Mankadan	7.4	8.2	6.9	17	40	5	0.01	0.04	0.00	0.00	0.01	0.00
18. Confluence of River Mandakan & Langanan	7.3	8.2	7.1	16	70	0	0.01	0.04	0.00	0.00	0.01	0.00
19. River Sugut At Kg. Moragan	7.4	8.1	7.0	35	145	10	0.01	0.03	0.00	0.00	0.01	0.00
20. Upstream of R. Labuk at Tupulid	7.4	8.2	6.8	2176	16920	5	0.00	0.01	0.00	0.00	0.00	0.00
21. Downstream of R. Labuk at Tupulid	7.1	8.2	4.6	219	810	10	1.67	10	0.00	0.00	0.00	0.00
22. River Malid At Tupulid	7.6	8.1	7.1	23	55	5	0.01	0.04	0.00	0.00	0.00	0.00
23. Sugui Monnad at Kg. Monrad	7.2	8.0	6.8	137	590	5	0.01	0.03	0.00	0.02	0.07	0.01
24. River Labuk At Beluran	7.0	7.2	6.6	813	3100	50	0.02	0.02	0.01	0.06	0.10	0.00
25. River Labuk At Sabah Palm	7.1	7.3	7.0	88	190	20	0.03	0.04	0.00	0.04	0.07	0.01
26. River Labuk At Botation	7.2	7.2	7.1	167	400	10	0.01	0.02	0.00	0.00	0.00	0.00
27. River Labuk At Kolapis	6.9	7.1	6.7	2906	9700	100	0.02	0.03	0.01	0.13	0.20	0.06
28. River Labuk At Klagan	7.2	7.2	7.1	67	100	40	0.01	0.01	0.01	0.00	0.00	0.00

Remarks; The location of sampling points is refered to Fig. 17

Source ; DOE

Table 10 WATER QUALITY DATA AROUND MAMUT COPPER MINE MONITORED BY DOE IN 1980 (2/2)

Unit: mg/l except pH

	Location of Sampling Point	Cr			Zn			Mn			Fe		
		Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min
1.	Waste Discharge Channel No.1	0.01	0.05	0.00	0.07	0.24	0.01	0.28	1.25	0.01	0.04	0.07	0.01
2.	Water Intake of Mamut River	0.00	0.00	0.00	0.05	0.14	0.02	0.07	0.36	0.00	0.14	0.70	0.00
3.	106 Thickener Discharge	0.00	0.01	0.00	0.05	0.20	0.01	0.03	0.16	0.00	0.04	0.18	0.00
4.	Mamut River Affected By the Open Pit Mine	0.02	0.04	0.01	0.31	1.10	0.05	4.64	20.00	0.06	2.55	20.25	0.03
5.	106 Thickener Discharge (Control) Before Lohan Tailing Dam	0.01	0.04	0.01	0.09	0.17	0.03	0.46	2.20	0.03	0.22	0.43	0.02
6.	Lohan Simpangan Road Bridge	0.00	0.01	0.01	0.12	0.26	0.02	0.24	1.55	0.01	0.59	4.10	0.01
7.	Effluent Discharge At Spillway of Lohan Tailing Dam	0.00	0.01	0.00	0.05	0.10	0.02	0.10	0.54	0.00	0.08	0.33	0.01
8.	Effluent Discharge From Spill-way Into River Bongkud	0.01	0.02	0.00	0.14	0.52	0.02	0.14	0.45	0.01	0.21	0.54	0.02
9.	Confluence of 8 & River Bongkud	0.00	0.01	0.00	0.06	0.21	0.02	0.09	0.32	0.00	0.39	1.45	0.00
10.	River Bongkud At Vehicle Crossing Road	0.00	0.01	0.00	0.05	0.11	0.00	0.02	0.12	0.00	0.11	0.34	0.00
11.	Sugui Mantukungan (Near the Road Before Poring)	0.00	0.00	0.00	0.06	0.16	0.01	0.00	0.01	0.00	0.03	0.05	0.00
12.	Poring Rest House Bridge Crossing Over Mamut River to Poring Hot Spring	0.00	0.00	0.00	0.08	0.25	0.01	0.05	0.18	0.00	0.28	1.65	0.00
13.	Ranau-Lohan Road Track Bridge Crossing Mensaban River	0.00	0.00	0.00	0.08	0.21	0.01	0.01	0.07	0.00	0.05	0.21	0.00
14.	River Rakurit At Kg. Marakan Rd. Stop Near Takurik-Liwagu Confluence	0.00	0.01	0.00	0.06	0.11	0.01	0.01	0.02	0.00	0.03	0.09	0.00
15.	Sugui Liwagu Near Rest House	0.00	0.00	0.00	0.07	0.13	0.02	0.02	0.06	0.00	0.06	0.19	0.01
16.	River Langunan At Kg. Togis Near the Bridge	0.00	0.00	0.00	0.07	0.17	0.02	0.02	0.10	0.00	0.08	0.27	0.00
17.	River Mankadan	0.00	0.01	0.00	0.04	0.08	0.02	0.01	0.05	0.00	0.03	0.09	0.00
18.	Confluence of River Mandakan & Langanan	0.00	0.00	0.00	0.14	1.00	0.01	0.01	0.02	0.00	0.03	0.14	0.00
19.	River Sugut At Kg. Moragan	0.00	0.01	0.00	0.14	0.96	0.02	0.02	0.07	0.00	0.06	0.22	0.00
20.	Upstream of R. Labuk at Tupulid	0.00	0.00	0.00	0.09	0.50	0.01	0.01	0.04	0.00	0.04	0.08	0.01
21.	Downstream of R. Labuk at Tupulid	0.00	0.00	0.00	0.25	1.00	0.02	0.05	0.35	0.00	1.51	10	0.01
22.	River Malio At Tupulid	0.00	0.00	0.00	0.10	0.26	0.02	0.00	0.01	0.00	0.04	0.07	0.00
23.	Sugui Monnad At Kg. Monnad	0.04	0.12	0.00	0.06	0.12	0.01	0.04	0.12	0.00	0.23	0.55	0.04
24.	River Labuk At Beluran	0.02	0.03	0.00	0.06	0.07	0.04	0.05	0.14	0.00	0.27	0.80	0.02
25.	River Labuk At Sabah Palm	0.00	0.00	0.00	0.31	0.10	0.03	0.03	0.08	0.00	0.11	0.22	0.05
26.	River Labuk At Botation	0.005	0.01	0.00	0.05	0.07	0.04	0.06	0.17	0.00	0.32	0.90	0.01
27.	River Labuk At Kolapis	0.02	0.02	0.01	0.10	0.25	0.02	0.05	0.14	0.01	0.21	0.44	0.02
28.	River Labuk At Klagan	0.01	0.01	0.00	0.03	0.05	0.01	0.07	0.18	0.00	0.48	1.25	0.01

Remarks; The location of sampling points is refer to Fig. 17

Source ; DOE

Table 11 WATER QUALITY DATA AROUND MAMUT COPPER MINE MONITORED BY MINING COMPANY IN 1980

Unit: mg/l except pH

* Sampling Point No.	pH			Turbidity			Cu		
	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min
1	7.0	8.3	6.3	3.39	11.67	0.33	0.11	0.32	0.04
2	8.5	8.9	8.1	0.76	2.57	0.00	0.11	0.36	0.04
3	8.1	8.3	7.7	1.30	5.66	0.00	0.10	0.28	0.03
4	8.2	8.5	7.9	3.28	21.52	0.07	0.12	0.27	0.03
5	8.5	8.9	8.0	0.54	2.39	0.00	0.07	0.19	0.01
6	8.2	8.5	7.6	4.17	19.76	0.17	0.14	0.52	0.08

Remarks; * The location of sampling points is refer to Fig. 9

Source ; Overseas Mineral Resources Development Sabah Bhd.

Table 12 WORLD HEALTH ORGANIZATION STANDARDS FOR DRINKING WATER

Substance or Proper	Maximum recommended concentration	Maximum permissible concentration
Total Solids (mg/1)	500	1,500
Colour (units*)	5	50
Turbidity (units*)	5	25
Taste	unobjectionable	
Odour	unobjectionable	
Fe (mg/1)	0.1	1
Mn (mg/1)	0.05	0.05
Cu (mg/1)	0.05	1.5
Zn (mg/1)	5	15
Ca (mg/1)	75	200
Mg (mg/1)	30	150
	If the water contains at least 250 mg/1 of sulphates	
So_4 (mg/1)	200	400
Cl (mg/1)	200	600
pH	7 to 8.5	6.5 to 9.2
Phenolic compounds (as phenol) (mg/1)	0.001	0.002
Anionic detergents (mg/1)	0.2	1.0
Mineral Oils (mg/1)	0.01	0.03
Total Hardness (meq/1)	2 (100mg/1 $CaCo_3$)	10 (500mg/1 $CaCO_3$)
Pb (mg/1)	-	0.05
As (mg/1)	-	0.05
Se (mg/1)	-	0.01
Cr (hexavalent) (mg/1)	-	0.05
CN (mg/1)	-	0.20
Cd (mg/1)	-	0.01
Ba (mg/1)	-	1.00
Ca (mg/1)	-	2.00
F (mg/1)	-	<1.5
NO_3 (mg/1)	-	<45
Carbon Chloroform extract (mg/1)	-	0.5
Alkyl Benzyl Surfonates (mg/1)	-	1.0

Remarks; * Platinum-Cobalt Colour Scale
** Turbidity Units

Table 13 POLLUTANT LEVELS OF RIVERS IN SABAH IN 1978

Unit: mg/l except pH

River Name & Basin No.	WQMS No.	No. of Samples	pH Mean	pH Max	pH Min	COD Mean	COD Max	COD Min	Suspended Solids Mean	Suspended Solids Max	Suspended Solids Min	Ammoniacal Nitrogen Mean	Ammoniacal Nitrogen Max	Ammoniacal Nitrogen Min
Segema 210	5181501	13	7.1	7.6	6.5	40	66	14	269	615	95	-	-	-
Kinabatangan 211	5373501	2	6.4	6.4	6.3	-	-	-	165	215	115	-	-	-
	5375501	5	7.0	7.4	6.5	73	-	-	216	630	15	-	-	-
Labuk 213	5768501	8	6.9	7.1	6.7	72	179	3	59	110	10	-	-	-
	5872501	11	6.8	7.3	6.2	29	47	6	171	560	25	-	-	-
	5961501	6	7.8	9.2	6.7	12	20	6	51	195	0	-	-	-
	6073501	7	7.1	7.2	6.7	15	60	3	81	270	10	-	-	-
Sugut 214	6172501	11	7.0	7.3	6.8	39	85	16	141	445	15	-	-	-
Bengkoka 216	6670501	4	6.9	7.1	6.8	28	47	2	28	55	15	-	-	-
Kadamaian 218	6264501	6	7.0	7.5	6.5	92	150	35	117	395	5	-	-	-
	6364501	5	7.3	7.8	6.9	22	40	3	11	20	5	-	-	-
Tuaran 219	6162501	3	6.8	6.9	6.7	66	114	3	8	10	5	-	-	-
Putatan 220	5961501	4	7.0	7.3	6.7	59	88	24	40	95	15	-	-	-
Papar 221	5760501	7	6.9	7.3	6.6	27	42	3	34	115	0	-	-	-
	5760502	3	6.9	7.3	6.4	16	-	-	20	30	0	-	-	-
Padas 224	4959501	2	7.5	8.1	6.8	3	-	-	50	80	20	-	-	-
	5159501	1	7.7	-	-	-	-	-	35	-	-	-	-	-
	5261502	2	7.7	8.3	7.1	4	-	-	30	30	30			
Mengalong 226	5055502	2	7.2	7.2	7.2	46	61	31	48	85	10	-	-	-

Table 14 POLLUTANT LEVELS OF RIVERS IN SABAH IN 1979

Unit: mg/l except pH

River Name & Basin No.	WQMS No.	No. of Samples	pH Mean	pH Max	pH Min	COD Mean	COD Max	COD Min	Suspended Solids Mean	Suspended Solids Max	Suspended Solids Min	Ammoniacal Nitrogen Mean	Ammoniacal Nitrogen Max	Ammoniacal Nitrogen Min
Pensiangan 201	4764501	6	7.0	7.3	6.7	32	90	3	33	65	5	0.02	0.03	0.01
Kalumpang 208	4581501	2	7.0	7.1	6.8	23	23	23	290	370	210	0.02	0.02	0.02
Segema 210	5181501	22	7.2	8.1	6.8	28	61	10	192	535	10	0.04	0.13	0.00
Kinabatangan 211	5373501	9	7.3	8.5	6.9	35	74	13	105	355	0	0.03	0.05	0.02
	5375501	8	7.2	7.7	7.1	42	89	10	124	360	20	0.02	0.03	0.00
Labuk 213	5768501	14	7.2	7.3	7.1	80	622	0	415	730	5	0.02	0.03	0.01
	5872501	18	7.0	7.4	6.5	27	89	3	80	625	5	0.02	0.04	0.00
	5961501	11	7.2	7.9	6.9	15	35	3	18	40	5	0.03	0.05	0.02
	6073501	2	7.5	7.5	7.4	5	6	3	15	20	10	0.03	0.03	0.03
Sugut 214	6172501	9	6.9	7.2	6.7	17	29	6	51	205	5	0.03	0.08	0.02
Bengkoka 216	6670501	6	7.6	8.7	6.9	24	66	7	65	305	5	0.04	0.07	0.02
Kadamaian 218	6264501	6	7.4	7.7	7.1	16	29	3	42	200	5	0.04	0.08	0.02
	6364501	5	7.3	7.4	6.9	10	19	3	15	30	10	0.02	0.03	0.02
Tuaran 219	6162501	2	7.3	7.4	7.1	5	6	3	15	30	10	0.02	0.03	0.01
Putatan 220	5961501	3	7.2	7.9	6.9	5	10	3	20	40	10	0.03	0.05	0.01
Papar 221	5760501	10	6.9	8.1	6.4	19	63	0	61	415	0	0.03	0.04	0.01
	5760502	5	6.9	7.4	6.6	24	50	10	41	145	10	0.02	0.04	0.00
Padas 224	4959501	6	7.0	7.2	6.6	61	97	15	52	145	15	0.03	0.06	0.01
	5159501	6	7.2	7.6	6.8	57	146	3	166	545	5	0.02	0.03	0.02
	5261502	3	7.2	7.6	6.9	30	32	28	42	60	5	0.02	0.02	0.01
Mengalong 226	5055502	8	7.0	7.4	6.6	21	61	3	28	50	5	0.03	0.03	0.02

Table 15 POLLUTANT LEVELS OF RIVERS IN SABAH IN 1980

Unit: mg/l except pH

River Name & Basin No.	WQMS No.	No. of Samples	pH			COD			Suspended Solids			Ammoniacal Nitrogen		
			Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min
Kalumpang 208	4581501	4	7.0	7.2	6.8	17	28	8	60	90	10	0.01	0.02	0.00
Kinabatangan 211	5373501	9	7.2	7.5	6.9	15	62	0	223	570	80	0.03	0.05	0.02
	5375501	8	7.5	8.0	7.0	22	81	0	198	330	75	0.03	0.03	0.02
Labuk 213	5768501	4	7.3	7.9	6.7	31	100	2	24	65	5	0.02	0.03	0.02
	5872501	4	7.1	7.2	6.8	23	43	8	86	155	20	0.07	0.20	0.02
	5961501	6	7.7	8.4	7.1	3	9	0	89	185	30	0.03	0.05	0.00
	6073501	5	7.6	8.5	7.1	37	66	8	46	75	15	0.03	0.03	0.02
Sugut 214	6172501	7	7.2	7.4	6.7	12	19	0	125	430	10	0.02	0.03	0.02
Bengkoka 216	6670501	2	7.2	7.3	7.0	8	15	0	8	15	0	0.01	0.02	0.00
Kadamaian 218	6264501	3	7.2	7.4	6.8	12	29	5	103	240	5	0.03	0.03	0.02
	6364501	4	7.2	7.6	6.5	13	20	8	20	30	15	0.04	0.04	0.03
Tuaran 219	6162501	2	7.6	8.0	7.2	11	11	11	128	175	80	0.03	0.03	0.02
Putatan 220	5961501	1	7.0	-	-	20	-	-	5	-	-	0.02	-	-
Papar 221	5760501	3	7.0	7.2	6.9	32	40	20	17	35	5	0.04	0.05	0.03
	5760502	3	7.2	7.2	7.2	1	4	0	28	35	15	0.02	0.02	0.02
Padas 224	4959501	1	6.9	-	-	13	-	-	120	-	-	0.00	-	-
	5159501	2	7.2	7.2	7.2	14	20	8	193	295	90	0.02	0.02	0.02
	5261502	2	7.1	7.3	6.9	13	26	0	33	45	20	0.02	0.03	0.00
Mengalong 226	5055502	2	7.3	7.6	7.0	17	23	10	18	25	10	0.02	0.03	0.00

Table 16 POLLUTANT LEVELS OF RIVERS IN SARAWAK IN 1981

Unit: mg/l except pH

River Name & Basin No.	WAMS No.	No. of Samples	pH Mean	pH Max	pH Min	BOD5 Mean	BOD5 Max	BOD5 Min	COD Mean	COD Max	COD Min	Suspended Solids Mean	Suspended Solids Max	Suspended Solids Min	Ammoniacal Nitrogen Mean	Ammoniacal Nitrogen Max	Ammoniacal Nitrogen Min
Limbang 229	4750601	1	6.9	-	-	0.80	-	-	12.5	-	-	6	-	-	0.02	-	-
	4750602	1	6.9	-	-	0.80	-	-	6.5	-	-	14	-	-	0.10	-	-
Baram 230	3744602	1	7.0	-	-	2.30	-	-	28.0	-	-	142	-	-	0.02	-	-
	4143601	1	6.8	-	-	2.30	-	-	12.5	-	-	93	-	-	0.02	-	-
Miri 231	4640601	1	5.9	-	-	1.00	-	-	56.5	-	-	19	-	-	0.04	-	-
Kemena 236	3130601	2	7.3	7.4	7.1	0.90	1.10	0.70	35.1	44.7	25.5	6	7	5	0.02	-	-
	3132602	2	6.3	6.5	6.0	0.60	0.80	0.40	26.3	35.0	17.5	7	12	2	0.02	0.02	0.02
	3133603	1	5.7	-	-	0.50	-	-	16.0	-	-	30	-	-	-	-	-
	3234604	1	6.0	-	-	0.60	-	-	35.0	-	-	32	-	-	0.04	-	-
Tatau 237	2825601	2	6.5	6.7	6.3	0.70	0.80	0.60	15.0	17.5	12.5	13	19	7	0.01	0.02	trace
	2828604	2	6.6	6.6	6.5	0.70	0.90	0.50	15.8	16.0	15.5	10	11	8	0.04	0.06	0.02
Mukah 239	2523602	1	6.8	-	-	1.40	-	-	16.0	-	-	5	-	-	0.02	-	-
Oya 240	2421602	1	6.6	-	-	1.20	-	-	13.0	-	-	4	-	-	trace	-	-
Rajang 241	2025605	1	6.8	-	-	0.80	-	-	14.0	-	-	20	-	-	-	-	-
	2029616	1	6.7	-	-	0.90	-	-	18.0	-	-	25	-	-	-	-	-
	2111614	1	6.6	-	-	0.80	-	-	11.0	-	-	28	-	-	-	-	-
	2120604	1	6.9	-	-	2.40	-	-	6.5	-	-	11	-	-	-	-	-
	2737608	1	6.8	-	-	0.70	-	-	20.0	-	-	41	-	-	-	-	-
Sarikei 241	2014609	1	6.9	-	-	1.40	-	-	16.0	-	-	15	-	-	-	-	-
Kerian 242	1713601	1	6.6	-	-	1.40	-	-	38.0	-	-	210	-	-	trace	-	-
Sebelak 243	1812603	1	6.0	-	-	1.40	-	-	31.5	-	-	90	-	-	trace	-	-
Saribas 243	1514602	1	6.6	-	-	1.70	-	-	9.5	-	-	5	-	-	trace	-	-
Lupar 244	1018603	1	7.0	-	-	2.10	-	-	6.5	-	-	1	-	-	trace	-	-
	1114607	2	6.3	6.3	6.2	0.50	0.60	0.40	7.3	8.0	6.5	14	18	10	trace	trace	-
	1115605	1	6.5	-	-	1.80	-	-	12.5	-	-	2	-	-	trace	-	-
	1214601	2	6.9	7.1	6.6	1.30	2.00	0.60	12.9	22.3	3.5	5,890	11,286	494	trace	trace	-
	1216604	1	6.6	-	-	1.85	-	-	9.5	-	-	8	-	-	-	-	-
Sadong 245	1006605	3	6.5	6.6	6.3	1.27	2.40	2.50	16.1	22.5	10.0	12	16	3	0.02	-	-
	1007604	3	6.2	6.6	5.5	1.93	2.50	1.50	28.3	42.5	18.0	15	28	4	trace	trace	-
	1105603	3	7.0	7.1	6.9	1.10	1.70	0.80	9.8	13.0	4.0	29	38	15	0.01	0.02	trace
Sarawak 246	1401605	2	7.1	7.1	7.0	0.50	0.60	0.40	12.5	13.0	12.0	8	11	5	trace	trace	-
	1402603	2	7.1	7.3	6.0	0.70	1.00	0.40	11.0	12.0	10.0	25	28	21	0.02	0.04	trace
	1502602	2	7.0	7.2	6.7	0.85	1.20	0.50	15.3	16.5	14.0	26	28	23	trace	trace	-
Samarahan 246	1204602	3	7.2	7.2	7.1	9.1	26.00	0.60	29.5	71.5	6.5	566	1,629	18	trace	trace	-
Kayan 247	1593601	1	6.0	-	-	0.40	-	-	22.0	-	-	11	-	-	trace	-	-
	1594603	3	6.0	6.3	5.6	0.70	1.20	0.30	14.8	22.5	6.30	10	13	7	0.01	0.02	trace
	1598002	3	5.7	6.1	5.4	0.67	0.90	0.50	22.7	30.5	12.00	17	30	5	-	-	-
	1599603	1	5.3	-	-	0.80	-	-	28.5	-	-	5	-	-	-	-	-
	1698601	3	6.4	7.0	6.0	0.67	0.90	0.50	23.3	30.5	14.0	108	162	70	trace	trace	-
	1963601	1	6.6	-	-	0.70	-	-	32.0	-	-	163	-	-	trace	-	-
Sematan 247	1797601	4	6.5	6.6	6.3	0.53	0.60	0.30	8.0	12.0	3.0	5	8	2	trace	trace	-
Sebaka 247	1797602	4	6.6	6.8	6.4	0.55	0.70	0.30	6.8	12.0	3.0	5	8	2	trace	trace	-
Serayan 247	1797603	4	6.2	6.3	6.0	0.58	1.00	0.40	14.4	22.0	6.0	7	11	4	trace	trace	-

Table 17 CAPITAL COST FOR SEWERAGE SYSTEMS PROPOSED BY MASTER PLAN

Unit: M$ 10^3

City/Town Component	Total Cost	Phase 1 1984 to 1987	Phase 2 1995 to 1997	Phase 3 2006 to 2007
1. Kota Kinabalu				
Main sewers	23,870	15,620	6,160	2,090
Pumping stations	20,420	8,190	5,722	6,508
Lagoons	27,890	7,661	10,653	9,576
Land	8,625	6,700	1,525	400
Total	80,805	38,171	24,060	18,574
2. Sandakan				
Main sewers	21,215	13,779	6,523	913
Pumping stations	14,605	5,628	5,531	3,446
Lagoons	12,928	4,309	6,464	3,155
Marine outfall	9,945	9,945	-	-
Land	2,960	2,960	-	-
Total	61,653	36,621	15,518	6,514
3. Tawau				
Main sewers	12,605	11,220	1,386	-
Pumping stations	3,759	1,907	1,066	785
Lagoons	15,332	4,668	5,181	4,788
Land	300	7,700	4,700	3,900
Total	47,996	25,495	12,333	9,473

Source; Refs. 1 to 3

Table 18 PARAMETER LIMITS OF SEWAGE AND INDUSTRIAL EFFLUENTS OF STANDARD A AND B

Parameter	Unit	Standard A	Standard B
Temperature	^oC	40	40
pH	-	6.0 - 9.0	5.5 - 9.0
BOD_5 at 20^oC	mg/l	20	50
COD	mg/l	50	100
Suspended Solids	mg/l	50	100
Mercury	mg/l	0.005	0.05
Cadmium	mg/l	0.01	0.02
Chromium, Hexavalent	mg/l	0.05	0.05
Arsenic	mg/l	0.05	0.10
Cyanide	mg/l	0.05	0.10
Lead	mg/l	0.10	0.5
Chromium, Trivalent	mg/l	0.20	1.0
Copper	mg/l	0.20	1.0
Manganese	mg/l	0.20	1.0
Nickel	mg/l	0.20	1.0
Tin	mg/l	0.20	1.0
Zinc	mg/l	1.0	1.0
Boron	mg/l	1.0	4.0
Iron (Fe)	mg/l	1.0	5.0
Phenol	mg/l	0.001	1.0
Free Chlorine	mg/l	1.0	2.0
Sulphide	mg/l	0.50	0.50
Oil and Grease	mg/l	Not Detectable	10.0

Remarks; Standard A is the parameter limit of effluent to be discharged into inland waters within the catchment areas, and Standard B, into any other inland waters.

Source; Ref. 16

Table 19 SUMMARY OF PROJECTED BOD LOAD AND BOD CONCENTRATION FOR CASE 1

Basin		1990			2000		
		BOD Load		BOD	BOD Load		BOD
No.	Name	From Source (ton/d)	Into River (ton/d)	Concentration in River (mg/l)	From Source (ton/d)	Into River (ton/d)	Concentration in River (mg/l)
201	Pensiangan	0	0	0 - 0	0	0	0 - 0
202	Serudong	0	0	0 - 0	0	0	0 - 0
203	Kalabakan	0	0	0 - 0	0	0	0 - 0
204	Barantian	0	0	0	0	0	0
205	Umas-Umas	0	0	0 - 0	0	0	0 - 0
206	Merutai Besar	0	0	0 - 0	3	2	5 - 5
207	Tawau	0 (3)	0	0 - 0	1 (6)	0	0 - 1
208	Kalumpaung	0 (0)	0	0 - 0	0 (1)	0	0 - 0
209	Silibukan	4 (5)	3	3 - 4	8 (9)	5	5 - 7
210	Segama	0	0	0 - 0	1	0	0 - 0
211	Kinaba Tangan	1	0	0 - 0	1	0	0 - 0
212	Segaliud	0 (4)	0	0	0 (11)	0	0
213	Labuk	2	1	0 - 1	6	3	0 - 3
214	Sugut	0	0	0 - 0	0	0	0 - 0
215	Paitan	0	0	0 - 0	0	0	0 - 0
216	Bengkoka	0	0	0 - 0	0	0	0 - 0
217	Bongan	4 (5)	3	7 - 9	3 (5)	2	4 - 5
218	Kadamaian	0	0	0 - 0	1	1	1 - 1
219	Tuaran	2	0	0 - 0	3	0	0 - 0
220	Putatan	1 (6)	0	0 - 0	1 (13)	0	0 - 0
221	Papar	1	0	0 - 1	2	1	0 - 2
222	Kimanis	0	0	0	0	0	0
223	Membakut	0	0	0 - 0	0	0	0 - 0
224	Padas	2	0	0 - 0	4	1	0 - 0
225	Labuan	0 (6)	0	0	0 (27)	0	0
226	Lakutan	0	0	0	0	0	0
227	Lawas	0	0	0 - 0	0	0	0 - 0
228	Trusan	0	0	0 - 0	0	0	0 - 0
229	Limbang	1	1	0 - 0	2	1	0 - 0
230	Baran	1	0	0 - 0	3	1	0 - 0
231	Miri	2 (7)	0	0 - 4	3 (21)	1	1 - 4
232	Sibuti	0	0	0 - 0	0	0	0 - 0
233	Niah	0	0	0 - 0	0	0	0 - 0
234	Suai	5	3	3 - 9	4	2	2 - 6
235	Similajau	0	0	0 - 0	0	0	0 - 0
236	Kemeha	0 (27)	0	0 - 0	0(120)	0	0 - 0
237	Tatau	2	1	0 - 0	2	1	0 - 0
238	Balingian	0	0	0 - 0	0	0	0 - 0
239	Mukah	0	0	0 - 0	0	0	0 - 0
240	Oya	0	0	0 - 0	0	0	0 - 0
241	Rajang	14	5	0 - 0	30	13	0 - 0
242	Kerian	0	0	0 - 0	1	0	0 - 0
243	Sarabas	1	0	0 - 0	1	0	0 - 0
244	Lupar	5	3	0 - 2	5	2	0 - 1
245	Sadong	18	2	0 - 1	28	5	0 - 3
246	Sarawak	16	6	0 - 1	25	11	0 - 2
247	Kayau	0	0	0 - 0	3	1	1 - 1
	Total	82(134)	28		144(341)	53	

Note; ( ): Encluding BOD load from cities located coastal area

Table 20 COMPOSITION OF BOD LOAD INTO RIVER FOR CASE 1

Unit: ton/d

Basin		1990 BOD Load into River				2000 BOD Load into River			
No.	Name	PR	UI	RA	Total	PR	UI	RA	Total
201	Pensiangan	0	0	0	0	0	0	0	0
202	Serudong	0	0	0	0	0	0	0	0
203	Kalabakan	0	0	0	0	0	0	0	0
204	Barantian	0	0	0	0	0	0	0	0
205	Umas-Umas	0	0	0	0	0	0	0	0
206	Merutai Besar	0	0	0	0	2	0	0	2
207	Tawau	0	0	0	0	0	0	0	0
208	Kalumpuang	0	0	0	0	0	0	0	0
209	Silibukan	3	0	0	3	5	0	0	5
210	Segama	0	0	0	0	0	0	0	0
211	Kinaba Tangan	0	0	0	0	0	0	0	0
212	Segaliud	0	0	0	0	0	0	0	0
213	Labuk	1	0	0	1	3	0	0	3
214	Sugut	0	0	0	0	0	0	0	0
215	Paitan	0	0	0	0	0	0	0	0
216	Bengkoka	0	0	0	0	0	0	0	0
217	Bongan	3	0	0	3	2	0	0	2
218	Kadamaian	0	0	0	0	0	1	0	1
219	Tuaran	0	0	0	0	0	0	0	0
220	Putatan	0	0	0	0	0	0	0	0
221	Papar	0	0	0	0	0	1	0	1
222	Kimanis	0	0	0	0	0	0	0	0
223	Membakut	0	0	0	0	0	0	0	0
224	Padas	0	0	0	0	0	1	0	1
225	Labuan	0	0	0	0	0	0	0	0
226	Lakutan	0	0	0	0	0	0	0	0
227	Lawas	0	0	0	0	0	0	0	0
228	Trusan	0	0	0	0	0	0	0	0
229	Limbang	0	1	0	1	0	1	0	1
230	Baran	0	0	0	0	0	1	0	1
231	Miri	0	0	0	0	0	0	1	1
232	Sibuti	0	0	0	0	0	0	0	0
233	Niah	0	0	0	0	0	0	0	0
234	Suai	3	0	0	3	2	0	0	2
235	Similajau	0	0	0	0	0	0	0	0
236	Kemena	0	0	0	0	0	0	0	0
237	Tatau	1	0	0	1	1	0	0	1
238	Balingian	0	0	0	0	0	0	0	0
239	Mukah	0	0	0	0	0	0	0	0
240	Oya	0	0	0	0	0	0	0	0
241	Rajang	0	4	1	5	3	9	1	13
242	Kerian	0	0	0	0	0	0	0	0
243	Sarabas	0	0	0	0	0	0	0	0
244	Lupar	3	0	0	3	2	0	0	2
245	Sadong	0	0	2	2	2	0	3	5
246	Sarawak	0	6	0	6	0	10	1	11
247	Kayau	0	0	0	0	1	0	0	1
	Total	14	11	3	28	23	24	6	53
		(50)	(39)	(11)	(100)	(43)	(45)	(11)	(100)

Note; PR : Palm oil mill and rubber factory effluent
UI : Urban domestic and urban industry effluent
RA : Rural and animal husbandry
( ): % of the total BOD load

Table 21 PROJECTED BOD LOAD IN 1990 AND 2000 FOR CASE 1 (1/6)

Basin No.	Outlet No.	1990 BOD Load from Pollution Sources (ton/d)	1990 BOD Load into Main Stream (ton/d)	1990 BOD Concen-tration (mg/l)	2000 BOD Load from Pollution Sources (ton/d)	2000 BOD Load into Main Stream (ton/d)	2000 BOD Concen-tration (mg/l)	Pollution Sources
201	1	0	0	0	0	0	0	R218
	2	0.1	0	0	0.2	0	0	R201, R221
	3	0	0	0	0	0	0	B.P.
	S-total	0.1	0		0.2	0		
202	1	0	0	0	0	0	0	R201
	2	0	0	0	0	0	0	B.P.
	3	0.2	0	0	0.4	0	0	R202
	S-total	0.2	0		0.4	0		
203	1	0.3	0	0	0.5	0	0	R202
	2	0	0	0	0	0	0	B.P.
	S-total	0.3	0		0.5	0		
204		0	0	0	0	0	0	
205	1	0	0	0	0	0	0	B.P.
	2	0.1	0	0	0.2	0	0	R202
	S-total	0.1	0		0.2	0		
206	1	0	0	0	3.2	1.9	5	P201
	2	0	0	0	0	0	5	B.P.
	S-total	0	0		3.2	1.9		
207	1	0	0	0	0	0	0	B.P.
	2	0.4	0	0	0.5	0	0	A201
	3	0	0	0	0.1	0	1	P202*, R201*
	4	(2.2)	-	-	(5.3)	-	-	C201, A202
	S-total	0.4	0		0.6	0		
208	1	0	0	0	0	0	0	P204*
	2	0	0	0	0	0	0	B.P.
	3	(0.2)	-	-	(0.8)	-	-	C202
	S-total	0	0		0	0		
209	1	4.4	2.6	4	8.4	5.1	7	P207, P208
	2	0	0	3	0	0	5	B.P.
	3	(0.2)	-	-	(0.8)	-	-	C203
	S-total	4.4	2.6		8.4	5.1		

Note; C: City, R: Rural, P: Palm oil mill, RF: Rubber factory,
A: Animal husbandry, *: P and RF with purification facilities
B.P.: Balance point
( ): BOD load discharged to the sea directly

Table 22 PROJECTED BOD LOAD IN 1990 AND 2000 FOR CASE 1 (2/6)

Basin No.	Outlet No.	1990 BOD Load from Pollution Sources (ton/d)	1990 BOD Load into Main Stream (ton/d)	1990 BOD Concen-tration (mg/l)	2000 BOD Load from Pollution Sources (ton/d)	2000 BOD Load into Main Stream (ton/d)	2000 BOD Concen-tration (mg/l)	Pollution Sources
210	1	0.3	0	0	0.5	0	0	R204
	2	0	0	0	0	0	0	R205
	3	0	0	0	0	0	0	B.P.
	4	0	0	0	0	0	0	P209*
	S-total	0.4	0		0.5	0.1		
211	1	0.1	0	0	0.1	0	0	R218
	2	0	0	0	0	0	0	R207
	3	0.4	0	0	0.6	0.1	0	R205
	4	0	0	0	0	0	0	B.P.
	S-total	0.5	0.1		0.8	0.1		
212		0	0	0	0	0	0	
		(3.7)	-	-	(10.7)	-	-	C212
	S-total	0	0		0	0		
213	1	0.3	0.2	1	1.2	0.7	3	C205
	2	0.2	0	0	0.3	0	1	R212
	3	0.1	0	0	0.1	0	1	R217
	4	0	0	0	0	0	0	P214*, P215*
	5	0	0	0	0	0	0	B.P.
	6	1.5	0.9	0	4.2	2.5	0	P213
	7	0.2	0	0	0.3	0	0	R207
	8	0	0	0	0	0	0	R206
	S-total	2.3	1.1		6.2	3.3		
214	1	0.1	0	0	0.2	0	0	R212
	2	0.1	0	0	0.1	0	0	R207
	3	0	0	0	0	0	0	B.P.
	S-total	0.2	0		0.3	0		
215	1	0.1	0	0	0.1	0	0	R207
	2	0	0	0	0	0	0	B.P.
	S-total	0.1	0		0.1	0		
216	1	0.1	0	0	0.1	0	0	R210
	2	0.2	0	0	0.4	0	0	R208
	3	0	0	0	0	0	0	B.P.
	S-total	0.3	0		0.5	0		

Note; C: City, R: Rural, P: Palm oil mill, RF: Rubber factory,
A: Animal husbandry, *: P and RF with purification facilities
B.P.: Balance point
( ): BOD load discharged to the sea directly

Table 23 PROJECTED BOD LOAD IN 1990 AND 2000 FOR CASE 1 (3/6)

Basin No.	Outlet No.	1990 BOD Load from Pollution Sources (ton/d)	1990 BOD Load into Main Stream (ton/d)	1990 BOD Concen-tration (mg/l)	2000 BOD Load from Pollution Sources (ton/d)	2000 BOD Load into Main Stream (ton/d)	2000 BOD Concen-tration (mg/l)	Pollution Sources
217	1	4.4	2.6	9	2.6	1.6	5	P216
	2	0	0	7	0	0	4	B.P.
	3	0	0	7	0	0	4	R208
	4	(0.7)	-	-	(2.7)	-	-	C206
	S-total	4.4	2.6		2.6	1.6		
218	1	0.3	0.2	0	1.2	0.7	1	C207
	2	0	0	0	0	0	1	B.P.
	S-total	0.3	0.2		1.2	0.7		
219	1	1.1	0.1	0	1.5	0.2	0	A210
	2	0.6	0.1	0	1.0	0.1	0	R213
	3	0	0	0	0	0	0	B.P.
	S-total	1.7	0.2		2.5	0.3		
220	1	0.3	0	0	0.5	0	0	R215
	2	0.3	0	0	0.4	0	1	A212
	3	0	0	0	0	0	1	B.P.
	4	(4.9)	-	-	(11.8)	-	-	C208, RF204
	S-total	0.6	0		0.9	0		
221	1	0.3	0	1	0.4	0	1	R215
	2	0.2	0	0	0.2	0	0	R216
	3	0.7	0.4	1	1.9	1.2	2	C209, B.P.
	S-total	1.2	0.4		2.5	1.2		
222		0	0	0	0	0	0	
223	1	0	0	0	0	0	0	B.P.
	2	0.2	0	0	0.3	0	0	R220
	S-total	0.2	0		0.3	0		
224	1	0.1	0	0	0.2	0	0	R222
	2	0.5	0.1	0	0.7	0.1	0	R221, A213
	3	1.0	0.3	0	2.2	0.9	0	C210, R217, RF205* R205, R218
	4	0.2	0	0	0.3	0	0	R220
	5	0	0	0	0	0	0	B.P.
	6	0.2	0	0	0.3	0	0	A214
	7	0.1	0	0	0.2	0	0	R219
	S-total	2.2	0.4		3.9	1.0		

Note; C: City, R: Rural, P: Palm oil mill, RF: Rubber factory,
A: Animal husbandry, *: P and RF with purification facilities
B.P.: Balance point
( ): BOD load discharged to the sea directly

Table 24 PROJECTED BOD LOAD IN 1990 AND 2000 FOR CASE 1 (4/6)

		1990			2000			
Basin No.	Outlet No.	BOD Load from Pollution Sources (ton/d)	BOD Load into Main Stream (ton/d)	BOD Concentration (mg/l)	BOD Load from Pollution Sources (ton/d)	BOD Load into Main Stream (ton/d)	BOD Concentration (mg/l)	Pollution Sources
225		(5.6)	0	0	(26.5)	0	0	C211, R223
226		0	0	0	0	0	0	
227	1	0.1	0	0	0.1	0	0	R224
	2	0	0	0	0	0	0	B.P.
	S-total	0.1	0		0.1	0		
228	1	0.2	0	0	0.3	0	0	R224
	2	0	0	0	0	0	0	B.P.
	S-total	0.2	0		0.3	0		
229	1	0.2	0	0	0.3	0	0	R225
	2	0.3	0.2	0	0.6	0.4	0	P218, RF206
	3	0.8	0.3	0	1.3	0.6	0	C212, A216
	4	0	0	0	0	0	0	B.P.
	S-total	1.2	0.5		2.2	1.0		
230	1	0.7	0.1	0	1.1	0.1	0	R226
	2	0.6	0.3	0	2.1	1.2	0	C213
	3	0	0	0	0	0	0	B.P.
	4	0	0	0	0.1	0	0	R227
	S-total	1.3	0.4		3.3	1.4		
231	1	0.1	0	1	0.3	0	2	R227
	2	0.3	0.2	4	0.3	0.2	4	RF207
	3	1.4	0.1	4	1.9	0.2	4	A218
	4	0	0	3	0	0	4	B.P.
	5	0.4	0	4	0.6	0.1	4	A217
	6	(4.7)	-	-	(18.4)	-	-	C214
	S-total	2.2	0.3		3.1	0.5		
232	1	0	0	0	0	0	0	B.P.
	2	0	0	0	0	0	0	P219*
	3	0.2	0	0	0.3	0	0	R227
	S-total	0.2	0		0.3	0		
233	1	0.3	0	0	0.4	0	0	R227
	2	0	0	0	0	0	0	B.P.
	3	0	0	0	0	0	0	P220*
	S-total	0.3	0		0.5	0.1		

Note; C: City, R: Rural, P: Palm oil mill, RF: Rubber factory,
A: Animal husbandry, *: P and RF with purification facilities
B.P.: Balance point
( ): BOD load discharged to the sea directly

Table 25 PROJECTED BOD LOAD IN 1990 AND 2000 FOR CASE 1 (5/6)

		1990			2000			
Basin No.	Outlet No.	BOD Load from Pollution Sources (ton/d)	BOD Load into Main Stream (ton/d)	BOD Concen-tration (mg/l)	BOD Load from Pollution Sources (ton/d)	BOD Load into Main Stream (ton/d)	BOD Concen-tration (mg/l)	Pollution Sources
234	1	5.3	3.2	9	3.7	1.9	6	R227, P221
	2	0	0	3	0	0	2	B.P.
	S-total	5.3	3.2		3.7	1.9		
235	1	0	0	0	0.1	0	0	R228
	2	0	0	0	0	0	0	B.P.
	S-total	0	0		0.1	0		
236	1	0.3	0	0	0.4	0	0	R228
	2	0	0	0	0	0	0	B.P.
	3	(26.4)	-	-	(119.7)	-	-	C215
	S-total	0.3	0		0.4	0		
237	1	0.2	0	0	0.4	0	0	R228
	2	0	0	0	0	0	0	B.P.
	3	1.5	0.9	0	2.1	1.3	0	P222
	S-total	1.7	0.9		2.5	1.3		
238	1	0	0	0	0	0	0	B.P.
	2	0.2	0	0	0.4	0		R229
	S-total	0.2	0		0.4	0		
239	1	0	0	0	0	0	0	B.P.
	2	0	0	0	0	0	0	P223*
	3	0.3	0	0	0.4	0	0	R229
	S-total	0.3	0		0.4	0		
240	1	0	0	0	0	0	0	B.P.
	2	0.3	0	0	0.5	0	0	R230
	S-total	0.3	0		0.5	0		
241	1	0.1	0	0	0.3	0	0	R233
	2	0.6	0.1	0	0.9	0.1	0	R234
	3	0.3	0	0	0.4	0	0	R235
	4	0.7	0.1	0	5.1	2.5	0	R232, R239, P224
	5	9.3	3.6	0	17.3	7.7	0	C216, R231, R221, R222
	6	0.4	0	0	0.5	0	0	A223
	7	0	0	0	0	0	0	B.P.
	8	0.4	0	0	0.6	0.1	0	R237
	9	2.6	1.0	0	4.6	2.0	0	C217, R238, RF208, A220
	S-total	14.4	4.9		29.6	12.5		

Note; C: City, R: Rural, P: Palm oil mill, RF: Rubber factory,
A: Animal husbandry, *: P and RF with purification facilities
B.P.: Balance point
( ): BOD load discharged to the sea directly

Table 26 PROJECTED BOD LOAD IN 1990 AND 2000 FOR CASE 1 (6/6)

		1990			2000			
Basin No.	Outlet No.	BOD Load from Pollution Sources (ton/d)	BOD Load into Main Stream (ton/d)	BOD Concen-tration (mg/l)	BOD Load from Pollution Sources (ton/d)	BOD Load into Main Stream (ton/d)	BOD Concen-tration (mg/l)	Pollution Sources
242	1	0	0	0	0	0	0	B.P.
	2	0.5	0	0	0.9	0.1	0	R240
	S-total	0.5	0		0.9	0.1		
243	1	0	0	0	0	0	0	B.P.
	2	0.9	0.1	0	1.4	0.1	0	R241, A224
	S-total	0.9	0.1		1.4	0.1		
244	1	3.3	2.0	1	2.1	1.3	1	P225
	2	0.3	0	1	0.5	0	1	R242
	3	0	0	0	0	0	0	B.P.
	4	0.8	0.5	0	0.7	0.4	0	RF209
	5	1.0	0.1	0	1.7	0.2	0	R243, A225
	S-total	5.4	2.6		5.0	1.9		
245	1	0	0	0	0	0	0	R246
	2	0.8	0.1	0	1.2	0	0	R245
	3	16.4	1.7	1	22.5	2.6	2	C218, A227
	4	0	0	2	2.9	1.7	5	P226
	5	0	0	0	0	0	1	B.P.
	6	0.7	0.1	0	0.9	0.1	1	A226
	S-total	17.9	1.9		27.6	4.5		
246	1	0 0	0	0	0	0	0	R245
	2	1.5	0.1	0	2.0	0.2	0	R247, A228, A230
	3	3.0	0.3	0	4.0	0.4	0	A231
	4	0.4	0	0	0.5	0	0	A229, B.P.
	5	0	0	0	0	0	0	RF210*
	6	9.7	5.8	1	15.8	9.8	2	C219
	7	1.8	0.2	1	2.8	0.3	2	R246
	S-total	16.3	6.5		25.3	10.8		
247	1	0	0	0	2.1	1.3	1	P227
	2	0.3	0	0	0.5	0	1	R248
	3	0	0	0	0	0	1	B.P.
	S-total	0.3	0		2.6	1.3		

Note; C: City, R: Rural, P: Palm oil mill, RF: Rubber factory
A: Animal husbandry, *: P and RF with purification facilities
B.P.: Balance point
( ): BOD load discharged to the sea directly

Table 27 SUMMARY OF PROJECTED BOD LOAD AND BOD CONCENTRATION FOR CASE 2

Basin No.	Basin Name	1990 BOD Load From Source (ton/d)	1990 BOD Load Into River (ton/d)	1990 BOD Concentration in River (mg/l)	2000 BOD Load From Source (ton/d)	2000 BOD Load Into River (ton/d)	2000 BOD Concentration in River (mg/l)
201	Pensiangan	0	0	0 - 0	0	0	0 - 0
202	Serudong	0	0	0 - 0	0	0	0 - 0
203	Kalabakan	0	0	0 - 0	1	0	0 - 0
204	Barantian	0	0	0	0	0	0
205	Umas-Umas	0	0	0 - 0	0	0	0 - 0
206	Merutai Besar	0	0	0 - 0	3	2	5 - 5
207	Tawau	0 (2)	0	0 - 0	1 (4)	0	0 - 1
208	Kalumpuang	0 (0)	0	0 - 0	0 (0)	0	0 - 0
209	Silibukan	4 (5)	3	3 - 4	8 (9)	5	5 - 7
210	Segama	0	0	0 - 0	1	0	0 - 0
211	Kinabatangan	0	0	0 - 0	1	0	0 - 0
212	Segaliud	0 (3)	0	0	0 (5)	0	0
213	Labuk	2	1	0 - 1	5	3	0 - 1
214	Sugut	0	0	0 - 0	0	0	0 - 0
215	Paitan	0	0	0 - 0	0	0	0 - 0
216	Bengkoka	0	0	0 - 0	0	0	0 - 0
217	Bongan	4 (5)	3	7 - 9	3 (4)	2	4 - 5
218	Kadamatan	0	0	0 - 0	1	0	1 - 1
219	Tuaran	2	0	0 - 0	2	0	0 - 0
220	Putatan	1 (5)	0	0 - 0	1 (8)	0	0 - 1
221	Papar	1	0	0 - 1	2	1	0 - 1
222	Kimanis	0	0	0	0	0	0
223	Membakut	0	0	0 - 0	0	0	0 - 0
224	Padas	2	0	0 - 0	3	1	0 - 0
225	Labuan	0 (4)	0	0	0 (11)	0	0
226	Lakutan	0	0	0	0	0	0
227	Lawas	0	0	0 - 0	0	0	0 - 0
228	Trusan	0	0	0 - 0	0	0	0 - 0
229	Limbang	1	0	0 - 0	2	1	0 - 0
230	Baram	1	0	0 - 0	2	1	0 - 0
231	Miri	2 (7)	0	0 - 4	3 (11)	1	1 - 4
232	Sibuti	0	0	0 - 0	0	0	0 - 0
233	Niah	0	0	0 - 0	1	0	0 - 0
234	Suai	5	3	3 - 9	4	2	2 - 6
235	Similajau	0	0	0 - 0	0	0	0 - 0
236	Kemena	0 (19)	0	0 - 0	0 (53)	0	0 - 0
237	Tatau	2	1	0 - 0	2	1	0 - 0
238	Balingian	0	0	0 - 0	0	0	0 - 0
239	Mukah	0	0	0 - 0	0	0	0 - 0
240	Oya	0	0	0 - 0	0	0	0 - 0
241	Rajang	14	5	0 - 0	25	10	0 - 0
242	Kerian	0	0	0 - 0	1	0	0 - 0
243	Sarabas	1	0	0 - 0	1	0	0 - 0
244	Lupar	5	3	0 - 2	5	2	0 - 1
245	Sadong	18	2	0 - 1	27	4	0 - 3
246	Sarawak	15	6	0 - 1	24	9	0 - 2
247	Kayau	0	0	0 - 0	3	1	1 - 1
	Total	80(119)	27		132(221)	46	

Note; ( ): Encluding BOD load from cities located coastal area

Table 28 COMPOSITION OF BOD LOAD INTO RIVER FOR CASE 2

Unit: ton/d

Basin		1990 BOD Load into River				2000 BOD Load into River			
No.	Name	PR	UI	RA	Total	PR	UI	RA	Total
201	Pensiangan	0	0	0	0	0	0	0	0
202	Serudong	0	0	0	0	0	0	0	0
203	Kalabakan	0	0	0	0	0	0	0	0
204	Barantian	0	0	0	0	0	0	0	0
205	Umas-Umas	0	0	0	0	0	0	0	0
206	Merutai Besar	0	0	0	0	2	0	0	2
207	Tawau	0	0	0	0	0	0	0	0
208	Kalumpuang	0	0	0	0	0	0	0	0
209	Silibukan	3	0	0	3	5	0	0	5
210	Segama	0	0	0	0	0	0	0	0
211	Kinaba Tangan	0	0	0	0	0	0	0	0
212	Segaliud	0	0	0	0	0	0	0	0
213	Labuk	1	0	0	1	3	0	0	3
214	Sugut	0	0	0	0	0	0	0	0
215	Paitan	0	0	0	0	0	0	0	0
216	Bengkoka	0	0	0	0	0	0	0	0
217	Bongan	3	0	0	3	2	0	0	2
218	Kadamaian	0	0	0	0	0	0	0	0
219	Tuaran	0	0	0	0	0	0	0	0
220	Putatan	0	0	0	0	0	0	0	0
221	Papar	0	0	0	0	0	1	0	1
222	Kimanis	0	0	0	0	0	0	0	0
223	Membakut	0	0	0	0	0	0	0	0
224	Padas	0	0	0	0	0	1	0	1
225	Labuan	0	0	0	0	0	0	0	0
226	Lakutan	0	0	0	0	0	0	0	0
227	Lawas	0	0	0	0	0	0	0	0
228	Trusan	0	0	0	0	0	0	0	0
229	Limbang	0	0	0	0	0	1	0	1
230	Baran	0	0	0	0	0	1	0	1
231	Miri	0	0	0	0	0	0	1	1
232	Sibuti	0	0	0	0	0	0	0	0
233	Niah	0	0	0	0	0	0	0	0
234	Suai	3	0	0	3	2	0	0	2
235	Similajau	0	0	0	0	0	0	0	0
236	Kemena	0	0	0	0	0	0	0	0
237	Tatau	1	0	0	1	1	0	0	1
238	Balingian	0	0	0	0	0	0	0	0
239	Mukah	0	0	0	0	0	0	0	0
240	Oya	0	0	0	0	0	0	0	0
241	Rajang	0	4	1	5	3	6	1	10
242	Kerian	0	0	0	0	0	0	0	0
243	Sarabas	0	0	0	0	0	0	0	0
244	Lupar	3	0	0	3	2	0	0	2
245	Sadong	0	0	2	2	2	0	2	4
246	Sarawak	0	5	1	6	0	8	1	9
247	Kayau	0	0	0	0	1	0	0	1
	Total	14 (52)	9 (33)	4 (15)	27 (100)	23 (50)	18 (39)	5 (11)	46 (100)

Note; PR : Palm oil mill and rubber factory effluent
UI : Urban domestic and urban industry effluent
RA : Rural and animal husbandry
( ): % of the total BOD load

Table 29 PROJECTED BOD LOAD IN 1990 AND 2000 FOR CASE 2 (1/6)

Basin No.	Outlet No.	1990 BOD Load from Pollution Sources (ton/d)	1990 BOD Load into Main Stream (ton/d)	1990 BOD Concentration (mg/l)	2000 BOD Load from Pollution Sources (ton/d)	2000 BOD Load into Main Stream (ton/d)	2000 BOD Concentration (mg/l)	Pollution Sources
201	1	0	0	0	0	0	0	R218
	2	0.1	0	0	0.2	0	0	R201, R221
	3	0	0	0	0	0	0	B.P.
	S-total	0.1	0	0	0.2	0		
202	1	0	0	0	0	0	0	R201
	2	0	0	0	0	0	0	B.P.
	3	0.2	0	0	0.4	0	0	R202
	S-total	0.2	0		0.4	0		
203	1	0.3	0	0	0.5	0.1	0	R202
	2	0	0	0	0	0	0	B.P.
	S-total	0.3	0		0.5	0.1	0.1	
204		0	0	0	0	0	0	
205	1	0	0	0	0	0	0	B.P.
	2	0.1	0	0	0.2	0	0	R202
	S-total	0.1	0		0.2	0	0	
206	1	0	0	0	3.2	1.9	5	P201
	2	0	0	0	0	0	5	B.P.
	S-total	0	0		3.2	1.9		
207	1	0	0	0	0	0	0	B.P.
	2	0.4	0	0	0.5	0	0	A201
	3	0	0	0	0.1	0	1	P202*, R201*
	4	(2.0)	-	-	(3.2)	-	-	C201, A202
	S-total	0.4	0		0.6	0		
208	1	0	0	0	0	0	0	P204*
	2	0	0	0	0	0	0	B.P.
	3	(0.2)	-	-	(0.5)	-	-	C202
	S-total	0	0		0	0		
209	1	4.4	2.6	4	8.4	5.1	7	P207,P208
	2	0	0	3	0	0	5	B.P.
	3	(0.2)	-	-	(0.5)	-	-	C203
	S-total	4.4	2.6		8.4	5.1		

Note; C: City, R: Rural, P: Palm oil mill, RF: Rubber factory,
A: Animal husbandry, *: P and RF with purification facilities
B.P.: Balance point
( ): BOD load discharged to the sea directly

Table 30 PROJECTED BOD LOAD IN 1990 AND 2000 FOR CASE 2 (2/6)

		1990			2000			
Basin No.	Outlet No.	BOD Load from Pollution Sources (ton/d)	BOD Load into Main Stream (ton/d)	BOD Concen-tration (mg/l)	BOD Load from Pollution Sources (ton/d)	BOD Load into Main Stream (ton/d)	BOD Concen-tration (mg/l)	Pollution Sources
210	1	0.3	0	0	0.5	0	0	R204
	2	0	0	0	0	0	0	R205
	3	0	0	0	0	0	0	B.P.
	4	0	0	0	0	0	0	P209*
	S-total	0.3	0		0.5	0.1		
211	1	0.1	0	0	0.1	0	0	R218
	2	0	0	0	0	0	0	R207
	3	0.4	0	0	0.7	0.1	0	R205
	4	0	0	0	0	0	0	B.P.
	S-total	0.5	0		0.8	0.1		
212		0	0	0	0	0	0	
		(3.3)	-	-	(5.1)	-	-	C212
	S-total	0	0		0	0		
213	1	0.2	0.1	1	0.6	0.4	1	C205
	2	0.2	0	0	0.3	0	1	R212
	3	0.1	0	0	0.1	0	0	R217
	4	0	0	0	0	0	0	P214*, P215*
	5	0	0	0	0	0	0	B.P.
	6	1.5	0.9	0	4.2	2.5	0	P213
	7	0.2	0	0	0.3	0	0	R207
	8	0	0	0	0	0	0	R206
	S-total	2.2	1.1		5.5	3.0		
214	1	0.1	0	0	0.2	0	0	R212
	2	0.1	0	0	0.1	0	0	R207
	3	0	0	0	0	0	0	B.P.
	S-total	0.2	0		0.3	0		
215	1	0.1	0	0	0.1	0	0	R207
	2	0	0	0	0	0	0	B.P.
	S-total	0.1	0		0.1	0		
216	1	0.1	0	0	0.1	0	0	R210
	2	0.2	0	0	0.3	0	0	R208
	3	0	0	0	0	0	0	B.P.
	S-total	0.3	0		0.4	0		

Note; C: City, R: Rural, P: Palm oil mill, RF: Rubber factory,
A: Animal husbandry, *: P and RF with purification facilities
B.P.: Balance point
( ): BOD load discharged to the sea directly

Table 31 PROJECTED BOD LOAD IN 1990 AND 2000 FOR CASE 2 (3/6)

		1990			2000			
Basin No.	Outlet No.	BOD Load from Pollution Sources (ton/d)	BOD Load into Main Stream (ton/d)	BOD Concentration (mg/l)	BOD Load from Pollution Sources (ton/d)	BOD Load into Main Stream (ton/d)	BOD Concentration (mg/l)	Pollution Sources
217	1	4.4	2.6	9	2.6	1.6	5	P216
	2	0	0	7	0	0	4	B.P.
	3	0	0	7	0	0	4	R208
	4	(0.6)	-	-	(1.3)	-	-	C206
	S-total	4.4	2.6		2.6	1.6		
218	1	0.3	0.2	0	0.6	0.4	1	C207
	2	0	0	0	0	0	1	B.P.
	S-total	0.3	0.2		0.6	0.4		
219	1	1.1	0.1	0	1.5	0.2	0	A210
	2	0.6	0.1	0	0.8	0.1	0	R213
	3	0	0	0	0	0	0	B.P.
	S-total	1.7	0.2		2.4	0.2		
220	1	0.3	0	0	0.5	0	0	R215
	2	0.3	0	0	0.4	0	1	A212
	3	0	0	0	0	0	1	B.P.
	4	(4.6)	-	-	(7.4)	-	-	C208, RF204
	S-total	0.6	0		0.9	0		
221	1	0.2	0	0	0.4	0	1	R215
	2	0.1	0	0	0.2	0	0	R216
	3	0.6	0.4	1	1.0	0.6	1	C209, B.P.
	S-total	1.0	0.4		1.7	0.7		
222		0	0	0	0	0	0	
223	1	0	0	0	0	0	0	B.P.
	2	0.2	0	0	0.2	0	0	R220
	S-total	0.2	0		0.2	0		
224	1	0.1	0	0	0.1	0	0	R222
	2	0.5	0	0	0.7	0.1	0	R221, A213
	3	0.9	0.3	0	1.7	0.6	0	C210, R217, RF205* R205, R218
	4	0.2	0	0	0.2	0	0	R220
	5	0	0	0	0	0	0	B.P.
	6	0.2	0	0	0.3	0	0	A214
	7	0.1	0	0	0.2	0	0	R219
	S-total	2.0	0.4		3.2	0.7		

Note; C: City, R: Rural, P: Palm oil mill, RF: Rubber factory,
A: Animal husbandry, *: P and RF with purification facilities
B.P.: Balance point
( ): BOD load discharged to the sea directly

Table 32 PROJECTED BOD LOAD IN 1990 AND 2000 FOR CASE 2 (4/6)

		1990			2000			
Basin No.	Outlet No.	BOD Load from Pollution Sources (ton/d)	BOD Load into Main Stream (ton/d)	BOD Concen-tration (mg/l)	BOD Load from Pollution Sources (ton/d)	BOD Load into Main Stream (ton/d)	BOD Concen-tration (mg/l)	Pollution Sources
225		(4.2)	0	0	(11.2)	0	0	C211, R223
226		0	0	0	0	0	0	
227	1	0.1	0	0	0.1	0	0	R224
	2	0	0	0	0	0	0	B.P.
	S-total	0.1	0		0.1	0		
228	1	0.2	0	0	0.3	0	0	R224
	2	0	0	0	0	0	0	B.P.
	S-total	0.2	0		0.3	0		
229	1	0.2	0	0	0.3	0	0	R225
	2	0.3	0.2	0	0.6	0.4	0	R218, RF206
	3	0.8	0.3	0	1.2	0.5	0	C212, A216
	4	0	0	0	0	0	0	B.P.
	S-total	1.2	0.5		2.0	0.9		
230	1	0.7	0.1	0	1.1	0.1	0	R226
	2	0.5	0.3	0	1.0	0.6	0	C213
	3	0	0	0	0	0	0	B.P.
	4	0	0	0	0.1	0	0	R227
	S-total	1.2	0.4		2.2	0.7		
231	1	0.1	0	1	0.3	0	2	R227
	2	0.3	0.2	4	0.3	0.2	4	RF207
	3	1.4	0.1	4	1.9	0.2	4	A218
	4	0	0	3	0	0	4	B.P.
	5	0.4	0	4	0.6	0.1	4	A217
	6	(4.3)	-	-	(8.4)	-	-	C214
	S-total	2.2	0.3		3.1	0.5		
232	1	0	0	0	0	0	0	B.P.
	2	0	0	0	0	0	0	P219*
	3	0.2	0	0	0.4	0	0	R227
	S-total	0.2	0		0.4	0		
233	1	0.2	0	0	0.5	0.1	0	R227
	2	0	0	0	0	0	0	B.P.
	3	0	0	0	0	0	0	P220*
	S-total	0.2	0		0.5	0.1		

Note; C: City, R: Rural, P: Palm oil mill, RF: Rubber factory,
A: Animal husbandry, *: P and RF with purification facilities
B.P.: Balance point
( ): BOD load discharged to the sea directly

Table 33 PROJECTED BOD LOAD IN 1990 AND 2000 FOR CASE 2 (5/6)

		1990			2000			
Basin No.	Outlet No.	BOD Load from Pollution Sources (ton/d)	BOD Load into Main Stream (ton/d)	BOD Concen-tration (mg/l)	BOD Load from Pollution Sources (ton/d)	BOD Load into Main Stream (ton/d)	BOD Concen-tration (mg/l)	Pollution Sources
234	1	5.3	3.2	9	3.7	2.0	6	R227, P221
	2	0	0	3	0	0	2	B.P.
	S-total	5.3	3.2		3.7	2.0		
235	1	0	0	0	0.1	0	0	R228
	2	0	0	0	0	0	0	B.P.
	S-total	0	0		0	0		
236	1	0.3	0	0	0.4	0	0	R228
	2	0	0	0	0	0	0	B.P.
	3	(18.8)	-	-	(52.4)	-	-	C215
	S-total	0.3	0		0.4	0		
237	1	0.2	0	0	0.4	0	0	R228
	2	0	0	0	0	0	0	B.P.
	3	1.5	0.9	0	2.1	1.3	0	P222
	S-total	1.7	0.9		2.5	1.3		
238	1	0	0	0	0	0	0	B.P.
	2	0.2	0	0	0.4	0	0	R229
	S-total	0.2	0		0.4	0		
239	1	0	0	0	0	0	0	B.P.
	2	0	0	0	0	0	0	P223*
	3	0.2	0	0	0.4	0	0	R229
	S-total	0.2	0		0.4	0		
240	1	0	0	0	0	0	0	B.P.
	2	0.3	0	0	0.4	0	0	R230
	S-total	0.3	0		0.4	0		
241	1	0.2	0	0	0.3	0	0	R233
	2	0.5	0.1	0	0.9	0.1	0	R234
	3	0.2	0	0	0.4	0	0	R235
	4	0.7	0.1	0	5.0	2.5	0	R232, R239, P224
	5	8.8	3.4	0	13.9	5.8	0	C216, R231, R221 R232
	6	0.4	0	0	0.5	0	0	A223
	7	0	0	0	0	0	0	B.P.
	8	0.4	0	0	0.5	0.1	0	R237
	9	2.5	1.0	0	3.7	1.5	0	C217, R238, RF208 A220
	S-total	13.6	4.6		25.2	10.0		

Note; C: City, R: Rural, P: Palm oil mill, RF: Rubber factory,
A: Animal husbandry, *: P and RF with purification facilities
B.P.: Balance point
( ): BOD load discharged to the sea directly

Table 34 PROJECTED BOD LOAD IN 1990 AND 2000 FOR CASE 2 (6/6)

Basin No.	Outlet No.	BOD Load from Pollution Sources (ton/d)	BOD Load into Main Stream (ton/d)	BOD Concen-tration (mg/l)	BOD Load from Pollution Sources (ton/d)	BOD Load into Main Stream (ton/d)	BOD Concen-tration (mg/l)	Pollution Sources
242	1	0	0	0	0	0	0	B.P.
	2	0.5	0	0	0.7	0.1	0	R240
	S-total	0.5	0		0.7	0.1		
243	1	0	0	0	0	0	0	B.P.
	2	0.8	0.1	0	1.2	0.1	0	R241, A224
	S-total	0.8	0.1		1.2	0.1		
244	1	3.4	2.0	1	2.1	1.3	1	P225
	2	0.3	0	1	0.4	0	1	R242
	3	0	0	0	0	0	0	B.P.
	4	0.8	0.5	0	0.7	0.4	0	RF209
	5	1.0	0.1	0	1.4	0.1	0	R243, A225
	S-total	5.4	2.6		4.6	1.8		
245	1	0	0	0	0	0	0	R246
	2	0.8	0.1	0	1.2	0.1	0	R245
	3	16.4	1.7	1	22.2	2.4	2	C218, A227
	4	0	0	2	2.9	1.7	5	P226
	5	0	0	0	0	0	1	B.P.
	6	0.7	0.1	0	0.9	0.1	1	A226
	S-total	17.9	1.9		27.3	4.4		
246	1	0	0	0	0	0	0	R245
	2	1.4	0.1	0	2.0	0.2	0	R247, A228, A230
	3	3.0	0.3	0	4.0	0.4	0	A231
	4	0.4	0	0	0.5	0	0	A229, B.P.
	5	0	0	0	0	0	0	RF210*
	6	9.0	5.4	1	13.9	8.4	2	C219
	7	1.7	0.2	1	3.1	0.3	2	R246
	S-total	15.5	6.0		23.5	9.3		
247	1	0	0	0	2.1	1.3	1	P227
	2	0.3	0	0	0.5	0	1	R248
	3	0	0	0	0	0	1	B.P.
	S-total	0.3	0		2.6	1.3		

Note; C: City, R: Rural, P: Palm oil mill, RF: Rubber factory,
A: Animal husbandry, *: P and RF with purification facilities
B.P.: Balance point
( ): BOD load discharged to the sea directly

Table 35 WATER DEMAND PROJECTION AND PURIFICATION SYSTEM OF PALM OIL MILLS

Unit: $10^6 m^3/y$

Palm Oil Mill No.	Name	District No.	Basin No.	1980	1985	1990	1995	2000	Remarks
201	Merotai	202	206	-	-	-	0.06	0.12	N.A.
202	Bal	202	207	0.12	0.12	0.12	0.12	0.12	with P.S.
203	Apas Balang	202	207	0.21	0.23	0.23	0.23	0.23	with P.S.
204	Mostyn Kuak	202	208	0.03	0.05	0.05	0.05	0.05	with P.S.
205	Sabah A.D.	203	208	0.04	0.04	0.04	0.04	0.04	with P.S.
206	Giram	203	208	0.02	0.05	0.05	0.05	0.05	with P.S.
207	Silabukan	204	209	0.05	0.07	0.09	0.09	0.09	with P.S.
208	Silabukan No.2	204	209	-	-	-	0.13	0.23	N.A.
209	Tomanggong	205	210	0.06	0.10	0.12	0.12	0.12	with P.S.
210	Suan Lamba	206	212	0.05	0.06	0.09	0.09	0.09	L.D.
211	Sungai Manila	206	212	0.09	0.09	0.09	0.09	0.09	L.D.
212	Sungai Majang	206	212	-	0.07	0.07	0.07	0.07	with P.S.
213	Sapi	207	213	-	-	0.03	0.09	0.16	N.A.
214	Sabah	207	213	0.07	0.07	0.07	0.07	0.07	with P.S.
215	Pamol	207	213	0.12	0.12	0.12	0.12	0.12	with P.S.
216	Lang Kon	210	217	-	0.06	0.09	0.10	0.10	N.A.
217	Beaufort	220	223	0.06	0.09	0.09	0.09	0.09	with P.S.
218	Danou	225	229	0	0	0	-	-	without P.S.
219	Sarawaku	227	232	0.06	0.08	0.08	0.08	0.08	with P.S.
220	Niah	227	233	0.09	0.21	0.23	0.23	0.23	with P.S.
221	Suai	227	234	-	-	0.11	0.12	0.12	N.A.
222	Tatau	228	237	-	-	0.03	0.07	0.08	N.A.
223	Mukah	229	239	0	0.07	0.11	0.15	0.15	with P.S.
224	Julau	239	241	-	-	-	0.10	0.15	N.A.
225	Lemanak	242	244	-	0.02	0.07	0.08	0.08	N.A.
226	Serian	245	245	-	-	-	0.04	0.11	N.A.
227	Bau/Lundu	247	246	-	-	0	0.07	0.08	N.A.

Remarks; P.S.: Purification system,
N.A.: Not available
L.D.: Land disposal

Table 36 WATER DEMAND PROJECTION AND PURIFICATION SYSTEM OF RUBBER FACTORIES

Unit: $10^6 m^3/y$

Rubber Factory No.	Rubber Factory Name	District No.	Basin No.	1980	1985	1990	1995	2000	Remarks
201	Ball Estate	202	207	0.14	0.15	0.15	0.34	0.34	with P.S.
202	Kudat SMR	209	217	-	-	-	0.11	0.34	N.A.
203	Paper SMR	213	219	-	0.23	0.45	0.45	0.45	N.A.
204	Putatan Crumb	214	220	0.23	-	-	-	-	without P.S.
205	Tenom SMR	221	224	0.03	0.14	0.34	0.45	0.68	with P.S.
206	Lubai Tengah	225	229	0.02	0.03	0.03	0.03	0.08	N.A.
207	Lambir	227	231	0.04	0.04	0.04	0.04	0.04	N.A.
208	Meradong	238	241	0.06	0.06	0.06	0.06	0.06	without P.S.
209	Skrang	243	244	0.09	0.09	0.09	0.09	0.09	without P.S.
210	Lim Liang Kee	246	246	0.05	0.05	0.05	0.05	0.05	Recycle Process

Remarks; P.S.: Purification system
N.A.: Not available

Table 37 PROJECTION OF PIG PRODUCTION

Unit: heads

Animal Husbandry No.	District No.	Basin No.	1980	1985	1990	1995	2000
201	202	207	670	1,110	1,830	2,140	2,470
202	202	207	1,060	1,760	2,890	3,380	3,900
203	202	207	490	810	1,340	1,560	1,800
204	202	207	1,500	2,490	4,110	4,800	5,540
205	206	212	1,650	2,740	4,520	5,280	6,090
206	206	212	11,100	18,400	30,200	35,300	40,800
207	206	212	1,400	2,330	3,830	4,480	5,170
208	206	212	1,400	2,330	3,830	4,480	5,170
209	209	217	490	810	1,330	1,550	1,790
210	213	219	2,100	3,490	5,740	6,710	7,740
211	214	220	1,520	2,520	4,160	4,860	5,600
212	214	220	590	980	1,620	1,890	2,180
213	218	224	330	540	890	1,040	1,200
214	219	224	450	750	1,230	1,440	1,660
215	223	225	380	630	1,030	1,200	1,390
216	225	229	510	850	1,400	1,630	1,880
217	227	231	810	1,350	2,230	2,600	3,000
218	227	231	2,550	4,230	6,970	8,150	9,400
219	227	231	1,770	2,950	4,850	5,670	6,540
220	238	241	1,440	2,390	3,940	4,600	5,310
221	231	241	3,770	6,260	10,300	12,100	13,900
222	231	241	2,470	4,100	6,760	7,900	9,110
223	231	241	650	1,090	1,790	2,090	2,410
224	241	243	580	960	1,570	1,840	2,120
225	243	244	300	500	820	960	1,110
226	245	245	1,230	2,040	3,360	3,920	4,520
227	245	245	29,600	49,100	80,900	94,600	109,000
228	247	246	1,440	2,400	3,950	4,620	5,330
229	246	246	650	1,080	1,770	2,070	2,390
230	246	246	500	830	1,370	1,600	1,800
231	246	246	5,480	9,100	15,000	17,500	20,200
232	246	246	5,910	9,820	16,200	18,900	21,800

Source: Ref. 21, 22 and 23

Table 38 ASSUMED DEVELOPMENT OF SEPTIC TANK IN URBAN AREA

Unit: %

Pollution Source	1980	1990	2000
Septic tank	20	35	50
Others	80	65	50

Table 39 ASSUMED BOD CONCENTRATION OF NON-SEWERAGE-URBAN-DOMESTIC

Unit: mg/l

Pollution Source	NUPL	1980	1990	2000
Septic tank	80	16	28	40
Others	200	160	130	100
Non sewerage urban domestic		180	160	140

Table 40 ASSUMED DEVELOPMENT OF LAND DISPOSAL IN PALM OIL MILLS AND RUBBER FACTORIES

Unit: %

	1980	1990	2000
Palm oil mills	25	50	75
Rubber factories	0	10	20

Table 41 ASSUMED DISCHARGE RATIO OF PALM OIL MILLS AND RUBBER FACTORIES

	1980	1990	2000
Palm Oil Mills			
Surface runoff ratio of land disposal area	0.25x0.1	0.5x0.1	0.75x0.1
Discharge ratio of palm oil mills	0.75	0.5	0.25
Runoff ratio	0.8	0.55	0.3
Rubber Factories			
Surface runoff ratio of land disposal area	0x0.1	0.1x0.1	0.2x0.1
Discharge ratio of rubber factories	1.0	0.9	0.8
Runoff ratio	1.0	0.9	0.8

Table 42 DISCHARGE RATIO, RUNOFF RATIO, INFILTRATION RATIO AND BOD CONCENTRATION OF EFFLUENT ASSUMED UNDER PRESENT PURIFICATION LEVEL

Pollution Source	Year	Dis-charge Ratio	BOD Con-Centration (mg/l)	Runoff Ratio	Infil-tration Ratio
Domestic					
Urban Sewerage	1990 & 2000	0.9	30	1.0	0.2
Urban Non-sewerage	1990	0.9	160	0.6	0
	2000	0.9	140	0.6	0
Rural	1990 & 2000	0.8	200	0.1	0
Manufacture					
Urban sewerage	1990 & 2000	1.0	30	1.0	0.2
Urban Non-sewerage	1990 & 2000	1.0	200	0.6	0
Rural	1990 & 2000	1.0	200	0.1	0
Palm Oil Mill					
With P.S./1	1990	0.55	50	0.6	0
	2000	0.3	50	0.6	0
Without P.S.	1990	0.55	22,000	0.6	0
	2000	0.3	22,000	0.6	0
Land Disposal	1990 & 2000	0.1	50	0.6	0
Rubber Factories					
With P.S.	1990	0.9	50	0.6	0
	2000	0.8	50	0.6	0
Without P.S.	1990	0.9	2,320	0.6	0
	2000	0.8	2,320	0.6	0
Land Disposal	1990 & 2000	0.1	50	0.6	0
Animal Husbandry	1990 & 2000	1.0	200/2	0.1	0

Remarks; /1: Purification System
/2: g/d/head

Table 43 EFFECTIVE CATCHMENT AREA AND RIVER MINIMUM MAINTENANCE FLOW FOR WATER QUALITY

Basin No.	Effective Catchment Area for Water Quality (km^2)	Minimum Maintenance Flow at Balance Point Q 97%		Basin No.	Effective Catchment Area for Water Quality (km^2)	Minimum Maintenance Flow at Balance Point Q 97%	
		(m^3/s)	($10^{-3}m^3/s/km^2$)			(m^3/s)	($10^{-3}m^3/s/km^2$)
201	5,285	67.1	12.7	227	973	7.8	8.00
202	918	8.2	8.94	228	2,598	14.3	5.50
203	1,288	12.4	9.65	229	3,865	71.1	18.4
204	538	4.7	8.74	230	21,822	388.4	17.8
205	408	3.3	8.19	231	138	0.9	6.76
206	358	3.2	8.84	232	790	4.5	5.74
207	118	1.2	10.5	233	1,117	6.1	5.48
208	1,020	10.5	10.3	234	1,242	8.5	6.83
209	530	7.5	14.1	235	465	3.9	8.49
210	4,787	63.2	13.2	236	5,718	61.8	10.8
211	15,528	73.6	4.74	237	4,753	51.3	10.8
212	353	4.9	13.8	238	1,548	16.3	10.5
213	5,698	82.1	14.4	239	1,375	14.9	10.8
214	2,826	40.4	14.3	240	1,277	10.8	8.46
215	623	9.9	15.9	241	46,035	1,408.7	30.6
216	898	4.2	4.68	242	849	11.3	13.3
217	730	3.1	4.24	243	799	10.1	12.7
218	905	5.7	6.26	244	5,209	68.8	13.2
219	935	6.4	6.88	245	2,935	40.5	13.8
220	248	1.5	5.91	246	2,152	36.4	16.9
221	785	4.8	6.14	247	990	20.5	20.7
222	255	1.5	5.86				
223	243	1.4	5.71				
224	8,475	57.2	6.75				
225	46	0.3	6.73				
226	290	1.5	5.17				

Table 44 STANDARDS RELATING TO LIVING ENVIRONMENT FOR RIVERS IN JAPAN

Category	Purpose of Utilization	Standard Values/1 pH	BOD (mg/lit)	SS (mg/lit)	DO (mg/lit)	Number of Coliform Groups (MPN/0.1 lit)
AA	Water supply, class 1; conservation of natural environment & uses listed in A-E	6.5-8.5	1 or less	25 or less	7.5 or more	50 or less
A	Water supply, class 2; fishery, class 1; bathing & uses listed in B-E	6.5-8.5	2 or less	25 or less	7.5 or more	1,000 or less
B	Water supply, class 3; fishery, class 2, & uses listed in C-E	6.5-8.5	3 or less	25 or less	5 or more	5,000 or less
C	Fishery, class 3; industrial water, class 1, & uses listed in D-E	6.5-8.5	5 or less	50 or less	5 or more	
D	Industrial water, class 2; agricultural water/2, & uses listed in E	6.0-8.5	8 or less	100 or less	2 or more	
E	Industrial water, class 3; conservation of environment	6.0-8.5	10 or less	Floating matter such as garbage should not be observed.	2 or more	

Remarks; /1: The standard value is based on the daily average value. (The same applies to the standard values of lakes and coastal waters.)

/2: At the point of abstraction for agriculture, pH shall be between 6.0 and 7.5 and dissolved oxygen shall not be less than 5 mg/lit.

(The same applies to the standard values of lakes.)

1. Conservation of natural environment: Conservation of scenic spots and other natural resources.

2. Water supply, class 1: Water treated by simply cleaning operation, such as filtration.
   Water supply, class 2: Water treated by normal cleaning operation, such as sedimentation and filtration.
   Water supply, class 3: Water treated through a highly sophisticated cleaning operation including pretreatment.

3. Fishery, class 1: For aquatic life such as trout and bull trout inhabiting oligosaprobic water, and those of fishery class 2 & class 3.
   Fishery, class 2: For aquatic life, such as the salmon family and sweetfish inhabiting oligosaprobic water and those of fishery class 3.
   Fishery, class 3: For aquatic life such as carp and silver carp inhabiting β-mesosaprobic water

4. Industrial water, class 1: Water given normal cleaning treatment such as sedimentation.
   Industrial water, class 2: Water given sophisticated treatment by chemicals.
   Industrial water, class 3: Water given special cleaning treatment.

5. Conservation of environment: Up to the limits at which no unpleasantness is caused to people in their daily life (including a walk by the riverside, etc.).

Source; Ref. 37

Table 45 WATER QUALITY CRITERIA FOR FRESH SURFACE WATER PROPOSED BY THE NATIONAL POLLUTION CONTROL COMMISSION IN PHILIPPINES

Classification	Purpose of Utilization	Standard Values			
		pH	BOD mg/lit	DO mg/lit	Coliform MPN/0.1 lit
AA	Domestic Water Supply/1	7 - 8.5	-	-	50 or less
A	Domestic Water Supply/2	6.5-8.5	5 or less	5 or more	500 or less
B	Bathing	6.5-8.5	10 or less	5 or more	1000 or less
C	Fishing	6.5-8.5	15 or less	5 or more	5000 or less
D	Agricultural and Industrial Water Supply	6.0-8.5	-	3 or more	-

Remarks; /1: Waters from watersheds which are uninhabited and otherwise protected and can be used for water supply with limited treatment.

/2: A conventional treatment is necessary for water supply use of these waters.

Source; Ref. 38

Table 46 BREAKDOWN OF CONSTRUCTION COST OF PUBLIC SEWERAGE SYSTEMS FOR BUTTERWORTH AND BUKIT MERTAJAM

	Cost ($M\$10^6$)	Share (%)
Trunk Sewer	166	27
Pumping Facilities	5	1
Treatment Facilities	50	8
Land	45	7
Sub-total	266	44
Branch Sewer	281	46
House Connection Pipe	62	10
Sub-total	343	56
Total	609	100

Remarks; (1): At 1976 price

(2): Excluding engineering cost and physical contingency.

Source; Penang State Sewerage and Drainage Master Plan 1978, JICA

Table 47 ASSUMED UNIT CONSTRUCTION COST FOR WATER POLLUTION ABATEMENT FACILITIES

Unit: $M\$10^6/10^3\ m^3/d$

Item	Public Sewerage Systems	Purification Facilities: Palm 1990	Purification Facilities: Palm 2000	Purification Facilities: Rubber 1990 & 2000	Pretreatment Facilities: Primary Pre-treatment	Pretreatment Facilities: Secondary Pre-treatment
Direct Const. Cost	105.3	2.50	2.25	0.96	26.70	78.60
Land Acquisition	5.3	-	-	-	-	-
Engineering	10.5	0.25	0.23	0.10	2.67	7.86
Sub-total	121.1	2.75	2.48	1.06	29.37	86.46
Physical Contingency	36.3	0.85	0.72	0.34	8.83	25.94
Total	157.4	3.60	3.20	1.40	38.20	112.40

FIGURES

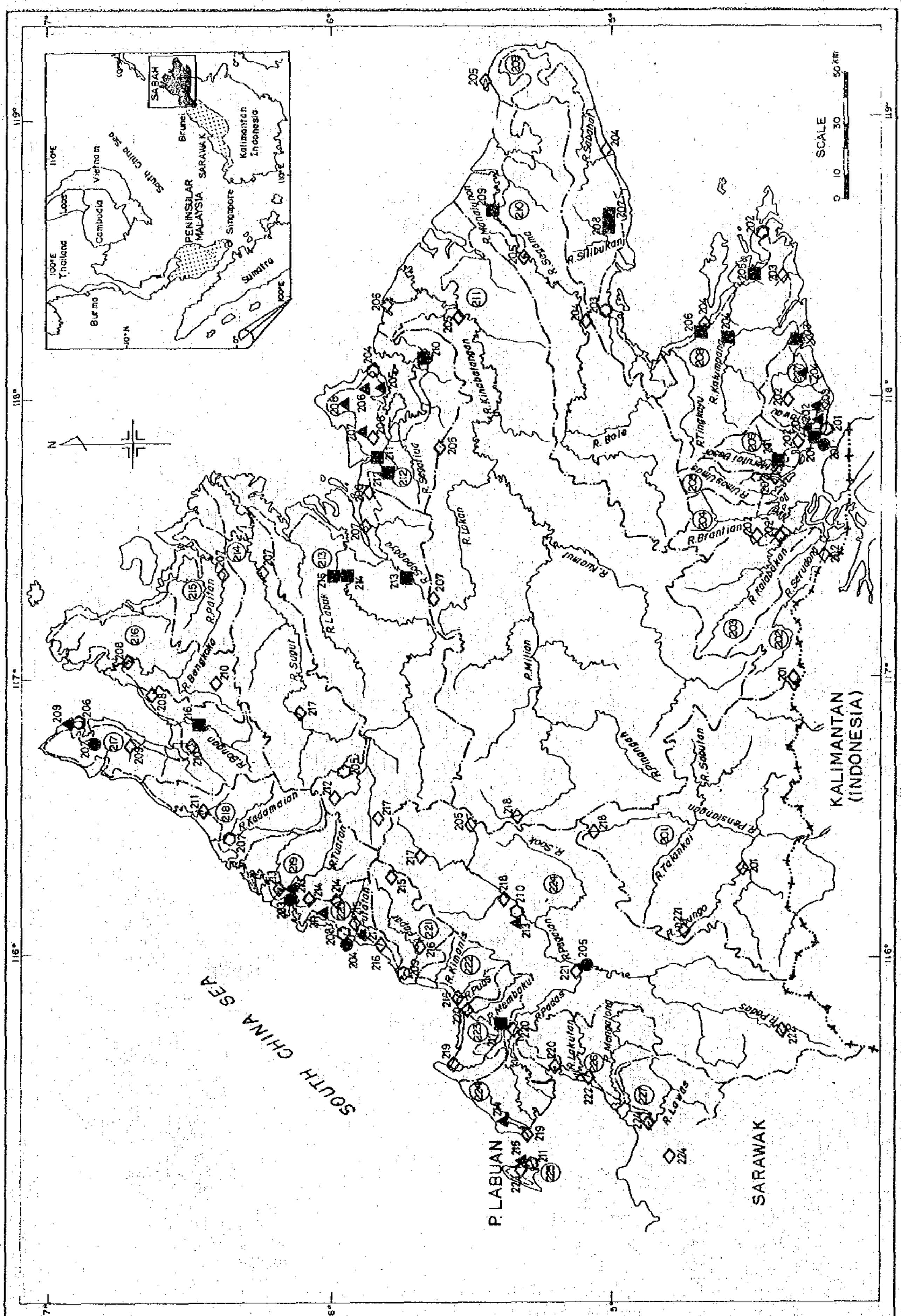

Fig. 1. Location of Pollution Sources in Sabah

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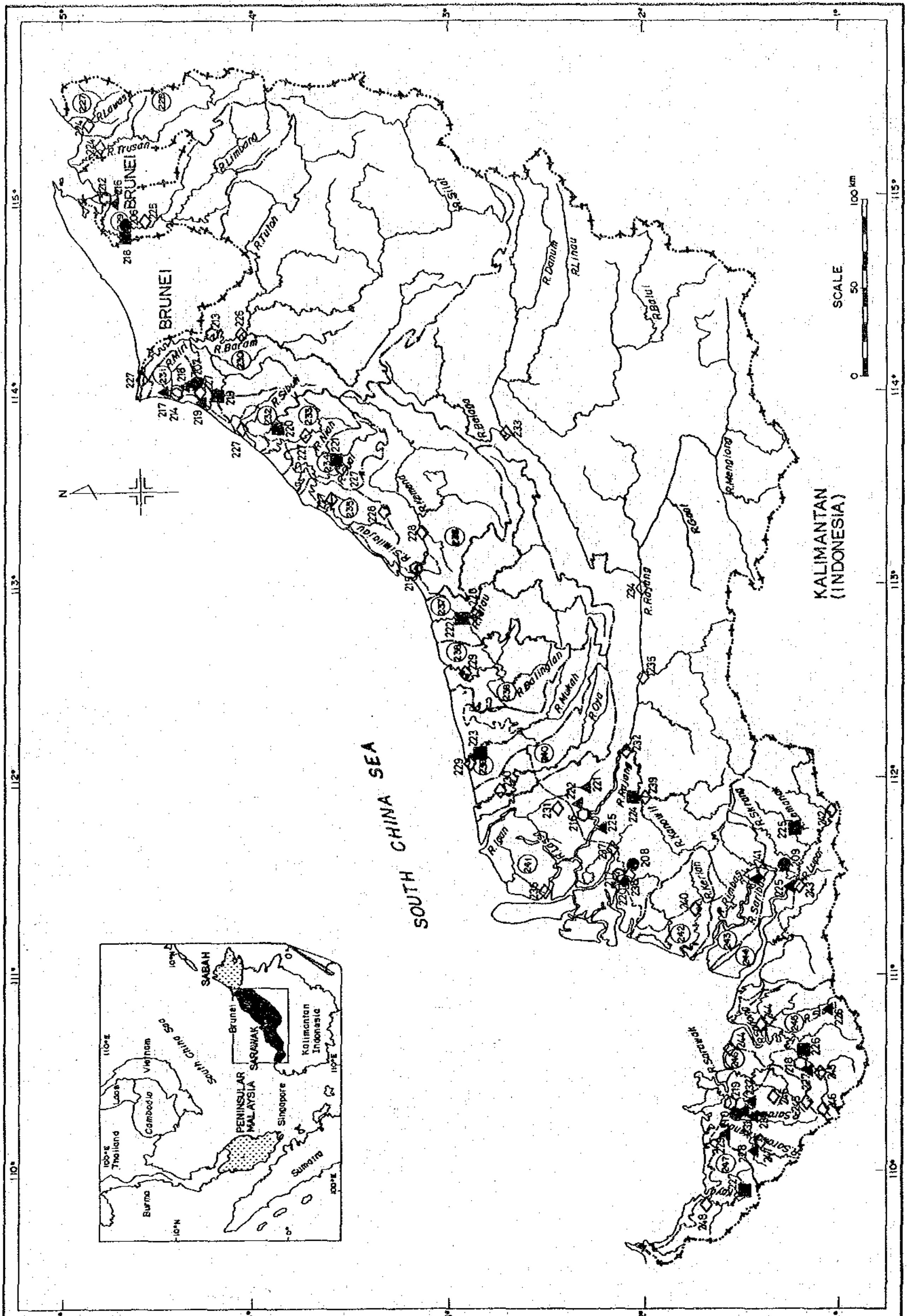

Fig. 2. Location of Pollution Sources in Sarawak

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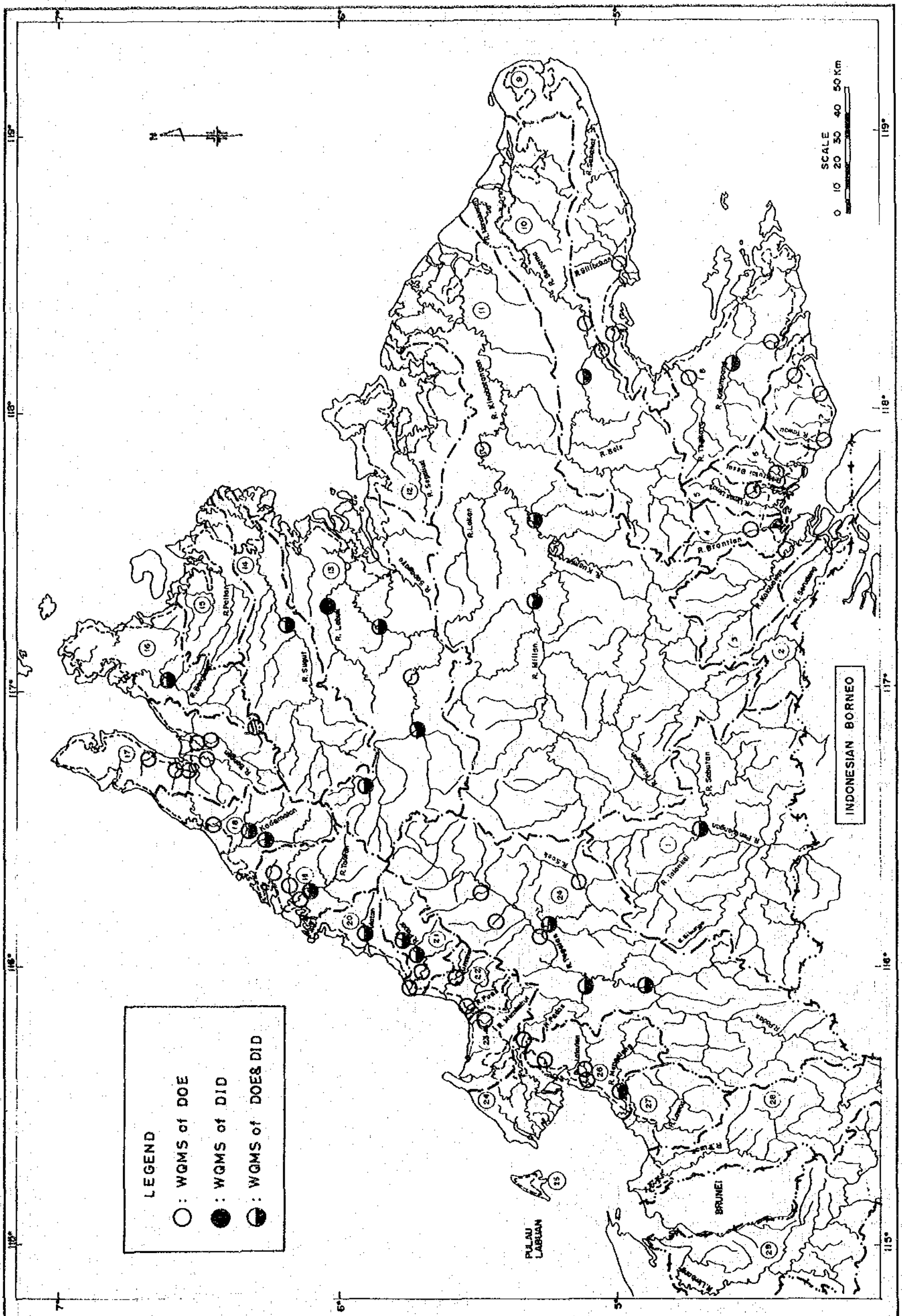

Fig. 3. Location of Water Quality Monitoring Stations (WQMS) of DOE and DID in Sabah

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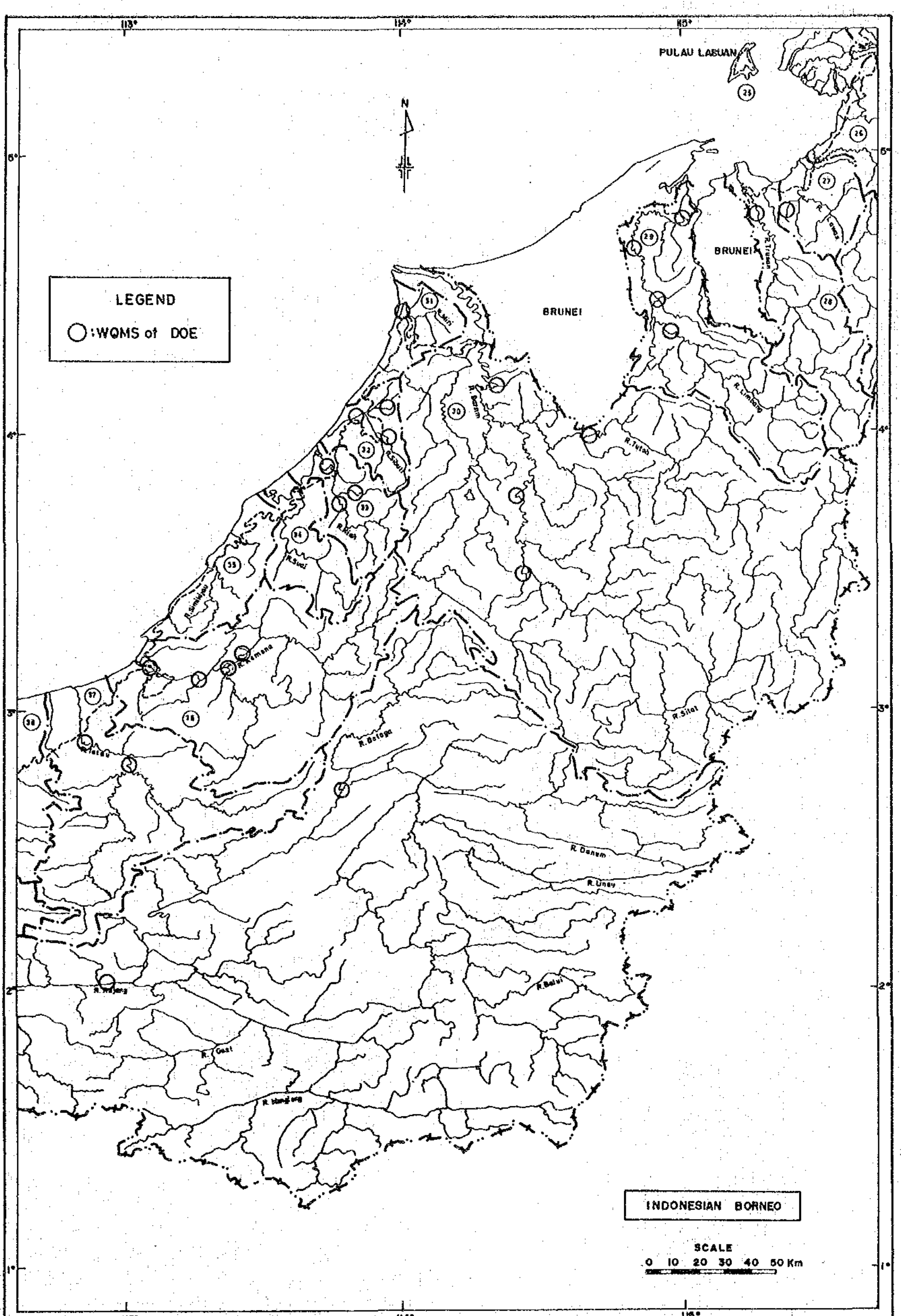

Fig. 4. Location of Water Quality Monitoring Stations (WQMS) of DOE in Sarawak (1/2)

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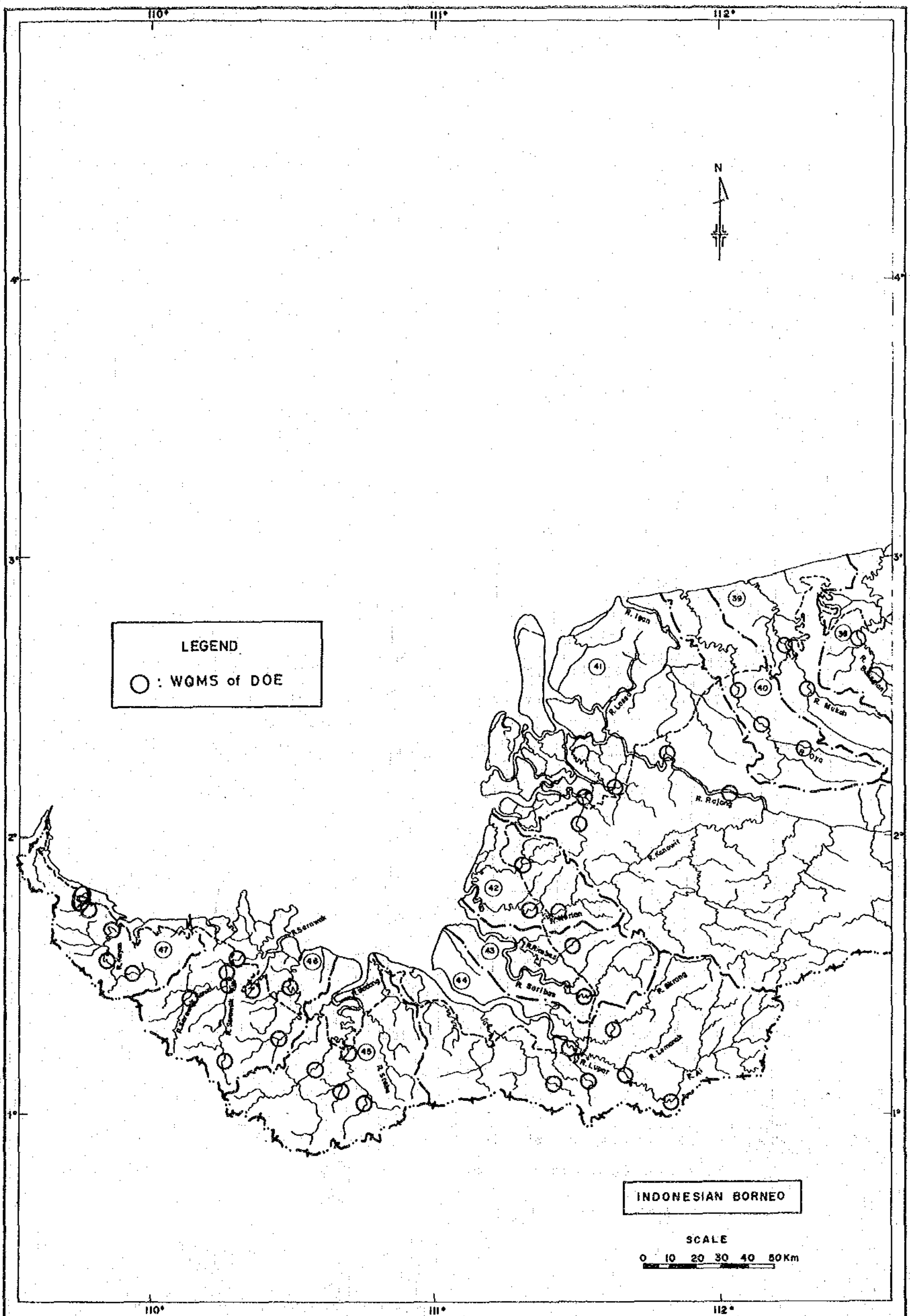

Fig. 5. Location of Water Quality Monitoring Stations (WQMS) of DOE in Sarawak (2/2)

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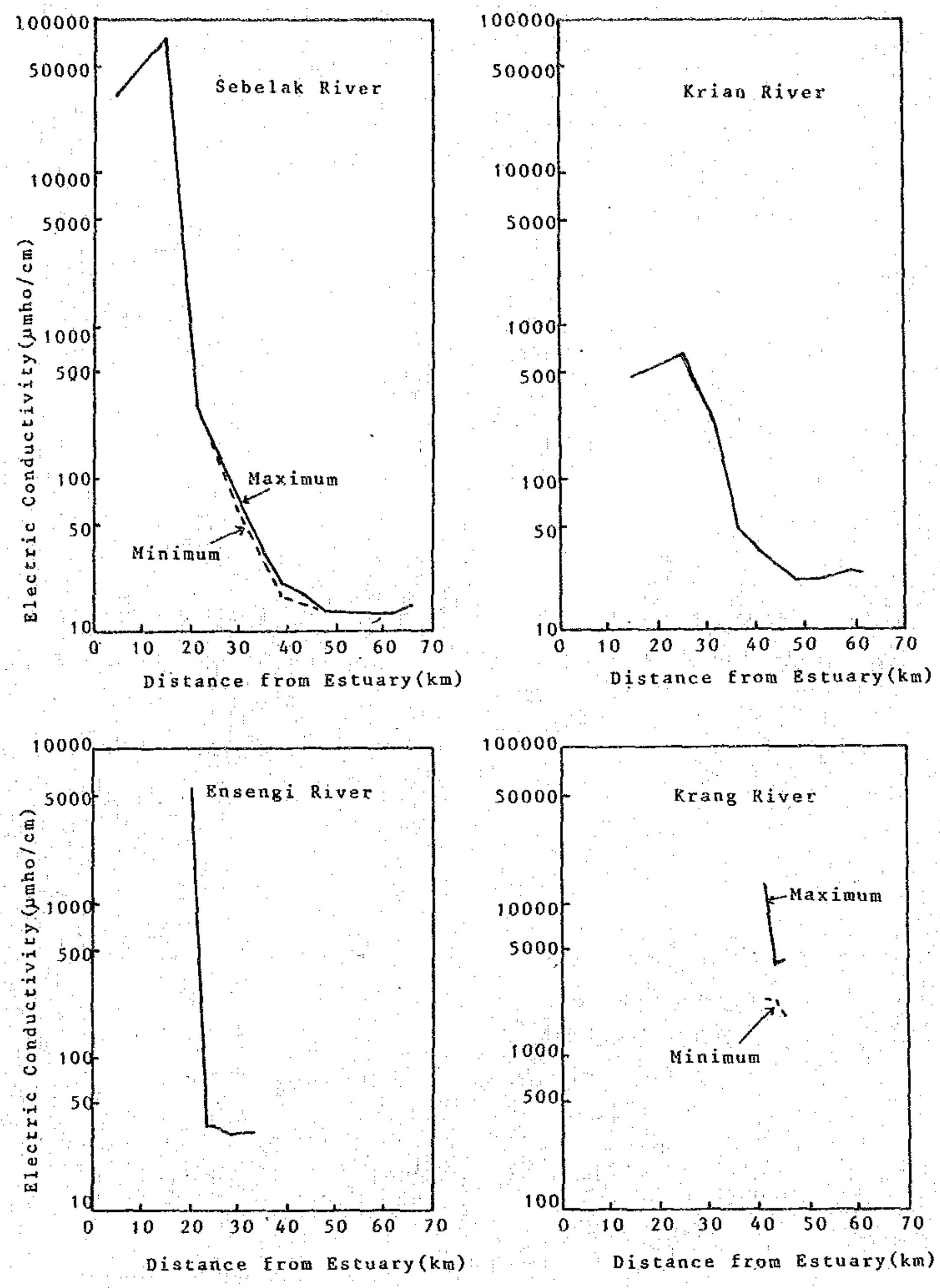

Fig. 6. Distribution of Electric Conductivity in Sarawak (1/2)

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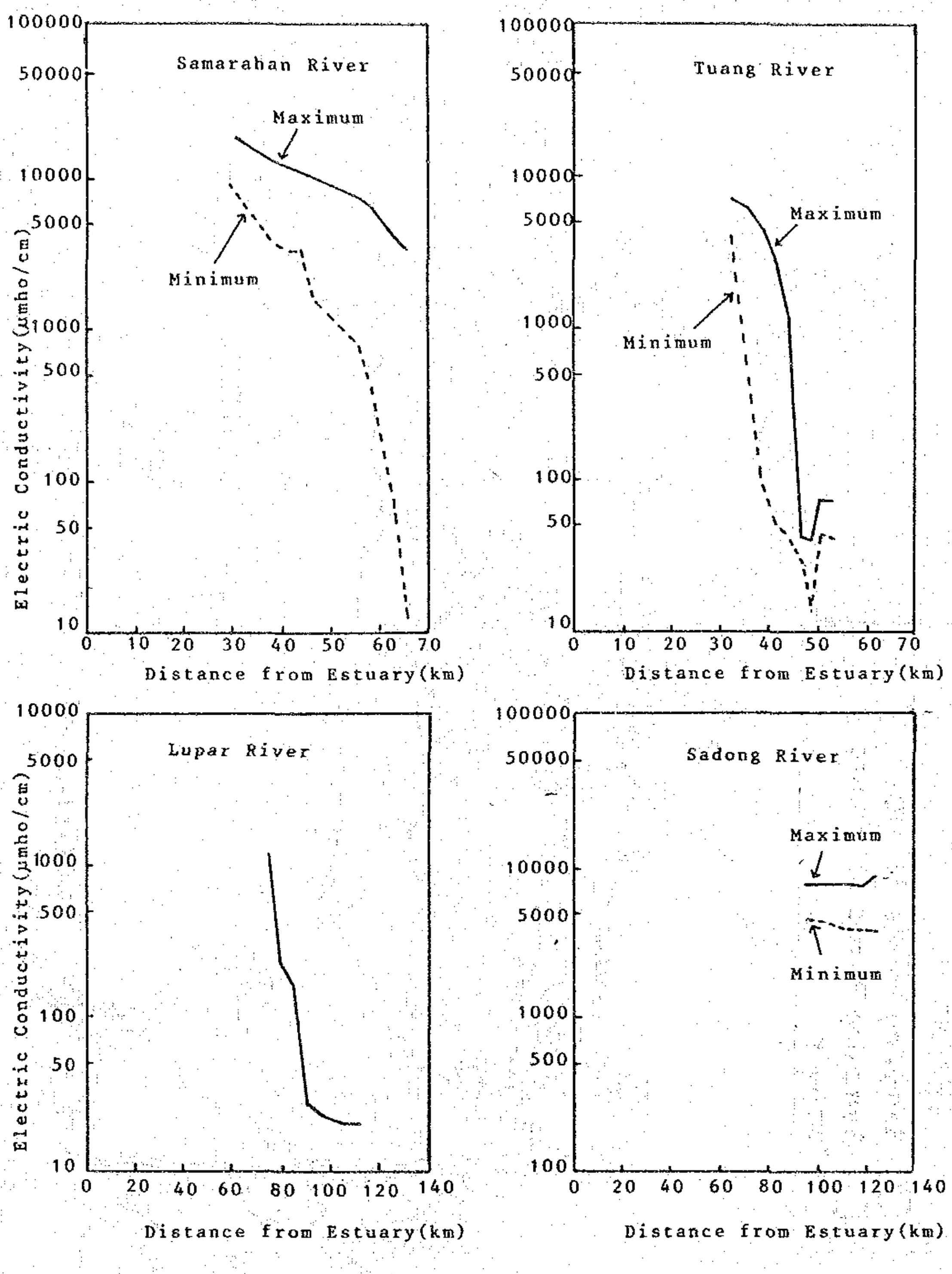

Fig. 7. Distribution of Electric Conductivity in Sarawak (2/2)

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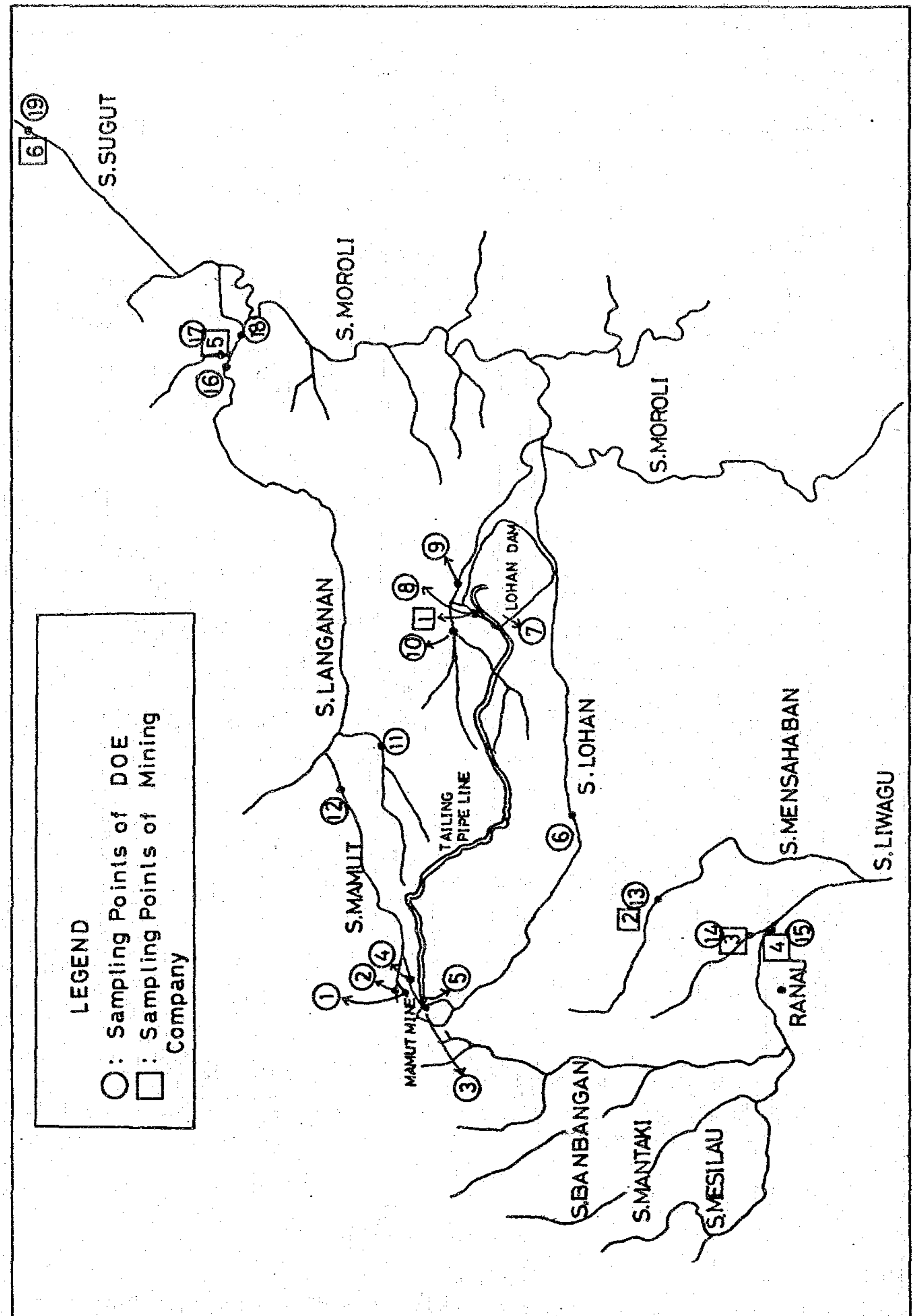

Fig. 8. Location of Water Quality Sampling Points around Mamut Copper Mine

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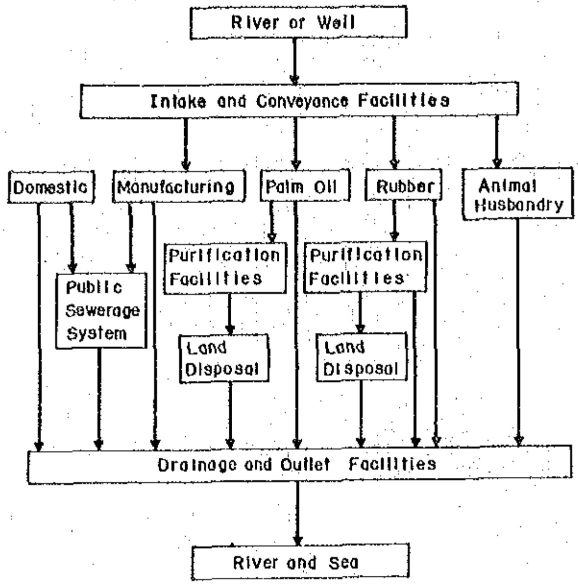

Fig. 9. Composition of Pollution Sources

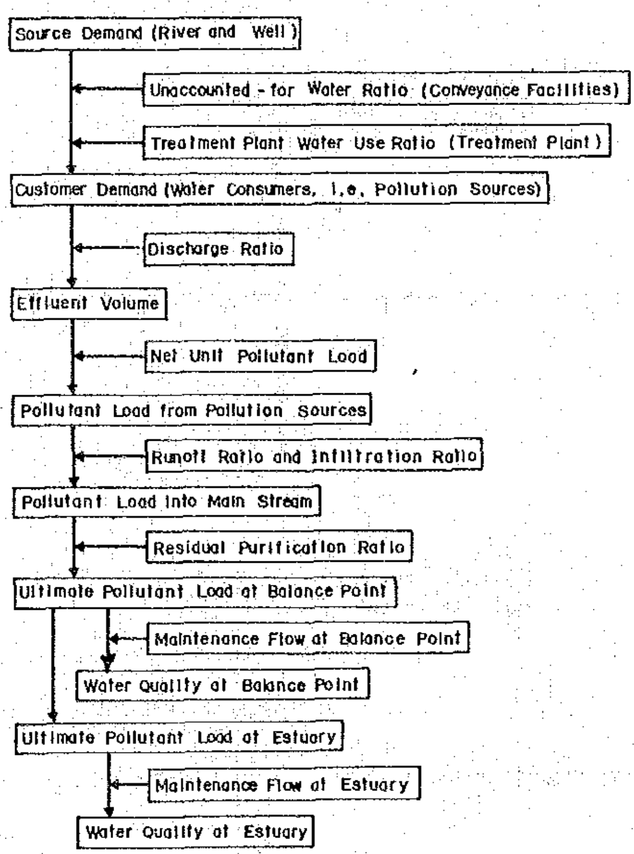

Fig. 10. Water Quality Projection Flow Chart

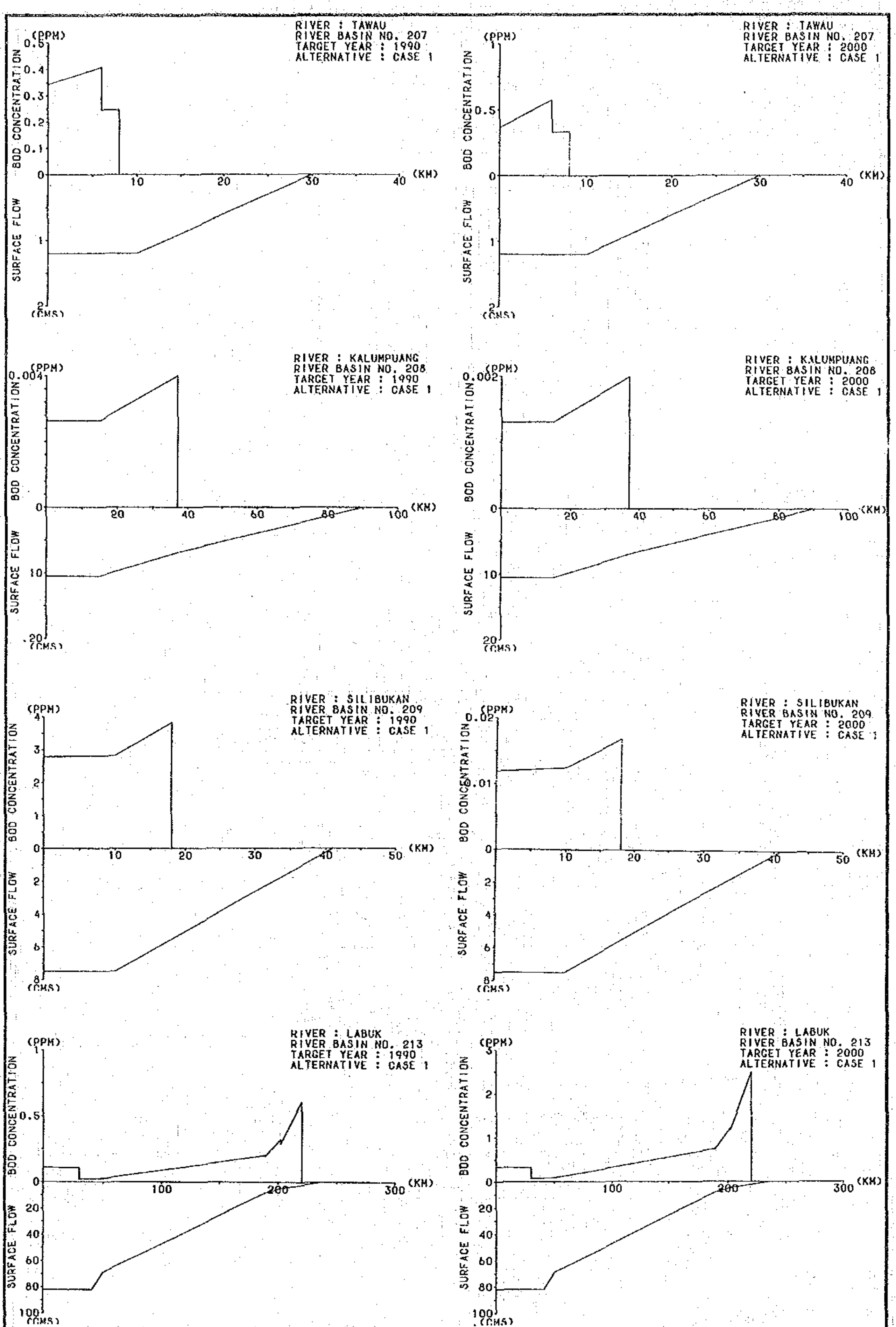

Fig. 11. Distribution of BOD Concentration in 1990 and 2000 for Case 1 (1/4)

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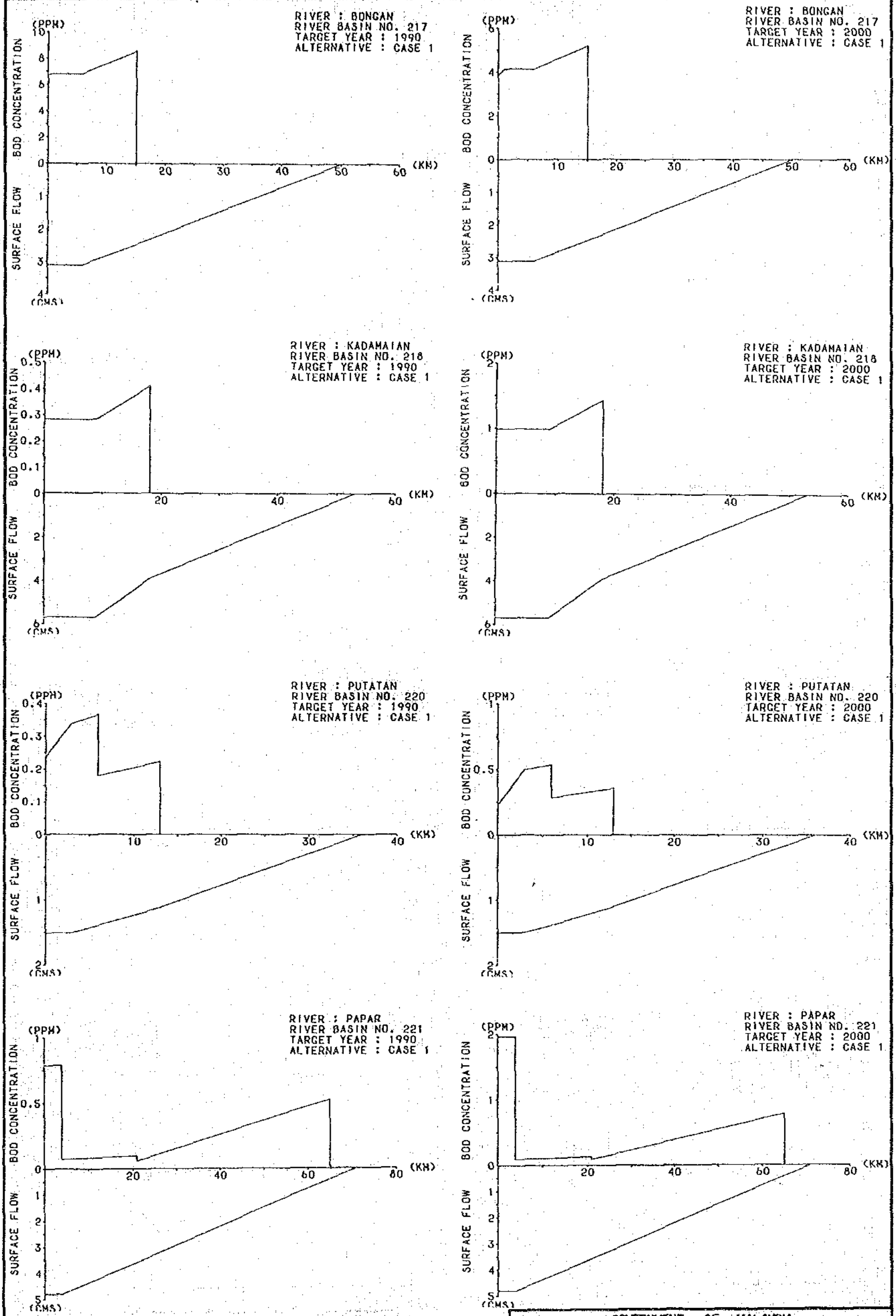

Fig. 12. Distribution of BOD Concentration in 1990 and 2000 for Case 1 (2/4)

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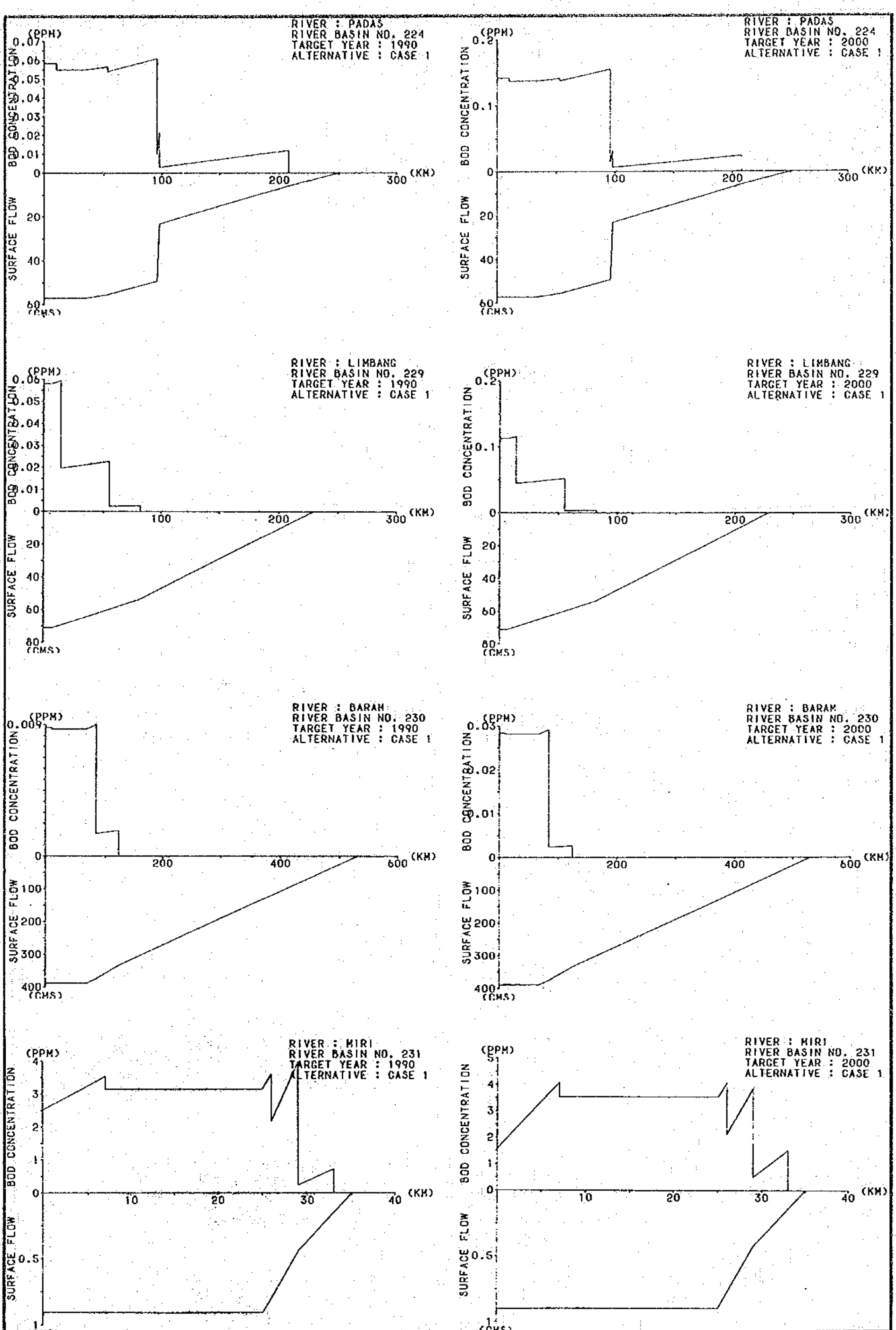

Fig. 13. Distribution of BOD Concentration in 1990 and 2000 for Case 1 (3/4)

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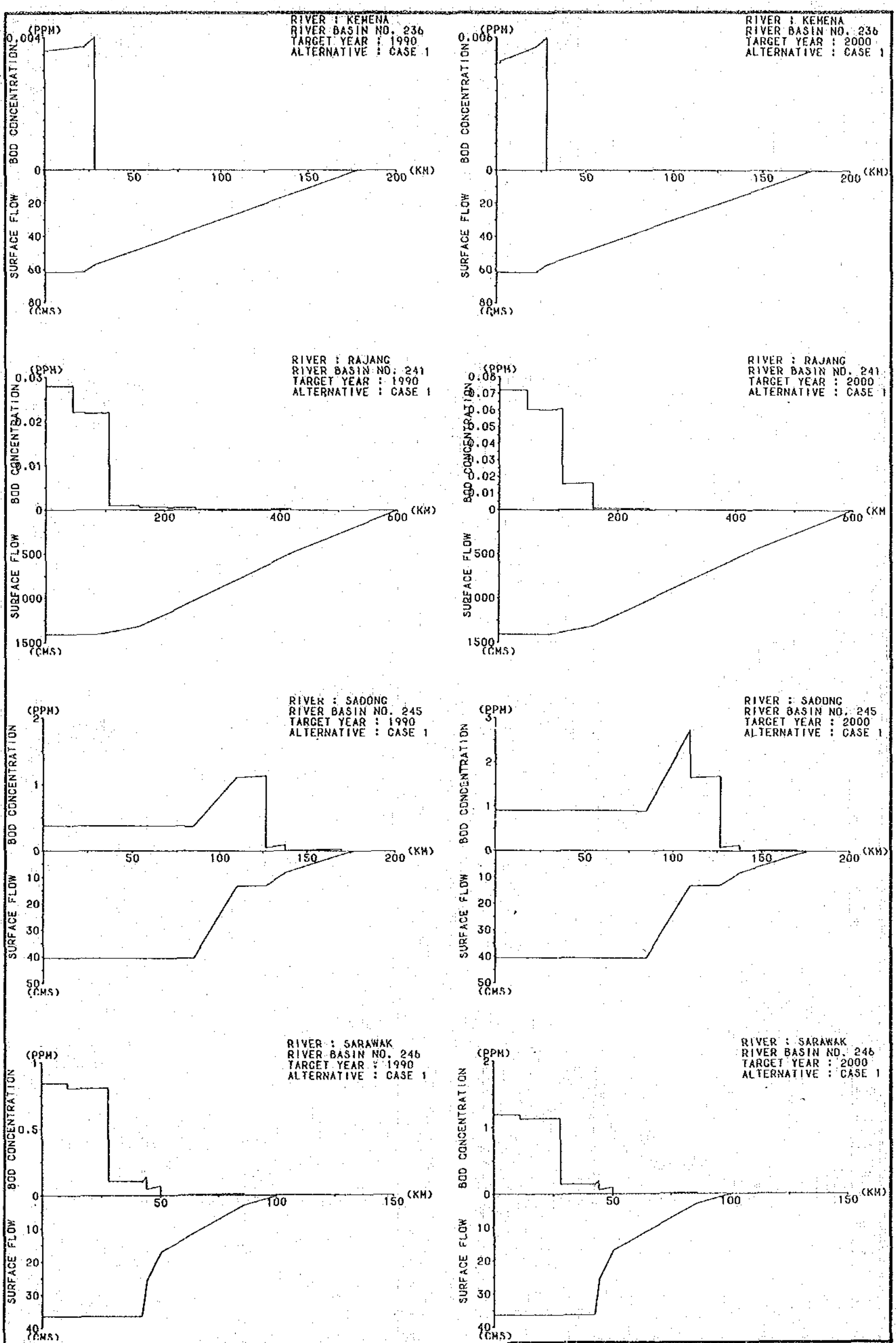

Fig. 14. Distribution of BOD Concentration in 1990 and 2000 for Case 1 (4/4)

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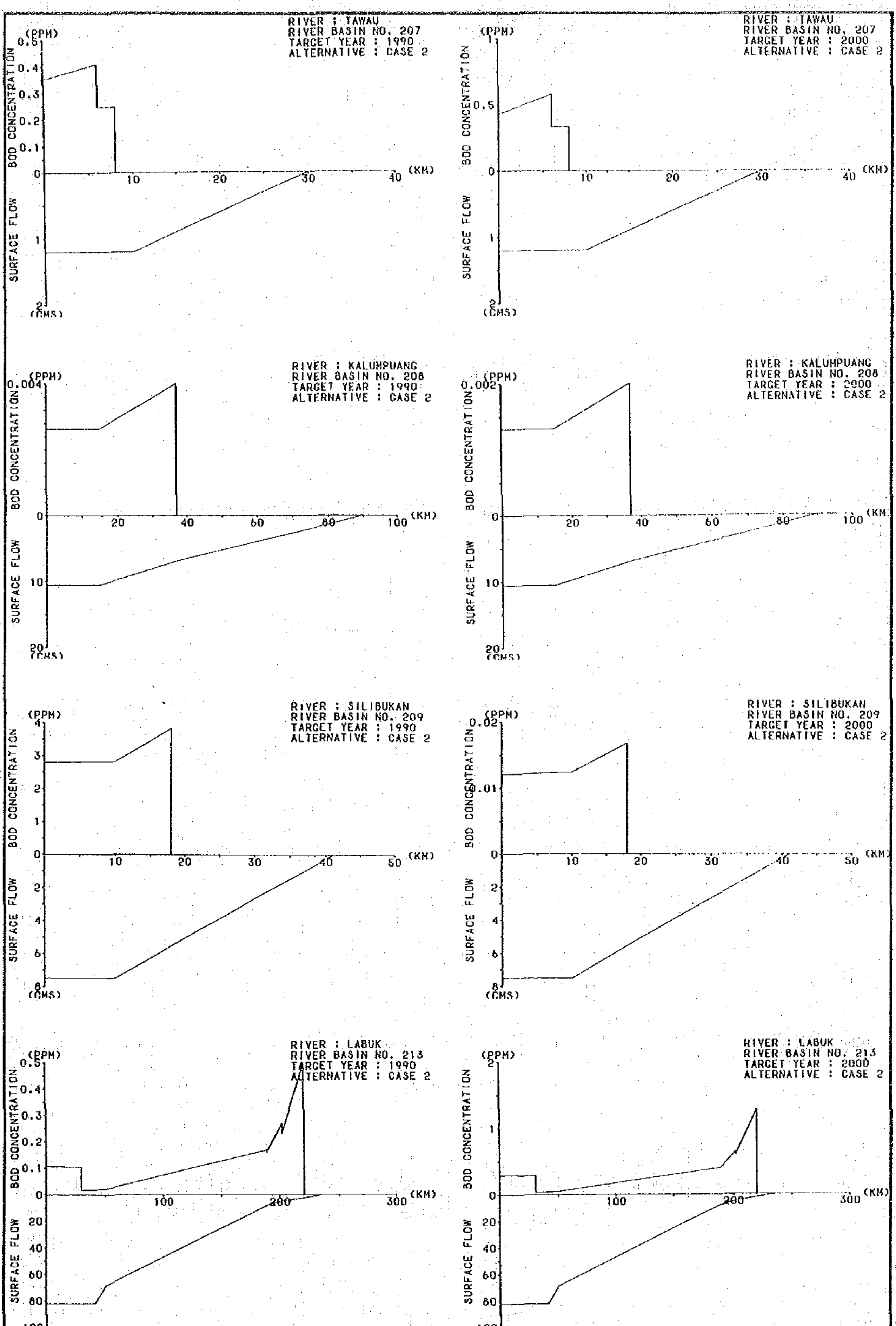

Fig. 15. Distribution of BOD Concentration in 1990 and 2000 for Case 2 (1/4)

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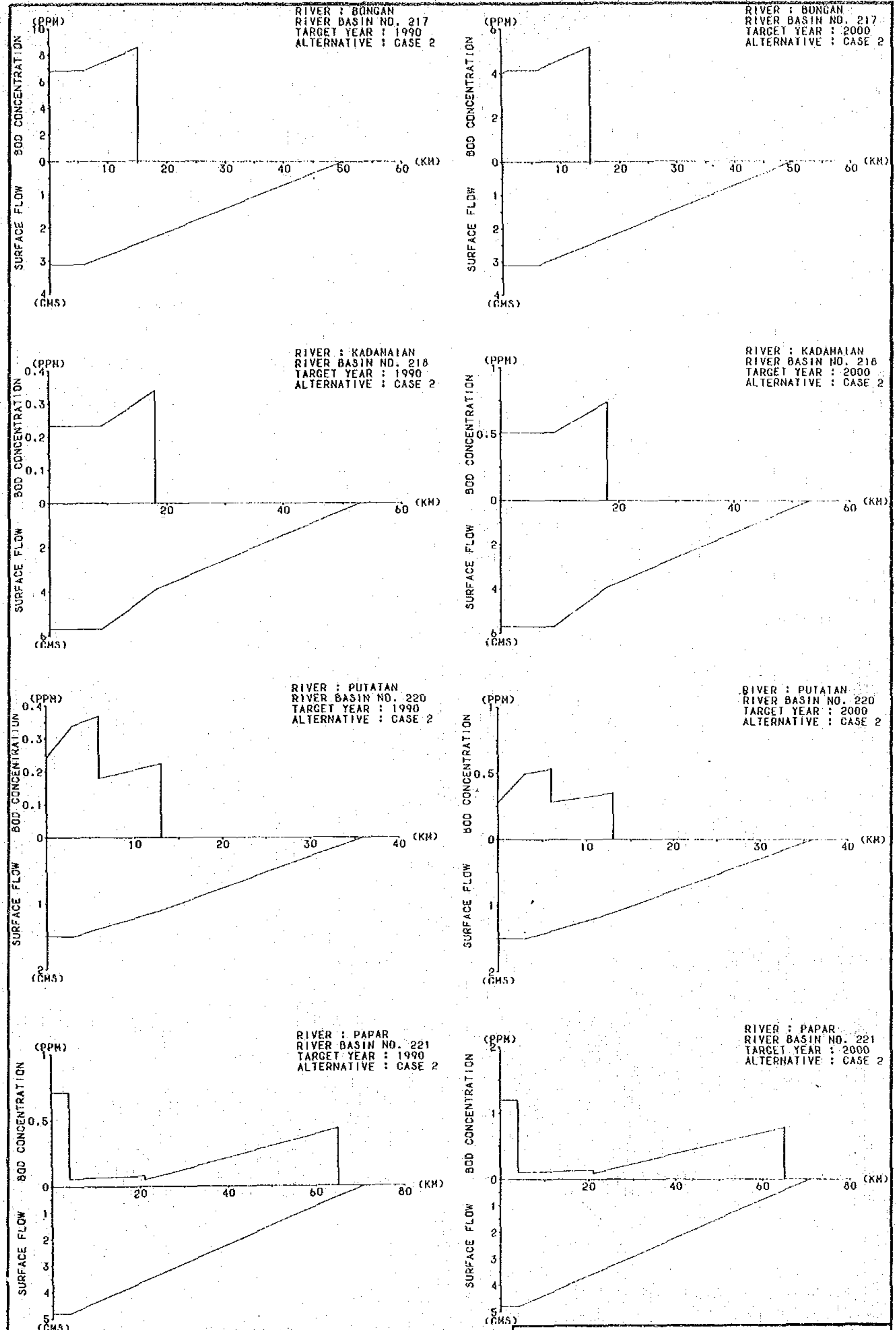

Fig. 16. Distribution of BOD Concentration in 1990 and 2000 for Case 2 (2/4)

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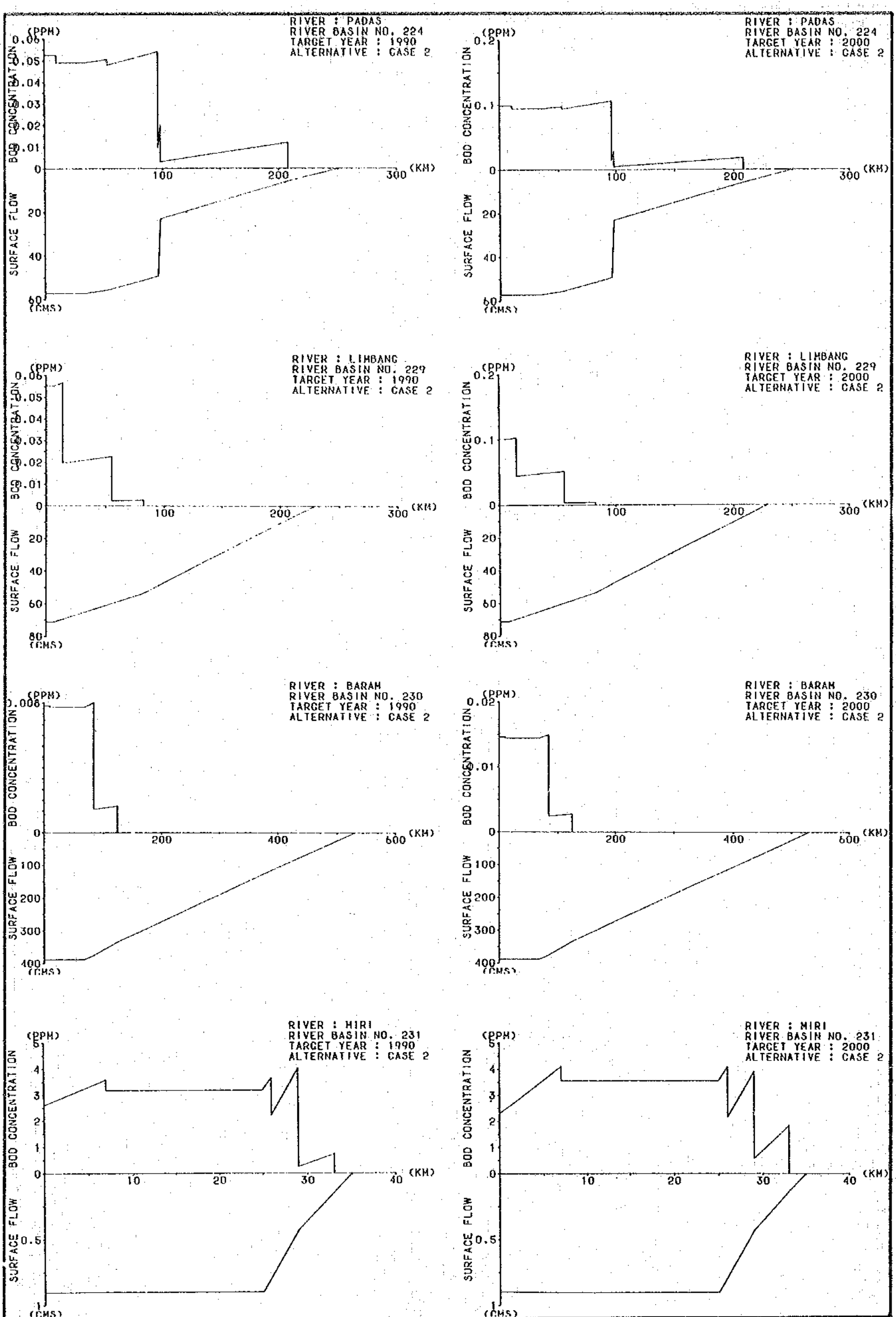

Fig. 17. Distribution of BOD Concentration in 1990 and 2000 for Case 2 (3/4)

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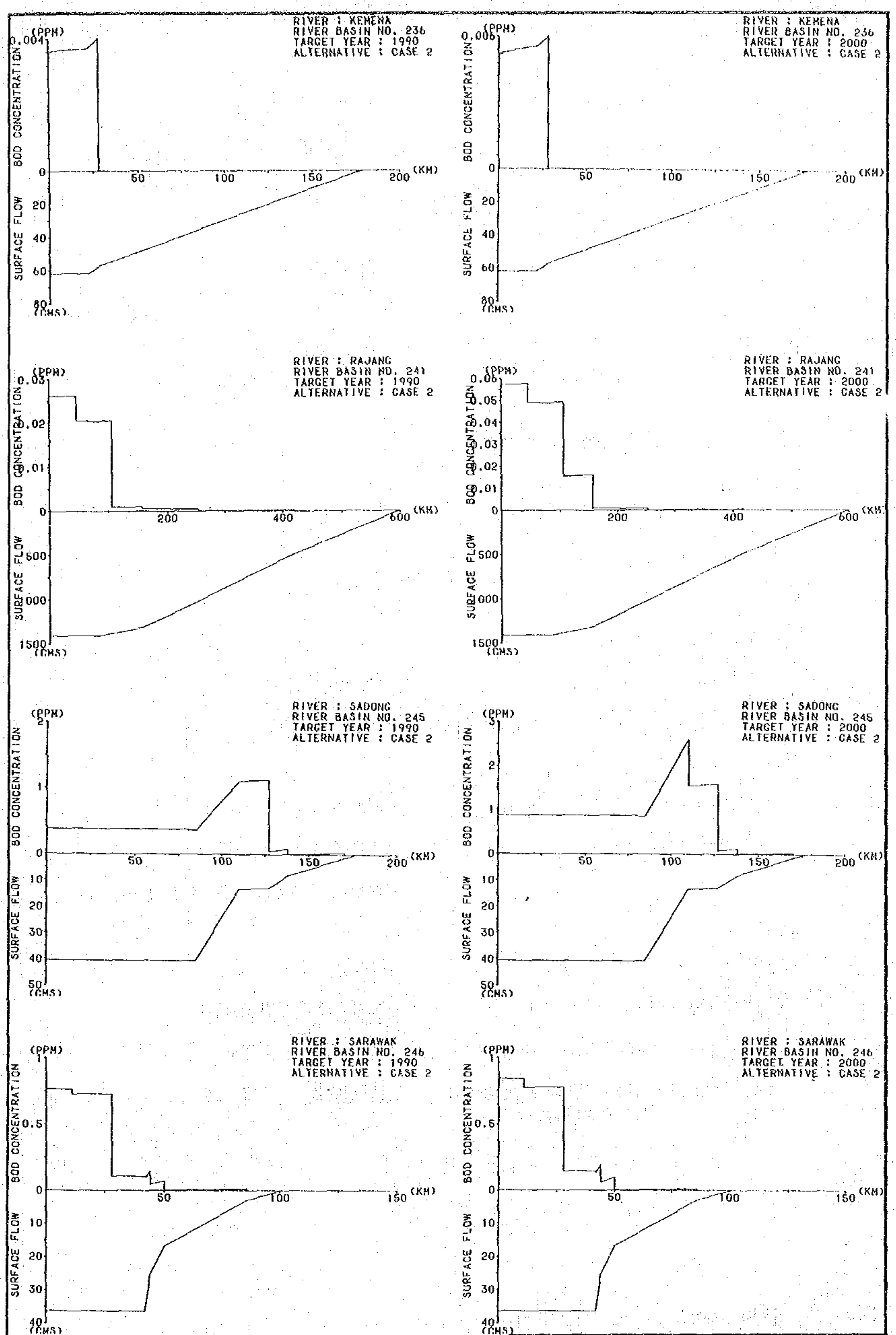

Fig. 18. Distribution of BOD Concentration in 1990 and 2000 for Case 2 (4/4)

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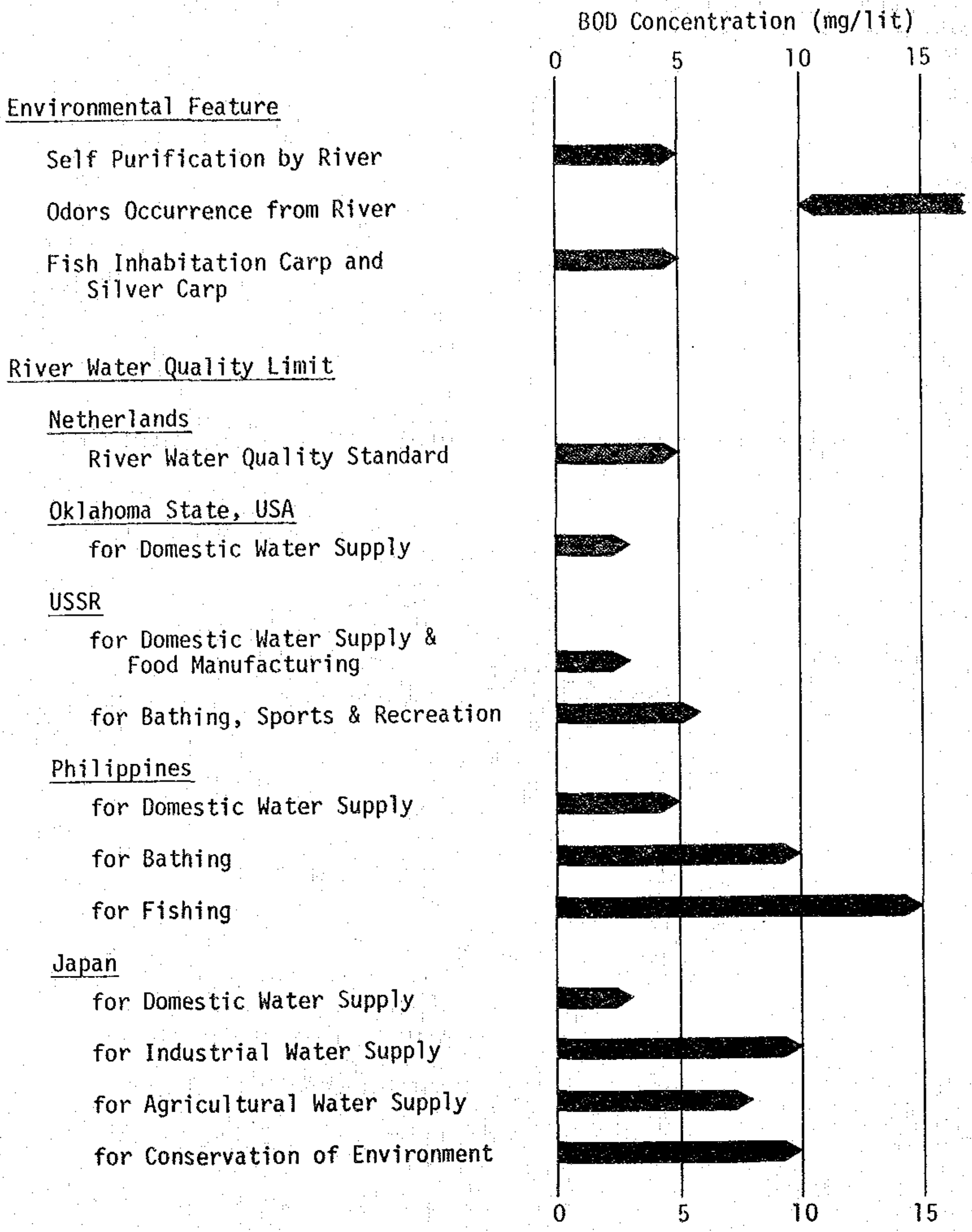

Fig. 19. Relationships between BOD Concentration and Environmental Feature, and River Water Quality Limit

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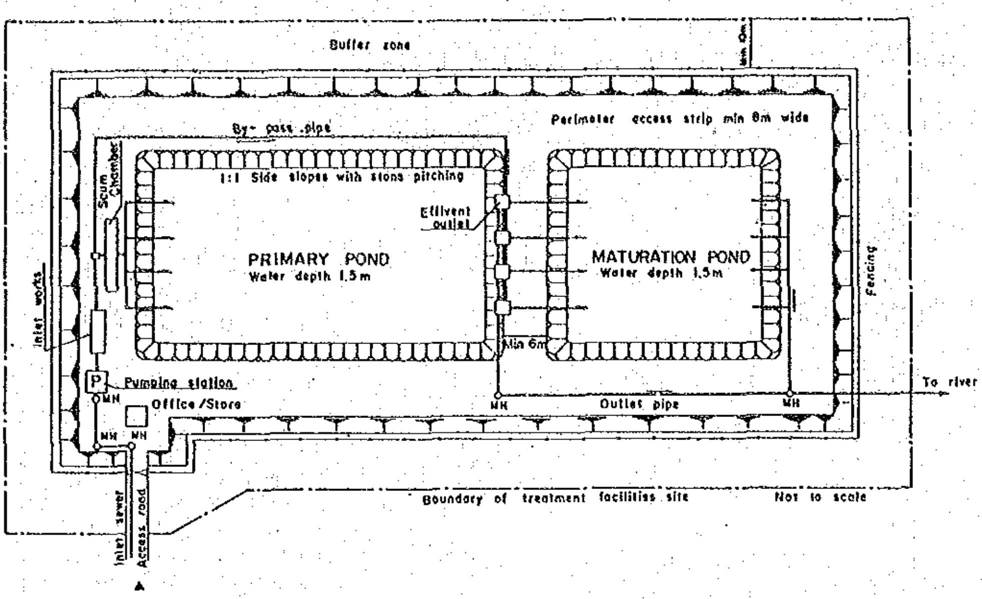

Fig. 20. Typical Layout of Stabilization Pond Process

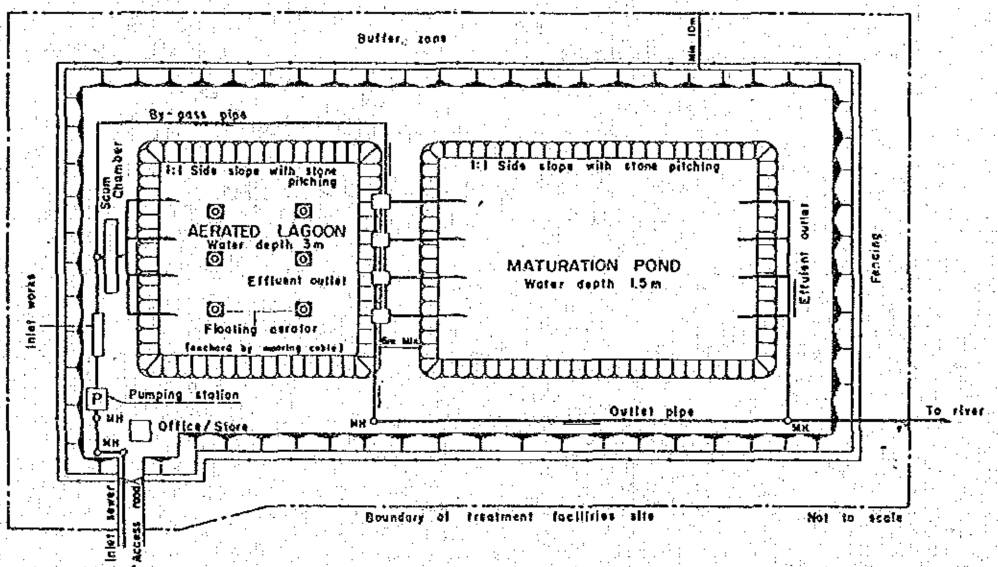

Fig. 21. Typical Layout of Aerated Lagoon Process

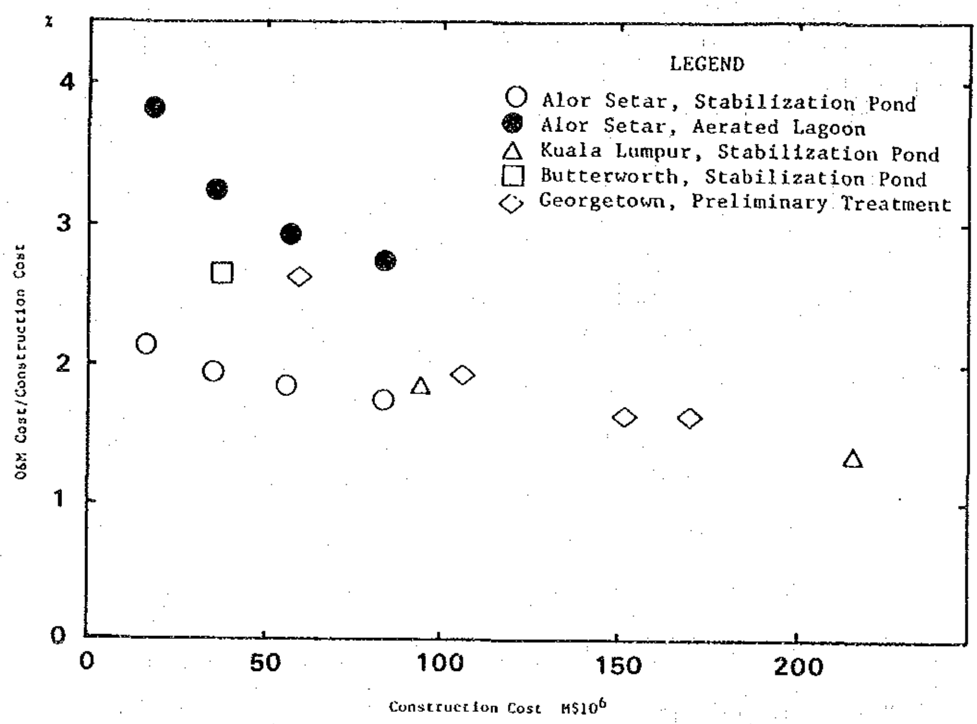

Fig. 22. Relationships between O&M and Construction Cost

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