2.3 Amounte of Conservable Water by Industry

Table 2.6 shows the amount of water that can be conserved and the conservation ratio for the above 20 factories divided by type of business. The following can be seen from the Table.

① The highest conservation ratio is in the chemical industry followed by machinery and metal processing. Both of these businesses have a high consumption ratio of cooling water. Furthermore, the reason for the high conservation ratio is that recirculation of this water is not being fully carried out.

As mentioned in 2.1, the ratio of the cost of water and wastewater for machinery and metal processing to the shipment price of products is extremely high compared to that of the same industry of Japan. However, this ratio can be reduced by promoting the water conservation.

② The conservation ratio of the textile industry is close to 20%. This is because the reclamation of wastewater, which has many technical and economic problems, is included. If this was excluded, the conservation ratio would come down to the same level as that of the food business, i.e., 12.5%.

A large volume of washing water is used in the textile industry in order to maintain the quality of products at a high level. Since the conservation of that water is difficult, the conservation ratio is low.

The ratio of the cost of water and wastewater of this type of business to the shipment price of products is quite high. However, because the quantity of water that can be conserved is small, one of the only ways this ratio can be lowered is to promote the reclamation of wastewater, a measure which involves many technical and economical problems. An alternative is to increase the shipment price, that is, to make the product a high value added product.

③ The conservation ratio of the food business, 12.5%, is the lowest among all the types of businesses. The reasons of this low level are that a large quantity of cleaning water is necessary in order to maintain the sanitary state of food at a good level, and it is difficult to conserve that water.

The effect in the event of a future rise in fees is as described in 2.2. Viewed by type of business, an increase in the conservable water volume can be expected through the reclamation of wastewater.

Table 2.6 **Expected Water Conservation for Industries**

Unit of Water Volume;m³/day

Industry	Machine & Metal Processing	Food	Textile	Furniture & Chemical Industry	Total
No. of Factories	6	6	5	3	20
City Water	1,495	1,094	1,092	488	4,169
Well Water		426	4,265	298	4,989
River Water	103		1,985	312	2,400
Total	1,598	1,520	7,342	1,098	11,558
Conserv. Volume	411	190	1,421	333	2,355
Conserv. Rate %	25.7	12.5	19.4	30.3	20.4
Note	There are many cases of once through use of cooling water.	Change of bottle washers is required.	1. Control of dyeing water is insufficient 2. Including reclamation of dyeing waste water	There are many cases of once through use of cooling water.	

2.4 Total Amount of Conservable Water in All Industrial Water

Of the factories that did not become the subject of this survey, the main ones are the machinery and metal-processing factories, including the MPP Group (ex TAM). The volume of industrial water being used by these is estimated to be about 3,000m³/day. The conservation ratio that is possible in this type of business is about 25%, as shown in Table 2.6. Thus, a total quantity of about 750m³/day can be conservable in these factories.

The total of this estimated quantity for the 20 factories and the potentially conservable amount of about 2,355m³/day (Table 2.6), that is, about 3,100m³/day, is the estimated volume of industrial water that can be conservable.

3. WWTP Project

Background

A schematic survey of the WWTP project was made for the following reasons.

(1) As the ratio of factory wastewater to the total volume of inflow wastewater is high, the volume of flow of factory wastewater and the pollutant load (COD_{Cr}, BOD, SS, etc.) has to be grasped as accurately as possible when drawing up the plan of the WWTP project. This time, the JICA study team studied 20 factories whose combined wastewater volume was believed to make up more than 80% of the total factory wastewater. Based on that data, the study team will comment on any point that warranted comment in the WWTP project planned by Maribor City.

(2) We carried out a survey on measures to be taken on textile/dyeing factory wastewater which contains a great amount of difficult-to-decompose COD_{Cr}, because its share of this wastewater is high.

3.1 Outline of Project

A proposal was submitted on WWTP construction to various enterprises in 1995 and it is now being studied by Maribor City. The outline of the proposal is as follows.

(1) Inlet conditions

Wastewater volume:	36,600m^3/d	
COD:	691mg/L	25,517kg/d
BOD:	311mg/L	11,400kg/d
SS :	342mg/L	12,517kg/d
T-P:	15mg/L	550kg/d
T-N:	47mg/L	1,730kg/d

(2) Treated water conditions

	Phase 1	Phase 2	Phase 3 & 4
COD mg/L	-	100	100
BOD mg/L	-	20	20
SS mg/L	-	35	35
T-P mg/L.	-		2
T-N mg/L	-		- 10

(3) Population increase rate

1996 to 2000	0.25%
2000 to 2020	0.5%

(4) Sewer pipe laying rate

1996	78%
1997	81%
1998	83%
1999	85%
2000	89%
2001	91%
2002	93%
2003	95%
2004 to 2020	95%

(5) Rate of increase of industrial water consumption

1996 to 1997	0%
1999 to 2000	2%
2001 to 2020	1%

(6) Rate of collection of fees from households for use of sewers

1996 to 2000	80%
2001	83%
2002	86%
2003	89%
2004	92%
2005 to 2020	95%

(7) Construction schedule

Phase 1	2000	
Phase 2	2002	
Phase 3 & 4		2004

3.2 Study of Fee System

3.2.1 Fee System and Pretreatment for Reducing Pollutant Load

The total system for Maribor City's entire wastewater can be divided into the WWTP and factories. Therefore, if Maribor City's entire total system was to be optimized using some sort of evaluation function, detailed data of both the factories and WWTP are necessary. However, as the WWTP is in the bidding stage and there is no detailed data, studies on optimizing the total system cannot be made. We therefore decided to investigate what sort of effect various fee systems would have on the actions of the factories and to submit the results as material for evaluating what sort of fee system would be best for Maribor City to adopt in the future. In other words, the process of judging whether or not the pretreatment of the factory would ultimately be appropriate and, based on that result, the preparation of a proposal for the optimum pretreatment system, will have to be done in accordance with the steps shown in the flow chart of Fig.3.2.1(1). However, in the study made in this section, of those steps, we carry out the simulation of the setup of the WWTP fee-calculation formula and the pretreatment.

The effect of a fee system on factories is indicated by judging whether or not it would be advantageous, under the specified fee system, for factories to lower the WWTP discharge fee by pretreating their wastewater at their own cost. For this purpose, as a tentative plan, we studied setting up a trial fee system based on information of the actual state of affairs prevailing in Maribor City and Japan. We then studied what sort of actions (pretreatment) each factory could be expected to take when that fee system was applied. Also, based on those results, we obtained information such as the number of factories that would carry out pretreatment, the total investment amount, and the amount of pollutant load that would be reduced.

We used the data (Table 1.2.2) on pretreatment for reducing pollutant load in Part II as the pretreatment process to be used by each factory, and as the cost of construction of the equipment (investment amount), treatment costs, etc.

At present, in Maribor City, the sewage fee for factory wastewater after construction of the WWTP is tentatively set at an average of 160 SIT/m^3. This is because it is the current outlook of Maribor City that the management and operation of the WWTP is possible with an average sewage fee of 160 SIT/m^3. It is also said that a pollution index for wastewater will be established and that a fee system increasing in proportion to that index is scheduled to be adopted. In other words, if the fee is Y and the pollution index is X, it can be expressed by the following equation.

$$Y = A \cdot X \quad \text{(where A is a constant and the gradient of the pollutant index)}$$

In this report, we generalized the above equation even further and employed the following equation.

$$Y = A \cdot X + B \quad \text{(where B is a constant and the basic fee)}$$

If the wastewater flowing into the WWTP is to meet the inflow standard, it is logical for the pollutant index X to consist of pollutant compositions that the WWTP can treat; that is, COD, BOD, and SS (phosphor and nitrogen that is be treated in the second phase are omitted). In this report, we established the pollutant index by the following equation. This type of equation was adopted because COD is usually a bigger figure than BOD and SS, and because the pollutant index now being considered by Maribor City places a weight on BOD that is double that of COD.

$$X = (COD + 2 \cdot BOD + 2 \cdot SS)/5$$

We estimated, by computer calculations, the actions that would be taken by factories against various fee systems under the above sort of conditions. The result was that we made it a condition that the sewage fee after pretreatment should become 160 SIT/m^3 by weighted average of the 20 factories that were studied. Of course, the above conditions, for example, the average fee of 160 SIT/m^3 or the pollutant index factors, can be changed. The flowchart of the program is shown if in Fig.3.2.1(2), but the actual calculations are shown in the program itself (attached).

1) Establishing of cases

As the following paragraph demonstrates, various approaches can be taken in deciding on the sewage fee system. In this report, we use a system which charges a high fee for wastewater with a high pollutant index. As mentioned before, this is done to urge factories that generate wastewater with high pollutant loads to make efforts to improve the quality of their wastewater. Also, since the fee for domestic effluent is assumed to be a uniform 80 SIT/m^3, we studied a fee system for factory wastewater that would be in balance with that domestic effluent fee, as follows. Whenever the factory wastewater fee by the tentative fee system becomes less than 80 SIT/m^3, it will be made a uniform 80 SIT/m^3, and whenever the fee is higher than that, it will be charged at the calculated figure. In addition, we also studied plans for establishing tentative controls on COD, BOD and SS, in the event that a policy for actively reducing the pollutant load to the WWTP was to be taken, because the implementation of such controls was regarded as the most effective means of reducing pollution load. To sum up the above, the cases were set as follows.

Case 1: System for determining the sewage fee for each factory by the equation $Y = A \cdot X + B$

Case 2: The sewage fee would be determined by the same method as above, but there would also be a minimum fee of 80 SIT/m^3.

Case 3: Control figures would be set for COD, BOD, and SS, and the sewage fee would be determined by the equation $Y = A \cdot X + B$

2) Results of studies

The fee-computing equation was as per the following, and a total of 96 calculations were respectively made and studied for each case.

Fee computing equation $Y = A \cdot X + B$, where,

$X = (COD + 2 \cdot BOD + 2 \cdot SS)/5$

$A = 0.3$ to 1.0 (in increments of 0.1)

$B = 0$ to 110 (in increments of 10)

With regard to Case 1 and Case 2, we checked the economical viability of the pretreatment (that is, whether or not the reduction of sewage fees as a result of pretreatment would exceed the pretreatment cost) of each factory against each computing equation. When doing this, if there was a plural number of pretreatment proposals for one factory, we made it a point to select the proposal which provided the largest sewage fee saving. However, the program has been set up so that the proposal which provides the lowest investment can also be selected.

Note that of variables A and B, variable A is the deciding factor that governs the economical viability of the pretreatment of each factory, and variable B is the factor that decides the sewage fee level.

(1) Results of studies of case 1

Ninety-six calculations were studied for Case 1. We extracted the cases for each gradient (A) where the calculation formulas resulted in average sewage fees of about 160 SIT/m^3 as a result of each factory carrying out pretreatment that was economically practical (shown in Tables 3.2.1(1) and (2)). In these tables, we indicate the actions the factories could be expected to take when the respective calculation formulas were applied, their effects, and the resultant sewage fees.

Table 3.2.1(1) Factories for Which Pretreatment is Economically Practical

	Calculation Formula	Factories for which Pretreatment is Economically Practical		Total Investment Amount(1,000 SIT)
		No. of Factories	Names of Factories	
Case-1a	0.3X+100	3	M-6,7,A-5	1,38,300
Case-1b	0.4X+ 90	4	M-4,6,7,A-5	195,260
Case-1c	0.5X+ 70	4	M-4,6,7,A-5	195,260
Case-1d	0.6X+ 50	4	M-4,6,7,A-5	195,260
Case-1e	0.7X+ 30	4	M-4,6,7,A-5	195,260
Case-1f	0.8X+ 30	5	M-1,4,6,7,A-5	238,460
Case-1g	0.9X+ 10	5	M-1,4,6,7,A-5	238,460
Case-1h	1.0X	6	M-1,4,5,6,7,A-5	263,090

Table 3.2.1(2) Effect of Pretreatment and Resultant Sewage Fees

	Pollutant Load Reduction (kg/d)			Treatment Cost Original Unit	Sewage Fees (SI/m³)		
	COD	BOD	SS	See Note	Max.	Ave.	Min.
Case-1a	1,258	695	579	182	241	162	102
Case-1b	1,963	944	548	197	246	164	93
Case-1c	1,963	944	548	197	265	162	74
Case-1d	1,963	944	548	197	284	160	54
Case-1e	1,963	944	548	197	303	159	35
Case-1f	2,413	1,244	458	205	342	163	36
Case-1g	2,413	1,244	458	205	361	160	17
Case-1h	2,461	1,281	450	222	260	164	7

Note: Total Investment Amount (1,000 SIT)/Pollutant Load Reduction Index [(COD+2BOD+2SS)kg/d/5]

Figure 3.2.2 shows a graph of the relationship between total investment and pollutant load reduction based on the above tables. The effectiveness of reduction versus investment amount is low for SS and high for COD, but the tendency is for a leveling off from around 240 million SIT.

In the above eight calculation formulas, when the gradient (A) is gradual, there is the demerit that the number of factories for which pretreatment is economically practical is small. When the gradient (A) is steep, the number of factories for which pretreatment is economically practical increases, but there is the demerit that the minimum sewage fee becomes too small. Therefore, Cases 1b, 1c, 1d, and 1e are believed to be appropriate. However, the case believed to be the most representative with the lowest gradient (A) (so the sewage fee before pretreatment does not become excessive) and the most appropriate minimum sewage fee is Case 1b.

(2) Results of studies of case 2

Case 2 covers those cases in Case 1 in which factories with sewage fees of less than 80 SIT/m³ appear but are calculated as being 80 SIT/m³. The calculation formulas that apply to this were the five that are shown in the Tables 3.2.2(1) and (2) below. In these tables, we show the actions that the factory could be expected to take when the respective calculation formulas were applied, their effects, and the resultant sewage fees.

Table 3.2.2(1) Factories for Which Pretreatment is Economically Practical

	Calculation Formula	Factories for which Pretreatment is Economically Practical		Total Investment Amount(1,000 SIT)
		No. of Factories	Names of Factories	
Case-2a	0.5X+ 70	4	M-4,6,7,A-5	195,260
Case-2b	0.6X+ 50	4	M-4,6,7,A-5	195,260
Case-2c	0.7X+ 30	4	M-4,6,7,A-5	195,260
Case-2d	0.8X+ 20	5	M-1,4,6,7,A-5	238,460
Case-2e	0.9X	5	M-1,4,6,7,A-5	238,460

Table 3.2.2(2) Effect of Pretreatment and Resultant Sewage Fees

	Pollutant Load Reduction (kg/d)			Treatment Cost Original Unit	Sewage Fees (SI/m³)		
	COD	BOD	SS	See Note	Max.	Ave.	Min.
Case-2a	1,963	944	548	197	265	162	80
Case-2b	1,963	944	548	197	284	163	80
Case-2c	1,963	944	548	197	303	164	80
Case-2d	2,413	1,244	457	205	332	160	80
Case-2e	2,413	1,244	457	205	351	160	80

Note: Total Investment Amount (1,000 SIT)/Pollutant Load Reduction Index [(COD+2BOD+2SS)kg/d/5]

In the above, Cases 2d and 2e have the higher pollutant load reductions. Of these, Case 2d has the more gradual gradient, so we will consider it as representative of Case 2.

(3) Results of studies of case 3

We studied Case 3 by assuming that control figures of COD≦600, BOD≦300 and SS≦300 would be set. These control figures are in accordance with the standard figures of the Sewerage Law of Japan. Also, they are values that somewhat exceed the water quality levels of the current sewage of Maribor City and are believed to be appropriate levels when imposing controls.

Of the 20 factories that were the subject of the current survey, there are seven whose wastewater pollution concentration exceeds this standard. Of these seven factories, two (S-1 and S-3) had only very slight excess pollutant concentration, and were therefore omitted from the factories needing pretreatment. In this Case 3, since it is a condition that the factories act to meet the controls, they all become uniform and only their sewage fees vary by the calculation formula. Of these, the representative calculation formulas are shown in Tables 3.2.3.

Table 3.2.3(1) Factories for Which Pretreatment is Economically Practical

	Calculation Formula	Factories for which Pretreatment is Economically Practical		Total Investment Amount(1,000 SIT)
		No. of Factories	Names of Factories	
Case-3a	0.3X+110	5	M-4,5,6,7,A-5	219,890
Case-3b	0.5X+ 80	5	M-4,5,6,7,A-5	219,890
Case-3c	0.6X+ 60	5	M-4,5,6,7,A-5	219,890

Table 3.2.3(2) **Effect of Pretreatment and Resultant Sewage Fees**

	Pollutant Load Reduction (kg/d)			Treatment Cost Original Unit	Sewage Fees (SI/m³)		
	COD	BOD	SS	See Note	Max.	Ave.	Min.
Case-3a	2,011	981	541	217	188	160	112
Case-3b	2,011	981	541	217	210	163	84
Case-3c	2,011	981	541	217	216	160	64

Note: Total Investment Amount (1,000 SIT)/Pollutant Load Reduction Index [(COD+2BOD+2SS)kg/d/5]

Of the above, Case-3b has a minimum sewage fee of about 80 SIT/m³, so we will consider it as representative of Case-3.

(3) Summary of results of studies

A comparison of the representative calculation formulas, Case-1b, Case-2d, and Case-3b, obtained from the above case studies is shown in Table 3.2.4. Also, the actions (pretreatment) taken by each factory for Case-1b, Case-2d, and Case-3b, respectively, are shown in Table 3.2.5, and the pollution load reduction and details of sewage fees are shown in Tables 3.2.6 and 3.2.7, respectively.

Of these, first, in the comparison of Case-1b and Case-2d, the latter has a big pretreatment promotion effect on the factories but has the demerit of having excessive sewage fees (especially before pretreatment). The maximum/minimum ratio of the sewage fees of the 20 factories before pretreatment is 5.7 times in Case-1b, but 11 times in Case-2d. In both cases, the fairness of the fee system will require explanation.

Case-3b does not differ too greatly from Cases-1b and Case-2d in terms of the effectiveness of pollution load reduction. This system promotes the active reduction of pollutant load and is being implemented in Japan.

3) Future issues

Studies were carried out on the precondition of promoting the reduction of pollutant loads by factories through pretreatment of their wastewater. From these studies, we were able to clarify the types of pretreatment factories would adopt under different fee calculation systems, as well as the levels of pollutant load reduction that would result from different levels of investment. In order to judge the effect of these results on the total system, including the WWTP, studies must be made in accordance with the steps shown in the previously-mentioned Fig.3.2.1(1), on how much impact they would have on the reduction of the construction and running costs of the WWTP. Also, forecasts must be made of the increase on pollutant loads that could be brought about by the future industrial growth and changes in the industrial structure of Maribor City. Careful studies will have to be conducted to determine whether or not the fee systems resulting from our studies will be effective as advance measures.

Fig.3.2.1(1) Flow Chart for Studying Pretreatment and Water Conservation

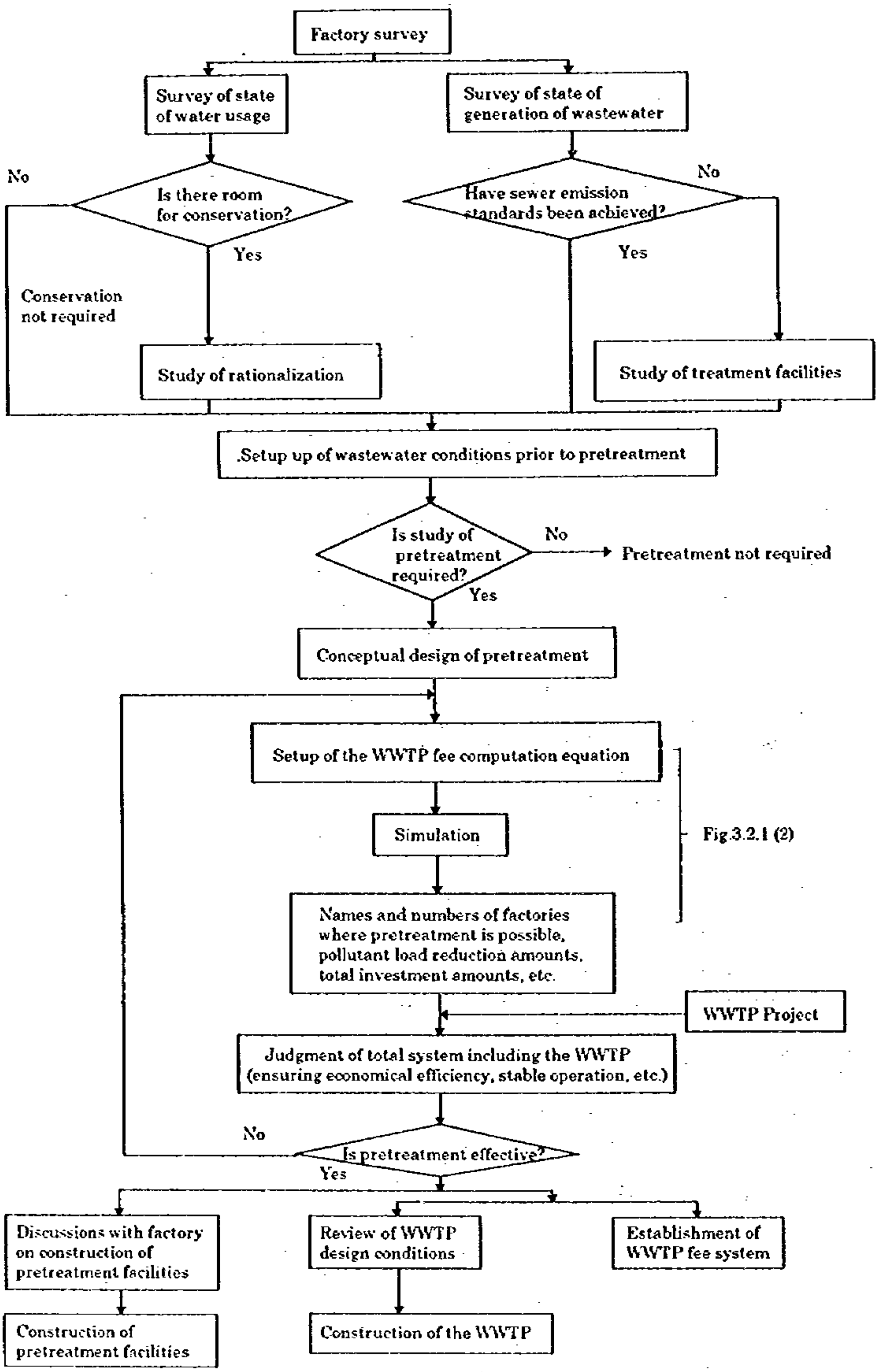

Fig.3.2.1 (2) Program Flowchart for Simulation of Pretreatment

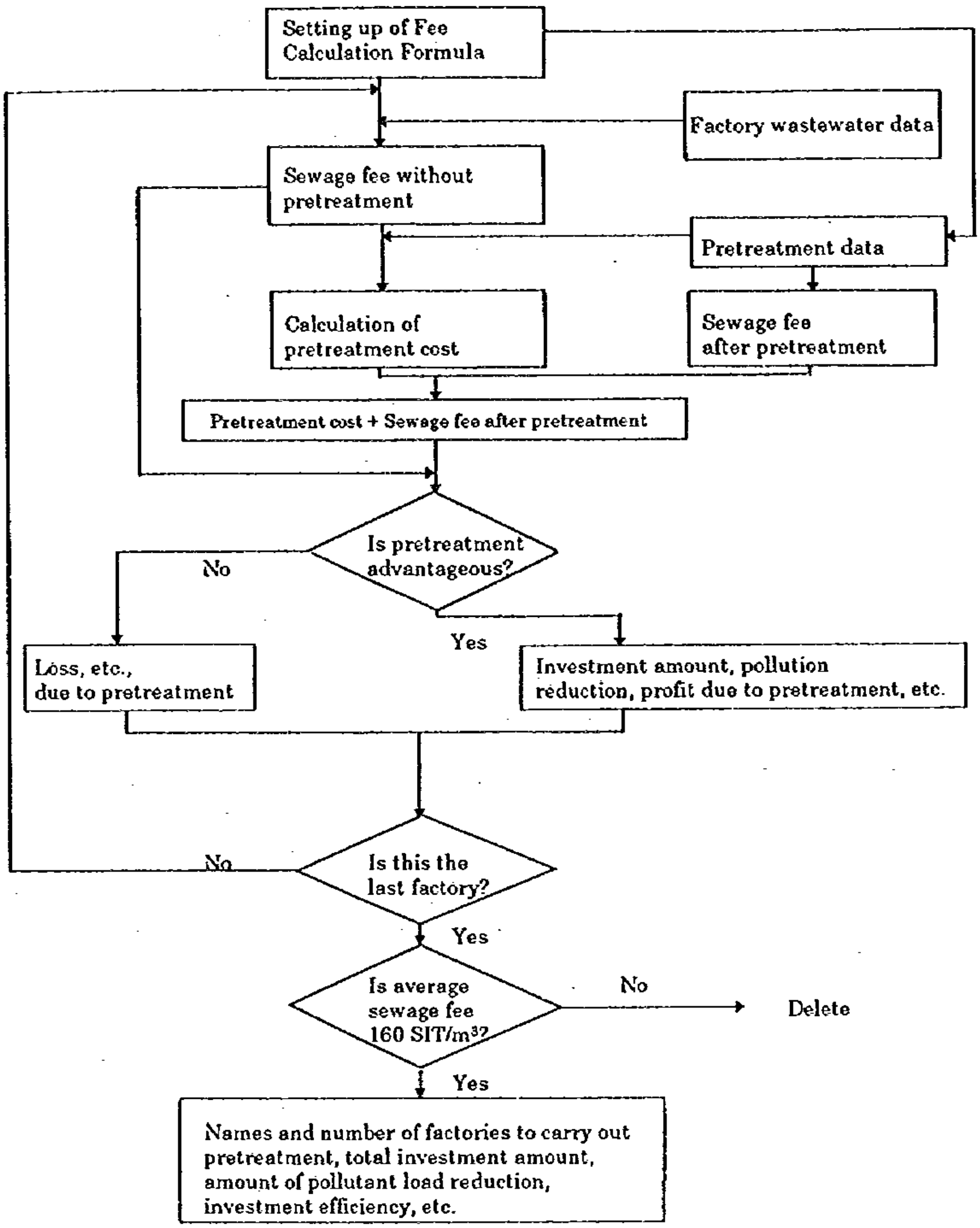

Fig. 3.2.2 Pollutant Reduction vs. Investment

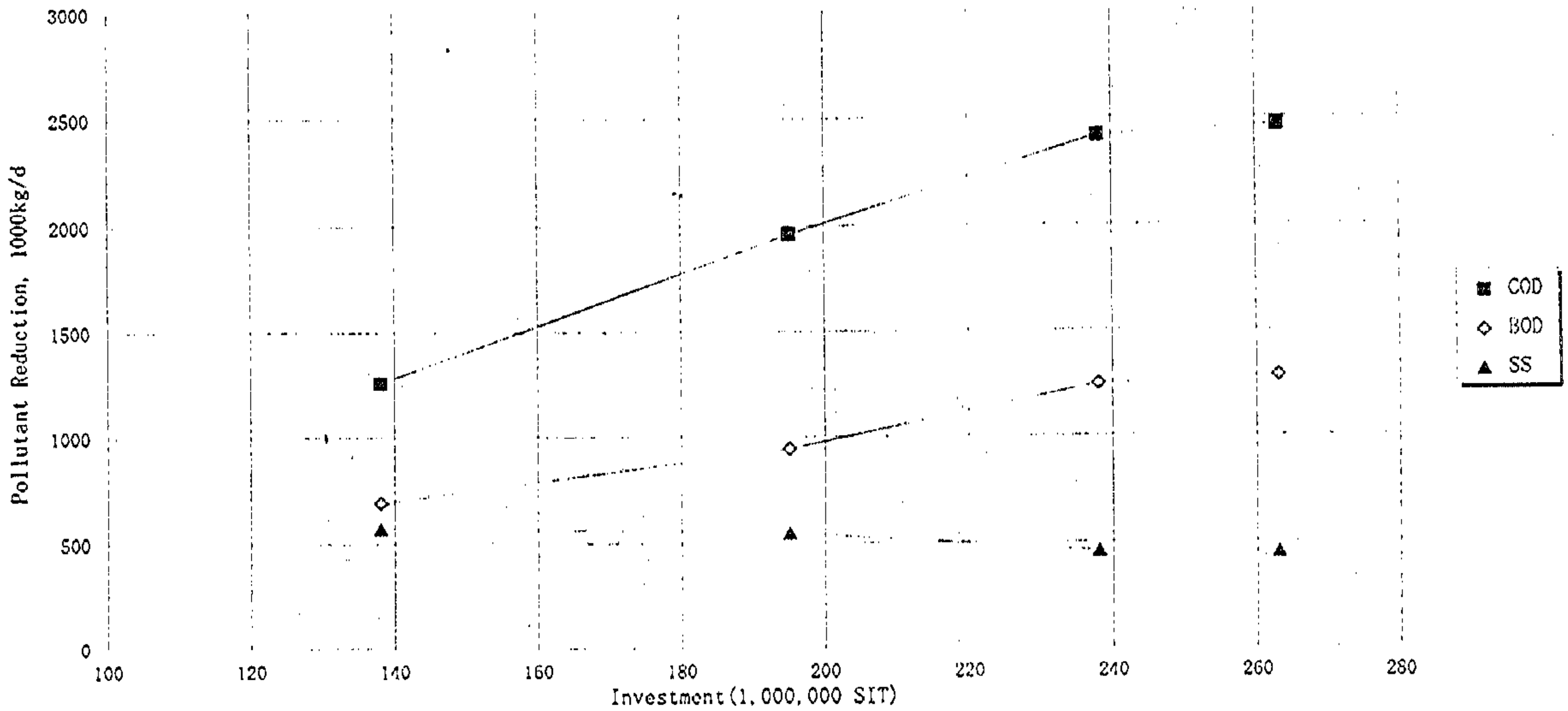

Table 3.2.4 Summary of Results of Studies

	Case-1	Case-2	Case-3
(1) Control figures	Not established	Not established	COD ≦ 600 BOD ≦ 300 SS ≦ 300
(2) Minimum fee	Not established	80 SIT/m³	Not established
(3) Representative case	Case-1b	Case-2d	Case-3b
Calculation formula	0.4X + 90	0.8X + 20	0.5X + 70
No. of factories installing pretreatment facilities	4	5	5
Nos. of above factories	M-4, 6, 7, A-5	M-1, 4, 6, 7 A-5	M-4, 5, 6, 7 A-5
Total investment amount (1,000 SIT)	195,260	238,460	219,890
Sewage fee: Max. (After pretreatment) Ave. (SIT/m³) Min.	246 164 93	332 160 80	210 163 84
COD reduction (kg/d) BOD reduction (kg/d) SS reduction (Kg/d)	1,963 944 548	2,413 1,244 458	2,011 981 541
Treatment Cost Original Unit (1,000 SIT/kg/d) Total Investment Amount (SIT) / Pollutant Load Reduction Index [(COD+2BOD+2SS)kg/d/5]	197	205	217
(4) Characteristics and Problem Points	The maximum sewage fee before pretreatment is 530 SIT/m³ and the ratio between maximum and minimum is 5.7 times. This is believed to be a relatively realistic system, but an explanation as to the fairness of the fee system is required.	As gradient (A) is steep, sewage fees become excessive. The maximum before pretreatment is 900 SIT/m³ and the ratio between maximum and minimum is as large as 11 times. Explanation of the fairness is required.	This system promotes factories to be self-responsible for the active reduction of pollutant loads, and is being implemented in Japan.

Table 3.2.5 Feasibility Study Result for Pretreatment in Case-1b

[Sewage charge(SIT) = 0.4X190]

NO	Factory		Pretreatment Equipment				Sewage charge			Daily Expense			Pretreatment		Sewage Charge		COD Reduction			BOD Reduction			SS Reduction		
	Name	Industry	Case	Process	Const. Cost	Treat. Cost	Quantity	before	after	before	after	Balance	Feasible	Invest.	Quant.	Charge	Before	After	Reduct.	Before	After	Reduct.	Before	After	Reduct.
					1000SIT	SIT/m3	m3/d	SIT/m3	SIT/m3	1000SIT/d	1000SIT/d	1000SIT/d	or not	SIT	m3/d	SIT/m3	kg/d	kg/d	kg/d	kg/d	kg/d	kg/d	kg/d	kg/d	kg/d
M-1	SVILA	Textile	Case-1	Aerobic	154.400	147	1500	184	151	277	447	170	No	-	1500	184	750	750	0	450	450	0	60	60	0
			Case-2	+Coa&Sedi.	55.000	103	1500	184	138	277	362	85													
			Case-3	Neutra.	43.200	82	1500	184	138	277	330	53													
M-2	MARLES	Furniture	Case-1	Coa&Sedi.	23.955	63	298	117	112	35	52	17	No	-	298	117	42	42	0	18	18	0	11	11	0
			Case-2	+Aero.	44.000	174	298	117	93	35	80	45													
M-3	ARMAL	Metal	-	-	-	-	372	93	93	35	35	0	No	-	372	93	7	7	0	3	3	0	0	0	0
M-4	PIVOVARNA	Food	Case-1	Anaerobic	39.300	117	515	215	134	111	129	19													
			Case-2	Aerobic	35.960	61	515	215	152	111	110	-1	Yes	35.960	515	152	458	206	252	134	38	96	39	58	-19
			Case-3	Aerobic	43.500	71	515	215	152	111	115	4													
M-5	VINAG	Food	Case-1	Aerobic	24.630	226	90	246	151	22	34	12	No	-	90	246	68	68	0	46	46	0	8	8	0
M-6	KOSAKI	Food	Case-1	Oil Sepa.	0	0	400	530	434	212	174	-38													
			Case-2	Coa & Flo	50.000	140	400	530	223	212	145	-67													
			Case-4	K+Cont.Oxi	80.000	188	400	530	131	212	128	-84	Yes	80.000	400	131	600	100	500	400	40	360	400	12	388
M-7	MLEKARNA	Food	Case-1	Neutra.	13.605	28	476	490	490	233	247	13													
			Case-2	Coa & Flot	19.000	65	476	490	278	233	163	-70													
			Case-3	Anaerobic	40.000	158	476	490	154	233	149	-85	Yes	40.000	476	154	1163	212	951	412	67	345	197	18	179
			Case-4	Case2+Aero	36.000	106	476	490	254	233	172	-62													
S-1	MERINKA	Textile	Case-1	Coa & Sedi	143.800	152	1200	172	136	206	345	139	No	-	1200	172	780	780	0	180	180	0	44	44	0
S-2	TABOR	Textile	Case-1	Coa & Sedi	50.000	265	1200	107	107	128	149	21													
			Case-2	Coa & Sedi	18.000	55	1200	107	107	128	65	-63	(Yes)	(18000)	(400)	107	120	40	(80)	30	10	(20)	36	12	(24)
S-3	MTT	Textile	Case-1	Coa & Sedi	50.000	18	3000	194	192	582	629	47	No	-	3000	194	1020	1020	0	420	420	0	1020	1020	0
S-4	TSP	Textile	Case-1	Coa & Sedi	40.000	205	200	160	128	32	67	34	No	-	200	160	80	80	0	40	40	0	8	8	0
			Case-2	Coa & Sedi	10.000	55	200	160	149	32	41	9													
S-5	METALNA	Metal	Case-1	Coagulat.	24.000	95	222	117	114	26	47	21	No	-	222	117	32	32	0	14	14	0	7	7	0
S-6	SLOSAD	Food	Case-1	Anaerobic	12.000	140	35	738	414	26	19	-6	No	-	(35)	(870)				49	49	0			
S-7	INTES	Food	-	-	-	-	126	131	131	16	16	0	No	-	126	131	27	27	0	10	10	0	8	8	0
A-1	TVT	Metal	-	-	-	-	620	99	99	61	61	0	No	-	620	99	16	16	0	6	6	0	21	21	0
A-2	SVETILKE	Metal	-	-	-	-	130	101	101	13	13	0	No	-	130	101	9	9	0	1	1	0	4	4	0
A-3	PRIMAT	Metal	Case-1	Coagu.	10.000	64	109	113	109	12	19	7	No	-	109	113	18	18	0	5	5	0	2	2	0
A-4	ELKO	Metal	-	-	-	-	155	97	97	15	15	0	No	-	155	97	7	7	0	1	1	0	3	3	0
A-5	HENKEL	Chemical	Case-1	Anaero.	39.300	50	651	245	178	160	148	-11	Yes	39.300	651	178	482	221	260	260	117	143	130	130	0
A-6	SVATY	Chemical	-	-	-	-	149	116	116	17	17	0	No	-	149	116	19	19	0	7	7	0	7	7	0
	Total												Total	195.260	10.213		5698	3655	1963	2487	1522	944	2005	1433	548
													Average			164									
													Max.			246									
													Min.			93									
													Rate(%)	-		-			34			38			27

Note: S-2(TABOR) and S-6(SLOSAD) are not included in the simulation.
Pretreatment for SLOSAD is not feasible because of short period(1-2M/Yr) for high concentration effluent.
Pretreatment for TABOR aims at water conservation for dilution.

Table 3.2.6 Feasibility Study Result for Pretreatment in Case-2d

[Sewage charge(SIT) = 0.8X+20. Min.80 SIT/m3]

NO	Factory Name	Industry	Pretreatment Equipment Case	Process	Const. Cost 1000SIT	Treat. Cost SIT/m3	Sewage charge Quantity m3/d	before SIT/m3	after SIT/m3	Daily Expense before 1000SIT/d	after 1000SIT/d	Balance 1000SIT/d
M-1	SVILA	Textile	Case-1	Aerobic	154.400	147	1500	209	142	313	433	120
			Case-2	+Coa&Sedi.	55.000	103	1500	209	116	313	329	15
			Case-3	Neutra.	43.200	82	1500	209	116	313	297	-16
M-2	MARLES	Furniture	Case-1	Coa&Sedi.	23.955	63	298	80	80	24	43	19
			Case-2	+Aero.	44.000	174	298	80	80	24	76	52
M-3	ARMAL	Metal	-	-	-	-	372	80	80	30	30	0
M-4	PIVOVARNA	Food	Case-1	Anaerobic	39.300	117	515	270	108	139	116	-23
			Case-2	Aerobic	35.960	61	515	270	144	139	105	-34
			Case-3	Aerobic	43.500	71	515	270	144	139	111	-28
M-5	VINAG	Food	Case-1	Aerobic	24.630	226	90	332	142	30	33	3
M-6	KOSAKI	Food	Case-1	Oil Sepa.	0	0	400	900	708	360	283	-77
			Case-2	Coa & Flo	50.000	140	400	900	286	360	170	-190
			Case-4	& Cont.Oxi	80.000	188	400	900	102	360	116	-244
M-7	MLEKARNA	Food	Case-1	Neutra.	13.605	28	476	820	820	391	404	13
			Case-2	Coa & Flot	19.000	65	476	820	396	391	220	-171
			Case-3	Anaerobic	40.000	158	476	820	149	391	146	-245
			Case-4	Case2+Aero	36.000	106	476	820	349	391	217	-174
S-1	MERINKA	Textile	Case-1	Coa & Sedi	143.800	152	1200	184	111	221	316	95
S-2	TABOR	Textile	Case-1	Coa & Sedi	50.000	265	1200	80	80	96	138	42
			Case-2	Coa & Sedi	18.000	55	1200	80	80	96	54	-42
S-3	MTT	Textile	Case-1	Coa & Sedi	50.000	18	3000	228	223	684	724	40
S-4	TSP	Textile	Case-1	Coa & Sedi	40.000	205	200	161	95	32	60	28
			Case-2	Coa & Sedi	10.000	55	200	161	138	32	39	7
S-5	METALNA	Metal	Case-1	Coagulat.	24.000	95	222	80	80	18	39	21
S-6	SLOSAD	Food	Case-1	Anaerobic	12.000	140	35	(1316)	668	46	28	-18
S-7	INTES	Food	-	-	-	-	126	102	102	13	13	0
A-1	TVT	Metal	-	-	-	-	620	80	80	50	50	0
A-2	SVETILKE	Metal	-	-	-	-	130	80	80	10	10	0
A-3	PRIMAT	Metal	Case-1	Coagu.	10.000	64	109	80	80	9	16	7
A-4	ELKO	Metal	-	-	-	-	155	80	80	12	12	0
A-5	HENKEL	Chemical	Case-1	Anacro.	39.300	50	651	330	196	215	160	-55
A-6	SVATY	Chemical	-	-	-	-	149	80	80	12	12	0
	Total											

NO	Factory Name	Case	Pretreatment Feasible or not	Invest. SIT	Sewage Charge Quant. m3/d	Charge SIT/m3	COD Reduction Before kg/d	After kg/d	Reduct. kg/d	BOD Reduction Before kg/d	After kg/d	Reduct. kg/d	SS Reduction Before kg/d	After kg/d	Reduct. kg/d
M-1	SVILA	Case-3	Yes	43.200	1500	116	750	300	450	450	150	300	60	150	-90
M-2	MARLES	Case-1	No	-	298	80	42	42	0	18	18	0	11	11	0
M-3	ARMAL	-	No	-	372	80	7	7	0	3	3	0	0	0	0
M-4	PIVOVARNA	Case-2	Yes	35.960	515	144	458	206	252	134	38	96	39	58	-19
M-5	VINAG	Case-1	No	-	90	332	68	68	0	46	46	0	8	8	0
M-6	KOSAKI	Case-4	Yes	80.000	400	102	600	100	500	400	40	360	400	12	388
M-7	MLEKARNA	Case-3	Yes	40.000	476	149	1163	212	951	412	67	345	197	18	179
S-1	MERINKA	Case-1	No	-	1200	184	780	780	0	180	180	0	44	44	0
S-2	TABOR	Case-2	(Yes)	(18000)	(400)	80	120	40	(80)	30	10	(20)	36	12	(24)
S-3	MTT	Case-1	No	-	3000	228	1020	1020	0	420	420	0	1020	1020	0
S-4	TSP	Case-1	No	-	200	161	80	80	0	40	40	0	8	8	0
S-5	METALNA	Case-1	No	-	222	80	32	32	0	14	14	0	7	7	0
S-6	SLOSAD	Case-1	No	-	(35)	(870)				49	49	0			
S-7	INTES	-	No	-	126	102	27	27	0	10	10	0	8	8	0
A-1	TVT	-	No	-	620	80	16	16	0	6	6	0	21	21	0
A-2	SVETILKE	-	No	-	130	80	9	9	0	1	1	0	4	4	0
A-3	PRIMAT	Case-1	No	-	109	80	18	18	0	5	5	0	2	2	0
A-4	ELKO	-	No	-	155	80	7	7	0	1	1	0	3	3	0
A-5	HENKEL	Case-1	Yes	39.300	651	196	482	221	260	260	117	143	130	130	0
A-6	SVATY	-	No	-	149	80	19	19	0	7	7	0	7	7	0
			Total	238.460	10.213		5698	3205	2413	2487	1222	1244	2005	1523	458
			Average			160									
			Max.			332									
			Min.			80									
			Rate(%)						42			50			23

Note: S-2(TABOR) and S-6(SLOSAD) are not included in the simulation.
Pretreatment for SLOSAD is not feasible because of short period(1-2M/Yr) for high concentration effluent.
Pretreatment for TABOR aims at water conservation for dilution.

Table 3.2.7 Expected Factory's Behavier and Sewage Charge with Regulation for COD, BOD, SS in Case-3

(Condisions to be required Pretreatment: COD>650 or BOD>350 or SS>350)

NO.	Factory		Quantity	Wastewater Quality			Pretreatment Equipment				Conditions after Pretreatment				Sewage charge(SIT/m3)		
	Name	Industry		COD	BOD	SS	Required or Not	Process	Const. Cost	Treat. Cost	Quantity	COD	BOD	SS	Case-3a	Case-3b	Case-3c
			m3/d	mg/L	mg/L	mg/L			1000SIT	SIT/m3	m3/d	mg/L	mg/L	mg/L	0.3X110	0.5X180	0.6X160
M-1	SYILA	Textile	1500	500	300	40	No	-	-	-	1,500	500	300	40	181	198	202
M-2	MARLES	Furniture	298	141	60	36	No	-	-	-	298	141	60	36	130	113	100
M-3	ARMAL	Metal	372	20	8	0	No	-	-	-	372	20	8	0	112	84	64
M-4	PIVOVARNA	Food	515	890	260	76	Case-2	Aerobic	35,960	61	515	400	74	113	156	157	153
M-5	VINAG	Food	90	750	510	90	Case-1	Aerobic	24,630	226	90	220	100	172	156	156	152
M-6	KOSAKI	Food	400	1500	1000	1000	Case-4	Contn.Oxi.	80,000	188	400	250	100	30	141	131	121
M-7	MLEKARNA	Food	476	2443	866	414	Case-3	Anaerobic	40,000	158	476	446	141	38	158	160	156
S-1	MERINKA	Textile	1200	650	150	37	No	-	-	-	1,200	650	150	37	171	182	183
S-2	TABOR	Textile	1200	100	25	30	No	-	-	-	1,200	100	25	30	123	101	85
S-3	MIT	Textile	3000	340	140	340	No	-	-	-	3,000	340	140	340	188	210	216
S-4	TSP	Textile	200	400	200	40	No	-	-	-	200	400	200	40	163	168	166
S-5	METALNA	Metal	222	146	62	32	No	-	-	-	222	146	62	32	130	113	100
S-6	SLOSAD	Food	35	4300	1400	500	No	-	-	-	(35)	4,300	1,400	500	(596)	(890)	(1032)
S-7	INTES	Food	126	212	82	67	No	-	-	-	126	212	82	67	141	131	121
A-1	TVT	Metal	620	26	10	33	No	-	-	-	620	26	10	33	117	91	73
A-2	SVETILKE	Metal	130	70	5	30	No	-	-	-	130	70	5	30	118	94	77
A-3	PRIMAT	Metal	109	161	46	17	No	-	-	-	109	161	46	17	127	109	94
A-4	ELKO	Metal	155	47	5	18	No	-	-	-	155	47	5	18	116	89	71
A-5	HENKEL	Chemical	651	740	400	200	Case-1	Anaero.	39,300	50	651	340	180	200	176	190	192
A-6	SWATY	Chemical	149	130	50	47	No	-	-	-	149	130	50	47	129	112	99
	Total		11448						219,890		11413						
	Average														160	163	160
	Max														188	210	216
	Min														112	84	64

Note:(1) [ ] : required Pretreatment.
(2)S-6(SLOSAD) is not included in the study because of low quantity.

NO.	Factory		COD Reduction			BOD Reduction			SS Reduction		
	Name	Industry	Before	After	Reduction	Before	After	Reduction	Before	After	Reduction
			kg/d	kg/d	kg/d	kg/d	kg/d	kg/d	kg/d	kg/d	kg/d
M-1	SYILA	Textile	750	750	0	450	450	0	60	60	0
M-2	MARLES	Furniture	42	42	0	18	18	0	11	11	0
M-3	ARMAL	Metal	7	7	0	3	3	0	0	0	0
M-4	PIVOVARNA	Food	458	206	252	134	38	96	39	58	-19
M-5	VINAG	Food	68	20	48	46	9	37	8	15	-7
M-6	KOSAKI	Food	600	100	500	400	40	360	400	12	388
M-7	MLEKARNA	Food	1163	212	951	412	67	345	197	18	179
S-1	MERINKA	Textile	780	780	0	180	180	0	44	44	0
S-2	TABOR	Textile	120	120	0	30	30	0	36	36	0
S-3	MIT	Textile	1020	1020	0	420	420	0	1020	1020	0
S-4	TSP	Textile	80	80	0	40	40	0	8	8	0
S-5	METALNA	Metal	32	32	0	14	14	0	7	7	0
S-6	SLOSAD	Food	151	151	0	49	49	0	18	18	0
S-7	INTES	Food	27	27	0	10	10	0	8	8	0
A-1	TVT	Metal	16	16	0	6	6	0	21	21	0
A-2	SVETILKE	Metal	9	9	0	1	1	0	4	4	0
A-3	PRIMAT	Metal	18	18	0	5	5	0	2	2	0
A-4	ELKO	Metal	7	7	0	1	1	0	3	3	0
A-5	HENKEL	Chemical	482	221	260	260	117	143	130	130	0
A-6	SWATY	Chemical	19	19	0	7	7	0	7	7	0
		Total	5849	3838	2011	2487	1506	981	2023	1483	541
		Rate(%)			34			39			27

3.2.2 Basic Thinking in Japan on Sewage Fee Calculations

According to the results of the fourth study, one of the systems that Maribor City is thinking of establishing is a WWTP fee system on the basis of the fee structure of the existing Domzale sewage-treatment plant. The fee structure of this sewage-treatment plant is a system in which the treatment fee is made higher as the degree of pollution of the wastewater increases. Also, COD/600+BOD/300 is included in a part of the pollution index to give BOD twice the weight of COD.

On the other hand, there was a request from Maribor City for an introduction of the Japanese system, so we would like to clarify its relation to the fee structures given in the previous section.

Summaries of the standard thinking in Japan regarding the fees for the use of the sewage system for factory wastewater are given below.

(1) Classification into normal wastewater and special wastewater

Effluent above a certain quantity that is discharged into sewers by factories and enterprises in the course of business activities is classified as special wastewater. The system charges a high fee for such effluent on the "polluter pays" principle. This system has been adopted by some municipalities. The standard for a certain quantity above which the effluent is classified as special wastewater is often 500 to 1,000m^3/month.

(2) Basic fee and progressive fee

This system has a basic fee and a progressive fee jointly set up so that the unit fee rate becomes higher as the amount of use increases. This acts as an incentive to control demand. The degree of progression (maximum unit rate/basic unit rate) is often in the range of 1 to 3. Many municipalities have adopted this system. An example of its implementation is shown below.

(per one month)

Classification	Fee Rate
0m^3 - 10m^3	Basic fee: 600 yen
11 - 50	80 yen/m^3 *
51 - 200	100 yen/m^3*
201 - 500..	125 yen/m^3*
501 or more	150 yen/m^3*

* Progressive fee

(3) Water quality fee

This system tries to be fair to ordinary users by imposing fees in accordance with the degree of pollution of the effluent over a certain standard. It acts as an incentive to improve the wastewater quality. It is set together with a progressive fee as shown above. A water quality fee should be charged against items that can be treated by the sewage-treatment plant, and is usually applied to COD, BOD, and SS. There are two ways of setting the water quality fee rate. One is against each water quality item, and the other is to charge against each pollution concentration index as calculated from the total concentration of the various water quality items. Also, the water quality to be applied the fee should be that exceeds the concentration of ordinary household effluent. This means that usually the applicable effluent is one with BOD of 200 mg/L or more and with SS of 200 mg/L or more. This system is employed by several municipalities which have large amounts of factory effluent.

These points summarize the standard thinking on the calculation of sewage fees. Their combinations can be largely divided, as shown below.

Specific examples are given in the Supplement.

(1) Basic fee + progressive fee system:

Refer to 8.3 of Relative information ; Ariake Treatment Plant

(2) Basic fee + progressive fee + water quality fee system:

Refer to 8.1 of Relative information ; Wakayama Treatment Plant

(3) Basic fee + water quality fee system:

Refer to 8.2 of Relative information ; Kashima Treatment Plant

Of the above, system (1) has an incentive to reduce water volume, system (3) has an incentive to improve water quality, and system (2) has a combination of the two. The calculation formula proposed in 3.2.1 belongs to system (3). Note that in Japan, a sewage emission standard is stipulated by the Sewerage Law, which includes BOD and SS as items of control. In the standard, 300 mg/L is the limitation on BOD and SS concentrations, respectively, for manufacturers who have effluent volumes of $50m^3$/day or more. However, since municipalities can set rules making this standard the lower limit, in actuality there are cases which permit COD_{Mn} and BOD levels up to 600mg/L and which BOD and SS levels are each 300mg/L. Therefore, naturally it is a precondition that there are controls on BOD and SS in the thinking on the calculation of usage fees mentioned above. Note that, as a rule, there are no restrictions on COD when the effluent of sewage-treatment plants is discharged into rivers.

3.3 Removal of Nitrogen and Phosphor

The standard for the discharge into rivers of factory effluent T-P is generally 2mg/L and, in the case of the textile industry, an extremely severe 1mg/L. Of the factories subjected to this survey, there were many whose effluent exceeded this standard. However, most exceeded the standard by single digit figures and only a small number exceeded it by double digits. The phosphor concentration of the entire wastewater of Maribor City is believed to be even lower than that.

Conceptual designs for discharge into rivers were prepared for the installation of pretreatment facilities for the removal of phosphor in each of the model factories that exceeded the emission standard. It is clear from the results that such installations will be extremely expensive. Therefore, it will more advisable for the treatment to be carried out collectively by the WWTP (the current WWTP plan includes a process for removing phosphor).

For the method of treatment, please refer to "1. Nitrogen-Phosphorus-Removal Technology," a supplement attached to Relative Information.

V. Recommendations

V. Recommendations

In this Chapter, we submit our proposals to the Government and to the factories based on the results of the preceding chapters. The contents of our proposals are divided into (1) industrial wastewater and pretreatment, (2) water conservation, (3) the WWTP, and (4) measures that should be taken by government.

In industrial wastewater and pretreatment, first we advise the factories to grasp the actual state of their industrial wastewater. To do so, each factory we recommend the appointment of person exclusively for that purpose, the installation of flowmeters in the factory facilities, the simplification of wastewater sampling procedures, and the regular measurement of water quality and volume. We also point out a few technical issues that should be tackled by the factories in the future. In addition, we give advice on injurious substances that the WWTP should be careful about when in operation.

In water conservation, first we mention that water conservation not only reduces the amount of water consumed but also indirectly reduces the amount of pollution flowing into rivers, lowers the volume of pollution to be treated by the WWTP, and improves the operational situation of the factory. Next, as suggestions to the Government, we take up (1) technical and financial assistance to enterprises, and (2) the setting up of a WWTP fee structure that will not hinder improvements and upgrading by enterprises. In addition, as recommendations to enterprises, we advise that they should (1) accurately grasp their water consumption and wastewater volume to work towards a perfect water balance, (2) grasp the minimum volume and quality required for each purpose, (3) review the water balance to cope with any changes in the operating state of their factories, (4) study specific improvement methods, and, after checking the economic efficiency of those methods, start carrying out those that can be implemented.

With regard to the WWTP, we make recommendations on the establishment of a fee structure for industrial wastewater. As the basic policy for establishing WWTP fee structure, we lay down the following principles: (1) WWTP's cost shall be covered by the fees paid by users, (2) the average treatment cost shall be 160 SIT/m^3, and this shall be raised or lowered depending on the degree of pollution of the industrial wastewater, (3) the index for expressing the degree of pollution shall be COD, BOD, and SS. Based on the above principles, the fee calculation formula was made a primary function of the pollution index. Based on this calculation formula, we propose the following three recommendable cases and describe their characteristics, whereby: (1) industrial wastewater is handled under a separate fee structure from household effluent, (2) the minimum fee for industrial wastewater is made the household effluent fee, and (3) pollutant load limits are set on industrial wastewater. Also, we describe what should be done by the administrative authorities based on the comments. In addition, we state that consideration should be given to high COD concentrations when the WWTP is in operation.

Finally, we give the measures that should be taken by the Government. First, we emphasize the need for a special agency for fostering human resources. We also give the position the special agency should hold, its main functions, and its operating method. In addition, we propose the establishment of a specialist qualification system, and the institution of a tax reduction and exemption system and low interest financial loans for environmental equipment investments as incentives for the implementation of environmental protection measures. We further mention the need for environmental engineering companies, and describe ways to foster them.

1. Treatment of Industrial Wastewater and Pretreatment

1.1 Necessity of Studying the Actual Condition of Industrial Wastewater

Through this survey, we learned that, with the exception of a few enterprises, general factories are not aware of the actual condition of the effluents they discharge. Nor are they aware of the volumes of water they consume other than tap water; i.e. water from their own wells and rivers. Even in large-sized factories, they do not measure water consumption by the building, much less by the process.

Following are our recommendations regarding the treatment of industrial wastewater in each factory:

(1) Establish in each factory an environmental-preservation section exclusively devoted to the management of industrial wastewater, and appoint a full-time person in charge.

a. Have the Chief Executive appoint the person directly, and invest the person with authority.

b. Benchmark model enterprises (like Henkel-Zlatrog).

(2) Install flowmeters.

c. Install flowmeters in each factory to measure the quantity of water taken from rivers and the factory's own wells.

d. Install flowmeters to measure the water consumption of each major process.

(Water consumption management like rationalization of water use starts with the installation of the flowmeters.)

(3) Secure the capability to collect proper effluent samples.

e. Install effluent pits if possible.

f. Prepare effluent ports of circular sections so that flowmeters can be installed on drainage canals.

(When flow proportional composite samples are collected, average water quality of a day can be obtained.)

(4) Regular measurement of water quantity and water quality

g. Enterprises and the Government must jointly determine a set of analysis items for voluntary management.

(Analysis of all items is not necessary every time.)

h. The WWTP will bear the cost of water quality analysis required for the assessment of sewage rates, and the cost of checking for observing the standards.

(Spot inspection by an inspector or NIGRAD must in principle be conducted.)

i. Accelerate the integration of discharge ports.

(With the integration, total drainage volume and water quality can be checked economically. Make the integration obligatory by providing subsidies.)

(5) Notify relevant agencies of changes made in major processes which affect effluent greatly, changes in product items, and the raw material.

j. Items regarding hazardous substances and those which affect the calculation of sewage rates must be notified in advance.

1.2 Continuous Study of Technology

This survey has shown that even factories in the same industry are affected by different types of problems. The report given here covers only general surveys and conceptual study and design.

For the actual planning of the installation of wastewater-treatment facilities and pretreatment facilities, We advise you to refer to this report in detail when checking the circumstances of the plan, and to continuously confirm the effects obtained through small-scale experiments as the plan is carried forward.

We also suggest that you conduct ongoing research on potentially fruitful subjects whose results many factories can hold in common. If foreign countries offer technical assistance, make use of it.

Following are several research subjects which we deem highly recommendable: (Not listed in any particular order)

(1) The effect of the charcoal-filtration equipment installed in S-2 TABOR was confirmed even under a low-concentration condition by the fourth on-site survey. Observe the performance of the equipment over a long period.

(2) It seems that S-2 TABOR uses more water than standard in order to lower the pollutant concentration of effluent. With the introduction of proper wastewater treatment, the volume of water used can be decreased sharply. Based on the result, the economy of direct discharge to rivers and discharge to the sewer must be compared minutely.

(3) The design of M-1 SVILA's model wastewater-treatment system, a design based on the information obtained from the second on-site survey, places too much of an emphasis on the removal of color. Judging from the result of the fourth on-site survey (coagulation tests etc.), when biological treatment is employed after coagulating-sedimentation treatment, the size of the biological treatment facilities can be reduced greatly, and ozonization and activated-carbon treatment introduced as a measure against coloring will possibly become unnecessary. Wastewater treatment facilities which discharge directly to rivers need to be reexamined.

(4) pH of the total effluent of S-3 MTT is very high and the pollutant concentration is higher than that of dyeing effluent. Bleaching and scouring may have a great influence. Check the matter and take necessary measures.

(5) The wastewater of A-5 Henkel-Zlatrog has high concentrations of COD, BOD, and oil, but these pollutants can be treated biologically. Aerobic biological treatment will cause foaming, but anaerobic biological treatment may be applicable. Small-sized experiments of anaerobic biological treatment must be conducted. This technology can be applied to the treatment of other high-concentration wastewater.

1.3 Education on Substances Hazardous to the WWTP

We recommend that the factories which send effluent for treatment at the WWTP be educated on the substances that hinder its operation. Refer to "Relative Information", Item 4 for a list of substances which hinder WWTP operations and the volumes required to cause hindrance; and "Relative Information" , Item 3 for a description of the technologies used to remove these substances.

2. Water Conservation

2.1 Effects of Water Conservation

2.1.1 Outline

The following beneficial effects can be obtained from the water conservation.

① Reduction in the volume of pollutants discharged into rivers

② Reduction in the pollution load requiring treatment by the WWTP

③ Improvement in the management of enterprises

Below is a simple description of these effects.

2.1.2 Reduction in the Volume of Pollutants Discharged into Rivers

① Reduction in the volume of pollutants generated in factories

It is rare that water conservation directly reduces the volume of pollutants. For water saving, however, working conditions and production processes must be improved. As a result, it is expected that the amount of pollutants discharged may be reduced.

② Reduction in the volume of pollutants in treated wastewater

After the industrial effluent is treated by the WWTP or by treatment equipment on-site at the factories in order to bring the water quality up to the emission standards, the treated water is discharged into rivers. When water is saved and the drainage volume is decreased, the volume of pollutants discharged into rivers will be decreased to a comparable degree since the water quality of treated water is constant.

2.1.3 Reduction in the Pollution Load Requiring Treatment by the WWTP

For the reasons described above in 2.1.2.①, water saving not only reduces the volume of pollutants requiring treatment by the WWTP, but also the pollution load.

Even if the volume of industrial effluent is increased and exceeds the WWTP's treatment capacity due to increased industrial production in the future, the circumstances can be improved by promoting water saving.

2.1.4 Improvement in the Management of Enterprises

This survey clearly showed that, for each of the factories surveyed, the ratio of the cost of industrial water and effluent to the shipping price is much higher than the corresponding ratios for factories in the same industry in Japan.

Promotion of water conservation is an effective way of decreasing the ratio and improving the management of enterprises for the time being.

It was also clarified that, with the present rates on industrial water and effluent, economical use of industrial water can be reduced by about 20%. This indicates that the management of enterprises can be improved by the promotion of water saving.

The ratio of the cost of industrial water and effluent in the shipping price must be compared with the corresponding ratios in countries other than Japan, particularly those of the countries in Europe. However, as the ratios are exclusive materials of enterprises, they are not published in Japan or any other foreign countries. The ratios used here for comparison are exclusive data possessed by the Water Reuse Promotion Center.

2.2 Recommendations on Water Conservation

2.2.1 Recommendations to the National Government and Cities

As mentioned above, the water conservation is expected to bring about much effect. Therefore, the water conservation must be propelled as a policy, and the national government and cities are requested to indirectly assist enterprises which are obliged to implement conservation.

Specifically, We recommend that the national government and cities take the following measures:

① Technical assistance to enterprises

Experts in water conservation must be positioned in the national government or cities to energetically advise and instruct enterprises.

② Financial assistance to enterprises

In principle, enterprises must implement water conservation with their own funds, but great benefit can be gained by providing a financing system with low interest rates such as that implemented in Japan in order to reduce the burden on enterprises.

③ Establishing a sewage rating system which does not hinder water conservation

As almost all industrial effluent is discharged to the WWTP, a sewage rating system which makes it disadvantageous to implement water conservation from an economic viewpoint (for example, a system under which the rate for unit waste volume increases with decreases of drainage volume) would not be favorable.

In relation to the above ②, several types of financial assistance given to enterprises in Japan are described below.

① Low-interest rate financing system for equipment for water conservation.

This is a system under which the national or local governments finance a certain percentage of the cost of equipment installed in enterprises at a rate lower than that of open market, with several limits set according to the plant site and facilities installed.

② Incentive taxation system for energy-conserving equipment

When an enterprise installs equipment which are certified by the national government as energy conserving equipment, a certain percentage of the installation cost is deducted from the taxes.

2.2.2 Recommendations to Enterprises

As all of our concrete recommendations and general technical guidance are presented in the report and attachments, only a few very fundamental recommendations will be given here.

① Enterprises must understand that the cost of industrial water and effluent have a substantial effect on their finances.

As mentioned previously, the ratio of the cost of industrial water and effluent in the shipping price is comparatively high. It is important to fully recognize this point and aggressively propel the water conservation.

② Correctly determine the volume of industrial water used and the volume of effluent,and make a complete balance of water.

As indicated in 1.1, the factories surveyed did not adequately manage the volume of industrial water used. Of the 9 factories which use well water and river water, water meters were installed in only 3. Of the factories to which tap water is supplied through the common water meter, 2 factories had not installed water meters of their own.

This recommendation was already made in 1.1, but as it is the most fundamental item for water conservation, we repeat it here.

③ Whenever possible, try to accurately ascertain the minimum volume of water and lowest limit of water quality required for a certain purpose.

The simplest way to save water is not to use it, supplying only the minimum volume of water required for a certain purpose. To reclaim the water used, it is imperative that the quality of the reclaimed water is above the lowest required level.

It is technically very difficult to ascertain the above-mentioned values. Execution of the above requires close cooperation of water-treatment engineers and production engineers. Even in Japan, execution is extremely rare, and limited to cases when there is an urgent need for water saving, for example, at times of drought.

④ Study concrete methods of water conservation, determine the most applicable method, confirm its economy, and begin execution.

One must be careful in confirming economy. It is essential to obtain a correct written estimate from the manufacturer of the equipment.

⑤ Water balance must be remade in accordance with the change in the operation of factories.

As water balance changes constantly, establish a certain remaking method and remake the balance periodically and regularly.

As water balance indicates a factory's production processes and production states, normally it is not presented to outsiders. It is not known, therefore, how water balance is actually remade. In the factories located in the areas which often suffer from droughts, water balance is remade even in normal times to promote water saving in preparation for future water shortages.

If the assistance of external experts can be obtained for executing the above ② to ⑤, we expect that it will be possible to compensate for the shortage of technical knowledge on the factory side and transfer the technology.

3. The WWTP

3.1 Setting of Rates

Before making any recommendations to the WWTP, let us rearrange the results of the simulation on the system to set sewage rates indicated in the preceding Chapter 3.2.1. First of all, the following principles are established as a fundamental policy in setting the system of WWTP rates.

(1) The total treatment cost of the WWTP must be covered by the rates paid by users.

(2) Average total treatment cost shall be 160 SIT/m³, and this rate shall be increased or decreased depending on the degree of pollution and the volume of industrial effluent.

(3) The indexes expressing the degree of pollution shall be COD, BOD, and SS (pollutants which the WWTP cannot treat, and phosphorus and nitrogen, which the WWTP plans to remove in the future, will not be taken into consideration). Based on the above principles, the calculation equation of the rate per 1m³ is decided as follows.

$$\text{Rate (SIT/m}^3\text{)} = A \cdot (\text{COD} + 2 \cdot \text{BOD} + 2 \cdot \text{SS})/5 + B$$

Having decided the rate calculation equation as above, it is now necessary to select one of two policies in setting a charging system. One policy is to set only a charging system and leave everything else to the principle of free economy. The other policy is to set a certain limit on the pollutant load of effluent, and let factories remove compulsorily the pollutant load which exceeds the limit. In Japanese sewage systems, a limit is set on the pollutant load and this limit is considered an effective measure for the reduction of pollutants. As every country has its own circumstances, however, judgment must be made accordingly.

Following are charging systems considered recommendable from the results of the surveys mentioned in the preceding chapters:

(1) To leave the actions of enterprises to the principle of free economy, two methods can be applied. One is managing household effluent and industrial effluent with separate charging systems. In this case, the rate calculation equation will be:

$$\text{Rate (SIT/m}^3\text{)} = 0.4 \cdot (\text{COD} + 2 \cdot \text{BOD} + 2 \cdot \text{SS})/5 + 90$$

The average rate of 20 factories surveyed will be 164 SIT/m³, with 4 of the factories out of the 20 applying preliminary treatment. Total amount invested by factories will be 195 million SIT, and as for the reduction of pollutant load implemented by this investment, COD will be reduced by 1,963kg/d, BOD by 944kg/d, and SS by 548kg/d.

(2) It is said that Maribor City will charge 80 SIT on 1m³ of household effluent uniformly. When this is taken into consideration, the above-mentioned method may be perceived as unfair since, in this case, the charge on the industrial effluent of low-pollutant load could potentially be less than 80 SIT/m³. The other method is to apply the charging system used for household effluent to industrial effluent of low-pollutant load, and to charge the industrial effluent with high-pollutant load according to the amount of the load. The rate calculation equation will be:

$$\text{Rate (SIT/m}^3\text{)} = 0.8 \cdot (\text{COD} + 2 \cdot \text{BOD} + 2 \cdot \text{SS})/5 + 20$$

The number of factories which apply preliminary treatment is 5 including SVILA, whose industrial effluent is large in volume, and the average rate will be 160/m³. The total amount invested will be 238 million SIT, and as for the reduction of pollutant load implemented by this investment, COD will be reduced by 2,413kg/d, BOD by 1,244kg/d, and SS by 458kg/d.

(3) To set a limit (COD:600mg/l, BOD:300mg/l,SS:300mg/l) on the pollutant load of the industrial effluent discharged to the WWTP, the following rate calculation equation can be applied:

$$\text{Rate (SIT/m}^3) = 0.5\cdot(\text{COD} + 2\cdot\text{BOD} + 2\cdot\text{SS}) + 70$$

In this case, the average rate will be 163/m³·, with 5 factories applying preliminary treatment. A total of 220 million SIT will be invested by the factories, with the reduction of the pollutant load implemented by the investment totaling 2,011kg/d for COD, 981kg/d for BOD, and 541kg/d for SS.

Three representative cases have been outlined above, and the characteristics of each case have been outlined in the preceding 3.2.1. There is another conception focusing in the reduction of load on the WWTP. The relation between load reduction and the investment amount required for the reduction is indicated in Fig. 3.2.1. According to the figures, SS reduction efficiency is almost constant regardless of the amount invested. Investment is very effective in the reduction of COD, with the reduction staying proportional to the amount invested until it reaches 240 million SIT, where the COD begins to show saturation. BOD has the same tendency as COD, but investment has less of an effect. Since there are more than one charging system equations for the same investment amount and reduction efficiency, both the investment effect and the characteristics of the calculation equations need to be taken into account in setting a calculation equation. Before any concept is applied, many cases, as well as their administrative, economic, and political implications, must be studied, and a sound judgment must be made. As a diskette with the calculation program (FORTRAN) is attached, please make use of it in the actual implementation.

It should be noted here that a calculation equation of rates concretely reflects the policies of the administration authorities, and that the method of estimating the result of the policies was established by this survey.

We present below the measures which, based on the results of the above study, the city authorities will have to take.

To begin with, the system to be adopted by the WWTP will have to be decided. As mentioned in the preceding Chapter 3.2.1, the total system to treat all of the effluent of Maribor City comprises both the WWTP and factories. Thus, the total system cannot be optimized unless the WWTP's system is determined beforehand.

Secondly, discussion will have to be held on how to allot the treatment of factories' pollutant load (COD, BOD, SS) to the WWTP and factories. As a result of this survey, it is estimated that almost all the factories will discharge their effluent to the WWTP under the current emission standards. If the city authorities are to request factories to reduce pollutant load of the effluent led to WWTP, they will have establish some regulations or set a charging system which necessitate the preliminary treatment of the effluent at the factories. In such a case, they will be able to make use of the relation of the pollutant reduction volume, the amount invested, and the charging system clarified by this survey.

Thirdly, note that the above-mentioned estimation of preliminary treatment is based on the economic calculation by the computer program, and not on the judgment of factories. Therefore, it will be necessary to discuss the estimation result with factories and confirm or amend the estimation.

When the above three items are cleared, it becomes possible to decide how to configure the total system. Please note that this recommendation is given based on the present condition. It is not possible to decide on a future system unless estimations on the industrial effluent of Maribor City in future are prepared. Incidentally, in Japan, a sharp increase in the demand for industrial water was estimated at the time of high growth, but in reality, the increase in substantial demand for industrial water was relatively slight due to the promotion of water reuse. Further, although in principle a factory's pollutant load is proportional to the production amount, change might be brought about to the industrial structure, so estimation will have to be made prudently.

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3.2 Removal of CODcr

The effluent of textile-dyeing factories accounts for about 20% of the total effluent led to the WWTP. As the effluent of textile-dyeing factories contains a large quantity of refractory COD component, there is a possibility that the WWTP's emission standard 100mg/L cannot be attained. That is why the removal of CODcr must be studied. For your reference, some recommendations based on actual examples in Japan are given below.

1) Characteristics of wastewater

The effluent from 5 textile dyeing factories (M-1, S-1, S-2, S-3, S-4) accounts for a high percentage of the wastewater for the whole of Maribor city, all of which will be led to the WWTP. The industrial effluent from these companies accounts for 20% in water volume, and 11% in the amount of CODcr. On the other hand, the industrial effluent of the 5 food and chemical factories (M-4, M-6, M-7, S-6, A-5), whose CODcr concentration is high, accounts for 5.3% in water volume and 11% in the amount of CODcr in the total wastewater.

The ratio of the above two types of industrial effluent put together accounts for 25% in water volume and 22% in the amount of CODcr (Table 3.2.1).

Table 3.2.1 Comparison of Total Wastewater, Textile Dyeing Industrial Effluent, and Other Effluent

		CODcr	
	m³/d	mg/l	kg/d
(1) Total Water Volume (to be treated at the WWTP)	36,600	691	25,517
(2) Effluent of 20 Factories Surveyed	11,558	500	5,784
(3) Effluent of Textile Dyeing Factories (5 factories)	7,342	387	2,838
Textile Dyeing/Total x 100, %	20		11
(4) Effluent of Food and Chemical Factories with High CODcr Concentration (5 factories)	1,938	1,400	2,710
Food and Chemical/Total x 100, %	5.3		11
(5) (3) + (4)/Total x 100, %	25		22

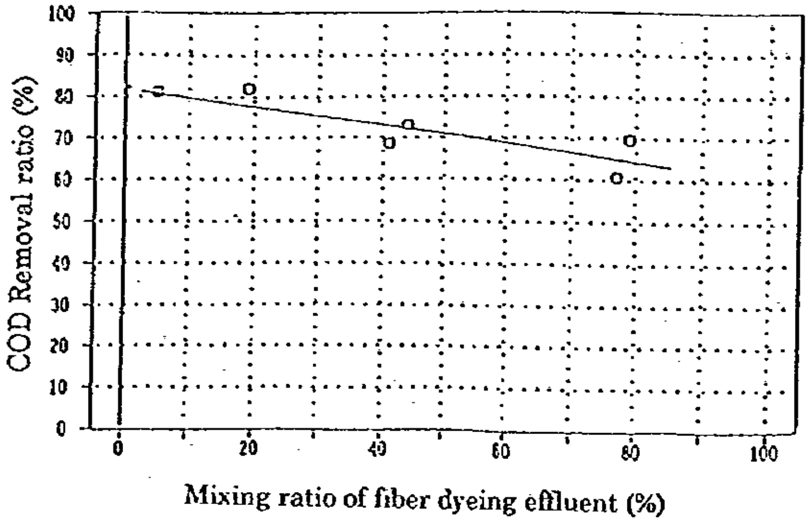
Notes: (1) Total water volume is quoted from the proposal made by Maribor City.
(2) The effluent of 20 factories surveyed was calculated from Table 1.1.2 of Chapter IV.
(3) The values of the effluent of 5 textile dyeing factories (M-1, S-1, S-2, S-3, S-4)

⑤ BOD/COD is low.

As refractory COD is contained in the effluent, the COD removal ratio in biological treatment will be low. In selecting the treatment system of the WWTP, this point must be taken into account.

(2) Matters demanding special attention in the removal of CODcr

When aerobic treatment is applied to the general household effluent mixed with textile dyeing effluent, the COD removal ratio decreases with the increase of the mixing ratio. This is confirmed by the records in Japan. The data are indicated in Fig. 3.2.1.



Source : Nippon Jogesuido Sekkei Co., Ltd.

Fig. 3.2.1 Relation of the Ratios of Water Volume Received and the COD_{Mn} Removal

From the above data, which covers exclusively the COD_{Mn} removal ratio, the removal ratio for CODcr is estimated to be a little lower. We are afraid, therefore, that it would be very difficult to reduce the 691mg/l CODcr contained in the raw effluent indicated in the proposal of the WWTP project to 100mg/l by treatment. When A2O system is applied and coagulant is added, the removal ratio will increase a little. Even in that case, the best result will be reduction from 500mg/l to 100mg/l COD. Consequently, textile dyeing factories may be obliged to install pretreatment equipment to remove some CODcr in advance. This point must be taken into account in studying the treatment processes of the WWTP.

3) Effluent of food and chemical factories of high CODcr concentration

As the effluent of food factories contains components which can be decomposed easily by biological treatment, it is estimated that its CODcr removal ratio will be higher than that of textile dyeing effluent. Its CODcr concentration is, however, very high, and the absolute volume is equal to that of textile dyeing effluent. This point must also be taken into account in studying the treatment processes of the WWTP.

Depending on the circumstances, it might be necessary to let the factories whose effluent contains a large quantity of CODcr apply preliminary treatment to reduce the volume of CODcr.

When the conceptual design of preliminary treatment equipment to reduce pollutant load was worked out for each factory, reduction in the volume of CODcr was estimated. Please make use of our data as references.

4. Measures Required of the Government

4.1 Fundamental Policy

Observation of regulatory standards is the first and minimum step we must take for the prevention of pollution, preservation of the environment, and minimization of the influence of business activities on the environment. For this purpose, four main pillars -framework, talent, technology, and funds-- must be set into balance.

Although standards for discharging industrial effluent to rivers and WWTP emission standards were both established in 1996, environmental pollution will keep progressing if enterprises fail to observe these standards and the government does not exercise proper management and instruction.

To propel preservation of the environment efficiently, it is essential not only to carry out personnel development on both the administration side and the factory side, but also to build up a financial incentive system in order to accelerate investment in environmental measures, and to encourage engineering companies to acquire the abilities to work as consultants to factories and design and install treatment equipment.

4.2 Personnel Development

To implement the measures to prevent water pollution, it is necessary to acquire a wide range of technologies and knowledge related to the mechanism of the generation of pollution, dispersion of pollutants, health damage, pollution-preventing measures, measuring methods, etc.

When experts with these technologies and knowledge are posted in the central government, local cities, and enterprises, environmental measures can be propelled efficiently.

To foster environmental experts as quickly as possible, it is important to establish an organization which handles the issues of the environment and personnel development exclusively under the leadership of the central government. Ideally, such an organization should have the following features:

1) Positioning

An organization under the direct control of the central government must take part in the organization, and the participation of persons from the private sector must be solicited in order to obtain wide-range cooperation.

2) Main function

① Promotion of environmental technology:

Offer training courses to disseminate knowledge of the mechanism of the generation of pollution, dispersion of pollutants, health damage, pollution-prevention measures, measuring methods, etc.

② Establishment of an expert qualification system:

Test those who have finished the above courses and qualify those who have passed the test as experts.

③ Production of texts on environmental technology:

Produce texts which contain all the knowledge required for experts, both for use in training courses and for distribution.

④ Propagation of the measures the government takes for the preservation of the environment

3) Funds for the establishment of the organization

Funds must be raised from far and wide; from the central government, local cities, industrial groups, enterprises, etc.

4) Management

In principle, the organization must be on a self-paying basis, but appropriation of national subsidies and membership fees from industrial groups for management must also be studied.

4.3 Incentive Systems for Investment in Environmental Measures

Enterprises regard the burden of the cost for environmental measures as negative investment which does not contribute to production.

The investment is, however, indispensable for the coexistence of the enterprises with society. Establishment of a taxation system and a financial incentive system which will accelerate the investment of enterprises in environmental measures is now required. The following systems are recommendable:

1) Tax reduction and exemption system for the installation of environment-preserving equipment

Establish and apply a cost depreciation period reduction system, and a fixed property taxes reduction and exemption system to the enterprises which have installed environment-preservation equipment in connection with wastewater treatment and rationalization of water use.

2) Low-interest rate financing system for investments in environment-preservation equipment

As environment-preservation equipment related with wastewater treatment exerts pressure on the finance of enterprises, governmental financial agencies are requested to establish a low-interest rate financing system or a system of grants-in-aid for paying interest to ease the pressure.

One possible option is the use of environmental taxes (for example, carbon taxes or taxation on the use of tap water and rivers, excess charges on sewage pollution, etc.) as the financial source for the above systems.

Appropriation of fines imposed on exceeding the standards for discharging effluent to public water bodies to finance the systems is inevitable for a certain period, but it must be noted that if such appropriation is continued as a permanent system, enterprises will feel unfairly treated and their will to invest in environmental measures may decrease.

4.4 Promotion of Engineering Companies

Slovenia appears to have a shortage of water-treatment engineering companies and the capacity of the existing companies has not been sufficiently developed due to the absence of any demand for wastewater-treatment technology in previous years.

Engineering companies earn money by offering professional knowledge to enterprises, and the enterprises can promote efficiency by acquiring technologies they presently lack. Engineering companies and enterprises are, so to speak, related like two wheels of a car.

Independent promotion of engineering companies requires much time and labor. To bring about an early promotion, it is advisable to pursue cooperation with foreign countries in the acquisition and propagation of technology.

VI. Conclusion

VI. Conclusion

The nature, society, economy, and environmental administration of Slovenia and Maribor City surveyed have been outlined. The condition of industrial water and effluent of 20 factories in the Maribor City was also surveyed. The industrial water and effluent of these 20 factories which occupy for more than 80% of the industrial wastewater of Maribor City, have been investigated. The survey results have clarified the following items:

(1) The ratio of the cost of industrial water and effluent to the shipping price is comparatively high.

(2) It is estimated that the volume of industrial water can be saved by an average of 20%.

(3) Under the current emission standards, it is more advantageous for almost all factories to discharge to the WWTP than to discharge directly to the rivers.

(4) The volume of pollutants can be reduced by applying pretreatment, but the level of reduction is closely related with the system of the rates on the discharge to the WWTP.

(5) The relation between the volume of pollutant load reduced and the discharge charging system can be obtained by setting a calculation equation of discharge rates based on pollutant load and by estimating what each factory will do about pretreatment.

(6) Administrative authorities can reflect their policies on the calculation equation of discharge rates and estimate the result. That is, it is possible to estimate the volume of pollutant load on the WWTP, rates income, total amount invested by factories, and consequently, the costs borne by administrative authorities and factories.

Moreover, recommendations were given on 1) Treatment of industrial waste water and pretreatment 2) Rationalization of water use 3) Setting of WWTP rates, and 4) Measures the administrative authorities must take. Although a number of recommendations were made to factories concerning the rationalization of water use and wastewater treatment methods in this survey, due to limitations in time, these recommendations were only very general. Detailed studies must be carried out at each factory to effectively implement our recommendations.

Throughout the course of this survey, the JICA Study Team was quite impressed by the earnest attitude and efforts taken by those concerned in Slovenia and Maribor City for the preservation of the environment. We felt everywhere an uncompromising determination to preserve the nation and its natural environment at any cost, irrespective of financially difficult circumstances. Slovenia is going to steadily carry forward its environment-preservation plan, taking the long view, backed by the long history and cultural traditions of Europe. It will be a great reward for us if our survey proves instrumental in not only preserving the environment in Slovenia, but also in imparting to other countries of Europe an understanding of the Japanese way of thinking, and Japanese techniques.

In conclusion, we would like to heartily thank all those concerned for their cooperation in this survey.

PART 2

TABLE OF CONTENTS

PART 2 Current Conditions and Model Systems of Factories and Economic Evaluation

1. General Summary

PART 2
CURRENT CONDITIONS AND MODEL SYSTEMS OF FACTORIES AND ECONOMIC EVALUATION

1. General Summary

1.1 Outline

In Chapter I, the following items are described with regard to the model factory group (seven factories) , the secondary beneficiary factory group (seven factories) and the tertiary beneficiary factory group (six factories).

① Analysis (including water quality analysis) of and comment on the current condition of water supply and waste water
② Model system for water conservation and economic evaluation of model system
③ Model systems for waste water treatment and pretreatment and economic evaluation of model systems
④ Financial analysis on selected model factories

Financial analysis shall be carried out on three factories: M-1 (Svila), M-2 (Marles) and M-6 (Kosaki). These factories were selected because they are situated close to the river and the factories themselves requested selection.

In 1.-General Summary, the common items in water conservation, waste water treatment, pretreatment and the financial analysis are indicated.

In 2.-Design Conditions, design conditions that are common to each factory are indicated for especially important waste water treatment and pretreatment model systems.

In 3., 4. and 5., the above items (analysis of current condition of water supply and waste water; economic evaluation of water conservation model systems; economic evaluation of waste water treatment and pretreatment model systems, etc.) are indicated for all factories in the model factory group, the secondary beneficiary factory group and the tertiary beneficiary factory group.

Tables 1.1.1, 1.1.2 and 1.1.3 show lists of each of the factories in the model factory group, the secondary beneficiary factory group and the tertiary beneficiary factory group respectively.

Fig. 1.1.1 shows the locations of each of the factories.

• Reasoning behind the selection of the target factories

As is shown in Table 1.1.4, seven target factories have been selected: one in the textile and dyeing sector, one in the furniture manufacturing sector, one in the machine sector and four in the foodstuff sector. In consideration of the fact that the main industries in Maribor are textile and dyeing, foodstuff and machines, factories possessing large water consumption volumes and waste water pollution loads were selected to represent these sectors.

The four factories in the foodstuff sector were selected to represent the different areas of alcohol (beer, wine), meat products and dairy products. Thus, the seven selected factories can be said to be representative of industry in Maribor today.

The 13 factories in the secondary factory group and tertiary factory group break down into four in the textile and dyeing sector, five in the machine sector, two in the foodstuff sector and two in the chemicals sector. These factories were selected for their large pollution loads, second only to the pollution loads of the model factories. Four factories were selected from the textile and dyeing sector because this is an industry with a high level of water consumption and is representative of Maribor.

The tertiary factory group was added during the survey stage in order to gain a better understanding of industrial waste water volumes and pollution loads over a wider range of factories. Factories (not included among the model factories and secondary factory group) with large pollution loads or water consumption levels were selected as tertiary factories.

The total of 20 selected target factories are, as described later, responsible for discharging approximately 80% of all the industrial waste water that is generated in Maribor.

Table 1.1.1 Outline of the Model Factories

No.	Name (Abbreviation)	Industry	Main Products: Products Quantity	Capital 1000SIT. Area m^2 & Employee	Water Source & Consumption m^3/d	Waste Water is discharded to
M-1	SVILA TEKSTILNA TOVARNA.d.d. (SVILA)	Textile (Knittng)	Viscose 1000m/y Rayon 6.687 Polyester 330	Capital 2.142.875 Area 15.611 Employee 490	Well Water 1.587	Drava River
M-2	MARLES HOLDING. d.d. MARLES POHISTVO. d.o.o. (MARLES)	Furniture	Kitchien Element 96.552 Pieces/y	Capital 1.509.109 Area 20.000 Employee 482	Well Water 298	Drava Riyer
M-3	LIVARNA Maribor ARMAL (ARMAL)	Machine & Metal Processing	Pipe Fittings 184t/y Sanetary Fittis.719t/y Heating Fittings 88t/y	Capital 182.287 Area 12.015 Employee 380	City Water 372	Public Sewerage
M-4	STAJERSKA PIVOVARNA.d.d. (PIVOVARNA)	Food (Brewery)	Beer 6.000 kl/y Soft Drinks 5.000 kl/y Juce 8.000 kl/y	Capital 130.000 Area 40.000 Employee 170	Well Water 411	Public Sewerage
M-5	VINAG VINARSTOV-SADJARTVO (VINAG)	Food (Wine Cellar)	Wine 5.000 kl/y	Capital Area Employee 400	City Water 71	Public Sewerage
M-6	KOSAKI TOVARNA MESNIH IZDELKOV (KOSAKI)	Food (Slaughter Hause)	Cows 11.500 head/y Pigs 43.000 head/y	Capital Area 22.534 Employee 100	City Water 365	Public Sewerage
M-7	MARIBORSKA MLEKARNA.d.o.o. MM MARIBORSKA MLEKARNA.d.o.o. (MLEKARNA)	Food (Dairy)	Milk 16.393 Ton/y Cheese 3.153 Ton/y Yogurt 1.508 Ton/y	Capital 808.790 Area 14.000 Employee 286	City Water 476	Public Sewerage

Table 1.1.2 Outline of the Secondary Beneficiary Factories

No.	Name (Abbreviation)	Industry	Main Products Products Quantity	Capital 1000SIT. Area m² & Employee	Water Source & Consumption m³/d	Waste Water is Discharged to
S-1	Tovarna Volnenih tkanin MERINKA, p. o. (TVT MERINKA) (MERINKA)	Textile (Dyeing)	Wool Fabric 650,000m/y Stoking 20,000,000 Pieces/y	Capital Area 33,430 Employee 613	Well Water 760 City Water 425 Total 1,185	Public Sewerage
S-2	Tekstilna Tovarna TABOR, d. o. o. (TABOR)	Textile (Dyeing)	Mixture Fabric 3,140,216 m²/y	Capital 1,005,895 Area Employee 400	Well Water 1,158 City Water 93 Total 1,251	Drava River
S-3	Mariborska tekstilna tovarna Melje, d. d. (MTT MELJE), d. d. Tovarna tkanin MELJE, d. o. o. (MTT)	Textile (Dyeing)	Cotton 7,140,000 m²/y Mixture Fabric 3,060,000 m²/y	Capital 1,369,568 Area Employee 750	Well Water 731 City Water 538 River Water 1707	Public Sewerage
S-4	Tovarna sukancev in trakov TSP, p. o. (TSP)	Textile (Dyeing)	Sewing Thread 182.3 Ton/y	Capital 637,588 Area 9,038 Employee 198	Well Water 29 City Water 36 River Wate 278	Public Sewerage
S-5	METALNA, STROJE-GRADNJA, KONSTRUKCI-JE MONTAZA IN STORI-TVE, d. d. (METALNA)	Machine & Metal Procss.	Power Plant, Cranes, Process Equipments, etc. Steel Handled 1,000t/m	Capital Area 300,000 Employee 2,100	City Water 212	Public Sewerage
S-6	MERKATOR-SLOSAD d. d. (SLOSAD)	Food (Drink)	Concentrated Fruit Juice 1,800 Ton/y Cherries in Alcohole 400	Capital Area 23,000 Employee 90	Well Water 15 City Water 20 Total 35	River
S-7	INTES MLIN TESTENINE (INTES)	Food (Miller)	Wheat Flour 26,399 Ton/y Pasta 3,565 Ton/y	Capital Area Employee 180	City Water 162	Public Sewerage

Table 1.1.3 Outline of the Tertiary Beneficiary Factories (1/2)

No.	Name (Abbreviation)	Industry	Main Products: Products / Quantity	Capital 1000SIT, Area m² & Employee	Water Source & Consumption m³/d	Waste Water is Discharged to
A-1	TVT-Tovarna Vozil in toplotne tehnike-Boris Kidric-TIRNA VOZILA (TVT)	Machine & Metal Proces-sing	Rolling Stocks Reparing Diesel Locomotives 5 Diesel Coach 20-30 Unit Electric Coach 10 Unit	Capital 448,000 Area 37,000 Employee 553	Well City 517 River 103 Total 620	Sewerage
A-2	ELEKTROKOVINA-SVETILA (SVETILKE)	Machine & Metal Proces-sing	Lighting Tool Units Interal Use 643,145 Industrial Use 282,316 Outdoor Use 9,450	Capital 1,000,000 Area Employee 266	Well City 130 River Total	Sewerage
A-3	PRIMAT-Tovarna kovinske opreme (PRIMAT)	Machine & Metal Proces-sing	Safty Safe 1,220 t Metal Wardrobe 727 t Annual Shipment 884,567 1,000 SIT	Capital Area 17,366 Employee 220	Well City 109 River Total	Sewerage
A-4	ELEKTROKOVINA Elektromotorji (ELKO)	Machine & Metal Proces-sing	Pumps 10,484 Sigle Phase Motor 8,246 Three Phase Motor 38,683 Annual Shipment 920 MSIT	Capital 882,795 Area 49,421 Employee 252	Well City 155 River Total	Sewerage

Table 1.1.3 Outline of the Tertiary Beneficiary Factories (2/2)

No.	Name (Abbreviation)	Industry	Main Products: Products Quantity	Capital 1000SIT, Area m² & Employee	Water Source & Consumption m³/d	Waste Water is Discharged to
A-5	HENKEL ZLATOROG (HENKEL)	Chemical Industry	Washing Powder 16,000 t Cosmetics 6,640 t Annual Shipment 8,317,517 1,000 SIT	Capital 5,817,130 Area 28,200 Employee 575	Well City 339 River 312 Total 651	Sewerage
A-6	SWATY Tovarna umetnih brusov (SWATY)	Chemical Industry	Grinding Wheels, Vitrified Bond 667t, Resin B. 465t, Reinforced R.B. 1 Kt Diamond & CBN 44 KCarats	Capital 2,124,000 Area 39,779 Employee 451	Well City 149 River Total	Sewerage

Table 1.1.4 Each Factories VS Classified Industry

	Machine & Metal Processing	Food	Textile	Furniture	Chemical Industry	Total
Model Factories	1	4	1	1	—	7
Secondary Beneficiary Factories	1	2	4		—	7
Tertiary Beneficiary Factories	4	—	—	—	2	6
Total	6	6	5	1	2	20

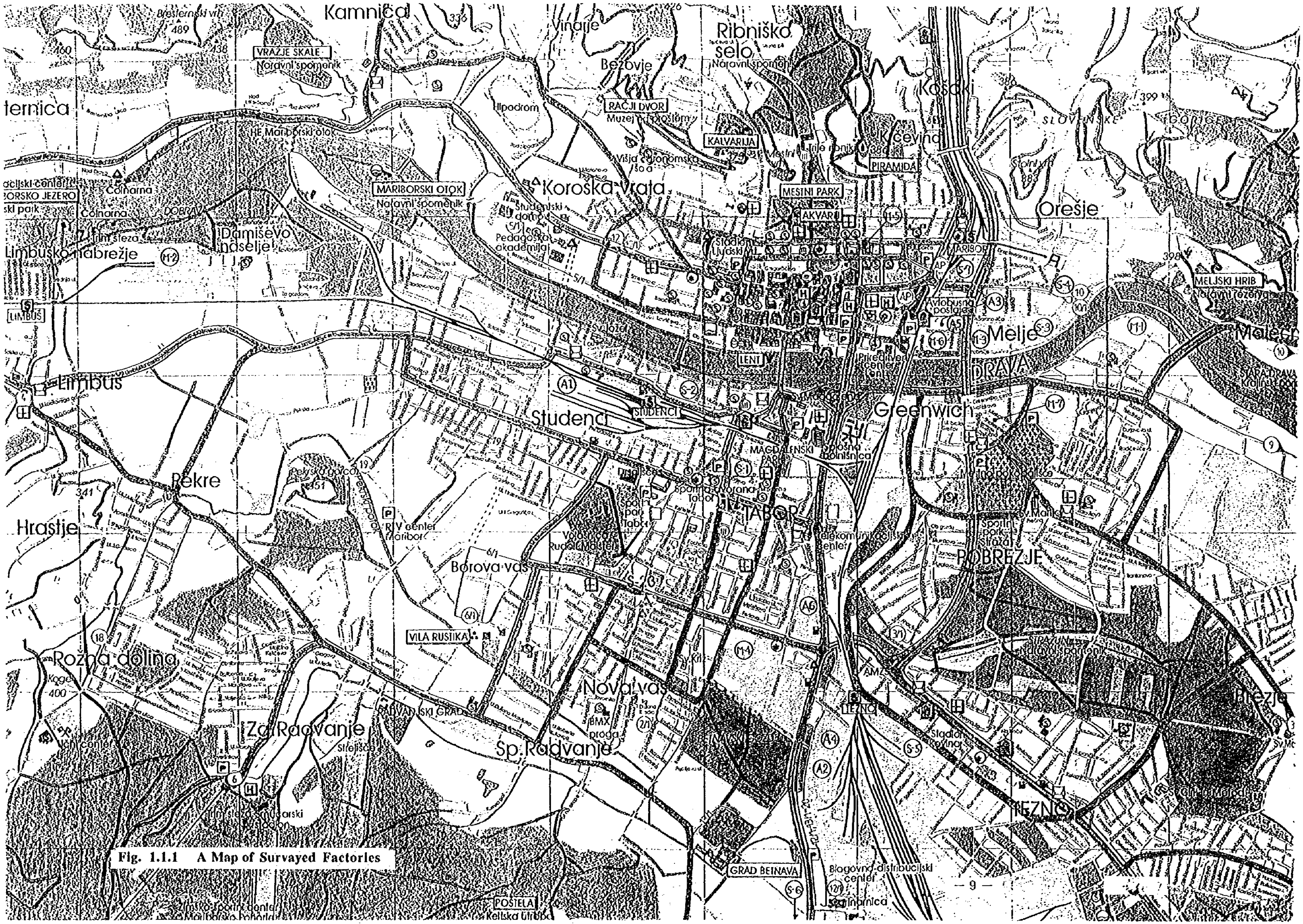


Fig. 1.1.1 A Map of Survayed Factories

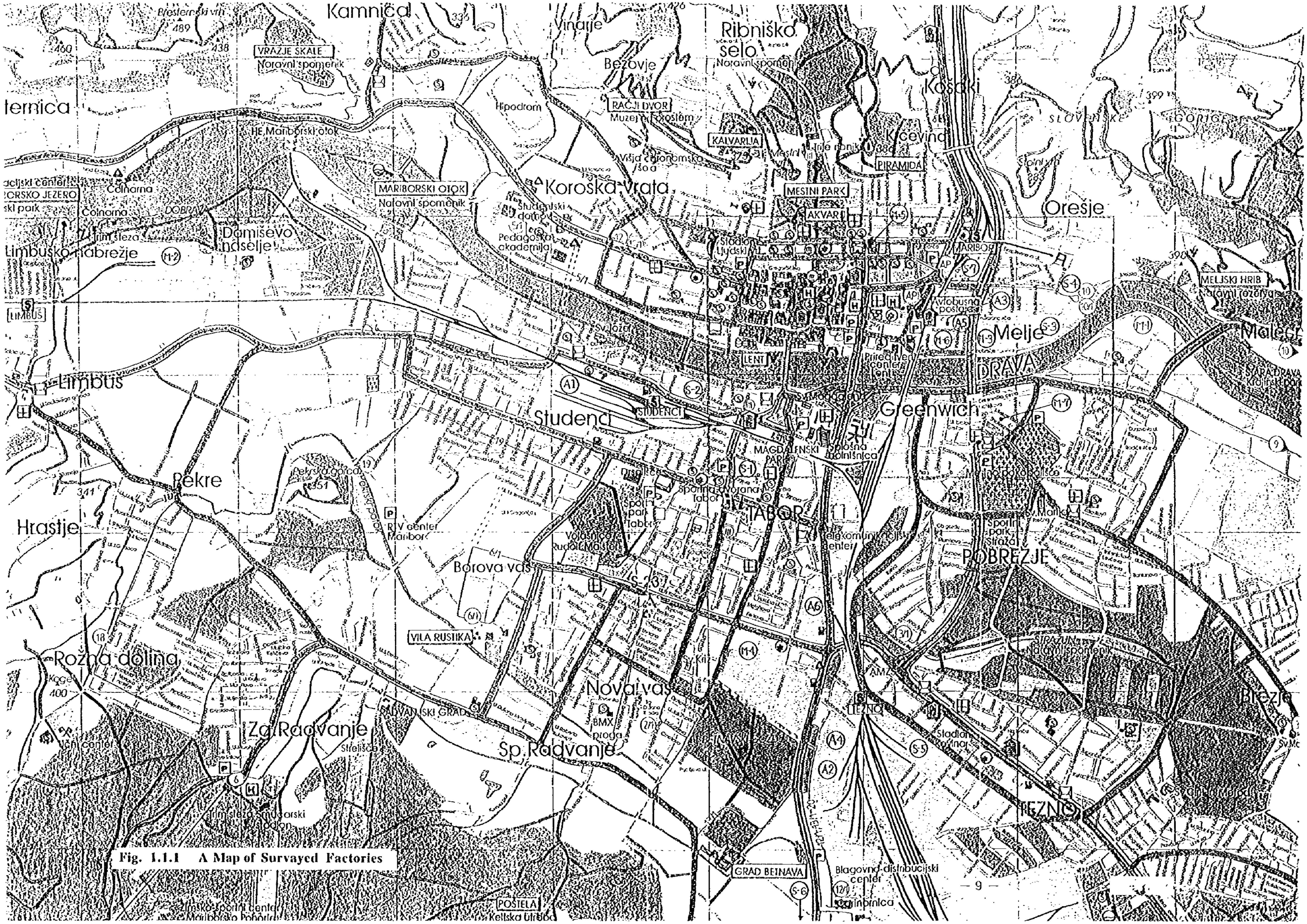


Fig. 1.1.1 A Map of Survayed Factories