1.2 Water Conservation

As described in the analysis of individual factories, the control of water consumption at the subject factories is far from efficient. Many of the factories do not measure the total water consumption volume. Given this situation, It is almost meaningless to examine water conservation. The first step towards carrying out water conservation is to conduct close control of the water supply.

Feasible ways of water conservation are examined here, assuming that the water consumption level indicated in the questionnaire is correct, in order to provide examples of how a water conservation plan can be advanced.

The results of a questionnaire survey and visiting survey are used to establish and analyze the present conditions of water consumption, followed by examination of the present conditions of water conservation efforts. A water conservation plan can then be formulated based on the analysis and examination results. A water conservation plan has the following structure.

① Outline of plan
② Specifications of equipment
③ Rough estimation of required costs
④ Technical comment
⑤ Economic comment

The costs consists of the equipment costs and operation costs and is accounted for in local currency (SIT). The figures given are fairly rough estimates as they are calculated to roughly examine the relative advantages of conservation spending, i.e. conservation costs, vis-a-vis the current water supply and drainage costs. When water conservation is, therefore, really on the agenda, more detailed examination, planning and estimation are required.

The technical comment mainly means examination of the suitability of the preconditions for the water conservation plan.

In the economic comment, the cost of water conservation is compared to the cost (water supply and drainage expenses, charges and taxes, etc.) without water conservation to determine whether or not conservation is economically advantageous.

Not all of the water conservation plans described here are economically advantageous but are included as conservation examples. Finally, changes of the total water consumption volume and unit consumption of water are given along with a general review of the water conservation if the presentation of such figures is deemed necessary.

1.3 Pretreatment and Waste Water Treatment

1.3.1 Pretreatment

1) Pretreatment that satisfies WWTP discharge standards

A conceptual design was carried out at each of the model factories to determine the kind of treatment systems the factories would need to install if they were to follow the Slovenia national factory waste water discharge standards established in 1996. Simple treatment systems were proposed for each of the secondary and tertiary beneficiary factories without carrying out conceptual design.

2) Pretreatment for reduction of the pollution load

Because the current WWTP discharge standards contain hardly any regulations on pollutants other than heavy metals, there is a risk that operation of the WWTP may be harmed in future if the factories continue discharging in the way they do now. Thus, it is necessary for the factories to install appropriate pretreatment systems in order to reduce pollution loads prior to discharge.
For this reason, except for a few factories not requiring consideration, conceptual design was prepared for a number of pretreatment cases set according to pollution load reduction volumes in each of the factories within the model factory group, the secondary beneficiary factory group and the tertiary beneficiary factory group.

Pretreatment systems, as a rule, were designed on the basis of physical and chemical treatment methods (biological treatment was considered in unavoidable cases), and the equipment and running costs in each case were calculated. Here, care was taken to reduce the treatment costs as much as possible.

The conceptual design was carried out in accordance with the design conditions described later in section 2. The design procedure is the same as that used in the design of the waste water treatment systems at each model factory, however, regarding the pretreatment system, costs, because this was estimated to grasp the general costs of various equipment combinations, estimate values are shown for the equipment costs and the treatment costs.

1.3.2 Waste Water Treatment

In each of the model factories, conceptual design was prerpared for waste water treatment facilities that would satisfy standard values in the case of waste water discharge into rivers. Regarding the secondary beneficiary factories, simple treatment systems were proposed without going through the conceptual design process.

2. Assumptions for Financial Analysis and Design Conditions

2. Assumptions for Financial Analysis and Design Conditions

2.1 Assumptions for Financial Analysis

Regarding three factories such as Svila, Marles and Kosaki among seven Model Factories, comparative analysis for waste water treatment is conducted for two cases, the discharge to sewerage and the discharge to the river.

As Maribor city plans to start the operation of the waste water treatment plant (WWTP) in 2005, the waste water treatment system is assumed to be constructed in 2004 and become operational in 2005.

In this section, common assumptions applicable to the three factories are described.

2.1.1 Capital Requirements

1) Basic assumptions

(1) Currency and exchange rate

The Deutsche Mark is used as the basic currency in this analysis and other currencies are converted into Deutsche Mark at the following exchange rate effective on June 19, 1996 indicated by the authorities in Maribor in the second on site survey.

1 Deutsche Mark (DEM) = 89.89 Slovenian Tolars (SIT)

(2) Pricing level

All the costs and prices as used in the analysis are fixed at the price prevailing in June, 1996 as said above, and no price escalation after that date is assumed.

(3) Project life

The project life for the analysis is sixteen years consisting of one year for construction and fifteen years of operation.

2) Capital requirements

In addition to the plant construction cost estimated based on the conceptual design in the next section, other costs and expenses forming part of the capital requirements are described.

(1) Land cost

Each factory has an adequate site required for the plant construction, and no land cost is appropriated. In addition, no site development cost is appropriated because of the minimal amount.

(2) Physical contingency

This is the cost to secure the unexpected cost exceeding the capital requirement which may arise due to unforeseeable factors or imperfect estimation at the time of this calculation.

At the time of the third site survey, this survey mission entrusted local engineering company to cross-check the cost data which was estimated by the mission considering local conditions. Consequently, it was ascertained that there was no difference in the estimation.

For the above reason, no physical contingency is appropriated at this stage.

(3) Price contingency

This is the cost to meet the increase in price which may arise in the future, but this cost is not considered since the analysis is made on the basis of the fixed price as mentioned in 2.1 1), (2).

(4) Import duty

Based on the discussion with the authorities in Maribor, the import duty on imported equipment and machinery is not considered at this stage.

(5) Sales tax

Sales tax of 5% is imposed on both foreign and domestic equipment and machinery, and services.

(6) Pre-operating expenses

The expenses include the costs incurred in the tasks for project preparation directly undertaken by the implementing body.

The expenses during the test run period are included in the plant construction cost, and the initial charges of chemicals and agents are regarded to be included in the above expenses.

(7) Interest during construction

The source of funds for the project has not determined yet. However, in accordance with the assumption concerning the financing plan mentioned in paragraph 1.4.2, it is assumed that loan will be available from a domestic financial institution. The loan is assumed to be incurred on the average during the construction period.

(8) Initial working capital

No initial working capital is appropriated because of its minimal amount.

(9) Capital requirements

The capital requirements represent the sum of the above-mentioned costs and expenses.

2.1.2 Financing Plan

It is assumed that the capital requirements estimated in paragraph 1.4.1 for the construction of the waste water treatment system would be provided under the following condition.

1) Debt-equity ratio

The debt-equity ratio will be separately established for each factory.

2) Financing conditions on long term loan

For the purpose of the study, it is assumed that domestic loan will be financed under the following conditions.

(1)Interest: Interest rate for each factory is separately established on a DEM basis.

(2)Grace period: Construction period

(3)Repayment: Equal annual installments for 10 years after the grace period

3) Other conditions

If a cash shortage occurs during the operation period, this is generally to be met by a short-term loan.However, the project is assumed to be compensated by the overall profit of the factory. Accordingly, the interest on short-term loan is not considered in the waste water treatment cost.

2.1.3 Waste Water Treatment Cost

1) Variable costs

Variable costs include chemicals and agents, electricity, water and sludge disposal. Regarding supplies and utilities required newly for waste water treatment, the prices shown in section 2.5 to 2.6 are used.

2) Fixed costs

Fixed costs include personnel cost, maintenance cost, sewage charge, pollution tax, depreciation and amortization, and interest on long-term loan.

(1) Personnel costs

Personnel cost will be separately established for each factory.

(2) Maintenance cost

Maintenance cost is assumed to be 5% of the plant construction cost excluding civil engineering and building works.

(3) Sewage charge

In case of the discharge to sewerage, with the implementation of WWTP, the sewage charge of 160 SIT/m^3(1.78 DEM/m^3) is imposed, so that financial analysis is performed. The charge is established by taking into account the costs of the construction, operation and maintenance of WWTP. It is a tentative price for the analysis at this time and could be changed in future if many parameters are changed.

(4) Pollution tax

Pollution tax is imposed at the state and local level. The local tax is imposed at 40.75 SIT/m^3(0.45 DEM/m^3) for all the water use.

On the other hand, the state tax is not paid if effluents are treated below standard value. In the analysis, no state tax is assumed in cases of the discharge to river and sewerage, however, the government charge of 4.8 SIT/m^3 for all the water use is imposed.

(5) Depreciation and amortization

The plant construction cost is depreciated using the following method.

Equipment and machinery : 15 years straight line method
Civil enginerring and building works: 40 years straight line method

Furthermore, interest during construction is amortized over 15 years under the straight line method.

(6) Other treatment cost

The interest on long-term loan mentioned in paragraph 2.1.2 is covered by this cost. However, in view of the nature of the project, the following costs are not considered in the analysis.

Interest on short-term loan
Income tax

2.1.4 Waste Water Treatment Fee

In the analysis, the unit cost per volume of waste water treated as of 2010 when the long-term loan is half repaid is assumed to be equivalent to a waste water treatment fee throughout the operation period. The above unit cost covers variable cost, direct fixed cost, depreciation and amortization as well as half of the interest on the long-term loan.

2.1.5 Method of Financial Analysis

In accordance with the assumptions mentioned above, the following financial statements required for the financial analysis have been prepared.

Waste water treatment cost statements
Funds flow statements including Financial Internal Rate of Return (FIRR) calculation

Based on the results of the above financial statements, financial analysis is performed using the following method.

1) The economical advantages in the cases between the discharge to sewerage and discharge to river are based on the comparison of waste water treatment cost.

For the comparative analysis purpose, the value as of 2010 is regarded as the average cost of the project.

The standard cost method used by the analysis assumes the average cost of the project to be close to the average of the costs to be obtained from year-by-year cost calculations during the operation period. Generally, it can be effectively used for the selection of a project scheme and cost analysis focusing on composition of cost elements.

In relation to the above, the following assumptions are established on the items to be taken into account of in the initial stage of operation.

(1) The treatment volume from the first year of operation shall be equal to the existing waste water volume.
(2) The factories concerned shall acquire the waste water treatment technology prior to the introduction of the model systems.
(3) The frequency of parts replacement for the maintenance of equipment is low in the initial operating stage but increases in line with the deterioration of equipment over time. In this analysis, taking into account costs in similar projects, repair costs shall be counted as average values throughout the period of operation.

2) The FIRR shall be used rather than profitability, in order to gauge the impact of fluctuations in major factors.

In the analysis, the plant construction cost and chemicals are taken up as the factors.

FIRR is one of the effective methods to assess profitability on investment made by a project. In the analysis, however, the waste water treatment fee as a major revenue source of the project is determined under rough assumptions, making the FIRR obtained and its comparison less meaningful. Nevertheless, since major elements of the project subject to this analysis are assumed to incur during different periods, the degree of change in FIRR can be compared on an objective basis.

3) Debt service ratio (DSR) on long-term loan is used as a method for analyzing the soundness on funds flow.

DSR is an indicator to measure the soundness for financial position, and is calculated by the following formula.

$$DSR = \frac{\text{Profit after tax} + \text{Depreciation \& Amortization} + \text{Interest on long-term loan}}{\text{Repayment on long-term loan} + \text{Interest on long-term loan}}$$

It is a general consensus that DSR is a safety value of 1.15 or higher at each year.

In the analysis, the value as of 2010 is regarded as an average of the project as same in item 1), while DSR is used in order to understand the impact on funds flow, especially in case of the reduction of cost.

2.1.6 Preconditions for Economic Evaluation

Except for the three factories on which financial analysis was carried out (Svila, Marles, Kosaki), simple economic evaluation for the case of equipment installation was carried out on the other factories based on the following conditions.

(1)	Depreciation period	:	equipment	15 years
		:	building, civil engineering	40 years
(2)	Interest	:	10%/annum	
(3)	Depreciation method	:	uniform depreciation	

2.2 Design Conditions (Common for All Model Factories)

2.2.1 Treatment System

As the quality of raw water is designed based on the field analysis results, some of the numerical values may differ from those of the questionnaire which was distributed to each factory prior to the field analysis.

The quality of the treated waste water is designed to meet Slovenia's Emission Standards which the Study Team received on June 12th, 1996. Past experience and results in Japan were also used to determine the design treated waste water quality. However, industrial waste water requires different treatment levels depending on the product type and raw materials and secondary raw materials used. Consequently, the necessary tests to obtain design data before proceeding to the actual design stage of a waste water treatment system, are essential.

2.2.2 Treatment Plant Site

Waste water treatment plant construction is planned on an empty site and no special site constraints are assumed unless stated otherwise.

2.2.3 Plant Installation Conditions

In view of easy plant maintenance in winter, the plant will be installed inside a building which is heated for 3 months in winter. An outdoor minimum temperature of -20°C and snow cover of 1 m in winter are assumed.

2.2.4 Scope of Estimation

The plant cost is estimated on the turn key basis. The following items are, however, excluded from the estimate.

a. Piping work outside the battery limit range
b. Power cabling work on the primary supply side
c. Substation
d. Piling and surplus soil removal
e. Spare parts

2.2.5 Utility Costs

1) Electricity : 15 SIT/kwh
2) Water : 200 SIT/m^3
3) Heating oil : 60 SIT/litre
4) Chemicals

a.	Urea H_2 $NCONH_2$ 100%	:	52	SIT/kg
b.	K_2 HPO_4 100%	:	394	SIT/kg
c.	PAC 11% Al_2O_3	:	74.7	SIT/kg
d.	$Al_2(SO_4)_3$ 18 H_2O	:	39.15	SIT/kg
e.	Ferric chloride 13% Fe	:	64	SIT/kg
f.	Polymer (nonion type100%	:	990	SIT/kg
g.	Polymer (anion type) 100%	:	990	SIT/kg
h.	Polymer (cation type) 100%	:	2,000	SIT/kg
i.	$NaHSO_3$ 32%	:	113.6	SIT/kg
j.	NaOCl 11% - 13% as Cl_2	:	54	SIT/kg
k.	H_2SO_4 98%	:	70.2	SIT/kg
l.	HCl 30%	:	22	SIT/kg
m.	NaOH 100%	:	83.2	SIT/kg
n.	Na_2CO_3 100%	:	40	SIT/kg
o.	Granular activated carbon	:	930	SIT/kg

2.2.6 Waste Disposal Cost

General waste : 1,423 SIT/m^3
Harmful waste : 49,683 SIT/m^3
(Disposed of at the waste disposal site located 10 km from Maribor.)

2.2.7 Control System

1) pH control : automated
2) Tank liquid level control: automated
3) Sand filter : automated

(All other operations are conducted manually.)

2.2.8 Operation Staff

When the waste water plant is in operation for 24 hours/day, 2 operators will supervise the operation for 8 hours each and no operator will be assigned to the over-night operation of 8 hours unless otherwise stated. A communication system to inform of any breakdown or accident during the unmanned night operation must be installed as a necessary condition for continuous operation.

2.2.9 Materials and Symbols

1) Symbols for materials

The equipment symbols have the following meanings.

- FC : Cast iron
- FC13Cr : Cast iron (13 Cr)
- SUS : Stainless steel
- SS : Mild steel
- SS/EP : Mild steel inside epoxi-tar lining
- PVC : Polyvinyl chloride resin
- PE : Polyethylene
- VP : Vinyl pipe
- FC + RL : Cast iron inside rubber lining
- SGP : Steel gas pipe
- FRP : Fibre reinforced plastic
- RC : Reinforced concrete

2) Symbols used in flow sheet

See Table 2.1.1 Symbols of Flow Sheet for the meaning of the symbols used in the flow sheet.

2.2.10 Miscellaneous

1) Voltage : 220 V/380 V

Frequency : 50 Hz

2) Rainwater, domestic waste water are treated separately and, therefore, are not mixed with the industrial waste water treatment plant, unles it's specially mentioned.

Table 2.1.1 Symbol of Flow Sheet

Symbol	Descriptions
M	Agitator
M	Chemical Feed Pump
P	Pump
	Automatic Valve
B	Blower
FI	Flow Indicator
ORP / ICA	ORP Indicating Controller with Alarm
LC LS	Level Controller / Level Switch
DO / I	Dissolved Oxygen Indicator
DO / IC	Dissolved Oxygen Indicating Controller
LCA	Level Controller with Alarm
PH / IC	pH Indicating Controller
PH / ICA	pH Indicating Controller with Alarm
PH / IRA	pH Indicating Recorder with Alarm

3. Model Factories

3. Model Factories

3.1 M-1 SVILA TEKSTILNA TOVARNA, d.d.

3.1.1 Factory Outline

1) Outline

SVILA manufactures synthetic fibers textile and mixture textile, dyeing, finishing, and finally fabric rolls. Its chief product is viscose rayon fabric. The raw fibers and dyeing materials are all imported, and 70% of the products are exported. Fabric dyeing process includes whole dyeing and pattern printing .

Capital	:	2,142,875 Thousand SIT (1995)
Total factory area	:	15,611m^2
Number of employees	:	490
Working conditions	:	7.7 hr/day (paying 8 hr), 252 days/year
Products	:	Rayon textile, Polyester textile, Polyamide textile, Mixed textile
Annual production	:	6,686,805m, 329,578m, 481,236m, 119,411m
Annual sales	:	2,404,476 Thousand SIT

The factory is situated facing the Drava canal. Its layout is shown in Fig. 3.3.1. All of the water is supplied from two private wells. The dyeing waste water is pumped to the Drava canal from the water pit. Domestic water, cooling water and regenerated water from a softener is discharged to the main stream of the Drava river with no pumps.

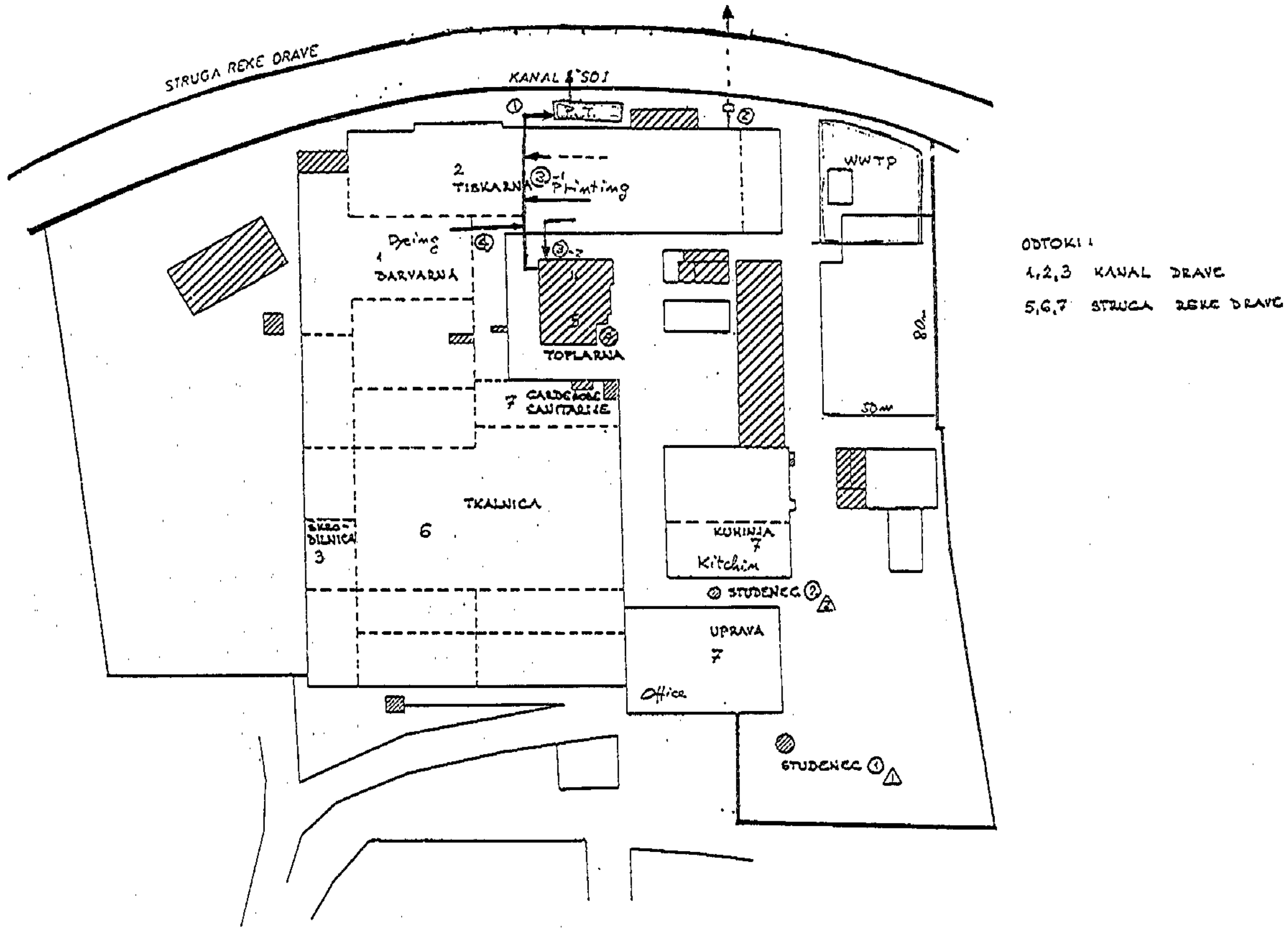
2) Quantity of consumed water classified by source and use

Table 3.3.1 shows the quantity of water consumption by source and use.
Two private wells supply all of the water, nearly 80% of which is used for dyeing and washing in the dyeing plant.

3) Flow diagram of water supply and waste water discharge

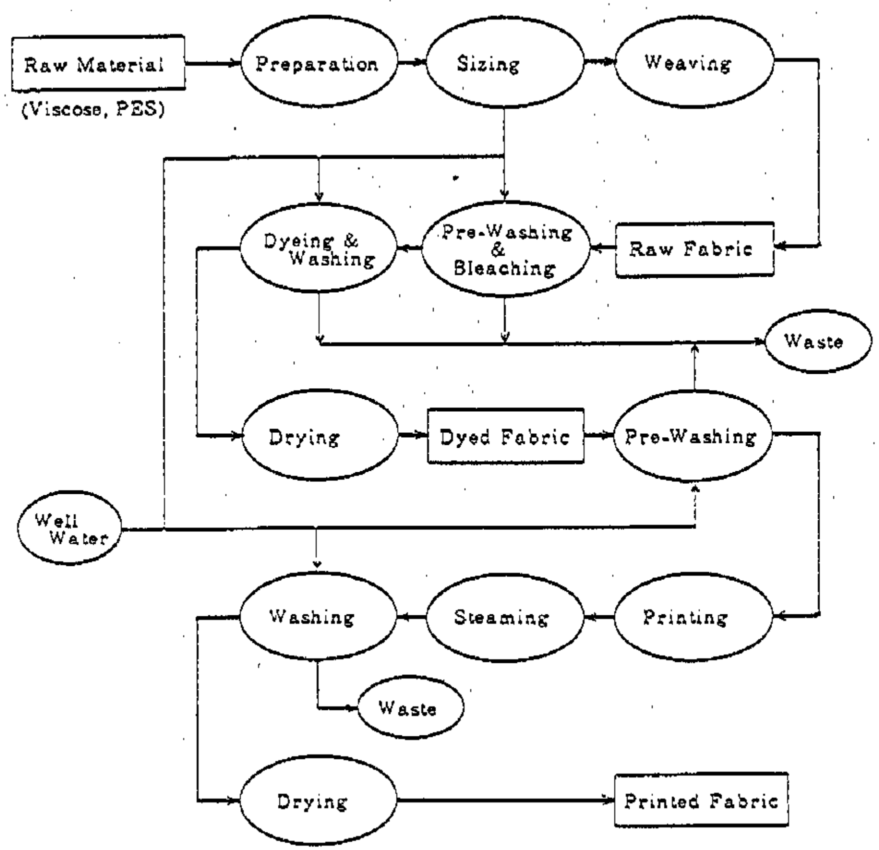
The outline is shown in Fig. 3.1.2 and Fig. 3.1.3.
Discharge 1 of the printing plant, cooled by heat exchange with the boiler water, and Discharge 2 combine with the waste water of the dyeing plant which accounts for about 30% of all the waste water. These are all directed to the outside pit.

Fig. 3.1.1 Factory Layout of SVILA



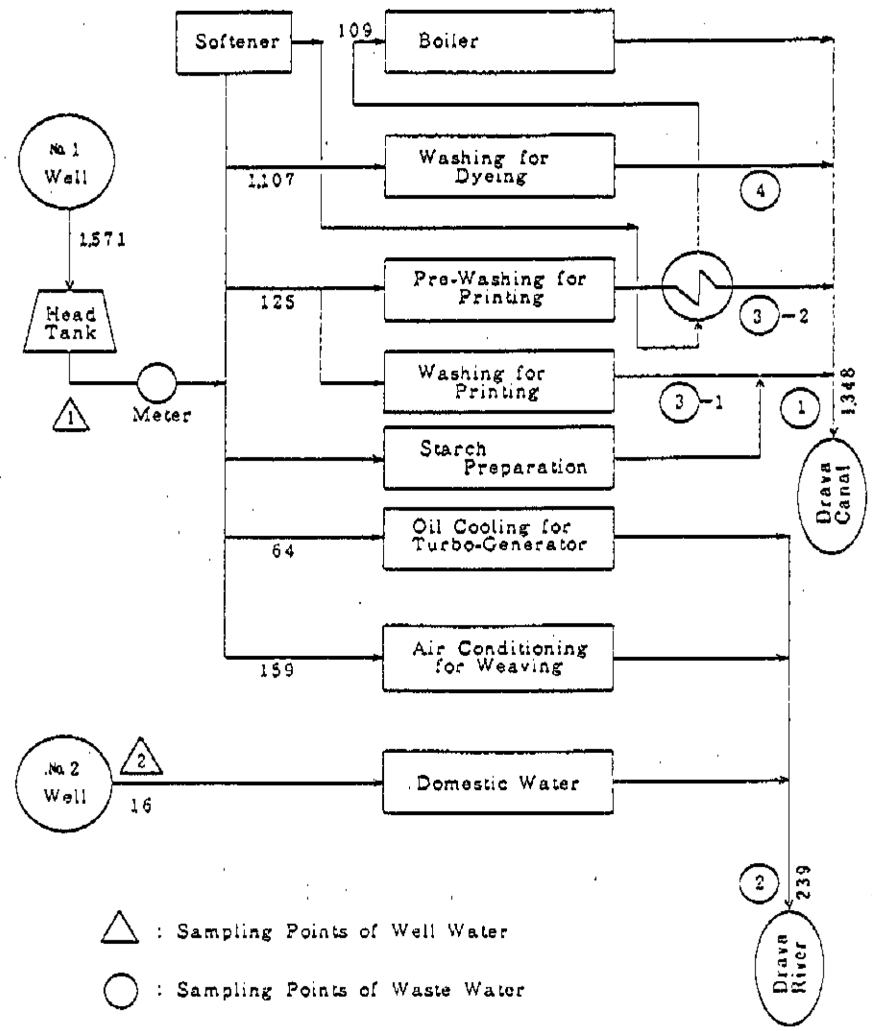
No. M-1-1

Fig. 3.1.2 Process Diagram of Production Line



No. M-1-2

Fig. 3.1.3 Water Balance Diagram (m³/day)



4) Quality of make-up water and waste water

The data were acquired by the field survey.
Table 3.1.2 shows the quality of feed water (water of the two wells); high in hardness but low in iron.

Tables 3.1.3 - 3.1.10 and Figs. 3.1.4 - 3.1.9 show the quality and the quantity of waste water.

Sampling spot No. 1 is the general effluent of the dyeing plant. Water quantity, temperature, and pH, shown in the graph, were measured every 10 minutes for 24 hours. SS, COD, and BOD were measured by composite sampling every 2 hours (Table 3.1.3). Other major items were measured by composite sampling every 4 hours (Table 3.1.4). The daily fluctuation of the pollutant load is evident. Minor items were also checked by spot sampling. But no problems were found, since almost all the items were under the detection limit.

Sampling spot No. 2 is the domestic water, cooling water, and regenerated water from a softener, except for that of the dyeing plant. The spot data of Table 3.1.6 shows that this may safely be discharged directly into the river. However, domestic water such as toilet effluent should be considered separately.

Sampling spot No.3 is waste water of the printing plant. Although there are three waste water lines, one of these is not in use and thus has no water discharge. Another line is for the printing unit's waste water, which is high in pollutants. Table 3.1.7 shows data by composite sampling every 8 hours.

The third waste water line is chiefly for rinsing water of high temperatures, when heat is exchanged with power plant water to recover heat and cool discharge. It is relatively low in pollutants. Table 3.1.8 shows data acquired by composite sampling.

Sampling spot No. 4 is the dyeing plant's waste water discharged intermittently from each dyeing unit. The water quality fluctuates greatly, but is less than that of the printing unit.

Table 3.1.1 Quantity of Consumed Water Classified by Source and Use

Factory Name M-1. SVILA Industry: Textile(Dycing)

Unit: m³/day

Source / Use	Well Water	City Water	River Water	Sub-Total	Recoverd Water	Total
Boiler Feed	109			109		109
Raw Material						
Washing	1,239			1,239		1,239
Cooling	64			64		64
Air Conditioning	159			159		159
Miscellaneous	16			16		16
Total	1,587			1,587		1,587
				Recoverd Water/Total		%

Table 3.1.2 Quality of Make-up Water

		Lab. No.	Well No. 1: 5391	Well No. 2 5392
Parameter	Expr. as	Unit		
Temperature		°C	11,8	12,2
pH:			8,2	8,0
Iron	Fe	mg/l	< 0,05	< 0,05
Manganese	Mn	mg/l	< 0,05	< 0,05
Total hardness		°dH	9,1	11,4
Alkalinity		mmol/l	2,7	3,1
Chloride	Cl	mg/l	8,0	7,1
Evaporated residue		mg/l	200	260
Electric conductivity		µS/cm	330	400

Table 3.1.3 No.1 Total Process Wastewater (2-hours samples)

Lab. No.			5400	5401	5402	5403	5404	5405	5406	5407	5408	5409	5410	5411
Date of sampl.			5.6.	5.6.	5.6	5.6.	5.6.	5.6.	6.6.	6.6.	6.6.	6.6.	6.6.	6.6.
Hour of sampl.			12-14	14-16	16-18	18-20	20-22	22-24	00-2	2-4	4-6	6-8	8-10	10-12
Parameter	Expr. as	Unit												
pH			10,0	7,8	9,0	7,9	7,9	8,1	8,0	10,2	9,7	9,0	7,9	7,8
Suspended solids		mg/l	840	< 30	< 30	< 30	< 30	< 30	< 30	< 30	< 30	< 30	40	< 30
COD	O_2	mg/l	1800	140	140	110	85	90	190	220	140	160	230	100
BOD_5	O_2	mg/l	300	45	50	30	10	50	45	50	35	.	< 5	< 5

Table 3.1.4 No1 Total Process Wastewater (6-hours samples)

Lab. No.			5396	5397	5398	5399
Date of sampling			5.6.	5.6.	6.6.	6.6.
Time of sampling			12-18	18-24	0-6	6-12
Parameter	Expr. as	Unit				
Colour:						
α (436 nm)		m^{-1}	42	14	17	25
α (525 nm)		m^{-1}	33	15	14	22
α (620 nm)		m^{-1}	25	18	19	26
Zinc	Zn	mg/l	0,09	< 0,05	< 0,05	< 0,05
Chromium (VI)	Cr	mg/l	< 0,05	< 0,05	< 0,05	< 0,05
Total nitrogen:	N	mg/l	13,5	7,3	16,2	15,2
- ammonium nitrogen	N	mg/l	2,1	1,2	3,7	8,0
- Kjeldahl nitrogen	N	mg/l	11	4,4	10,2	10,2
- nitrite nitrogen	N	mg/l	< 0,1	0,3	2,1	1,3
- nitrate nitrogen	N	mg/l	2,5	2,6	3,9	3,7
Total phosphorus	P	mg/l	0,3	8,7	4,4	9,4
Sulfate	SO_4	mg/l	100	27	41	47
Total fat		mg/l	< 5	5	10	5
Anionic surfactants	DBS	mg/l	< 0,05	0,7	6,7	2,4

Table 3.1.5 No.1 Total Process Wastewater (Additional Analysis)

Lab. No.			6664
Date of sampling			03.07.
Time of sampling			11:00
Type of the sample			spot
Parameter	Expr. as	Unit	
Settable solids		ml/l	< 0,1
Aluminium	Al	mg/l	0,50
Copper	Cu	mg/l	< 0,05
Cadmium	Cd	mg/l	0,02
Cobalt	Co	mg/l	< 0,05
Tin	Sn	mg/l	< 0,1
Chromium-total	Cr	mg/l	< 0,05
Lead	Pb	mg/l	< 0,05
Free chlorine	Cl_2	mg/l	< 0,05
Total chlorine	Cl_2	mg/l	< 0,05
Total cyanide	CN	mg/l	< 0,01
Easily liberatable cyanide	CN	mg/l	< 0,01
Fluoride	F	mg/l	< 0,5
Chloride	Cl	mg/l	65
Sulfide	S	mg/l	< 0,05
Sulfite	SO_3	mg/l	< 0,1
TOC	C	mg/l	70
Total hydrocarbons (mineral oils)		mg/l	
AOX	Cl	mg/l	0,09
Organic solvents:			
- chloroform	Cl	mg/l	< 0,01
- dichloromethane	Cl	mg/l	< 0,01
- tetrachloromethane	Cl	mg/l	< 0,01
1,1,2,2-tetrachloroethene	Cl	mg/l	< 0,01
- 1,1,2-trichlorethene	Cl	mg/l	< 0,01
- 1,1,1-trichloroethane	Cl	mg/l	< 0,01
- benzene		mg/l	< 0,05
- toluene		mg/l	< 0,05
- xylene		mg/l	< 0,05
Phenole index	Phenole	mg/l	0,045

Fig. 3.1.4 No.1 Temperature of Total Process Wastewater (10 min average)

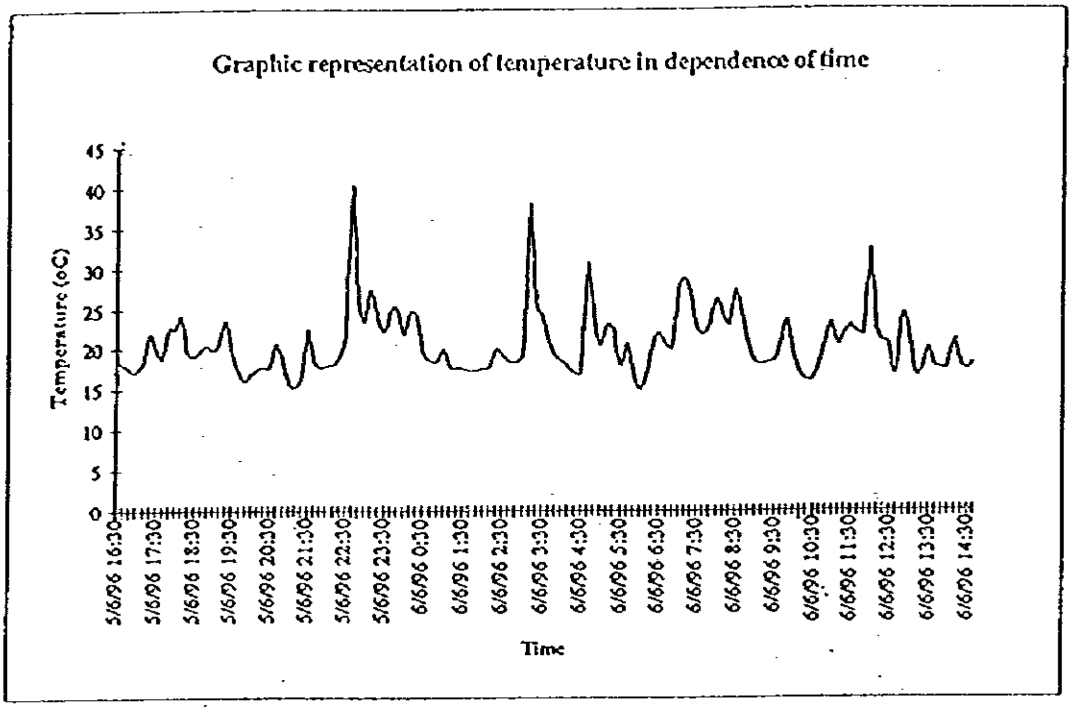


Fig. 3.1.5 No.1 pH of Total Process Wastewater (10 min average)

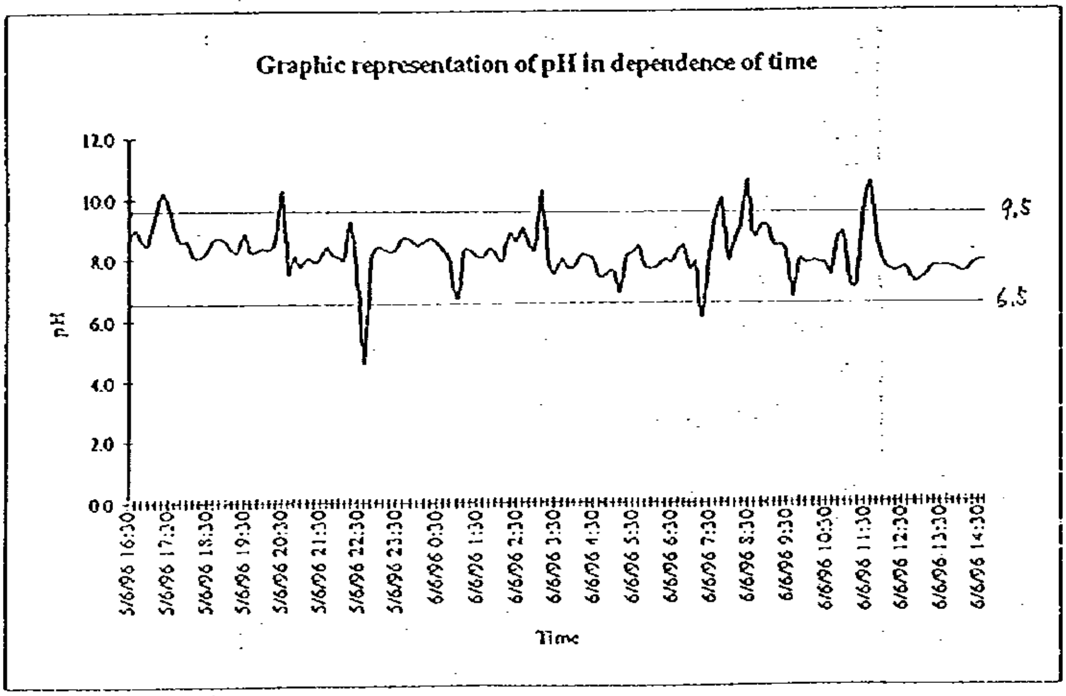


Fig. 3.1.6 No.1 Flow of Total Process Wastewater (10 min average)

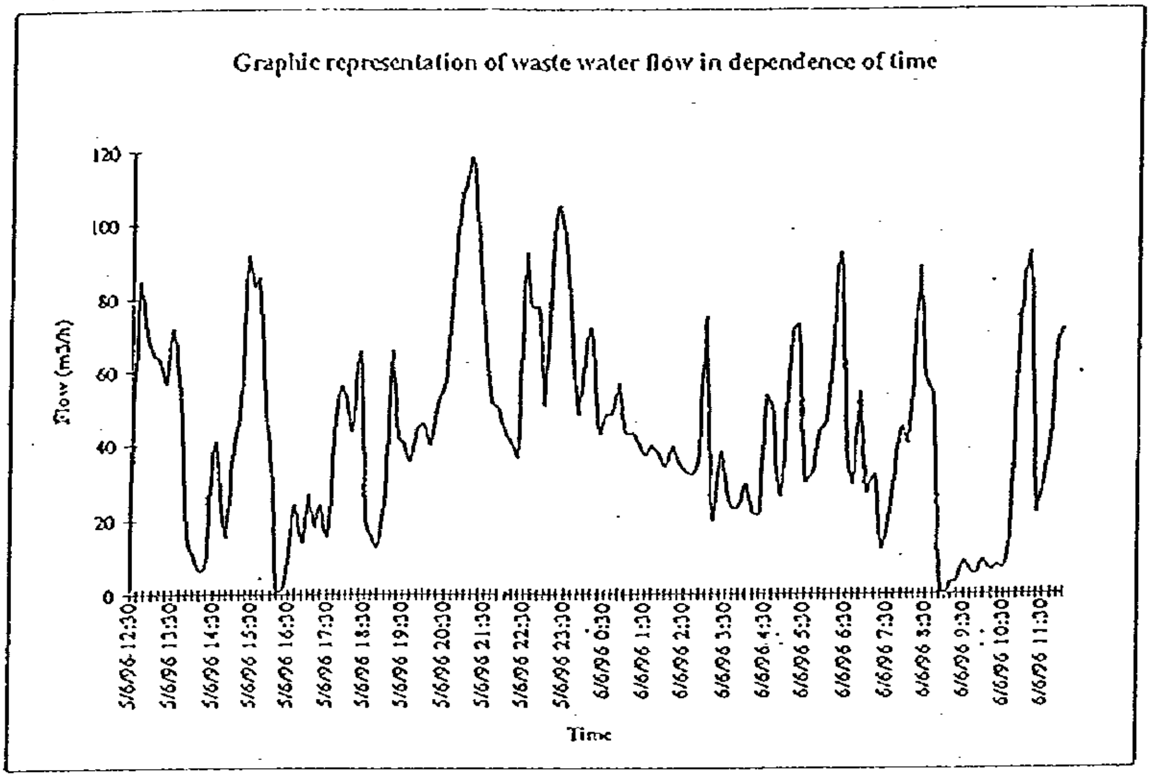


Table 3.1.6 No.2 Other Wastewater (Cooling water and Household)

		Lab. No.	5393
Date of sampling			6.6.
Hour of sampling			7:45
Parameter	Expr. as	Unit	
Temperature		°C	14,9
pH			8,7
Suspended solids		mg/l	< 30
COD	O_2	mg/l	110
BOD_5	O_2	mg/l	10

Table 3.1.7 No.3-1 Printing Wastewater

Parameter	Expr. as	Unit	6614	6615	6616
Lab. Nr.			6614	6615	6616
Date of sampling			1.7.	1.7.	2.7.
Time of sampling			8 - 16	16 - 24	00 - 8
pH			8,4	8,7	8,6
Suspended solids		mg/l	40	30	< 30
Colour: α (436 nm)		m^{-1}	14	16	20
α (525 nm)		m^{-1}	11	11	16
α (620 nm)		m^{-1}	9,8	9,5	13
Total nitrogen:	N	mg/l	29,9	36	42,6
- ammonium nitrogen	N	mg/l	5,6	2,8	1,4
- Kjeldahl nitrogen	N	mg/l	20	22	34
- nitrite nitrogen	N	mg/l	0,2	< 0,1	< 0,1
- nitrate nitrogen	N	mg/l	9,7	14	8,6
Total phosphorus	P	mg/l	5,5	1,2	8,9
COD	O_2	mg/l	370	390	330
BOD_5	O_2	mg/l	120	100	60
Anionic surfactants	DBS	mg/l	11,5	8,0	1,1

Fig. 3.1.7 No.3-1 Flow of Printing Wastewater (10 min average)

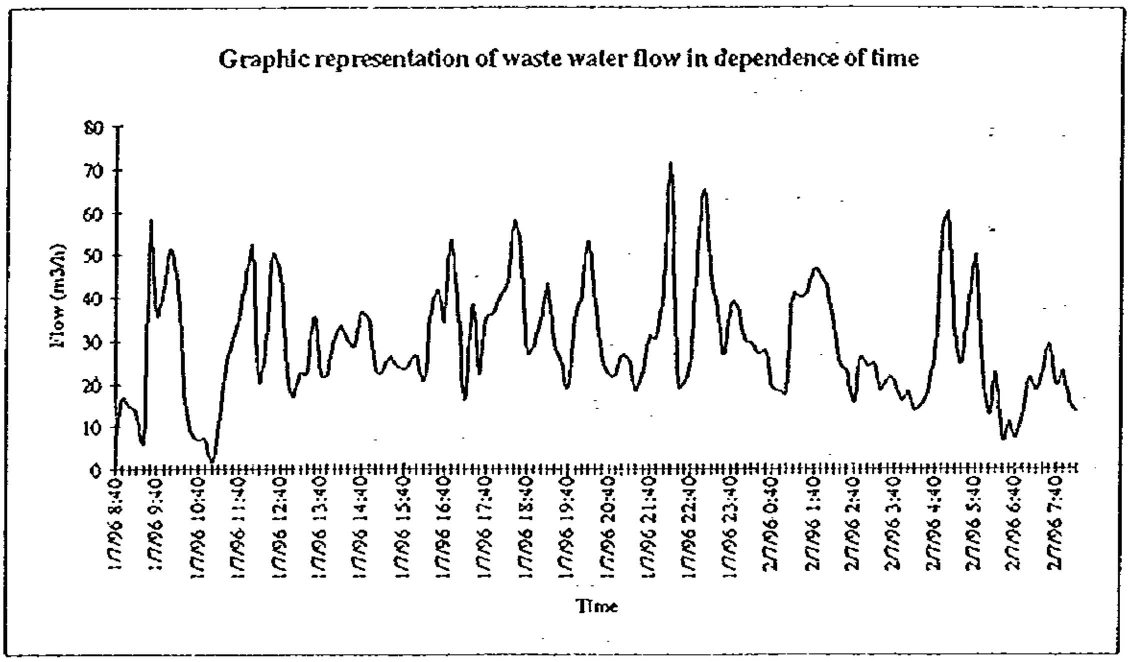


Fig. 3.1.8 No.3-2 Flow of Heat-exchanger Outlet (10 min average)

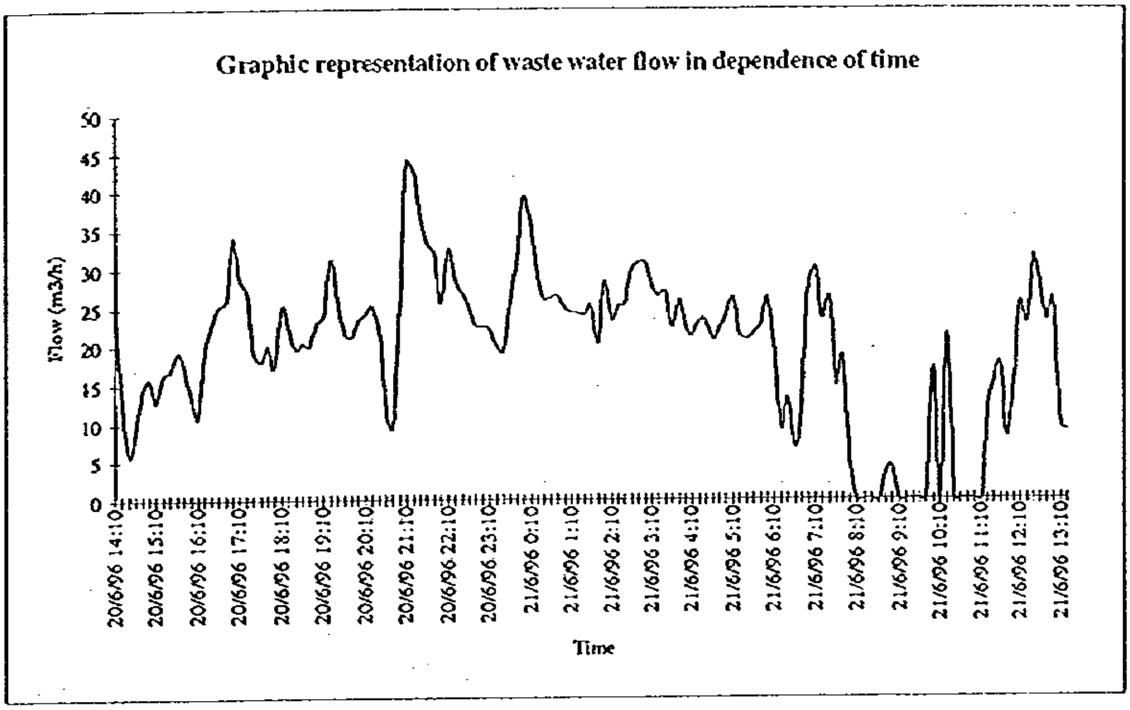


Table 3.1.8 No.3-2 Outlet of Heat-exchanger Coming from Pre-washing

		Lab. Nr.	6510	6511	6512
Date of sampling			20.6.	20/21.6.	21.6.
Time of sampling			14 - 22	22 - 6	6 - 14
Parameter	Expr. as	Unit			
pH			7,1	7,3	7,7
Suspended solids		mg/l	< 30	< 30	< 30
Colour: α (436 nm)		m^{-1}	11	3,1	3,3
α (525 nm)		m^{-1}	6,8	1,9	2,2
α (620 nm)		m^{-1}	5,9	1,2	1,6
Total nitrogen:	N	mg/l	8,0	6,0	6,7
- ammonium nitrogen	N	mg/l	< 0,05	0,27	1,0
- Kjeldahl nitrogen	N	mg/l	3,0	3,4	4,2
- nitrite nitrogen	N	mg/l	< 0,1	< 0,1	< 0,1
- nitrate nitrogen	N	mg/l	5,0	2,6	2,5
Total phosphorus	P	mg/l	7,8	4,2	2,7
COD	O_2	mg/l	160	80	110
BOD_5	O_2	mg/l	50	25	25
Anionic surfactants	DBS	mg/l	0,5	< 0,05	0,4

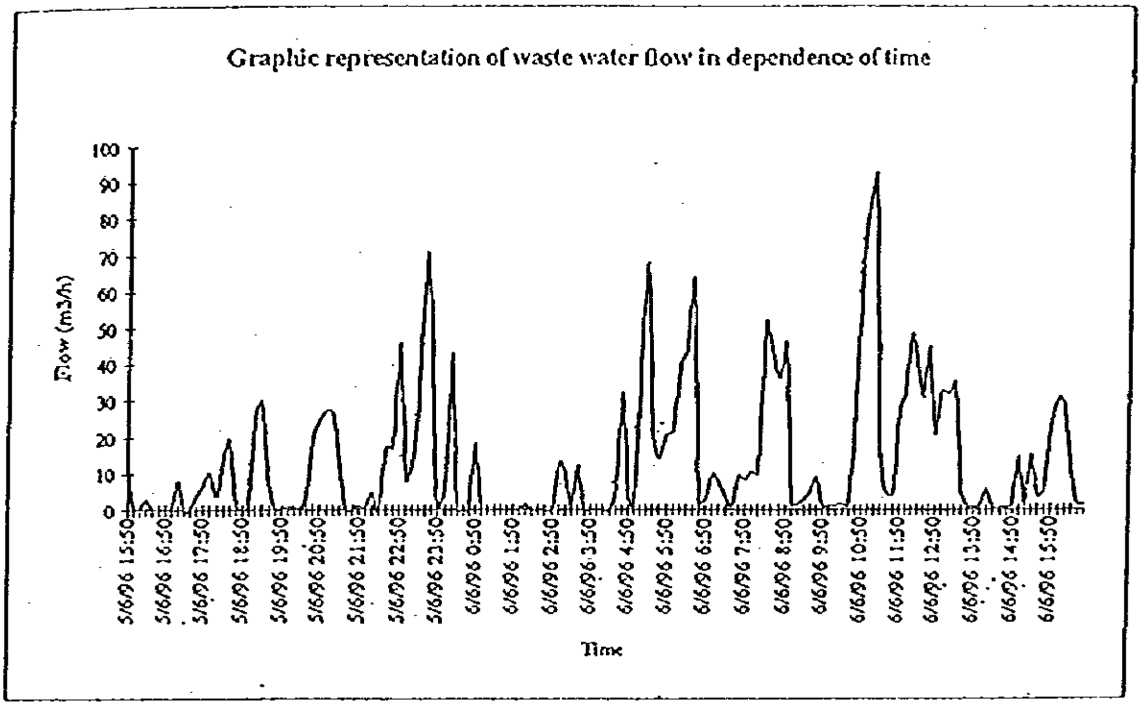
Table 3.1.9 No.4 Dyeing Wastewater (2 hours samples)

		Lab. No.	5415	5416	5417	5419	5421	5422	5423	5424	5425	5426
Date of sampling			5.6.	5.6.	5.6.	6.6.	6.6.	6.6.	6.6.	6.6.	6.6.	6.6.
Hour of sampling			15-17	17-19	19-21	21-3	3-5	5-7	7-9	9-11	11-13	13-15
Parameter	Expr. as	Unit										
pH			8,9	7,6	7,6	8,9	10,3	9,5	9,5	8,1	9,6	7,9
Suspended solids		mg/l	< 30	< 30	< 30	40	< 30	< 30	< 30	< 30	< 30	< 30
COD	O_2	mg/l	100	70	100	380	230	90	340	70	100	80
BOD_5	O_2	mg/l	50	15	50	150	75	< 5	130	15	60	< 5

Table 3.1.10 No.4 Dyeing Wastewater (6 hours samples)

		Lab. No.	5427	5419	5428	5429
Date of sampling			5.6.	6.6.	6.6.	6.6.
Hour of sampling			12-21	21-3	3-9	9-15
Parameter	Expr. as	Unit				
Colour:						
α (436 nm)		m^{-1}	9,7	74	12	11
α (525 nm)		m^{-1}	7,1	80	16	13
α (620 nm)		m^{-1}	6,0	69	31	13
Zinc	Zn	mg/l	0,20	0,15	0,10	< 0,05
Chromium (VI)	Cr	mg/l	0,04	1,8	< 0,05	0,19
Total nitrogen:	N	mg/l	7,1	38,3	11,8	7,2
- ammonium nitrogen	N	mg/l	1,7	18	1,7	3,3
- Kjeldahl nitrogen	N	mg/l	4,8	21	6,0	4,1
- nitrite nitrogen	N	mg/l	0,4	0,3	< 0,1	1,3
- nitrate nitrogen	N	mg/l	1,9	17	5,8	1,8
Total phosphorus	P	mg/l	9,7	14	4,9	6,7
Sulfate	SO_4	mg/l	39	90	50	70
Total fat		mg/l	< 5	25	25	15
Anionic surfactants	DBS	mg/l	< 0,05	1,2	5,4	< 0,05

Fig. 3.1.9 No.4 Flow of Dyeing Wastewater (10 min average)



3.1.2 Water Conservation

1) Current conditions of water usage and water conservation

(1) Features of water usage

① Two wells provide the only source of water. Well No. 1 water is temporarily pumped up to the overhead tank, and then supplied to the whole factory as water for production. Well No. 2 water, which is limited to domestic water, is directly supplied from the well.
There is no difference in water quality between the two wells. The difference in usage is due only to location and pipe layout.

② No recovered water is used; the water is used only once.

③ Most of the water (about 78 % of the total) is used as washing water for the dyeing process.

④ Cooling water is used for cooling the oil cooler of the turbine generator.

⑤ The spinning and weaving processes use water for temperature and moisture regulation (also to clean the air). But few weaving and spinning machines are installed, and since the heating load of each machine is small, not much water is used.

(2) Current conditions of water conservation

① Evidence of water usage control is seen in that the wells are equipped with flow meters. And with the installation of the overhead tank, unnecessary pumping of the well water is avoided.

② The unit consumption of water of the dyeing process alone is approximately $30m^3/1,000\ m^2$ (textile width of 1.5m); slightly smaller than that of the Japanese plant. Since unit consumption varies with type and quality of products, it cannot be concluded by this factor alone that the factory is progressively improving.

③ In the spinning and weaving plant, water for air conditioning is also used to clean air in the ventilator. Some water is circulated by the pump without controling the quantity of feed water.

④ The dyeing units used are Jet Type 1, Pressure Jigger Type 4, Pressure Roll Type 2, and Atmospheric Roll Type 2. Apart from the Jigger Type, they are all water saving types of low liquor ratio. With regard to dyeing machines, the system improvement may be deemed adequate.

⑤ Two continuous washing machines are installed for pre-rinsing and bleaching. Both are water saving units of the counter current system.

⑥ Soft water is used as indirect cooling water for some of the dyeing machines. Heated waste water is used as washing water for dyeing by the cascade process. This water is of unknown quantity.

⑦ Hand control valves are installed at the top of hoses for washing floors and machines. Some hoses do not yet have this installation, however.

2) Planning of water conservation system

(1) Recycling of indirect cooling water of oil cooler for turbine generator

(a) Plan outline

At present, the indirect water of the oil cooler is not recycled. Water temperature at the outlet is about 20℃. Waste water is to be recycled.

(b) Basic conditions

		Present	plan
Water quantity (m^3/d)		64	64
Operation time (h/d)		24	12
Water quantity (m^3/h)		2.53	5.0
Water temperature ℃	inlet	12	25
	outlet	20	35
Recovery rate %			95
Reduced water (m^3/d)			60.8
Cooling load (Kcal/h)		20,270	50,000
Annual operating days : 208			

(c) Equipment outline specification

Item	Number of unit	Specifications
Cooling tower	1	50,000Kcal/h Fan power 0.4kw
Circulation pump	2 (1 reserve pump)	Aperture 40 ϕ, Power 1.5kw
Meters, Controller	Overall	Electrical conductivity
Piping	Overall	Circulation pipe 40 ϕ Discharge pipe 20 ϕ Water supply pipe 15 ϕ

(d) Outline flow sheet and layout drawing

Fig 3.1.10 Outline flow sheet

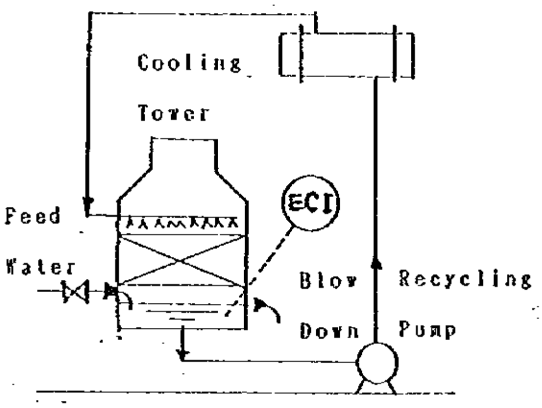
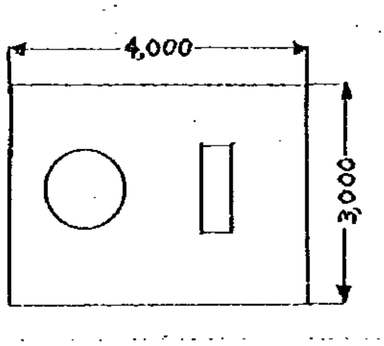


Fig 3.1.11 Layout drawing



(e) Cost estimates

• Facility cost

Item	Unit price (Thousand SIT)	Number	Price (Thousand SIT)
Cooling tower	370	1	370
Circulation pump	180	2	360
Instruments Controller		Overall	100
Pipe and piping		Overall	670
Installation and other construction		Overall	250
Total			1,750

• Operation costs

Item	Necessary amount	Unit price	Necessary cost (SIT/d)	Necessary cost (Thousand SIT/y)	Cost per recovery (SIT/m^3)
Electricity	1.9kw x 12h/d x 0.8	4.2SIT/kw・h	76.6	15.9	1.3
Labor	Concurrent service				
Chemicals			243	50.5	4.0
Total			320	66.4	5.3

• Necessary costs

Item	Annual cost (Thousand SIT)	Cost per recovery (SIT/m^3)	Remarks
Fixed cost			
Facility depreciation	117.3		15 year equal depreciation
Interest	105.0		12%
Facility maintenance	87.5		5% of annual facility cost/year
Subtotal	309.8	24.5	
Operation cost	66.4	5.3	
Total	376.2	29.8	

(f) Technical comment

① At present, the temperature of the cooling water is about 12°C. The water temperature of the cooling tower during the hottest season is about 25°C. During the short summer period there is probably inadequate cooling of oil. Under certain conditions, the heat transfer area of the oil cooler should thus be expanded. Either water from the well should be increased, or all water should be well water. But since this period is at most only 2 months, overall water conservation may be considered effective.

② The well water contains much dissolved salt (electrical conductivity 300-400 μs/cm), and is quite hard (approx. 10° dh). If the extent of circulation (usually expressed as degree of concentration) by the cooling tower is increased, precipitation of scale or corrosion can thus occur. The quality of well water shows that problem-free operation has a degree of concentration of about 2. With this in mind, the following conditions of the cooling tower operation may be set forth :

- The cooling temperature difference is 10°C. The corresponding evaporation rate is about 2%.
- The blow down rate (discharge rate) corresponding to the degree of concentration is about 2%.
- The water loss rate of all water, dispersal, etc. is about 5%. Thus the feed water rate is about 5%.
- According to the above, the recovery rate (equal to water saving rate) is 95%.

(g) Economic comment

The water recovery cost of this system is about 30 SIT/m^3., The following remarks are in order :

① Since the present cost of water supply and water discharge is only 3.2SIT/m^3, water recycling is clearly disadvantageous.

② If waste water is discharged into the sewerage system, over 100 SIT/m^3 will be charged, which makes water recycling economically feasible.

③ If in future waste water is continuously discharged into the river, tax for water use (about 41 SIT/m^3) must be paid. Although waste water treatment cost is unnecessary in this case, water recycling is more economical.

(2) Conservation of air conditioning water

(a) Outline of plan

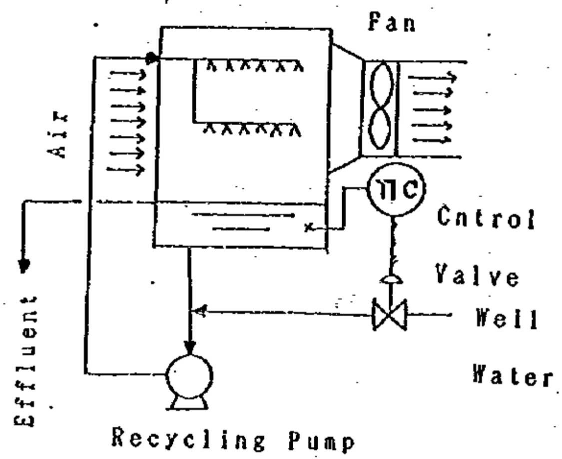
The amount of water for the air conditioner is not specifically controled. It is probably used more than necessary. Water quantity can be controled with the installation of a flow controller.

(b) Concrete method

① Equip the feed water pipe of the air conditioner with an auto-flow controling valve.

② Control the amount of feed water by the auto- flow controling valve to maintain a constant water temperature, by checking the tank water temperature at the bottom of the air conditioner.
The outline is shown in Fig 3.1.12.

Fig. 3.1.12 Auto-flow Regulating Valve for Air Conditioner



(c) Estimated water conservation

Potential water conservation depends on the current operating conditions of the air conditioner, factory operating conditions, weather, etc. This poses obstacles to estimates. However, experience shows that a 20% water saving is possible.

Present water consumption : $159m^3/d$
Annual operation days : 315 days
Possible saving amount : 20% of whole water quantity,
approx. $32m^3/d$, about $10,000m^3/y$

(d) Costs estimates

• Equipment

Item	Number	Specifications	Estimated costs
Temperature	Overall	Liquid expanding direct action (including controlling valve)	500 (Thousand SIT/m^3)

• Necessary costs

Item	Annual costs (Thousand SIT/y)	Costs per recovery (SIT/m^3)	Remarks
Fixed costs			
Equipment depreciation	50.0	5.0	10 year equal depreciation
Interest	25.0	2.5	10%
Equipment maintenance			This const not counted.
Subtotal	75.0	7.5	
Operation costs	0	0	
Total	75.0	7.5	

(e) Technical comment

The temperature of air conditioning water must, like cooling water, be low. The recycling rate will only increase with the installation of a cooling facility.
A cooling tower may be considered for a cooling facility. But this poses the following problems :

① As mentioned in (2),the cooling capacity may be inadequate in summer.
② Since solid materials such as textile dusts mix with the circulating water, a filtering unit must be installed in the circulation system.

Due to the small volume of water to be conserved in the subject factory and the high costs of a cooling tower, the water conservation proposal was limited to the feed water control method mentioned above.

(f) Economic comment

The recovery cost is low. If this method goes as planned, water conservation is economically feasible.

(3) Reclamation of waste water

(a) Basic considerations

In the factory, waste water reclamation without regard to cost is a possibility. But since the dyeing process requires good quality water, it is not economically feasible, except for special cases. Therefore it will not be discussed here in detail.
Basic guidelines for waste water reclamation are as follows:

① Good quality waste water should be extracted as the source reclamation water.
② The reclaimed water should only be used for processes that have little impact on product quality.
③ Reclaimed water need not be of the highest quality.

(b) Reclamation plan

i. Selection of source water

According to Basic Guideline ①, waste water of a color which is difficult to remove, should not be used. The following may be considered for source water :

① The effluent of cooling water and air conditioning water.
② The effluent of the bleaching process and pre-rinsing process, which has no color.
③ The effluent of the relatively clean part (late stage of rinsing process) of the batch dyeing process.

The water of ① may be economically recycled in same usage. The water of ② and ③ combined may be selected as source water, since recycling is ineffective (due to the small effluent quantity of ②).

ii. Water quality of source water and reclaimed water

The water quality of source water should be determined based on the quality and the quantity of effluent and its hourly fluctuations with regard to the desired quality of reclaimed water.

The desired quality of reclaimed water depends how it is to be used (e.g., rinsing water of dyeing process). The quality required for some purposes is not always known, however. Then it is necessary to by experiment to determine the required quality.

The basic procedure for determining the desired water quality is given below. Details will of course differ depending on individual conditions.

① Select the most important water quality items seen in terms of purpose of use.
② Set rough target values for important water quality items.
③ Artificially wake up water that has the same quality as set above and carry out bench experiment to see whether or not this water can be used for the desired purposes.
④ Carry out treatment on actual waste water and wake up water possessing the set quality in a large-scale experiment system (pilot plant).
⑤ Using an experiment system of almost production plant scale, verify whether or not the above-mentioned treated water can be used for the desired purposes.

Due to insufficient data for this factory, the following assumptions concerning source water quality and desired water quality are based on analyzing waste water data and the Japanese experimental data of reclamation :

Quality item	Source	Reclaimed
SS mg/l	<30	<1
BOD mg/l	<100	<1
CODMn mg/l	<100	<10

iii. Treatment capacity and reclamation process

- Treatment capacity

It is not precisely known how much waste water can be recycled, but half of the dyeing process discharge, 500m³/d, may be assumed for this amount

Annual operation days : 315 Annual recovered water : 157,500m³

- Reclamation process

According to water reclamation experiments in Japan, the basic process is as follows :

Water source→pH control→Two stage biological treatment (Trickling filter, Submerged bio-filter)→Coagulation and sand filtration→ Activated carbon absorption→Recovered water

(c) Estimated costs

- Facility costs

According to experimental tests in Japan, the estimated cost of a reclamation facility is about 160,000 thousand SIT.

- Operation costs

Item	Required amount	Unit price	Necessary costs (SIT/d)	Necessary costs (Thousand SIT/y)	Costs per recovery
Electricity	1.2kw · h/m³	4.2 SIT/kw · h	2,520	794	5.0
Labor	Concurrent service	4.2			
Chemicals			25,000	7,875	50.0
Total			27,520	8,669	55.0

- Necessary costs

Item	Annual costs (Thousand SIT/y)	Costs per recovery (SIT/m³)	Remarks
Fixed costs			
Facility depreciation	10,720		15 year equal depreciation
Interest	9,600		12%
Facility maintenance	8,000		5% of annual facility costs/year
Subtotal	28,320	179.8	
Operation costs	8,669	55.0	
Total	36,989	234.8	

(d) Technical comment

① The biggest problem in waste water reclamation is to find the least desired water quality for its purpose of use. If this is impossible, the waste water should be improved up to the water quality of the current water source (which in this factory is well water). This is extremely expensive.

② The least desired water quality value shown above was determined as a result of large-scale water reclamation experiments in Japan. But the value may differ greatly according to the type of waste water and production process for the treated water. The value should be considered as an example only.

③ The desired values for treated water quality indicated here were obtained from large-scale experiment on the reclamation of dyeing waste water in Japan. The basic procedure employed is indicated in (b) ii.

④ This value could vary greatly depending on the nature of the raw waste water and the conditions of the production processes in which the reclaimed water is used. Therefore, rather than the water quality value itself, the actual experiment process used to determine the water quality is more important. However, in cases where a target water quality level is set, the figure here can be used as a reference case.

(e) Economical comment

① The water reclamation costs listed here are estimates, which naturally vary according to the quality of water source and reclaimed water.

② Apart from water reclamation, required costs are on the facility to collect waste water, on the storage tank to pool the water source and reclaimed water temporarily, and on equipment to supply reclaimed water (piping, pump, etc.).
In particular the waste water collecting facility to separate relatively clean water from waste water of the batch system dyeing process is a rather complex system, with a branch pipe combining electromagnetic valve, timer, etc. Consequently, the costs of this facility are comparatively higher.

③ If the waste water is discharged into the sewerage system in the future, if the sewage charge is around 160 SIT/m^3, waste water reclamation will become too expensive to be economically feasible. However, if the sewage charge is raised to a higher level, waste water reclamation will become a means of water conservation that is worth considering.

④ If waste water continues to be discharged into the river, the waste water treatment costs for discharging will be saved, in addition to the tax of 41 SIT/m^3 for water usage, which is equivalent to the recycling quantity.
Since waste water treatment costs are estimated to be large, water reclamation is economically feasible.

(f) Summary

Reclamation of waste water has many technical difficulties. Given the present data, it can only be discussed in general terms. Conditions of economical feasibility are limited, however.

Investigation of waste water reclamation possibilities requires an exhaustive feasibility study (including experiments, if necessary), which is time- and costs- consuming.
Moreover, considering factory conditions (water supply and discharge, production, and management), it is probably unnecessary.

(4) Other possibilities of water conservation

① Equip a hand control valve at the top of the hose for cleaning floors and equipment.
This is essential, because a hand control valve can be installed for 10.000 SIT.

② Recover the steam drain of boiler.
This is not feasible, since most of the steam drain is used for hot water.

③ Save and reclaim domestic water, etc.
This is ineffective, since there is little domestic water.

(5) Summary of water conservation plan

No.	Contents of Water Conservation Plan	Saving amount m³/day	Cost per recovered SIT/m³
1	Recycling of indirect cooling water for oil cooler by cooling tower	69.8	29.8
2	Saving of air conditioning water by flow regulator	32	7.5
3	Reclamation of dyeing waste water by high degree process	500	234.8
	Total	592.8	201.4

		Now	After Water Conservation
Volume of water usage	m³/day	1,587	994
Unit consumption of water	m³/Thousand m	52.5	32.9

Remarks : Production of dyed fabric 30,230m/d
Water saving rate 37.4%

3.1.3 Pre-treatment and Waste Water Treatment

1) Present conditions

Dyeing waste water is pumped from the water pit to the Drava canal. Other waste water is discharged to the main stream of the Drava river with no pumps (See 3.1.1 - 3 for quality and quantity of water).

2) Pre-treatment

Discharge into the sewerage systeem requires a pretreatment system, since the pH of dyeing waste water sometimes exceeds the regulation value. Equip the existing water collecting pit with neutralization facilities of pH controlling, chemical injection, strring, etc., as a pretreatment system. Other types of waste water may be discharged without treatment.

(1) System design

The following compares two cases with regard to dyeing waste water :

Case A.

Equip the existing water pit with neutralization facilities of pH controlling, chemical injection, stirring, etc. The advantage is the low costs of the facility. Chemical costs, chemical replenishment work, etc. are necessary.

Case B.

Install a stabilization tank equivalent to 1/3 day capacity. The advantage is that neutralization chemicals are not needed.

(2) Case A.

Specifications of the system are shown in the following table and figure :

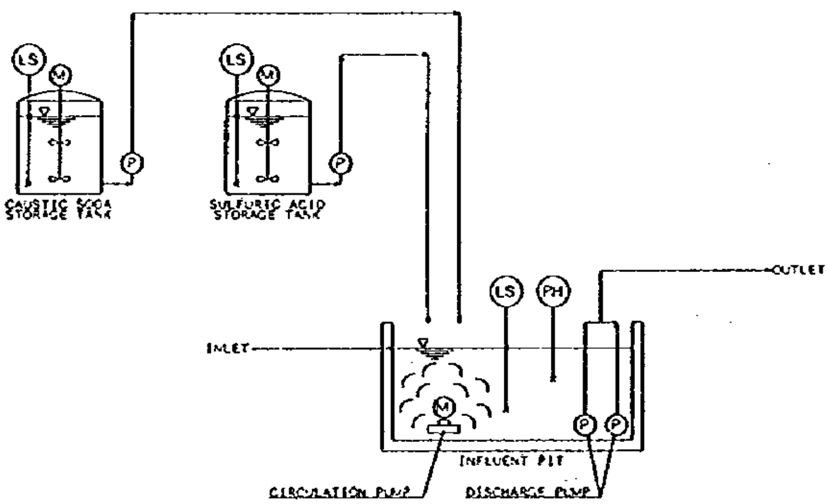
Table 3.1.16 Equipment list

Fig. 3.1.13 Flow sheet

Table 3.1.16 Equipment List of Pre-treatment System (Case A)

No.	Item	Q'ty	Material	Specification	Remark
1	Influent pit	1	RC	Capacity 25 m^3	Existing
	Discharge Pump	1+1	RC		
	Level switch	1			
2	Neutralization system	1			
	Pump (for mixing)	1	FC	100A×1.8m^3/min×8m×5.5kw	
	pH meter/controler	1		pH 0 - 14	
	Chemical pump	2	PVC	Diaphram 50 - 500cc/min 0.2kw	
3	Chemical Tank	2	PE FRP	Capacity 4m3 1.85m×2.055mH	
	Level Switch	2	SUS	Electrode type	
	Agitator	2	SUS	Virtical 88rpm 5.5kw	
4	Control Box	1		Outdoor selfstanding	
				push buttens, alarm lamps	
				pH indicator	

Fig. 3.1.13 Flow Sheet Pretreatment (Case A)



Facility costs

Thousand SIT	
Equipment	8,438
Machine electric work	1,750
Civil work	1,250
Trial operation costs	1,125
Design costs	1,406
Total	13,969

Annual depreciation, Interest		
Civil work related	40 year repayment	1,250/40 = 31.3 T-SIT
Non civil work	15 year repayment	12,719/15 = 847.9
Facility interest	12% Average 6%	13,969 x 0.06 = 698.5
Total		1,555.7

Repayment per water amount, interest
(Divided by annual water treatment of 378,000m^3) 4.2 SIT/m^3

Operating costs

H_2SO_4(100%)	23 kg/day x 70.2 x 252	=	406.9
NaOH(100%)	30 kg/day x 83.2 x 252	=	314.5
Electricity	0.8 x 16.9 kwH/day x 4.2 SIT/kwH x 252	=	14.3
Water	1m^3/day x 200 SIT/m^3 x 252	=	50
Maintenance	340,648 T-SIT x 0.05	=	700
(5% of non civil work)			
Labor	0.5 x 19,200DM/y x 87.5 SIT/DM	=	840
Total		=	2,327.2

Operation costs per water amount
(Divided by annual water treatment 378,000m^3) 6.2 SIT/m^3

(3) Case B.

The specifications of the system are summarized in the following table and figure :

Table 3.1.17 Equipment list
Fig. 3.1.14 Flow sheet
Fig. 3.1.15 Layout

Facility costs are as follows :

Thousand SIT	
Equipment	2,500
Machine electric work	875
Civil work	28,125
Trial operation costs	1,688
Design costs	1,125
Total	34,313

Annual repayment, Interest

Civil work related	40 year repayment	28,125/40 = 703.1 T-SIT
Non civil work	15 year repayment	6,188/15 = 412.5
Facility interest	12% Average 6%	34,313 x 0.06 = 2,058,8
Total		3,174.4

Repayment per water amount, interest
(Divided by annual water treatment of 378,000m³) 8.4 SIT/m³

Operation costs

Electricity Charge	0.8 x 11kwH/day x 4.2 SIT/kwH x 252	= 33.3
Maintenance (5% of non civil work)	5,500 T-SIT x 0.05	= 275
Labor	0.2 person x 19,200DM/y x 87.5 SIT/DM	= 336
Total		= 644.3

Operation costs per water amount : 1.6 SIT/m³
(Divided by annual water treatment : 373,000m³)

3) Waste water treatment

In the event of direct discharge into the river, the color, NH4-N and P must be strictly regulated.
There is sufficient space for a waste water treatment system.

Table 3.1.17 Equipment List of Pretreatment System (Case B)

No.	Item	Q'ty	Material	Specification	Remark
1	Influent pit	1	RC	Capacity 25 m^3	Existing
	Pump	1+1	RC		
	Level switch	1			
2	Stabilization tank	1	RC	Capacity 500 m^3 (1/3 day)	
				6m×21m×4.5mD	
	Pumps (circulation)	1	FC	100A×1.8m^3/min×8m×5.5kw	
	Level switch	1	PVC	Floating	
	pH meter	1			
3	Discharge pump	1+1	FC	100A×1.8m^3/min×8m×5.5kw	
4	Control Box	1		Outdoor selfstanding	
				push buttens, alarm lamps	
				pH indicator	

Fig. 3.1.14 Flowsheet of Pretreatment (Case B)

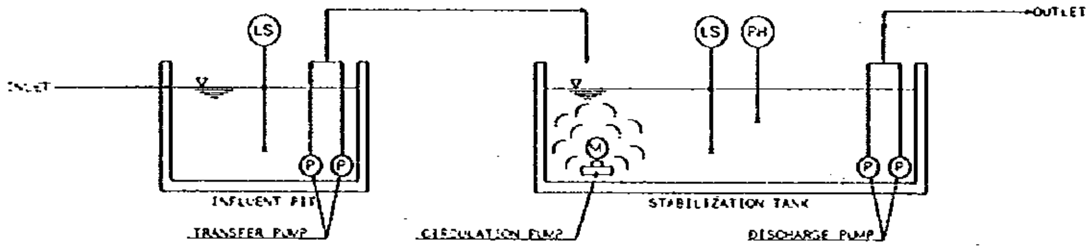
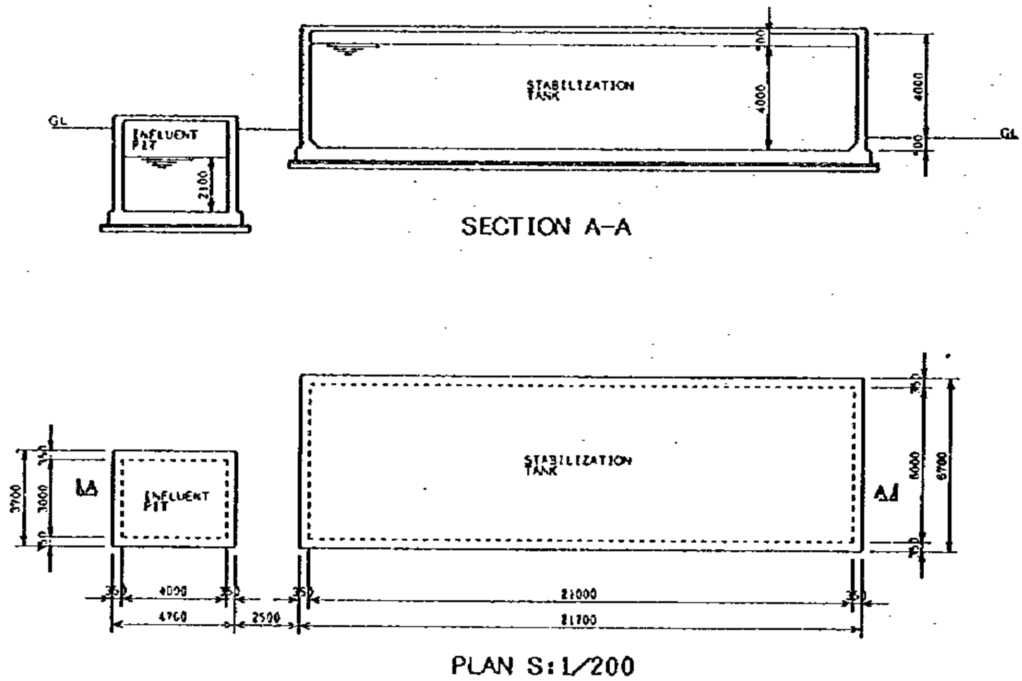


Fig. 3.1.15 Layout of Pretreatment (Case B)



(1) System design

Water discharge	:	1500 m^3/day		
Intake hour	:	24 hr/day		
Treatment hour	:	24 hr/day	Dehydrator	8 hr/day

Water quality		Intake	Discharge	Emission standard
pH		7-10	7-8	6.5-9
COD	mg/l	500	90	200
BOD	mg/l	300	10	30
SS	mg/l	40	10	80
NH4-N	mg/l	30	4	5
Total N	mg/l	50	20	-
Total P	mg/l	10	1	1
Color (436)	l/m	30	7	7
	(525)l/m	30	5	5
	(620)l/m	30	3	3

The water quantity is 50% extra of survey time with regard to recovery of operation rate and facility improvement. The quality of waste water COD and BOD is show slightly higher than the analyzed value of the survey time.

(2) Waste water treatment flow

(waste water)→Collecting pit (present)→Stabilization tank→Neutralization tank→Aeration tank→1st Sedimentation tank→Aeration tank→2nd Sedimentation tank→Anaerobic tank→Aeration tank→Coagulation tank→3rd Sedimentation tank→Sand filter→Ozonizing tube→Activated carbon adsorber →Treated water tank→Discharge to the river

(coagulated sludge) →Sludge storage tank→Sludge dehydrator→Cake hopper→Truck

4) Reasons for selection of waste water system

① A separate emission standard is established for the textile factory.

② In cases of direct discharge into the river, the emission standard of the textile industry is particularly strict regarding the color and P. Ozone treatment and activated carbon absorption are then needed so that BOD, COD, SS, and oil will clear the standard.

③ Chemical coagulation separation may be considered as a candidate of the primary treatment. But since the BOD standard is 30mg/l, biological treatment is more appropriate. N-NH_3 is easily decreased by the standard activated sludge treatment, which requires anti-forming facility, since bubbles are produced by the influence of the active surface agent

④ P is removed by coagulation sedimentation. Sand filtration is essential to post treatment.

⑤ Activated carbon adsorption works better than the ozone process for the completion of bleaching. The ozone process precedes the activated carbon adsorption, in order to lower the adsorption load of activated carbon. At the stage when the color is thick, the ozone process works well. Although it is possible for the ozone process alone to clear the color regulation, activated carbon adsorption is used for the completion of bleaching. Since the function of activated carbon adsorption is not to lower COD but to enhance the bleaching, it should be kept to a minimum. If the ozone process passes the standard, the activated carbon adsorption may be omitted. On the other hand, if the standard is not cleared even after the activated carbon adsorption, additional measures must be taken, such as lowering the speed of the passing water to extend contact time with the activated carbon.

5) Facility specifications

(1) List of facility and reference figures

The facility specifications are summarized in the following table and figures.

Table 3.1.18	Equipment list
Fig. 3.1.16	Material balance sheet
Fig. 3.1.17	Flow sheet
Fig. 3.1.18	Layout
Fig. 3.1.19	Structural drawing of major equipment

(2) Design Calculation

(a) Water volume and quality are as set in the system design conditions.

(b) Calculation of main capacities

i. Inflow pit

Equivalent to 20 minutes of average hourly waste water volume

$62.5\ m^3/hr \times 1/3 = 21.6$

The existing 25 m^3 shall be applied

ii. Homogenization tank

Retention time: 1 day, aeration strength

$9\ m \times 42.85\ m \times 4\ m\ (effective) = 1{,}540\ m^3$

iii. Neutralization tank

Retention time: equivalent to 20 minutes

2.6 m x 2.6 m x 3.2 m (effective) = 21.6 m^3

iv. Aeration tank

BOD capacity load: 0.5 kg-BOD/d or more

1,500 m^3/d x 300 mg/l = 450 kg-BOD/d

450 kg-BOD/d ÷ 0.5 kg-BOD/d = 900 m^3

Equivalent to approximately 14 hr of the retention time

Aeration strength: 2.0 Nm^3/hr/m^3 1,800 Nm^3/hr = 30 Nm^3/min.

3 tanks x 3.9 m x 18.7 m x 4 m (effective) = 876 m^3

v. Mild aeration tank

Retention time: equivalent to 14 hr, 62.5 m^3/hr x 14 = 875 m^3

Aeration strength: 1.0 Nm^3/hr/m^3 875 Nm^3/hr = 15 Nm^3/min.

12.3 m x 18.1 m x 4 m (effective) = 890 m^3

vi. No. 1 sedimentation tank

Surface area load: 12 m^3/m^2/d

Required surface area: 1,500 m^3/d ÷ 12 m^3/m^2/d = 125 m^2

Retention time: equivalent to 4 hr, 62.5 m^3/hr x 4 hr = 250 m^3

12 m x 12 m x 1.8 m (effective) Surface area: 144 m^2

Capacity: 259 m^3

vii. Contact aeration tank

Retention time: equivalent to 4 hr 62.5 m^3/hr x 4 hr = 250 m^3

Aeration strength: 2.0 Nm^3/hr/m^3, 500 Nm^3/hr = 8.3 Nm^3/min.

12 m x 5.8 m x 3.6 m (effective) = 251 m^3

viii. No. 2 sedimentation tank

Surface area load: 15 m^3/m^2/d

Required surface area: 1,500 m^3/d ÷ 15 m^3/m^2/d = 100 m^2

Retention time: equivalent to 3 hr, 62.5 m^3/hr x 3 hr = 188 m^3

10 m x 10 m x 2.0 m (effective) Surface area: 100 m^2

Capacity: 200 m^3

iix. Denitrification tank

Retention time: equivalent to 4 hr, 62.5 m^3/hr x 4 hr = 250 m^3

10 m x 8.4 m x 3.2 m (effective) = 269 m^3

ix. Oxidation tank

Retention time: equivalent to 1 hr, 82.5 m^3

Aeration strength: 2.0 $Nm^3/hr/m^3$, 62.5 Nm^3/hr = 1 Nm^3/min.

6.4 m x 3.4 m x 3.2 m (effective) = 91 m^3

x. Reaction tank, pH adjustment tank, coagulation tank

Retention time: equivalent to 20 min. in each

2.6 m x 2.6 m x 3.2 m (effective) = 21.6 m^3

xi. No. 3 sedimentation tank

Surface area load: 15 $m^3/m^2/d$

Required surface area: 1,500 m^3/d ÷ 15 $m^3/m^2/d$ = 100 m^2

Retention time: equivalent to 2.5 hr, 62.5 m^3/hr x 2.5 hr = 156 m^3

10 m x 10 m x 1.6 m (effective) Surface area: 100 m^2

Capacity: 160 m^3

xii. No. 1 intermediate tank

Retention time: equivalent to 2 hr, 62.5 m^3/hr x 2 hr = 125 m^3

9.5 m x 5.7 m x 2.8 m (effective) = 152 m^3

xiii. Sand filter

Filtration LV: 8.0 $m^3/m^2/hr$

62.5 m^3/hr ÷ 8.0 $m^3/m^2/d$ = 7.8 m^2

2 x 2,400 D x 2,250 H (straight body: 1,800)

xiv. Ozone treatment device

Ozone injection volume : 1.0 mg/l

Ozone generation volume : 62.5 g/hr

Reaction tower : 680 H x 2,010 H

xv. No. 2 intermediate tank

Retention time: equivalent to 2 hr, 62.5 m^3/hr x 2 hr = 125 m^3

9.5 m x 5.7 m x 2.8 m (effective) = 152 m^3

xvi. Activated carbon adsorption tower

Water passage LV: 8.0 $m^3/m^2/hr$

Empty tower SV: 5.0 $m^3/m^2/hr$

Required cross sectional area: 62.5 m^3/hr ÷ 8.0 $m^3/m^2/d$ = 7.8 m

Activated carbon height: 8.0 m /m /hr ÷ 5.0 m /m /hr = 1.6 m

2 towers (1 standby) x 2,400 D x 3,500 H

xvii. Treated water tank

Retention time: equivalent to 1 hr

xviii. Sludge storage tank

Generated sludge	:	0.8 t/d
Water content	:	99%
Retention time	:	2 d

xix. Dewaterer

Generated sludge	:	0.8 t/d
Water content	:	99%
Dewatered cake water content	:	85%
Operating time	:	8 hr
Dewatering speed	:	100 kg/hr
Dewatered cake volume	:	0.8 ÷ (1-0.85) = 5.3 m^3/d

6) Facility cost

	Thousand SIT
(1) Equipment	
(a) Pumps, blowers, agitators, decelerator, dehydrator	65,706
(b) Instrumentation	7,254
(c) Other equipment	103,182
(2) Site works	
(d) Equipment installation, piping work	46,427
(e) Electrical work	37,316
(f) Painting work	2,469
(g) Civil engineering work	157,188
(h) Building work	69,925
(i) Site supervision cost	7,875
(j) Trial run cost	3,150
(3) Design cost	5,625
Total	506,117

(4) Annual repayment, Interest

(a) Civil work related	40 year repayment	227,113/40 = 5,678 T-SIT
(b) Non civil work	15 year repayment	279,004/15 = 18,600
(c) Facility interest	12% Average 6%	506,117 x 0.06 = 30,367
Total		54,645

(5) Repayment per water amount, interest

Divided by annual water treatment of 378,000m^3 144.6 SIT/m^3

7) Running Costs

(1) Chemical Costs Thousand SIT/Year

(a) PAC (11%)	600 kg/day x 74.7 SIT/kg x 252 days	= 11,294.6
(b) H_2SO_4 (98%)	46 kg/day x 70.2 x 252	= 813.8
(c) NaOH (100%)	30 kg/day x 83.2 x 252	= 629
(d) Polymer A (powder)	7 kg/day x 990 x 252	= 1,746.4
(e) Polymer K (powder)	4 kg/day x 2000 x 252	= 2,016
(f) Nutrition agent (Urea 100%)	2 kg/day x 52 x 252	= 26.2
(g) Activated carbon	450 kg/day x 930 x 252	= 105,462
Subtotal		= 121,988

(2) Electricity Charge

0.8 x 7,878 kwh/day x 4.2 SIT/kwh x 252 = 6,654.6

(3) Sludge Disposal Cost

5.3 m^3/day x 1,423 SIT/m^3 x 252 = 1,900.6

(4) Water Charge

40 m^3/day x 200 SIT/m^3 x 252 = 2,016.0

(5) Kerosene Charge

0.5 l/day x 60 SIT/l x 90 = 2,700

(6) Maintenance Cost

The cost of maintenance is assumed to be 5% of the equipment cost.
278,937 T- SIT x 0.05 = 13,946.8

(7) Personnel expenses

2 staff/year x 19,200 DM/y x 87.5 SIT/DM = 3,451.8
Total 152,658

(8) Operation costs per water volume

Divided by annual water treatment 378,000m³ = 404 SIT/m³

8) Economic comment (the normal economic comment is described in 3.6.4)

Here, in order to compare with the other model factories for which a normal economic comment is not carried out, the same simple economic comment that was performed on those factories shall be conducted.

(a) Conditions

① Depreciation period : equipment 15 years
: civil engineering, building 40 years
② Interest : 10%/annum
③ Depreciation method : uniform depreciation
④ WWTP discharge charge : 160 SIT/m³
⑤ River discharg : 0
⑥ Annual waste water treatment volume : 100,000 m³/year

(b) Treatment costs per 1 m³ of waste water

Item		Contents (SIT/year)			Costs (SIT/m³)
Depreciation	Machinery	184,004,000 SIT ÷ 15 years	=	12,312,000	123
	Building, civil engineering	111,390,000 SIT ÷ 40 years	=	2,785,000	28
Interest		507,117,000 SIT x 0.06	=	30,367,000	148
Running costs				26,592,000	266
Total					565

9) Conclusion

In the case of river discharge, because the discharge standards are so harsh, the equipment costs and running costs would both be expensive. As a result, it would be more advantageous for this factory to pay the charge for sewerage system discharge rather than independently install waste water treatment facilities.

Table 3.1.18 Equipment List of Waste Water Treatment System for SVILA

No.	Item	Q'ty	Material	Specification	Remark
1	Influent pit	1	RC	Capacity 25 m^3	Existing
	Pump	1+1	RC		
	Level switch	1			
2	Stabilization tank	1	RC	Capacity 1,500 m^3 (1 day)	
				9.0m×42.8m×4.5mD	
	Pumps (submersion)	1+1	FC	100A×1.8m^3/min×8m×5.5kw	
	Blower (roots)	1	FC	150A×15.4Nm^3/min×0.5kg/cm2×30kw	
	Screen	1	SUS	edgewire type 140m^3/hr 1mm slit	
	Level switch	1	PVC	Float type	
	Flow meter	1	PVC	V-notch Box type 20 - 100m^3/hr	
3	Neutralization tank	1	RC	Capacity 21.6 m^3 (20 min)	
				2.6m×2.6m×4.5m(actual 3.2m)D	
	Agitator	1	FC SUS	Vertical 295rpm 3.7 kw	
	pH meter/controler	1		Dip type pH 0~14	
4	Aeration tank	3	RC	Capacity 292 m^3 (14hr)	
				3.9m×18.7m×4.5m(4.0m)	
	air difuser	6	SUS		
	circulation pump	6	FC	100/80A×2.5m^3/min×12m×7.5kw	
	water flow meter	6	FC		
	air flow meter	6	FC		

No.	Item	Q'ty	Material	Specification	Remark
5	Mild aeration tank	1	RC	Capacity 890 m^3 (14hr)	
				12.3m×18.1m×4.5m(4.0m)D	
	air difuser	1	SUS		
	#1 defoaming pump	1	FC	100A×1.1m^3/min×15m×5.5kw	
	air flow meter	1	FC		
6	#1 Sedimentation tank	1	RC	Capacity 259m^3 Surface 144 m^2	
				12m×12m×4.5mD	
	Sludge collector	1	SS	rake type 0.4 kw	
	Pump	1	FC	100/80A×1.1m^3/min×15m×18.5kw	
7	Contact aeration tank	1	RC	Capacity 251 m^3 (4hr)	
				12m×5.8m×4.5m(3.6m)D	
	contact media	1	PE	200m^3	
	#2 defoaming pump	1	FC	80A×0.8m^3/min×15m×3.7kw	
	air flow meter	1	FC		
8	#2 Sedimentation tank	1	RC	Capacity 160 m^3 Surface 100 m^2	
				10m×10m×4.5m(2.0m)D	
	Sludge collector	1	SS	rake type 0.4 kw	
	Sludge pump	1	FC	100/80A×1.1m^3/min×15m×18.5kw	

No.	Item	Q'ty	Material	Specification	Remark
9	De-N tank	1	RC	Capacity 269 m³ (4hr)	
				10m×8.4m×4.5m(3.2m)D	
	contact media	1	PE	40m³	
	circulation blower	1	FC	50A×30Nm³/min×3.5m×2.2kw	
10	Oxidation tank	1	RC	Capacity 91.4 m³ (1 hr)	
				8.4m×3.4m×4.5m(3.2m)D	
	blower	1	FC	150A×18.6Nm³/min×0.5kg/cm2×37kw	
	air flow meter	1	FC		
	difuser	1	SS		
11	Reaction tank	1	RC	Capacity 21.6 m³	
			acid coating	2.6m×2.6m×4.5m(3.2m)D	
	Agitator	1	SS SUS	Vertical 295rpm 3.7 kw	
12	pH control tank	1	RC	Capacity 21.6 m³ (20min)	
			acid coating	2.6m×2.6m×4.5m(3.2m)D	
	Agitator	1	SS SUS	Vertical 295rpm 3.7 kw	
	pH meter	1		Dip type pH 0~14	
13	Coagulation tank	1	RC	Capacity 21.6 m³ (20min)	
				1.6m×1m×2mD	
	Agitator	1	SUS	Vertical puddle 88rpm 3.7 kw	

No.	Item	Q'ty	Material	Specification	Remark
14	#3 Sedimentation tank	1	RC	Capacity 160 m³ Surface 100 m²	
				10m×10m×4.5m(2.0m)D	
	Sludge collector	1	SS	rake type 0.4 kw	
	Sludge pump	1	FC	100/80A×1.1m³/min×15m×18.5kw	
15	#1 intermidiate tank	1	RC	Capacity 152 m³	
				9.5m×5.7m×4.5m(2.8m)D	
	sandfilter feed pump	1+1	FC	80/65A×1.2m³/min×18m×5.5kw	
	level switch	3	PVC	float type	
16	Sand filter	1	SS	LV=8m/hr automatic back washing	
				2.4mφ×2.25mH (straght zone 1.8H)	
17	Ozonizing tower	1	SUS	0.6mφ×2H (straght zone 1.8H)	
	ozon generator	1	SUS	10 - 70g-ozon/hr×100g/Nm³ 0.6kW	
	excess ozon absorber	1	SUS		
18	#2 intermidiate tank	1	RC	Capacity 152 m³	
				9.5m×5.7m×4.5m(2.8m)D	
	ACB feed pump	1+1	FC	80/65A×1.2m³/min×18m×5.5kw	
	level switch	3	PVC	floating type	
19	A-carbon adsorber	2	SS	LV=8m/hr manual back washing	
				2.4mφ×3.5mH (straght zone 3mH)	

No.	Item	Q'ty	Material	Specification	Remark
20	Treated water tank	1	RC	Capacity 151 m³	
				8.4m×4.5m×4.5m(4.0m)D	
	Level switch	1	PVC	Float type	
	pH meter	1		Dip type 10~14	
	Pumps	1+1	FC	100/80A×1.8m³/min×18m×7.5kw	
21	Sludge storage tank	1	RC	Capacity 21	
				8.4m×8.4m×4.5mD	
	sludge pump	1	FC	80A×0.2m³/min×12m×3.7kw	
	blower (roots)	1	FC	100A×3.2Nm³/min×5m×7.5kw	
	level switch	1	SUS	float type	
	air flow meter	1	SS		
22	Dehydrator	2	SS	Belt press type, 6.7 kw	
				0.8t/day(99%) cake(86%)	
	sludge coagulation tank	2	SS	0.64m³ with agitator 88rpm	
	belt convayer	2	SS NBR	0.4m width 8m length	
	cake hopper	1	SS	12.5m³ 0.2kW	
23	PAC tank	1	PE FRP	Capacity 20 m³	
				2.85mφ×3.46mH	
	Pump (diaphram)	1	PVC	500 - 5,000cc/min×3kg/cm²×0.4kw	

No.	Item	Q'ty	Material	Specification	Remark
24	H2SO4 tank	1	PE FRP	Capacity 4 m^3	
				1.85m×2.055mH	
	Pump (diaphram)	2	PVC	6 - 60cc/min×13kg/cm^2×0.1kw	
	Level switch	1	SUS	Electrode type	
25	NaOH tank	1	PE FRP	Capacity 4 m^3	
				1.85mφ×2.055mH	
	Pump (diaphram)	1	PVC	14 140cc/min×13kg/cm^2×0.1kw	
	Level switch	1	SUS	Electrode type	
26	Polymer(A) solving tank	1	PE FRP	Capacity 20 m^3	
				2.85mφ×3.46mH	
	powder solver	1	PVC	3 - 9 kg/hr 0.06kw	
	Agitator	1	SUS	Vertical 88rpm 5.5kw	
	Pump (roots)	1	FC	65/50A×0.31m^3/min×10m×2.2kw	
27	Polymer(A) storage tank	1	PE FRP	Capacity 20 m^3	
				2.85mφ×3.46mH	
	Pump (diaphram)	2	PVC	500 - 5,000cc/min×3kg/cm^2×0.4kw	
	Level switch	1	SUS	Electrode type	
28	Polymer(K) solving tank	1	PE FRP	Capacity 20 m^3	
				2.85mφ×3.46mH	
	powder solver	1	PVC	3 - 9 kg/hr 0.06kw	
	Agitator	1	SUS	Vertical 88rpm 5.5kw	
	Pump (roots)	1	FC	65/50A×0.31m^3/min×10m×2.2kw	

No.	Item	Q'ty	Material	Specification	Remark
29	Polymer(A) storage tank	1	PE FRP	Capacity 20 m³	
				2.85mφ×3.46mH	
	Pump (diaphram)	2	PVC	210 - 2,100cc/min×5kg/cm²×0.4kw	
	Level switch	1	SUS	Electrode type	
30	Nutrients solving tank	1	PE FRP	Capacity 20 m³	
				2.85mφ×3.46mH	
	powder solver	1	PVC	3 - 9 kg/hr 0.06kw	
	Agitator	1	SUS	Vertical 88rpm 5.5kw	
	Pump (roots)	1	FC	65/50A×0.31m³/min×10m×2.2kw	
31	Nutrients storage tank	1	PE FRP	Capacity 20 m³	
				2.85mφ×3.46mH	
	Pump (diaphram)	2	PVC	210 - 2,100cc/min×5kg/cm²×0.4kw	
	Level switch	1	SUS	Electrode type	
32	Compressor	1	FC	36 /min×9.9kg/cm²×0.4kw	
33	Control panel	1		Indoor Self-standing enclosed type	
				1.6m×0.6m×2mH	
				AC 400V×50Hz	
				Push button switches	
				Alarm lamps	
				pH indicators	
				Do indicator	

Fig. 3.1.16 Material Balance of Water Teratment

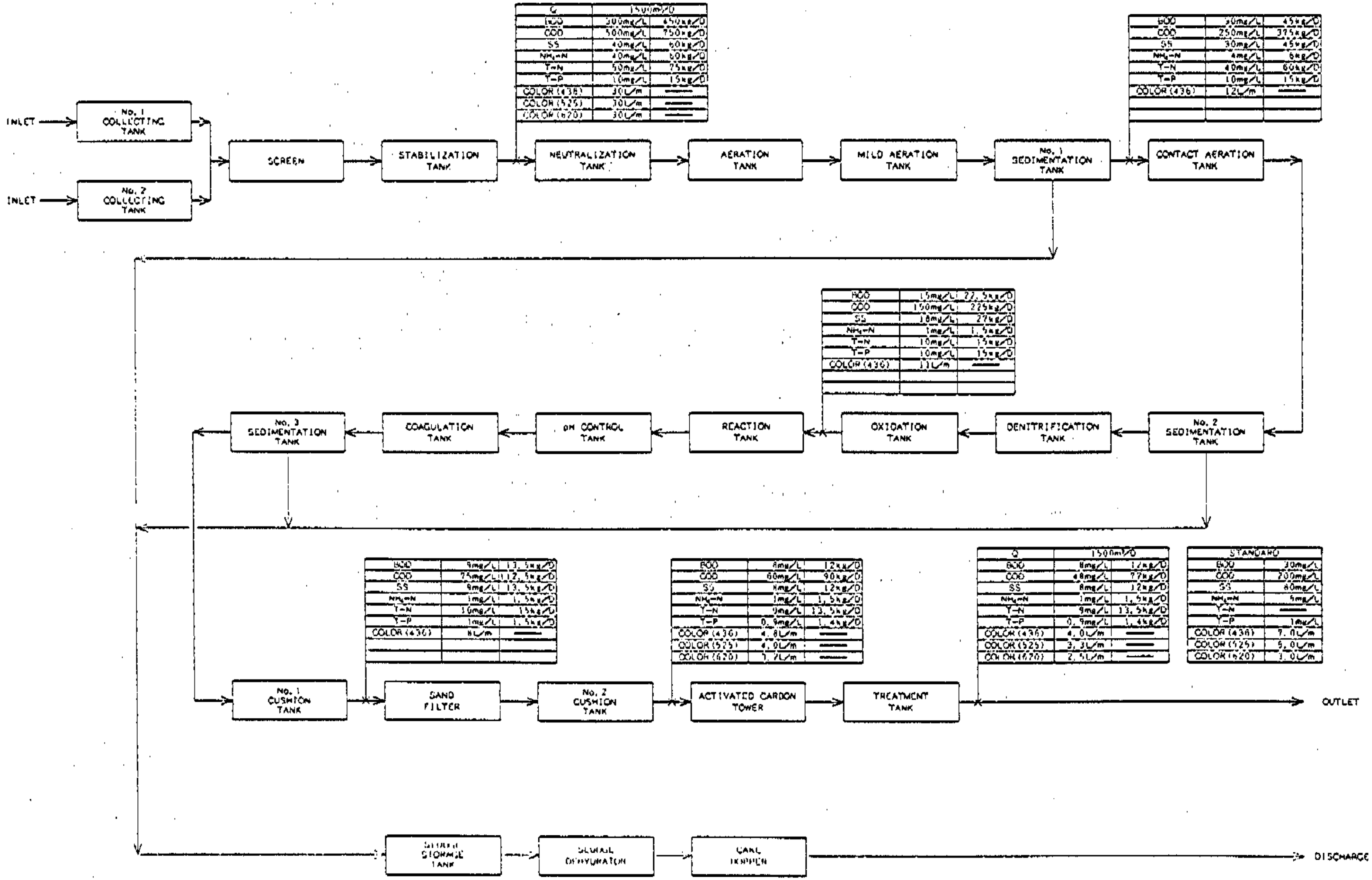


Fig. 3.1.17 Flowsheet of Waste Water Treatment

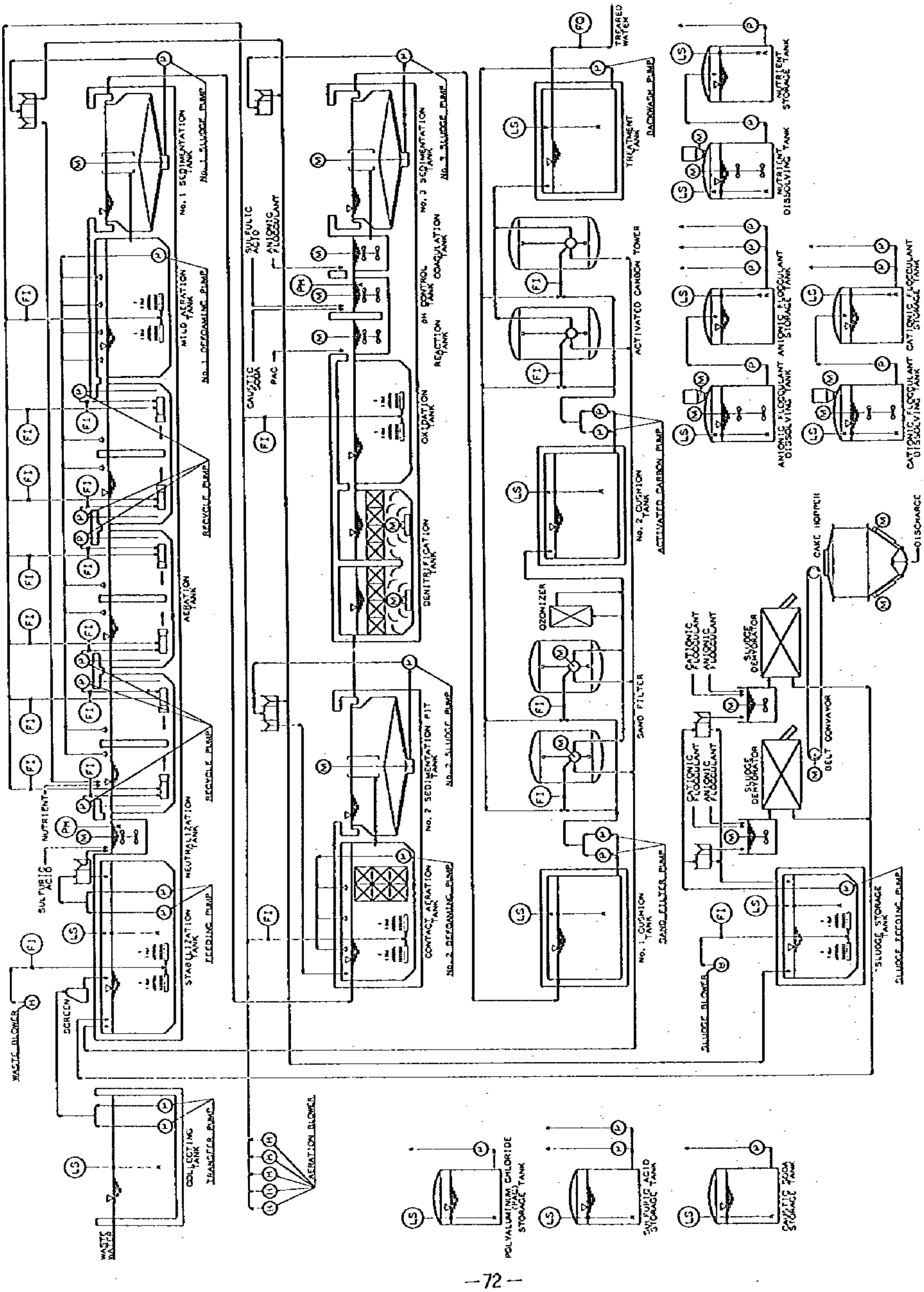
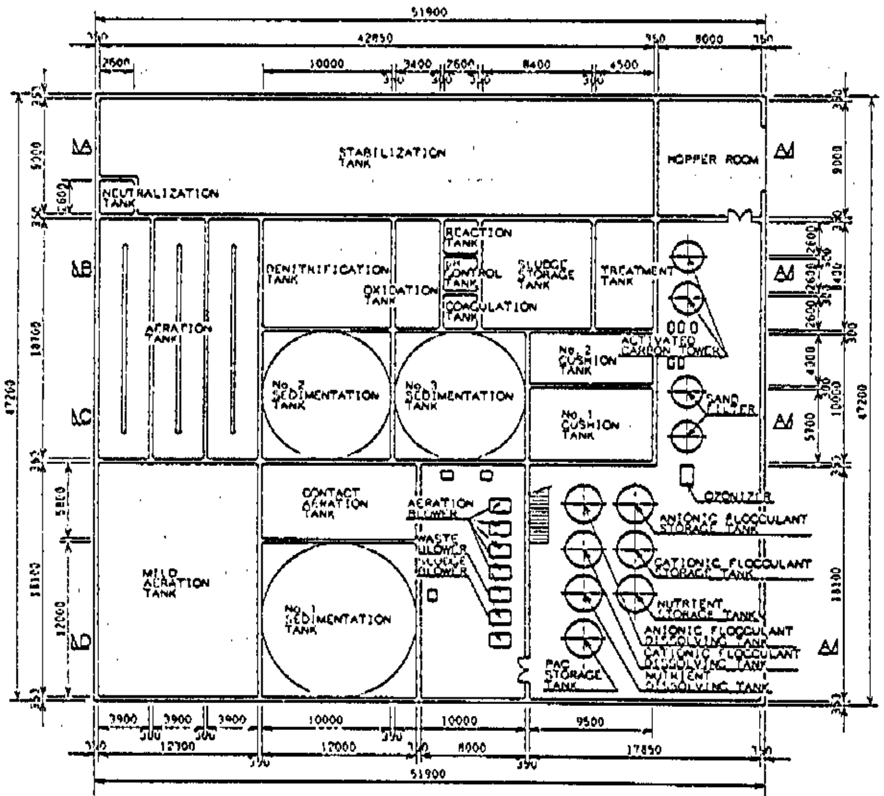


Fig. 3.1.18 Layout of Waste Water Treatment



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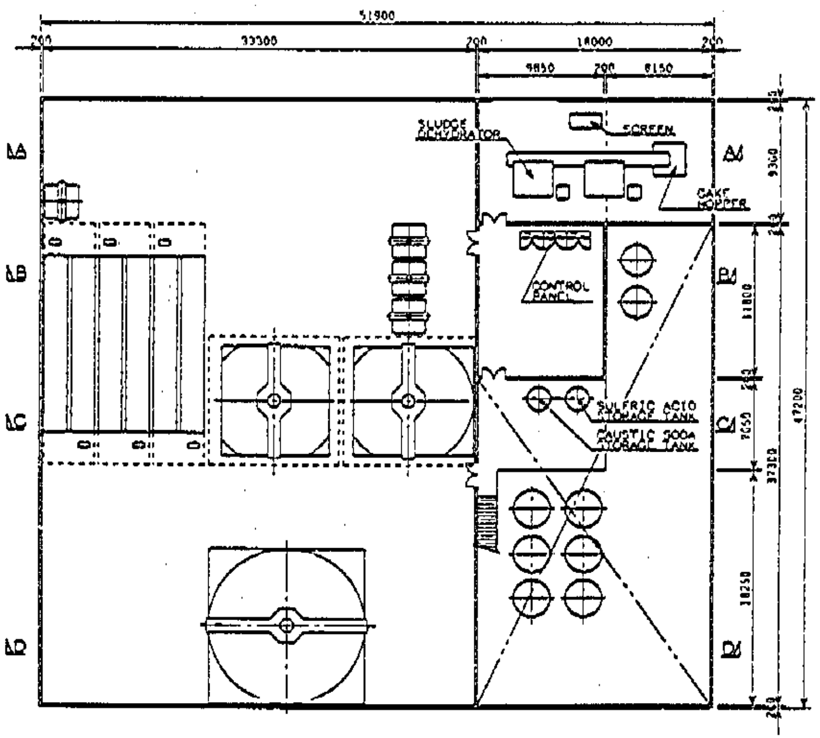

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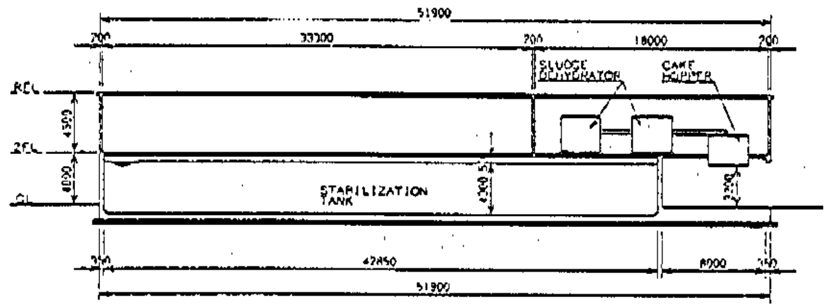
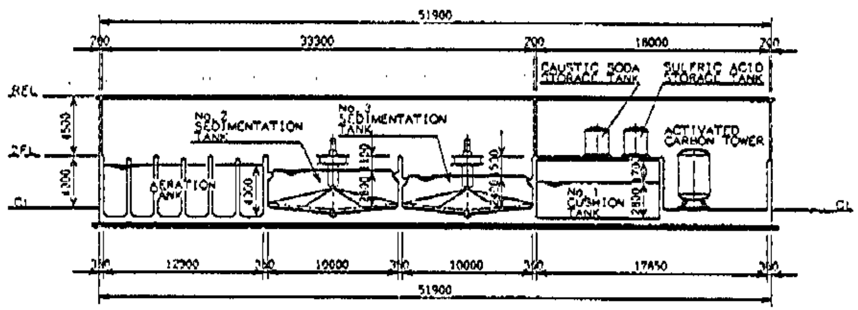
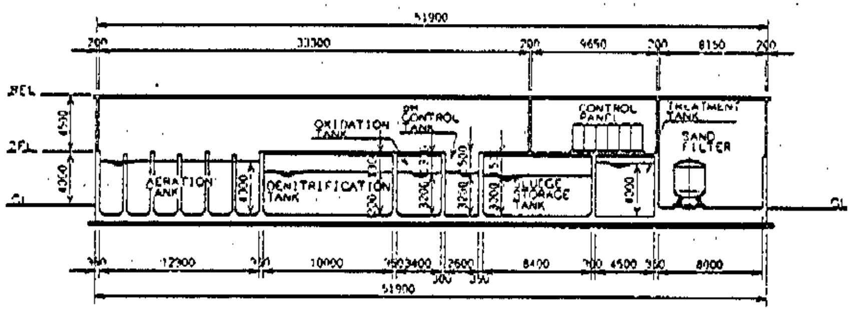
Fig. 3.1.19 Section of Waste Water Treatment



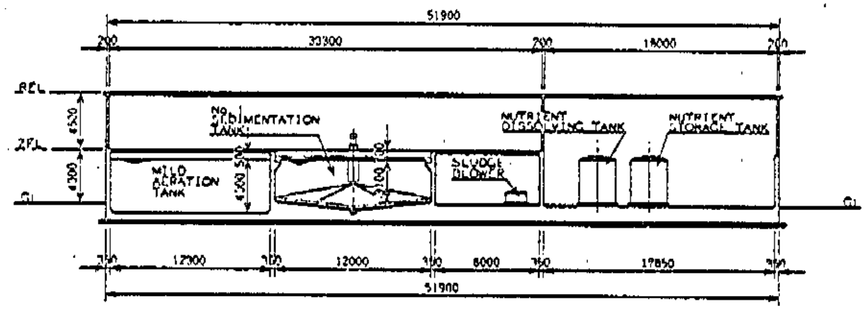
SECTION A–A S:1/400



SECTION C–C S:1/400



SECTION B–B S:1/400



SECTION D–D S:1/400

3.1.4 Financial Analysis

1) Financial assumption

(1) Project cases

In addition to the discharge to river (Case 1), technical study for the discharge to sewerage was made with the following cases. Based on the results, financial analysis is carried out.

Case 2-A: Plan to install a neutralization process in the existing collecting pit for waste water discharged from dyeing

Case 2-B: Plan to install stabilization tank having capacity of 1/3 days for waste water discharged from dyeing.

(2) Treatment capacity

Treatment capacity: 378,000 m^3/y
Operable days: 252 d/y

(3) Capital requirement

In addition to the plant construction cost estimated in the previous section, based on the assumption mentioned in paragraph 1.4.1, the details of capital requirement on each case are summarized below. For the calculation of interest during construction, the construction period on Case 1 is 1 year and that on Case 2-A and 2-B is 6 months.

Details of Capital Requirement

(Unit: DEM, 1,000)

Items	Case 1	Case 2-A	Case 2-B
Plant Construction Cost	5,912	163	401
- Equipment & Machinery	3,259	148	72
- Civil & Building	2,653	15	329
Interest during Construction	355	5	12
Total	6,267	168	413

2) Financial analysis

The detailed breakdowns of waste water treatment costs based on the above-mentioned preconditions are shown in Tables 3.1.20, 3.1.23 and 3.1.26, and the statements of cash income and disbursement are shown in Table 3.1.21, 3.1.24 and 3.1.27.

The results of the financial analysis are outlined in the following paragraphs.

The breakdown of the waste water treatment costs in 2010 is as follows.

Breakdown of waste water treatment costs

(Unit: DEM/m^3)

Item	Case 1	Case 2-1	Case 2-B
Variable costs	3.98	0.03	0.00
Direct fixed costs	1.02	2.32	2.29
Treatment costs excluding depreciation and interest	(5.00)	(2.35)	(2.29)
Depreciation and interest	1.81	0.05	0.10
Treatment costs including depreciation and interest (Total costs)	6.81	2.40	2.39

From the above table, it can be seen that the waste water treatment cost including depreciation and interest (total costs) in Cases 2-A and 2-B (discharge into sewerage system) is practically the same (2.4 DEM/m^3) and that, compared to the same cost in Case 1 (river discharge), it is 4.4 DEM/m^3 cheaper.

In terms of the largest costs factors in each case, the sewage charge (direct fixed cost) in Cases 2-A and 2-B accounts for 74% of the total cost, and the activated carbon cost (fluctuating cost) in Case 1 accounts for 46% of the total.

With regard to fund management, the ability to repay the long-term debt (DSR) in 2010 is shown below.

Long-term debt service capacity

Item	Case 1	Case 2-A	Case 2-B
(A) Cash, DEM 1,000	683	20.6	38.6
(B) Debt, DEM 1,000	1,003	26.9	66.1
(C) DSR, (A)/(B)	0.68	0.76	0.58

(Note) (A) is the numerator of the formula shown in 1.4.5, and (B) is the denominator.

In each case the DSR is less than 1.00, indicating that there is a lack of cash to service the debt.

As a result of the above basic cases, sensitivity analysis using the FIRR and DSR shall be carried out to examine cases of fluctuations in important factors such as the plant construction costs and the chemicals costs.

Sensitivity analysis chart

(Unit: FIRR, % (DSR, ratio))

Item	Plant construction costs	Chemicals
Case 1		
20% down	13.41% (0.89)	14.58% (0.95)
0% (basic case)	9.13% (0.68)	9.13% (0.68)
20% up	6.10% (0.54)	3.13% (0.41)
Case 2-A		
20% down	14.90% (1.02)	11.35% (0.85)
0% (basic case)	9.53% (0.76)	9.53% (0.76)
20% up	5.56% (0.59)	7.62% (0.68)

(Note) Case 2-B is omitted because chemicals are not used.

This shows that, in Case 1, the chemicals costs is more sensitive to fluctuations than the plant construction costs and that, in Case 2-B, the opposite is true.

Furthermore, investigation shall be carried out into the case where low-interest funding can be utilized in the future. Here, it is assumed that the interest rate is reduced from 12% to 6%. The ability to repay the long-term debt (DSR) in 2010 in this case is shown below.

Long-term debt service capacity

Item	Case 1	Case 2-A	Case 2-B
(A) Cash, DEM 1,000	683	20.6	38.6
(B) Debt, DEM 1,000	792	21.6	52.9
(C) DSR, (A)/(B)	0.86	0.95	0.73

(Note) (A) is the numerator of the formula shown in 1.4.5, and (B) is the denominator.

This shows that, if low-interest funding can be utilized, the effect of this in terms of the plant construction cost is the same as a 20% reduction in each of the cases.

As a result of the analyses described here, it was found that the case of sewerage system discharge is more economically advantageous than the case of direct river discharge.

Two technically different cases were examined for discharge into the sewerage system. As the waste water treatment cost in both of these cases was the same, the decision on which case to adopt shall be left to the factory management.

Textile exports in recent years have been poor, resulting in harsh business conditions for the factory. For this reason, it is considered that a low-interest loan in the future could make a big contribution to reducing the funding burden on the factory.

Table 3.1.19 Project Profile and Assumptions for Financial Projection (1/3)

1 Project

Title	:	Wastewater Treatment Project
Factory	:	Svila, Tekstilna Tovarna d.d. (M-1)
Location	:	Maribor, Slovenia
Project Case	:	Base Case 1: Discharge to River
Annual Production	:	Textile: 7,617,030 m/y
Maximum Operable Days	:	(365.25 - 113.25) x 100% = 252.00 DPY
Treatment Capacity (100%)	:	252.00 DPY x 1,500 m^3/d = 378,000 m^3/y
Operation Start Year	:	2005
Monetary Unit	:	DEM in Terms of Fixed Price in 1996
Exchange Rates	:	1.0 DEM = 89.89 SIT as of June, 1996

2 Schedule

Start of Project Implementation	:	January 01, 2004
Project Completion	:	December 31, 2004
Commercial Operation	:	January 01, 2005
Project Phase Out	:	December 31, 2019
Project Life	:	15.0 Years from Start of Commercial Operation
Project Year	:	From January 01 to December 31
Construction and Commissioning	:	1.0 Year from Start of Project Implementation

3 Financing Required and Financing Plan - 1996

Financing Required	DEM, '000
Land/Site Development	-
Plant Construction Cost*	5,912.00
- Equipment & Machinery	3,259.00
- Civil & Building	2,653.00
Interest during Construction	355.00
Fixed Capital Cost	6,267.00
Initial Working Capital	0.00
Total Capital Requirement	6,267.00

Financing Plan		DEM, '000
Equity	: 0.00 %	0.00
Long Term Loan	: 100.00 %	6,267.00
- Interest	: 12.00 %	
Short Term Loan	:	-
Total Project Financing Cost		6,267.00

* Including Sales Tax of 5%.

Table 3.1.19 Project Profile and Assumptions for Financial Projection (2/3)

4 Inputs and Costing
(CIF at the Plant with Full Capacity Utilization in 1996)

Inputs	Unit		Per Sewage		Annual	
	Unit	Price (DEM/Unit)	Consumption (Unit/m^3)	Cost (DEM/m^3)	Consumption ('000, Unit)	Cost DEM, '000
Chemicals			-	3.590	-	1,357.083
- PAC	kg	0.831	0.4000	0.332	151.2000	125.647
- H_2SO_4 (98%)	kg	0.781	0.0307	0.024	11.5920	9.053
- NaOH (100%)	kg	0.926	0.0200	0.019	7.5600	7.001
- A Polymer (powder)	kg	11.013	0.0047	0.051	1.7640	19.427
- K Polymer (powder)	kg	22.249	0.0027	0.059	1.0080	22.427
- Urea (100%)	kg	0.578	0.0013	0.001	0.5040	0.291
- Activated Carbon	kg	10.346	0.3000	3.104	113.4000	1,173.236
Utility Cost			-	0.390	-	147.602
- Electricity	kWH	0.047	4.2016	0.196	1,588.2050	74.010
- Sludge Disposal	m^3	15.830	0.0035	0.056	1.3360	21.149
- Water	m^3	2.225	0.0267	0.059	10.0800	22.428
- Fuel	Ltr.	0.667	0.1190	0.079	45.0000	30.015
Variable Cost	-	-	-	3.981	378.0000	1,504.685
Personnel	Man-Year	19,200		0.102	2.0000	38.400
Maintenance	Equipment & Machinery x 5.0%			0.431	-	162.950
Government Charge	m^3	0.036	1.0000	0.036	378.0000	13.608
Local Pollution Tax	m^3	0.453	1.0000	0.453	378.0000	171.234
Direct Fixed Cost	-	-	-	1.022	-	386.192
Cash Treatment Cost		-	-	5.002	378.0000	1,890.877

5 Outputs and Pricing
(FOB at the Plant with Full Capacity Utilization in 1996)

Outputs	Unit		Per Sewage		Annual	
	Unit	Price (DEM/Unit)	Treatment (Unit/m^3)	Price (DEM/m^3)	Treatment ('000, Unit)	Sales DEM, '000
Treatment Fee	m^3	6.810	1.0000	6.810	378.0000	2,574.155

Table 3.1.19 Project Profile and Assumptions for Financial Projection (3/3)

6 Operation Schedule

(Unit: %)

Items	Project Year						Total/ Average
	(-)1	1	2	3	4	15	
	04	05	06	07	08	2019	
Financing Disbursement	100						100
Sewage Treatment							
- Rated Capacity Utilization		100	100	100	100	100	1,500

Depreciation (Plant & Machinery)	15 Years Straight Line Method
Depreciation (Civil & Building)	40 Years Straight Line Method
Amortization (Interest during Const.)	15 Years Straight Line Method

Debt Service

Loan Type		Maximum Grace + Maturity	Annual Interest Rate, %
- Bank Loan/Local		(1 + 10) Years	12.00
- Short Term Loan/Local	Not considered.		

Corporate Income Tax	Zero
Sales Tax	5.00%

7 Financial Performance

Treatment Fee			
- Base Case, DEM/m^3-year	6.81 - 2005	6.81 - 2010	6.81 - 2014
Treatment Cost including D&I			
- Base Case, DEM/m^3-year	7.81 - 2005	6.81 - 2010	6.01 - 2014
Sensitivity Analysis using FIRR	(-20%)	(0%)	(+20%)
- Investment Cost, %	13.41	9.13	6.10
- Chemical Cost, %	14.58	9.13	3.13
Sensitivity Analysis using DSR as of 2010	(-20%)	(0%)	(+20%)
- Investment Cost, times	0.89	0.68	0.54
- Chemical Cost, times	0.95	0.68	0.41
Debt Service Ratio (DSR), times-year			
- Base Case, @12% interest	0.50 - 2005	0.68 - 2010	0.97 - 2014
- Alt. Case, @6% interest	0.70 - 2005	0.86 - 2010	1.06 - 2014

Table 3.1.20 Wastewater Treatment Cost Statements

*** WASTEWATER TREATMENT PROJECT IN SVILA (K-1) ***
WASTEWATER TREATMENT COST STATEMENTS
\- CASE 1: DISCHARGE TO RIVER - (DEN, 1000)

YEAR	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
WASTEWATER TREATMENT (1000M3/Y)	0.0	378.00	378.00	378.00	378.00	378.00	378.00	378.00	378.00	378.00
CHEMICAL COST	0.0	1357.13	1357.13	1357.13	1357.13	1357.13	1357.13	1357.13	1357.13	1357.13
PAC	0.0	125.65	125.65	125.65	125.65	125.65	125.65	125.65	125.65	125.65
H2SO4	0.0	9.06	9.06	9.06	9.06	9.06	9.06	9.06	9.06	9.06
NAOH	0.0	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00
A POLYMER	0.0	19.44	19.44	19.44	19.44	19.44	19.44	19.44	19.44	19.44
K POLYMER	0.0	22.46	22.46	22.46	22.46	22.46	22.46	22.46	22.46	22.46
UREA	0.0	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28
ACTIVATED CARBON	0.0	1173.24	1173.24	1173.24	1173.24	1173.24	1173.24	1173.24	1173.24	1173.24
UTILITIES COST	0.0	147.57	147.57	147.57	147.57	147.57	147.57	147.57	147.57	147.57
ELECTRICITY	0.0	74.01	74.01	74.01	74.01	74.01	74.01	74.01	74.01	74.01
SLUDGE DISPOSAL	0.0	21.12	21.12	21.12	21.12	21.12	21.12	21.12	21.12	21.12
WATER	0.0	22.43	22.43	22.43	22.43	22.43	22.43	22.43	22.43	22.43
FUEL	0.0	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
VARIABLE COST	0.0	1504.69	1504.69	1504.69	1504.69	1504.69	1504.69	1504.69	1504.69	1504.69
EMPLOYMENT COST	0.0	38.40	38.40	38.40	38.40	38.40	38.40	38.40	38.40	38.40
MAINTENANCE COST	0.0	162.95	162.95	162.95	162.95	162.95	162.95	162.95	162.95	162.95
GOVERNMENT CHARGE	0.0	13.61	13.61	13.61	13.61	13.61	13.61	13.61	13.61	13.61
LOCAL POLLUTION TAX	0.0	171.23	171.23	171.23	171.23	171.23	171.23	171.23	171.23	171.23
DIRECT FIXED COST	0.0	386.19	386.19	386.19	386.19	386.19	386.19	386.19	386.19	386.19
CASH TREATMENT COST	0.0	1890.89	1890.89	1890.89	1890.89	1890.89	1890.89	1890.89	1890.89	1890.89
EQUIPMENT & MACHINERY	0.0	217.27	217.27	217.27	217.27	217.27	217.27	217.27	217.27	217.27
CIVIL & BUILDING	0.0	66.32	66.32	66.32	66.32	66.32	66.32	66.32	66.32	66.32
INTEREST DRG. CONSTRUCTION	0.0	23.67	23.67	23.67	23.67	23.67	23.67	23.67	23.67	23.67
DEPRECIATION AND AMORTIZATION	0.0	307.26	307.26	307.26	307.26	307.26	307.26	307.26	307.26	307.26
TOTAL TREATMENT COST	0.0	2198.14	2198.14	2198.14	2198.14	2198.14	2198.14	2198.14	2198.14	2198.14
UNIT TREATMENT COST	0.0	5.8152	5.8152	5.8152	5.8152	5.8152	5.8152	5.8152	5.8152	5.8152
INTEREST ON LONG TERM DEBT	0.0	752.04	676.84	601.63	526.43	451.22	376.02	300.81	225.61	150.41
INTEREST ON SHORT TERM DEBT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL TREATMENT COST	0.0	2950.18	2874.98	2799.78	2724.57	2649.37	2574.16	2498.96	2423.76	2348.55
UNIT TREATMENT COST	0.0	7.8047	7.6058	7.4068	7.2079	7.0089	6.8100	6.6110	6.4121	6.2131

YEAR	2014	2015	2016	2017	2018	2019
WASTEWATER TREATMENT (1000M3/Y)	378.00	378.00	378.00	378.00	378.00	378.00
CHEMICAL COST	1357.13	1357.13	1357.13	1357.13	1357.13	1357.13
PAC	125.65	125.65	125.65	125.65	125.65	125.65
H2SO4	9.06	9.06	9.06	9.06	9.06	9.06
NAOH	7.00	7.00	7.00	7.00	7.00	7.00
A POLYMER	19.44	19.44	19.44	19.44	19.44	19.44
K POLYMER	22.46	22.46	22.46	22.46	22.46	22.46
UREA	0.28	0.28	0.28	0.28	0.28	0.28
ACTIVATED CARBON	1173.24	1173.24	1173.24	1173.24	1173.24	1173.24
UTILITIES COST	147.57	147.57	147.57	147.57	147.57	147.57
ELECTRICITY	74.01	74.01	74.01	74.01	74.01	74.01
SLUDGE DISPOSAL	21.12	21.12	21.12	21.12	21.12	21.12
WATER	22.43	22.43	22.43	22.43	22.43	22.43
FUEL	30.00	30.00	30.00	30.00	30.00	30.00
VARIABLE COST	1504.69	1504.69	1504.69	1504.69	1504.69	1504.69
EMPLOYMENT COST	38.40	38.40	38.40	38.40	38.40	38.40
MAINTENANCE COST	162.95	162.95	162.95	162.95	162.95	162.95
GOVERNMENT CHARGE	13.61	13.61	13.61	13.61	13.61	13.61
LOCAL POLLUTION TAX	171.23	171.23	171.23	171.23	171.23	171.23
DIRECT FIXED COST	386.19	386.19	386.19	386.19	386.19	386.19
CASH TREATMENT COST	1890.89	1890.89	1890.89	1890.89	1890.89	1890.89
EQUIPMENT & MACHINERY	217.27	217.27	217.27	217.27	217.27	217.27
CIVIL & BUILDING	66.32	66.32	66.32	66.32	66.32	66.32
INTEREST DRG. CONSTRUCTION	23.67	23.67	23.67	23.67	23.67	23.67
DEPRECIATION AND AMORTIZATION	307.26	307.26	307.26	307.26	307.26	307.26
TOTAL TREATMENT COST	2198.14	2198.14	2198.14	2198.14	2198.14	2198.14
UNIT TREATMENT COST	5.8152	5.8152	5.8152	5.8152	5.8152	5.8152
INTEREST ON LONG TERM DEBT	75.20	0.0	0.0	0.0	0.0	0.0
INTEREST ON SHORT TERM DEBT	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL TREATMENT COST	2273.35	2198.14	2198.14	2198.14	2198.14	2198.14
UNIT TREATMENT COST	6.0141	5.8152	5.8152	5.8152	5.8152	5.8152

Table 3.1.21 Funds Flow Statements

*** WASTEWATER TREATMENT PROJECT IN SVILA (W-1) ***
FUNDS FLOW STATEMENTS
- CASE 1: DISCHARGE TO RIVER - (DEN. 1000)

YEAR	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
SOURCE OF FUNDS	6267.00	683.29	683.29	683.29	683.29	683.29	683.29	683.29	683.29	683.29
CASH GENERATED FROM OPERATION	0.0	683.29	683.29	683.29	683.29	683.29	683.29	683.29	683.29	683.29
PROFIT AFT. TAX, BFR INT.	0.0	376.04	376.04	376.04	376.04	376.04	376.04	376.04	376.04	376.04
DEPRECIATION AND AMORTIZATION	0.0	307.26	307.26	307.26	307.26	307.26	307.26	307.26	307.26	307.26
FINANCIAL RESOURCES	6267.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SHARE CAPITAL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LONG TEAM LOAN	6267.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SHORT TERM DEBT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
USES OF FUNDS	6267.00	1378.74	1303.54	1228.33	1153.13	1077.92	1002.72	927.51	852.31	777.11
FIXED CAPITAL EXPENDITURE	6267.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NON-DEPRECIABLE ASSETS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DEPRECIABLE FIXED ASSETS	5912.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INTEREST DURING CONSTRUCTION	355.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CHANGE IN WORKING CAPITAL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DEBT SERVICES	0.0	1378.74	1303.54	1228.33	1153.13	1077.92	1002.72	927.51	852.31	777.11
REPAYMENT OF LONG TERM DEBT	0.0	626.70	626.70	626.70	626.70	626.70	626.70	626.70	626.70	626.70
REPAYMENT OF SHORT TERM DEBT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INTEREST ON LONG TERM DEBT	0.0	752.04	676.84	601.63	526.43	451.22	376.02	300.81	225.61	150.41
INTEREST ON SHORT TERM DEBT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DIVIDENDS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CASH INCREASE OR (DECREASE)	0.0	-695.45	-620.24	-545.04	-469.83	-394.63	-319.42	-244.22	-169.02	-93.81
BEGINNING CASH BALANCE	0.0	0.0	-695.45	-1315.69	-1860.72	-2330.56	-2725.18	-3044.61	-3288.83	-3457.85
ENDING CASH BALANCE	0.0	-695.45	-1315.69	-1860.72	-2330.56	-2725.18	-3044.61	-3288.83	-3457.85	-3551.66

YEAR	2014	2015	2016	2017	2018	2019
SOURCE OF FUNDS	683.29	683.29	683.29	683.29	683.29	683.29
CASH GENERATED FROM OPERATION	683.29	683.29	683.29	683.29	683.29	683.29
PROFIT AFT. TAX, BFR INT.	376.04	376.04	376.04	376.04	376.04	376.04
DEPRECIATION AND AMORTIZATION	307.26	307.26	307.26	307.26	307.26	307.26
FINANCIAL RESOURCES	0.0	0.0	0.0	0.0	0.0	0.0
SHARE CAPITAL	0.0	0.0	0.0	0.0	0.0	0.0
LONG TEAM LOAN	0.0	0.0	0.0	0.0	0.0	0.0
SHORT TERM DEBT	0.0	0.0	0.0	0.0	0.0	0.0
USES OF FUNDS	701.90	0.0	0.0	0.0	0.0	0.0
FIXED CAPITAL EXPENDITURE	0.0	0.0	0.0	0.0	0.0	0.0
NON-DEPRECIABLE ASSETS	0.0	0.0	0.0	0.0	0.0	0.0
DEPRECIABLE FIXED ASSESS	0.0	0.0	0.0	0.0	0.0	0.0
INTEREST DURING CONSTRUCTION	0.0	0.0	0.0	0.0	0.0	0.0
CHANGE IN WORKING CAPITAL	0.0	0.0	0.0	0.0	0.0	0.0
DEBT SERVICES	701.90	0.0	0.0	0.0	0.0	0.0
REPAYMENT OF LONG TERM DEBT	626.70	0.0	0.0	0.0	0.0	0.0
REPAYMENT OF SHORT TERM DEBT	0.0	0.0	0.0	0.0	0.0	0.0
INTEREST ON LONG TERM DEBT	75.20	0.0	0.0	0.0	0.0	0.0
INTEREST ON SHORT TERM DEBT	0.0	0.0	0.0	0.0	0.0	0.0
DIVIDENDS	0.0	0.0	0.0	0.0	0.0	0.0
CASH INCREASE OR (DECREASE)	-18.61	683.29	683.29	683.29	683.29	683.29
BEGINNING CASH BALANCE	-3551.66	-3570.27	-2886.97	-2203.68	-1520.39	-837.09
ENDING CASH BALANCE	-3570.27	-2886.97	-2203.68	-1520.39	-837.09	-153.80

*** WASTEWATER TREATMENT PROJECT IN SVILA (W-1) ***
RETURN ON INVESTMENT (IN 1996 FIXED PRICE)
- CASE 1: DISCHARGE TO RIVER - (DEN. 1000)

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
(1) GROSS CAPITAL EXPENDITURE	5912.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(2) GROSS CASH IN-FLOW	0.0	683.29	683.29	683.29	683.29	683.29	683.29	683.29	683.29	683.29
OPERATING PROFIT	0.0	376.04	376.04	376.04	376.04	376.04	376.04	376.04	376.04	376.04
DEPRECIATION & AMORTIZATION	0.0	307.26	307.26	307.26	307.26	307.26	307.26	307.26	307.26	307.26
(4) BFR-TAX NET IN-FLOW (2)-(1)	-5912.00	683.29	683.29	683.29	683.29	683.29	683.29	683.29	683.29	683.29

	2014	2015	2016	2017	2018	2019
(1) GROSS CAPITAL EXPENDITURE	0.0	0.0	0.0	0.0	0.0	-1658.12
(2) GROSS CASH IN-FLOW	683.29	683.29	683.29	683.29	683.29	683.29
OPERATING PROFIT	376.04	376.04	376.04	376.04	376.04	376.04
DEPRECIATION & AMORTIZATION	307.26	307.26	307.26	307.26	307.26	307.26
(4) BFR-TAX NET IN-FLOW (2)-(1)	683.29	683.29	683.29	683.29	683.29	2341.42

INTERNAL RATE OF RETURN

ON (4) BFR-TAX NET IN-FLOW (2)-(1) 9.13 PER CENT

Table 3.1.22 Project Profile and Assumptions for Financial Projection (1/3)

1 Project

Title	:	Wastewater Treatment Project
Factory	:	Svila, Tekstilna Tovarna d.d. (M-1)
Location	:	Maribor, Slovenia
Project Case	:	Base Case 2-A: Discharge to WWTP
Annual Production	:	Textile: 7,617,030 m/y
Maximum Operable Days	:	(365.25 - 113.25) x 100% = 252.00 DPY
Treatment Capacity (100%)	:	252.00 DPY x 1,500 m^3/d = 378,000 m^3/y
Operation Start Year	:	2005
Monetary Unit	:	DEM in Terms of Fixed Price in 1996
Exchange Rates	:	1.0 DEM = 89.89 SIT as of June, 1996

2 Schedule

Start of Project Implementation	:	July 01, 2004
Project Completion	:	December 31, 2004
Commercial Operation	:	January 01, 2005
Project Phase Out	:	December 31, 2019
Project Life	:	15.0 Years from Start of Commercial Operation
Project Year	:	From January 01 to December 31
Construction and Commissioning	:	0.5 Year from Start of Project Implementation

3 Financing Required and Financing Plan - 1996

Financing Required	DEM, '000
Land/Site Development	-
Plant Construction Cost*	163.00
- Equipment & Machinery	148.00
- Civil & Building	15.00
Interest during Construction	5.00
Fixed Capital Cost	168.00
Initial Working Capital	0.00
Total Capital Requirement	168.00

Financing Plan		DEM, '000
Equity	: 0.00 %	0.00
Long Term Loan	: 100.00 %	168.00
- Interest	: 12.00 %	
Short Term Loan	:	-
Total Project Financing Cost		168.00

* Including Sales Tax of 5%.

Table 3.1.22 Project Profile and Assumptions for Financial Projection (2/3)

4 Inputs and Costing
(CIF at the Plant with Full Capacity Utilization in 1996)

Inputs	Unit		Per Sewage		Annual	
	Unit	Price (DEM/Unit)	Consumption ($Unit/m^3$)	Cost (DEM/m^3)	Consumption ('000, Unit)	Cost DEM, '000
Chemicals			-	0.030	-	11.527
- H_2SO_4 (98%)	kg	0.781	0.01533	0.012	5.7960	4.527
- NaOH (100%)	kg	0.926	0.02000	0.019	7.5600	7.001
Utility Cost			-	0.001	-	0.440
- Electricity	kWH	0.047	0.00901	0.000	3.4070	0.160
- Water	m^3	1.112	0.00067	0.001	0.2520	0.280
Variable Cost	-	-	-	0.032	378.0000	11.968
Personnel	Man-Year	19,200		0.025	0.5000	9.600
Maintenance	Equipment & Machinery x 5.0%			0.020	-	7.400
Government Charge	m^3	0.036	1.0000	0.036	378.0000	13.608
Local Pollution Tax	m^3	0.453	1.0000	0.453	378.0000	171.234
Sewage Charge	m^3	1.780	1.0000	1.780	378.0000	672.840
Direct Fixed Cost	-	-	-	2.314	-	874.682
Cash Treatment Cost		-	-	2.346	378.0000	886.650

5 Outputs and Pricing
(FOB at the Plant with Full Capacity Utilization in 1996)

Outputs	Unit		Per Sewage		Annual	
	Unit	Price (DEM/Unit)	Treatment ($Unit/m^3$)	Price (DEM/m^3)	Treatment ('000, Unit)	Sales DEM, '000
Treatment Fee	m^3	2.400	1.0000	2.400	378.0000	907.200

Table 3.1.22 Project Profile and Assumptions for Financial Projection (3/3)

6 Operation Schedule

(Unit: %)

Items	Project Year						Total/ Average
	(-)1	1	2	3	4	15	
	04	05	06	07	08	2019	
Financing Disbursement	100						100
Sewage Treatment							
- Rated Capacity Utilization		100	100	100	100	100	1,500

Depreciation (Plant & Machinery)	15 Years Straight Line Method
Depreciation (Civil & Building)	40 Years Straight Line Method
Amortization (Interest during Const.)	15 Years Straight Line Method

Debt Service

Loan Type		Maximum Grace + Maturity	Annual Interest Rate, %
- Bank Loan/Local		(1 + 10) Years	12.00
- Short Term Loan/Local	Not considered.		

Corporate Income Tax	Zero
Sales Tax	5.00%

7 Financial Performance

Treatment Fee			
- Base Case, DEM/m³-year	2.40- 2005	2.40 - 2010	2.40 - 2014
Treatment Cost including D&I			
- Base Case, DEM/m³-year	2.43 - 2005	2.40 - 2010	2.38 - 2014
Sensitivity Analysis using FIRR	(-20%)	(0%)	(+20%)
- Investment Cost, %	14.90	9.53	5.56
- Chemical Cost, %	11.36	9.53	7.62
Sensitivity Analysis using DSR as of 2010	(-20%)	(0%)	(+20%)
- Investment Cost, times	1.02	0.76	0.59
- Chemical Cost, times	0.85	0.76	0.68
Debt Service Ratio (DSR), times-year			
- Base Case, @12% interest	0.56 - 2005	0.76 - 2010	1.09 - 2014
- Alt. Case, @6% interest	0.77 - 2005	0.95 - 2010	1.17 - 2014

Table 3.1.23 Wastewater Treatment Cost Statements

*** WASTEWATER TREATMENT PROJECT IN SYRIA (K-1) ***
WASTEWATER TREATMENT COST STATEMENTS
-- CASE 2-A: DISCHARGE TO WWTP -- (DEM. 1000)

YEAR	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
WASTEWATER TREATMENT (1000M3/Y)	0.0	378.00	378.00	378.00	378.00	378.00	378.00	378.00	378.00	378.00
CHEMICAL COST	0.0	11.53	11.53	11.53	11.53	11.53	11.53	11.53	11.53	11.53
H2SO4	0.0	4.53	4.53	4.53	4.53	4.53	4.53	4.53	4.53	4.53
NAOH	0.0	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00
UTILITIES COST	0.0	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44
ELECTRICITY	0.0	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16
WATER	0.0	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28
VARIABLE COST	0.0	11.97	11.97	11.97	11.97	11.97	11.97	11.97	11.97	11.97
EMPLOYMENT COST	0.0	9.60	9.60	9.60	9.60	9.60	9.60	9.60	9.60	9.60
MAINTENANCE COST	0.0	7.40	7.40	7.40	7.40	7.40	7.40	7.40	7.40	7.40
GOVERNMENT CHARGE	0.0	13.61	13.61	13.61	13.61	13.61	13.61	13.61	13.61	13.61
LOCAL POLLUTION TAX	0.0	171.23	171.23	171.23	171.23	171.23	171.23	171.23	171.23	171.23
SEWAGE CHARGE	0.0	672.84	672.84	672.84	672.84	672.84	672.84	672.84	672.84	672.84
DIRECT FIXED COST	0.0	874.68	874.68	874.68	874.68	874.68	874.68	874.68	874.68	874.68
CASH TREATMENT COST	0.0	886.65	886.65	886.65	886.65	886.65	886.65	886.65	886.65	886.65
EQUIPMENT & MACHINERY	0.0	9.87	9.87	9.87	9.87	9.87	9.87	9.87	9.87	9.87
CIVIL & BUILDING	0.0	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38
INTEREST DRG. CONSTRUCTION	0.0	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33
DEPRECIATION AND AMORTIZATION	0.0	10.57	10.57	10.57	10.57	10.57	10.57	10.57	10.57	10.57
TOTAL TREATMENT COST	0.0	897.22	897.22	897.22	897.22	897.22	897.22	897.22	897.22	897.22
UNIT TREATMENT COST	0.0	2.3736	2.3736	2.3736	2.3736	2.3736	2.3736	2.3736	2.3736	2.3736
INTEREST ON LONG TERM DEBT	0.0	20.16	18.14	16.13	14.11	12.10	10.08	8.06	6.05	4.03
INTEREST ON SHORT TERM DEBT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL TREATMENT COST	0.0	917.38	915.37	913.35	911.34	909.32	907.30	905.29	903.27	901.26
UNIT TREATMENT COST	0.0	2.4269	2.4216	2.4163	2.4109	2.4056	2.4003	2.3949	2.3896	2.3843

YEAR	2014	2015	2016	2017	2018	2019
WASTEWATER TREATMENT (1000M3/Y)	378.00	378.00	378.00	378.00	378.00	378.00
CHEMICAL COST	11.53	11.53	11.53	11.53	11.53	11.53
H2SO4	4.53	4.53	4.53	4.53	4.53	4.53
NAOH	7.00	7.00	7.00	7.00	7.00	7.00
UTILITIES COST	0.44	0.44	0.44	0.44	0.44	0.44
ELECTRICITY	0.16	0.16	0.16	0.16	0.16	0.16
WATER	0.28	0.28	0.28	0.28	0.28	0.28
VARIABLE COST	11.97	11.97	11.97	11.97	11.97	11.97
EMPLOYMENT COST	9.60	9.60	9.60	9.60	9.60	9.60
MAINTENANCE COST	7.40	7.40	7.40	7.40	7.40	7.40
GOVERNMENT CHARGE	13.61	13.61	13.61	13.61	13.61	13.61
LOCAL POLLUTION TAX	171.23	171.23	171.23	171.23	171.23	171.23
SEWAGE CHARGE	672.84	672.84	672.84	672.84	672.84	672.84
DIRECT FIXED COST	874.68	874.68	874.68	874.68	874.68	874.68
CASH TREATMENT COST	886.65	886.65	886.65	886.65	886.65	886.65
EQUIPMENT & MACHINERY	9.87	9.87	9.87	9.87	9.87	9.87
CIVIL & BUILDING	0.38	0.38	0.38	0.38	0.38	0.38
INTEREST DRG. CONSTRUCTION	0.33	0.33	0.33	0.33	0.33	0.33
DEPRECIATION AND AMORTIZATION	10.57	10.57	10.57	10.57	10.57	10.57
TOTAL TREATMENT COST	897.22	897.22	897.22	897.22	897.22	897.22
UNIT TREATMENT COST	2.3736	2.3736	2.3736	2.3736	2.3736	2.3736
INTEREST ON LONG TERM DEBT	2.02	0.0	0.0	0.0	0.0	0.0
INTEREST ON SHORT TERM DEBT	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL TREATMENT COST	899.24	897.22	897.22	897.22	897.22	897.22
UNIT TREATMENT COST	2.3789	2.3736	2.3736	2.3736	2.3736	2.3736

Table 3.1.24 Funds Flow Statements

*** WASTEWATER TREATMENT PROJECT IN SVILA (W-1) ***
FUNDS FLOW STATEMENTS
- CASE 2-A: DISCHARGE TO WWTP -- (DEM, 1000)

YEAR	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
SOURCE OF FUNDS	168.00	20.55	20.55	20.55	20.55	20.55	20.55	20.55	20.55	20.55
CASH GENERATED FROM OPERATION	0.0	20.55	20.55	20.55	20.55	20.55	20.55	20.55	20.55	20.55
PROFIT AFT. TAX. BFR INT.	0.0	9.98	9.98	9.98	9.98	9.98	9.98	9.98	9.98	9.98
DEPRECIATION AND AMORTIZATION	0.0	10.57	10.57	10.57	10.57	10.57	10.57	10.57	10.57	10.57
FINANCIAL RESOURCES	168.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SHARE CAPITAL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LONG TEAM LOAN	168.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SHORT TERM DEBT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
USES OF FUNDS	168.00	36.96	34.94	32.93	30.91	28.90	26.88	24.86	22.85	20.83
FIXED CAPITAL EXPENDITURE	168.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NON-DEPRECIABLE ASSETS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DEPRECIABLE FIXED ASSETS	163.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INTEREST DURING CONSTRUCTION	5.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CHANGE IN WORKING CAPITAL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DEBT SERVICES	0.0	36.96	34.94	32.93	30.91	28.90	26.88	24.86	22.85	20.83
REPAYMENT OF LONG TERM DEBT	0.0	16.80	16.80	16.80	16.80	16.80	16.80	16.80	16.80	16.80
REPAYMENT OF SHORT TERM DEBT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INTEREST ON LONG TERM DEBT	0.0	20.16	18.14	16.13	14.11	12.10	10.08	8.06	6.05	4.03
INTEREST ON SHORT TERM DEBT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DIVIDENDS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CASH INCREASE OR (DECREASE)	0.0	-16.41	-14.39	-12.38	-10.36	-8.34	-6.33	-4.31	-2.30	-0.28
BEGINNING CASH BALANCE	0.0	0.0	-16.41	-30.80	-43.18	-53.54	-61.88	-68.21	-72.52	-74.82
ENDING CASH BALANCE	0.0	-16.41	-30.80	-43.18	-53.54	-61.88	-68.21	-72.52	-74.82	-75.10

YEAR	2014	2015	2016	2017	2018	2019
SOURCE OF FUNDS	20.55	20.55	20.55	20.55	20.55	20.55
CASH GENERATED FROM OPERATION	20.55	20.55	20.55	20.55	20.55	20.55
PROFIT AFT. TAX. BFR INT.	9.98	9.98	9.98	9.98	9.98	9.98
DEPRECIATION AND AMORTIZATION	10.57	10.57	10.57	10.57	10.57	10.57
FINANCIAL RESOURCES	0.0	0.0	0.0	0.0	0.0	0.0
SHARE CAPITAL	0.0	0.0	0.0	0.0	0.0	0.0
LONG TEAM LOAN	0.0	0.0	0.0	0.0	0.0	0.0
SHORT TERM DEBT	0.0	0.0	0.0	0.0	0.0	0.0
USES OF FUNDS	18.82	0.0	0.0	0.0	0.0	0.0
FIXED CAPITAL EXPENDITURE	0.0	0.0	0.0	0.0	0.0	0.0
NON-DEPRECIABLE ASSETS	0.0	0.0	0.0	0.0	0.0	0.0
DEPRECIABLE FIXED ASSETS	0.0	0.0	0.0	0.0	0.0	0.0
INTEREST DURING CONSTRUCTION	0.0	0.0	0.0	0.0	0.0	0.0
CHANGE IN WORKING CAPITAL	0.0	0.0	0.0	0.0	0.0	0.0
DEBT SERVICES	18.82	0.0	0.0	0.0	0.0	0.0
REPAYMENT OF LONG TERM DEBT	16.80	0.0	0.0	0.0	0.0	0.0
REPAYMENT OF SHORT TERM DEBT	0.0	0.0	0.0	0.0	0.0	0.0
INTEREST ON LONG TERM DEBT	2.02	0.0	0.0	0.0	0.0	0.0
INTEREST ON SHORT TERM DEBT	0.0	0.0	0.0	0.0	0.0	0.0
DIVIDENDS	0.0	0.0	0.0	0.0	0.0	0.0
CASH INCREASE OR (DECREASE)	1.74	20.55	20.55	20.55	20.55	20.55
BEGINNING CASH BALANCE	-75.10	-73.37	-52.81	-32.26	-11.71	8.84
ENDING CASH BALANCE	-73.37	-52.81	-32.26	-11.71	8.84	29.39

*** WASTEWATER TREATMENT PROJECT IN SVILA (W-1) ***
RETURN ON INVESTMENT (IN 1996 FIXED PRICE)
- CASE 2-A: DISCHARGE TO WWTP -- (DEM, 1000)

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
(1) GROSS CAPITAL EXPENDITURE	163.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(2) GROSS CASH IN-FLOW	0.0	20.55	20.55	20.55	20.55	20.55	20.55	20.55	20.55	20.55
OPERATING PROFIT	0.0	9.98	9.98	9.98	9.98	9.98	9.98	9.98	9.98	9.98
DEPRECIATION & AMORTIZATION	0.0	10.57	10.57	10.57	10.57	10.57	10.57	10.57	10.57	10.57
(4) BFR-TAX NET IN-FLOW (2)-(1)	-163.00	20.55	20.55	20.55	20.55	20.55	20.55	20.55	20.55	20.55

	2014	2015	2016	2017	2018	2019
(1) GROSS CAPITAL EXPENDITURE	0.0	0.0	0.0	0.0	0.0	-9.38
(2) GROSS CASH IN-FLOW	20.55	20.55	20.55	20.55	20.55	20.55
OPERATING PROFIT	9.98	9.98	9.98	9.98	9.98	9.98
DEPRECIATION & AMORTIZATION	10.57	10.57	10.57	10.57	10.57	10.57
(4) BFR-TAX NET IN-FLOW (2)-(1)	20.55	20.55	20.55	20.55	20.55	29.93

INTERNAL RATE OF RETURN

ON (4) BFR-TAX NET IN-FLOW (2)-(1) 9.53 PER CENT

Table 3.1.25 Project Profile and Assumptions for Financial Projection (1/3)

1 Project

Title	:	Wastewater Treatment Project
Factory	:	Svila, Tekstilna Tovarna d.d. (M-1)
Location	:	Maribor, Slovenia
Project Case	:	Base Case 2-B: Discharge to WWTP
Annual Production	:	Textile: 7,617,030 m/y
Maximum Operable Days	:	(365.25 - 113.25) x 100% = 252.00 DPY
Treatment Capacity (100%)	:	252.00 DPY x 1,500 m^3/d = 378,000 m^3/y
Operation Start Year	:	2005
Monetary Unit	:	DEM in Terms of Fixed Price in 1996
Exchange Rates	:	1.0 DEM = 89.89 SIT as of June, 1996

2 Schedule

Start of Project Implementation	:	July 01, 2004
Project Completion	:	December 31, 2004
Commercial Operation	:	January 01, 2005
Project Phase Out	:	December 31, 2019
Project Life	:	15.0 Years from Start of Commercial Operation
Project Year	:	From January 01 to December 31
Construction and Commissioning	:	0.5 Year from Start of Project Implementation

3 Financing Required and Financing Plan - 1996

Financing Required	DEM, '000
Land/Site Development	-
Plant Construction Cost*	401.00
- Equipment & Machinery	72.00
- Civil & Building	329.00
Interest during Construction	12.00
Fixed Capital Cost	413.00
Initial Working Capital	0.00
Total Capital Requirement	413.00

Financing Plan		DEM, '000
Equity	: 0.00 %	0.00
Long Term Loan	: 100.00 %	413.00
- Interest	: 12.00 %	
Short Term Loan	:	-
Total Project Financing Cost		413.00

* Including Sales Tax of 5%.

Table 3.1.25 Project Profile and Assumptions for Financial Projection (2/3)

4 Inputs and Costing
(CIF at the Plant with Full Capacity Utilization in 1996)

Inputs	Unit		Per Sewage		Annual	
	Unit	Price (DEM/Unit)	Consumption ($Unit/m^3$)	Cost (DEM/m^3)	Consumption ('000, Unit)	Cost DEM, '000
Utility Cost			-			
- Electricity	kWH	0.047	0.00587	0.000	2.2180	0.103
Variable Cost	-	-	-	0.000	378.0000	0.103
Personnel	Man-Year	19,200		0.010	0.2000	3.840
Maintenance	Equipment & Machinery x 5.0%			0.010	-	3.600
Government Charge	m^3	0.036	1.0000	0.036	378.0000	13.608
Local Pollution Tax	m^3	0.453	1.0000	0.453	378.0000	171.234
Sewage Charge	m^3	1.780	1.0000	1.780	378.0000	672.840
Direct Fixed Cost	-	-	-	2.289	-	865.122
Cash Treatment Cost		-	-	2.289	378.0000	865.225

5 Outputs and Pricing
(FOB at the Plant with Full Capacity Utilization in 1996)

Outputs	Unit		Per Sewage		Annual	
	Unit	Price (DEM/Unit)	Treatment ($Unit/m^3$)	Price (DEM/m^3)	Treatment ('000, Unit)	Sales DEM, '000
Treatment Fee	m^3	2.391	1.0000	2.391	378.0000	903.798

Table 3.1.25 Project Profile and Assumptions for Financial Projection (3/3)

6 Operation Schedule

(Unit: %)

Items	Project Year						Total/ Average
	(-)1	1	2	3	4	15	
	04	05	06	07	08	2019	
Financing Disbursement	100						100
Sewage Treatment							
- Rated Capacity Utilization		100	100	100	100	100	1,500

Depreciation (Plant & Machinery) — 15 Years Straight Line Method
Depreciation (Civil & Building) — 40 Years Straight Line Method
Amortization (Interest during Const.) — 15 Years Straight Line Method

Debt Service

Loan Type		Maximum Grace + Maturity	Annual Interest Rate, %
- Bank Loan/Local		(1 + 10) Years	12.00
- Short Term Loan/Local	Not considered.		

Corporate Income Tax — Zero

Sales Tax — 5.00%

7 Financial Performance

Treatment Fee			
- Base Case, DEM/m^3-year	2.39 - 2005	2.39 - 2010	2.39 - 2014
Treatment Cost including D&I			
- Base Case, DEM/m^3-year	2.46 - 2005	2.39 - 2010	2.34 - 2014
Sensitivity Analysis using FIRR	(-20%)	(0%)	(+20%)
- Investment Cost, %	10.81	7.80	5.73
Sensitivity Analysis using DSR as of 2010	(-20%)	(0%)	(+20%)
- Investment Cost, times	0.74	0.58	0.48
Debt Service Ratio (DSR), times-year			
- Base Case, @12% interest	0.42 - 2005	0.58 - 2010	0.83 - 2014
- Alt. Case, @6% interest	0.59 - 2005	0.73 - 2010	0.89 - 2014

Table 3.1.26 Wastewater Treatment Cost Statements

*** WASTEWATER TREATMENT PROJECT IN SVILA (K-1) ***
WASTEWATER TREATMENT COST STATEMENTS
- CASE 2-B: DISCHARGE TO BTIP -- (DEN. 1000)

YEAR	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
WASTEWATER TREATMENT (1000M3/Y)	0.0	378.00	378.00	378.00	378.00	378.00	378.00	378.00	378.00	378.00
CHEMICAL COST	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
UTILITIES COST	0.0	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
ELECTRICITY	0.0	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
VARIABLE COST	0.0	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
EMPLOYMENT COST	0.0	3.84	3.84	3.84	3.84	3.84	3.84	3.84	3.84	3.84
MAINTENANCE COST	0.0	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60
GOVERNMENT CHARGE	0.0	13.61	13.61	13.61	13.61	13.61	13.61	13.61	13.61	13.61
LOCAL POLLUTION TAX	0.0	171.23	171.23	171.23	171.23	171.23	171.23	171.23	171.23	171.23
SEWAGE CHARGE	0.0	672.84	672.84	672.84	672.84	672.84	672.84	672.84	672.84	672.84
DIRECT FIXED COST	0.0	865.12	865.12	865.12	865.12	865.12	865.12	865.12	865.12	865.12
CASH TREATMENT COST	0.0	865.23	865.23	865.23	865.23	865.23	865.23	865.23	865.23	865.23
EQUIPMENT & MACHINERY	0.0	4.80	4.80	4.80	4.80	4.80	4.80	4.80	4.80	4.80
CIVIL & BUILDING	0.0	8.22	8.22	8.22	8.22	8.22	8.22	8.22	8.22	8.22
INTEREST DRG. CONSTRUCTION	0.0	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80
DEPRECIATION AND AMORTIZATION	0.0	13.82	13.82	13.82	13.82	13.82	13.82	13.82	13.82	13.82
TOTAL TREATMENT COST	0.0	879.05	879.05	879.05	879.05	879.05	879.05	879.05	879.05	879.05
UNIT TREATMENT COST	0.0	2.3255	2.3255	2.3255	2.3255	2.3255	2.3255	2.3255	2.3255	2.3255
INTEREST ON LONG TERM DEBT	0.0	49.56	44.60	39.65	34.69	29.74	24.78	19.82	14.87	9.91
INTEREST ON SHORT TERM DEBT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL TREATMENT COST	0.0	928.61	923.65	918.70	913.74	908.79	903.83	898.87	893.92	888.96
UNIT TREATMENT COST	0.0	2.4566	2.4435	2.4304	2.4173	2.4042	2.3911	2.3780	2.3649	2.3518

YEAR	2014	2015	2016	2017	2018	2019
WASTEWATER TREATMENT (1000M3/Y)	378.00	378.00	378.00	378.00	378.00	378.00
CHEMICAL COST	0.0	0.0	0.0	0.0	0.0	0.0
UTILITIES COST	0.10	0.10	0.10	0.10	0.10	0.10
ELECTRICITY	0.10	0.10	0.10	0.10	0.10	0.10
VARIABLE COST	0.10	0.10	0.10	0.10	0.10	0.10
EMPLOYMENT COST	3.84	3.84	3.84	3.84	3.84	3.84
MAINTENANCE COST	3.60	3.60	3.60	3.60	3.60	3.60
GOVERNMENT CHARGE	13.61	13.61	13.61	13.61	13.61	13.61
LOCAL POLLUTION TAX	171.23	171.23	171.23	171.23	171.23	171.23
SEWAGE CHARGE	672.84	672.84	672.84	672.84	672.84	672.84
DIRECT FIXED COST	865.12	865.12	865.12	865.12	865.12	865.12
CASH TREATMENT COST	865.23	865.23	865.23	865.23	865.23	865.23
EQUIPMENT & MACHINERY	4.80	4.80	4.80	4.80	4.80	4.80
CIVIL & BUILDING	8.22	8.22	8.22	8.22	8.22	8.22
INTEREST DRG. CONSTRUCTION	0.80	0.80	0.80	0.80	0.80	0.80
DEPRECIATION AND AMORTIZATION	13.82	13.82	13.82	13.82	13.82	13.82
TOTAL TREATMENT COST	879.05	879.05	879.05	879.05	879.05	879.05
UNIT TREATMENT COST	2.3255	2.3255	2.3255	2.3255	2.3255	2.3255
INTEREST ON LONG TERM DEBT	4.96	0.0	0.0	0.0	0.0	0.0
INTEREST ON SHORT TERM DEBT	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL TREATMENT COST	884.01	879.05	879.05	879.05	879.05	879.05
UNIT TREATMENT COST	2.3386	2.3255	2.3255	2.3255	2.3255	2.3255

Table 3.1.27 Funds Flow Statements

*** WASTEWATER TREATMENT PROJECT IN SVILA (K-1) ***
FUNDS FLOW STATEMENTS
- CASE 2-B: DISCHARGE TO WWTP -- (DEM. 1000)

YEAR	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
SOURCE OF FUNDS	413.00	38.57	38.57	38.57	38.57	38.57	38.57	38.57	38.57	38.57
CASH GENERATED FROM OPERATION	0.0	38.57	38.57	38.57	38.57	38.57	38.57	38.57	38.57	38.57
PROFIT AFT. TAX. BFR INT.	0.0	24.75	24.75	24.75	24.75	24.75	24.75	24.75	24.75	24.75
DEPRECIATION AND AMORTIZATION	0.0	13.82	13.82	13.82	13.82	13.82	13.82	13.82	13.82	13.82
FINANCIAL RESOURCES	413.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SHARE CAPITAL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LONG TERM LOAN	413.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SHORT TERM DEBT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
USES OF FUNDS	413.00	90.86	85.90	80.95	75.99	71.04	66.08	61.12	56.17	51.21
FIXED CAPITAL EXPENDITURE	413.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NON-DEPRECIABLE ASSETS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DEPRECIABLE FIXED ASSETS	401.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INTEREST DURING CONSTRUCTION	12.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CHANGE IN WORKING CAPITAL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DEBT SERVICES	0.0	90.86	85.90	80.95	75.99	71.04	66.08	61.12	56.17	51.21
REPAYMENT OF LONG TERM DEBT	0.0	41.30	41.30	41.30	41.30	41.30	41.30	41.30	41.30	41.30
REPAYMENT OF SHORT TERM DEBT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INTEREST ON LONG TERM DEBT	0.0	49.56	44.60	39.65	34.69	29.74	24.78	19.82	14.87	9.91
INTEREST ON SHORT TERM DEBT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DIVIDENDS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CASH INCREASE OR (DECREASE)	0.0	-52.29	-47.33	-42.38	-37.42	-32.46	-27.51	-22.55	-17.60	-12.64
BEGINNING CASH BALANCE	0.0	0.0	-52.29	-99.62	-141.99	-179.41	-211.88	-239.38	-261.94	-279.53
ENDING CASH BALANCE	0.0	-52.29	-99.62	-141.99	-179.41	-211.88	-239.38	-261.94	-279.53	-292.17

YEAR	2014	2015	2016	2017	2018	2019
SOURCE OF FUNDS	38.57	38.57	38.57	38.57	38.57	38.57
CASH GENERATED FROM OPERATION	38.57	38.57	38.57	38.57	38.57	38.57
PROFIT AFT. TAX. BFR INT.	24.75	24.75	24.75	24.75	24.75	24.75
DEPRECIATION AND AMORTIZATION	13.82	13.82	13.82	13.82	13.82	13.82
FINANCIAL RESOURCES	0.0	0.0	0.0	0.0	0.0	0.0
SHARE CAPITAL	0.0	0.0	0.0	0.0	0.0	0.0
LONG TERM LOAN	0.0	0.0	0.0	0.0	0.0	0.0
SHORT TERM DEBT	0.0	0.0	0.0	0.0	0.0	0.0
USES OF FUNDS	46.26	0.0	0.0	0.0	0.0	0.0
FIXED CAPITAL EXPENDITURE	0.0	0.0	0.0	0.0	0.0	0.0
NON-DEPRECIABLE ASSETS	0.0	0.0	0.0	0.0	0.0	0.0
DEPRECIABLE FIXED ASSETS	0.0	0.0	0.0	0.0	0.0	0.0
INTEREST DURING CONSTRUCTION	0.0	0.0	0.0	0.0	0.0	0.0
CHANGE IN WORKING CAPITAL	0.0	0.0	0.0	0.0	0.0	0.0
DEBT SERVICES	46.26	0.0	0.0	0.0	0.0	0.0
REPAYMENT OF LONG TERM DEBT	41.30	0.0	0.0	0.0	0.0	0.0
REPAYMENT OF SHORT TERM DEBT	0.0	0.0	0.0	0.0	0.0	0.0
INTEREST ON LONG TERM DEBT	4.96	0.0	0.0	0.0	0.0	0.0
INTEREST ON SHORT TERM DEBT	0.0	0.0	0.0	0.0	0.0	0.0
DIVIDENDS	0.0	0.0	0.0	0.0	0.0	0.0
CASH INCREASE OR (DECREASE)	-7.68	38.57	38.57	38.57	38.57	38.57
BEGINNING CASH BALANCE	-292.17	-299.85	-261.28	-222.71	-184.14	-145.56
ENDING CASH BALANCE	-299.85	-261.28	-222.71	-184.14	-145.56	-106.99

*** WASTEWATER TREATMENT PROJECT IN SVILA (K-1) ***
RETURN ON INVESTMENT (IN 1996 FIXED PRICE)
- CASE 2-B: DISCHARGE TO WWTP -- (DEM. 1000)

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
(1) GROSS CAPITAL EXPENDITURE	401.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(2) GROSS CASH IN-FLOW	0.0	38.57	38.57	38.57	38.57	38.57	38.57	38.57	38.57	38.57
OPERATING PROFIT	0.0	24.75	24.75	24.75	24.75	24.75	24.75	24.75	24.75	24.75
DEPRECIATION & AMORTIZATION	0.0	13.82	13.82	13.82	13.82	13.82	13.82	13.82	13.82	13.82
(4) BFR-TAX NET IN-FLOW (2)-(1)	-401.00	38.57	38.57	38.57	38.57	38.57	38.57	38.57	38.57	38.57

	2014	2015	2016	2017	2018	2019
(1) GROSS CAPITAL EXPENDITURE	0.0	0.0	0.0	0.0	0.0	-205.62
(2) GROSS CASH IN-FLOW	38.57	38.57	38.57	38.57	38.57	38.57
OPERATING PROFIT	24.75	24.75	24.75	24.75	24.75	24.75
DEPRECIATION & AMORTIZATION	13.82	13.82	13.82	13.82	13.82	13.82
(4) BFR-TAX NET IN-FLOW (2)-(1)	38.57	38.57	38.57	38.57	38.57	244.20

INTERNAL RATE OF RETURN

ON (4) BFR-TAX NET IN-FLOW (2)-(1) 7.80 PER CENT

3.1.5 Pretreatment for Reduction of the Pollution Load

1) Background

The previous report concentrated on the case of direct river discharge based on the survey conducted as of June 1996. Here, the study focuses on pretreatment systems for discharge into the sewerage system.

2) Preliminary study

As was mentioned in the general summary, one of the river discharge standards relates to water color. In order for the WWTP to satisfy standards for river discharge in the future, there is a possibility that calls may be raised for it to install an appropriate pretreatment system for dealing with textile factories which discharge colored waste water. If a pretreatment system were not to be installed, it is likely that premium charges would be imposed.

Table 3.1.28 M-1 SVILA Color Data of the Wastewater

Sample	α (436 nm)	α (525 nm)	α (620 nm)
No. 1 Total Wastewater			
12 - 18 5. 6. 1996	42	33	25
18 - 24	14	15	18
0 - 6 6. 6. 1996	17	14	19
6 - 12	25	22	26
No. 3-1 Printing Wastewater			
8 - 16 1. 7. 1996	14	11	10
16 - 24	16	11	10
0 - 8	20	16	13
No. 3-2 Pre-washing Wastewater			
14 - 22 20. 6. 1996	11	6.8	5.9
22 - 6	3.1	1.9	1.2
6 - 14 21. 6. 1996	3.3	2.2	1.6
No.4 Dyeing Wastewater			
15 -21 5. 6. 1996	9.7	7.1	6
21 - 3	74	80	69
3 - 9 6. 6. 1996	12	16	31
9 - 15	11	13	13
Design Base for Model System	30	30	30
Emission Standard	7	5	3

The color conditions of waste water, as extracted from data in 3.1.1, are shown in Table 3.1.28.

The design values in the waste water treatment model system were made 30 for each of the three wave lengths (for convenience). Because the average value never exceeds 30, this is a high value on the safety side.

Generally speaking, the most economical method of pretreatment in the case of a dyeing factory is coagulating sedimentation. Moreover, if the highly concentrated waste water following dyeing can be separated and treated apart, the treatment can become even more economical. In consideration of this, testing of separation by coagulation sedimentation was carried out on a sample of concentrated waste water from the dyeing process. A spot sample of waste water from the circulation pit was taken as representative waste water from the printing plant. The results of jar testing are shown in Table 3.1.29.

Table 3.1.29 M-1 SVILA Result of Coagulation Test

Circulation Tank in Dyeing Factory		Sampling	Coagulation Test
Note		02.12.1996 11:30 Spot Sampling	PAC 100 ppm Anion P 200 Cation P 0
			Floc size Large Settling time 30sec
Parameter			
pH		8.7	6.6
SS	mg/l	70	< 30
Color		black	no color
α(436nm)	1/m	53	3
α(525nm)		41	2
α(620nm)		40	1
t-N	mg/l	11.2	
t-P	mg/l	0.9	< 0.5
COD_{Cr}	mg/l	270	
COD_{Mn}	mg/l	240	
BOD_5	mg/l	90	

According to the test results, the effects to be gained from coagulation treatment are great. Moreover, good decoloring can be achieved simply by using an inorganic coagulant and not a decoloring cation polymer. Because the test conditions were equivalent to ideal batch treatment, the water quality may deteriorate in an actual process of continuous treatment, however, the coagulation method can still be said to be highly suited to this factory.

3) Selection of pretreatment system

Examination was carried out on the following three cases:

① pH adjustment and coagulating sedimentation treatment of total waste water; dewatering and external disposal of sludge

② Coagulation sedimentation treatment of thick colored waste water only; dewatering and external disposal of sludge

③ Coagulation treatment of thick colored waste water only, followed by direct discharge

① Case 1: pH adjustment and coagulating sedimentation treatment of total waste water; dewatering and external disposal of sludge

In this case, the existing facilities from the water collecting pipes to the water collection pit can be used as they are. Because all the waste water is treated, the scale of facilities is large and cost of chemicals high. The color can be reduced to extremely low levels. Regarding the effect in terms of reduced sewage charge due to the reduction in pollution load, although the COD Mn will fall significantly, because the reduction in COD Cr will be small and the BOD and COD values are not very high to start with, it is estimated that the saving in sewage charges gained from reduction of the pollution load would not be very high and would not be enough to cover the pretreatment cost.

② Case 2: coagulating sedimentation treatment of thick colored waste water only; dewatering and external disposal of sludge

In this case, new facilities for treating only the concentrated waste water need to be installed in addition to the existing ones from the water collecting pipes to the water collecting pit. These installation works would prove very difficult in reality. However, once those works are completed, because the waste water volumes to be treated are small, equipment and running costs could be significantly reduced.

Furthermore, color could be efficiently removed from the waste water and, due to the dilution effect of other water, it is estimated that color could be reduced to sufficiently low levels to enable the treated water to satisfy river discharge standards.

Table 3.1.30 Quality and Pollution Loads of Waste Water and Treated Water

Kind of wastewater	Quan-tity m3/d	CODcr mg/L (kg/d)	BOD mg/L (kg/d)	SS mg/L ( )	color (1/m)	T-N mg/L (kg/d)	T-P mg/L (kg/d)
*1 (for design) Raw total wastewater	1,500	500 (750)	300 (450)	40 (60)	30	20 (30)	10 (15)
*2 Case-1 Treated total wastewater	1,500	300 (450)	200 (300)	30 (45)	3	20 (30)	1 (1.5)
*3 Thick wastewater (Raw water)	400	800 (320)	400 (160)	100 (40)	60	20 (8)	10 (4)
*4 CASE-2 Treated thick wastewater	400	400 (160)	200 (80)	30 (12)	3	20 (8)	1 (<1)
*5 CASE-3 Treated thick wastewater	400	400 (288)	200 (80)	300 (120	3	20 (8)	1 (<1)
*6 Case-3' Mixed total discharge	1,500 Design base	200 (300)	100 (150)	100 (150	2	20 (30)	1 (2)

Notes) * 1 : quality of total waste water (design value of model system)
* 2 Case 1 : case where total waste water undergoes pretreatment
* 3 water quality when colored waste water from the dyeing process only is separated
* 4 Case 2 : case where colored waste water only undergoes pretreatment
* 5 Case 3 : case where colored waste water only undergoes pretreatment and there is no floc separation
* 6 : total waste water when treated colored waste water is mixed with other waste water

③ Case 3: coagulation treatment of thick colored waste water only, followed by direct discharge

In this case, there is no separation and removal of floc that adsorbs the waste water color (Case 2), but the treated water is discharged as it comes out of the system. Although the SS value increases, the color discharge standards are satisfied and the method is the least expensive of the three.

Table 3.1.31 Equipment and Running Costs of the Treatment System

	Equipment cost SIT	Depreciation & Interest SIT/m³	Running Cost SIT/m³	Total treatment cost SIT/m³
CASE-1	154,400,000	40	107	147
CASE-2	55,000,000	15	88	103
CASE-3	43,200,000	12	70	82
Discharge to River	506,117,000	144	404	548

Case 1: case where total waste water undergoes pretreatment
Case 2: case where colored waste water only undergoes pretreatment
Case 3: case where colored waste water only undergoes pretreatment and there is no floc separation

4) Conclusion

Rather than treating all the waste water, it is more economic to collect only the concentrated waste water and treat it by coagulation. If it is possible to discharge the treated water without separating and removing floc which adsorbs the colored matter, the system can be made even more economic.