付 属 資 料 その2

1. 第1章関連

1.1 Questionnqare FOR THE STUDY ON THE

1.2 List of Equipment Supplied by JICA to IWD

1.3 Seminor Program of Effective Ues of Industrial Water

2. 第2章関連

2.1 日本の紙パルプ工業における工業用水の水質

2.2 工業用水に対する要望標準水質（パルプ・紙・紙加工品製造業）

2.3 日本のある製鉄所の用水水質管理基準

2.4 Factory Act, B.E. 2512 (1969), 抜粋

2.5 Notification of Ministry of Industry No. 13 (B.E.2525)

2.6 Notification of Ministry of Industry No. 15 (B.E.2527), 抜粋

2.7 Implementation of Ground Water Act, (B.E.2520), 抜粋

2.8 Notification of Ministry of Industry №7 (B. E. 2520)、抜粋

3. 第3章関連

3.1 Mannal for Visting Survey in the Study on Effective Use of Industrial Water

3.2 水使用の原単位について

3.3 個別工場の工業用水使用量

3.4 日本の井戸水の水質例

3.5 廃水処理の状況

1.1 Questionnaire

(1) Questionnaire for the study on the Effective Use of Industrial Water

(2) Answer Example

(3) Instruction to Answer

==========
CONFIDENTIAL
==========

C#: _____

F#: _____

QUESTIONNAIRE

FOR

THE STUDY

ON

THE EFFECTIVE USE OF INDUSTRIAL WATER

IN

THE KINGDOM OF THAILAND

(DRAFT)

AUGUST 1987

INDUSTRIAL WORKS DEPARTMENT
MINISTRY OF INDUSTRY

AND

JAPAN INTERNATIONAL COOPERATION AGENCY

F#: _____

1. Outlines of Company and Factory

1.1 Company

A. Name: _____

B. Capital: _____ Thousand B

1.2 Factory

A. Name: _____

B. Address: _____

C. Telephone: _____

D. Classification of Industry: _____

E. Annual Amount of Shipment *1: _____ Million B

F. Total Area *2: _____ m²

G. Total Number of Workers: _____

H. Average Daily Working Hour *3: _____ (_____) hours/day

I. Annual Working Day *4: _____ (_____) days/year

J. Product Shipment

Name of Main Product				
Annual Quantity of Production in 1986 ( ) *5				
Annual Quantity of Shipment (mil B)				

K. Special Notes on Operation and Others in 1986:

_____

_____

_____

_____

F#: _____

1.3 Person to Contact related to this Study

A. Name: _____

B. Title: _____

_____

- -

Notes:

*1: Please fill in actual quantity of shipment from January to December in 1986.

If difficult, please fill in quantity of shipment in recent one year.

*2: Please fill in total area including plant, dormitory and company house.

*3 and 4: Please fill in data in 1986.

If operation in 1986 was different from normal year, please fill in data in normal year in ( ).

*5: Please fill in unit such as unit, ton, kg, m^2, m^3, and others.

F#: _____

2. Monthly quantity of make-up water in 1986

Please complete the table below of monthly quantity of make-up water in 1986.

Items / Month	Total Quantity of Make-up Water (m^3/day)	Well Water (m^3/day)	Potable Water (m^3/day)*	Other (m^3/day)	Monthly Operating Day (day)
Jan					
Feb					
Mar					
Apr					
May					
Jun					
Jul					
Aug					
Sept					
Oct					
Nov					
Dec					
Avr**					

Remarks: * Fresh water supplied by MWWA.
** Annual average

F#: ____

3. Quantity of consumed water classified to use

   Please fill in quantity of consumed water classified to usage in Table A of page 5, referring to page 5 of "Answer Example".

4. Process diagram of production line

   Please draw detailed process diagram of each production line of main product in your factory, indicating source of water, usage of water and place from where waste water is discharged, referring to page 10 of "Answer Example".

   If you have diagram, please fill in necessary information.

5. Flow diagram of water supply and waste discharge

   Please complete Figure A of page 6, referring to page 6 of "Answer Example".

6. Drawing of factory layout

   Please draw drawing of your factory layout that shows places where water is used, referring to page 11 of "Answer Example".

   If you have drawing, please indicate places where water is used.

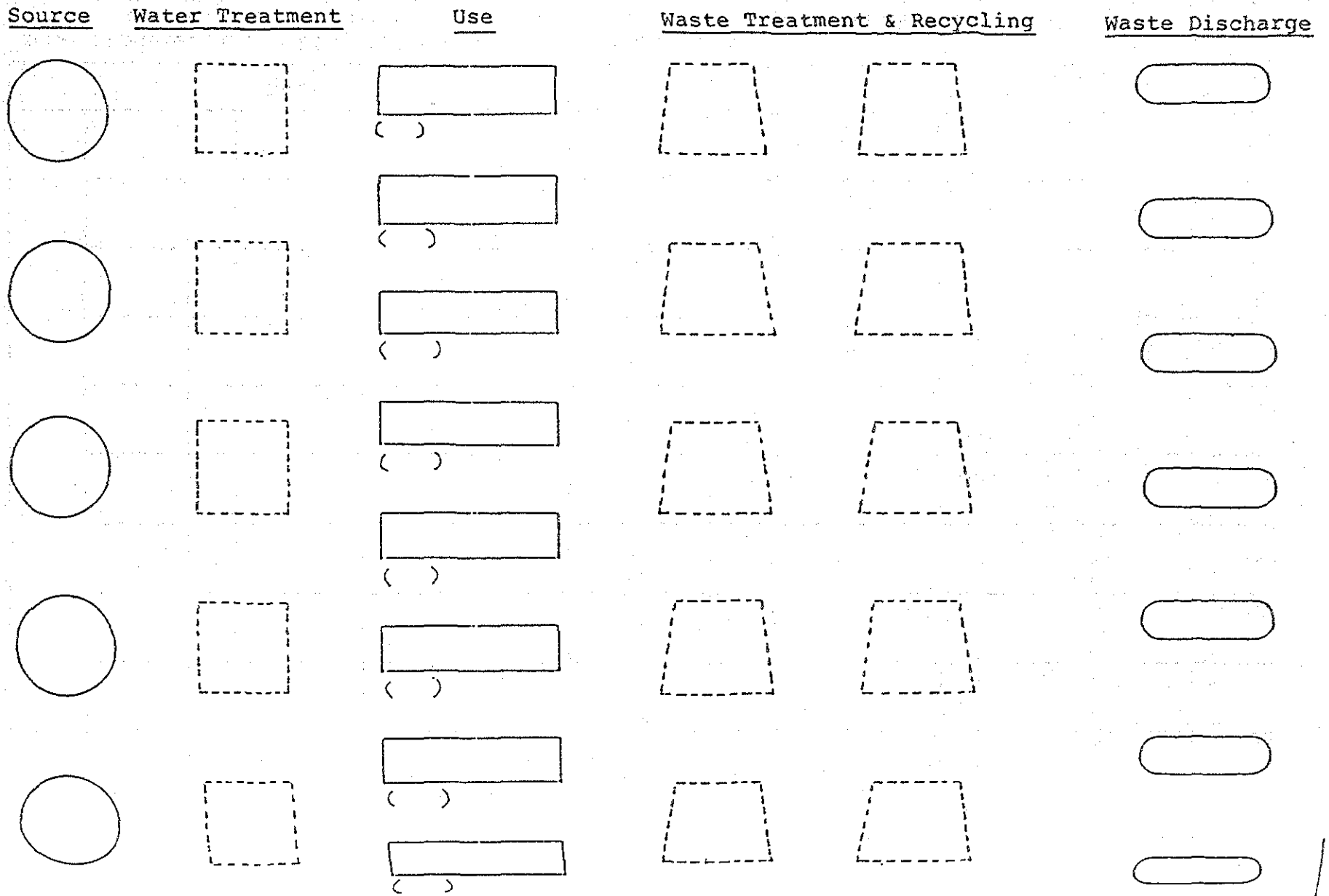
   Please use same number as the above Item 3.

Table A: Quantity of Consumed Water Classified to Use (__/__)

Place	Use	No.	Process or Equipment	Water Quantity in Operating Day (m^3/d) cl. to Source 1)					Op Hr (h/d)	Op Dy (d/y)	CW Temp at Outlet (°C) 6)	Specification of Equipment and Operating Method	Remarks
				WW 2)	PW 3)	OW 4)	RW 5)	Total					
Total													

Note: 1) Please fill in annual average quantity of operating day.
Please fill in additionally peak quantity in ( ) if seasonal change is high.
2) WW = Well water; 3) PW = Potable Water; 4) OW = Riverbed and/or Surface Water; 5) RW = Recycling Water;
6) CW = Cooling Water

Figure A: Flow Diagram of Water Supply and Waste Discharge



F#: _____

7. Quality of well water

If you have analysis data of well water, please complete the table below:

Items	Unit	Raw Water	After Treatment
Temperature	°C		
Turbidity	°		
pH	-		
COD by Mn	ppm		
BOD	ppm		
Alkalinity	ppm		
Total Hardness	ppm		
Chroline Ion	ppm		
Total Iron	ppm		
Evaporation Residue	ppm		
Electric Conductivity	μS/cm		
Depth of Well	m		

F#: _____

8. Waste water treatment and recycling

   Please complete Table B of page 9, referring to page 9 of "Answer Example".

   If you do not have analysis data, please fill in design data in ( ).

   Please use separate sheet for each object of treatment.

9. Please describe outlines of water saving, if you have carried out in recent one year.

10. Please describe outlines of the existing or planned water saving system.

11. Please describe the possibility of adopting water saving system in your factory.

(Thank you for your cooperation)

F#: _____

Table B: Waste Water Treatment and Recycling (__/__)

Object of Treatment (Please circle 1 or 2.) (Please fill in 3, if otherwise)	1. Waste Discharge 2. Water Recycling 3.	
Treatment Process		
Maximum Capacity (m^3/d)		
Treatment Quantity (m^3/d)		
Date of Installation		
Water Quality	Influent	Effluent
SS (ppm)		
BOD (ppm)		
COD (ppm)		
Cl^- (ppm)		
pH		
Temperature (°C)		
Oil (ppm)		
Heavy Metals (ppm)		
Flow in from		
Flow out to		
Remarks		

ANSWER EXAMPLE

OF

QUESTIONNAIRE

FOR

THE STUDY

ON

THE EFFECTIVE USE OF INDUSTRIAL WATER

IN

THE KINGDOM OF THAILAND

AUGUST 1987

INDUSTRIAL WORKS DEPARTMENT
MINISTRY OF INDUSTRY

AND

JAPAN INTERNATIONAL COOPERATION AGENCY

1. Outlines of Company and Factory

1.1 Company

A. Name: A Co., Ltd

B. Capital: 2,500 Thousand B

1.2 Factory

A. Name: B Factory

B. Address: C Road, Samrongtai, Praopradaeng Samut Prakan

C. Telephone: 250-1010

D. Classification of Industry: Textile Deying & Finishing

E. Annual Amount of Shipment *1: 35 Million B

F. Total Area *2: 3,702 m^2

G. Total Number of Workers: 35

H. Average Daily Working Hour *3: ( ) 9 hours/day

I. Annual Working Day *4: 291 days/year

J. Product Shipment

Name of Main Product	Towel			
Annual Quantity of Production in 1986 (kg) *5	250,000			
Annual Quantity of Shipment (mil B)	35			

K. Special Notes on Operation and Others in 1986:

1.3 Person to Contact related to this Study

A. Name: _____

B. Title: _____

_____

- -

Notes:

*1: Please fill in actual quantity of shipment from January to December in 1986.

If difficult, please fill in quantity of shipment in recent one year.

*2: Please fill in total area including plant, dormitory and company house.

*3 and 4: Please fill in data in 1986.

If operation in 1986 was different from normal year, please fill in data in normal year in ( ).

*5: Please fill in unit such as ton, kg, m^2, m^3, psc. and others.

2. Monthly quantity of make-up water in 1986.

please complete the table below of monthly quantity of make-up water in 1986.

Items / Month	Total Quantity of Make-up Water (m^3/day)	Well Water (m^3/day)	Potable Water (m^3/day)*	Other (m^3/day)	Monthly Operating Day (day)
Jan	312	311	1		19
Feb	293	292	1		25
Mar	357	356	1		24
Apr	302	301	1		26
May	358	357	1		22
Jun	326	325	1		27
Jul	301	300	1		26
Aug	377	376	1		21
Sept	301	300	1		27
Oct	421	420	1		23
Nov	325	324	1		26
Dec	306	305	1		25
Avr**	330	329	1		291

Remarks: * Fresh water supplied by MWWA.
** Annual average

3. Quantity of consumed water classified to use

Please fill in quantity of consumed water classified to usage in Table A of page 5, referring to page 5 of "Answer Example".

4. Process diagram of production line

Please draw detailed process diagram of each production line of main product in your factory, indicating source of water, usage of water and place from where waste water is discharged, referring to page 10 of "Answer Example".

If you have diagram, please fill in necessary information.

5. Flow diagram of water supply and waste discharge

Please complete Figure A of page 6, referring to page 6 of "Answer Example".

6. Factory layout drawing

Please draw layout drawing of your factory that shows places where water is used, referring to page 11 of "Answer Example".

If you have drawing, please indicate places where water is used.

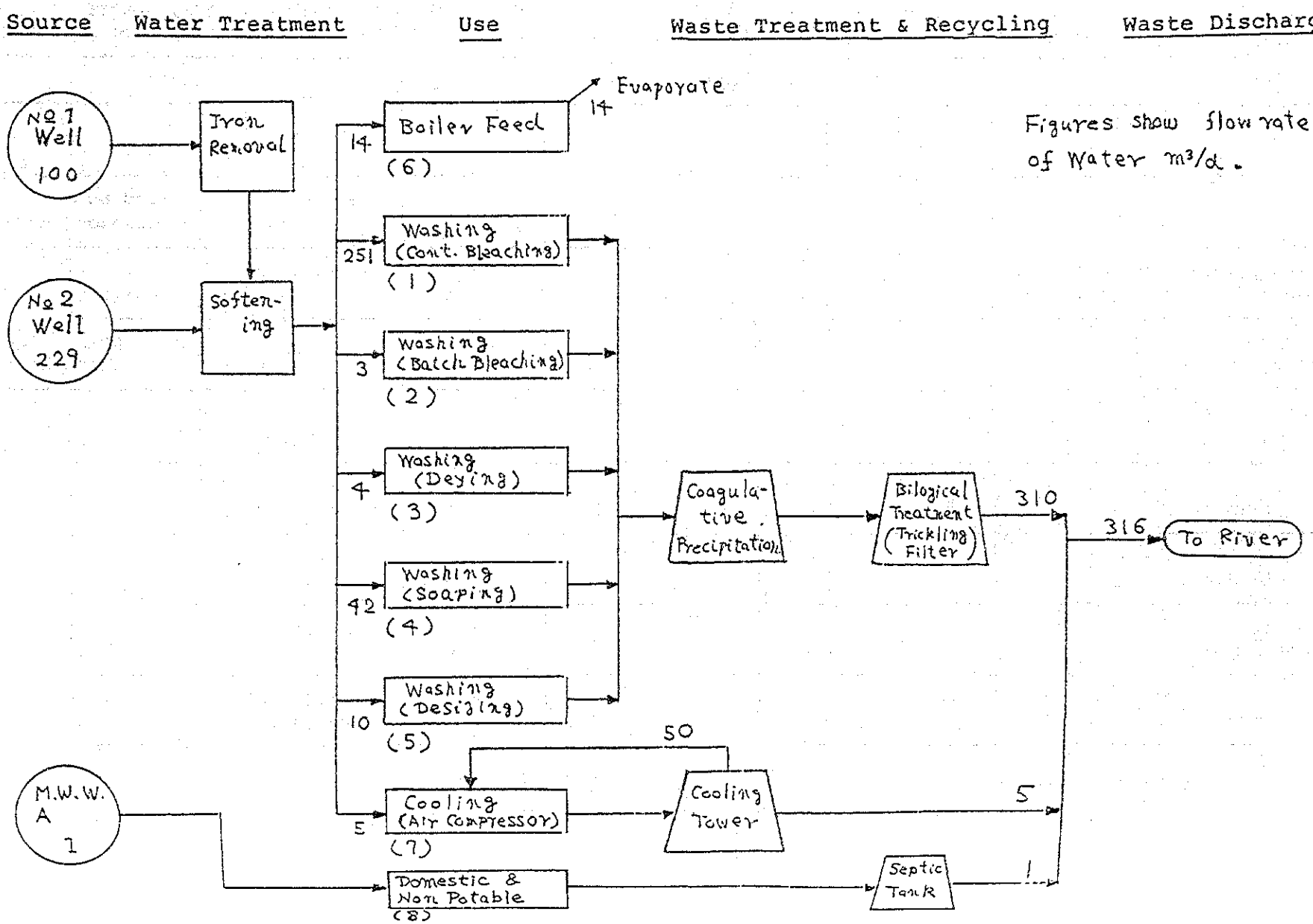
Please use same number as the above Item 3.

Table A: Quantity of Consumed Water Classified to Use (1/1)

Place	Use	No.	Process or Equipment	Water Quantity in Operating Day cl. to Source (m^3/d) 1)					Op Hr (h/d)	Op Dy (d/y)	CW Temp at Outlet (°C) 6)	Specification of Equipment and Operating Method	Remarks
				WW 2)	PW 3)	OW 4)	RW 5)	Total					
Plant	Washing	1	Continuous bleaching	251				251	7	291			1 unit
	"	2	Batch bleaching	3				3	4	"			Wins type, 1 unit
	"	3	Deying	4				4	7	"			Overmyer type, 4 units
	"	4	Soaping	42				42	"	"			2 units
	"	5	Desizing	10				10	6	"			Wins type, 1 unit
Boiler House	Boiler Feed	6	Boiler	14				14	9	"			Max. Capacity 4 tons/hr
	Cooling	7	Air Compressor	5			50	55	9	"	35	Motor 5.0 kW Cooling Tower	Recycling use 42°C to 35°C
Office	Domestic & Non-pot.	8	Drinking, Toilet, etc.		1			1	9	"			
Total				329	1		50	380					

Note: 1) Please fill in annual average quantity of operating day.
Please fill in additionally peak quantity in ( ) if seasonal change high.
2) WW = Well water; 3) PW = Potable Water; 4) OW = Riverbed and/or Surface Water 5) RW = Recycling Water;
6) CW = Cooling Water

Figure A; Flow Diagram of Water Supply and Waste Discharge



7. Quality of well water

If you have analysis data of well water, please fill in the table below:

Items	Unit	Raw Water	After Treatment
Temperature	°C	18	
Turbidity	°	1	1
pH	-	7.0	7.1
COD by Mn	ppm	3.4	4.0
BOD	ppm		
Alkalinity	ppm	188	154
Total Hardness	ppm	57	28
Chroline Ion	ppm	40	36
Total Iron	ppm	1.7	0.2
Evaporation Residue	ppm	452	375
Electric Conductivity	μS/cm	770	700
Depth of Well	m	50	-

8. Waste water treatment and recycling

Please complete Table B of page 11, referring to page 9 of "Answer Example".

If you do not have analysis data, please fill in design data in ( ).

Please use separate sheet for each object of treatment.

9. Please describe outlines of water saving, if you have carried out in recent one year.

10. Please describe outlines of the existing or planned water saving system.

11. Please describe the possibility of adopting water saving system in your factory.

(Thank you for your cooperation)

Table B: Waste Water Treatment and Recycling (__/__)

Object of Treatment (Please circle 1 or 2.) (Please fill in 3, if otherwise)	1. Waste Discharge 2. Water Recycling 3.	
Treatment Process	Coagulative Sedimentation and Biological Treatment	
Maximum Capacity (m^3/d)	500	
Treatment Quantity (m^3/d)	311	
Date of Installation	July 1975	
Water Quality	Influent	Effluent
SS (ppm)	68	15
BOD (ppm)	110	30
COD (ppm)	60	35
Cl^- (ppm)		
pH	6.9	7.2
Temperature (°C)		
Oil (ppm)	8.7	2.0
Heavy Metals (ppm)		
Flow in from	Bleaching and Deying Process	
Flow out to	River	
Remarks		

Figure B: Process Diagram of Production Line

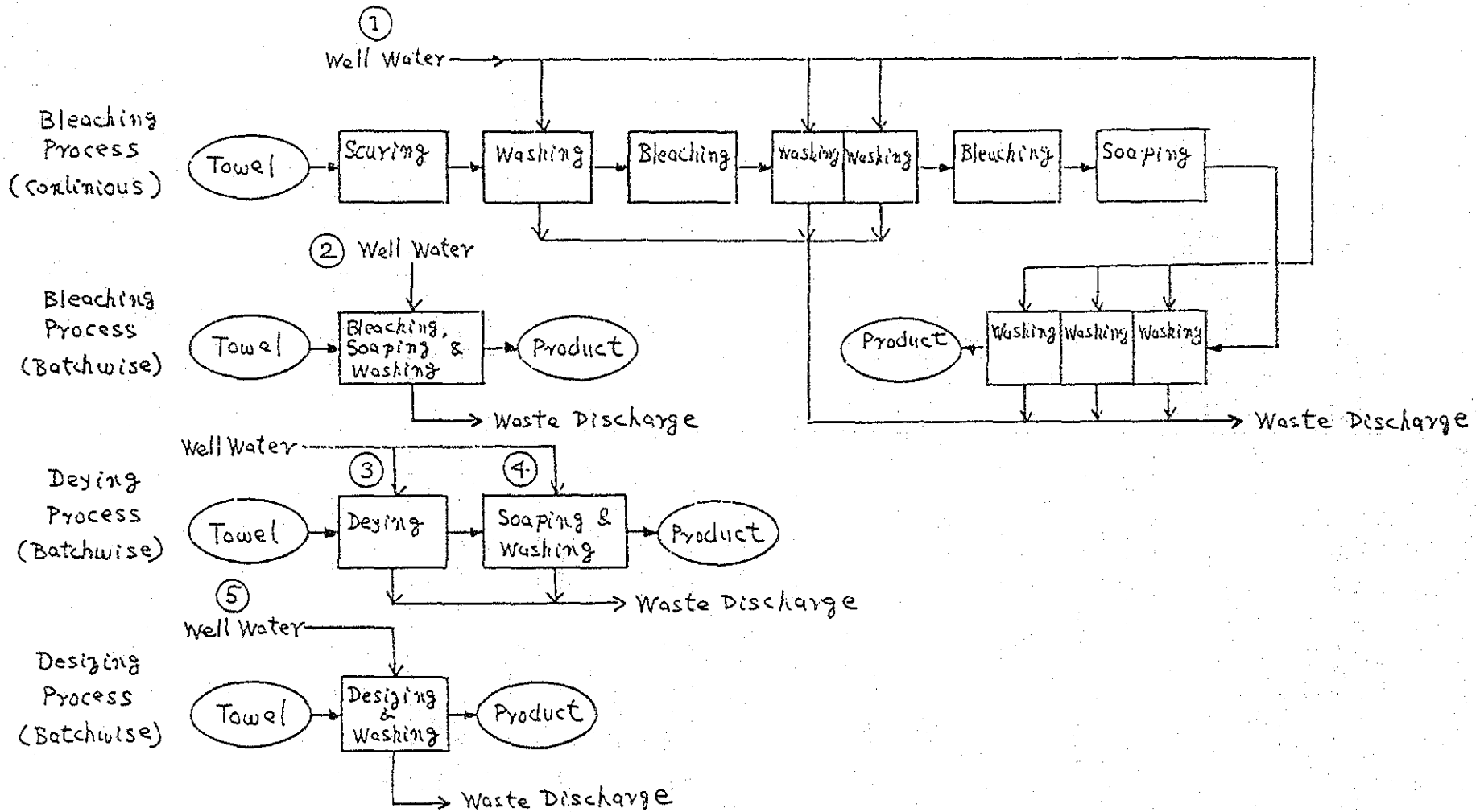
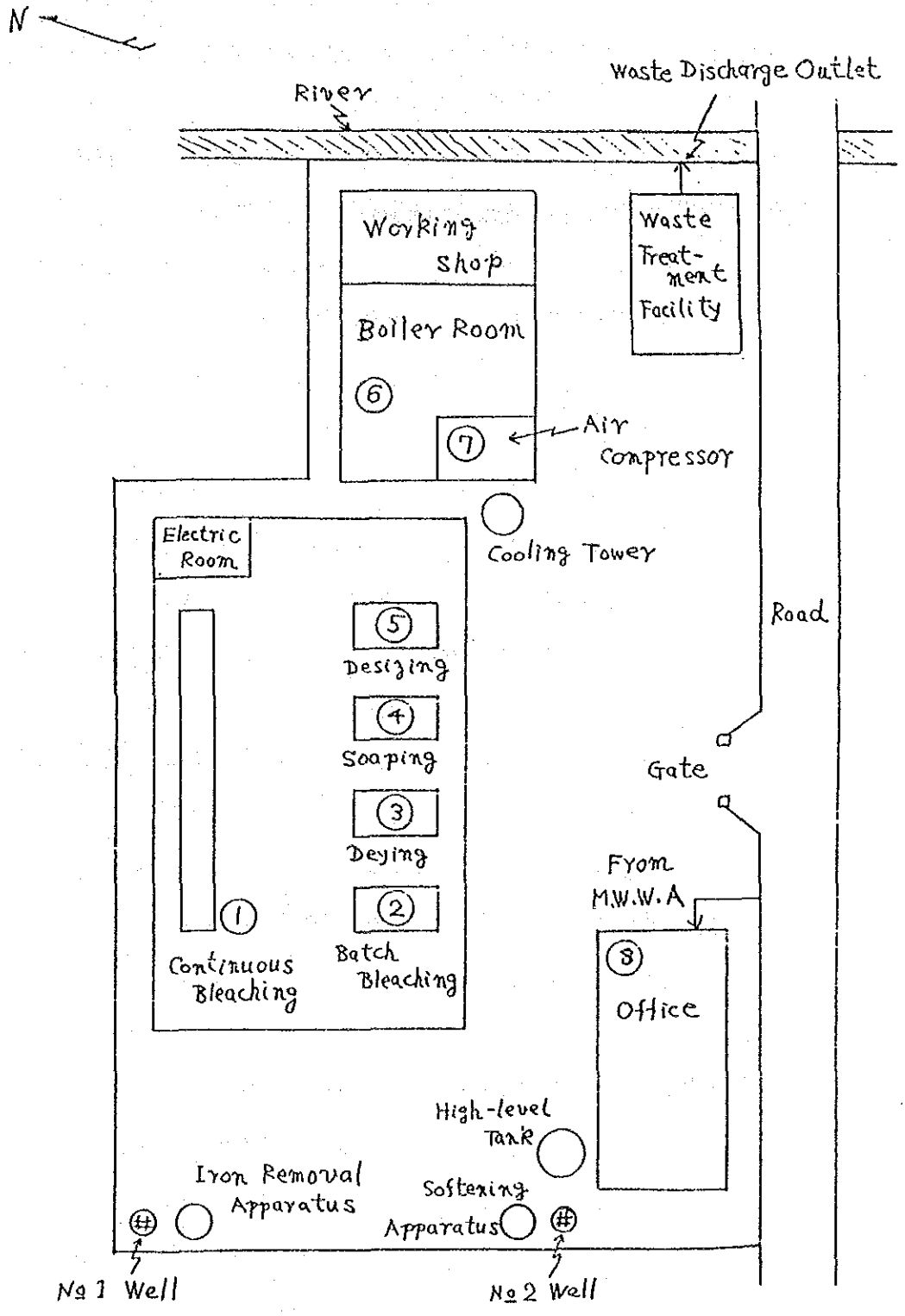


Figure C: Drawing of Factory Layout



INSTRUCTION TO ANSWER

QUESTIONNAIRE

FOR

THE STUDY

ON

THE EFFECTIVE USE OF INDUSTRIAL WATER

IN

THE KINGDOM OF THAILAND

AUGUST 1987

INDUSTRIAL WORKS DEPARTMENT

MINISTRY OF INDUSTRY

AND

JAPAN INTERNATIONAL COOPERATION AGENCY

When you answer to the "Qustionnaire" for "The Study on the Effective Use of Industrial Water in the Kingdom of Thailand", please read carefully the following instructions.

1. Table A: Quantity of Consumed Water Classified to Use

(Cl. 3 of Questionnaire & p-5 of Answer Example)

1.1 Terms for use of water

Please use the following terms for use of water:

A. "Boiler Feed": water that is used for generating steam in a boiler.

B. "Material": water that is used as a part of final product or is added as a part of product material.

C. "Process": water that is used for dipping and resolution of material and/or semi-product.

D. "Washing": water that is used for washing equipment, material, semi-product and final product.

When it is difficult to distinguish "C" and "D", please use a term "Process/Washing water".

E. "Cooling": water that is used for cooling equipment and/or product.

F. "Air Conditioning": water that is used for adjusting temperature and moisture inside the building.

Water used by air washer for air cleaning and temperature conditioning is included in this category.

G. "Domestic": water that is used for drinking, cooking, washing, bathing and others.

H. "Non-potable": water that is used for toilet flushing, sprinkling, pond and washing, other than "G".

When it is difficult to distinguish "G" and "H", please use a term "Other".

1.2 Source and Quantity of consumed water

1.2.1 Source

Terms for "Water Source" in this study are as follows:

A. "Well": water that is supplied by well.

B. "Potable": water that is supplied by WMMA.

C. "Other": water that is supplied from riverbed underflow and/or surface.

D. "Recycling": water that is used again after it is used in one process.

It does not matter whether water is treated after the first use and it is used in the same process as the first.

In case that "Air Conditioning Water" is used again after it is cooled by a cooling tower, please classify it as "Recycling water".

1.2.2 Quantity of consumed water

Please fill in annual average quantity of operating day.

In case quantity of consumed water changes much in accordance with season, please fill in quantity of peak season (average quantity in summer, for example) in ( ).

1.3 Temperature of cooling water outlet

Please fill in if you have data.

1.4 Specification of equipment and operating method

Please fill in such informations as capacity of refrigerator, driving power of compressor, capacity of cooling tower and operating method of equipment.

Especially, please fill in season and period when peak quantity is filled in.

2. *Figure B: Process Diagram of Production Line*

(Cl. 4 of Questionnaire & p-10 of Answer Example)

2.1 General

The diagram is used to understand how water is used in your factory. Therefore, please clearly point out places where water is used.

2.2 Production line

Please write name of process and/or equipment, starting from material to final product.

Please also fill in the same number of process and/or equipment as is used in the Table A.

2.3 Equipment and/or process where water is used

Please connect process and/or equipment where water is used with arrow line (→) to show flow direction of supply and/or waste water.

3. Figure A: Flow Diagram of Water Supply and Waste Discharge

(Cl. 5 of Questionnaire & p-6 of Answer Example)

3.1 Water source

Please use the terms in the above Clause 1.2.1.

In case your factory has more than two wells, please draw flow diagram for each well.

3.2 Water treatment

Water treatment is a process (such as filtration, softening, ion exchange, iron removal, disinfection and so forth) conducted before water is used.

3.3 Use of water

Please use the terms specified in the above Clause 1.1 and list up in the same order as Clause 1.1.

In the case of same use, please sum up in accordance with place of use or process.

3.4 Place

Please write "No." in ( ) using the same "No." in Table A.

3.5 Waste treatment and recycling

Please be sure to fill in not only waste water treatment but also cooling tower, heater, cooler and others.

3.5 Waste discharge

If there are more than two outlets, please give name and number to each outlet.

3.6 Flow quantity of each point

Please fill in flow quantity (m^3/d) of each point. The value should be same as that in Table A.

4. Figure C: Drawing of factory layout

(Cl. 6 of Questionnaire & p-11 of Answer Example)

4.1 Naming

Please use same name as that in Table A.

4.2 Facilities where water is used

Please point out clearly facilities where water is used, using the same name as that in Table A.

4.3 River water inlet point and others

Please show clearly locations of river water inlet point, wells, water works service pipe, discharge gate of waste water and others.

5. Other General Items

5.1 Flow quantity

If flow quantity is not known because of lack of flow meter, please assume flow quantity from the followings:

A. Diameter of pipe

B. Capacity of installed pump

C. Distribute quantity at water source to each process

D. Quantity of recycling water of cooling tower is figured out from the capacity of circulating pump.

Quantity of make-up water for cooling tower is generally two to three per cent of total reclycling water.

E. Quantity of cooling water for refrigerator and compressor is figured out from specification of each equipment.

5.2 Quantity of domestic water

Quantity of domestic water consumed in factory is generally 100 to 300 liters per day per head.

1.2 List of Equipment Supplied by JICA to IWD

No.	Items	Qt.	Remarks
1	Portable Type Ultrasonic Flow Meter (Fuji Electric Co., Ltd.: FLB-2002)	2 units	
	1) Main Unit	2 sets	
	2) Small Sensor	2 sets	Mounting barker and 5 m cable
	3) Soft Case	2 sets	Strap
	4) Power Cords	2 sets	Cable for AC & DC 2 m
	5) Test Piece	2 sets	
	6) Extension cable for sensor	80 m	
	7) Others	1 set	Compound for mounting sensor, roll paper & printer ink cartridge etc.
2	Portable Digital Temperature Meter (Sato Co., Ltd.: MC-20R)	2 units	
	1) Main Unit	2 sets	
	2) Sensor	2 sets	
	3) Soft Case	2 sets	
	4) Others	1 set	Battery
3	Portable Digital pH/ORP Meter (Central Kagaku Co., Ltd.: UC-23)	2 units	
	1) Meter Unit	2 sets	
	2) Sensor		
	a) Standard Type (UC-502E)	2 sets	
	b) Throw-in Type pH Control (UC-303E)	2 sets	
	3) UC Meter Carrying Case	2 sets	
	4) Exclusive Battery Charger (220V)	2 sets	
	5) Others	1 set	Internal Fluid, 4M-KCl,Thermometer
4	Portable Digital Conductivity Meter (Central Kagaku Co., Ltd.: UC-33)	2 units	
	1) Meter Unit	2 sets	
	2) Sensor	2 sets	
	3) UC Meter Carrying Case	2 sets	
	4) Exclusive Battery Charger (220 V)	2 sets	
5	Portable Digital Turbidity/Temp. Meter (Central Kagaku Co., Ltd.: UC-61)	2 units	
	1) Meter Unit	2 sets	
	2) Sensor Unit	2 sets	10m Cable, Light Shield Tube & Standard Plate
	3) Meter Unit Storage & Carrying Case	2 sets	
	4) Exclusive Battery Charger (220V)	2 sets	

List of Equipment Supplied by JICA to IWD (2/2)

No.	Items	Qt.	Remarks
6	COD Meter	2 units	
	(Central Kagaku Co., Ltd.: HC-407)		
	1) Main Unit	2 sets	Transformer
	2) Elelctrolytic Electrode	2 sets	(-) PT-207, (+) PV-207
	3) Indicator Electrode	2 sets	
	4) Stirrer	2 sets	
	5) Support Rod	2 sets	
	6) Exclusive Heater	2 sets	
	7) Tall Beaker	10 sets	
	8) Others	1 set	Reagent, Pilette, etc.
7	Sample Bottle	1 set	
8	Personal Computer	1 set	
	1) Computer (NEC: PC-9801 VM 21)	1 unit	
	2) Display (NEC: N-5913-L)	1 unit	
	3) Printer		
	a) PC-PR201-F2 (NEC)	1 unit	
	b) HR-25 (BROTHER)	1 unit	
	4) CVT Sheet Feeder		
	a) PC-PR201-24 (NEC)	1 unit	
	b) CF-100 (NEC)	1 unit	
	5) Rack (NEC: RS-253)	1 unit	
	6) Software		
	a) TwinStar (NEC)	1 unit	
	b) Lotus 1,2,3 (NEC)	1 unit	
	7) Converter for Printer (NEC, KSW-P2)	1 unit	
	8) Tractor Feeder (NEC: PR-201-23)	1 unit	
	9) Automatic Voltage Regulator (MATSUNAGA: SVC-1010-A)	1 unit	
	10) Others		
	a) Connector Leads	1 unit	
	b) Floppy Disc	1 set	
	c) Printer Ribbon	1 set	
9	Video Camera (National: NV-M5EN)	1 unit	
	Accessories		
	1) Battery Pack	2 unit	
	2) Carrying Case	1 unit	
	3) Video Tape	10 units	
	4) Others	1 unit	Connector Leads
10	Video Television System		
	1) Video Cassette Recorder (Panasonic: NV-G15PX)	1 unit	
	2) Color Television (National: TC-AL2100NT)	1 unit	
	3) Others	1 unit	Connector Leads

1.3 Seminar Program of Effective Use of Industrial Water

Held on Wednesday, November 11, 1987

at Bangkok Palace Hotel

	Time
1. Opening Address by Director-General of IWD	09:30-09:50
" by Resident Representative of JICA Bangkok Office	
2. "Use of Water, Especially Industrial Water in Japan" by Shun-ichiro Uchida	09:50-11:00
Coffee Break	11:00-11:15
3. "Problems caused by Pumping Up of Ground Water" by Shun-ichiro Uchida	11:15-12:20
Luncheon	12:20-13:20
4. Projection of a Film entitled "Re-Use of Water"	13:20-13:50
5. "Guidance of Effective Use of Industrial Water in Japan" by Naoto Hashimoto	13:50-15:00
Coffee Break	15:00-15:15
6. Question and Discussion	15:15-17:00

# # #

Note: Interpreted by Mrs. Nongnuch J. of IWD

List of Participants' Organization in Seminar

Organization	Person
Ministry of Industry	
Department of Industrial Works	2
Department of Mineral Resources	6
Provincial Industrial Office	
Samut Prakan Provincial Industrial Office	1
Nakorn Pathom Provincial Industrial Office	1
Chantaburi Provincial Industrial Office	5
Songkhla Provincial Industry Office	1
Bang Poo Industrial Estate	1
Sura Maharas Public Co., Ltd.	3
Sugar Factories Inc.	2
Ministry of University Affairs	
Faculty of Engineering, Kasetsart University	2
Faculty of Engineering, Khon Kean University	2
Faculty of Engineering, Chieng Mai University	1
King Mongkut's Institute of Technology, North Bangkok Campus	5
King Mongkut's Institute of Technology, Latkrabang Campus	4
Institute of Environmental Research, Chulalongkorn University	4
Ministry of Defence	
The Glass Organization	3
The Textile Organization	2
The Tanning Organization	2
The Preserved Food Organization	1
Ministry of Science, Technology and Energy	
Office of National Environment Board	2
Thailand Institute of Scientific and Technological Research	3
Ministry of Finance	
The Excise Department	2
Ministry of Public Health	
The Government Pharmaceutical Organization	1
Department of Health	2
Asian Institute of Technology	1
Total Participants	59

Program of Technical Seminar

Date: Monday, December 12, 1988

1. Opening Address by Mr. Ben Saito, Resident Representative of JICA Bangkok Office	09:30-09:35
" by Mr. Yingyong Srithong, Director-General of the IWD	09:35-09:45
2. Seminar, chaired by Mr. Shun-ichiro Uchida	
(1) "Background and Objectives of the Study" by Mr. Adisorn Naphavaranonth Chief Industrial Water Supply Service Sub-Division	09:45-10:15
Coffee Break	10:15-10:30
(2) "Present Situation of the Water Usage and Effective Use of Industrial Water for the Studies Area" by Mr. Naoto Hashimoto	10:30-11:40
Luncheon	11:40-13:00
3. Seminar, chaired by Mr. Naoto Hashimoto	
(1) "Practical Methods of the Effective Use of Industrial Water for Cooling" by Mr. Hozumi Eto	13:00-14:10
(2) "Practical Methods of the Effective Use of Industrial Water for Washing" by Mr. Shun-ichiro Uchida	14:10-15:05
Coffee Break	15:05-15:25
4. Question and Discussion chaired by Mr. Hozumi Eto	15:25-16:45

List of Participant's Organization in Seminar

Organization	Person
Private Company	
Chemical Fact.	14
Food Fact.	15
Metal Fact.	15
Paper Fact.	5
Textile Fact.	6
Consultant	3
Industrial Works Depertment	
Industrial Enrironment Division	9
Total Participants	67

2.1　日本の紙パルプ工業における工業用水の水質

水質項目	水源	工業用水道	上水道	表流水	伏流水	地下水	海水
	工場数	5	2	11	15	27	6
濁度〔ppm〕		0～7.0	0～0.9	0～35	0～7.6	0～138	3.7
pH		7.1～7.7	6.4～6.5	6.5～8.2	6.5～8.2	6.5～7.3	6.9～8.9
全硬度〔ppm〕		1～55	1.3	1.7～42	4.2～47	2.5～161	699～5,780
蒸発残渣〔ppm〕		55～113	79	37～167	42～158	2～476	3,600～38,000
過マンガン酸カリ消費〔ppm〕		—	—	0～8.7	0～2.3	1.6～4.8	—
溶解酸素〔ppm〕		8.0	—	2.6～10	0～8.8	0～130	5.2
鉄分〔ppm〕		0～0.3	0.2～0.8	0～0.5	0～0.7	0～2.8	0～0.9
塩素イオン〔ppm〕		0～7.7	1.3	0～14.4	0～16.4	6.4～12,500	17,200～18,600
硫酸イオン〔ppm〕		—	—	4～19.2	0～6.0	2.4～6.1	2,350～6,000

2.2　日本のパルプ・紙・紙加工品製造業の工業用水に対する要望標準水質

用途別	濁度（度）	pH	アルカリ度（$CaCO_3$）	硬度（$CaCO_3$）	蒸発残留物	塩素イオン（Cl^-）	鉄（Fe）	マンガン（Mn）
冷却用	10	7.5	50	100	150	30	0.05	0.02
洗浄用	5	7.5	30	30	100	10	0.05	0.02
原料用	5	7	50	80	80	30	0.05	0.02
温湿調整用	2	7	50	50	100	10	0.05	0.02
製品処理用	5	7.5	40	50	100	50	0.05	0.02

注）濁度、pHを除きいずれもppm。

2.3　日本のある製鉄所の用水水質管理基準

水種＼項目	pH	濁度 (ppm)	SS (ppm)	全硬度 (ppm)	Ca硬度 (ppm)	全鉄 (ppm)	塩素イオン (ppm)	燐酸イオン (ppm)	シリカ (ppm)	導電率 (μS/cm)	油脂 (ppm)	備考
市工水	6.0～8.6	16＞	18＞	100＞		2＞	50＞					市基準
市工水	6.5～8.6	10＞	10＞	90＞			30＞		25＞			市基準
高炉間接送水	7.0～8.6	20＞	10＞	100＞	70＞	2＞	30＞			300＞		
高炉集塵送水	8.0～8.6		50＞									
化工間接送水	7.5～8.5	20＞	10＞	120＞	80＞	2＞	20＞		100＞	600＞		
焼結間接送水	7.0～8.4	20＞	10＞	150＞	100＞	2＞	30＞			400＞		
転炉OGフード送水	8.0～9.0	10＞	5＞	35＞	25＞	1＞	50＞	1＞	150＞	900＞		
転炉間接送水	7.0～8.4	20＞	10＞	100＞	70＞	2＞	30＞			300＞		
転炉集塵送水	9.0～12.0		30＞									
電気炉間接送水	7.0～8.4	20＞	10＞	120＞	80＞	2＞	30＞			400＞		
連鋳モールド送水	7.0～8.4	20＞	10＞	100＞	70＞	2＞	30＞			300＞	1＞	
連鋳スプレー送水	7.0～8.6	5＞	3＞	150＞	100＞	1＞	100＞			600＞		
圧延間接送水	7.0～8.4	20＞	10＞	150＞	100＞	2＞	100＞			600＞		対象工場　分塊・厚板・熱延
圧延直接送水	7.0～8.4		30＞							1000＞	5＞	〃
動力一般送水	7.0～8.4	20＞	10＞	150＞	100＞	2＞	30＞			400＞		対象設備　高炉送風機・空気圧縮機
ボイラ用水	7.0～8.0	5＞	1＞	Tr		Tr						対象設備　CDQ・焼結・熱延の各ボイラ

2.4 Factory Act, B.E. 2512 (1969), An Extract

Section 4. This Act shall not apply to factories owned by the State or governmental organisations and operated by the State or governmental organisations.

Section 5. In this Act:

"Factory" means a building, place or vehicle using machines, the output of which is more than 2 H.P. or is equivalent thereto, or employing seven or more workers whether or not using machines for making, producing, assembling, canning, repairing, maintaining, testing, modifying transforming or destroying any matters. However, it is in accordance with the category and kind of factories specified in the Ministerial Regulations.

"Machine" means an object, of several components, used for creating energy, changing or converting energy, or transmitting power, whether by means of water pressure, steam, fuel, air, gas, electricity or other forms of energy, either separately or collectively, and to include accessories, fly-wheel, pully, fan belt, axle, gear or other conjunctive parts.

"Worker" means a person working in a factory but does not include a person who does an administrative work.

"Official" means a person appointed by the Minister for carrying out this Act.

2.5 Notification of Ministry of Industry No. 13 (B.E. 2525) issued in accordance with the Factory Act B.E. 2512

Subject: Duty of Licensees to operate industrial plants

GOVERNMENT GAZETTE Volume 99 Part 89 dated June 29, 1982: — By virtue of Section 39 (16) of the Factory Act B.E. 2512, the Minister of Industry hereby announces the principles and procedures to be followed by the licensees to operate industrial plants:

1. The following industrial plants must have the supervisors and machine operators to take responsibility of the system of prevention of polution, whose qualifications are specified in 2.

   1.1 An industrial plant discharging waste water at higher than 60 cubic meters/hour (with the exception of cooled water), or having the BOD load of influent at higher than 100 kilogram /day.

   1.2 An industrial plant using heavy metals in the production process discharging waste water at higher than 50 cubic meters/ day, and having the content of heavy metals in the discharged waste water at the following values:

      1.2.1 Zinc at higher than 250,000 milligrams/day
      1.2.2 Chromium at higher than 25,000 milligrams/day
      1.2.3 Arsenic at higher than 12,500 milligrams/day
      1.2.4 Copper at higher than 50,000 milligrams/day
      1.2.5 Mercury at higher than 250 milligrams/day
      1.2.6 Cadmium at higher than 1,500 milligrams/day
      1.2.7 Barium at higher than 50,000 milligrams/day
      1.2.8 Selenium at higher than 1,000 milligrams/day
      1.2.9 Lead at higher than 10,000 milligrams/day
      1.2.10 Nickel at higher than 10,000 milligrams/day
      1.2.11 Manganese at higher than 250,000 milligrams/day

   1.3 An industrial plant dealing with iron and steel:

      1.3.1 Using drying furnace or acids or other substances which may be poluting the environment in the production process, with production capacity of higher than 100 tons/day;

1.3.2 Using steel smelters with the total capacity of 5 tons/batch.

1.4 An industrial plant producing petrochemicals from the raw materials obtained as by-products of the oil refinery in the production process at higher than 100 tons/day.

1.5 An industrial plant of any size separating or processing the natural gas.

1.6 An industrial plant producing chlor-alkali, using sodium chloride (NaCl) as raw material in the production of soda ash (Na_2CO_3), caustic soda (NaOH), hydrochloric acid (HCl), chlorine (Cl_2) and bleaching (NaOCl) each or several combined at higher than 100 tons/day.

1.7 An industrial plant of any size producing cement.

1.8 An industrial plant engaged in ore smelting or production of metals at higher than 50 tons/day.

1.9 An industrial plant producing paper pulp at higher than 50 tons/day.

1.10 An industrial plant of any size engaged in crude oil refinery.

2. The supervisors, machine operators responsible for the system of prevention of pollution, shall meet the following qualifications:

2.1 The supervisors are holders of bachelor degree in engineering, or science with experiences in the field of environment, who are approved by the Industrial Works Department. For an engineering consultant firm, it must have the service of qualified persons as indicated earlier.

2.2 The machine operators must be graduates of the secondary education, lower level, with the certification from the persons as mentioned in 2.1.

2.3 The persons stated in 2.1 and 2.2 must register themselves with the Industrial Works Department, and complying with the regulations and procedures as prescribed by the Industrial Work Department.

2.6 Notification of Ministry of Industry No. 15 (B.E. 2527) issue in accordance with the Factory Act B.E. 2512

Subject : Duty of Licensees to operate industrial plants

By virtue of Section 39(16) of the Factory Act B.E. 2512, the Minister of Industry hereby announces the principles and procedures to be followed by the licensees to operate industrial plants

1. The licensees to operate the following industrial plants must take response to do as specified in 2.

1.1 An industrial plant producing pulp at higher than 50 tons/day

1.2 An industrial plant producing chemical except fertilizer as follows :

1.2.1 Chlor-alkali plant, using Sodium Chloride (NaCl) as raw material for the production of Soda Ash ($Na_2 CO_3$), Caustic Soda (NaOH), Hydrochloric Acid (HCl), Chlorine (Cl_2), Sodium Hydrochlorite (NaOCl) and Bleaching Powder each or several combined at higher than 100 tons/day.

1.2.2 An industrial plant producing petrochemicals from the raw materials obtained as by products of the Oil Refinery in the production process at higher than 100 tons/day.

1.3 An industrial plant of any size engaged in crude oil refinery.

1.4 An industrial plant of any size producing cement.

1.5 An industrial plant producing iron and steel, using iron ores or scrap iron as raw material with production capacity higher than 100 tons/day or using melting furnace with the total capacity of 5 tons/batch.

1.6 An industrial plant engaged in are smelting or production of metals at higher than 50 tons/day.

2.7 Implementation of Ground Water Act, (B. E. 2520)

Groundwater Act

The original Groundwater Act was named the Groundwater Act B.E. 2520* which has been enforcing since 1977 until now. The principle of the Groundwater Act is government control of groundwater activities. This includes drilling for groundwater and its use as well as disposal of wastewater through wells. Under the provisions of the Act, no one may utilize groundwater from designated "groundwater areas" without an official permit.

The Act is comprised of 8 sections which deal with the definition of terms and general informations, the constitution of groundwater committee, the application for and cancellation of permits, the duties of permit holders, the authority of officials, the amendment and revoke of permits, the penalties for violations and the temporary enforcement.

The Minister of Industry has responsibility for the Act. He may issue directives on drilling, cancellation of drilling, conservation of groundwater, disposal of liquids into the aquifers through wells, and protection of public health and environment.

The Act will not be immediately enforced in all region of the country, it will be implemented in specific areas where groundwater resources are indicated critical with respect to water quality or overexploitation. In doing so, the Minister may issue a directive designating the region of concern as a "Groundwater Area". Groundwater in this area is defined as one occurring in layers of earth or rocks at depths indicated in the ministerial regulations. Under provisions of the Act, it will still possible to utilize groundwater outside the Groundwater Area or even within the area if permission is obtained.

The chief executive administering the Act is the Director-General of the Department of Mineral Resources, Ministry of Industry. The Director-General has a mandate to issue, amend or revoke all permits. He shall appoint Groundwater Area Officials to process applications for permits, permit renewal, appeals, and registration of wells which existed prior to the Act. Personnel shall also be appointed for on-site inspection. They will have power to give written instruction to

a permit holder to refrain from or correct activities which may cause damages to the groundwater resources. Although the permit holder has the right to appeal, he must abide by the order until a decision is made by the Minister on the matter.

The Act also requires that there be a Groundwater Committee to advise the Minister in establishing regulations and in making recommendations to the Director-General. The Committee is to be chaired by the Director-General of the Department of Mineral Resources. Other members include administrative personnel from the Public Works Department, the Royal Irrigation Department, the Public Health Department, the Metropolitan Water Works Authority and three experts appointed by the Minister.

Three kinds of permits are designated, they may be issued for one year for drilling purpose, for five years to facilitate disposal of liquids into the aquifers through wells, and for ten years for groundwater use. All may be renewed. Permits for drilling and groundwater use are not required for government organizations which have responsibility to provide water for agricultural or non-industrial purposes. However, these government organizations are not exempt from ministerial regulations concerned with drilling, well development or abandonment, controlled extraction of groundwater, public health or environmental protection.

Implementation of the Act

The Minister issued directives on technical principles involving groundwater use as follows:

1. Bangkok and five adjoining provinces were designated as the Bangkok Groundwater Area, (see fig.1). Groundwater occurring at depths exceeding 15 meters below ground surface in this area is subject to administration under the Act.

2. Specifications for drilling and construction of wells provided under the Act. Standard forms for daily drilling reports, well records and other informations were prescribed.

3. Methods of groundwater extraction and conservation were outlined.

4. Technical measures to protect groundwater from pollution were described and drinking water standards issued.

5. Technical principles were given for disposal or injection of water or liquids into the aquifers through wells.

6. Pricing of water use rate by any methods not more than one Baht per cubic meter of water, and discount rate or exemption for particular holders of permit for use of groundwater in particular groundwater areas are under consideration.

Violations of the Act or of the ministerial directives are to be punished by a fine which may range from 500 to 20,000 Baht (US $1.00 is approximately equivalent to 22.50 Baht) depending on the nature of violation. .Severe punisment is reserved for those engaged in groundwater activities without a permit. The penalty is imprisonment not exceeding six months or a fine not exceeding 20,000 Baht, or both. Equipment, tools or machinery used in carrying out the violation may also be confiscated.

Under the ministerial regulations, orders and rules were made by the Director-General of the Department of Mineral Resources to certify private drillers or contractors and to direct the authorized personnel. Critiria for issuing permits are also created by the Groundwater Committee. The most significant criterion for issuing the groundwater drilling permit is the site where groundwater to be drilled should be situated beyond a certain distance from the nearest public water distributing pipeline and no any other source of suitable surface water available, e.g., 200 meters for a household and 300 meters for a factory. Moreover, the well is specified with size and depth in order to control the pump capacity and to allocate water from each aquifer respectively.

2.8 NOTIFICATION OF MINISTRY OF INDUSTRY No. 7 (B.E. 2528)

Issued under the Deep Well Act, B.E. 2520
Re: Prescribing principles and technical measures for conservative use of deep well water.

By virtue of Section 6 (1) of the Deep Well Act, B.E. 2520, the Minister of Industry on advice of the Deep Well Commission, hereby issues a Notification prescribing principles and technical measures for conservative use of deep well water as follows:

Clause 1. The provision of Clause 2 of the Notification of Ministry of Industry No. 3 (B.E. 2521), issued under the Deep Well Act, B.E. 2520; Re: Prescribing principles and technical measures for conservative use of deep well water, shall be cancelled and replaced by the followings:

"Clause 2. Pumping of deep well water.

(1) All deep wells shall have water meter, except that the Commission shall specify to the contrary.

(2) In case the meter is installed, fill in the particular as prescribed by the authority for the use of deep well according to the form specified by the Mineral Resources Department, and submit it to the Local Deep Well Official within the 7th of the following month.

(3) The deep well having diameter from 200 mm. upwards shall have the diameter of the top of the well no less than 25 mm., complete with cover so that the water level in the well could be inspected.

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(4) The level of water in the deep well must be measured and the result found shall be reported together with sample water collected from the well according to the method prescribed by the Mineral Resource Department, which shall be submitted to the Local Deep Well Official within 15 days from the date having been notified in writing by the Local Deep Well Official.

Clause 2. Add the following as Clause 3, Clause 4, Clause 5 and Clause 6 of the Notification of Ministry of Industry No. 3 (B.E. 2521), issued under the Deep Well Act, B.E. 2520; Re: Prescribing principles and technical measures for conservative use of deep well.

"Clause 3. Water meter

(1) The water meter installed at the deep well shall be magnetic type meter, which has been certified by the Ministry of Commerce and has been tested for accuracy by the institute approved by the Mineral Resources Department, and shall have the following features:

A. The accrued water consumed shall be in cubic meter.

B. The figure for measuring the volume of water at the dial can record no less than five figures discounting the decimal points and shall be in the same line.

C. There is no other button or mechanism for which the figure can be adjusted from outside.

Clause 4. Installation of water meter for the deep well.

3.1 Manual for Visiting Survey in the Study on Effective Use of Industrial Water in the Kingdom of Thailand

1. Main Point of the Study

This Study is conducted to collect information on actual status of water usage in factory in order to examine effective use of industrial water, and main point is to clarify how industrial water (including domestic water and non-potable water) is used.

For this purpose, it is necessary to understand production process first and to grasp completely status of water usage in connection with production process.

Items related to environment such as waste water treatment and waste water quality are closely connected with effective use of industrial water, but those items are not included in the main point of the Study. Therefore, it is advised not to make mistake in understanding the main point.

2. Preparation

2.1 Study on Answered Questionnaire

The following items in the answered questionnaire shall be studied:

(1) Production process, especially process where water is used;

(2) Quantity of water usage classified by source of water and purpose of water usage, and variation of water usage;

(3) Usage of recovered water (Does the recirculating process of water clearly described?);

(4) Is the water balance complete?;

(5) Layout of equipment that uses water;

(6) Location and diameter of water source (well, intake gate, service pipe of public water works and others).

2.2 Outlines and Problems related to Measures for Effective Use of Industrial Water

On the basis of the above study described in Clause 2.1, outlines of measures for effective use of industrial water, as well as problems related to measures shall be grasped.

(1) Possibility of adopting measures for effective use of product processing and washing water (adoption of multi-stage counter current washing process, recycling of waste water and other measures);

(2) Water quantity of one through process in indirect cooling system;

(3) Water quantity of one through process in air conditioning system;

(4) Relations between quantities of domestic water and non-potable water, and numbers of workers.

3. Visiting Survey

3.1 Hearing and Question

Survey team shall hear explanation of contents of answered questionnaire by factory staff.

Question by survey team shall aim to clarify unclear points in answered questionnaire, paying attention to the following items in addition to the items described in 2.1.

(1) In case water quantity is unknown, survey team shall collect such data as diameter of pipeline, specification of pump, capacity of cooling tower, capacity of refrigerator, capacity of compressor and others by which water quantity could be estimated.

(2) In the case of boiler feed water, recovery of drain shall be checked.

(3) Quality of material water, and influence of water quality to product quality.

(4) In case product processing and washing water, the followings shall be checked:

(a) Influence of water quality to product quality;

(b) Influence of decrease of water quantity to product quality;

(c) Waste flow of water (in such a case that water is supplied in spite of the process is not in operation.);

(5) As for indirect cooling water, the followings shall be checked;

(a) Shape of cooling equipment (heat exchanger, jacket, coil and others);

(b) Condition of cooled substance (air, liquid, solid and others) and its temperature;

(c) Temperatures of inlet and outlet, or raise of temperature;

(d) Necessity of using well water (requirements for temperature, quality and others).

(6) As for direct cooling water, pollution of discharged waste water shall be checked in addition to the above (5).

(7) As for air conditioning water, installed condition and capacity of cooling tower shall be checked.

(8) As for domestic and non-potable water, details of usage (water is supplied to neighboring houses as domestic water, for example) shall be checked.

3.2 Site Observation

In order to grasp the whole production process, it is preferable to check from the first process to the final process. It is also advised that survey team endeavors to understand production process as much as possible, not adhering to water usage.

Survey team shall pay special attention to the followings:

(1) It is preferable to confirm, at the site, route of water flow, diameter of pipeline, specifications of pump and other equipment, and so forth, even if informations on these items are answered.

(2) As for material water, survey team shall confirm that it is used only as material and that it does not include water for other use (washing and others).

(3) Product processing and washing water shall be checked carefully. Special attention shall be paid because unnecessary flow and/or meaningless overflow is applied in some cases.

Survey team must be careful because explanation by factory

staff and actual condition related to water usage of batch wise type, semi-continuous type and continuous type are occationally different.

(4) As for cooling water, the followings shall be checked:

(a) Temperatures at inlet and outlet, and temperature of cooled substance.

(b) Route of recycling water shall be confirmed in case recycling water (recovered water) is used.

(c) In case well water is used in one through process, problems to be occurred by recycled use of water.

(5) Operating condition of air washer, in air conditioning process.

(6) As for domestic water and non-potable water, it is all right to omit observation except water that is consumed for special uses.

(7) As for waste water treatment facility, use of non-potable water for treatment (defoaming water, deluting water, chemical dissolving water and other) shall be confirmed.

Waste water treatment itself and discharge condition of waste water shall be observed from standpoint of water re-use.

Site observation shall be conducted taking time as long as possible. If time is limited, however, the following items shall be observed:

(1) Facilities that consumes large quantity of water;

(2) Product processing and washing water;

(3) Direct cooling water.

3.3 Water Flow Measurement

Point of water flow measurement shall be carefully decided after completing observation of the whole factory.

The following points shall be studied as those of flow measurement:

(1) Point where total quantity of make-up water can be measured;

(2) Point where large quantity of water is used;

(3) Point where estimation of quantity of water use is completely impossible;

Measurement point and obtained data shall be carefully evaluated, and they shall be adopted only in case that their rationality in the total water balance is confirmed.

3.4 Water Quality Measurement

Sampling point and measurement items shall be carefully decided after completing observation of the whole factory. Main sampling points and measurement items are as follows:

(1) Well water -- temperature, pH and electric conductivity

(2) Make-up water other than well water -- temperature, pH and electric conductivity;

(3) Waste water from product processing and washing (for re-use) -- pH, turbidity, electric conductivity and COD;

(4) Recycling water for cooling and air-conditioning -- temperature and electric conductivity;

(5) Recycling water and re-used water other than above -- measurement items shall be decided in accordance with condition.

Quality measurement of waste water (before treatment and after treatment) shall be conducted only when it is necessary for measures for effective use of industrial water such as water re-use, and shall be conducted after obtaining complete concent of the factory side.

4. Others

(1) Items and figures filled in the answered questionnaire shall be reconfirmed as much as possible. Especially, special attention shall be paid to the usage of recovered water and the recycling route because wrong data on these items are often filled in.

(2) As for the factory which owns independent water source other than well and public water works (for example, the rights to river water and others), details of its water source and possibility of stable water intake in the future shall be confirmed.

(3) Layout drawing of the factory is very useful, even if it is uncomplete. In case survey team cannot receive drawing itself, be sure to make a sketch of drawing.

(4) As brochure, catalog of product and other publications of the factory are useful to understand production process, be sure collect as many as possible.

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3.2　水使用の原単位について

この報告書では記述できなかったが、調査期間中に質問の多かった、工業用水の水使用原単位と、生活用水１人１日当たり水使用量、さらに水道料金について、ここに記する。

(1)　工業用水の水使用原単位について

一般に、工業用水の将来の需要量を想定することなどに用いられる水使用原単位というのは、①その工場（工業）の出荷額当たり、②その工場（工業）の従業員１人当たり、③その工場（工業）の敷地面積当たりの原単位であるが、一般によく用いられるのは①である。

ある工場で、ある一定の出荷額を得るために必要となる工業用水の使用量を、その工場の年間出荷額で割って得られた数値を工業用水使用原単位と言っている。類似の工場、例えば繊維工場で得られた数値を平均して、その国の繊維工業の原単位としている。当然、この数値は、各工場の生産プロセス、生産設備の仕様、労働時間、その地域の水の事情などによって変動があり、決してある一定の値にはならないが、たくさんのデータを集めることによって、その数値にある意義をもたせることもでできる。一般によく利用されるのは、将来の水需要の想定に対してであるが、この原単位に採用されているのが生産量（物量）ではなく、生産額（金額）である点は注意を要する。例えば、紙１トンを生産するのに必要な用水量がほぼ一定であっても、生産される紙が高級化していくと出荷額は増大し、従って原単位は低下することになるので、同じ産業の中で、原単位が低くなっていると、一般的傾向として製品の高級化、高付加価値化が進んでいると見ることもできる。

先にも述べたように、出荷額（金額）による原単位では、経済動向などに大きく影響を受けるので、水使用合理化といった短期の業務に利用する時には、その工場の長期の原単位変動といったデータがないと、仲々判断がむつかしく、従って将来想定といったものに用いられることが多い。例えば、事業認可申請に対するチェックリストとしても利用できるであろう。各産業ではこれを別個に、その産業の代表的生産品目、例えば、一貫製鉄業の場合は、粗鋼生産トン数によりデータを集積している場合が大部分である。石油精製工場では、処理バーレル当たりの水使用量といったように、各産業でそれぞれ利用し易いデータを集積しているが、これを全産業に亘り集積するためには、共通の指標として出荷額を採らざるを得なかったという事情があ

るので、各産業の代表製品当たりの原単位も集積し、それで修正を加えていくということも必要である。

また、日本では、一日当たり使用水量（m^3／日）を年間出荷額（億円／年）で割って出荷額原単位とみているが、他の国では、年間使用水量を年間出荷額で割って示しているところもあるので、原単位に用いられている単位には注意が必要である。

参考のために、タイ国東部で行なわれている東部臨海地域開発計画での水需要推定の計算式は、表1の如く行なわれている。工業用水の需要量は従業員1人当りの原単位によっている。港湾用水の方は労務者1人当りのものと、取扱い船荷トン当りの原単位によっている。そして、この場合の工業用水とは、工場の外から供給される水（いわゆる補給水)を見ようとしているので、回収水の比率という項目が入っている。また、漏水率も水源開発計画にも重要な項目で、日本の工業用水道では、給水区域が比較的に狭いこともあって、漏水率は7％以下となっている。この数値が大きくなると、実際に各工場が必要とする水量の合計に、漏水量を加わえたものが水資源開発水量となるので、注意しなければならない。

表1.　東部臨海地域開発計画の水需要推定

○　工業用水の需要量の推定

$$D_I = En \times Ucn \times (1 - Rn) \times 365 / (1 - Uw)$$

D_I ：工業用水需要量（m^3／年）

En ：従業員数（人）

Ucn：従業員1人当たり水消費量（m^3／日／人）

Rn ：回収水の比率

Uw ：漏水率

○　港湾用水需要量

$$D_p = [(W \times Ucw) \times 365 + (C_v \times Ucc)] / (1 - Uw)$$

D_p ：港湾用水需要量（m^3／年）

W　：港湾労働者数（人）

Ucw：労働者1人当たり水消費量（m^3／日／人）

Cv ：取扱い船荷量（10^6 ton／年）

Ucc：船荷1 ton当たり水消費量（m^3／ton／年）

Uw ：漏水率

(2) 調査対象工場の原単位

われわれがサムトプラカン地域で調査した５９の工場の原単位を求めてみる。表2及び表３は、それぞれ補給水ベースのものと、全使用水ベースで示してある。参考のために表４、表５に日本での実績を示した。ただ日本では、主として冷却用水として海水を使用する工場が多いので、１９８５年のところで、外数として（　　）で示してある。淡水と海水とを加えたものが実際の原単位ということになる。サムトプラカン地域の調査対象工場と日本の工場とでは、生産規模、生産品目などで相当の差異もあるし、使用水の水温でも違いがあるので、一概に原単位が大きい、小さいとは言えないが、参考にはなるのではなかろうか。表６には、日本での原単位の例として、敷地面積当たり、従業員１人当たりのものも示しておいた。

こうしたデータを見る時に、一般的傾向として、日本の産業構造は重化学工業、タイ国それも調査工場群では軽工業が大部分を占めるので、そうした点にも配慮すべきである。

日本だけでなく、諸外国にこうした原単位に関するデータがないかと探さくした結果、中国の北京（Beijing），天津（Tianjin）のデータが得られたので表７に北京の例を、表８に天津の例を示してみた。しかし、原単位というのは、前述したように、それぞれの国、地域、気象条件、産業構造などによって一概には示すことができないものであるから、サムトプラカン地区の工場で長期に亘たりデータを集積していって、その内から補給水量を減少させるための方策を探さくしていくようにしなければならない。

表 2 Water/Production Ratio of Surveyed Factories (Make-Up Water Base)

Code No.	Fact. No.	Make-up Water (m³/d)	Production Output (MB)	Total Area (m²)	No of Workers (Person)	(m³/year /10⁴ B)	(m³/d /100m²)	(m³/d /person)
F-01	170	1,200	400	12,100	700	10.95	0.99	1.71
F-02	103	1,065	–	48,000	450	–	2.22	2.37
F-03	135	178	200	5,500	100	3.25	3.24	1.78
F-04	130	100	–	56,000	214	–	0.18	0.47
F-05	127	654	–	27,200	465	–	2.40	1.41
F-06	114	1,998	670	33,600	400	5.98	3.27	2.75
F-07	110	163	48	13,000	130	12.39	1.25	1.25
F-08	109	665	–	16,400	1,000	–	4.05	0.67
F-09	91	300	–	24,000	150	–	1.25	2.00
F-10	78	54	–	–	45	–	–	1.20
F-11	65	37	0.6	3,600	75	225.08	1.03	0.49
F-12	48	323	350	64,000	214	3.37	0.50	1.51
F-13	43	1,120	459	44,800	880	8.91	2.50	1.27
F-14	21	68	3.5	2,000	15	70.91	3.40	4.53
P-01	145	1,245	60	10,000	65	75.74	12.45	19.15
P-02	124	1,230	–	30,000	330	–	4.10	3.73
P-03	107	2,958	–	4,800	249	–	61.63	11.88
P-04	84	13,260	1,100	80,000	900	44.00	16.58	14.73
P-05	39	152	–	81,600	323	–	0.19	0.47
T-01	146	10,384	–	144,000	4,530	–	7.21	2.29
T-02	197	166	–	19,200	100	–	0.86	1.66
T-03	203	1,885	–	6,400	180	–	29.45	10.47
T-04	193	26	3	3,200	50	31.63	0.81	0.52
T-05	200	180	–	12,800	76	–	1.41	2.37
T-06	198	442	–	6,400	76	–	6.91	5.82
T-07	189	549	120	4,800	300	16.70	11.44	1.83
M-01	61	504	544.5	45,108	507	3.38	1.12	0.99
M-02	96	1,192	1,200	9,600	684	3.63	12.42	1.74

Code No.	Fact. No	Make-up Water (m³/d)	Production Output (MB)	Total Area (m²)	No. of Workers (Person)	(m³/year /10⁴ B)	(m³/d 100m²)	(m³/d /person)
M-03	89	162	15	24,000	250	39.42	0.68	0.65
M-04	206	8	8	4,000	40	3.65	0.20	0.20
M-05	73	620	143.9	70,400	350	15.73	0.88	1.77
M-06	53	70	50	8,807	390	5.11	0.79	0.18
M-07	34	58	–	2,400	87	–	2.42	0.67
M-08	42	40	72	15,600	201	2.03	0.26	0.20
M-09	69	496	–	21,000	200	–	2.36	2.48
M-10	207	17	15	6,400	60	4.14	0.27	0.28
M-11	116	212	530	24,300	345	1.46	0.87	0.61
M-12	97	107	–	7,200	31	–	1.49	3.45
M-13	208	20	–	9,600	90	–	0.21	0.22
M-14	115	269	73.2	83,315	310	13.41	0.32	0.87
M-15	101	3,162	2,139	41,600	460	5.40	7.60	6.74
M-16	100	529	140	12,634	127	13.79	4.19	4.17
M-17	56	140	–	24,213	413	–	0.58	0.34
M-18	64	617	5,476	124,800	583	0.41	0.49	1.06
M-19	57	350	2,710	17,600	341	0.47	1.99	1.03
M-20	49	23	70	19,200	105	1.20	0.12	0.22
C-01	155	75	100	20,800	67	2.74	0.36	1.12
C-02	168	330	450	81,600	102	2.68	0.40	3.24
C-03	209	36	15	275	120	8.76	13.09	0.30
C-04	210	40	–	32,000	110	–	0.13	0.36
C-05	149	1,560	–	64,000	325	–	2.44	4.80
C-06	147	27	180	32,000	67	0.55	0.08	0.40
C-07	106	138	100	12,000	96	5.04	1.15	1.44
C-08	94	752	533	20,336	531	5.15	3.70	1.42
C-09	82	226	720	22,400	276	1.15	1.01	0.82
C-10	51	300	–	17,000	100	–	1.76	3.00
C-11	25	1,020	180	80,000	240	20.68	1.28	4.25
C-12	7	250	–	20,000	109	–	1.25	2.29
C-13	29	45	18.8	25,600	94	8.74	0.18	0.48

表3 Water/Production Ratio of Surveyed Factories (Total Water Base)

Code. No.	Fact. No.	Total Water (m³/d)	Production Output (MB)	Total Area (m²)	No. of Workers (Person)	(m³/year /10⁴ B)	(m³/d /100m²)	(m³/d /person)
F-01	170	1,740	400	12,100	700	15.88	14.38	2.49
F-02	103	5,065	–	48,000	450	–	10.55	11.26
F-03	135	850	200	5,500	100	15.51	15.45	8.50
F-04	130	100	–	56,000	214	–	0.18	0.47
F-05	127	5,451	–	27,200	465	–	20.04	11.72
F-06	114	5,618	670	33,600	400	30.61	16.72	14.05
F-07	110	5,923	48	13,000	130	450.34	45.56	45.56
F-08	109	14,825	–	16,400	1,000	–	90.40	14.83
F-09	91	3,865	–	24,000	150	–	16.10	25.77
F-10	78	714	–	–	45	–	–	15.87
F-11	65	41	0.6	3,600	75	249.42	1.14	0.55
F-12	48	346	350	64,000	214	3.61	0.54	1.62
F-13	43	1,720	459	49,800	880	13.68	3.84	1.95
F-14	21	68	3.5	2,000	15	70.91	3.40	4.53
P-01	145	1,845	60	10,000	65	112.24	18.45	28.38
P-02	124	3,430	–	30,000	330	–	11.43	10.39
P-03	107	6,307	–	4,800	249	–	131.40	25.33
P-04	84	18,060	1,100	80,000	900	59.93	22.58	20.07
P-05	39	212	–	81,600	323	–	0.26	0.66
T-01	146	63,873	–	144,000	4,530	–	44.36	14.10
T-02	197	166	–	19,200	100	–	0.86	1.66
T-03	203	1,925	–	6,400	180	–	30.08	10.69
T-04	193	26	3	3,200	50	31.63	0.81	0.52
T-05	200	unknoun	–	12,800	76	–	–	–
T-06	198	442	–	6,400	76	–	6.91	5.82
T-07	189	555	120	4,800	300	16.88	11.56	1.85
M-01	61	731	544.5	45,108	507	4.90	1.62	1.44
M-02	96	1,562	1,200	9,600	684	4.75	16.27	2.28

Code No.	Fact. No.	Total Water (m³/d)	Production Output (MB)	Total Area (m²)	No. of Workers (Person)	(m³/year /10⁴ B)	(m³/d 100m²)	(m³/d /person)
M-03	89	2,604	15	24,000	250	633.64	10.85	10.42
M-04	206	968	8	4,000	40	441.65	24.20	24.20
M-05	73	1,432	143.9	70,400	350	36.32	2.03	4.09
M-06	53	70	50	8,807	390	5.11	0.79	0.18
M-07	34	153	–	2,400	87	–	0.38	1.76
M-08	42	50	72	15,600	201	2.53	0.32	0.25
M-09	69	8,866	–	21,000	200	–	42.22	44.33
M-10	207	145	15	6,400	60	35.28	2.27	2.42
M-11	116	350	530	24,300	345	2.43	1.44	1.01
M-12	97	2,282	–	7,200	31	–	31.69	73.61
M-13	208	164	–	9,600	90	–	1.71	1.82
M-14	115	1,369	73.2	83,315	310	68.26	1.64	4.42
M-15	101	7,962	2,139	41,600	469	13.59	19.14	16.98
M-16	100	1,601	140	12,634	127	41.74	12.67	12.61
M-17	56	1,396	–	24,213	413	–	5.77	3.38
M-18	64	2,077	5,476	124,800	583	1.38	1.66	3.56
M-19	57	950	2,710	17,600	341	1.28	5.40	2.79
M-20	49	427	70	19,200	105	22.27	2.22	4.07
C-01	155	355	100	20,800	67	12.96	1.71	5.30
C-02	158	6,030	450	81,600	102	48.91	7.39	59.12
C-03	209	90	15	275	120	21.90	32.73	0.75
C-04	210	40	–	32,000	110	–	0.13	0.36
C-05	149	15,960	–	64,000	325	–	24.94	49.11
C-06	147	27	180	32,000	67	0.55	0.08	0.40
C-07	106	178	100	12,000	96	262.00	1.48	1.85
C-08	94	4,522	533	20,336	531	30.97	22.24	8.52
C-09	82	1,016	720	22,400	276	5.15	4.54	3.68
C-10	51	2,300	–	17,000	100	–	13.53	23.00
C-11	25	15,420	180	80,000	240	312.68	19.28	64.25
C-12	7	2,477	–	20,000	109	–	12.39	22.72
C-13	29	77	18.8	25,500	94	14.95	0.30	0.32

表4. 日本の業種別工業用水原単位（補給水原単位）の推移

（単位：$m^3/10^4$ B）

業種＼年	1973	1978	1985
食料品製造業	15.09	4.13	3.23 (1.66)
繊維工業	14.42	12.06	9.20
衣服・その他の繊維製品製造業	1.64	0.93	0.54
木材・木製品製造業	1.04	0.88	0.80 (0.02)
家具・装備品製造業	1.16	0.66	0.50
パルプ・紙・紙加工品製造業	33.68	32.08	27.29 (0.26)
出版・印刷・同関連産業	0.62	0.56	0.32
化学工業	13.65	9.98	7.87 (11.98)
石油製品・石炭製品製造業	1.33	1.13	1.19 (37.20)
ゴム製品製造業	4.00	2.82	1.97
なめしがわ・同製品・毛皮製造業	2.08	1.52	1.25
窯業・土石製品製造業	4.84	3.65	2.95 (5.78)
鉄鋼業	5.84	5.06	4.37 (16.50)
非鉄金属製造業	4.02	3.08	3.23 (5.31)
金属製品製造業	2.22	1.69	1.21 (0.002)
一般機械器具製造業	1.33	1.01	0.56 (0.15)
電気機械器具製造業	1.64	1.08	0.63
輸送用機械器具製造業	1.48	0.89	0.47 (0.06)
精密機械器具製造業	1.46	0.93	0.70
その他の製造業	3.23	2.53	0.64
合計	6.66	4.30	2.89 (3.16)

表5. 日本の業種別工業用水原単位（使用水量原単位）の推位

（単位：$m^3/10^4$ B）

業種＼年	1973	1978	1985
食料品製造業	16.12	6.18	5.07 (1.66)
繊維工業	15.45	15.09	11.61
衣服・その他の繊維製品製造業	1.76	0.94	0.56
木材・木製品製造業	1.08	0.95	0.94 (0.02)
家具・装備品製造業	1.21	0.68	0.53
パルプ・紙・紙加工品製造業	48.03	51.57	46.97 (0.26)
出版・印刷・同関連産業	1.02	1.07	0.58
化学工業	50.47	50.52	39.78 (11.98)
石油製品・石炭製品製造業	6.76	7.49	8.61 (37.20)
ゴム製品製造業	7.98	9.00	7.41
なめしがわ・同製品・毛皮製造業	2.15	1.62	1.32
窯業・土石製品製造業	9.54	9.69	10.34 (5.78)
鉄鋼業	34.51	43.66	42.83 (16.50)
非鉄金属製造業	12.93	11.66	10.89 (5.31)
金属製品製造業	2.54	2.19	2.37 (0.002)
一般機械器具製造業	1.78	2.12	1.50 (0.15)
電気機械器具製造業	2.40	2.78	1.97
輸送用機械器具製造業	6.66	7.08	5.47 (0.06)
精密機械器具製造業	1.76	1.17	1.12
その他の製造業	4.56	4.94	1.49
合計	15.86	15.24	11.33 (3.16)

：通商産業省「工業統計表ー用地用水編ー」

：(1)従業員30人以上の事業所について算定 (2)1973年、1978年の出荷額は1980年価格に修正する (3)1985年の（ ）内は海水使用によるものを外数として示してある。1973年、1978年は何れも淡水のみについて算定 (4)5円≒1Bとして換算す。

表6　日本の工業用水原単位の例（1985年）

（単位：m^3／日）

産業分類	淡水		海水	
	工場敷地面積（100m^2）	常用労働者（1人当り）	工場敷地面積（100m^2）	常用労働者（1人当り）
全製造業	10.40	19.16	2.90	5.34
食料品製造業	5.80	6.92	1.90	2.27
繊維工業（衣服・その他の繊維製品を除く。）	5.78	10.16	—	—
衣服・その他の繊維製品製造業	0.47	0.22	—	—
木材・木製品製造業（家具を除く）	0.33	1.08	0.01	0.02
家具・装備品製造業	0.30	0.52	—	—
パルプ・紙・紙加工品製造業	28.48	90.14	0.16	0.50
出版・印刷・同関連産業	2.46	0.75	—	—
化学工業	27.25	118.73	8.21	35.76
石油製品・石炭製品製造業	9.96	202.43	10.03	203.85
ゴム製品製造業	6.90	8.82	—	—
なめしかわ・同製品・毛皮製造業	1.58	1.11	—	—
窯業・土石製品製造業	3.11	12.37	1.74	6.91
鉄鋼業	20.74	114.87	7.99	44.24
非鉄金属製造業	6.88	26.67	3.35	13.00
金属製品製造業	1.72	2.91	—	—
一般機械器具製造業	1.45	2.15	0.15	0.22
電気機械器具製造業	3.88	2.71	—	—
輸送用機械器具製造業	7.74	12.54	0.08	0.13
精密機械器具製造業	1.76	1.18	—	—
武器製造業	0.06	1.02	—	—
その他の製造業	1.79	1.85	—	—

出典：通商産業省工業統計表（1985）

表 7. Industrial Water Use in Variaus Industrial Sectors in Beijing (1984)

Item / Sector	Make-up Water (10^6 m³/year)	Production Value (10^9 B/year)	Unit Water Usage (m³/10^4 B)
Metallurgy	100.56	19.75	50.9
Coking Plant	22.08	2.88	76.8
Chemical Industry	195.83	38.61	50.7
Construction Materials	45.47	6.62	68.9
Pulp & Paper	25.10	1.52	165.1
Mechanical Industry	106.04	59.12	17.9
Timber Industry	63.53	3.24	196.1
Food Industry	44.39	13.95	31.8
Textil	55.11	19.66	28.0
Sensing Factory	3.89	7.90	4.9
Leather Industry	3.71	2.77	13.4
Educatioral Products	16.33	9.93	16.4
Others	15.15	5.82	26.0
Total	697.19	191.74	36.4
Power Plant	296.49	5.25	564.5
Sum	993.68	196.99	50.4

Source : "Report on Water Resources Palicy and Management for tho Beijin-Tianjin Region of China"

Noto : Currency Translation Yuan≒35¥ Baht≒5¥

表 8. Industrial Water Use in Variaus Industrial Sectors in Tianjin (1984)

ITEM / SECTOR	Number of Enterprises	Make-up Water (10^6 m³/yaer)			Make-up Water Sub-total	Water Reused (10^6 m³/year)	Water Used (10^6 m³/year)	Recovery Rate (%)	Industrial Output (10^9 B/year)	Water Used /Output (m³/10^4 B)	Mare-up Water1/Output (m³ /10^4 B)
		River Water	Tap Water	Ground Water							
Total	4,289	63.0	116.0	243.0	422.0	1,120.0	1,540.0	72.7	175,700	87.6	24.0
Metallurqy	61	2.8	7.4	17.1	27.3	123.7	151.0	81.9	14,728	1025	18.5
Power	4	5.8	0.2	2.6	8.6	397.2	405.8	97.9	3,542	1,145.7	24.3
Petroleum	12	1.5	0.1	58.0	59.6	68.7	128.2	53.5	7,343	174.6	81.2
Chemicav	413	18.4	20.2	80.6	119.1	267.9	387.1	69.2	26,579	145.6	44.8
Machinery	1,454	0.9	40.1	22.5	63.6	34.9	98.5	35.5	51,772	19.0	12.3
Building Materials	270	0.6	2.7	5.1	8.5	2.8	11.2	24.6	3,248	34.5	26.2
Forestry	100	—	1.1	0.8	1.9	0.60	2.5	22.7	1,428	17.5	13.3
Food	270	8.8	8.8	14.4	32.0	11.2	43.1	25.9	12,803	33.7	25.0
Textile	319	2.4	17.4	29.2	49.1	182.2	231.3	78.8	33,159	60.8	14.8
Garment	458	—	1.0	0.05	1.0	0.02	1.1	1.6	5,530	2.0	1.8
Leather	130	0	0.6	1.2	1.8	0.1	1.9	5.3	2,030	9.4	8.9
Pwp and Paper	36	21.5	6.7	7.5	35.6	25.0	60.7	41.3	2,506	242.2	142.1
Culture Education	286	—	3.7	1.2	4.9	0.3	5.1	5.4	5,019	10.2	9.8
Others	476	0.2	5.5	2.9	8.6	5.7	14.3	39.9	6,356	22.5	13.5

Source: "Reparton Water Resources Policy and Management for the Beijin — Tianjin Region of China"

Note: Curvency Translation Yuan ≒ 35¥en, Baht ≒ 5 ¥en.

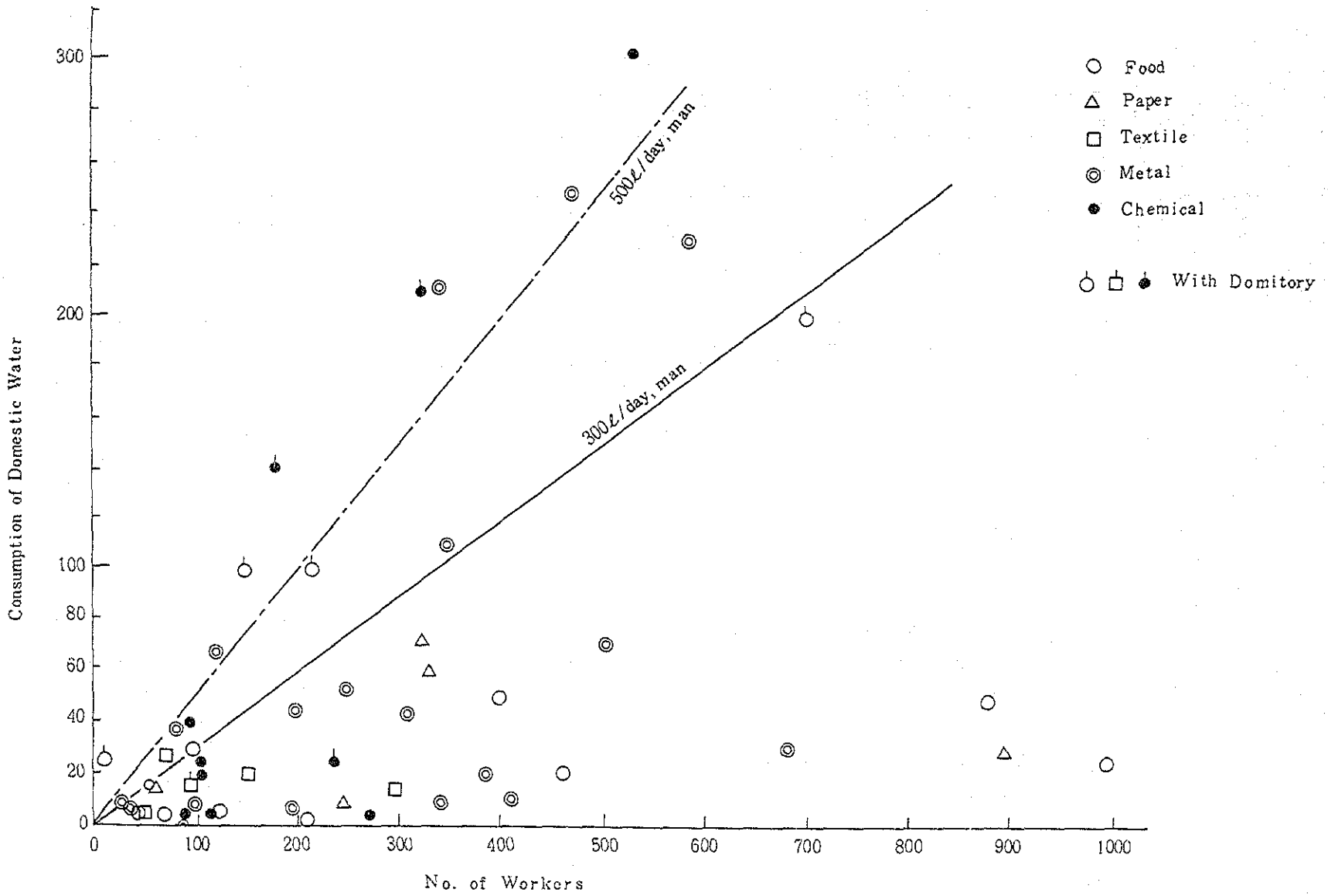
Consumption of Domestic Water
No. of Workers
500ℓ/day, man
300ℓ/day, man
Food
Paper
Textile
Metal
Chemical
With Domitory
0
20
40
60
80
100
200
300
400
500
600
700
800
900
1000

図 1 生活用水の使用量

表9. 世界主要都市における水道用水の原単位

国名	都市名	1人1日使用水量(ℓ)		年次
		平均	最大	
イギリス	テームズ水政庁	257	—	1976
〃	セバン・トロント水政庁	—	289	1981
キプロス	ニコシア	117	158	1977
フランス	リヨン	311	400	〃
〃	パリ	315	—	1976
スイス	チューリッヒ	303	399	1981
〃	ジュネーブ	523	765	1980
オーストリア	ウィーン	301	406	1977
オランダ	アムステルダム	205	269	1978
ドイツ	デュッセルドルフ	321	480	1977
〃	フランクフルト	262	324	1980
〃	ハンブルグ	221	303	1980
ポルトガル	リスボン	196	256	1979
スペイン	バルセロナ	246	294	1980
イタリア	トリノ	376	420	1980
デンマーク	コペンハーゲン	265	360	1980
フィンランド	ヘルシンキ	401	504	1981
ノルウェー	オスロ	655	818	1977
南ア連邦	ヨハネスブルグ	365	462	1981
チュニジア	チュニス	82	—	1977
オーストラリア	メルボルン	490	1,161	1980
タイ	バンコク	443	526	1981
シンガポール	シンガポール	302	—	1981
香港	香港	278	—	1981
アメリカ	ロスアンゼルス	693	1,166	1980
〃	サンフランシスコ	1,491	2,718	1979
〃	デンバー	956	2,025	1980
〃	ボストン	1,036	1,560	1978
〃	シカゴ	888	1,602	1980
〃	ホノルル	697	929	1980
カナダ	モントリオール	925	1,105	1981
ベネズエラ	カラカス	476	494	1978
日本	東京	447	556	1981
〃	大阪	566	753	1981

(注) 使用水量は給水量ベース

資料：日本水道協会「海外主要都市における水道事業の現状について－アンケート調査－1982」による。

(3) 生活用水使用量の検討

われわれが調査した５９工場の生活用水を検討した図は既に図３・７に示してあるが、再掲すると図１のようである。この図に示されるように、従業員１人当たりの１日水使用量という原単位でプロットすると工場によってバラツキが大きいことがわかる。大部分は３００ℓ／人・日 以下にあるが、調査工場の約 ２０％はそれ以上、なかには５００ℓ／人・日 を超えるものがある。こうした水使用原単位について検討してみる。

日本の水道協会（ Japanese Water Works Association ）が１９８２年、各国にアンケート調査した結果が表９に示してある。この調査によると１９８１年、バンコクの原単位は平均で４４３ℓ／人・日，最大で５２６ℓ／人・日となっているが、 １９８１年というと、ＭＷＡの給水は表流水によるサムセンとトンブリ浄水場にさらにバンケン浄水場のStage1,Phase 1が始まった時期で、地下水もまだ相当量利用していた時期である。その当時のＭＷＡの料金体系は未調査であるが、仮に現在のそれと変わらないとすれば、後で述べるように、５００ℓ／人・日 の水使用量であれば、家庭での消費支出に占める水道料金の割合が大きく、個人的負担に耐えられないのではないかと考える。また、飲料水としては、大部分が瓶詰の飲料水によっている現況をふまえて考えると、表９のバンコクの数値は、民間企業の地下水利用の一例ではないかと推考する。

また、ＭＷＡによる給水とすると、漏水率 ４０％と考えると、実際の使用者ベースの水量は、平均で４４３×（１－0.4）＝２２６ℓ／人・日、最大で５２６×（１－0.4）＝３１６ℓ／人・日となり、大体３００ℓ／人・日 となる。しかし家庭での水道料金の負担としては大きいことに変わりはない。

日本の場合は、表９にも東京、大阪が示されているが、全国ベースで、しかも有効水量といって、実際の使用者の使用水量で示したのが表１０である。日本とバンコクでは、気象条件などいろいろの条件の差異があって、例えば、洗たく用水、水浴び用水などでバンコクの方が大きくなる要素もあるので、日本の数値をそのまま比較することには注意を要するが、バンコクで水道の普及が進むと、この原単位は、料金のことから考えても低下していくであろうと思われる。

タイ国で進められている東部臨海地域開発計画では、２００１年の人口推定 1,３８４,０００ 人に対する水需要量は、９１.５×10^6 m^3／年と言われているので、１人１日当たり水使用量を計算すると１８１ℓ／人・日 となり、ここらあたりがよい数字ではなかろ

表１０　日本における上水道の１人１日平均給水量（有効水量ベース）

（ℓ／人・日）

給水人口（万人）＼年度	1975	1980	1982	1983	1984	1985	1975～1985年平均伸び率（%）
100　以上	355	345	349	353	356	354	0.0
50 ～ 100　未満	314	325	344	348	349	347	1.0
25 ～ 50　〃	311	309	318	327	332	332	0.7
10 ～ 25　〃	292	289	296	306	317	318	0.9
5 ～ 10　〃	289	288	297	309	316	316	0.9
3 ～ 5　〃	264	278	284	294	301	302	1.4
2 ～ 3　〃	248	254	263	273	283	282	1.3
1 ～ 2　〃	231	244	254	266	275	280	19
0.5 ～ 1　〃	212	235	247	255	266	266	2.3

資料：厚生省「水道統計」から作成した。

うか。もっとも、水浴び用、洗たく用には、料金のかかる水道水を使わず、井戸を掘って地下水によるとも考えられるので、実際の水使用原単位は、もっと大きな数値になるかもしれない。従つて、サムトプラカン地区の調査工場の工業用水のなかには、こうした生活用水の水も含まれているので、特に水使用原単位が５００ℓ／人・日 を超える工場について、今後の追跡調査に待たねばならない。

予想される原単位が大きな原因ならびに対応策は次のようなものではなかろうか。

a．今まで水に恵まれた環境に育った住民、特に従業員ならびに家族に節水意識をうえつけるということは仲々難しいことであろうが、地域全般の地盤沈下という障害防止のため指導力を強める。

b．工場の労務対策の一つとして、地下水による個人の生活用水を無料で供給しているのではなかろうか。無料であると節水意識を高めることは難しい。

c．工場での給水量は、井戸に流量計があるのみで、他は管径などによる推定値である。従って、工場内での漏水等の損失量の把握が難しく、水収支をとる場合に生活用水にそうした損失量をしわよせしているので、大きな数値となっているのではな

かろうか。

d．従業員宿舎以外にも給水されるものを明らかにしなければならない。散水、隣接地での工事用水なども量的に明らかにする必要がある。

(4) 用水の料金について

水道料金については第２章の 2.8 に述べたが、もう少し、家庭用の用水料金と、工業用水の価格について述べてみる。

日本の水道料金が各家庭の消費支出額に対してどのような割合いを占めるかを見たのが表１１である。水道使用に支払った支出が大体、消費支出の 1.0 %であることが分る。同じような計算をしてみるためタイ国における資料を探した結果、表12 及び表13 が得られたが、資料が少し古いので類推を加えて検討せざるを得なかった。

表１１　日本の家庭で、１カ月平均の消費支出総額に占める水道料金

項目＼年度	1975	1979	1980	1981	1982	1983	1984
消費支出総額(B)	32,095	43,816	46,989	48,901	51,532	52,775	54,196
水道料金(B)	150	307	330	378	448	475	539
構成比(%)	0.5	0.7	0.7	0.8	0.9	0.9	1.0

資料：総理府統計局家計調査年報（人口５万人以上の都市の世帯を対象）

注：５¥　≒ 1 Bahtで換算。

先ず表１１と対比するためには表１３によることとし、バンコク首都圏での数字を参考にすることとした。そして１９７５／７６当時の支出合計3,３２３B／月が現在ではおよそ２倍になっているとして 6,６４６B／月と類推した。１人１日当りの水消費量が２００ℓ であるとすると、家族構成5.6 人として、２００ℓ／人・日×5.6×３０日＝３３.6 m^3／月。この量に基づいて表2.２６からＭＷＡの民生用料金を調べると 4.３０B／m^3となっている。従って月当りにすると、4.３０B／m^3×３３.6m^3／月＝１４４.４８B／月となる。この支出が、その家庭の月当りの消費支出に対し、どの程度になるのかを見ると、１４４.４８／6,６４６×１００＝2.2% となり、日本の場合より大きな負担割合いとなっている。

仮定を設けて計算しているので、こうした割合いも多少変動があることとは思うが、

表12　タイ国の年度別家計収入明細

単位：バーツ（家族当り）

収入項目	全国			首都圏			東北部			東部			中央部			南部		
	1962／63	1968／69	1975／76	1962／63	1968／69	1975／76	1962／63	1968／69	1975／76	1962／63	1968／69	1975／76	1962／63	1968／69	1975／76	1962／63	1968／69	1975／76
収入合計／月	685	1,183	1,923	1,557	2,063	3,442	493	790	1,496	499	854	1,536	811	1,302	2,251	785	908	788
現金収入	553	997	1,426	1,519	1,965	3,012	316	528	902	372	695	1,066	702	1,137	1,753	661	775	1,384
給与所得	174	376	545	785	994	1,608	92	166	287	95	231	345	172	298	548	193	250	531
副収入	338	560	762	564	857	1,169	157	327	532	252	434	624	474	781	1,074	444	480	736
雑収入	41	61	119	170	114	235	67	35	83	25	30	97	56	58	131	24	45	117
現金以外の収入	132	186	502	38	98	430	177	262	594	127	159	470	109	165	498	124	133	44
平均家族人員数	5.5	5.7	5.5	5.5	6.2	5.6	5.9	6.0	5.9	5.3	5.6	5.0	5.6	5.6	5.2	5.3	5.3	5.2

資料：Report, Household Expenditure Survey 1962/63
Report, Socio-Economics Survey 1968/69 and 1975/76
throuhh National Statistical Offical.

表13. タイ国の年度別月別家計支出明細

単位：バーツ（家族当り）

支出項目	全国			首都圏			東北部			東部			中央部			南部		
	1962／63	1968／69	1975／76	1962／63	1968／69	1975／76	1962／63	1968／69	1975／76	1962／63	1968／69	1975／76	1962／63	1968／69	1975／76	1962／63	1968／69	1975／76
支出合計／月	723	916	2004	1476	1664	3323	549	540	1612	551	688	1592	834	998	2375	835	765	1913
飲食費	308	441	923	658	855	1345	241	254	813	223	330	773	347	498	1032	356	373	901
嗜好品	30	49	95	66	88	128	25	30	60	25	42	68	31	53	75	32	39	74
衣服費	108	96	203	131	128	249	89	69	188	92	94	158	132	98	261	118	85	190
家屋費	109	96	338	251	185	741	71	62	238	94	58	263	117	87	378	144	69	278
医療費	48	61	128	98	88	209	29	42	94	34	46	109	66	70	165	56	58	117
交通費	29	56	151	95	118	296	19	25	100	20	40	101	31	60	179	34	43	190
交際教養教育費	27	43	79	79	99	182	22	17	50	18	25	58	27	40	85	26	28	80
雑費	64	74	107	98	103	173	53	41	69	45	53	62	83	92	200	69	70	83
平均家族人員数	5.5	5.7	5.5	5.5	6.2	5.6	5.9	6.0	5.9	5.3	5.6	5.0	5.6	5.6	5.2	5.3	5.3	5.2

資料：Report, Household Expenditure Survey 1962/63

Report, Socio-Economics Survey 1968/69 and 1975/76

through National Statistical Office.

各家庭にとって負担が大きいとなれば当然、使用水量を減らしてくるであろう。1人1日当り使用水量を200ℓ でなく、半分の100ℓ と仮定すると、消費支出に占める負担割合いも大体1.0％ということになる。

各家庭の消費支出に、水の料金がどう影響しているかを見ることは、今後の水資源開発、特に地下水揚水抑制策と深くかかわりあっている問題なので、極めて重要な事項であると考えられる。

(3)でも言及したように、今回の調査工場のなかには生活用水の使用量が300～500ℓ／人・日という工場がある。これはMWAによる給水の範囲外の地域では、比較的安いコストで得られる地下水を使用しているので、水を使用する場合にコスト意識が薄いという事実が表われているのではないかと考えられる。もしそうであるならば、地下水にコスト意識をもたせるような指導が待たれるところである。

表9によると、バンコクにおける水道用水の原単位は最大520ℓ／人・日、平均443ℓ／人・日 となっているが、もしこの数字がMWAの給水実績とすれば大きすぎるように思える。仮に500ℓ／人・日 として前のような計算をしてみると、家庭での消費支出に占める水の支出が7.8％となり、とても負担できない数字となるのではなかろうか。

3.3 個別工場の工業用水使用量

Code No.	Fact. No.	Water Quantity Classified by Use and Source (m^3/d)							
F-01	170	Source / Use	Well Water	MWA	Others	Sub Total	Recycled Water	Total	Recovery Rate (%)
		Boiler	0	24	0	24	0	24	
		Material	0	2	0	2	0	2	
		Washing	635	0	231	866	0	866	
		Cooling	0	0	54	54	540	594	
		Air Cond.	0	0	0	0	0	0	
		Others	235	4	15	254	0	254	
		Total	870	30	300	1,200	540	1,740	31.0
F-02	103	Source / Use	Well Water	MWA	Others	Sub Total	Recycled Water	Total	Recovery Rate (%)
		Boiler	65	0	0	65	0	65	
		Material	0	0	0	0	0	0	
		Washing	470	0	0	470	0	470	
		Cooling	180	0	0	180	4,000	4,180	
		Air Cond.	0	0	0	0	0	0	
		Others	350	0	0	350	0	350	
		Total	1,065	0	0	1,065	4,000	5,065	78.9
F-03	135	Source / Use	Well Water	MWA	Others	Sub Total	Recycled Water	Total	Recovery Rate (%)
		Boiler	24	0	0	24	0	24	
		Material	5	0	0	5	0	5	
		Washing	78	0	0	78	0	78	
		Cooling	36	0	0	36	672	708	
		Air Cond.	0	0	0	0	0	0	
		Others	35	0	0	35	0	35	
		Total	178	0	0	178	672	850	79.1
F-04	130	Source / Use	Well Water	MWA	Others	Sub Total	Recycled Water	Total	Recovery Rate (%)
		Boiler	0	0	0	0	0	0	
		Material	5	0	0	5	0	5	
		Washing	93	0	0	93	0	93	
		Cooling	0	0	0	0	0	0	
		Air Cond.	0	0	0	0	0	0	
		Others	2	0	0	2	0	2	
		Total	100	0	0	100	0	100	0.0

Quantity of Consumed Water (Continued, 2/18)

Code No.	Fact. No.	Water Quantity Classified by Use and Source (m^3/d)							
F-05	127	Source / Use	Well Water	MWA	Others	Sub Total	Recycled Water	Total	Recovery Rate (%)
		Boiler	38	0	0	38	0	38	
		Material	20	0	0	20	0	20	
		Washing	492	0	0	492	0	492	
		Cooling	44	0	40	84	4,797	4,881	
		Air Cond.	0	0	0	0	0	0	
		Others	20	0	0	20	0	20	
		Total	614	0	40	654	4,797	5,451	88.9
F-06	114	Source / Use	Well Water	MWA	Others	Sub Total	Recycled Water	Total	Recovery Rate (%)
		Boiler	100	0	0	100	0	100	
		Material	52	0	0	52	0	52	
		Washing	206	0	0	206	40	246	
		Cooling	589	0	0	589	4,480	5,069	
		Air Cond.	0	0	0	0	0	0	
		Others	71	0	0	71	0	71	
		Outside	80	0	0	80	0	80	
		Total	1,098	0	0	1,098	4,520	5,618	81.6
F-07	110	Source / Use	Well Water	MWA	Others	Sub Total	Recycled Water	Total	Recovery Rate (%)
		Boiler	0	0	0	0	0	0	
		Material	0	0	0	0	0	0	
		Washing	100	0	0	100	0	100	
		Cooling	53	0	0	53	5,760	5,813	
		Air Cond.	0	0	0	0	0	0	
		Others	10	0	0	10	0	10	
		Total	163	0	0	163	5,760	5,923	97.2
F-08	109	Source / Use	Well Water	MWA	Others	Sub Total	Recycled Water	Total	Recovery Rate (%)
		Boiler	1	0	0	1	0	1	
		Material	9	0	0	9	0	9	
		Washing	420	0	0	420	0	420	
		Cooling	179	0	0	179	14,160	14,339	
		Air Cond.	0	0	0	0	0	0	
		Others	56	0	0	56	0	56	
		Total	665	0	0	665	14,160	14,825	95.5

Quantity of Consumed Water (Continued, 3/18)

Code No.	Fact. No.	Water Quantity Classified by Use and Source (m^3/d)							
F-09	91	Source / Use	Well Water	MWA	Others	Sub Total	Recycled Water	Total	Recovery Rate (%)
		Boiler	55	0	0	55	65	120	
		Material	0	0	0	0	0	0	
		Washing	20	0	0	20	0	20	
		Cooling	100	0	0	100	3,500	3,600	
		Air Cond.	0	0	0	0	0	0	
		Others	115	0	0	115	0	115	
		Outside	10	0	0	10	0	10	
		Total	300	0	0	300	3,565	3,865	92.5
F-10	78	Source / Use	Well Water	MWA	Others	Sub Total	Recycled Water	Total	Recovery Rate (%)
		Boiler	0	10	0	10	0	10	
		Material	0	0	0	0	0	0	
		Washing	0	30	0	30	0	30	
		Cooling	0	9	0	9	660	669	
		Air Cond.	0	0	0	0	0	0	
		Others	0	5	0	5	0	5	
		Total	0	54	0	54	660	714	92.4
F-11	65	Source / Use	Well Water	MWA	Others	Sub Total	Recycled Water	Total	Recovery Rate (%)
		Boiler	2	0	0	2	4	6	
		Material	6	0	0	6	0	6	
		Washing	5	0	0	5	0	5	
		Cooling	19	0	0	19	0	19	
		Air Cond.	0	0	0	0	0	0	
		Others	5	0	0	5	0	5	
		Total	37	0	0	37	4	41	9.8
F-12	48	Source / Use	Well Water	MWA	Others	Sub Total	Recycled Water	Total	Recovery Rate (%)
		Boiler	123	0	0	123	8	131	
		Material	10	0	0	10	0	10	
		Washing	18	0	0	18	0	18	
		Cooling	15	0	0	15	15	30	
		Air Cond.	0	0	0	0	0	0	
		Others	157	0	0	157	0	157	
		Total	323	0	0	323	23	346	11.7

Quantity of Consumed Water (Continued, 4/18)

Code No.	Fact. No.	Water Quantity Classified by Use and Source (m^3/d)							
F-13	43	Source / Use	Well Water	MWA	Others	Sub Total	Recycled Water	Total	Recovery Rate (%)
		Boiler	20	0	0	20	0	20	
		Material	0	0	0	0	0	0	
		Washing	940	0	0	940	0	940	
		Cooling	30	0	80	110	600	710	
		Air Cond.	0	0	0	0	0	0	
		Others	50	0	0	50	0	50	
		Total	1,040	0	80	1,120	600	1,720	34.9
F-14	21	Source / Use	Well Water	MWA	Others	Sub Total	Recycled Water	Total	Recovery Rate (%)
		Boiler	8	0	0	8	0	8	
		Material	4	0	0	4	0	4	
		Washing	31	0	0	31	0	31	
		Cooling	0	0	0	0	0	0	
		Air Cond.	0	0	0	0	0	0	
		Others	25	0	0	25	0	25	
		Total	68	0	0	68	0	68	0.0
Food Total		Source / Use	Well Water	MWA	Others	Sub Total	Recycled Water	Total	Recovery Rate (%)
		Boiler	436	34	0	470	77	547	14.1
		Material	111	2	0	113	0	113	0.0
		Washing	3,508	30	231	3,769	40	3,809	1.1
		Cooling	1,245	9	174	1,428	39,184	40,612	96.5
		Air Cond.	0	0	0	0	0	0	0.0
		Others	1,131	9	15	1,155	0	1,155	0.0
		Outside	90	0	0	90	0	90	0.0
		Total	6,521	84	420	7,025	39,301	46,326	84.8

Quantity of Consumed Water (Continued, 5/18)

Code No.	Fact. No.	Water Quantity Classified by Use and Source (m^3/d)							
P-01	145	Source / Use	Well Water	MWA	Others	Sub Total	Recycled Water	Total	Recovery Rate (%)
		Boiler	180	0	0	180	0	180	
		Material	0	0	0	0	0	0	
		Washing	1,050	0	0	1,050	600	1,650	
		Cooling	0	0	0	0	0	0	
		Air Cond.	0	0	0	0	0	0	
		Others	15	0	0	15	0	15	
		Total	1,245	0	0	1,245	600	1,845	32.5
P-02	124	Source / Use	Well Water	MWA	Others	Sub Total	Recycled Water	Total	Recovery Rate (%)
		Boiler	70	0	0	70	0	70	
		Material	0	0	0	0	0	0	
		Washing	1,100	0	0	1,100	2,200	3,300	
		Cooling	0	0	0	0	0	0	
		Air Cond.	0	0	0	0	0	0	
		Others	60	0	0	60	0	60	
		Total	1,230	0	0	1,230	2,200	3,430	64.1
P-03	107	Source / Use	Well Water	MWA	Others	Sub Total	Recycled Water	Total	Recovery Rate (%)
		Boiler	115	0	0	115	77	192	
		Material	0	0	0	0	0	0	
		Washing	2,833	0	0	2,833	3,272	6,105	
		Cooling	0	0	0	0	0	0	
		Air Cond.	0	0	0	0	0	0	
		Others	10	0	0	10	0	10	
		Total	2,958	0	0	2,958	3,349	6,307	53.1
P-04	84	Source / Use	Well Water	MWA	Others	Sub Total	Recycled Water	Total	Recovery Rate (%)
		Boiler	330	0	0	330	300	630	
		Material	0	0	0	0	0	0	
		Washing	11,000	0	1,900	12,900	4,500	17,400	
		Cooling	0	0	0	0	0	0	
		Air Cond.	0	0	0	0	0	0	
		Others	30	0	0	30	0	30	
		Total	11,360	0	1,900	13,260	4,800	18,060	26.6

Quantity of Consumed Water (Continued, 6/18)

Code No.	Fact. No.	Water Quantity Classified by Use and Source (m^3/d)							
P-05	39	Source / Use	Well Water	MWA	Others	Sub Total	Recycled Water	Total	Recovery Rate (%)
		Boiler	0	0	0	0	0	0	
		Material	0	0	0	0	0	0	
		Washing	26	0	0	26	0	26	
		Cooling	2	0	0	2	60	62	
		Air Cond.	0	0	0	0	0	0	
		Others	94	0	0	94	0	94	
		Outside	30	0	0	30	0	30	
		Total	152	0	0	152	60	212	33.0
Paper Total		Source / Use	Well Water	MWA	Others	Sub Total	Recycled Water	Total	Recovery Rate (%)
		Boiler	695	0	0	695	377	1,072	35.2
		Material	0	0	0	0	0	0	0.0
		Washing	16,009	0	1,900	17,909	10,572	28,481	37.1
		Cooling	2	0	0	2	60	62	96.8
		Air Cond.	0	0	0	0	0	0	0.0
		Others	209	0	0	209	0	209	0.0
		Outside	30	0	0	30	0	30	0.0
		Total	16,945	0	1,900	18,845	11,009	29,854	36.9

Quantity of Consumed Water (Continued, 7/18)

Code No.	Fact. No.	Water Quantity Classified by Use and Source (m^3/d)							
T-01	146	Source / Use	Well Water	MWA	Others	Sub Total	Recycled Water	Total	Recovery Rate (%)
		Boiler	720	0	0	720	0	720	
		Material	0	0	0	0	0	0	
		Washing	8,128	0	0	8,128	0	8,128	
		Cooling	0	0	0	0	0	0	
		Air Cond.	830	0	0	830	53,489	54,319	
		Others	706	0	0	706	0	706	
		Total	10,384	0	0	10,384	53,489	63,873	83.7
T-02	197	Source / Use	Well Water	MWA	Others	Sub Total	Recycled Water	Total	Recovery Rate (%)
		Boiler	0	32	0	32	0	32	
		Material	0	0	0	0	0	0	
		Washing	99	6	0	105	0	105	
		Cooling	14	0	0	14	0	14	
		Air Cond.	0	0	0	0	0	0	
		Others	0	15	0	15	0	15	
		Total	113	53	0	166	0	166	0.0
T-03	203	Source / Use	Well Water	MWA	Others	Sub Total	Recycled Water	Total	Recovery Rate (%)
		Boiler	50	0	0	50	40	90	
		Material	0	0	0	0	0	0	
		Washing	1,460	0	0	1,460	0	1,460	
		Cooling	150	0	0	150	0	150	
		Air Cond.	0	0	0	0	0	0	
		Others	205	0	0	205	0	205	
		Outside	20	0	0	20	0	20	
		Total	1,885	0	0	1,885	40	1,925	2.1
T-04	193	Source / Use	Well Water	MWA	Others	Sub Total	Recycled Water	Total	Recovery Rate (%)
		Boiler	5	0	0	5	0	5	
		Material	0	0	0	0	0	0	
		Washing	15	0	0	15	0	15	
		Cooling	0	0	0	0	0	0	
		Air Cond.	0	0	0	0	0	0	
		Others	5	1	0	6	0	6	
		Total	25	1	0	26	0	26	0.0

Quantity of Consumed Water (Continued, 8/18)

Code No.	Fact. No.	Water Quantity Classified by Use and Source (m^3/d)							
T-05	200	Source / Use	Well Water	MWA	Others	Sub Total	Recycled Water	Total	Recovery Rate (%)
		Boiler Material Washing Cooling Air Cond. Others	This factory does not operate normally and is now being under test run only. (155) assumed (25)						
		Total	Plan180			180		Unknown	Unknown
T-06	198	Source / Use	Well Water	MWA	Others	Sub Total	Recycled Water	Total	Recovery Rate (%)
		Boiler	62	0	0	62	0	62	
		Material	0	0	0	0	0	0	
		Washing	353	0	0	353	0	353	
		Cooling	0	0	0	0	0	0	
		Air Cond.	0	0	0	0	0	0	
		Others	27	0	0	27	0	27	
		Total	442	0	0	442	0	442	0.0
T-07	189	Source / Use	Well Water	MWA	Others	Sub Total	Recycled Water	Total	Recovery Rate (%)
		Boiler	21	0	0	21	0	21	
		Material	0	0	0	0	0	0	
		Washing	513	0	0	513	6	519	
		Cooling	0	0	0	0	0	0	
		Air Cond.	0	0	0	0	0	0	
		Others	15	0	0	15	0	15	
		Total	549	0	0	549	6	555	1.1
Textile Total		Source / Use	Well Water	MWA	Others	Sub Total	Recycled Water	Total	Recovery Rate (%)
		Boiler	858	32	0	890	40	930	43.0
		Material	0	0	0	0	0	0	0.0
		Washing	10,723	6	0	10,729	6	10,735	0.1
		Cooling	164	0	0	164	0	164	0.0
		Air Cond.	830	0	0	830	53,489	54,319	98.5
		Others	983	16	0	999	0	999	0.0
		Outside	20	0	0	20	0	20	0.0
		Total	13,578	54	0	13,632	53,535	67,167	79.7

Quantity of Consumed Water (Continued, 9/18)

Code No.	Fact. No.	Water Quantity Classified by Use and Source (m^3/d)							
M-01	61	Source / Use	Well Water	MWA	Others	Sub Total	Recycled Water	Total	Recovery Rate (%)
		Boiler	0	0	0	0	0	0	
		Material	0	0	0	0	0	0	
		Washing	245	0	0	245	0	245	
		Cooling	189	0	0	189	227	416	
		Air Cond.	0	0	0	0	0	0	
		Others	69	0	0	69	0	69	
		Total	503	0	0	503	227	730	31.1
M-02	96	Source / Use	Well Water	MWA	Others	Sub Total	Recycled Water	Total	Recovery Rate (%)
		Boiler	51	0	0	51	50	101	
		Material	0	0	0	0	0	0	
		Washing	70	0	0	70	0	70	
		Cooling	290	0	0	290	320	610	
		Air Cond.	0	0	0	0	0	0	
		Others	30	0	0	30	0	30	
		Outside	750	0	0	750	0	750	
		Total	1,191	0	0	1,191	370	1,561	45.6
M-03	89	Source / Use	Well Water	MWA	Others	Sub Total	Recycled Water	Total	Recovery Rate (%)
		Boiler	5	0	0	5	0	5	
		Material	0	0	0	0	0	0	
		Washing	18	0	0	18	1,417	1,435	
		Cooling	46	0	0	46	1,025	1,071	
		Air Cond.	0	0	0	0	0	0	
		Others	93	0	0	93	0	93	
		Total	162	0	0	162	2,442	2,604	93.8
M-04	206	Source / Use	Well Water	MWA	Others	Sub Total	Recycled Water	Total	Recovery Rate (%)
		Boiler	0	0	0	0	0	0	
		Material	0	0	0	0	0	0	
		Washing	0	0	0	0	0	0	
		Cooling	1	0	0	1	960	961	
		Air Cond.	0	0	0	0	0	0	
		Others	5	2	0	7	0	7	
		Total	6	2	0	8	960	968	99.2

Quantity of Consumed Water (Continued, 10/18)

Code No.	Fact. No.	Water Quantity Classified by Use and Source (m^3/d)							
M-05	73	Source / Use	Well Water	MWA	Others	Sub Total	Recycled Water	Total	Recovery Rate (%)
		Boiler	38	0	0	38	0	38	
		Material	0	0	0	0	0	0	
		Washing	314	0	0	314	0	314	
		Cooling	76	0	0	76	812	888	
		Air Cond.	0	0	0	0	0	0	
		Others	110	0	0	110	0	110	
		Outside	82	0	0	82	0	82	
		Total	620	0	0	620	812	1,432	56.7
M-06	53	Source / Use	Well Water	MWA	Others	Sub Total	Recycled Water	Total	Recovery Rate (%)
		Boiler	5	0	0	5	0	5	
		Material	0	0	0	0	0	0	
		Washing	25	0	0	25	0	25	
		Cooling	0	0	0	0	0	0	
		Air Cond.	0	0	0	0	0	0	
		Others	20	0	0	20	0	20	
		Outside	20	0	0	20	0	20	
		Total	70	0	0	70	0	70	0.0
M-07	34	Source / Use	Well Water	MWA	Others	Sub Total	Recycled Water	Total	Recovery Rate (%)
		Boiler	0	0	0	0	0	0	
		Material	0	0	0	0	0	0	
		Washing	0	0	0	0	0	0	
		Cooling	20	0	0	20	95	115	
		Air Cond.	0	0	0	0	0	0	
		Others	38	0	0	38	0	38	
		Total	58	0	0	58	95	153	62.1
M-08	42	Source / Use	Well Water	MWA	Others	Sub Total	Recycled Water	Total	Recovery Rate (%)
		Boiler	0	0	0	0	0	0	
		Material	0	0	0	0	0	0	
		Washing	29	0	0	29	0	29	
		Cooling	5	0	0	5	10	15	
		Air Cond.	0	0	0	0	0	0	
		Others	6	0	0	6	0	6	
		Total	40	0	0	40	10	50	20.0

Quantity of Consumed Water (Continued, 11/18)

Code No.	Fact. No.	Water Quantity Classified by Use and Source (m^3/d)							
M-09	69	Source / Use	Well Water	MWA	Others	Sub Total	Recycled Water	Total	Recovery Rate (%)
		Boiler	0	0	0	0	0	0	94.3
		Material	0	0	0	0	0	0	
		Washing	122	0	0	122	2,251	2,373	
		Cooling	329	0	0	329	6,119	6,448	
		Air Cond.	0	0	0	0	0	0	
		Others	0	45	0	45	0	45	
		Total	451	45	0	496	8,370	8,866	94.4
M-10	207	Source / Use	Well Water	MWA	Others	Sub Total	Recycled Water	Total	Recovery Rate (%)
		Boiler	0	0	0	0	0	0	
		Material	0	0	0	0	0	0	
		Washing	0	0	0	0	0	0	
		Cooling	2	0	0	2	128	130	
		Air Cond.	0	0	0	0	0	0	
		Others	15	0	0	15	0	15	
		Total	17	0	0	17	128	145	88.3
M-11	116	Source / Use	Well Water	MWA	Others	Sub Total	Recycled Water	Total	Recovery Rate (%)
		Boiler	5	0	0	5	0	5	
		Material	0	0	0	0	0	0	
		Washing	130	0	0	130	10	140	
		Cooling	67	0	0	67	128	195	
		Air Cond.	0	0	0	0	0	0	
		Others	10	0	0	10	0	10	
		Total	212	0	0	212	138	350	39.4
M-12	97	Source / Use	Well Water	MWA	Others	Sub Total	Recycled Water	Total	Recovery Rate (%)
		Boiler							
		Material	assumed						
		Washing	(49)						
		Cooling	(48) 97			97	2,175	2,272	
		Air Cond.							
		Others	10			10	0	10	
		Total	107			107	2,175	2,282	95.3

Quantity of Consumed Water (Continued, 12/18)

Code No.	Fact. No.	Water Quantity Classified by Use and Source (m^3/d)							
M-13	208	Source / Use	Well Water	MWA	Others	Sub Total	Recycled Water	Total	Recovery Rate (%)
		Boiler	0	0	0	0	0	0	
		Material	0	0	0	0	0	0	
		Washing	0	0	0	0	0	0	
		Cooling	18	0	0	18	144	162	
		Air Cond.	0	0	0	0	0	0	
		Others	2	0	0	2	0	2	
		Total	20	0	0	20	144	164	87.8
M-14	115	Source / Use	Well Water	MWA	Others	Sub Total	Recycled Water	Total	Recovery Rate (%)
		Boiler	0	0	0	0	0	0	
		Material	0	0	0	0	0	0	
		Washing	205	0	0	205	350	555	
		Cooling	2	0	0	2	750	752	
		Air Cond.	0	0	0	0	0	0	
		Others	62	0	0	62	0	62	
		Total	269	0	0	269	1,100	1,369	80.3
M-15	101	Source / Use	Well Water	MWA	Others	Sub Total	Recycled Water	Total	Recovery Rate (%)
		Boiler	75	0	0	75	0	75	
		Material	0	0	0	0	0	0	
		Washing	1,768	0	0	1,768	0	1,768	
		Cooling	844	0	0	844	4,800	5,644	
		Air Cond.	0	0	0	0	0	0	
		Others	475	0	0	475	0	475	
		Total	3,162	0	0	3,162	4,800	7,962	60.3
M-16	100	Source / Use	Well Water	MWA	Others	Sub Total	Recycled Water	Total	Recovery Rate (%)
		Boiler	0	0	0	0	0	0	
		Material	0	0	0	0	0	0	
		Washing	440	0	0	440	0	440	
		Cooling	21	0	0	21	1,072	1,093	
		Air Cond.	0	0	0	0	0	0	
		Others	68	0	0	68	0	68	
		Total	529	0	0	529	1,072	1,601	67.0

Quantity of Consumed Water (Continued, 13/18)

Code No.	Fact. No.	Water Quantity Classified by Use and Source (m^3/d)							
M-17	56	Source / Use	Well Water	MWA	Others	Sub Total	Recycled Water	Total	Recovery Rate (%)
		Boiler	4	0	0	4	0	4	
		Material	0	0	0	0	0	0	
		Washing	37	0	0	37	0	37	
		Cooling	88	0	0	88	1,256	1,344	
		Air Cond.	0	0	0	0	0	0	
		Others	11	0	0	11	0	11	
		Total	140	0	0	140	1,256	1,396	90.0
M-18	64	Source / Use	Well Water	MWA	Others	Sub Total	Recycled Water	Total	Recovery Rate (%)
		Boiler	1	0	0	1	0	1	
		Material	0	0	0	0	0	0	
		Washing	301	0	0	301	0	301	
		Cooling	15	0	0	15	1,420	1,435	
		Air Cond.	2	0	0	2	40	42	
		Others	298	0	0	298	0	298	
		Total	617	0	0	617	1,460	2,077	70.3
M-19	57	Source / Use	Well Water	MWA	Others	Sub Total	Recycled Water	Total	Recovery Rate (%)
		Boiler	8	0	0	8	0	8	
		Material	0	0	0	0	0	0	
		Washing	40	0	0	40	0	40	
		Cooling	90	0	0	90	600	690	
		Air Cond.	0	0	0	0	0	0	
		Others	212	0	0	212	0	212	
		Total	350	0	0	350	600	950	63.2
M-20	49	Source / Use	Well Water	MWA	Others	Sub Total	Recycled Water	Total	Recovery Rate (%)
		Boiler	0	0	0	0	0	0	
		Material	0	0	0	0	0	0	
		Washing	10	0	0	10	0	10	
		Cooling	5	0	0	5	404	409	
		Air Cond.	0	0	0	0	0	0	
		Others	8	0	0	8	0	8	
		Total	23	0	0	23	404	427	94.6

Quantity of Consumed Water (Continued, 14/18)

Code No.	Fact. No.	Water Quantity Classified by Use and Source (m^3/d)						
Metal Total		Source / Use	Well Water	MWA	Others	Sub Total	Recycled Water	Total	Recovery Rate (%)
		Boiler	192	0	0	192	50	242	20.7
		Material	0	0	0	0	0	0	0.0
		Washing	3,803	0	0	3,803	4,028	7,831	51.4
		Cooling	2,156	0	0	2,156	22,445	24,601	91.2
		Air Cond.	2	0	0	2	40	42	95.2
		Others	1,542	47	0	1,589	0	1,589	0.0
		Outside	852	0	0	852	0	852	0.0
		Total	8,547	47	0	8,594	26,563	35,157	75.5

Quantity of Consumed Water (Continued, 15/18)

Code No.	Fact. No.	Water Quantity Classified by Use and Source (m^3/d)							
C-01	155	Source / Use	Well Water	MWA	Others	Sub Total	Recycled Water	Total	Recovery Rate (%)
		Boiler	5	0	0	5	0	5	
		Material	0	0	0	0	0	0	
		Washing	20	0	0	20	0	20	
		Cooling	1	0	0	1	280	281	
		Air Cond.	0	0	0	0	0	0	
		Others	49	0	0	49	0	49	
		Total	75	0	0	75	280	355	78.9
C-02	168	Source / Use	Well Water	MWA	Others	Sub Total	Recycled Water	Total	Recovery Rate (%)
		Boiler	19	0	0	19	0	19	
		Material	10	0	0	10	0	10	
		Washing	80	0	0	80	500	580	
		Cooling	50	0	0	50	5,200	5,250	
		Air Cond.	0	0	0	0	0	0	
		Others	151	0	0	151	0	151	
		Outside	20	0	0	20	0	20	
		Total	330	0	0	330	5,700	6,030	94.8
C-03	209	Source / Use	Well Water	MWA	Others	Sub Total	Recycled Water	Total	Recovery Rate (%)
		Boiler	1	0	0	1	0	1	
		Material	0	0	0	0	0	0	
		Washing	29	0	0	29	0	29	
		Cooling	2	0	0	2	54	56	
		Air Cond.	0	0	0	0	0	0	
		Others	4	0	0	4	0	4	
		Total	36	0	0	36	54	90	60.0
C-04	210	Source / Use	Well Water	MWA	Others	Sub Total	Recycled Water	Total	Recovery Rate (%)
		Boiler	0	0	5	5	0	5	
		Material	0	0	0	0	0	0	
		Washing	0	10	5	15	0	15	
		Cooling	0	0	0	0	0	0	
		Air Cond.	0	0	0	0	0	0	
		Others	0	20	0	20	0	20	
		Total	0	30	10	40	0	40	0.0

Quantity of Consumed Water (Continued, 16/18)

Code No.	Fact. No.	Water Quantity Classified by Use and Source (m^3/d)							
C-05	149	Source / Use	Well Water	MWA	Others	Sub Total	Recycled Water	Total	Recovery Rate (%)
		Boiler	25	0	0	25	0	25	
		Material	400	0	0	400	0	400	
		Washing	285	0	0	285	0	285	
		Cooling	300	0	0	300	14,400	14,700	
		Air Cond.	0	0	0	0	0	0	
		Others	350	0	0	350	0	350	
		Outside	200	0	0	200	0	200	
		Total	1,560	0	0	1,560	14,400	15,960	90.2
C-06	147	Source / Use	Well Water	MWA	Others	Sub Total	Recycled Water	Total	Recovery Rate (%)
		Boiler	0	0	0	0	0	0	
		Material	0	0	0	0	0	0	
		Washing	2	0	0	2	0	2	
		Cooling	0	0	0	0	0	0	
		Air Cond.	0	0	0	0	0	0	
		Others	16	0	0	16	0	16	
		Outside	9	0	0	9	0	9	
		Total	27	0	0	27	0	27	0.0
C-07	106	Source / Use	Well Water	MWA	Others	Sub Total	Recycled Water	Total	Recovery Rate (%)
		Boiler	65	0	0	65	15	80	
		Material	0	0	0	0	0	0	
		Washing	10	0	0	10	0	10	
		Cooling	3	0	55	58	25	83	
		Air Cond.	0	0	0	0	0	0	
		Others	5	0	0	5	0	5	
		Total	83	0	55	138	40	178	22.5
C-08	94	Source / Use	Well Water	MWA	Others	Sub Total	Recycled Water	Total	Recory Rate (%)
		Boiler	102	0	0	102	20	122	
		Material	4	0	0	4	0	4	
		Washing	88	0	0	88	0	88	
		Cooling	200	0	0	200	3,750	3,950	
		Air Cond.	0	0	0	0	0	0	
		Others	328	0	0	328	0	328	
		Outside	30	0	0	30	0	30	
		Total	752	0	0	752	3,770	4,522	83.9

Quantity of Consumed Water (Continued, 17/18)

Code No.	Fact. No.	Water Quantity Classified by Use and Source (m^3/d)							
C-09	82	Source / Use	Well Water	MWA	Others	Sub Total	Recycled Water	Total	Recovery Rate (%)
		Boiler	0	0	0	0	0	0	
		Material	0	0	0	0	0	0	
		Washing	184	0	0	184	0	184	
		Cooling	30	0	0	30	790	820	
		Air Cond.	0	0	0	0	0	0	
		Others	4	0	0	4	0	4	
		Outside	8	0	0	8	0	8	
		Total	226	0	0	226	790	1,010	78.2
C-10	51	Source / Use	Well Water	MWA	Others	Sub Total	Recycled Water	Total	Recovery Rate (%)
		Boiler	26	0	0	26	0	26	
		Material	10	0	0	10	0	10	
		Washing	135	0	0	135	0	135	
		Cooling	60	0	0	60	2,000	2,060	
		Air Cond.	0	0	0	0	0	0	
		Others	69	0	0	69	0	69	
		Total	300	0	0	300	2,000	2,300	87.0
C-11	25	Source / Use	Well Water	MWA	Others	Sub Total	Recycled Water	Total	Recovery Rate (%)
		Boiler	100	0	0	100	0	100	
		Material	30	0	0	30	0	30	
		Washing	190	0	0	190	0	190	
		Cooling	450	0	0	450	14,400	14,850	
		Air Cond.	0	0	0	0	0	0	
		Others	50	0	0	50	0	50	
		Outside	200	0	0	200	0	200	
		Total	1,020	0	0	1,020	14,400	15,420	93.4
C-12	7	Source / Use	Well Water	MWA	Others	Sub Total	Recycled Water	Total	Recovery Rate (%)
		Boiler	0	0	0	0	67	67	9
		Material	0	0	0	0	0	0	
		Washing	130	0	0	130	0	130	
		Cooling	43	0	0	43	2,160	2,203	
		Air Cond.	0	0	0	0	0	0	
		Others	77	0	0	77	0	77	
		Total	250	0	0	250	2,227	2,477	89.9

Quantity of Consumed Water (Continued, 18/18)

Code No.	Fact. No.	Water Quantity Classified by Use and Source (m^3/d)							
C-13	29	Source / Use	Well Water	MWA	Others	Sub Total	Recycled Water	Total	Recovery Rate (%)
		Boiler	1	0	0	1	2	3	6
		Material	0	0	0	0	0	0	
		Washing	34	0	0	34	0	34	
		Cooling	2	0	0	2	30	32	
		Air Cond.	0	0	0	0	0	0	
		Others	8	0	0	8	0	8	
		Total	45	0	0	45	32	77	41.6
Chemical Total		Source / Use	Well Water	MWA	Others	Sub Total	Recycled Water	Total	Recovery Rate (%)
		Boiler	344	0	5	349	104	453	23.0
		Material	454	0	0	454	0	454	0.0
		Washing	1,187	10	5	1,202	500	1,702	29.3
		Cooling	1,141	0	55	1,196	43,089	44,285	97.3
		Air Cond.	0	0	0	0	0	0	0.0
		Others	1,111	20	0	1,131	0	1,131	0.0
		Outside	467	0	0	467	0	467	0.0
		Total	4,704	30	65	4,799	43,693	48,492	90.1
Gross Total		Source / Use	Well Water	MWA	Others	Sub Total	Recycled Water	Total	Recovery Rate (%)
		Boiler	2,525	66	5	2,596	648	3,244	20.0
		Material	565	2	0	567	0	567	0.0
		Washing	35,230	46	2,136	37,412	15,146	52,558	28.7
		Cooling	4,709	9	229	4,947	104,778	109,725	95.5
		Air Cond.	832	0	0	832	53,529	54,361	98.5
		Others	4,975	92	15	5,082	0	5,082	0.0
		Outside	1,459	0	0	1,459	0	1,459	0.0
		Total	50,295	215	2,385	52,895	174,101	226,996	76.7

3. 4　日本の井戸水の水質例

水質指標＼区別	範囲	平均値
濁度 °	0 ～ 35.0	4.4
pH	6.0 ～ 8.7	7.2
全硬度 mg/ℓ	1.0 ～ 250.0	62.4
塩化物イオン 〃	1.5 ～1,000.0	38.2
全鉄 〃	0 ～ 5.0	0.59
蒸発残留物 〃	21.0 ～ 432.0	154.7

備考：パルプ・紙工場約60の調査結果

3.5 廃水処理の状況

Note: Influent / Effluent

Code No.	Fact. No.	Main Treatment Process	SS (mg/l)	BOD (mg/l)	COD (mg/l)	pH	Oil (mg/l)	Heavy Metals (mg/l)	Flow out to	
									River	Sea
F-01	170	Coagulation/-Sedimentation &	-	-	-	-	-	-	o	
		Trickling Filter	*1-3	-	-	11.9	-	-		
F-02	103	Activated Sludge	71-184	2,000	1,587-4,448	5.4-7.5	-	-	o	
			13-19	20	87-114	7.8	-	-		
F-03	135	Sedimentation,	100	550	1,200	8	-	-	o	
		Oil Separater &								
		Oxidation Ditch	20	20	60	8				
F-04	130	Activated Sludge	-	-	-	-	-	-		o
			-	-	-	-	-	-		
F-05	127	Anaerobic Digestion & Activated	507	1,821	2,740	6.6	214	-	o	
		Sludge	*18	27	219	7.1	<5	-		
F-06	114	Activated Sludge	*190	*559	310	*7.70	-	-	o	
			*2	*12	<3	*8,20				
F-07	110	Activated Sludge & Activated	-	-	-	-	-	-	o	
		Carbon	*8	-	-	*7.46	-	-		
F-08	109	Activated Sludge	-	-	-	-	-	-	o	
			*7	30	-	*6.95	-	-		
F-09	91	Oxidation Ditch (Biological	1,140	4,180	2,011	5.9	7,303	-	o	
		Treatment)	10	280	103	7.5	6.7	-		
F-10	78	Activated Sludge	-	-	-	-	-	-	o	
			-	-	-	-	-	-		
F-11	65	Septic Tank	-	-	-	-	-	-	o	
			-	-	-	-	-	-		

Note: Figure starting from * was measured by the Study Team.

Table 3.5: Waste Water Treatment (Continued, 2/6)

Note: Influent / Effluent

Code No.	Fact. No.	Main Treatment Process	SS (mg/l)	BOD (mg/l)	COD (mg/l)	pH	Oil (mg/l)	Heavy Metals (mg/l)	Flow out to	
									River	Sea
F-12	48	Septic Tank	-	-	-	-	-	-	o	
			-	-	-	-	-	-		
F-13	43	Oil Separation & Activated Sludge	-	-	-	7-8	-	-	o	
			*68		*273	*7.1				
F-14	21	Sedimentation & Aeration	-	-	-	-	-	-	o	
			-	-	-	-	-	-		
P-01	145	Not equipped	-	-	-	-	-	-	o	
			-	-	-	-	-	-		
P-02	124	Sedimentation & Lagoon	-	-	-	-	-	-	o	
			-	-	-	-	-	-		
P-03	107	Precipitation & Biological Treatment	2,653	589	-	*7.54	-	-	o	
			*83	50	-	*7.38	-	-		
P-04	84	Coagulation & Sedimentation	1,200-1,350	130-180	-	6.5-7.5	-	-	o	
			28	20-80	-	"	-	-		
P-05	39	Chemical Treatment	-	-	-	-	-	-	o	
			-	-	-	-	-	-		
T-01	146	Activated Sludge	70	200	640	7.3	-	-		o
			14	10	80	7.6	-	-		
T-02	197	Sedimentation	-	-	-	-	-	-	o	
			*6	-	-	*7.7	-	-		
T-03	203	Aeration & Sedimentation	-	-	-	-	-	-	o	
			-	-	-	*7.61	-	-		

Note: Figure starting from * was measured by the Study Team.

Table 3.5: Waste Water Treatment (Continued, 3/6)

Note: Influent / Effluent

Code No.	Fact. No.	Main Treatment Process	SS (mg/l)	BOD (mg/l)	COD (mg/l)	pH	Oil (mg/l)	Heavy Metals (mg/l)	Flow out to	
									River	Sea
T-04	193	Coagulation & Sedimentation,	-	-	-	-	-	-	o	
		Aeration & Sedimentation	-	-	-	-	-	-		
T-05	200	Surface Aeration (Biological Treatment)	220	418	-	8.5	-	-	o	
			-	-	-	-	-	-		
T-06	198	Surface Aeration (Biological Treatment)	-	-	-	-	-	-	o	
			-	-	-	-	-	-		
T-07	189	Coagulation/- Sedimentation & Biological Treatment	-	-	-	-	-	-	o	
			-	-	-	-	-	-		
M-01	61	Coagulation & Sedimentation	68	8	8	7.0	5	-	o	
			*30	6	4	*7.5	1	-		
M-02	96	Sedimentation & Filtration	-	-	-	-	-	-	o	
			300~500	-	-	*7.7	-	-		
M-03	89	Sedimentation, Aeration & Activated Carbon	-	-	-	-	-	-	o	
			4	-	-	6.42	3.6	-		
M-04	206	Not Equipped	-	-	-	-	-	-	o	
			-	-	-	-	-	-		
M-05	73	Coagulatiuon & Sedimentation	*210	-	-	*12.0	-	-	o	
			*7	0.2	-	*7.72	-	-		
M-06	53	Sedimentation Sand Filtration & Charcoal	-	-	-	-	-	-	o	
			-	-	-	-	-	-		

Note: Figure starting from * was measured by the Study Team.

Table 3.5: Waste Water Treatment (Continued, 4/6)

Note: Influent / Effluent

Code No.	Fact. No.	Main Treatment Process	SS (mg/l)	BOD (mg/l)	COD (mg/l)	pH	Oil (mg/l)	Heavy Metals (mg/l)	Flow out to	
									River	Sea
M-07	34	Not Equipped	-	-	-	-	-	-	o	
			-	-	-	-	-	-		
M-08	42	Not Equipped	-	-	-	-	-	-	o	
			-	-	-	-	-	-		
M-09	69	Sedimentation	-	-	-	-	-	-	o	
			-	-	-	-	-	-		
M-10	207	Not Equipped	-	-	-	-	-	-	o	
			-	-	-	-	-	-		
M-11	116	Coagulation & Sedimentation	139	-	-				o	
			20	-	-					
M-12	97	Chemical Reduction, Coagulation & Sedimentation	-	-	-	-	-	-	o	
			-	-	-	-	-	-		
M-13	208	Pond	-	-	-	-	-	-	o	
			-	-	-	-	-	-		
M-14	115	Coagulation & Sedimentation	84	-	36	10.6	29	CrO.52	o	
			18	-	29	7.9	5	CrO.40		
M-15	101	Chemical Reduction, Caugulation & Sedimentation	19	-	-	7.2	-	20	o	
			10.6	-	-	6.6	-	0		
M-16	100	Chemical Treatment	-	-	-	-	-	-	o	
			5	16.4	-	5.97	-	0		
M-17	56	Neutralization & Sedimentation	-	-	-	-	-	-	o	
			-	-	-	-	-	-		

Note: Figure starting from * was measured by the Study Team.

Table 3.5: Waste Water Treatment (Continued, 5/6)

Note: Influent / Effluent

Code No.	Fact. No.	Main Treatment Process	SS (mg/l)	BOD (mg/l)	COD (mg/l)	pH	Oil (mg/l)	Heavy Metals (mg/l)	Flow out to	
									River	Sea
M-18	64	Coagulaltion & Sedimentation	-	-	305	-	7.9	-	o	
			-	-	190	-	7.3	-		
M-19	57	Precipitation	136	-	6	7	7		o	
			25	-	3	7	4			
M-20	49	Precipitation & Sand Filtration	-	-	-	7	-	12	o	
			-	-	-	7	-	0.2		
C-01	155	Biodisc & Sedimentation	65	74	-	7.48	-		o	
			27	13	-	6.78	-			
C-02	168	Aerated Lagoon	25	720	147	7.2	-	-	o	
			8	15	34	7.5	-	-		
C-03	209	Coagulation & Sedimentation & Sand Filtration	-	-	-	5-6	-	-	o	
			-	-	-	7.2-7.8				
C-04	210	Pond	-	-	-	-	-	-	o	
			-	-	-	-	-	-		
C-05	149	Sedimentation, Sand Filtration, Activated Carbon & Resin	-	-	-	-	-	-	o	
			*0	-	-	*6.89	-	-		
C-06	147	Activated Sludge, Sand Filtration & Carbon Filtration	-	-	-	-	-	-	o	
			-	-	-	-	-	-		
C-07	106	Caugulation/- Sedimentation & Biological Treatment	-	-	-	-	-	-	o	
			-	15-20	-	6.5-7.5	-	-		

Note: Figure starting from * was measured by the Study Team.

Table 3.5: Waste Water Treatment (Continued, 6/6)

Note: Influent / Effluent

Code No.	Fact. No.	Main Treatment Process	SS (mg/l)	BOD (mg/l)	COD (mg/l)	pH	Oil (mg/l)	Heavy Metals (mg/l)	Flow out to	
									River	Sea
C-08	94	Activated Sludge	-	-	400-800	5-7	-	-	o	
			*6	-	10-40	7.5-8.0	-	-		
C-09	82	Coagulation & Sedimentation	-	600-1,100	500-1,000	6.5-7.5	5-10	-	o	
			-	15-45	20-40	6.5-7.5	3-5	-		
C-10	51	Coagulation/-Sedimentation & Aeration	-	-	-	-	-	-	o	
			*56	-	-	-	-	-		
C-11	25	Coagulation/-Sedimentation & Activated Sludge	300-500	1,000-1,500	2,000-3,000	7-8 9	- -	- -	o	
			29	9	88	9	-	-		
C-12	7	Aerated Lagoon	-	-	-	-	-	-	o	
			-	-	-	-	-	-		
C-13	29	Not Equipped	-	-	-	-	-	-	o	
			-	-	-	-	-	-		

Note: Figure starting from * was measured by the Study Team.