

Table-7.3 UNIT PRICE OF WATER, PWA

<u>Item</u>	<u>Water Consumption (m<sup>3</sup>/d)</u>			
	<u>50</u>	<u>100</u>	<u>300</u>	<u>400</u>
1. Size of connection Pipe (inches)	2	3	4	6
2. Water Price				
- Service Charge (Baht/month)	100	160	200	200
- Connection Fees in terms of monthly lot (20 years)*	80	130	250	250
- Monthly Price (Baht/month)	12,750	25,500	76,500	102,000
- Total Monthly Price (Baht/month)	12,930	25,790	76,950	102,450
3. Unit Price of Water (Baht/m <sup>3</sup> )	8.62	8.60	8.55	8.54

Note: \* Based upon the assumption that connection is set at 30 m from the main pipe, i.e., 2 x Basic Fee.

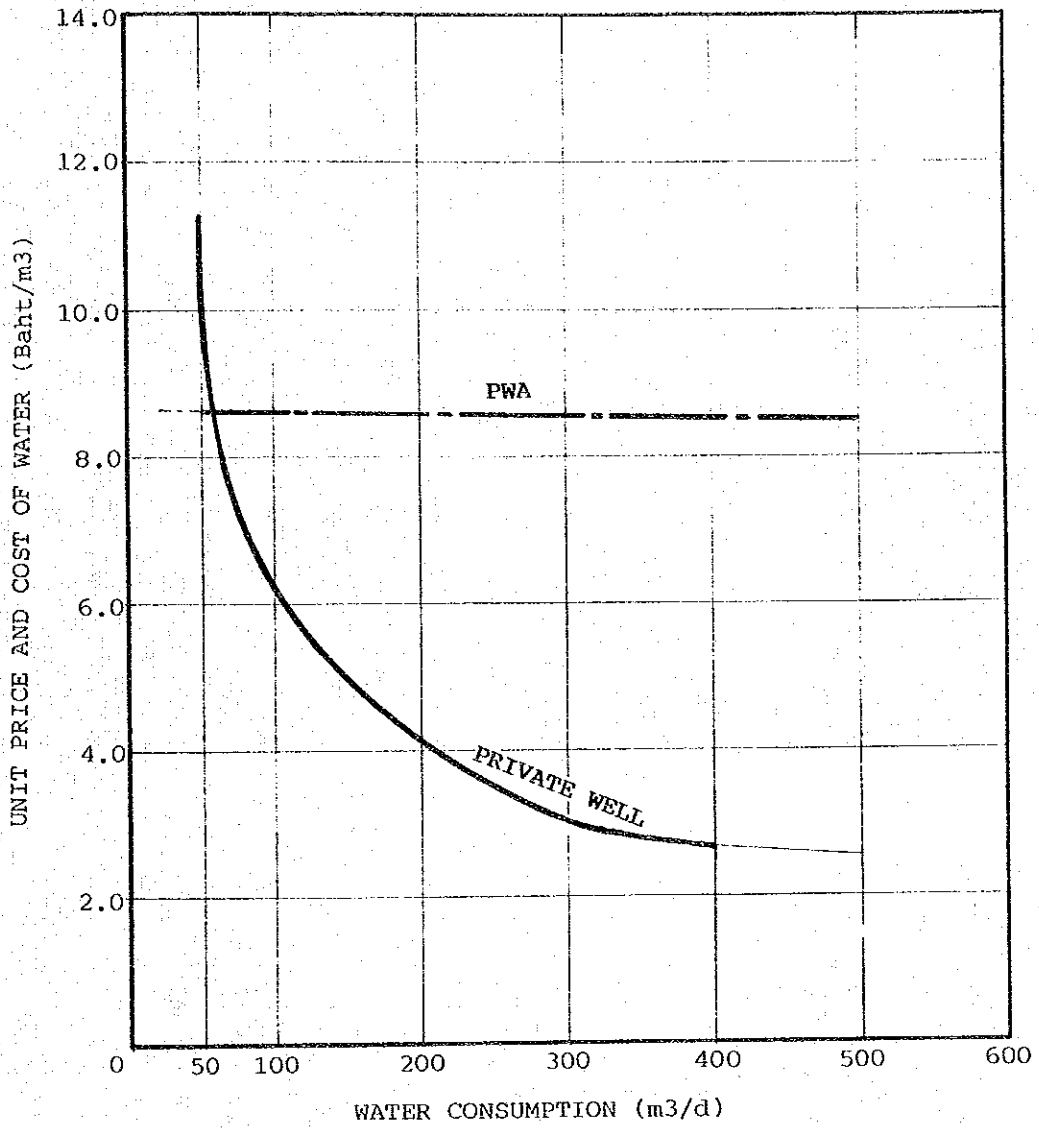
#### 7-2.4 Remarks

The following can be induced from the study results as revealed in Fig-7.1.

1. The break-even point where the unit cost of water produced by private facilities and the unit price of water by PWA may be found at a consumption volume between 50 cu m/day and 100 cu m/day, and very near to 50 cu m/day.
2. The unit cost of water by private facilities decreases as the consumption volume increases, i.e., so low as 2.67 Baht/m<sup>3</sup> at 400 cu m per day.

3. Because of no exact data available on the ratio of successful drilling in Ubon and Warin, no consideration is given to such ratio. If the ratio is assumed to be 50 %, the unit cost of water per cu m in case of 100 m<sup>3</sup>/day consumption will be 10.29 Baht\*, very near to PWA's unit price of water.

Note: [monthly depreciation allowances (12,150 Baht x 2) + monthly O/M cost (6,580 Baht)]/consumption volume (100 m<sup>3</sup> x 30 days) = 10.29 Baht/m<sup>3</sup>



COMPARISON OF UNIT PRICE AND COST

WATER CONSUMPTION (m <sup>3</sup> /d)	PWA (Baht/m <sup>3</sup> )	PRIVATE WELL (Baht/m <sup>3</sup> )
50	8.62	11.26
100	8.60	6.24
300	8.55	3.02
400	8.54	2.67

<b>FIGURE</b>	COMPARISON OF UNIT PRICE AND COST
7.1	
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APPENDIX 8

PRELIMINARY DESIGN



APPENDIX 8 PRELIMINARY DESIGN

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## APPENDIX 8 PRELIMINARY DESIGN

## 8.1 Rehabilitation and Modification Works

The objective of the rehabilitation and modification works is to supplement insufficient supply before the completion of the expansion works, by 1) updating the present deteriorated equipment and obsolete pipelines and 2) to uprate the present production of the Ubon and Warin Treatment Plants.

The possible increase of production capacity was studied on the Ubon and Warin Treatment Plants. Each component of the facilities in the Ubon and Warin supply systems was examined for its capacity whether it could afford the increase proposed as follows:

Unit: cu m/d

Item	Ubon		Warin
	No.1 & 2 altogether	No.3	
Present capacity	3,840	12,000	12,000
Proposed incremental	760	1,800	600
Proposed production	4,600	13,800	12,600
Proposed treatment capacity (8% loss plus production)	5,000	14,900	13,600

## 8.1.1 Ubon Treatment Plant

## 1) Increase of production capacity of the Ubon Treatment Plant

Item	No.1 and No.2 altogether		No.3	
	Original	Proposed	Original	Proposed
Production Capacity (cu m/d)	3,840	4,600	12,000	13,800
Treatment Capacity (cu m/d)	4,150	5,000	13,000	14,900
Flocculation Basins				
Detention Time (min)	38	30	28	23
Sedimentation Basins				
Detention Time (hr),	2.8	2.2	4.2	3.5
Flow Velocity (m/min)	0.11	0.14	0.23	0.28
Filters				
Filtration Rate (m/hr)	4.3	5.4	4.9	5.9

The proposed conditions in the table are consistent with the design criteria of the present study, so it is concluded that the production capacity of the Ubon Treatment Plant can be increased technically to 18,400 cu m/d, within reasonable investment of capital.

## 2) Necessary works for Ubon Treatment Plant

## (1) Replacement/Installation of flow meters and indicators

Flow meters and indicators will be newly installed on the 250 and 400 mm diameter raw water transmission mains, for recording daily intake and determination of the chemical feeding rate and consumption. The malfunctioning present flow meters and indicators on the 250, two 300 and 400 mm diameter distribution mains will be replaced for recording the daily production. The differential

pressure type is proposed because of simpler mechanism and less costliness than other types.

(2) Replacement of level gauge

The defective float type water level gauges (direct reading type) will be replaced, for measuring the level of the two, 500 and 3,000 cu m storage clear water reservoirs and elevated tank.

(3) Provision of chlorine gas container scale

A set of chlorine gas container scale will be provided for precise timing of replacement of the gas container, to secure continuous disinfection as well as reading consumption.

(4) Installation of chemical feeding equipment and construction of chemical house

The existing chemical feeding equipment for alum is housed in a room of the chemical building which is also used for chemical storage. To meet the proposed treatment capacity, an additional alum feeding equipment will be needed, and a lime feeding system will be installed to control pH for more adequate coagulation, as follows:

Alum feeding pump with flow meter, piping and valve : 1 unit  
Lime solution tanks, feeding pump with flow meter, piping and valves : 2 units

In addition to the equipment above, a chemical house will be newly constructed, since the existing chemical house will become undersized due to the proposed installation of additional equipment.

(5) Purchase of filter sand washer

A movable filter sand washer is proposed for purchase, and washing of filter sand should be practiced to provide clean sand for make-up.

(6) Other works

Of the access bridge to the intake tower, the wood made footboard is partly rotted and replacement by steel one is urgently needed.

8.1.2 Warin Treatment Plant

1) Increase of production capacity of Warin Treatment Plant

Item	Warin	
	Original	Proposed
Production Capacity (cu m/d)	12,000	12,600
Treatment Capacity (cu m/d)	13,000	13,600
Flocculation Basins		
Detention Time (min)	31	28
Sedimentation Basins		
Detention Time (hr),	3.1	2.7
Flow Velocity (m/min)	0.14	0.15
Filters		
Filtration Rate (m/hr)	6.7	7.4

All the above conditions are consistent with the design criteria, except for the filtration rate. It is slightly higher than the recommended upper limit, 7 m/hr, if properly operated and maintained, the rate will be

acceptable practically. Conclusively, the production capacity of the Warin Treatment Plant can be increased to 12,600 cu m/d, within reasonable investment of capital.

## 2) Necessary Works for Warin Treatment Plant

Similar improvement and rehabilitation works to those required for the Ubon Treatment Plant shall also be applied to the Warin Treatment Plant.

### (1) Replacement/Installation of flow meter and indicator

- Installation of raw water flow meter and indicator of 400 mm : 1 set
- Replacement of treated flow meter and indicator of 300 mm : 1 set

### (2) Replacement of level gauge

- Float type water level gauge for clear water reservoir : 1 set

### (3) Provision of chlorine gas container scale : 1 set

### (4) Chemical feeding equipment installation and chemical house construction

- Alum feeding pump with flow meter, pipings and valves : 1 unit
- Lime solution tank, feeding pump with pipings, valves, and flow meter : 2 units
- Chemical house : 1 lump sum

### (5) Installation of distribution pump

- Q 6.2 cu m/min. x H 30 m : 1 pump

### 8.1.3 Distribution Pipeline

Immediate replacement is proposed for obsolete and defective pipes as listed Table-8.1 below. The waterworks also requested the relocation of those pipes installed under rain sewers or in driveways where traffic is heavy. The location of replacement is shown in Fig-8.1.

Table-8.1 LIST OF PIPELINES TO BE REPLACED

Dia. (mm)	Length (m)
150	6,450
100	770
Total	7,220

## 8.2 Expansion Works

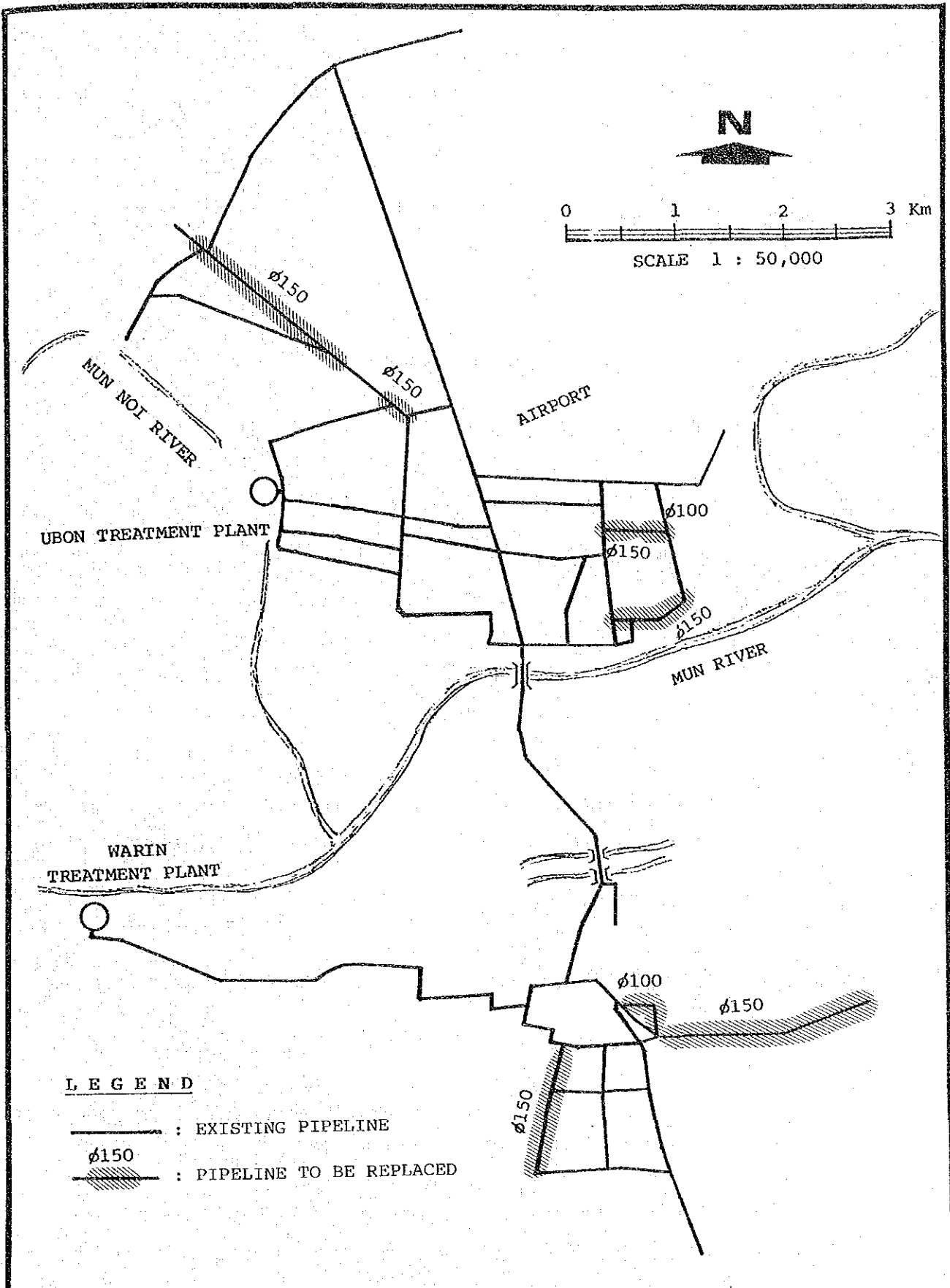
Preliminary design for the expansion works of Stage I is planned in accordance with the design criteria mentioned in Appendix 6. A proposed treatment plant of 22,000 cu m/d production capacity will be constructed in the existing Ubon Treatment Plant site together with an intake facility.

Design capacity of the proposed plant is 23,800 cu m/d including 8 % of treatment loss. The maximum hour flow, as calculated from the maximum day demand and peak factor of 1.4, is used for calculation of the distribution network.

### 8.2.1 Intake and Treatment Plant

#### 1) Intake and Raw Water Pipeline

Intake tower is the same structure as the existing one, constructed on the left bank of the Mun Noi River and an access bridge will connect the intake



**LEGEND**

- : EXISTING PIPELINE
- $\phi 150$  : PIPELINE TO BE REPLACED

<b>FIGURE</b>	PIPELINES TO BE REPLACED
8.1	
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tower to the treatment plant. Raw water is taken and transmitted to the mixing well, through a 500 mm diameter pipe, by pumps which are installed in the pump house of the intake tower.

- (1) Intake tower
  - pump house, access bridge and a protective barrier
- (2) Raw water pump
  - Q 8.4 cu m/min, x H 25 m x 3 pumps (includ. one standby)
- (3) Raw water pipeline
  - dia. 500 mm x 80 m long (intake to mixing well)

The existing raw water pump house of the intake tower is already occupied by the six pumps, and has no allowable space for installation of additional pumps. It is therefore proposed that a new additional intake tower be built at about 200 m upstream of the existing intake tower along the Mun Noi River.

In the stage of the detail designing study is recommends to be carried out on possible use of the existing intake tower and pump house without building new ones by way of increasing the capacity of pumps and enlarging the size of pipe.

#### 8.2.2 Ubon (No.4) Treatment Plant

Water quality of the Mun Noi River is acceptable as the raw water to be treated by a series of treatment process of pre- and post-liming, coagulation, flocculation, sedimentation, rapid sand filtration and post-chlorination as planned in the Stage I Expansion Works.

The capacity, dimensions and features of the facilities proposed for the plant's unit processes and operations are described below:

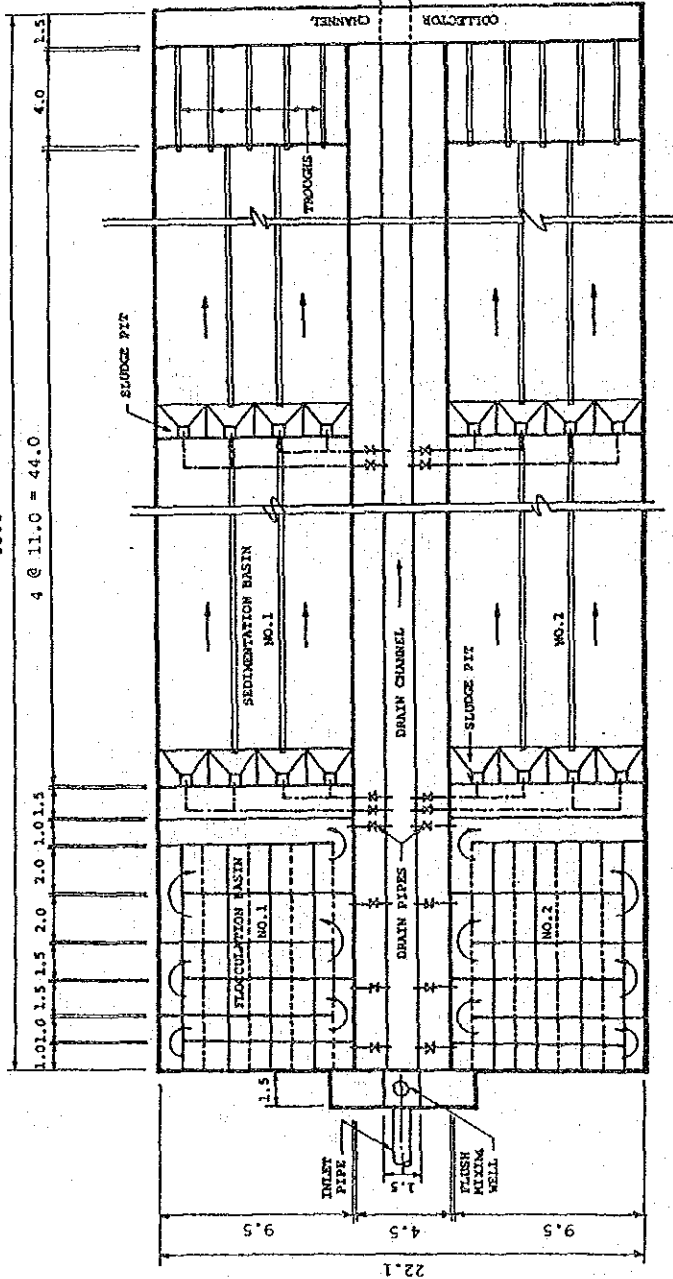


- 1) Flash Mixing Well (Fig-8.2)  
hydraulic mixing by adjustable cone type for instance,  
W 1.5 m x L 1.5 m x D 2.0 m, 1 well  
G Value :  $650 \text{ sec}^{-1}$  (average in well)  
Mixing Time : 1 - 3 sec, Detention Time : 16 sec ( $V/Q$ )
- 2) Flocculation Basin (Fig-8.2)  
hydraulic flocculation by baffled channels, 3 stages,  
Volume : 280 cu m/basin, 2 basins, Detention Time : 34 min,  
G Value : 25 - 70  $\text{sec}^{-1}$
- 3) Sedimentation Basin (Fig-8.2)  
rectangular, one direction horizontal flow,  
Volume : 1,220 cu m/basin, 2 basins, W 9.5 m x L 44.0 m x D 3.0 m,  
Detention Time : 2.5 h, hydraulic loading :  $1.4 \text{ m}^3/\text{m}^2/\text{h}$ ,  
flow velocity : 0.3 m/min, manual desludging
- 4) Rapid Sand Filter (fig-8.3)  
declining rate filtration,  
filtration rate :  $130 \text{ cu m}/\text{sq m}/\text{d}$  in average,  
6 filter beds including 1 stand-by,  $37 \text{ sq m}/\text{bed}$ ,  
backwashing together with surface washing
- 5) Clear Water Reservoir  
for storing in-plant water consumption including filter backwash-  
ing and distribution,  
Volume : 3,100 cu m/reservoir, 2 reservoirs  
Detention Time : 6 hrs
- 6) Elevated Tank  
for backwashing of filter bed,  
Volume : 250 cu m/tank, 1 tank
- 7) Chemical Feeding Equipment  
- Alum  
solution tanks with mixers, feeding pumps, elevated header  
tanks, and appurtenances

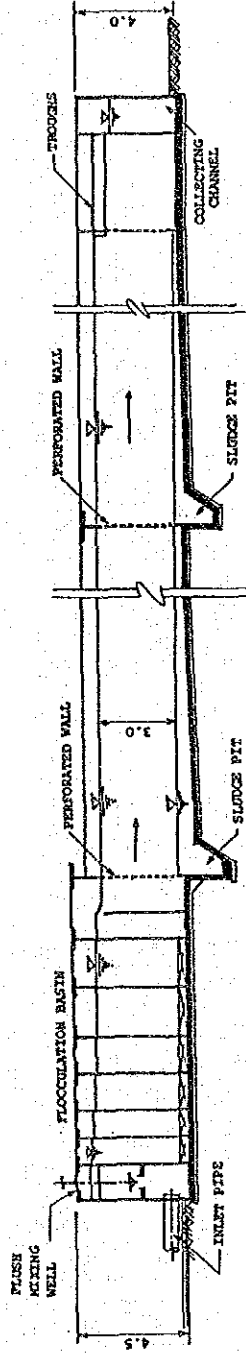
63.3

4 @ 11.0 = 44.0

1.0 1.0 1.5 2.0 2.0 1.0 1.0 1.5



PLAN



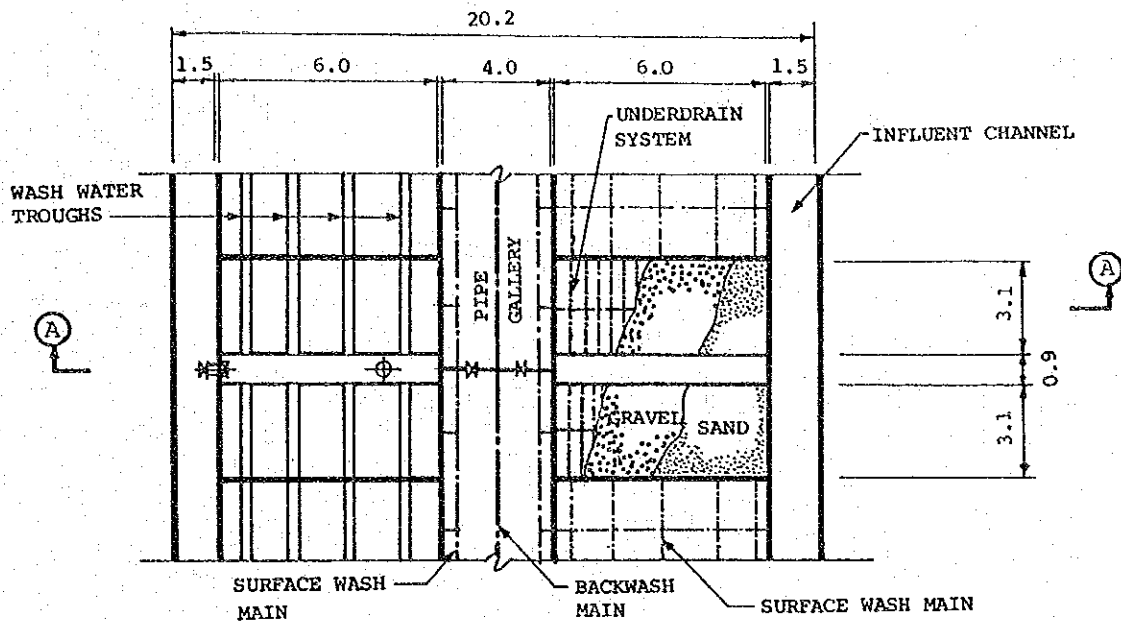
SECTION A-A

FLUSH MIXING, FLOCCULATION AND  
SEDIMENTATION BASINS

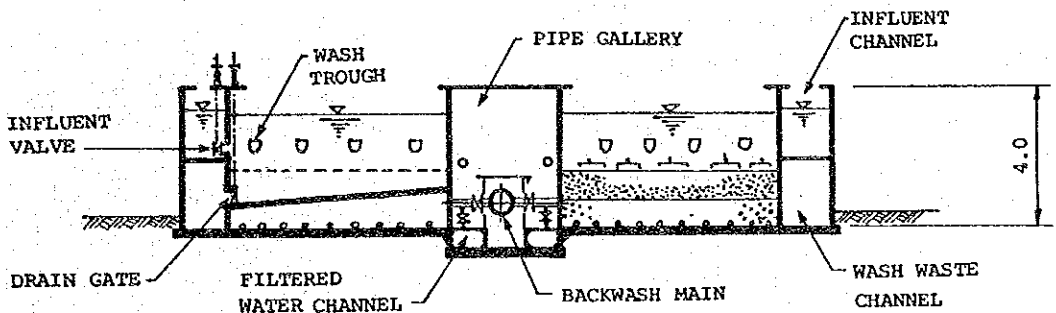
FIGURE

8.2

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P L A N



S E C T I O N A - A

FIGURE	RAPID SAND FILTER
8.3	
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- Lime  
hopper, solution tanks with mixers, feeding pumps, header tank,  
saturation tanks and appurtenances
- Chlorination  
container scale, evaporator, chlorinator and appurtenances
- 8) Instrumentation
  - flow meter and controller
  - flow and level indicator and recorder
- 9) Power Substation
- 10) Others
  - construction of 5 staff houses
  - replacement of dia. 250 mm, about 250 m long, raw water pipeline  
of Air Force.
  - relocating about 30 families in the proposed treatment site

### 8.2.3 Distribution Pipeline

The hydraulic analysis of the distribution system incorporating the existing pipelines and proposed ones was carried out by means of computer-aided network analysis. Table-8.2 on the next page presents the results of the analysis. Fig-8.4 shows the land use plan by which the areawise water demands are computed.

The routes of distribution pipeline for the target year of 2000 were determined in due consideration of the planned service area and future road planning envisaged in the City Development Plan, and through exchange of views with the officials concerned.

Table-8.3 shows the summary of the proposed distribution pipelines based on the results of hydraulic analysis.

Table-8.2 RESULT OF PIPE NETWORK ANALYSIS

Node	-	Node Type	D (mm)	L (m)	C	Q (l/sec)	V (m/sec)	i (o/oo)	dH (m)	Hb/r (m)	H (m)	GL (m)	He (m)	
101	-	1	0	528	550	110	324.396	1.482	4.99	2.74	0.00	144.26	121.00	23.26
1	-	2	0	528	1240	110	247.742	1.131	3.03	3.75	0.00	140.50	121.00	19.50
3	-	2	0	272	1060	110	30.730	0.529	1.61	1.71	0.00	140.50	121.00	19.50
101	-	3	0	455	1150	110	198.930	1.223	4.16	4.79	0.00	142.21	120.00	22.21
4	-	3	0	296	450	110	48.930	0.711	2.52	1.14	0.00	142.21	120.00	22.21
5	-	4	0	440	1320	110	119.675	0.787	1.91	2.53	0.00	143.35	118.00	25.35
101	-	5	0	440	450	110	138.275	0.909	2.50	1.13	0.00	145.87	120.00	25.87
2	-	6	0	350	410	110	100.752	1.047	4.24	1.74	0.00	139.76	121.00	17.76
6	-	7	0	195	710	110	12.226	0.409	1.48	1.05	0.00	137.71	121.00	16.71
8	-	7	0	293	730	110	53.606	0.795	3.14	2.29	0.00	137.71	121.00	16.71
3	-	8	0	495	910	110	185.429	0.964	2.43	2.21	0.00	140.00	122.00	18.00
8	-	9	0	250	950	110	6.400	0.130	0.13	0.13	0.00	139.88	119.00	20.88
4	-	9	0	295	1650	110	43.945	0.643	2.10	3.47	0.00	139.88	119.00	20.88
7	-	10	0	400	1200	110	36.732	0.292	0.34	0.41	0.00	137.30	121.00	16.30
14	-	10	0	200	700	110	13.859	0.441	1.65	1.16	0.00	137.30	121.00	16.30
8	-	14	0	400	1100	110	78.823	0.627	1.41	1.55	0.00	138.46	118.00	20.46
14	-	13	0	300	800	110	30.564	0.432	0.99	0.79	0.00	137.67	118.00	19.67
9	-	13	0	250	910	110	30.745	0.626	2.43	2.21	0.00	137.67	118.00	19.67
10	-	11	0	400	500	110	34.591	0.275	0.31	0.15	0.00	137.15	121.00	16.15
12	-	11	0	400	1150	110	22.860	0.182	0.14	0.16	0.00	137.15	121.00	16.15
13	-	12	0	400	860	110	40.509	0.322	0.41	0.35	0.00	137.31	117.00	20.31
11	-	17	0	200	1700	110	12.045	0.383	1.27	2.16	0.00	134.98	118.00	16.98
15	-	17	0	200	650	110	14.755	0.470	1.85	1.20	0.00	134.98	118.00	16.98
11	-	15	0	300	950	110	30.906	0.437	1.01	0.96	0.00	136.19	119.00	17.19
15	-	16	0	100	1000	110	0.351	0.045	0.05	0.05	0.00	136.13	117.00	19.13
12	-	16	0	150	1500	110	4.349	0.246	0.78	1.18	0.00	136.13	117.00	19.13
17	-	18	0	150	1000	110	8.500	0.481	2.71	2.71	0.00	132.27	117.00	15.27
1	-	22	0	300	1700	110	56.254	0.796	3.06	5.20	0.00	139.06	121.00	18.06
22	-	21	0	260	650	110	46.254	0.871	4.28	2.78	0.00	136.28	125.00	11.28
19	-	21	0	200	1860	110	11.340	0.361	1.14	2.12	0.00	136.28	125.00	11.28
2	-	19	0	450	850	110	146.020	0.918	2.48	2.11	0.00	138.40	122.00	16.40
21	-	20	0	260	650	110	31.494	0.593	2.10	1.37	0.00	134.91	124.00	10.91
19	-	20	0	411	1620	110	106.480	0.803	2.15	3.48	0.00	134.91	124.00	10.91
20	-	24	0	400	430	110	96.874	0.771	2.06	0.89	0.00	134.03	123.00	11.03
24	-	23	0	200	1450	110	14.284	0.455	1.75	2.53	0.00	131.50	123.00	8.50
6	-	23	0	195	1970	110	20.026	0.671	3.69	7.27	0.00	131.50	123.00	8.50
24	-	25	0	400	1850	110	49.890	0.397	0.60	1.12	0.00	132.91	124.00	8.91
25	-	23	0	150	1450	110	4.890	0.277	0.98	1.41	0.00	131.50	123.00	8.50
25	-	26	0	200	1250	110	6.400	0.204	0.40	0.49	0.00	132.42	125.00	7.42
102	-	27	0	521	3110	110	204.200	0.958	2.26	7.03	0.00	145.72	125.00	20.72

(Continued)

Node - Node	Type	D (mm)	L (m)	C	Q (1/sec)	V (m/sec)	i (o/oo)	dH (m)	Hb/r (m)	H (m)	GL (m)	He (m)
27 - 28	0	463	1200	110	125.036	0.743	1.62	1.94	0.00	143.78	130.00	13.78
28 - 32	0	336	590	110	69.055	0.779	2.57	1.52	0.00	142.26	130.00	12.26
32 - 35	0	150	580	110	5.029	0.285	1.03	0.60	0.00	141.67	130.00	11.67
43 - 35	0	250	1150	110	17.603	0.359	0.87	1.00	0.00	141.67	130.00	11.67
27 - 43	0	300	950	110	57.864	0.819	3.22	3.06	0.00	142.66	126.00	16.66
28 - 29	0	250	500	110	44.681	0.910	4.85	2.43	0.00	141.35	133.00	8.35
29 - 30	0	300	1010	110	2.981	0.042	0.01	0.01	0.00	141.34	133.00	8.34
31 - 30	0	300	460	110	15.211	0.215	0.27	0.13	0.00	141.34	133.00	8.34
32 - 31	0	300	360	110	47.226	0.668	2.21	0.80	0.00	141.46	130.00	11.46
30 - 33	0	231	490	110	7.392	0.176	0.26	0.13	0.00	141.21	130.00	11.21
34 - 33	0	150	450	110	1.294	0.073	0.08	0.04	0.00	141.21	130.00	11.21
31 - 34	0	300	450	110	20.515	0.290	0.47	0.21	0.00	141.25	130.00	11.25
35 - 34	0	150	500	110	4.477	0.253	0.83	0.41	0.00	141.25	130.00	11.25
33 - 36	0	195	700	110	5.087	0.170	0.29	0.20	0.00	141.01	130.00	11.01
37 - 36	0	300	590	110	4.567	0.065	0.03	0.02	0.00	141.01	130.00	11.01
34 - 37	0	300	680	110	16.897	0.239	0.33	0.22	0.00	141.03	130.00	11.03
38 - 37	0	300	650	110	0.270	0.004	0.00	0.00	0.00	141.03	130.00	11.03
35 - 38	0	150	690	110	4.755	0.289	0.93	0.64	0.00	141.03	130.00	11.03
42 - 38	0	200	1050	110	8.684	0.276	0.70	0.73	0.00	141.03	130.00	11.03
43 - 42	0	250	700	110	21.861	0.445	1.29	0.91	0.00	141.76	127.00	14.76
36 - 39	0	195	810	110	2.854	0.096	0.10	0.08	0.00	140.93	130.00	10.93
39 - 40	0	100	1650	110	1.554	0.198	0.84	1.39	0.00	139.54	130.00	9.54
38 - 40	0	100	750	110	2.469	0.314	1.98	1.49	0.00	139.54	130.00	9.54
41 - 40	0	100	1000	110	2.277	0.290	1.71	1.71	0.00	139.54	130.00	9.54
42 - 41	0	200	750	110	8.577	0.273	0.68	0.51	0.00	141.25	127.00	14.25
30 - 44	0	195	1620	110	7.200	0.241	0.56	0.90	0.00	140.44	133.00	7.44
29 - 45	0	250	890	110	24.100	0.491	1.55	1.38	0.00	139.97	120.00	19.97
45 - 51	0	295	1500	110	5.900	0.086	0.05	0.08	0.00	139.90	120.00	19.90
51 - 9	0	295	1100	110	3.300	0.048	0.02	0.02	0.00	139.88	119.00	20.88
39 - 46	0	100	800	110	1.300	0.166	0.61	0.48	0.00	140.44	130.00	10.44
51 - 52	0	100	2100	110	1.300	0.166	0.61	1.27	0.00	138.62	119.00	19.62
15 - 47	0	100	1700	110	1.300	0.166	0.61	1.03	0.00	135.16	119.00	16.16
47 - 48	0	100	1500	110	0.600	0.076	0.14	0.22	0.00	134.94	120.00	14.94
25 - 49	0	200	1000	110	11.600	0.369	1.19	1.19	0.00	131.72	124.00	7.72
49 - 50	0	150	2300	110	5.800	0.328	1.34	3.08	0.00	128.65	123.00	5.65

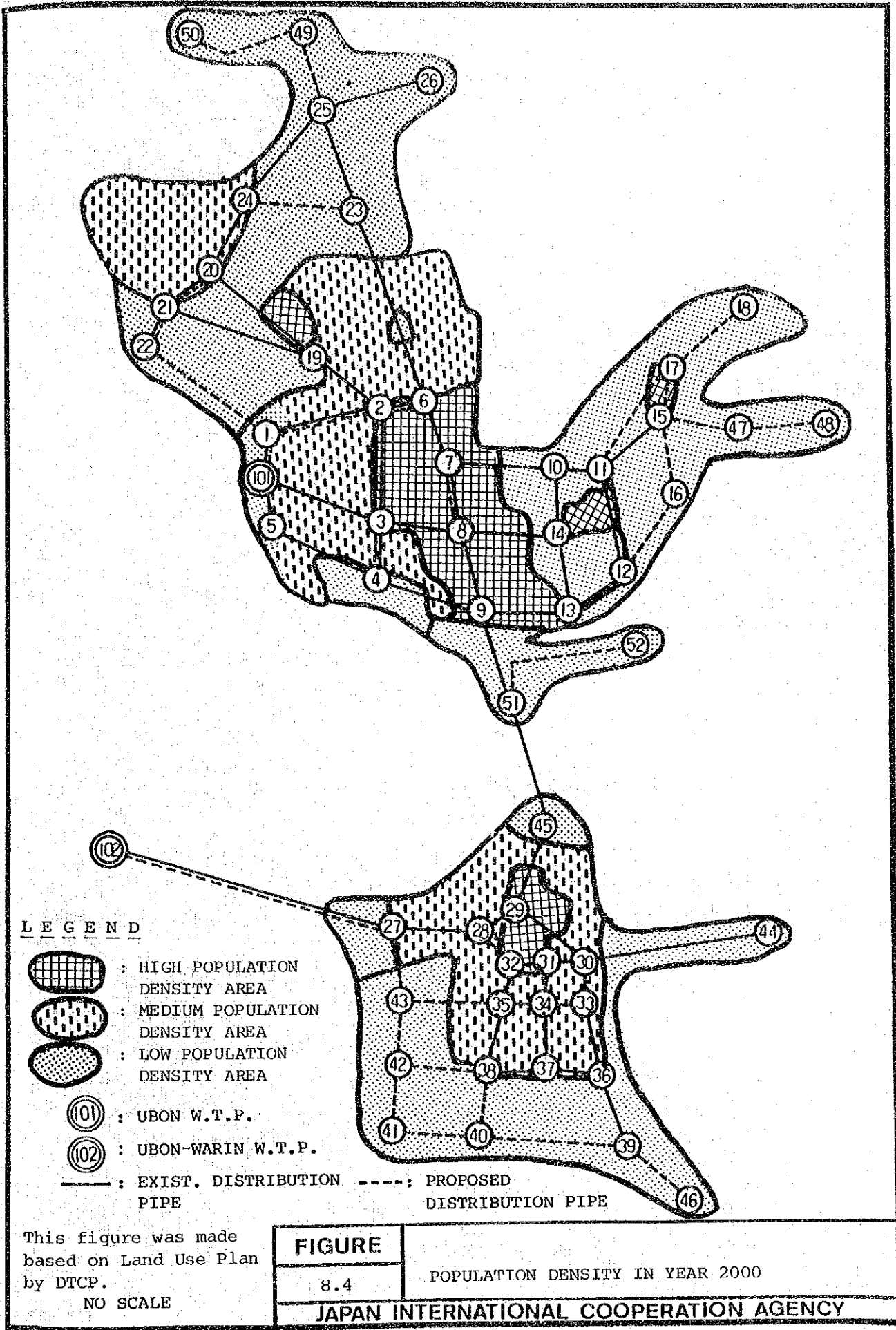


Table-8.3 PROPOSED DISTRIBUTION PIPELINES

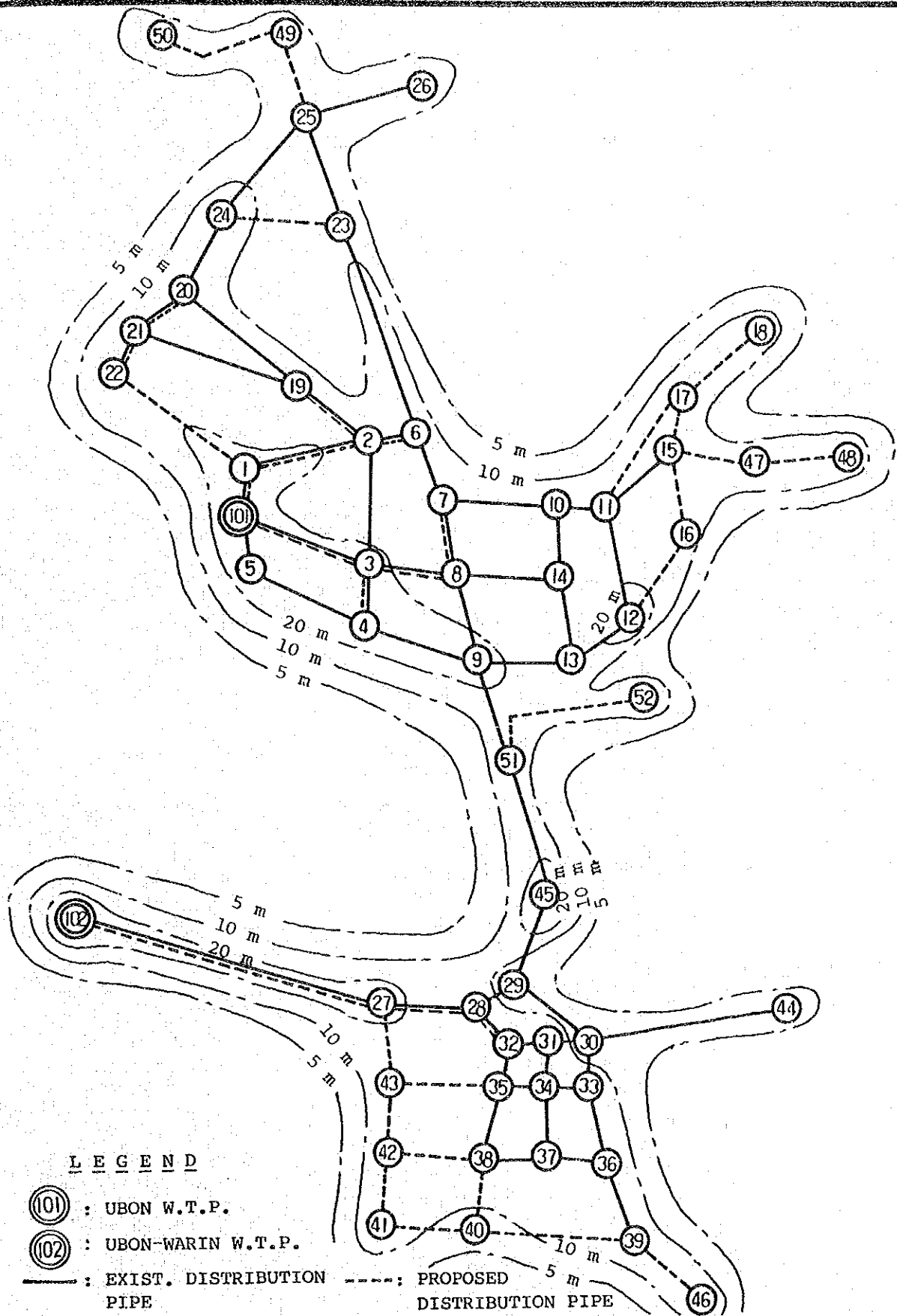
DIAMETER (mm)	LENGTH (m)
400	4,900
300	5,410
250	4,790
200	8,490
150	4,800
100	24,450
Total	52,840

According to the result of hydraulic analysis of the distribution network, the area will be served mostly around 1.0 to 2.5 kg/sq cm service pressure, as shown in Fig-8.5. And the production capacity and the demand will be balanced mostly by 2000 in each area of Ubon and Warin.

In case water shortage should occur for unforeseeable reasons in either of the two areas of Ubon or Warin, inter-area water transfer can and should be made through the existing 200 mm and 250 mm pipeline connecting the two areas. For this emergency use of the pipelines, the existing shutting valves thereof should be maintained in the working conditions all the time.

Regarding Node 50 where the Ubon University and Ubon Skill Development Institute are planned for construction at the site used by the refugee camp before, the service pressure is expected to decrease to 0.56 kg/sq cm during the peak hour flow. A particular measure will not be required because such a large consumer as the university generally can prepare storage facility and lift pumps.





**LEGEND**

(101) : UBON W.T.P.

(102) : UBON-WARIN W.T.P.

— : EXIST. DISTRIBUTION PIPE      - - - : PROPOSED DISTRIBUTION PIPE

- - - : EFFECTIVE PRESSURE CONTOUR

NO SCALE

<b>FIGURE</b>	8.5
	NODE OF PIPE NETWORK AND EFFECTIVE PRESSURE CONTOUR IN 2000
<b>JAPAN INTERNATIONAL COOPERATION AGENCY</b>	



APPENDIX 9

COST DATA AND CONSTRUCTION COST



APPENDIX 9 COST DATA AND CONSTRUCTION COST

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## APPENDIX 9

### 9.1 Cost Data

#### 9.1.1 Cost Data Collection

PWA has its own standard price list of materials, products and works. In this estimate, the prices of listed items were quoted directly.

Regarding unlisted items, estimation was made by illation from related prices in the list.

Market prices of the materials and products to be used in the estimation were collected and quoted when found applicable reasonably.

Prices of some products and equipments were quoted by the suppliers and manufacturers were used in the estimation.

#### 9.1.2 Pipelaying Cost

As pipelaying constitutes major part of this project, the cost is detailed in this sub-section.

Three assumptions are made in estimating pipelaying.

The first is that the 20 and 80 % of the total length of a pipeline are allocated to ductile-iron and asbestos-cement pipe respectively.

The second is that 10 % of the estimated cost including pipes, fittings and laying works is counted for railroad crossing, riverbed crossing and pipe bridge additionally.

The third is that 15 % of the estimated cost as above is counted for installation of valves, concrete thrust blocks and other miscellaneous works.

Table-9.1 (a) Unit Cost of Pipelaying (ACP)

(Unit: ₱/m)

Dia. (mm)	Labor	Pipe Material	Sub-Total	Pavement	Total
100	47	140	187	140	327
150	66	230	296	154	450
200	80	398	478	166	644
250	111	551	662	179	841
300	146	780	926	223	1,149
400	181	1,478	1,659	248	1,907
500	261	2,050	2,311	283	2,594
600	338	2,703	3,041	319	3,360

Table-9.1 (b) Unit Cost of Pipelaying (DIP)

(Unit: ₱/m)

Dia. (mm)	Labor	Pipe Material	Sub-Total	Pavement	Total
100	53	504	557	140	697
150	87	723	810	154	964
200	98	972	1,070	166	1,236
250	135	1,224	1,359	179	1,538
300	179	1,596	1,775	223	1,998
350	197	1,917	2,114	236	2,350
400	221	2,346	2,567	248	2,815
450	266	2,839	3,105	266	3,371
500	318	3,362	3,680	283	3,963
600	413	4,505	4,918	319	5,237
700	515	5,897	6,412	341	6,753
800	629	7,414	8,043	378	8,421
900	749	9,122	9,871	402	10,273
1,000	873	11,053	11,926	436	12,362
1,100	1,001	13,086	14,087	470	14,557
1,200	1,125	15,175	16,300	504	16,804



Table-9.1 (a) and (b) show the cost of unit length (meter) of pipelaying for asbestos-cement and ductile-iron pipes including pipes, fittings, labor and pavement restoration.

#### 9.1.3 Treatment Plant, Buildings and Others

In estimating approximately the construction cost of treatment plant and buildings used for administration and others in the plant site, the cost function graphs shown in Fig-9.1 are used.

To prepare the cost function curves, production capacities and construction costs of seven PWA treatment plants plotted and the curves are drawn as most appropriate. Similar data made by other consultants were also referred for comparison.

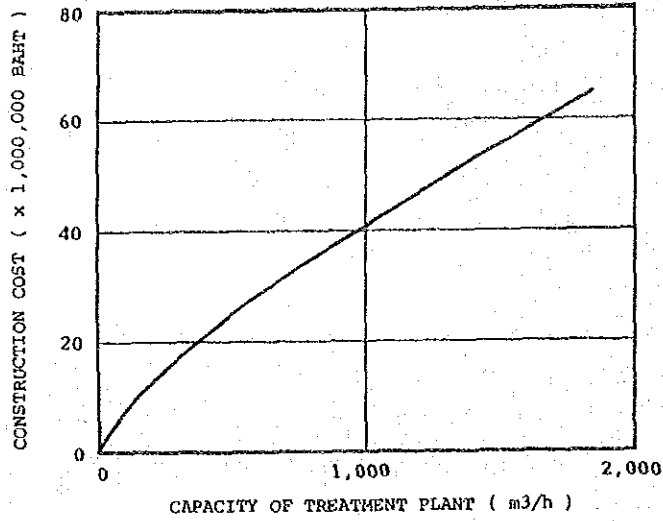
The approximately estimated costs were checked with the costs prepared by calculating, item by item, components of the whole construction work involved in the PWA standard design and the both were found close satisfactorily.

For other construction works like deep well, available data were studied and modification was made by illation from them.

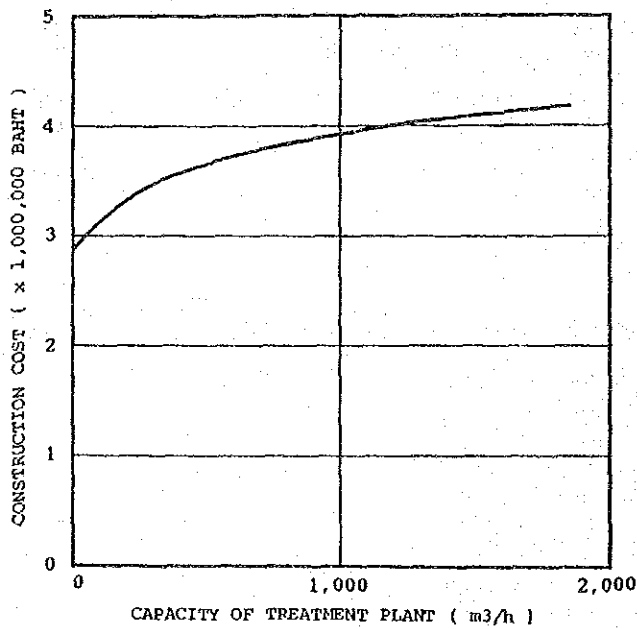
#### 9.1.4 Land Acquisition

Land price of the prospective sites of treatment plants, pump stations and other facilities under this plan were estimated based on the contacts with PWA local officials.

TREATMENT PLANT



BUILDINGS FOR ADMINISTRATION AND OTHER USES



<b>FIGURE</b>	COST FUNCTION OF TREATMENT PALNT AND BUILDINGS FOR ADMINISTRATION AND OTHER USES
9.1	
<b>JAPAN INTERNATIONAL COOPERATION AGENCY</b>	

## 9.2 Classification of Works

Every work involved in the project is to be classified into either one of the following six:

1. Pipelaying works : laying pipes above- and under-ground
2. Civil works : construction of barrage, grit chamber, clear water reservoir, intake tower, and earthwork, groundwork
3. Treatment plant construction : inclusive of 1, 2 and 5
4. Pump station construction : inclusive of 1, 2, 5 and architectural works
5. Equipment/machinery installation
6. Purchase of equipment/machinery

This classification is used in making allocation of foreign and local currency portion in the following section and in Table-9.2 listed later.

## 9.3 Costs allocation of Foreign and Local Currency Portions

All of the estimated costs are allocated to two currency portions, foreign and local, and to each of the six works classified before an appropriate ratio is to be applied.

### 9.3.1 Basic Conception

Those products which are imported as finished and do not need further processing in Thailand are considered to be of 100 % foreign currency portion.

Labor, both skilled and unskilled, and services locally procured are considered to be 100 % local currency portion.

In between the above two extremes, a certain appropriate ratio is applied upon consideration of the characteristic of item.

Even the majority of domestically made materials and products contain foreign currency portion. Cement and steel are made by consuming imported fuel and electricity, generated by imported fuel. Equipments and machineries producing these materials are imported sometimes. The asbestos-cement pipe, a local product, is made of imported asbestos.

Earthwork and concrete mixing and casting made by laborers in former days are worked by machineries, using foreign currency partly.

#### 9.3.2 Foreign and Local Currency Elements

The foreign currency elements are imported raw and processed materials, equipments and machineries, consumable goods including fuel, etc.

The local currency elements are local raw materials, skilled and unskilled labors used directly or indirectly, for instance, further processing of imported goods, etc.

#### 9.3.3 Combination of Foreign and Local Currency Elements

Of the six classified works, Fig-9.2 (1) to (6) shows how the foreign and local currency elements are combined to construct them.

The six figures are then summarized and shown in Table-9.2.

Seen in the table are:

- 1) The foreign currency portion increases in the order of the item number.

- 2) The locally processed portion is largest in treatment plant construction and smallest in equipment/machinery installation, as it involves installation of imported goods finished to higher degree.
- 3) The skilled labor portion is also highest in treatment plant construction and civil works.
- 4) The unskilled labor portion decreases in the order of the item number.
- 5) The sum of labor portions also decreases in the order of the item number, corresponding the labor-intensitiveness of those works.

Table-9.2 ALLOCATION OF FOREIGN AND LOCAL CURRENCY PORTIONS

No.	Works Description	F/C Portion	L/C Portion		
			Locally Processed Portion	Skilled Labor	Unskilled Labor
1.	Pipelaying	60	10	14	16
2.	Civil works	63	11	12	14
3.	Treatment Plant Construction	66	12	12	10
4.	Pump Station Construction	75	10	7	8
5.	Equipments/ Machinery Installation	85	5	7	3
6.	Equipments/ Machinery Purchase	100	0	0	0

#### 9.4 Construction Cost

Using the cost data mentioned in 9.1, estimation was made on Rehabilitation and Modification Works and Expansion Works planned for Stage I.

It is shown in Table-9.3.

Foreign or  
Local Currency

L/C

- 1. Skilled Labor
- 2. Unskilled Labor

Labor  
(L/C only)

Products  
Installation  
Works

F/C

- 3. Imported Portion

Products  
(F/C, L/C  
Combined)

L/C

- 4. Locally Processed-  
Portion

Whole  
Work

L/C

- 5. Skilled Labor

Labor  
(L/C only)

Civil  
Works

L/C

- 6. Unskilled Labor

F/C

- 7. Imported Portion

General  
Construction  
Materials  
(F/C, L/C  
Combined)

L/C

- 8. Locally Processed  
Portion

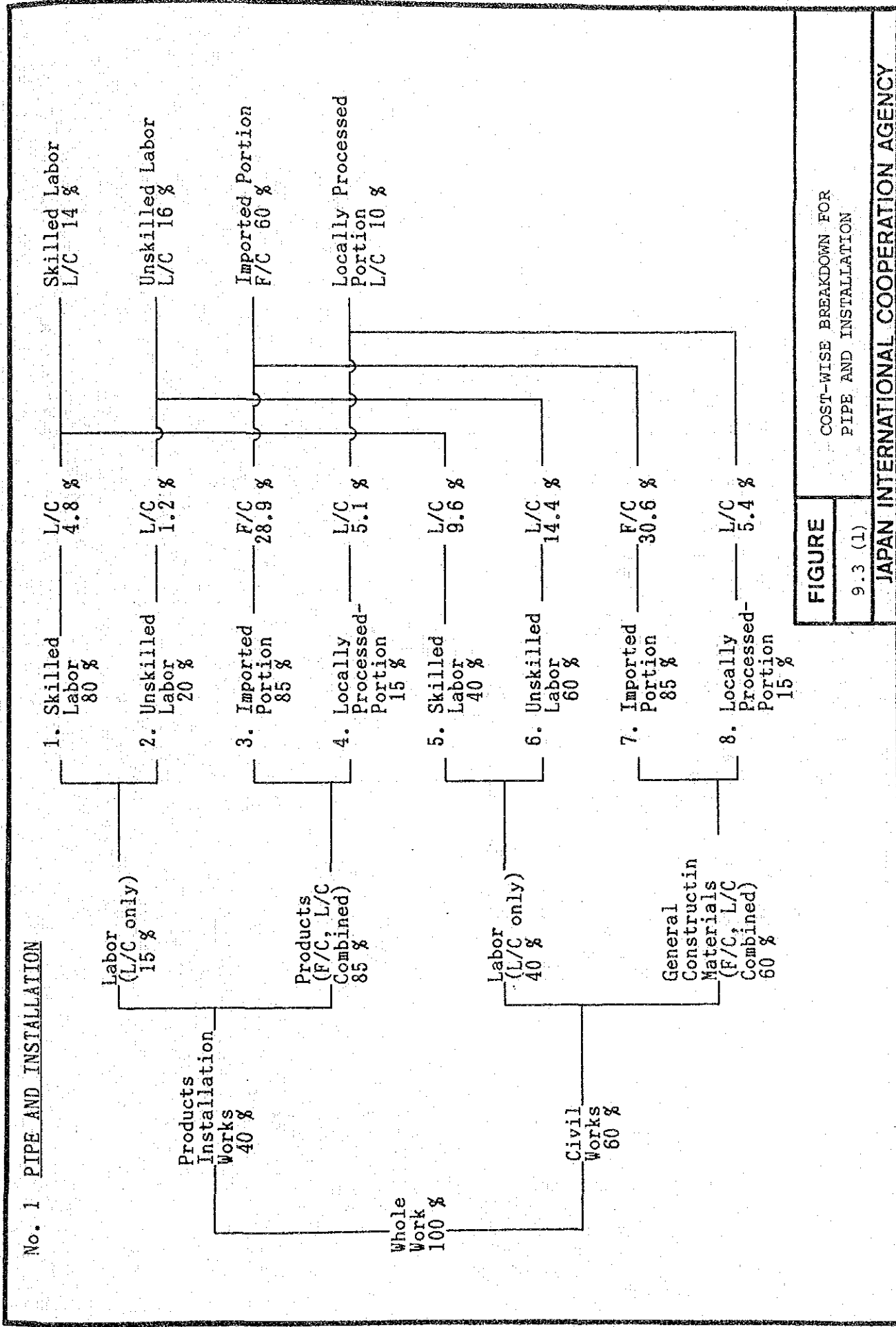
FIGURE

COST-WISE BREAKDOWN

9.2

JAPAN INTERNATIONAL COOPERATION AGENCY





**FIGURE**

9.3 (1)

COST-WISE BREAKDOWN FOR  
PIPE AND INSTALLATION

JAPAN INTERNATIONAL COOPERATION AGENCY

No. 2 CIVIL WORKS

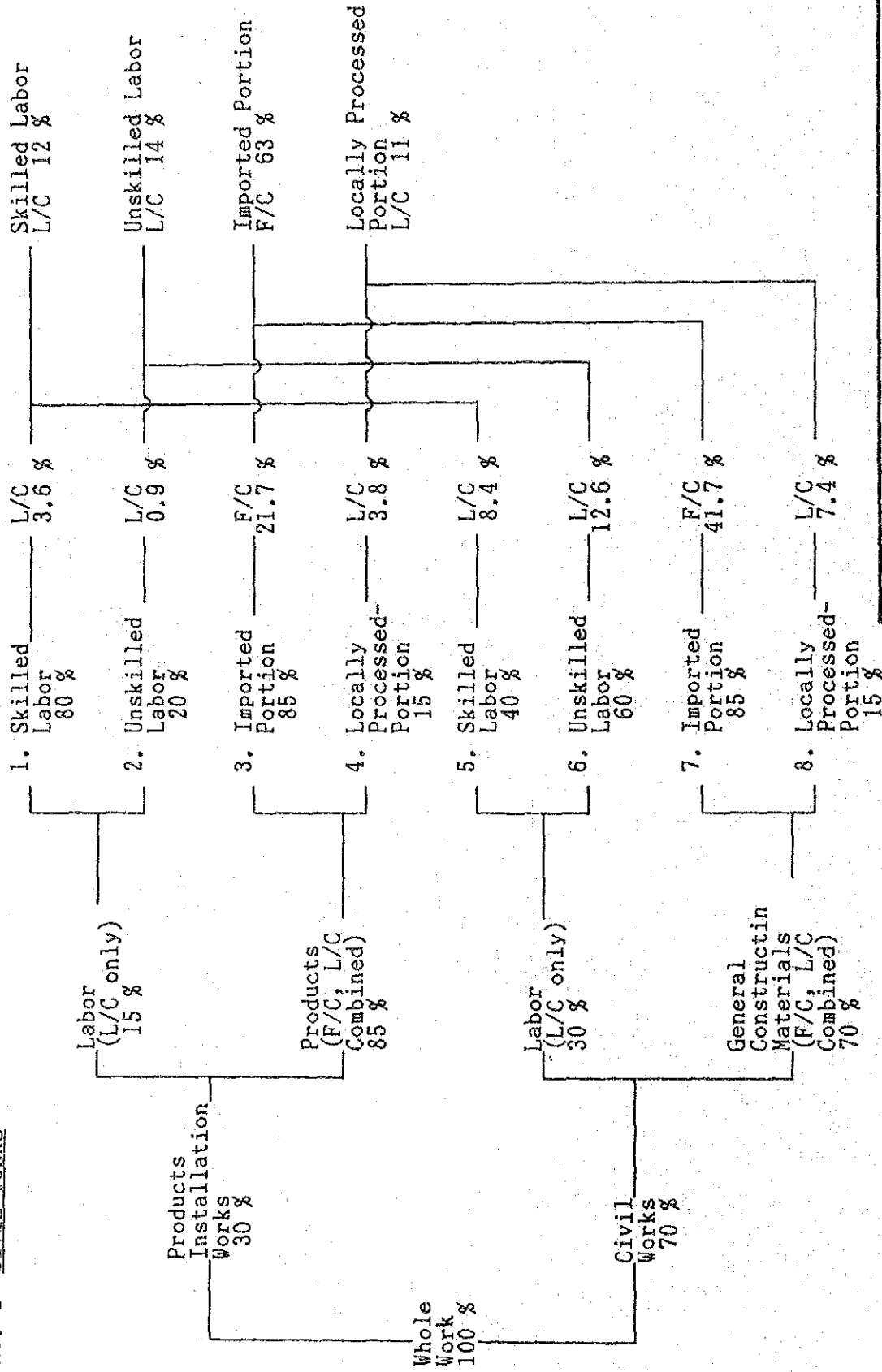
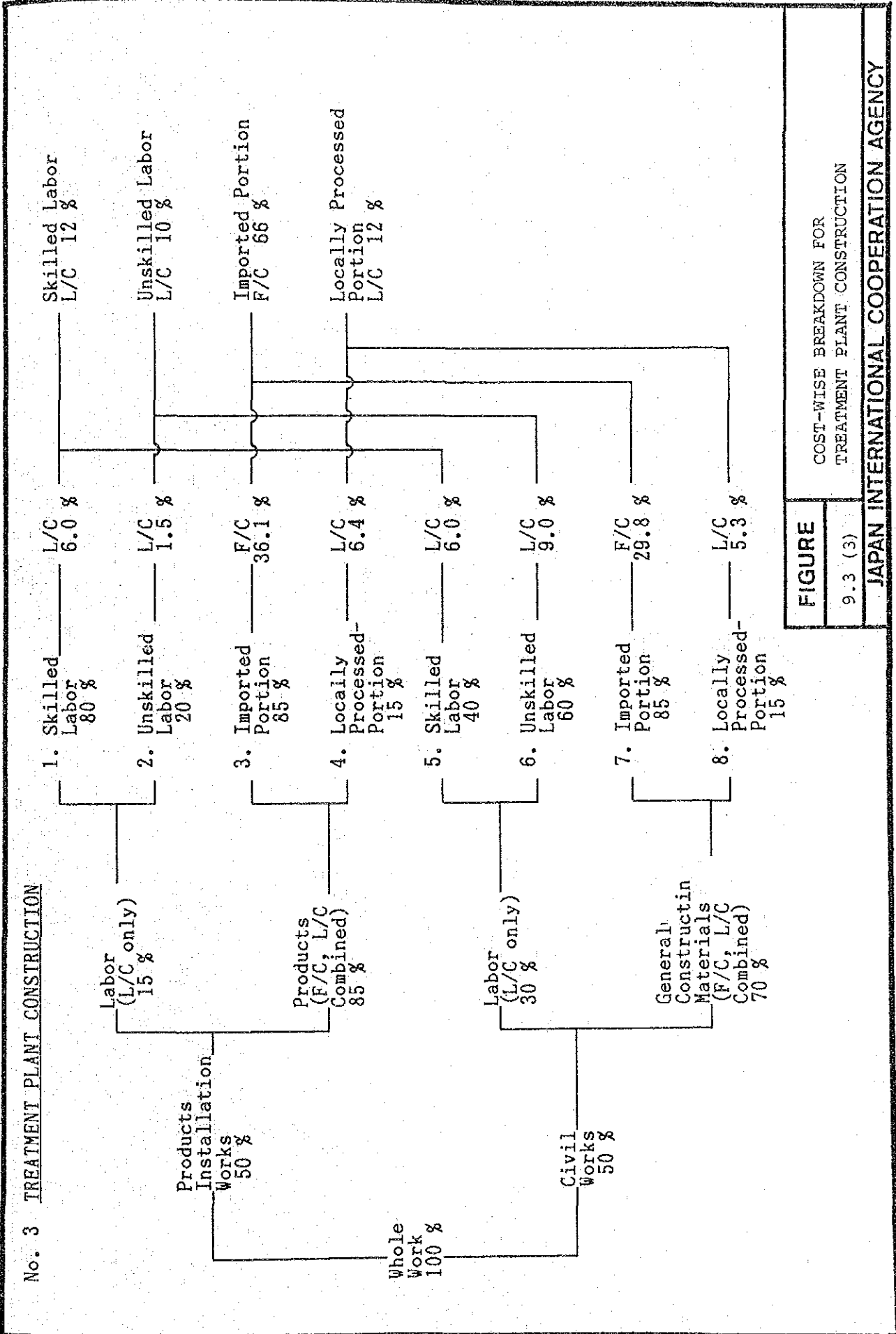


FIGURE  
9.3 (2)  
JAPAN INTERNATIONAL COOPERATION AGENCY

COST-WISE BREAKDOWN FOR  
CIVIL WORKS

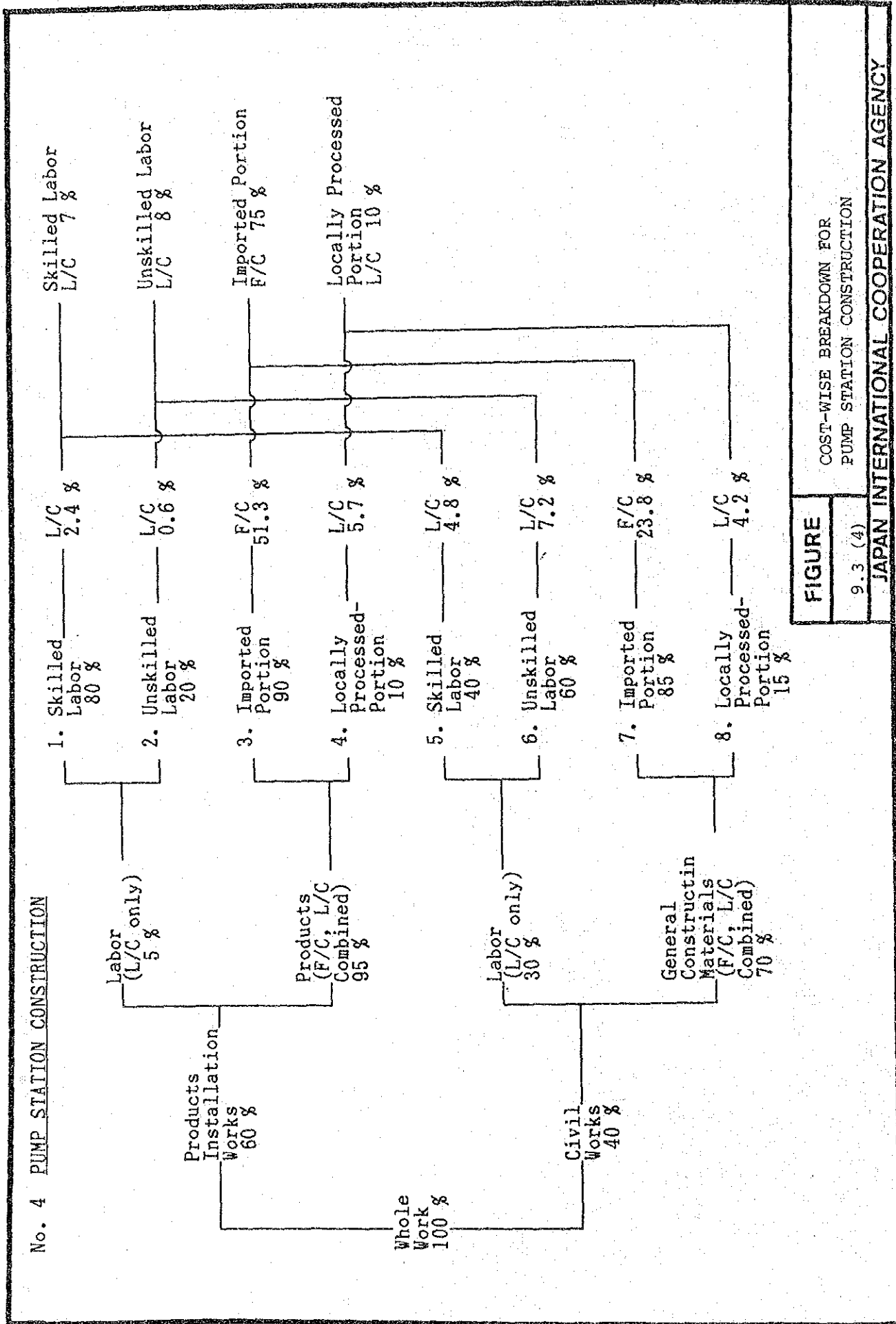
JAPAN INTERNATIONAL COOPERATION AGENCY



**FIGURE**  
9.3 (3)

COST-WISE BREAKDOWN FOR  
TREATMENT PLANT CONSTRUCTION

JAPAN INTERNATIONAL COOPERATION AGENCY

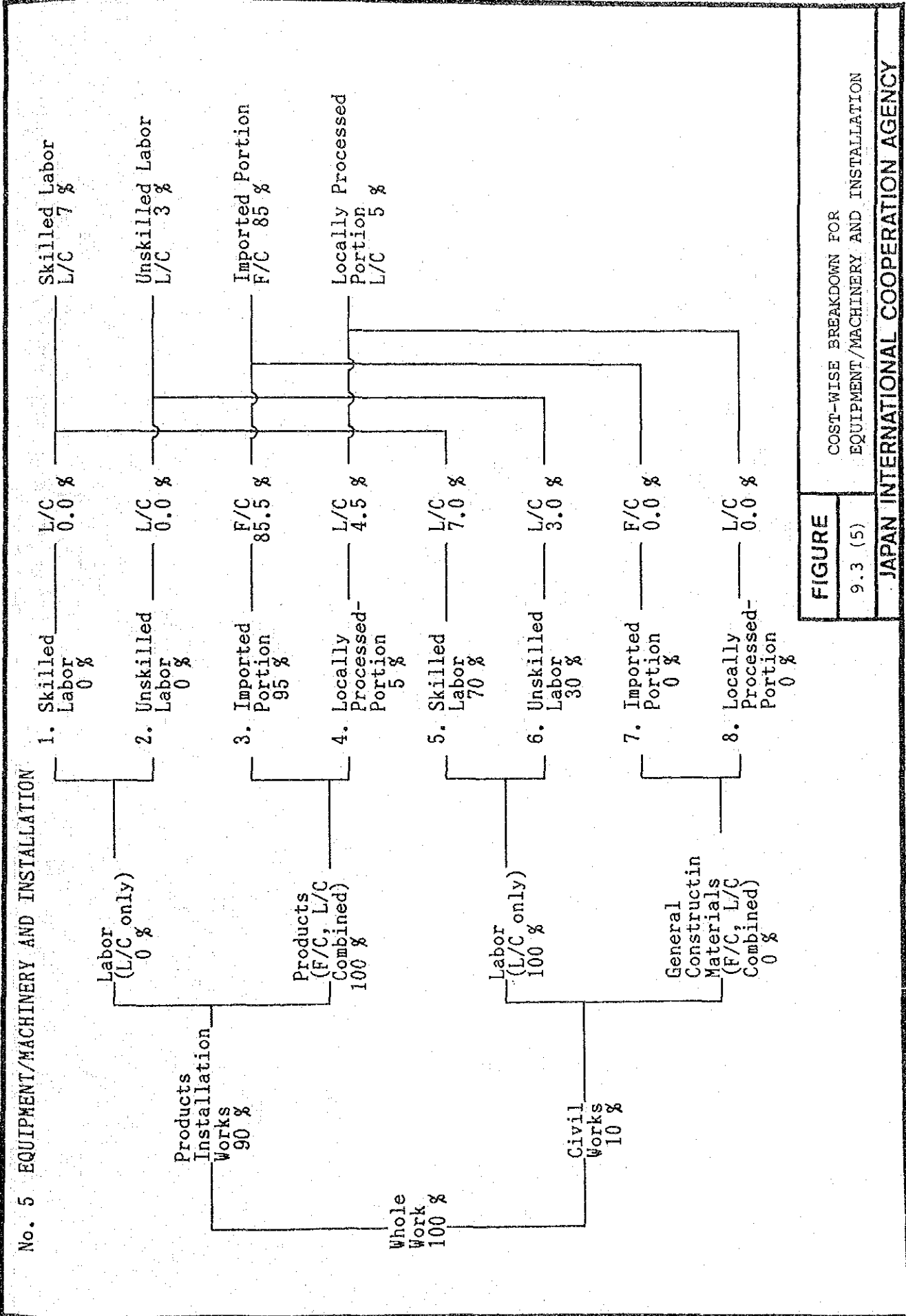


**FIGURE**

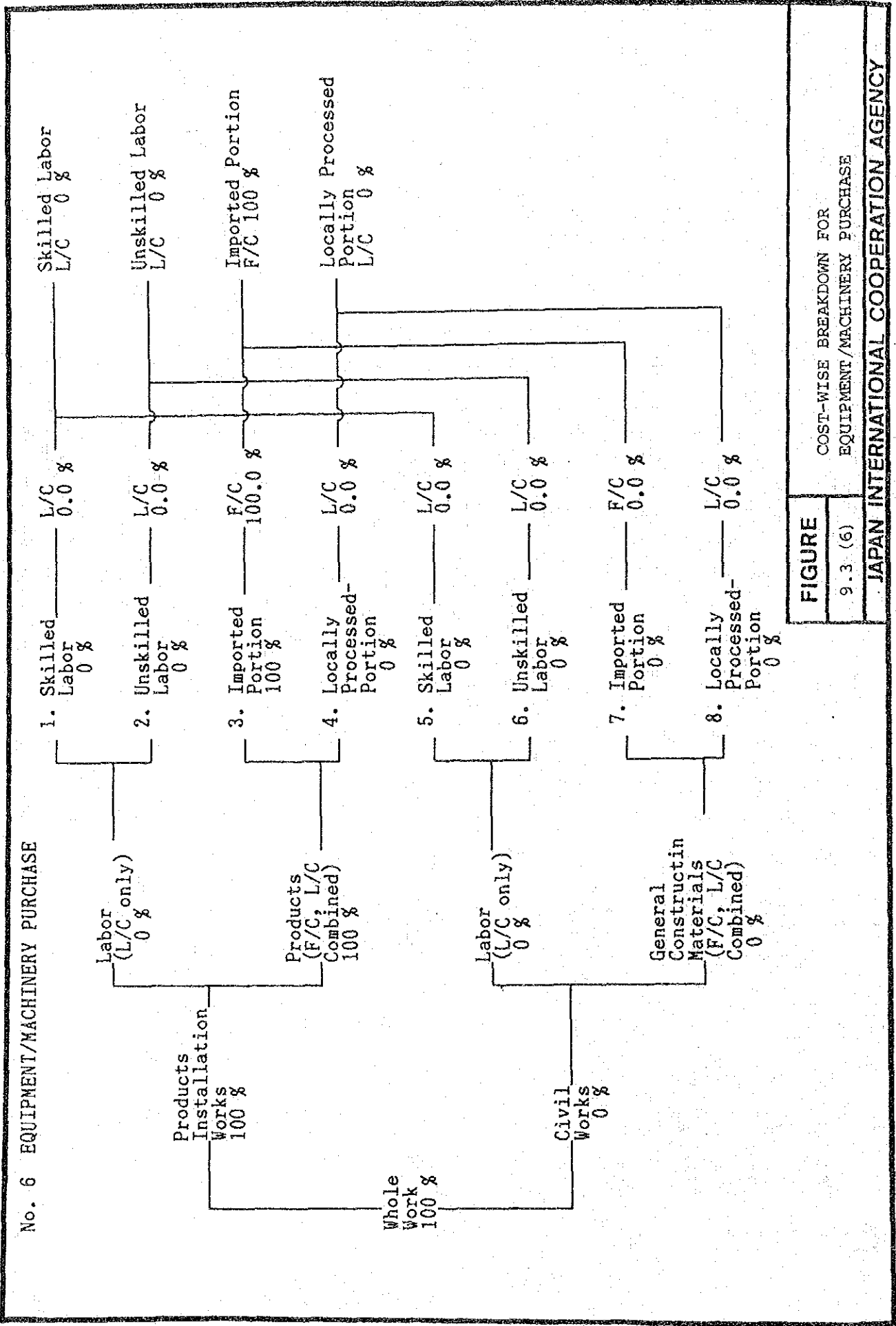
COST-WISE BREAKDOWN FOR  
PUMP STATION CONSTRUCTION

9.3 (4)

JAPAN INTERNATIONAL COOPERATION AGENCY



**FIGURE**  
9.3 (5)  
COST-WISE BREAKDOWN FOR  
EQUIPMENT/MACHINERY AND INSTALLATION  
JAPAN INTERNATIONAL COOPERATION AGENCY



**FIGURE**

9.3 (6)

COST-WISE BREAKDOWN FOR  
EQUIPMENT/MACHINERY PURCHASE

JAPAN INTERNATIONAL COOPERATION AGENCY

Table-9.3 CONSTRUCTION COST

Unit : x 1,000 Baht

Work Item	Description	Quantity	Unit Cost	Cost
<b>I. Stage I Rehabilitatin/Modification Works</b>				
<b>1. Land Acquisition</b>				
T o t a l 1				-
<b>2. Treatment Plant Facilities</b>				
<b>1) Ubon Plant</b>				
a)	Flow Meter & Indicator	6	550	3,300
b)	Level Gauge	3	200	600
c) Chemical Feeding Equipment				
	Alum Feeding Pump	1	85	85
	Appurtenances of Alum Feeding Pump	L.S.		100
	Lime Solution Tank	2	15	30
	Lime Feeding Pump	2	71	142
	Appurtenances of Lime Feeding Pump	L.S.		193
	Chemical House	L.S.		400
d)	Chlorine Gas Container Scale	1	300	300
e)	Filter Sand Washer (for Ubon Waterworks	1	650	650
Sub-Total 1)				5,800
<b>2) Warin Plant</b>				
a)	Flow Meter & Indicator	2	550	1,100
b)	Level Gauge	1	200	200
c) Chemical Feeding Equipment				
	Alum Feeding Pump	1	85	85
	Appurtenances of Alum Feeding Pump	L.S.		100
	Lime Solution Tank	2	15	30
	Lime Feeding Pump	2	71	142
	Appurtenances of Lime Feeding Pump	L.S.		193
	Chemical House	L.S.		400
d)	Chlorine Gas Container Scale	1	300	300
e) Distribution Pump:				
	Q6.2 m <sup>3</sup> /min x H30 m x 55 kW Motor and Engine Drive Type	1	560	560
	Piping and Wiring Work	L.S.		290
Sub-Total 2)				3,400
T o t a l 2				9,200
<b>3. Distribution Pipeline</b>				
<b>1) Replacement of Pipe-line</b>				
	Dia. 150 mm ACP x 6,450 m	6,450	0.45	2,903
	Dia. 100 mm ACP x 770 m	770	0.327	252
	Miscellaneous Works	L.S.		595
Sub-Total 1)				3,750
<b>2) Leak Detection Equipment</b>				
	Metal Pipe Detector	1	80	80
	Non-Metal Pipe Detector	1	200	200
	Box Locator	1	20	20
	Leak Detector	2	60	120
	Stethoscopic Bar	2	3	6
	Spare Parts	L.S.		24
Sub-Total 2)				450
T o t a l 3				4,200
<b>I. Stage I Rehabilitatin/Modification Works TOTAL</b>				<b>13,400</b>

Unit : x 1,000 Baht				
Work Item	Description	Quantity	Unit Cost	Cost
<b>II. Stage I Expansion Works</b>				
<b>1. Land Acquisition</b>				
a)	Space for Staff Houses $\varnothing 200$ m <sup>2</sup> x 5 houses	1,000	0.5	500
b)	Space for Dweller $\varnothing 160$ m <sup>2</sup> x 30 houses = 4,800 m <sup>2</sup>	4,800	0.5	2,400
T o t a l 1				2,900
<b>2. Treatment Plant Facilities</b>				
<b>1) Ubon Plant</b>				
a)	Intake and Raw Water Pipeline Intake Tower W8 m x L 20 m x H20 m = 3,200 m <sup>3</sup> Raw Water Pump Q6.2 m <sup>3</sup> /min x H 30 m x 55 kW Motor Drive Type 3 263 789 Engine Drive Type 3 447 1,341 Piping and Wiring Works L.S. 1,070 Raw Water Pipeline 80 4 320 Dia 500 mm SP x 80 m Miscellaneous Works L.S. 280 Sub-Total a)	3,200	2	6,400
b)	Ubon No.4 Plant Civil Works of Treatment Plant L.S. 38,500 Buildings of Administration and L.S. 3,900 Elevated Tank V=250 m <sup>3</sup> L.S. 2,000 Instrumentation Facilities L.S. 3,900 Miscellaneous Works L.S. 5,800 Distribution Pump Q10.8 m <sup>3</sup> /min x H 30 m x 75 kW Motor Drive Type 2 325 650 Engine Drive Type 1 552 552 Q5.4 m <sup>3</sup> /min x H 30 m x 45 kW Motor Drive Type 1 243 243 Engine Drive Type 1 377 377 Piping and Wiring Works L.S. 978 Pump House 8 m x 25 m = 200 m <sup>2</sup> 200 4 800 Clear Water Reservoir V=5,500 m <sup>3</sup> 5,500 2 11,000 Sub-Total b)			68,700
c)	Other Works Staff House 5 388 1,940 Replacement of Pipeline 250 0.841 210 ACP Dia 250 x 250 m L.S. Miscellaneous Works L.S. 50 Dwellers' House Construction (one house for two families; 30/2 = 15 houses) 15 410 6,150 Compensation and Others L.S. 1,850 Sub-Total c)			10,200
Sub-Total 1)				89,100
<b>2) Warin Plant</b>				
	Clear Water Reservoir V=1,200 m <sup>3</sup> 1,200 2.5 3,000 Miscellaneous Works L.S. 600 Distribution Pump Q6.2 m <sup>3</sup> /min x H 30 m x 55 kW Motor and Engine Drive Type 1 560 560 Q3.1 m <sup>3</sup> /min x H 30 m x 30 kW Motor and Engine Drive Type 1 360 360 Piping and Wiring Works L.S. 460 Pump House 8 m x 10 m = 80 m <sup>2</sup> 80 4 320 Miscellaneous Works L.S. 300 Sub-Total 2)			5,600
T o t a l 2				94,700
<b>3. Distribution Facilities</b>				
	Dia. 400 mm DIP x 980 m 980 2.815 2,759 Dia. 400 mm ACP x 3,920 m 3,920 1.907 7,475 Dia. 300 mm DIP x 1,020 m 1,020 1.998 2,038 Dia. 300 mm ACP x 4,390 m 4,390 1.149 5,044 Dia. 250 mm DIP x 960 m 960 1.538 1,475 Dia. 250 mm ACP x 3,830 m 3,830 0.841 3,221 Dia. 200 mm DIP x 1,700 m 1,700 1.236 2,101 Dia. 200 mm ACP x 6,790 m 6,790 0.644 4,373 Dia. 150 mm ACP x 4,800 m 4,800 0.45 2,160 Dia. 100 mm ACP x 24,450 m 24,450 0.327 7,995 Pipe Bridge and Road Crossing Works L.S. 3,864 Miscellaneous Works L.S. 5,794			48,300
T o t a l 3				48,300
<b>II. Stage I Expansion Works TOTAL</b>				145,900
<b>GROUND TOTAL ( I + II )</b>				159,300



APPENDIX 10

FINANCIAL AND ECONOMIC STUDY



APPENDIX 10 FINANCIAL AND ECONOMIC STUDY

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Table-10.1 CASH FLOW PROJECTED (1,000 Baht) AT 1986 PRICE. (UBON-WARIN WATERWORKS)

Description	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
(A) Water Production (x1000 m3)	7,333	7,719	8,094	8,511	8,880	9,264	10,052	10,669	11,257	11,846	12,529	13,112	13,710	14,221	14,726
(B) Unaccounted for Water (%)	34.0	33.0	32.0	31.0	30.0	29.0	28.0	27.0	26.0	25.0	24.6	24.2	23.8	23.4	23.0
(C) Water Sales (x1000 m3)	4,840	5,172	5,504	5,873	6,216	6,577	7,237	7,788	8,330	8,884	9,447	9,939	10,447	10,893	11,339
(D) No. of Connections	10,850	11,475	12,130	12,844	13,544	14,043	15,415	16,449	17,413	18,329	19,075	19,728	20,314	20,850	21,322
(E) Average Water Tariff (Baht/m3)	6.90	6.90	6.90	6.90	6.90	6.90	6.90	6.90	6.90	6.90	6.90	6.90	6.90	6.90	6.90
1. Operating Revenue:															
1.1 Water Sales	33,395	35,687	37,979	40,523	42,890	45,383	49,937	53,740	57,480	61,303	65,181	68,576	72,085	75,165	78,237
1.2 Connection Fees	2,400	2,500	2,620	2,856	2,800	1,996	5,488	4,136	3,856	3,664	2,984	2,612	2,344	2,064	1,968
1.3 Service Charges	1,603	1,695	1,792	1,897	2,001	2,074	2,277	2,430	2,572	2,708	2,818	2,914	3,001	3,077	3,150
1.4 Other Revenue	209	223	237	253	266	276	322	336	357	378	396	413	432	448	465
Total 1.	37,607	40,105	42,627	45,529	47,957	49,730	58,024	60,642	64,265	68,052	71,379	74,516	77,861	80,754	83,829
2. Expenses:															
2.1 Operation & Maintenance															
- Personnel Cost	4,432	4,552	4,803	4,907	5,055	6,006	6,639	6,820	6,967	7,312	7,487	7,487	7,624	7,875	7,875
- Electricity & Fuel Cost	4,384	4,937	5,186	5,399	5,686	5,126	6,452	6,850	7,226	7,603	8,030	8,411	8,794	9,135	9,452
- Chemical Cost	1,440	1,511	1,590	1,669	1,741	1,819	1,974	2,095	2,210	2,325	2,436	2,572	2,698	2,794	3,223
- Connection Cost	893	939	984	1,073	1,052	750	2,062	1,554	1,449	1,377	1,121	981	881	775	739
- Other Cost	940	1,007	1,060	1,101	1,142	1,156	1,445	1,461	1,506	1,570	1,611	1,641	1,686	1,736	1,796
Sub-total 2.1	12,089	12,947	13,624	14,149	14,675	14,856	18,571	18,780	19,358	20,187	20,704	21,092	21,674	22,516	23,086
2.2 Share of Head & Regional Office Overhead Expenses	5,494	5,859	6,228	6,652	7,007	7,266	8,477	8,860	9,389	9,942	10,429	10,887	11,376	11,798	12,246
2.3 Debt Service	0	76	555	1,328	4,606	9,559	12,501	17,749	18,332	17,469	16,606	23,190	22,151	21,113	14,710
Total 2.	17,583	18,882	20,407	22,129	26,288	31,681	39,550	45,388	47,079	47,599	47,738	55,169	55,201	55,227	50,042
3. Net Cash Flow Surplus:															
3.1 Annual	20,024	21,223	22,221	23,400	21,669	18,049	18,474	15,254	17,185	20,453	23,641	19,348	22,660	25,527	33,778
3.2 Cumulative	20,024	41,247	63,467	86,867	108,536	126,585	145,059	160,313	177,498	197,952	221,593	240,940	263,600	289,127	322,905
4. Unit Cost of Water after Debt Service (Baht/m3)*	3.2	3.2	3.3	3.4	3.8	4.4	4.7	5.2	5.1	4.8	4.6	5.1	4.9	4.7	4.1

Note: \* [(Total 2.) x ((1.1 Water Sales) / (Total 1.))] / (3. Water Sales m3)

Table-10.2 CASH FLOW PROJECTED (1,000 Baht) AT CURRENT PRICE (UBON-WARIN WATERWORKS)

Description	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
(A) Water Production (x1000 m3)	7,333	7,719	8,094	8,511	8,880	9,264	10,052	10,669	11,257	11,846	12,529	13,112	13,710	14,221	14,726
(B) Unaccounted for Water (%)	34.0	33.0	32.0	31.0	30.0	29.0	28.0	27.0	26.0	25.0	24.6	24.2	23.8	23.4	23.0
(C) Water Sales (x1000 m3)	4,840	5,172	5,504	5,873	6,216	6,577	7,237	7,788	8,330	8,884	9,447	9,939	10,447	10,893	11,339
(D) No. of Connections	10,850	11,475	12,130	12,844	13,544	14,043	15,415	16,449	17,413	18,329	19,075	19,728	20,314	20,830	21,322
(E) Average Water Tariff (Baht/m3)**	6.90	7.13	7.36	7.61	7.86	8.12	8.38	8.66	8.95	9.24	9.55	9.86	10.19	10.52	10.87
<b>1. Operating Revenue:</b>															
1.1 Water Sales	33,395	36,865	40,527	44,668	48,838	53,382	60,577	67,452	74,528	82,108	90,183	98,012	106,426	114,635	123,259
1.2 Connection Fees	2,400	2,583	2,796	3,148	3,188	2,348	6,669	5,192	5,000	4,908	4,129	3,733	3,461	3,148	3,101
1.3 Service Charges	1,603	1,751	1,912	2,091	2,278	2,440	2,767	3,050	3,335	3,627	3,899	4,165	4,430	4,693	4,962
1.4 Other Revenue	209	230	252	278	303	325	391	422	462	506	548	591	638	683	733
<b>Total 1.</b>	<b>37,607</b>	<b>41,428</b>	<b>45,487</b>	<b>50,186</b>	<b>54,608</b>	<b>58,495</b>	<b>70,503</b>	<b>76,116</b>	<b>83,325</b>	<b>91,148</b>	<b>98,759</b>	<b>106,501</b>	<b>114,955</b>	<b>123,159</b>	<b>132,054</b>
<b>2. Expenses:</b>															
2.1 Operation & Maintenance															
- Personnel Cost	4,432	4,871	5,499	6,012	6,626	8,423	9,964	10,952	11,971	13,443	14,728	15,759	17,170	18,978	20,306
- Electricity & Fuel Cost	4,384	4,529	4,678	4,833	4,992	5,157	5,327	5,503	5,685	5,872	6,066	6,266	6,473	6,687	6,907
- Chemical Cost	1,440	1,561	1,697	1,840	1,982	2,140	2,398	2,630	2,866	3,114	3,398	3,676	3,971	4,262	5,078
- Connection Cost	893	970	1,050	1,183	1,198	882	2,505	1,950	1,878	1,844	1,551	1,403	1,300	1,183	1,165
- Other Cost	940	1,006	1,090	1,170	1,248	1,400	1,703	1,774	1,889	2,048	2,171	2,286	2,439	2,624	2,822
<b>Sub-total 2.1</b>	<b>12,089</b>	<b>12,938</b>	<b>14,015</b>	<b>15,037</b>	<b>16,046</b>	<b>18,003</b>	<b>21,898</b>	<b>22,809</b>	<b>24,289</b>	<b>26,321</b>	<b>27,914</b>	<b>29,391</b>	<b>31,354</b>	<b>33,733</b>	<b>36,279</b>
2.2 Share of Head & Regional Office Overhead Expenses ***	5,494	6,053	6,646	7,332	7,978	8,546	10,301	11,121	12,174	13,317	14,429	15,560	16,795	17,994	19,293
2.3 Debt Service	0	76	555	1,328	4,606	9,559	12,501	17,749	18,332	17,669	16,606	25,190	22,151	21,113	14,710
<b>Total 2.</b>	<b>17,583</b>	<b>19,066</b>	<b>21,216</b>	<b>23,697</b>	<b>28,631</b>	<b>36,108</b>	<b>44,700</b>	<b>51,679</b>	<b>54,795</b>	<b>57,107</b>	<b>58,949</b>	<b>68,140</b>	<b>70,300</b>	<b>72,840</b>	<b>70,282</b>
<b>3. Net Cash Flow Surplus:</b>															
3.1 Annual	20,024	22,362	24,271	26,490	25,977	22,387	25,804	24,438	28,530	34,041	39,810	38,361	44,655	50,320	61,773
3.2 Cumulative	20,024	42,386	66,657	93,147	119,124	141,510	167,314	191,752	220,282	254,323	294,132	332,493	377,148	427,468	489,240
<b>4. Unit Cost of Water after Debt Service (Baht/m3)*</b>	<b>3.2</b>	<b>3.3</b>	<b>3.4</b>	<b>3.6</b>	<b>4.1</b>	<b>5.0</b>	<b>5.3</b>	<b>5.9</b>	<b>5.9</b>	<b>5.8</b>	<b>5.7</b>	<b>6.3</b>	<b>6.2</b>	<b>6.2</b>	<b>5.8</b>

Note: \* [(Total 2.) x ((1.1 Water Sales) / (Total 1.))] / (3 Water Sales m3)

\*\* Based upon the assumption that the water tariff increases every year at the rate of 3.5%.

Table-10.3 CASH FLOW PROJECTED (1,000 Baht) AT CURRENT PRICE (UBON-WARIN WATERWORKS)

Description	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
(A) Water Production (x1000 m3)	7,333	7,719	8,094	8,511	8,880	9,264	10,052	10,669	11,257	11,846	12,529	13,112	13,710	14,221	14,726
(B) Unaccounted for Water (%)	34.0	33.0	32.0	31.0	30.0	29.0	28.0	27.0	26.0	25.0	24.6	24.2	23.8	23.4	23.0
(C) Water Sales (x1000 m3)	4,840	5,172	5,504	5,873	6,216	6,577	7,237	7,788	8,330	8,884	9,447	9,939	10,447	10,893	11,339
(D) No. of Connections	10,850	11,475	12,130	12,844	13,544	14,043	15,415	16,449	17,413	18,329	19,075	19,728	20,314	20,830	21,322
(E) Average Water Tariff (Baht/m3)**	6.90	6.90	6.90	6.90	6.90	6.90	6.90	6.90	6.90	6.90	6.90	6.90	6.90	6.90	6.90
<b>1. Operating Revenue:</b>															
1.1 Water Sales	33,395	35,687	37,979	40,523	42,890	45,383	49,937	53,740	57,480	61,303	65,181	68,576	72,085	75,165	78,237
1.2 Connection Fees	2,400	2,500	2,620	2,856	2,800	1,996	5,488	4,136	3,856	3,664	2,984	2,612	2,344	2,064	1,968
1.3 Service Charges	1,603	1,695	1,792	1,897	2,001	2,074	2,277	2,430	2,572	2,708	2,818	2,914	3,001	3,077	3,150
1.4 Other Revenue	209	223	237	253	266	276	322	336	357	378	396	413	432	448	465
Total 1.	37,607	40,105	42,627	45,529	47,957	49,730	58,024	60,642	64,265	68,052	71,379	74,516	77,861	80,754	83,820
<b>2. Expenses:</b>															
2.1 Operation & Maintenance															
- Personnel Cost	4,432	4,871	5,499	6,012	6,626	8,423	9,964	10,952	11,971	13,443	14,728	15,759	17,170	18,978	20,306
- Electricity & Fuel Cost	4,384	4,921	5,340	5,743	6,247	5,817	7,564	8,295	9,040	9,826	10,719	11,598	12,527	13,443	14,368
- Chemical Cost	1,440	1,581	1,697	1,840	1,982	2,140	2,398	2,630	2,866	3,114	3,398	3,676	3,971	4,262	5,078
- Connection Cost	893	970	1,050	1,183	1,198	882	2,505	1,950	1,878	1,844	1,551	1,403	1,300	1,183	1,165
- Other Cost	940	1,039	1,146	1,246	1,354	1,456	1,892	2,010	2,173	2,381	2,564	2,736	2,950	3,194	3,451
Sub-total 2.1	12,089	13,362	14,732	16,023	17,407	18,719	24,323	25,837	27,928	30,608	32,960	35,173	37,918	41,059	44,369
2.2 Share of Head & Regional Office Overhead Expenses	5,494	5,859	6,228	6,652	7,007	7,266	8,477	8,860	9,389	9,942	10,429	10,887	11,376	11,798	12,246
2.3 Debt Service	0	76	555	1,328	4,606	9,559	12,501	17,749	18,332	17,469	16,606	23,190	22,151	21,113	14,710
Total 2.	17,583	19,298	21,515	24,003	29,020	35,544	45,302	52,446	55,649	58,019	59,995	69,249	71,445	73,970	71,325
<b>3. Net Cash Flow Surplus:</b>															
3.1 Annual	20,024	20,807	21,112	21,526	18,937	14,186	12,722	8,197	8,616	10,033	11,385	5,267	6,416	6,784	12,495
3.2 Cumulative	20,024	40,831	61,943	83,469	102,407	116,593	129,315	137,512	146,127	156,160	167,545	172,812	179,228	186,012	198,507
4. Unit Cost of Water after Debt Service (Baht/m3)*	3.2	3.3	3.5	3.6	4.2	4.9	5.4	6.0	6.0	5.9	5.8	6.4	6.3	6.3	5.9

Note: \* [(Total 2.) x ((1.1 Water Sales) / (Total 1.))] / (3. Water Sales m3)

\*\* Based upon the assumption that the water tariff remains unchanged up to 2000.

Table-10.4 FORMULA SUGGESTED FOR SHARE ALLOCATION OF HEAD AND REGIONAL OFFICE EXPENSES BASED ON WATERWORKS NET SURPLUSES FOR 1985 (in Million Baht)

Item	Chiangmai Waterworks	Pattaya Waterworks	Ubon-Rat Waterworks	Suphanburi Waterworks	Total Revenue of PWA	All Waterworks of PWA	Item	Head Office	Regional Office I	Regional Office II	Regional Office VIII	Regional Office IX
Revenue	64.614	49.106	27.999	7.556	1,307.990	1,307.990	Revenue of w/w under its jurisdiction	1,307.990	196.049	130.639	100.181	168.066
Expenses	21.627	8.205	11.039	4.960	901.730	641.685	Expense of office	159.273	6.959	8.102	5.545	8.001
Surplus (B)	42.987	40.901	16.960	2.596	406.260	666.305	Expens/Surplus of all waterworks under jurisdiction	0.239	0.010	0.012	0.006	0.012
Share Percentage (A)							=SHARE PERCENTAGE (A)					
Head Off Expenses	0.239	0.239	0.239	0.239	0.239	0.239						
Reg Off Expenses	0.012	0.010	0.008	0.012	0.012	0.012						
Total	0.251	0.249	0.247	0.251	0.251	0.251						
Share Amount ((B)x(A))												
Head Off Expenses	10.276	9.777	4.054	0.621	0.621	0.621						
Reg Off Expenses	0.516	0.427	0.141	0.032	0.032	0.032						
Total	10.792	10.204	4.195	0.652	0.652	0.652						



Table-10.5 CASH FLOW PROJECTED (1,000 Baht) AT 1986 PRICE. (UBON-MARTIN WATERWORKS)

Description	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
(A) Water Production (x1000 m3)	7,333	7,719	8,094	8,511	8,880	9,264	10,052	10,669	11,257	11,846	12,529	13,112	13,710	14,221	14,726
(B) Unaccounted for Water (%)	34.0	33.0	32.0	31.0	30.0	29.0	28.0	27.0	26.0	25.0	24.6	24.2	23.8	23.4	23.0
(C) Water Sales (x1000 m3)	4,840	5,172	5,504	5,873	6,216	6,577	7,237	7,788	8,330	8,884	9,447	9,939	10,447	10,893	11,339
(D) No. of Connections	10,850	11,475	12,130	12,844	13,544	14,043	15,415	16,449	17,413	18,329	19,075	19,728	20,314	20,830	21,322
(E) Average Water Tariff (Baht/m3)	6.90	6.90	6.90	6.90	6.90	6.90	6.90	6.90	6.90	6.90	6.90	6.90	6.90	6.90	6.90
<b>1. Operating Revenue:</b>															
1.1 Water Sales	33,395	35,687	37,979	40,523	42,890	45,383	49,937	53,740	57,480	61,303	65,181	68,576	72,085	75,165	78,237
1.2 Connection Fees	2,400	2,500	2,620	2,856	2,800	1,996	5,488	4,136	3,856	3,664	2,984	2,612	2,344	2,064	1,968
1.3 Service Charges	1,603	1,695	1,792	1,897	2,001	2,074	2,277	2,430	2,572	2,707	2,818	2,914	3,001	3,077	3,150
1.4 Other Revenue	209	223	237	253	266	276	322	336	357	378	396	413	432	448	465
Total 1.	37,607	40,105	42,627	45,529	47,957	49,730	58,024	60,642	64,265	68,052	71,379	74,516	77,861	80,754	83,820
<b>2. Expenses:</b>															
2.1 Operation & Maintenance															
- Personnel Cost	4,432	4,552	4,803	4,907	5,055	6,006	6,639	6,820	6,967	7,312	7,487	7,687	7,624	7,875	7,875
- Electricity & Fuel Cost	4,384	4,937	5,186	5,399	5,686	5,126	6,452	6,850	7,226	7,603	8,030	8,411	8,794	9,135	9,452
- Chemical Cost	1,440	1,511	1,590	1,669	1,741	1,819	1,974	2,095	2,210	2,325	2,456	2,572	2,690	2,794	3,223
- Connection Cost	893	939	984	1,073	1,052	750	2,062	1,554	1,449	1,377	1,121	981	881	775	739
- Other Cost	940	1,007	1,060	1,101	1,142	1,156	1,445	1,461	1,506	1,570	1,611	1,641	1,686	1,736	1,796
Sub-total 2.1	12,089	12,947	13,624	14,149	14,675	14,856	18,571	18,780	19,358	20,187	20,704	21,092	21,674	22,316	23,086
2.2 Share of Head & Regional Office Overhead Expenses **	5,635	6,009	6,387	6,822	7,185	7,451	8,694	9,086	9,629	10,196	10,695	11,165	11,666	12,099	12,559
2.3 Debt Service	0	76	555	1,328	4,606	9,559	12,501	17,749	18,332	17,469	16,606	23,190	22,151	21,113	14,710
Total 2.	17,723	19,032	20,566	22,299	26,467	31,867	39,766	45,615	47,319	47,853	48,005	55,447	55,492	55,528	50,354
<b>3. Net Cash Flow Surplus:</b>															
3.1 Annual	19,883	21,073	22,062	23,230	21,490	17,863	18,258	15,027	16,945	20,199	23,374	19,069	22,370	25,225	33,465
3.2 Cumulative	19,883	40,956	63,018	86,248	107,738	125,601	143,858	158,886	175,831	196,031	219,405	238,474	260,844	286,069	319,535
4. Unit Cost of Water after Debt Service (Baht/m3)*	3.3	3.3	3.3	3.4	3.8	4.4	4.7	5.2	5.1	4.9	4.6	5.1	4.9	4.7	4.1

Note: \* [(Total 2.) x ((1.1 Water Sales) / (Total 1.))] / (3. Water Sales m3)  
 \*\* Calculated by a new tentative formula based on waterworks net surplus.

Table-10.6 CASH FLOW PROJECTED (1,000 Baht) AT CURRENT PRICE (UBON-WARIN WATERWORKS)

Description	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
(A) Water Production (x1000 m <sup>3</sup> )	7,333	7,719	8,094	8,511	8,880	9,264	10,052	10,669	11,257	11,846	12,529	13,112	13,710	14,221	14,726
(B) Unaccounted for Water (%)	34.0	33.0	32.0	31.0	30.0	29.0	28.0	27.0	26.0	25.0	24.6	24.2	23.8	23.4	23.0
(C) Water Sales (x1000 m <sup>3</sup> )	4,840	5,172	5,504	5,873	6,216	6,577	7,237	7,788	8,330	8,884	9,447	9,939	10,447	10,893	11,339
(D) No. of Connections	10,850	11,475	12,130	12,844	13,544	14,043	15,415	16,449	17,413	18,329	19,075	19,728	20,314	20,830	21,322
(E) Average Water Tariff (Baht/m <sup>3</sup> )**	6.90	7.13	7.36	7.61	7.86	8.12	8.38	8.66	8.95	9.24	9.55	9.86	10.19	10.52	10.87
<b>1. Operating Revenue:</b>															
1.1 Water Sales	33,395	36,865	40,527	44,668	48,838	53,382	60,677	67,452	74,528	82,108	90,183	98,012	106,426	114,635	123,259
1.2 Connection Fees	2,400	2,583	2,796	3,148	3,188	2,348	6,669	5,192	5,000	4,908	4,129	3,733	3,461	3,148	3,101
1.3 Service Charges	1,603	1,751	1,912	2,091	2,278	2,440	2,767	3,050	3,335	3,627	3,899	4,165	4,430	4,693	4,962
1.4 Other Revenue	209	230	252	278	303	325	391	422	462	506	548	591	638	683	733
<b>Total 1.</b>	<b>37,607</b>	<b>41,428</b>	<b>45,487</b>	<b>50,186</b>	<b>54,608</b>	<b>58,495</b>	<b>70,503</b>	<b>76,116</b>	<b>83,325</b>	<b>91,148</b>	<b>98,759</b>	<b>106,501</b>	<b>114,955</b>	<b>123,159</b>	<b>132,054</b>
<b>2. Expenses:</b>															
2.1 Operation & Maintenance	4,432	4,871	5,499	6,012	6,626	8,423	9,964	10,952	11,971	13,443	14,728	15,759	17,170	18,978	20,306
- Personnel Cost	4,384	4,921	5,340	5,743	6,247	5,817	7,564	8,295	9,040	9,826	10,719	11,598	12,527	13,443	14,368
- Electricity & Fuel Cost	1,440	1,361	1,697	1,840	1,982	2,140	2,398	2,630	2,866	3,114	3,398	3,676	3,971	4,262	5,078
- Chemical Cost	893	970	1,050	1,183	1,198	882	2,505	1,950	1,878	1,844	1,551	1,403	1,300	1,183	1,165
- Connection Cost	940	1,039	1,146	1,246	1,354	1,456	1,892	2,010	2,173	2,381	2,564	2,736	2,950	3,194	3,451
- Other Cost	12,089	13,562	14,732	16,023	17,407	18,719	24,323	25,837	27,928	30,608	32,960	35,173	37,978	41,059	44,369
<b>Sub-total 2.1</b>	<b>5,635</b>	<b>6,207</b>	<b>6,815</b>	<b>7,520</b>	<b>8,182</b>	<b>8,764</b>	<b>10,564</b>	<b>11,405</b>	<b>12,485</b>	<b>13,657</b>	<b>14,797</b>	<b>15,957</b>	<b>17,224</b>	<b>18,453</b>	<b>19,786</b>
2.2 Share of Head & Regional Office Overhead Expenses ***	0	76	555	1,328	4,606	9,559	12,501	17,749	18,332	17,469	16,606	23,190	22,151	21,113	14,710
2.3 Debt Service	17,723	19,646	22,103	24,870	30,195	37,043	47,388	54,990	58,745	61,733	64,363	74,319	77,293	80,625	78,865
<b>Total 2.</b>	<b>19,883</b>	<b>21,783</b>	<b>23,385</b>	<b>25,316</b>	<b>24,412</b>	<b>21,452</b>	<b>23,115</b>	<b>21,126</b>	<b>24,580</b>	<b>29,414</b>	<b>34,396</b>	<b>32,182</b>	<b>37,661</b>	<b>42,534</b>	<b>53,190</b>
<b>3. Net Cash Flow Surplus:</b>															
3.1 Annual	19,883	41,666	65,051	90,367	114,779	136,232	159,347	180,473	205,053	234,467	268,863	301,044	338,705	381,240	434,430
3.2 Cumulative	3.3	3.4	3.6	3.8	4.3	5.1	5.6	6.3	6.3	6.3	6.2	6.9	6.8	6.9	6.5
<b>4. Unit Cost of Water after Debt Service (Baht/m<sup>3</sup>)*</b>															

Note: \* [(Total 2.) x ((1.1 Water Sales) / (Total 1.))] / (3 Water Sales m<sup>3</sup>)

\*\* Based upon the assumption that the water tariff increases every year at the rate of 3.5%.

\*\*\* Calculated by a new tentative formula based on waterworks net surplus.

Table-10.7 CASH FLOW PROJECTED (1,000 Baht) AT CURRENT PRICE (UBON-WATIN WATERWORKS)

Description	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
(A) Water Production (x1000 m3)	7,333	7,719	8,094	8,511	8,880	9,264	10,052	10,669	11,257	11,846	12,529	13,112	13,710	14,221	14,726
(B) Unaccounted for Water (%)	34.0	33.0	32.0	31.0	30.0	29.0	28.0	27.0	26.0	25.0	24.6	24.2	23.8	23.4	23.0
(C) Water Sales (x1000 m3)	4,840	5,172	5,504	5,873	6,216	6,577	7,237	7,788	8,330	8,884	9,447	9,939	10,447	10,893	11,339
(D) No. of Connections	10,850	11,475	12,130	12,844	13,544	14,043	15,415	16,449	17,413	18,329	19,075	19,728	20,314	20,830	21,322
(E) Average Water Tariff (Baht/m3)**	6.90	6.90	6.90	7.61	7.61	7.61	8.38	8.38	8.38	9.24	9.24	9.24	10.19	10.19	10.19
<b>1. Operating Revenue:</b>															
1.1 Water Sales	33,395	35,687	37,979	44,668	47,278	50,026	60,677	65,298	69,842	82,108	87,302	91,849	106,426	110,973	115,509
1.2 Connection Fees	2,400	2,500	2,620	3,148	3,087	2,200	6,669	5,026	4,686	4,908	3,997	3,499	3,461	3,047	2,906
1.3 Service Charges	1,603	1,695	1,792	2,091	2,205	2,287	2,767	2,953	3,126	3,627	3,774	3,903	4,430	4,543	4,650
1.4 Other Revenue	209	223	237	278	293	304	391	409	433	506	530	554	638	661	687
<b>Total 1.</b>	<b>37,607</b>	<b>40,105</b>	<b>42,627</b>	<b>50,186</b>	<b>52,863</b>	<b>54,817</b>	<b>70,503</b>	<b>73,685</b>	<b>78,086</b>	<b>91,148</b>	<b>95,604</b>	<b>99,805</b>	<b>114,955</b>	<b>119,225</b>	<b>123,752</b>
<b>2. Expenses:</b>															
2.1 Operation & Maintenance															
- Personnel Cost	4,432	4,871	5,499	6,012	6,626	8,423	9,964	10,952	11,971	13,443	14,728	15,759	17,170	18,978	20,306
- Electricity & Fuel Cost	4,384	4,921	5,340	5,743	6,247	5,817	7,564	8,295	9,040	9,826	10,719	11,598	12,527	13,443	14,368
- Chemical Cost	1,440	1,561	1,697	1,840	1,982	2,140	2,398	2,630	2,866	3,114	3,398	3,676	3,971	4,262	5,078
- Connection Cost	895	970	1,050	1,183	1,198	882	2,505	1,950	1,878	1,844	1,551	1,403	1,300	1,183	1,165
- Other Cost	940	1,039	1,146	1,246	1,354	1,456	1,892	2,010	2,173	2,381	2,564	2,736	2,950	3,194	3,451
<b>Sub-total 2.1</b>	<b>12,089</b>	<b>13,362</b>	<b>14,732</b>	<b>16,023</b>	<b>17,407</b>	<b>18,719</b>	<b>24,323</b>	<b>25,837</b>	<b>27,928</b>	<b>30,608</b>	<b>32,960</b>	<b>35,173</b>	<b>37,918</b>	<b>41,059</b>	<b>44,369</b>
2.2 Share of Head & Regional Office Overhead Expenses ***	5,655	6,009	6,387	7,519	7,920	8,213	10,563	11,040	11,700	13,656	14,324	14,954	17,223	17,863	18,541
<b>2.3 Debt Service</b>	<b>0</b>	<b>76</b>	<b>555</b>	<b>1,328</b>	<b>4,606</b>	<b>9,559</b>	<b>12,501</b>	<b>17,749</b>	<b>18,332</b>	<b>17,469</b>	<b>16,606</b>	<b>23,190</b>	<b>22,151</b>	<b>21,113</b>	<b>14,710</b>
<b>Total 2.</b>	<b>17,723</b>	<b>19,447</b>	<b>21,674</b>	<b>24,870</b>	<b>29,934</b>	<b>36,491</b>	<b>47,386</b>	<b>54,626</b>	<b>57,959</b>	<b>61,733</b>	<b>63,890</b>	<b>73,316</b>	<b>77,293</b>	<b>80,035</b>	<b>77,620</b>
<b>3. Net Cash Flow Surplus:</b>															
3.1 Annual	19,884	20,658	20,953	25,316	22,930	18,326	23,116	19,059	20,127	29,415	31,714	26,489	37,662	39,190	46,132
3.2 Cumulative	19,884	40,541	61,495	86,811	109,741	128,067	151,182	170,241	190,368	219,783	251,496	277,986	315,647	354,837	400,969
<b>4. Unit Cost of Water after Debt Service (Baht/m3)*</b>	<b>3.3</b>	<b>3.3</b>	<b>3.5</b>	<b>3.8</b>	<b>4.3</b>	<b>5.1</b>	<b>5.6</b>	<b>6.2</b>	<b>6.2</b>	<b>6.3</b>	<b>6.2</b>	<b>6.8</b>	<b>6.8</b>	<b>6.8</b>	<b>6.4</b>

Note: \*  $[(Total\ 2.) \times ((1.1\ Water\ Sales) / (Total\ 1.))] / (3. Water\ Sales\ m3)$

\*\* Based upon the assumption that the water tariff increases every three years at the rate of 3.3 % per annum

\*\*\* Calculated by a new tentative formula based on waterworks net surplus.

Table-10.8 CASH FLOW PROJECTED (1,000 Baht) AT CURRENT PRICE (UBON-WARIN WATERWORKS)

Description	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
(A) Water Production (x1000 m3)	7,333	7,719	8,094	8,511	8,880	9,264	10,052	10,669	11,257	11,846	12,529	13,112	13,710	14,221	14,726
(B) Unaccounted for Water (%)	34.0	33.0	32.0	31.0	30.0	29.0	28.0	27.0	26.0	25.0	24.6	24.2	23.8	23.4	23.0
(C) Water Sales (x1000 m3)	4,840	5,172	5,504	5,873	6,216	6,577	7,237	7,788	8,330	8,884	9,447	9,939	10,447	10,893	11,339
(D) No. of Connections	10,850	11,475	12,130	12,844	13,544	14,043	15,415	16,449	17,413	18,329	19,075	19,728	20,314	20,830	21,322
(E) Average Water Tariff (Baht/m3)**	6.90	6.90	6.90	6.90	6.90	6.90	6.90	6.90	6.90	6.90	6.90	6.90	6.90	6.90	6.90
<b>1. Operations Revenue:</b>															
1.1 Water Sales	33,395	35,687	37,979	40,523	42,890	45,383	49,937	53,740	57,480	61,303	65,181	68,576	72,085	75,165	78,237
1.2 Connection Fees	2,400	2,500	2,620	2,856	2,800	1,996	5,488	4,136	3,856	3,664	2,984	2,612	2,344	2,064	1,968
1.3 Service Charges	1,603	1,695	1,792	1,897	2,001	2,074	2,277	2,430	2,572	2,708	2,818	2,914	3,001	3,077	3,150
1.4 Other Revenue	209	223	237	253	266	276	322	336	357	378	396	413	432	448	465
Total 1.	37,607	40,105	42,627	45,529	47,957	49,750	58,024	60,642	64,265	68,052	71,379	74,516	77,861	80,754	83,820
<b>2. Expenses:</b>															
2.1 Operation & Maintenance															
- Personnel Cost	4,432	4,871	5,499	6,012	6,626	8,423	9,964	10,952	11,971	13,443	14,728	15,759	17,170	18,978	20,306
- Electricity & Fuel Cost	4,384	4,921	5,340	5,743	6,247	5,817	7,564	8,295	9,040	9,826	10,719	11,598	12,527	13,443	14,368
- Chemical Cost	1,440	1,561	1,697	1,840	1,982	2,140	2,398	2,630	2,866	3,114	3,398	3,676	3,971	4,262	5,078
- Connection Cost	893	970	1,050	1,183	1,198	882	2,505	1,950	1,878	1,844	1,551	1,403	1,300	1,183	1,165
- Other Cost	940	1,039	1,146	1,246	1,354	1,456	1,892	2,010	2,173	2,381	2,564	2,736	2,950	3,194	3,451
Sub-total 2.1	12,089	13,362	14,732	16,023	17,407	18,719	24,323	25,837	27,928	30,608	32,960	35,173	37,918	41,059	44,369
2.2 Share of Head & Regional Office Overhead Expenses***	5,635	6,009	6,387	6,822	7,186	7,451	8,694	9,086	9,629	10,196	10,695	11,165	11,666	12,100	12,559
2.3 Debt Service	0	76	555	1,328	4,606	9,559	12,501	17,749	18,332	17,469	16,606	23,190	22,151	21,113	14,710
Total 2.	17,723	19,447	21,674	24,173	29,199	35,729	45,518	52,672	55,889	58,273	60,261	69,527	71,736	74,271	71,637
<b>3. Net Cash Flow Surplus:</b>															
3.1 Annual	19,883	20,658	20,953	21,356	18,758	14,001	12,506	7,970	8,376	9,779	11,118	4,989	6,126	6,482	12,183
3.2 Cumulative	19,883	40,541	61,494	82,851	101,609	115,609	128,115	136,085	144,461	154,241	165,359	170,348	176,474	182,956	195,139
<b>4. Unit Cost of Water after Debt Service (Baht/m3)*</b>	3.3	3.3	3.5	3.7	4.2	5.0	5.4	6.0	6.0	5.9	5.8	6.4	6.4	6.3	5.9

Note: \* [(Total 2.) x ((1.1 Water Sales) / (Total 1.))] / (3. Water Sales m3)

\*\* Based upon the assumption that the water tariff remains unchanged up to 2000.

\*\*\* Calculated by a new tentative formula based on waterworks net surplus.

LUBON-WARIN WATERWORKS

Table-10.9 DEBT SERVICE PROJECTED

FOREIGN CURRENCY PORTION (in 1,000 Baht)  
Interest : 8.5% per annum\*

LOCAL CURRENCY PORTION (in 1,000 Baht)  
Interest : 13.0% per annum

Year	Rehabilitation Stage 1 and Expansion Modification		Loans		Interest Payments		Principal Repayment		Debt Service		TOTAL DEBT SERVICE
	Beginning	Ending	Beginning	Ending	1st year	Later year	Rehab. & Mod.	Expansion	Sub-total	Sub-total	
1987	2,250	0	2,250	0	96	0	0	0	96	0	132
1988	11,938	2,250	14,188	191	507	191	0	0	699	0	966
1989	10,959	14,188	25,147	1,206	466	1,206	0	0	1,672	0	2,311
1990		59,579	84,726	2,137	2,332	2,137	0	0	4,670	0	7,353
1991		90,630	175,356	3,852	3,852	7,202	0	0	11,053	0	16,061
1992			175,356	175,356	0	14,905	0	0	14,905	0	16,061
1993			175,356	175,356	0	14,905	0	0	14,905	0	16,061
1994			175,356	175,356	0	14,905	0	0	14,905	0	16,061
1995			175,356	175,356	0	14,905	0	0	14,905	0	16,061
1996			175,356	175,356	0	14,905	0	0	14,905	0	16,061
1997			175,356	175,356	0	14,905	0	0	14,905	0	16,061
1998			175,356	175,356	0	14,905	0	0	14,905	0	16,061
1999			175,356	175,356	0	14,905	0	0	14,905	0	16,061
2000			175,356	175,356	0	14,905	0	0	14,905	0	16,061
2001			175,356	175,356	0	14,905	0	0	14,905	0	16,061
2002			175,356	175,356	0	14,905	0	0	14,905	0	16,061
2003			175,356	175,356	0	14,905	0	0	14,905	0	16,061
2004			175,356	175,356	0	14,905	0	0	14,905	0	16,061
2005			175,356	175,356	0	14,905	0	0	14,905	0	16,061
2006			175,356	175,356	0	14,905	0	0	14,905	0	16,061
2007			175,356	175,356	0	14,905	0	0	14,905	0	16,061
2008			175,356	175,356	0	14,905	0	0	14,905	0	16,061
2009			175,356	175,356	0	14,905	0	0	14,905	0	16,061
2010			175,356	175,356	0	14,905	0	0	14,905	0	16,061
2011			175,356	175,356	0	14,905	0	0	14,905	0	16,061
2012			175,356	175,356	0	14,905	0	0	14,905	0	16,061
2013			175,356	175,356	0	14,905	0	0	14,905	0	16,061
2014			175,356	175,356	0	14,905	0	0	14,905	0	16,061

Note: \* Based upon the assumption that the foreign currency portion is financed by a foreign financial institution whose lending rate is 8.5% per annum.

Table-10.10 CASH FLOW PROJECTED (1,000 Baht) AT CURRENT PRICE (UBON-WARIN WATERWORKS)

Description	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
(A) Water Production (x1000 m <sup>3</sup> )	7,333	7,719	8,094	8,511	8,880	9,264	10,052	10,669	11,257	11,846	12,529	13,112	13,710	14,221	14,726
(B) Unaccounted for Water (%)	34.0	33.0	32.0	31.0	30.0	29.0	28.0	27.0	26.0	25.0	24.6	24.2	23.8	23.4	23.0
(C) Water Sales (x1000 m <sup>3</sup> )	4,840	5,172	5,504	5,873	6,216	6,577	7,257	7,788	8,330	8,884	9,447	9,939	10,447	10,993	11,539
(D) No. of Connections	10,850	11,475	12,150	12,844	13,544	14,043	15,415	16,449	17,413	18,329	19,075	19,728	20,314	20,830	21,322
(E) Average Water Tariff (Baht/m <sup>3</sup> )**	6.90	6.90	6.90	7.61	7.61	7.61	8.38	8.38	8.38	9.24	9.24	9.24	10.19	10.19	10.19
<b>1. Operating Revenue:</b>															
1.1 Water Sales	33,395	35,687	37,979	44,668	47,278	50,026	60,677	65,298	69,842	82,108	87,302	91,849	106,426	110,973	115,509
1.2 Connection Fees	2,400	2,500	2,620	3,148	3,087	2,200	6,669	5,026	4,686	4,908	3,997	3,499	3,461	3,047	2,906
1.3 Service Charges	1,603	1,695	1,792	2,091	2,205	2,287	2,767	2,953	3,126	3,627	3,774	3,903	4,430	4,543	4,650
1.4 Other Revenue	209	223	237	278	293	304	391	409	433	506	530	554	638	661	687
<b>Total 1.</b>	<b>37,607</b>	<b>40,105</b>	<b>42,627</b>	<b>50,186</b>	<b>52,863</b>	<b>54,817</b>	<b>70,503</b>	<b>73,685</b>	<b>78,086</b>	<b>91,148</b>	<b>95,604</b>	<b>99,805</b>	<b>114,955</b>	<b>119,225</b>	<b>123,752</b>
<b>2. Expenses:</b>															
2.1 Operation & Maintenance															
- Personnel Cost	4,432	4,871	5,499	6,012	6,626	8,423	9,964	10,952	11,971	13,443	14,728	15,759	17,170	18,978	20,306
- Electricity & Fuel Cost	4,364	5,100	5,534	5,952	6,475	6,029	7,839	8,597	9,370	10,183	11,110	12,021	12,983	13,932	14,891
- Chemical Cost	1,440	1,561	1,697	1,840	1,982	2,140	2,398	2,630	2,866	3,114	3,398	3,676	3,971	4,262	5,078
- Connection Cost	893	970	1,050	1,183	1,198	882	2,505	1,950	1,878	1,844	1,551	1,403	1,300	1,183	1,165
- Other Cost	940	1,055	1,162	1,264	1,373	1,474	1,915	2,035	2,200	2,411	2,597	2,772	2,988	3,235	3,496
Sub-total 2.1	12,089	13,557	14,943	16,250	17,654	18,949	24,622	26,164	28,285	30,996	33,384	35,631	38,413	41,598	44,936
2.2 Share of Head & Regional Office Overhead Expenses	5,494	5,859	6,228	7,332	7,723	8,009	10,301	10,765	11,408	13,317	13,968	14,582	16,795	17,419	18,080
2.3 Debt Service ***	0	132	966	2,311	7,353	16,061	21,269	26,517	27,100	26,167	25,234	31,748	30,222	28,697	21,807
<b>Total 2.</b>	<b>17,583</b>	<b>19,548</b>	<b>22,137</b>	<b>25,893</b>	<b>32,730</b>	<b>43,019</b>	<b>56,192</b>	<b>63,447</b>	<b>66,793</b>	<b>70,479</b>	<b>72,585</b>	<b>81,960</b>	<b>85,430</b>	<b>87,706</b>	<b>86,823</b>
<b>3. Net Cash Flow Surplus:</b>															
3.1 Annual	20,024	20,557	20,491	24,293	20,133	11,799	14,312	10,238	11,293	20,668	23,019	17,845	29,524	31,519	38,929
3.2 Cumulative	20,024	40,580	61,071	85,364	105,497	117,296	131,607	141,845	153,138	173,807	196,825	214,670	244,194	275,714	314,642
<b>4. Unit Cost of Water after Debt Service (Baht/m<sup>3</sup>)*</b>	<b>3.2</b>	<b>3.4</b>	<b>3.6</b>	<b>3.9</b>	<b>4.7</b>	<b>6.0</b>	<b>6.7</b>	<b>7.2</b>	<b>7.2</b>	<b>7.1</b>	<b>7.0</b>	<b>7.6</b>	<b>7.6</b>	<b>7.5</b>	<b>7.0</b>

Note: \*  $[(Total\ 2.) \times (1.1\ Water\ Sales) / (Total\ 1.)] / (3\ Water\ Sales\ m^3)$

\*\* Based upon the assumption that the water tariff increases every three years at the rate of 3.5 % per annum.

\*\*\* Based upon the assumption that the foreign currency portion is financed by a foreign financial institution whose lending rate is 8.5 % per annum.

Table-10.11 FIXED ASSETS, UNIT COST AFTER DEPRECIATION AND RATE OF RETURN

[USON-WARIN WATERWORKS] x 1,000 BAHT

ITEM	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Fixed Assets														
Accumulative Fixed Assets	65,814	67,986	73,037	90,308	113,772	191,407	309,901	320,128	330,692	341,605	352,878	364,522	376,552	388,972
Less Accumulative Depreciation	23,995	27,053	30,380	34,393	39,320	46,998	56,879	71,493	84,876	99,063	114,095	130,011	146,855	164,665
Net Fixed Assets in Operation	41,819	40,933	42,656	55,915	74,451	144,409	251,022	248,634	245,816	242,541	238,783	234,512	229,699	224,313
Work in Progress	2,807	17,668	35,345	94,365	186,058	112,177	0	0	0	0	0	0	0	0
TOTAL	44,626	58,601	78,001	150,280	260,509	256,586	251,022	248,634	245,816	242,541	238,783	234,512	229,699	224,313
Total Cost before Depreciation and Interest **	19,145	20,831	22,556	24,228	26,768	32,462	34,214	36,774	39,978	42,712	45,348	46,577	52,186	56,065
Total Cost after Depreciation but before Interest	23,889	23,889	25,884	28,241	31,695	40,140	46,095	49,388	53,360	56,899	60,380	64,493	69,028	73,877
Total Cost after Depreciation and Interest *	24,444	24,444	27,211	31,949	40,356	51,743	57,581	60,060	63,169	65,845	68,463	71,538	75,055	78,845
Unit Cost of Water (Baht/cm3) after Depreciation and Interest	4.44	4.44	4.63	5.14	6.14	7.15	7.39	7.21	7.11	6.97	6.89	6.85	6.89	6.95
Average Rate Base	41,376	41,376	41,795	49,285	65,183	109,430	197,715	249,828	247,225	244,179	240,662	236,647	232,105	227,006
Surplus after Depreciation and Interest	21,044	21,044	22,975	22,658	18,139	18,761	18,535	23,265	27,978	32,913	38,038	43,417	48,125	53,210
Rate of Return after Completion of Construction				17%	9%	9%	11%	9%	11%	13%	16%	18%	21%	23%

Note: \* [((Total Cost after Depreciation and Debt Service) of this Table) x ((1.1 Water Sales) / (1. Operating Revenue) of Cash Flow Table)] / ((C) Water Sales (x 1,000 m3)) of Cash Flow Table

\*\* Includes Share of Head & Regional Office Overhead Expenses calculated by a new tentative formula based on waterworks net surplus.

Table-10.12 FINANCIAL INTERNAL RATE OF RETURN (FIRR)

[UBON-WARIN WATERWORKS]x 1,000 BAHT

YEAR	TOTAL WATER REVENUE	CAPITAL INVESTMENT COST	OPERATING COSTS & H.R.O.*	1986 PRICE NET REVENUE	NET BENEFITS	
					DISCOUNTED AT 8 %	DISCOUNTED AT 9 %
1987	0	2,723	0	-2,723	-2,521	-2,498
1988	0	13,984	0	-13,984	-11,989	-11,770
1989	7,922	12,428	3,248	-7,754	-6,155	-5,987
1990	10,350	65,404	4,137	-59,191	-43,507	-41,932
1991	12,123	96,313	4,584	-88,774	-60,418	-57,697
1992	20,417		9,542	10,876	6,853	6,485
1993	23,035		10,142	12,893	7,523	7,053
1994	26,658		11,264	15,394	8,317	7,726
1995	30,445		12,660	17,785	8,897	8,189
1996	33,772		13,676	20,097	9,309	8,489
1997	36,909		14,534	22,376	9,597	8,671
1998	40,255		15,617	24,638	9,784	8,760
1999	43,147		16,692	26,455	9,727	8,629
2000	46,213		17,921	28,292	9,632	8,466
2001	46,213		17,921	28,292	8,919	7,767
2002	46,213		17,921	28,292	8,258	7,126
2003	46,213		17,921	28,292	7,646	6,538
2004	46,213		17,921	28,292	7,080	5,998
2005	46,213		17,921	28,292	6,556	5,503
2006	46,213		17,921	28,292	6,070	5,048
Salvage		-90,656		90,656	19,450	4,173
TOTALS	608,527	100,196	241,544	266,787	19,028	-5,266

Note: Share Allocation of Head and Regional

Office Overhead Expenses calculated by a new

tentative formula based on waterworks net surplus.

$$FIRR = 8 + (9 - 8) \times 19,028 / (19,028 + 5,266)$$

$$= 8.783\%$$



Table-10.13 AVERAGE INCREMENTAL COSTS (AIC)

[UBON-WARIN WATERWORKS] x 1,000 BAHT

YEAR	CAPITAL INVESTMENT			ECONOMIC VALUE OF CAPITAL INVESTMENT			DISCOUNTED AT 10%	TOTAL INVESTMENT	DISCOUNTED AT 10%	SALES VOLUMES (increments) / 1,000 cm	DISCOUNTED AT 10%	OPERATION AND MAINTENANCE	DISCOUNTED AT 10%
	FORIGN PORTION	LOCAL PORTION	TOTAL INVESTMENT	FORIGN PORTION	LOCAL PORTION	TOTAL INVESTMENT							
	PROCUR.	SKILLED LABOR	UNSKILLED LABOR	PROCUR.	SKILLED LABOR	UNSKILLED LABOR							
1987	1,634	0	1,089	0	805	0	2,439	2,217	0	0	0	0	0
1988	8,824	639	3,864	511	2,856	183	12,373	10,226	0	0	0	0	0
1989	5,934	4,093	1,415	3,274	1,046	274	10,529	7,910	1,033	776	2,375	1,934	1,934
1990	41,699	7,000	9,271	5,600	6,851	2,067	56,217	38,397	1,376	940	3,279	2,239	2,239
1991	61,472	10,501	13,188	8,400	9,746	3,100	82,718	51,362	1,737	1,079	3,651	2,255	2,255
1992									2,397	1,353	7,572	4,274	4,274
1993									2,948	1,513	6,945	4,128	4,128
1994									3,490	1,628	8,932	4,167	4,167
1995									4,044	1,715	10,037	4,257	4,257
1996									4,607	1,776	10,840	4,179	4,179
1997									5,099	1,787	11,517	4,037	4,037
1998									5,607	1,787	12,573	3,943	3,943
1999									6,053	1,753	13,225	3,831	3,831
2000									6,499	1,711	14,199	3,739	3,739
2001									6,499	1,556	14,199	3,399	3,399
2002									6,499	1,414	14,199	3,090	3,090
2003									6,499	1,286	14,199	2,809	2,809
2004									6,499	1,169	14,199	2,554	2,554
2005									6,499	1,063	14,199	2,322	2,322
2006									6,499	966	14,199	2,111	2,111
Salvage							-78,000	-11,594					
TOTAL							86,276	98,518	25,272				59,267

TOTAL INVEST. DISCOUNTED 98,518  
 O&M COST DISCOUNTED + 59,267

AVERAGE INCREMENTAL COST = 157,785 / 25,272 = 6.244

(SALES M3 DISCOUNTED)

Table-10.14 AVERAGE INCREMENTAL COSTS (AIC)

[UBON-WARIN WATERWORKS] x 1,000 BAHT

YEAR	CAPITAL INVESTMENT			ECONOMIC VALUE OF CAPITAL INVESTMENT			TOTAL INVESTMENT	DISCOUNTED AT 10%	SALES VOLUMES (increments) 1,000 cm	DISCOUNTED AT 10%	OPERATION AND MAINTENANCE *	DISCOUNTED AT 10%
	FORN PORTION	LOCAL PORTION	SKILLED UNSKILLED LABOR	FORN PORTION	LOCAL PORTION	SKILLED UNSKILLED LABOR						
1987	1,634	0	1,089	1,634	0	805	2,439	2,217	0	0	0	0
1988	8,824	639	3,864	8,824	511	2,856	12,373	10,226	0	0	0	0
1989	5,934	4,093	1,415	5,934	3,274	1,046	10,529	7,910	1,033	776	2,598	1,952
1990	41,699	7,000	9,271	41,699	5,600	6,851	56,217	38,397	1,376	940	3,310	2,261
1991	61,472	10,501	13,188	61,472	8,400	9,746	82,718	51,362	1,737	1,079	3,667	2,277
1992									2,397	1,353	7,633	4,309
1993									2,948	1,513	8,114	4,164
1994									3,490	1,628	9,011	4,204
1995									4,044	1,715	10,128	4,295
1996									4,607	3,776	10,940	4,218
1997									5,099	1,787	11,627	4,075
1998									5,607	1,787	12,494	3,981
1999									6,053	1,753	13,354	3,868
2000									6,499	1,711	14,337	3,775
2001									6,499	1,556	14,337	3,432
2002									6,499	1,414	14,337	3,120
2003									6,499	1,286	14,337	2,836
2004									6,499	1,169	14,337	2,579
2005									6,499	1,063	14,337	2,344
2006									6,499	966	14,337	2,131
Salvage							-78,000	-11,594				
TOTAL							86,276	98,518		25,272		59,822

Note: \* Includes shares of Head & Regional Office Overhead Expenses calculated by a new tentative formula based on waterworks net surplus.

AVERAGE INCREMENTAL COST = 158,339 / 25,272 = 6.265 (SALES M3 DISCOUNTED)

AIC 1 14

Table-10.15 ECONOMIC BENEFITS VS COSTS (INCREMENTAL)

[UBON-WARIN WATERWORKS] x 1,000 BAHT				
YEAR	AT 1986 PRICE		DISCOUNTED AT 10% PER ANNUM	
	BENEFITS	COSTS*	BENEFITS	COSTS
1987	0	2,439	0	2,217
1988	0	12,373	0	10,226
1989	8,027	13,127	6,031	9,862
1990	10,692	59,526	7,303	40,657
1991	13,497	86,386	8,381	53,639
1992	18,625	7,633	10,514	4,309
1993	22,907	8,114	11,755	4,164
1994	27,118	9,011	12,651	4,204
1995	31,423	10,128	13,326	4,295
1996	35,798	10,940	13,802	4,218
1997	39,621	11,627	13,887	4,075
1998	43,568	12,494	13,882	3,981
1999	47,033	13,354	13,624	3,868
2000	50,499	14,337	13,298	3,775
2001	50,499	14,337	12,089	3,432
2002	50,499	14,337	10,990	3,120
2003	50,499	14,337	9,991	2,836
2004	50,499	14,337	9,083	2,579
2005	50,499	14,337	8,257	2,344
2006	50,499	14,337	7,506	2,131
Salvage		-78,000		-11,594
TOTAL	651,802	279,511	196,368	158,339
	BENEFITS/COSTS = 2.332		BENEFITS/COSTS = 1.240	

Note: \* Share of Head & Regional Office Overhead Expenses calculated by a new tentative formula based on waterworks net surplus.

Table-10.16 ECONOMIC INTERNAL RATE OF RETURN (EIRR)

(UBON-WARIN WATERWORKS) x 1,000 BAHT

YEAR	TOTAL ECONOMIC BENEFITS *		TOTAL CAPITAL INVESTMENT		OPERATING COSTS & H.R.O.**		NET BENEFITS AT 1986 PRICE		CONVERTED ECONOMIC VALUE			NET BENEFITS	
	AT 1986 PRICE	1986 PRICE	AT 1986 PRICE	1986 PRICE	AT 1986 PRICE	1986 PRICE	AT 1986 PRICE	1986 PRICE	TOTAL ECONOMIC BENEFITS	TOTAL CAPITAL INVESTMENT	OPERATING COSTS & H.R.O.*	NET BENEFITS AT 14%	DISCOUNTED AT 15%
1987	0	2,723	0	2,723	0	0	-2,723	0	2,439	0	-2,439	-2,140	-2,121
1988	0	13,984	0	13,984	0	0	-13,984	0	12,373	0	-12,373	-9,521	-9,356
1989	8,002	12,428	3,248	9,180	8,002	3,248	-7,574	8,002	10,529	2,598	-5,125	-3,459	-3,370
1990	10,659	65,404	4,137	61,267	10,659	4,137	-58,882	10,659	56,217	3,310	-48,867	-28,933	-27,940
1991	13,455	96,312	4,584	91,728	13,455	4,584	-87,441	13,455	82,718	3,667	-72,930	-37,878	-36,259
1992	18,568		9,542	9,026	18,568	9,542	9,026	18,568		7,633	10,935	4,982	4,727
1993	22,836		10,142	12,694	22,836	10,142	12,694	22,836		8,114	14,722	5,884	5,535
1994	27,035		11,264	15,771	27,035	11,264	15,771	27,035		9,011	18,024	6,318	5,892
1995	31,325		12,660	18,666	31,325	12,660	18,666	31,325		10,128	21,198	6,519	6,026
1996	35,687		13,676	22,012	35,687	13,676	22,012	35,687		10,940	24,747	6,675	6,117
1997	39,499		14,534	24,965	39,499	14,534	24,965	39,499		11,627	27,872	6,595	5,991
1998	43,434		15,617	27,817	43,434	15,617	27,817	43,434		12,494	30,940	6,422	5,783
1999	46,889		16,692	30,196	46,889	16,692	30,196	46,889		13,354	33,535	6,106	5,450
2000	50,343		17,921	32,422	50,343	17,921	32,422	50,343		14,337	36,006	5,751	5,089
2001	50,343		17,921	32,422	50,343	17,921	32,422	50,343		14,337	36,006	5,044	4,425
2002	50,343		17,921	32,422	50,343	17,921	32,422	50,343		14,337	36,006	4,425	3,848
2003	50,343		17,921	32,422	50,343	17,921	32,422	50,343		14,337	36,006	3,881	3,346
2004	50,343		17,921	32,422	50,343	17,921	32,422	50,343		14,337	36,006	3,405	2,910
2005	50,343		17,921	32,422	50,343	17,921	32,422	50,343		14,337	36,006	2,987	2,530
2006	50,343		17,921	32,422	50,343	17,921	32,422	50,343		14,337	36,006	2,620	2,200
Salvage		-90,656		90,656					-78,060		78,060	5,675	4,766
TOTAL				308,054							370,282	1,357	-4,412

Note : \* Average water tariff in 1986 used as benefits. (5.90 Baht)  
 \*\* Share Allocation of Head and Regional Office Overhead Expenses calculated by a new tentative formula based on waterworks net surplus.  
 EIRR =  $14 + (15 - 14) \times 1,357 / (1,357 + 4,412)$   
 = 14.235%

Table-10.17 ECONOMIC INTERNAL RATE OF RETURN

[UBON-WARIN WATERWORKS] x 1,000 BAHT

YEAR	TOTAL ECONOMIC BENEFITS *		TOTAL CAPITAL INVESTMENT		OPERATING COSTS & H.R.O.**		NET BENEFITS AT 1986 PRICE		CONVERTED ECONOMIC VALUE			NET BENEFITS		
	1986 PRICE	AT	1986 PRICE	AT	1986 PRICE	AT	1986 PRICE	AT	TOTAL ECONOMIC BENEFITS	TOTAL CAPITAL INVESTMENT	OPERATING COSTS & H.R.O.*	NET BENEFITS	DISCOUNTED AT 9%	DISCOUNTED AT 11%
1987	0	0	2,723	0	0	0	-2,723	0	0	2,439	0	-2,439	-2,238	-2,197
1988	0	0	13,984	0	0	0	-13,984	0	0	12,373	0	-12,373	-10,414	-10,043
1989	6,450	6,450	12,428	3,218	3,218	6,450	-9,197	6,450	6,450	10,529	2,575	-6,653	-5,138	-4,865
1990	8,591	8,591	65,404	4,099	4,099	8,591	-60,911	8,591	8,591	56,217	3,279	-50,904	-36,062	-33,532
1991	10,845	10,845	96,312	4,539	4,539	10,845	-90,006	10,845	10,845	82,718	3,631	-75,504	-49,073	-44,808
1992	14,966	14,966		9,466	9,466	14,966	5,500	14,966	14,966		7,572	7,393	4,408	3,953
1993	18,406	18,406		10,056	10,056	18,406	8,350	18,406	18,406		8,045	10,361	5,668	4,990
1994	21,790	21,790		11,164	11,164	21,790	10,626	21,790	21,790		8,932	12,858	6,453	5,580
1995	25,249	25,249		12,547	12,547	25,249	12,702	25,249	25,249		10,037	15,212	7,004	5,947
1996	28,764	28,764		13,550	13,550	28,764	15,214	28,764	28,764		10,840	17,924	7,571	6,313
1997	31,836	31,836		14,396	14,396	31,836	17,440	31,836	31,836		11,517	20,319	7,874	6,447
1998	35,008	35,008		15,467	15,467	35,008	19,541	35,008	35,008		12,373	22,634	8,047	6,470
1999	37,792	37,792		16,531	16,531	37,792	21,261	37,792	37,792		13,225	24,567	8,013	6,326
2000	40,577	40,577		17,749	17,749	40,577	22,828	40,577	40,577		14,199	26,378	7,893	6,120
2001	40,577	40,577		17,749	17,749	40,577	22,828	40,577	40,577		14,199	26,378	7,242	5,513
2002	40,577	40,577		17,749	17,749	40,577	22,828	40,577	40,577		14,199	26,378	6,644	4,967
2003	40,577	40,577		17,749	17,749	40,577	22,828	40,577	40,577		14,199	26,378	6,095	4,475
2004	40,577	40,577		17,749	17,749	40,577	22,828	40,577	40,577		14,199	26,378	5,592	4,031
2005	40,577	40,577		17,749	17,749	40,577	22,828	40,577	40,577		14,199	26,378	5,130	3,632
2006	40,577	40,577		17,749	17,749	40,577	22,828	40,577	40,577		14,199	26,378	4,707	3,272
Salvage			-90,656				90,656			-78,000		78,000	13,918	9,675
TOTAL							184,264					246,039	9,356	-7,737

Note : \* AIC used as benefits. ( 6.244 Baht)

\*\* Share Allocation of Head and Regional Office Overhead Expenses.

$$EIRR = 9 + ((-9) \times 9,356 / (9,356 + 7,737)) = 10.094\%$$

Table-10.18 ECONOMIC INTERNAL RATE OF RETURN

CUBON-MARIN WATERWORKS] x 1,000 BAHT

YEAR	TOTAL ECONOMIC BENEFITS *		TOTAL CAPITAL INVESTMENT AT		OPERATING COSTS & H.R.O.** AT		NET BENEFITS AT 1986 PRICE		CONVERTED ECONOMIC VALUE			NET BENEFITS		
	1986 PRICE	AT	1986 PRICE	AT	1986 PRICE	AT	1986 PRICE	AT	TOTAL ECONOMIC BENEFITS	TOTAL CAPITAL INVESTMENT	OPERATING COSTS & H.R.O.*	NET BENEFITS	DISCOUNTED AT 11%	DISCOUNTED AT 12%
1987	0	0	2,723	0	0	-2,723	0	0	0	2,439	0	-2,439	-2,197	-2,178
1988	0	0	13,984	0	0	-13,984	0	0	0	12,373	0	-12,373	-10,043	-9,864
1989	6,472	6,472	12,428	2,598	2,598	-8,554	6,472	6,472	2,079	10,529	2,079	-6,135	-4,486	-4,367
1990	8,621	8,621	65,404	3,310	3,310	-60,092	8,621	8,621	2,648	56,217	2,648	-50,243	-33,097	-31,930
1991	10,883	10,883	96,312	3,667	3,667	-89,096	10,883	10,883	2,934	82,718	2,934	-74,769	-44,372	-42,426
1992	15,018	15,018		7,633	7,633	7,385	15,018	15,018	6,107		6,107	8,912	4,765	4,515
1993	18,471	18,471		8,114	8,114	10,357	18,471	18,471	6,491		6,491	11,980	5,770	5,419
1994	21,867	21,867		9,011	9,011	12,855	21,867	21,867	7,209		7,209	14,658	6,360	5,920
1995	25,338	25,338		10,128	10,128	15,209	25,338	25,338	8,103		8,103	17,235	6,738	6,215
1996	28,865	28,865		10,940	10,940	17,925	28,865	28,865	8,752		8,752	20,113	7,083	6,476
1997	31,948	31,948		11,627	11,627	20,321	31,948	31,948	9,301		9,301	22,646	7,185	6,510
1998	35,131	35,131		12,494	12,494	22,637	35,131	35,131	9,995		9,995	25,136	7,185	6,452
1999	37,925	37,925		13,354	13,354	24,571	37,925	37,925	10,683		10,683	27,242	7,015	6,243
2000	40,719	40,719		14,337	14,337	26,382	40,719	40,719	11,470		11,470	29,250	6,786	5,985
2001	40,719	40,719		14,337	14,337	26,382	40,719	40,719	11,470		11,470	29,250	6,113	5,344
2002	40,719	40,719		14,337	14,337	26,382	40,719	40,719	11,470		11,470	29,250	5,508	4,771
2003	40,719	40,719		14,337	14,337	26,382	40,719	40,719	11,470		11,470	29,250	4,962	4,260
2004	40,719	40,719		14,337	14,337	26,382	40,719	40,719	11,470		11,470	29,250	4,470	3,804
2005	40,719	40,719		14,337	14,337	26,382	40,719	40,719	11,470		11,470	29,250	4,027	3,396
2006	40,719	40,719		14,337	14,337	26,382	40,719	40,719	11,470		11,470	29,250	3,628	3,032
Salvage			-90,656			90,656			-78,000			78,000	9,675	8,086
TOTAL						232,143						284,709	3,075	-4,337

Note : \* AIC used as benefits. ( 6,265 Baht)  
 \*\* Share Allocation of Head and Regional Office Overhead Expenses calculated by a new tentative formula based on waterworks net surplus.  
 EIRR =  $11 + (12 - 11) \times 3,075 / (3,075 + 4,337)$   
 = 11.415%

APPENDIX 11

UNACCOUNTED-FOR WATER STUDY





APPENDIX 11 UNACCOUNTED-FOR WATER STUDY

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## APPENDIX 11 UNACCOUNTED-FOR WATER STUDY

### 11.1 Introduction

Unaccounted-for water is defined as the difference between the volume of produced water (water production) and that of sold water (water sales). The water production is measured as the outflow of treatment plant, while the water sales is calculated as the sum of customer meters' reading.

Included in the water sales are discount rate consumption, bad debt, public use and others.

Discount rate is applied to the consumption by veterans, waterworks staff and hospitals. As the consumption is very small in size, the impact on the whole revenue is almost negligible.

Bad debt is the uncollected credit which should be written off. Although some consumers delay regular payment because of handy money's shortage or unwillingness by reason of their dissatisfaction with the service, payment is made eventually in most cases. Bad debt is also negligibly small.

Regarding the public use, most of the public institutions are paying the normal rate duly, excepting those applied with discount rates.

All of the water sales can be considered revenue-bearing or accounted-for water practically in Thailand.

This study aims for setting up the framework to reduce unaccounted-for water in the future. During the field leakage survey undertaken as a part of the study, some useful and important findings were made, as reported in the Attachment herewith. Some of the essential findings are quoted in the main report.

In the following sections, classification of the unaccounted-for water, existing conditions related to the issue, framework for reduction are discussed.

## 11.2 Classification of the unaccounted-for water

For the present study, "Unaccounted-for Water" is classified into four categories, as shown below;

- 1) Illegal Connection
- 2) Meter Reading Error
- 3) Metering Loss (Under-sensitivity of Consumer's Meter)
- 4) Leakage

### 1) Illegal Connection

Illegal connections are defined as intentional mismanagement of water meters and pipeworks conspired to steal the public supply water. They include breaking or bypassing water meters and making a connection unlawfully. The water consumed through such connection is stolen partly or wholly.

### 2) Meter Reading Error

Meter reading error occurs in such cases as 1) the meter reader fails to read the meter because of very difficult accessibility, and 2) the meter reader mistakes reading. The part of water guessed for consumption and under-estimated by mistaken reading becomes unaccounted-for water.

### 3) Metering Loss

Undersensitive or malfunctioning water meters under-register the actual flow. The under-registered part of water becomes the unaccounted-for.

### 4) Leakage

Water loss caused by leakage from cracks, holes and loose joints of pipes and fittings before flowing into consumers' meter belongs this classification. However, the water loss from the plumbing on the down-stream side of water meter is not classified herein.

### 11.3 Approach of the Study

The four categories of unaccounted-for water itemized in the previous section are sorted out into two groups by the way of approach, namely;

Group 1 : Reducible by Institutional Management

- Illegal Connection
- Meter Reading Error

Group 2 : Reducible by Technical Management

- Metering Loss
- Leakage

The following steps will be taken in narrowing down the leakage:

- estimation of the total unaccounted-for water, firstly
- estimation of the metering loss, secondly
- estimation of the illegal connections' loss and meter reading error, thirdly
- deducting the sum of the second and third from the first

The balance calculated by the deduction is designated as the leakage.