Option No. 1-2

Location of Intake : Right bank of Mekong river at Cham village
Location of Plant : Northern area of Beng Kok
Pipeline System : Raw water transmission main through invert siphon consisting of D700 pipelines

Construction and O/M costs of the above two options are compared below:

(Unit : Thousand U.S.Dollars)

Option	No. 1-1	No. 1-2
Construction Cost	131,366	131,629
Annual O/M Cost for		
Electric Power	4,078	4,199
Personnel Expenses	22	27
Chemicals	478	473
Repair	274	275

Note: 1 U.S.Dollars = 118.41 Yen

As shown above, both the construction and the annual O/M costs for option No.1 is lower than that for option No. 1-2. Thus, option No. 1-1 is selected for the new treatment plant.

5.4.6 Options for Cham WTP Distribution System

The following two options for distribution system are considered for comparison. Fig-5.10 shows the two options.

a) Option No. 2-1
Outline of System : Treated water is distributed through distribution pipelines consisting of D1,000 and D800 pipelines
Location of Reservoir: At the treatment plant site

b) Option No. 2-2
Outline of System : Treated water is sent to the reservoir, and distributed by distribution pumps to the service area

Location of Reservoir : Beside Chrouy Changwar bridge located at the right bank of the Sap river.

Construction and O/M costs for the two options are compared below:

(Unit : Thousand U.S.Dollar)

Option	No. 2-1	No. 2-2
Construction Cost	22,371	19,360
Annual O/M Cost for		
Electric Power	3,077	3,926
Personnel Expenses	2	5
Chemicals	-	-
Repair	47	4,627
Sub-Total	3,126	3,970
Present Value for 10 Years at Annual Interest Rate		
1 %	48,656	52,195
3 %	45,345	48,175
5 %	42,463	44,692

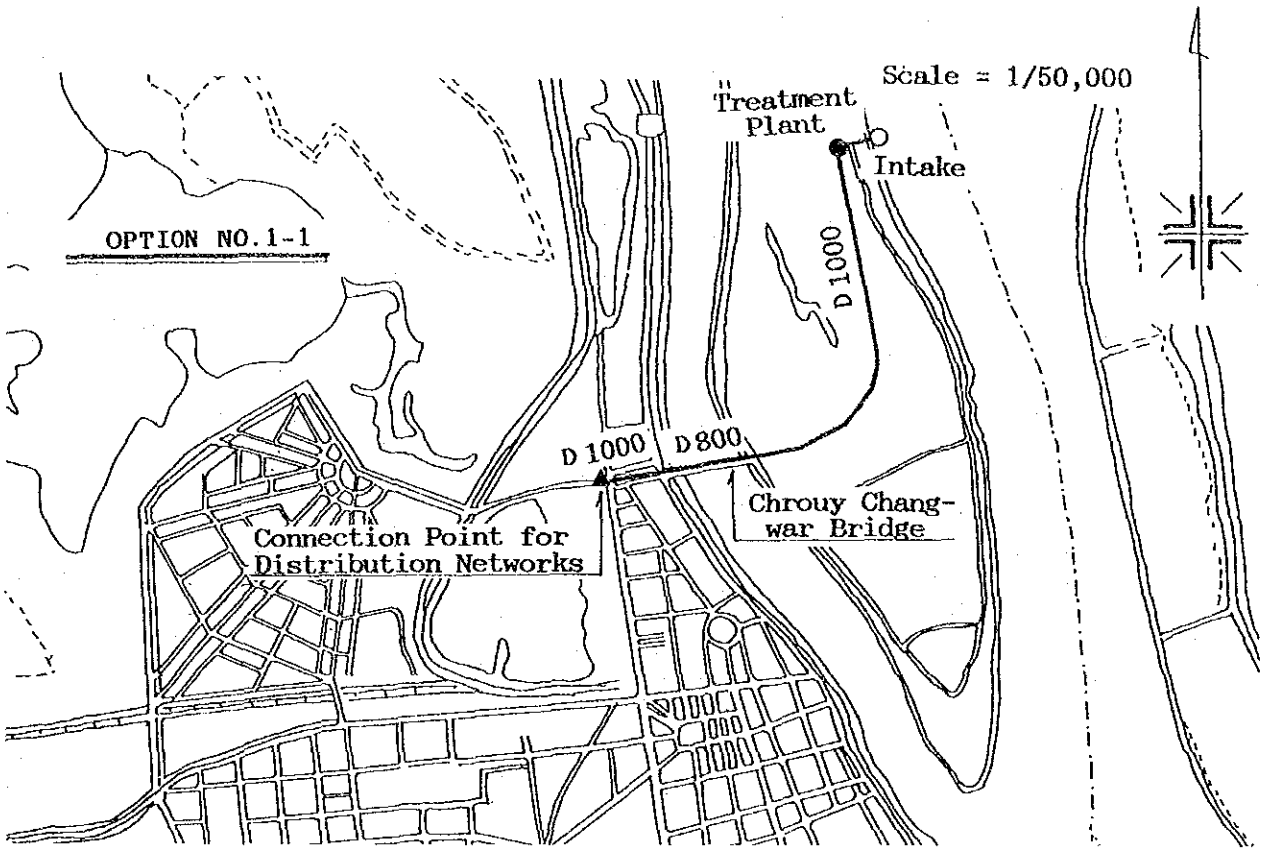
The construction cost is estimated for the following facilities.

Option No.2-1 - From the distribution pumps in the treatment plant to the connection point shown in Fig-5.10

Option No.2-2 - From the transmission pumps in the treatment plant to the distribution pumps in the distribution center besides the reservoir

The construction cost for option No. 2-1 is higher than that for No. 2-2, but the annual O/M cost is lower. The present values for 10 years at three different rates are calculated as shown above. Option No. 2-1 is selected because of its lower present value.

Fig-5.9 OPTIONS FOR LOCATIONS OF TREATMENT PLANT



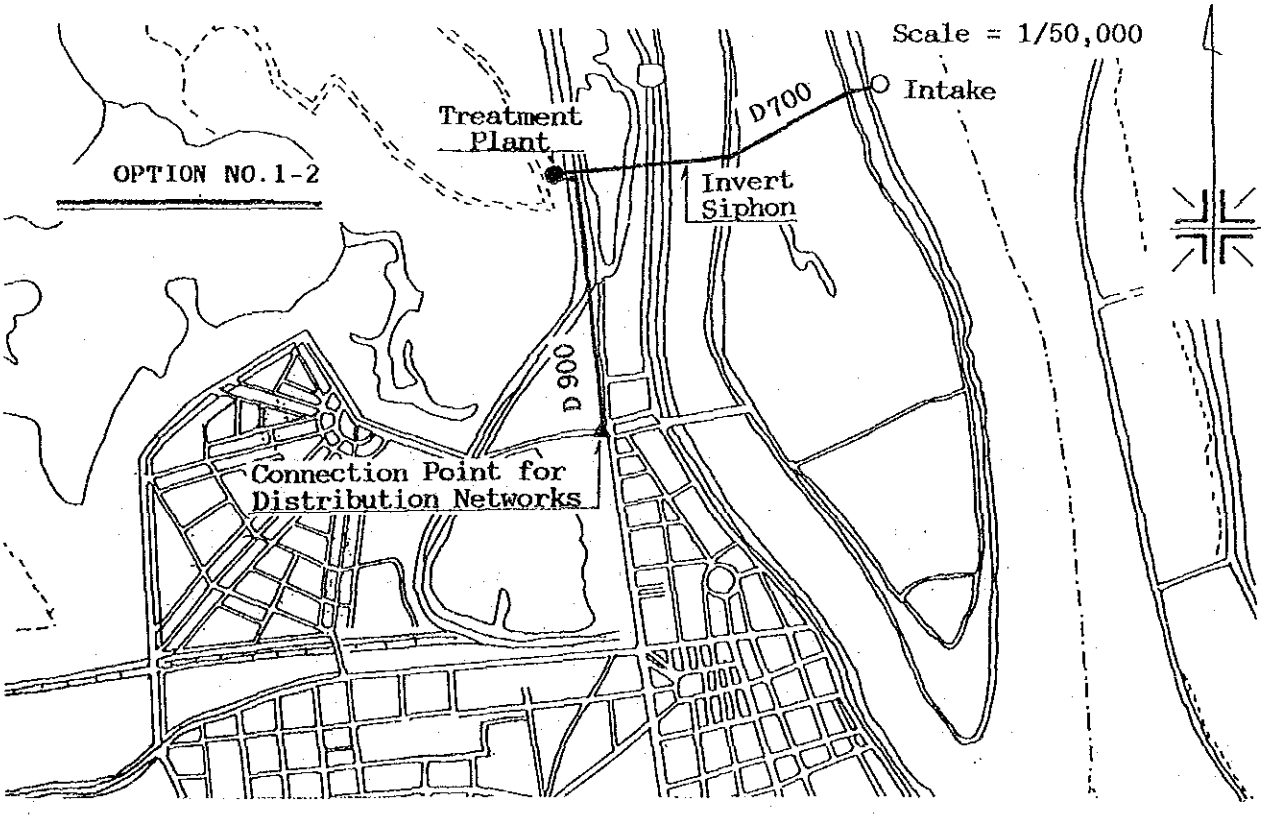
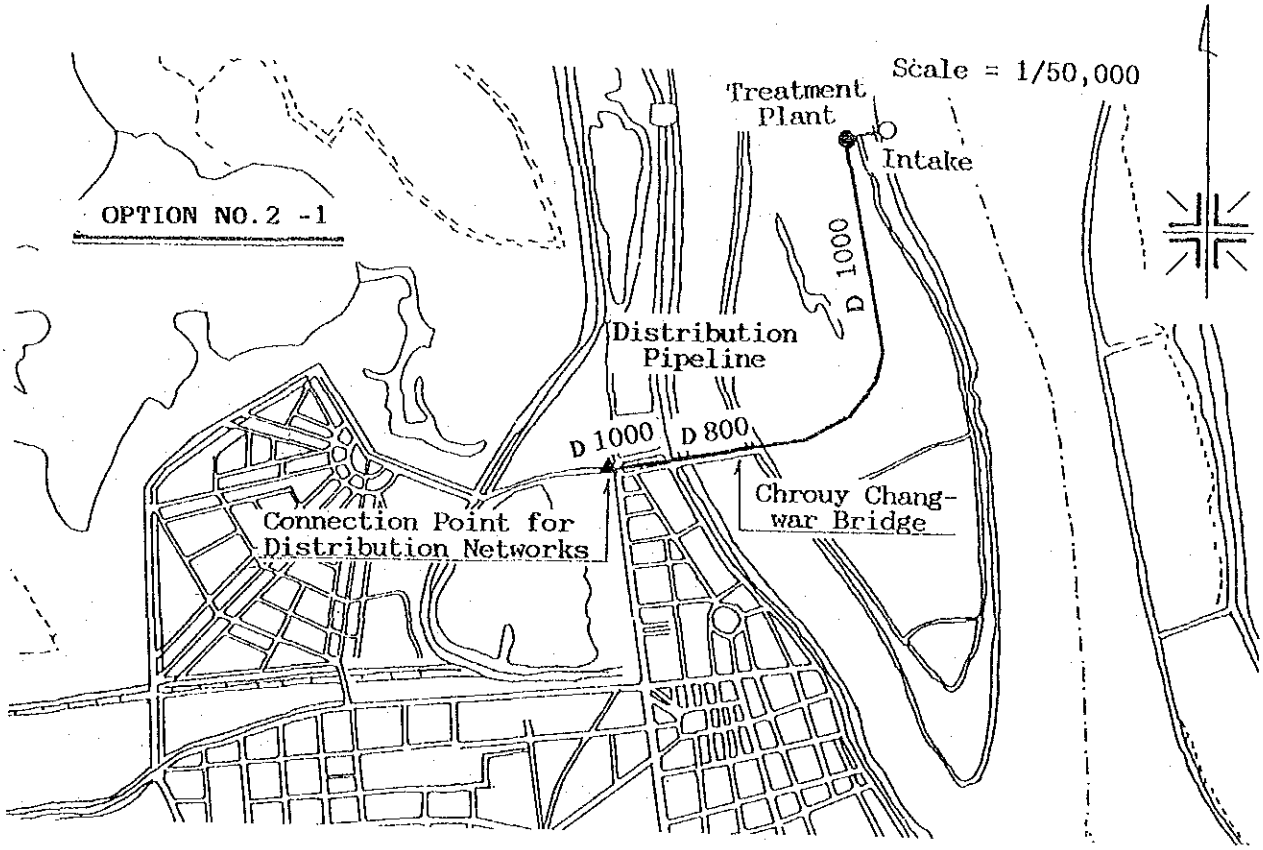
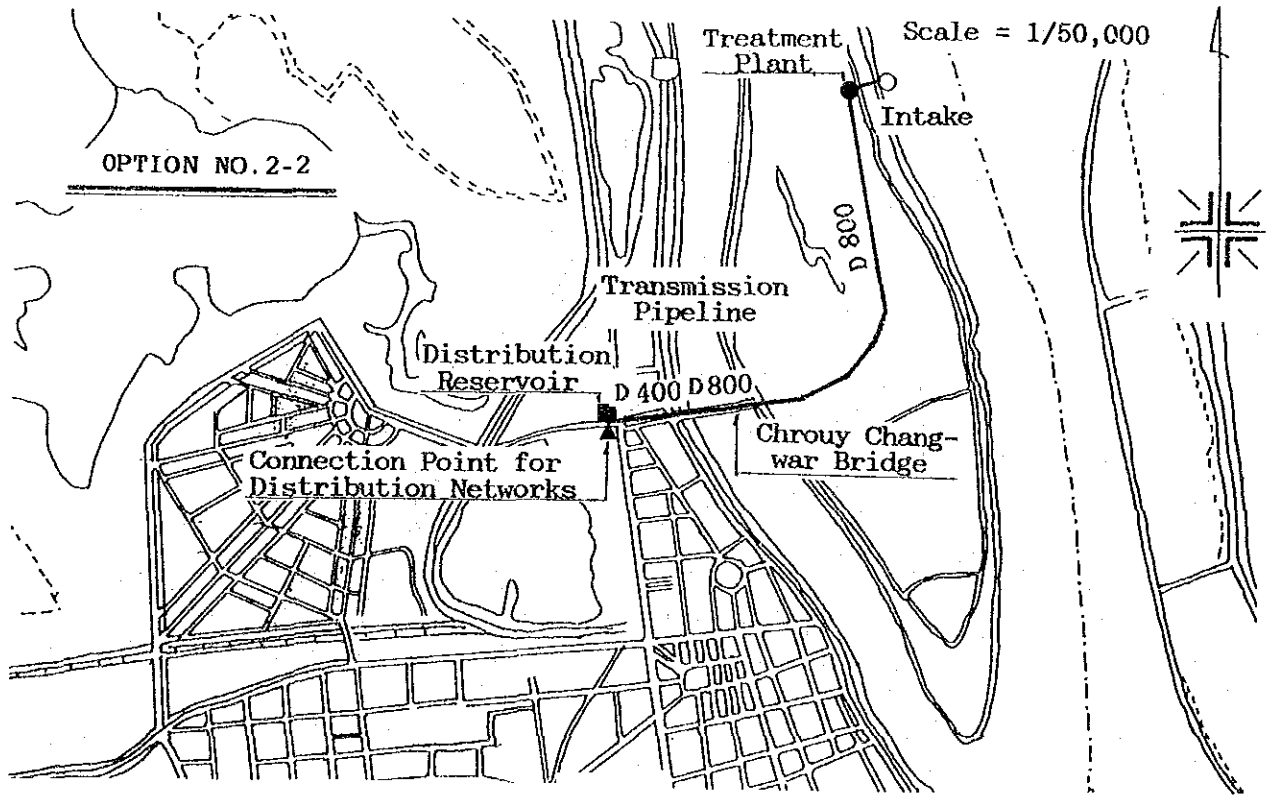


Fig-5.10 OPTIONS FOR DISTRIBUTION AND TRANSMISSION SYSTEMS





5.4.7 Distribution Facilities

5.4.7.1 Main features of the design

The main features of the design are summarized below.

a) A looped distribution system around the city to deliver pressure equally in all directions.

b) Pumping stations are regrouped taking into account the limited number of skilled staff at present and ease of operation and maintenance.

c) Pipes are sized so as to match the peak flows both in 2003and 2010.

d) The Chrouy Changwar bridge under repair is used for the tank mains crossing over the Sap river.

5.4.7.2 Main Characteristics of the Two Possible Distribution System options

It appears that two main options satisfy the above criteria, constraints, and guidelines.

Both options include the existence of two water treatment plants in the first target year 2003, and the existence of three water treatment plants in the target year 2010. The third water treatment plant in 2010 would be the new plant to be built at Cham village on Chrouy Changwar island.

In both cases,the pressure head reference has been assumed to be the same as the Phum Prek delivered pressure.

In both options, the storage necessary to supply peak hour demand has been assumed to be at Phum Prek.

For both options, the pipes lengths have been computed in the following way:

- For the trunk main pipes (diameter 300 mm and above), by using the Piccolo hydraulic model.

- For the distribution pipes (diameter 250 mm and below), by considering that each cu.m. of daily water production capacity will correspond to an average of 2.3 m

length of trunk main and distribution pipes. The current figure is 2.2 m in Phnom Penh, taking into account the design capacity of the working plants, (cf it is 3 in Bangkok).

5.4.7.3 Option 3-1 Main Network Incorporating the Existing Elevated Tank

This first option sallows the existing elevated tank to play an active hydraulic role, from the time of its rehabilitation to the target year 2010. The sketch hereafter shows the two implementation phases of this first option. Table-5.8 summarizes the planned growth in the pipe network according to this options. Table-5.9 shows the diameters and lengths of the additional trunk main pipes.

Table-5.8 PLANNED GROWTH IN THE PIPE NETWORK - OPTION 3-1

Description	Production Capacity (m^3/d)	Trunk Main Length (m)	Secondary Length (m)
Existing 1993	110,000	34,550	242,300
Additional 1993-2003	+60,000	+28,600	+97,100
Planned situation in 2003	170,000	63,150	339,400
Additional 2003-2010	+130,000	+20,350	+64,700
Planned situation in 2010	300,000	83,500	404,100

Table-5.9 LENGTH AND DIAMETER OF THE ADDITIONAL PIPE - OPTION 3-1

1993 / 2003		2003 / 2010	
Diameter (mm)	Length (m)	Diameter (mm)	Length (m)
1,000	2,200	1,000	5,200
900	1,300	900	0
800	3,750	800	1,150
700	0	700	2,600
600	2,500	600	1,700
500	4,450	500	4,000
450	0	450	0
400	6,400	400	1,500
350	0	350	0
300	8,000	300	4,200
Total	28,600	Total	20,350

5.4.7.4 *Option 3-2 Main network not incorporaty the Existing Elevated Tank*

The second option envisages not using the existing elevated tank. As it is located close to the Phum Prek WTP, Table-5.10 summarizes the planned growth of the network according to this option. Table-5.11 shows the diameter and length of the additional trunk main pipes.

Table-5.10 PLANNED GROWTH IN THE PIPE NETWORK - OPTION 3-2

Description	Production Capacity (m^3/d)	Trunk Main Length (m)	Secondary Length (m)
Existing 1993	110,000	34,550	242,300
Additional 1993-2003	+60,000	+27,200	+97,100
Planned situation in 2003	170,000	61,750	339,400
Additional 2003-2010	+130,000	+20,800	+64,700
Planned situation in 2010	300,000	82,550	404,100

Table-5.11 LENGTH AND DIAMETER OF THE ADDITIONAL PIPES-OPTION 3-2

1993 / 2003		2003 / 2010	
Diameter (mm)	Length (m)	Diameter (mm)	Length (m)
1,200	900	1,200	0
1,100	0	1,100	0
1,000	900	1,000	5,200
900	1,600	900	0
800	1,000	800	2,700
700	1,100	700	3,100
600	0	600	1,550
500	5,550	500	3,800
450	500	450	0
400	7,650	400	250
350	0	350	0
300	8,000	300	4,200
Total	27,200	Total	20,800

5.4.7.5 Necessary delivered pressure from the new plant

Connecting the new plant to be built on Chrouy Chang War Island to the main networks the pressure head to be delivered downstream of the plant can be calculated. The computations with the model have been made with the following assumptions:

- peak consumption for the year 2003;
- storage for the peak consumption to be located in Phum Prek;
- delivered pressure downstream of Phum Prek: 40 m head;
- delivered flow downstream of the New Water Treatment Plant : 1.505 m^3/s

In the framework of options 1 and 2, the pressure head on the west bank of the Sap river is 42 m head.

5.4.7.6 Conclusions

Two options have been studied.

In the short term, option 1 appears to be more interesting, as it includes the possibility of using the existing elevated tank, from now on as part of an urgent rehabilitation works, up to 2010, the second target year. The urgent rehabilitation works would include a new pumping station delivering an average of 1000 m^3/h at 25 m pressure head, and a new transmission line of diameter 500 mm, both dedicated to the filling of the tank.

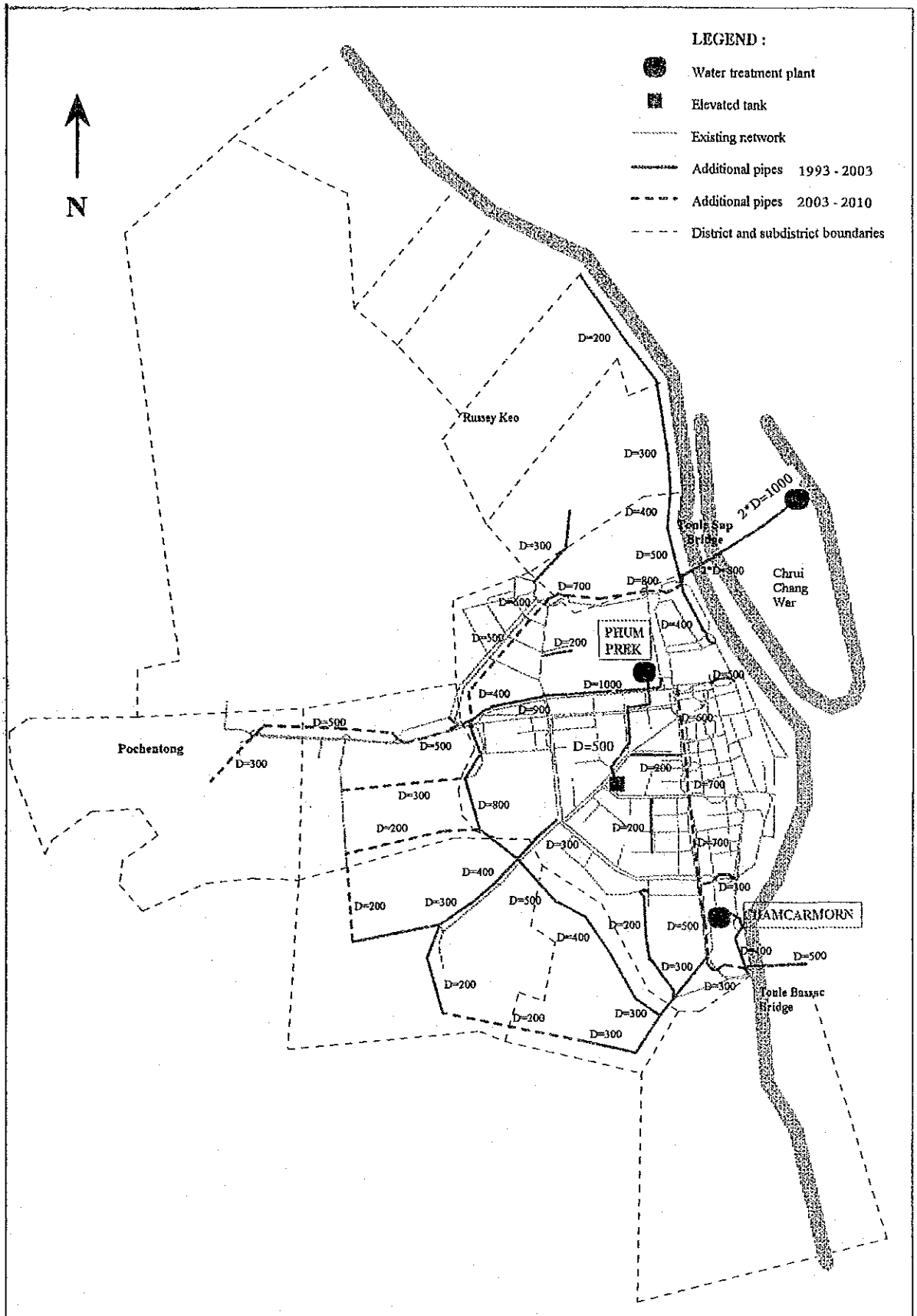


Fig.-5.11

PHNOM PENH WATER SUPPLY MASTER PLAN 1993-2010

OPTION NO. 3 - 1

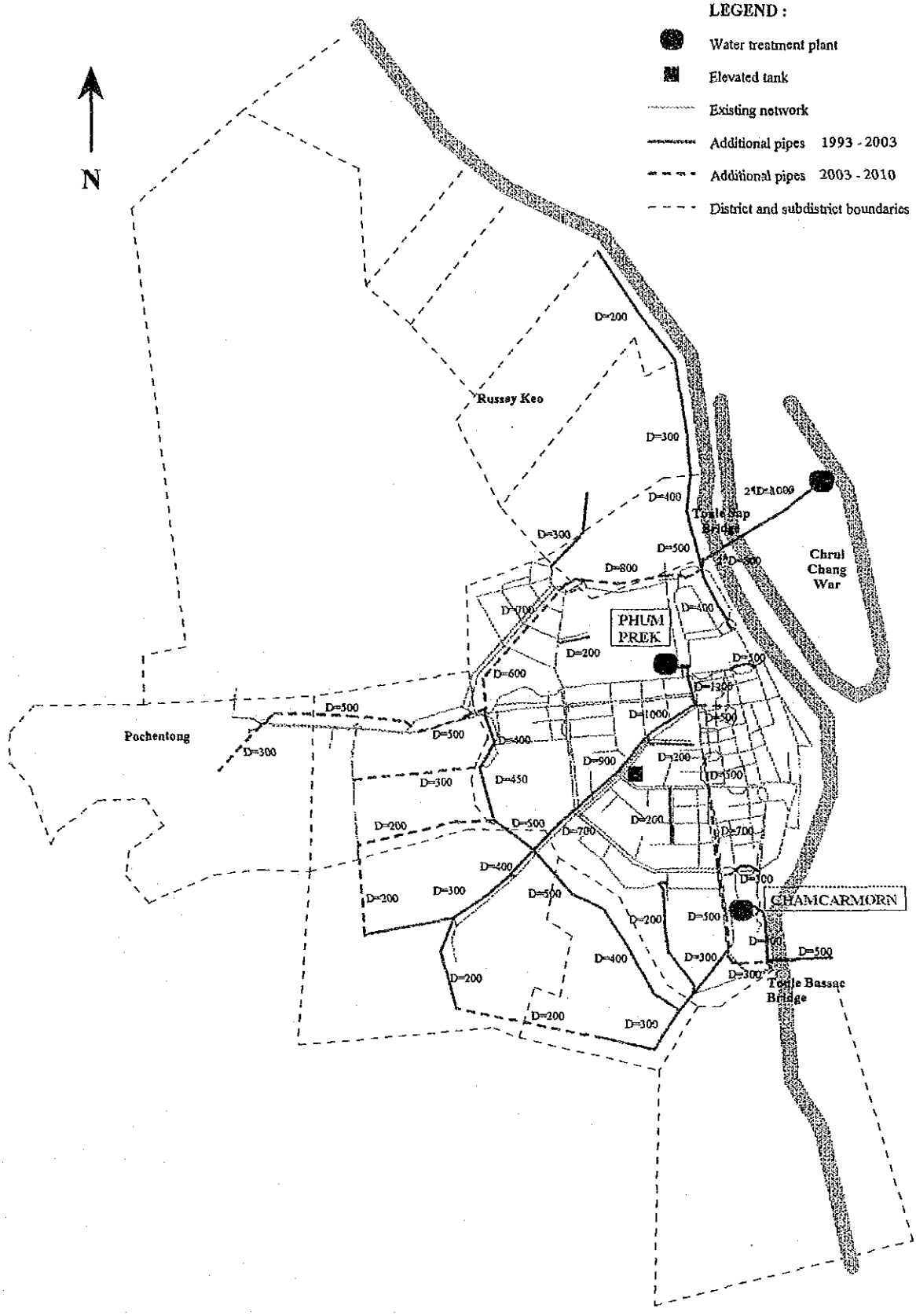


Fig.-5.12

PHNOM PENH WATER SUPPLY MASTER PLAN 1993-2010

OPTION NO. 3-2

In the long term, option 2 would be expected to be cheaper by 2%. Nevertheless, option 1 is recommended because the elevated tank included in Option 1 would contribute to absorption of diurnal fluctuation of the demand. In addition, the elevated tank would contribute to the ease of operation of the distribution pumps. Options 1 and 2 are shown in the Fig-5.11 and Fig-5.12 respectively.

5.5 Proposed System

On the basis of the previous section 5.4, entitled "Development Plan", the proposed facilities for the future System are stated below:

5.5.1 Intake Facilities

The raw water is abstracted from the Mekong river through an intake tower 40 m from the right bank of the river. The bank and tower is connected by an access bridge for convenience of operation and maintenance. The raw water is conveyed through intake pumps installed in the pump house on the tower to the treatment plant, by two raw water main DCIP pipelines each having diameter D900 mm and length 150 m in length.

The summarized list of the facilities is shown below, and the plan of intake facilities is given along with treatment facilities in Fig-5.13.

Intake Facilities and Raw Water Main

a) Intake Tower

Size & No.	RC Tower (Ellipse Shaped)
	W8.0 m x L14.0 m x H 34.0 m x 1 no.
Intake Gate	W1.5 m x H1.5 m x 6 sets
	with Screen and Headstock
Appurtenances	Access Bridge (W2.5 m x L40.0 m)
	Inspection House (W8.0 m x L14.0 m)

b) Intake Pump

Pump Type	Vertical Mixed-Flow type
Capacity	D500 x Q24.0 m^3/min x H22.0 m x 132 kw
	x 3,000 v/50 Hz x 6p x 6 units (2 Stand-by)

c) Raw Water Main

Size & No.	D900 DIP x 150 m x 2 pipelines
Appurtenances	Line valves, air release valves and drain.

5.5.2 Treatment Facilities

The raw water from the intake facilities is conveyed to receiving wells. Aluminum sulfate and lime are mixed with the raw water in the mixing chamber by means of a hydraulic mixing system.

In the treatment plant, distribution pump house and chemical building are constructed with the administration and control buildings. For the operations staff, staff quarters are also provided.

The sizes and capacities of the treatment facilities are as follows.

Treatment Facilities

a) Receiving Well

Size & No.	W6.0 m x L8.0 m x D4.0 m x 1 well
Capacity	192 m^3
Detention Time	2.0 min
Appurtenances	Measuring Weir for Raw Water Flow

b) Mixing Chamber

Size & No.	W6.0 m x L8.0 m x D3.0 m x 1 chamber
Capacity	144 m^3
Detention Time	1.5 min
Chemicals	Alum. and Lime
Flash Mixing Type	Hydraulic Mixing Type

c) Flocculation Basin

Size & No.	W12.0 m x L10.4 m x D3.85 m x 6 basins
Capacity	480 m^3
Detention Time	30 min
Type	Vertical Baffled Flow Type

d) Sedimentation Basin

Size & No.	W12.0 m x L80.0 m x D3.0 m x 6 basins

Capacity	2,880 m^3
Overflow Rate	1.0 $m^3/m^2/hr$
Detention time	3.0 hr

e) Filter

Size & No.	W8.8 m x L9.3 m x 16 filters
Filter Area	81.8 m^2/filter
Filter Speed	120.5 m/day
Washing Type	Surface Wash and Backwash by Water
Filter Control	Control system x 16 units
Appurtenances	Raw Water, Filtered Water, Surface Wash, and Backwash Water Pipes

f) Clear Water Reservoir

Size & No.	W36.8 m x L74.0 m x D4.0 m x 4 units
Capacity	43,400 m^3
Detention Time	8.0 hr
Appurtenances	Water level meters, and ventilators

g) Distribution Pump and Pump House

Type	Horizontal Volute Type
Size & No.	Ø350 x Ø200 x Q20.0 m^3/min x H55 m x 270 kw x 3,000 V/50 Hz x 4P x 6 units Ø300 x Ø200 x Q10.0 m^3/min x H55 m x 132 kw x 3,000 V/50 Hz x 4P x 4 unit
Pump House	W6.0 m x L42.0 m x H6.0 m x 1 house
Appurtenances	Suction Pipe and Overhead traveling crane

h) Chemical Building

Size & No.	W12.0 m x L30.0 m x 2 stories x 1 house
Chemicals	Alum., Lime and Chlorine
Appurtenances	Overhead traveling crane, dosing equipment, water supply equipment, solution tanks, storage area, and others.

i) Storage House

Size & No.	W10.0 m x L30.0 m x 1 house

j) Administration & Control Building (including Laboratory)

Size & No.	W10.0 m x L34.0 m x 2 stories x 1 house
Rooms	Office, Control Center, Laboratory and Conference Room Water Tank (500 m^3)for backwash water set on the roof.

k) Staff Quarters

Size & No.	W4.0 m x L12.0 m x One-Story x 6 houses

The plan of treatment facilities is shown in Fig-5.14 along with the intake facilities. The hydraulic profile is shown in Fig-5.15.

5.5.3 Distribution Facilities

5.5.3.1 Proposed Distribution Main

In the existing service area, the distribution mains are to be replaced by larger diameter pipes because of increased water supplied from expansion works in the Phum Prek and the Chamcar Morn water treatment plants in the URW and by the construction of a new Cham treatment plant.

In the expanded service area, new distribution mains, secondary and tertiary pipes are planned. The total length of distribution mains and branch pipes are estimated on the basis of pipe length per existing service population. The result is shown in Table-5.12.

Table-5.12 PROPOSED DISTRIBUTION PIPE

Diameter (mm)	Pipe Length 2003 (m)	Pipe Length 2010 (m)	Pipe Length Total (m)	Remarks
1,000	2,200	5,200	7,400	
900	1,300	0	1,300	
800	3,750	1,150	4,900	
700	0	2,600	2,600	
600	2,500	1,700	4,200	
500	4,450	4,000	8,450	
450	0	0	0	
400	6,400	1,500	7,900	
350	0	0	0	
300	8,000	4,200	12,200	
Sub-total	28,600	20,350	48,950	
250	9,000	6,000	15,000	
200	18,100	12,100	30,200	
150	14,300	9,500	23,800	
100	55,700	37,100	92,800	
Sub-total	97,100	64,700	161,800	
Total	125,700	85,050	210,750	

Note : Refer Fig.-5.11

5.5.3.2 Rehabilitation and Improvement of the Existing Distribution System

Many problems are observed in existing pipe facilities because of lack of scheduled maintenance work in the last 30 years. These include;

a) Progress of corrosion and significant accumulation of mud in the pipes, which disturbs smooth flow.
b) In the network system, there are very few to wash out drains.
c) Treatment plants now operate intermittently, resulting in air being introduced inside the pipes, which prevents normal flow in the pipes. There are very few air valves in distribution system.
d) There are very few fire hydrants in the existing system.
e) Almost all the existing water supply branch pipes were laid in the center of roads which makes it difficult to carry out maintenance work because of heavy traffic.
f) There are very few stop valves in the network system.

To solve the above problems, the following rehabilitation works are necessary:

1) Cleaning and Lining of the Trunk Mains

For the existing branch pipes of less than 250 mm diameter, there is no need for cleaning and lining, since they would be replaced. Trunk mains of diameter between 300 mm to 800 mm should be cleaned and lined to restore the hydraulic condition and to decrease leakage from the pipes. The necessary pipe lengths for improvements are shown in Table-5.13.

Cleaning is a preliminary process on pipe renovation works. There are three conventional methods for cleaning. These are 1) pig method, 2) scraper method and 3) flushing method. Considering effects on house connections, leakage and interior surface conditions of pipes, the scraper method is recommended.

There are two lining process. One is lining or coating of the interior surface of the pipe with cement mortar or painting. The second process involves insertion of new, smaller pipes, for which seal hose lining method is recommended. This lining does not affect downstream water quality and is sufficiently durable.

2) Replacement of Secondary Pipes

Replacement of the existing secondary pipes of diameters between 60 to 250 mm should be carried out in order to decrease leakage in house connections, since cost

evaluation studies show that cleaning and lining of secondary pipes is almost as expensive as laying new pipes. The pipes that need to be replaced are shown in Table-5.14.

3) Installation of Stop Valves

Installation of stop valves in the existing distribution pipes of diameter between 300 to 800 mm for maintenance work is necessary. The number of valves are shown in Table-5.15.

4) Installation of Air Valves

Air valves in the existing distribution trunk mains need to be installed to vent air from the pipes and improve flow. The number of valves required are shown in Table-5.15.

5) Installation of Fire Hydrants

Installation of fire hydrants is necessary to protect private and public assets from fire damage. Fire hydrants should be installed in the distribution pipes of less than 350 mm diameter in order to prevent high pressure in the pipes. The number of hydrants are shown in Table-5.15.

6) Installation of Washouts

Installation of washouts is necessary in order to wash out pipes during maintenance operation or to flush muddy water when present. The number of washouts ever routs required is shown in Table-5.15.

5.5.4. Service Facilities

Rehabilitation of service facilities would cost significantly and take a lot of time, considering the severely damaged condition at present. Its rehabilitation will be needed urgently when URW of production and distribution facilities is completed. As a basic principle, rehabilitation cost should be paid by the consumer, but in the present situation, it would be better to install public taps as a temporary measure to cope with the urgent need of low income groups.

Fig-5.13 LOCATION OF TREATMENT PLANTS

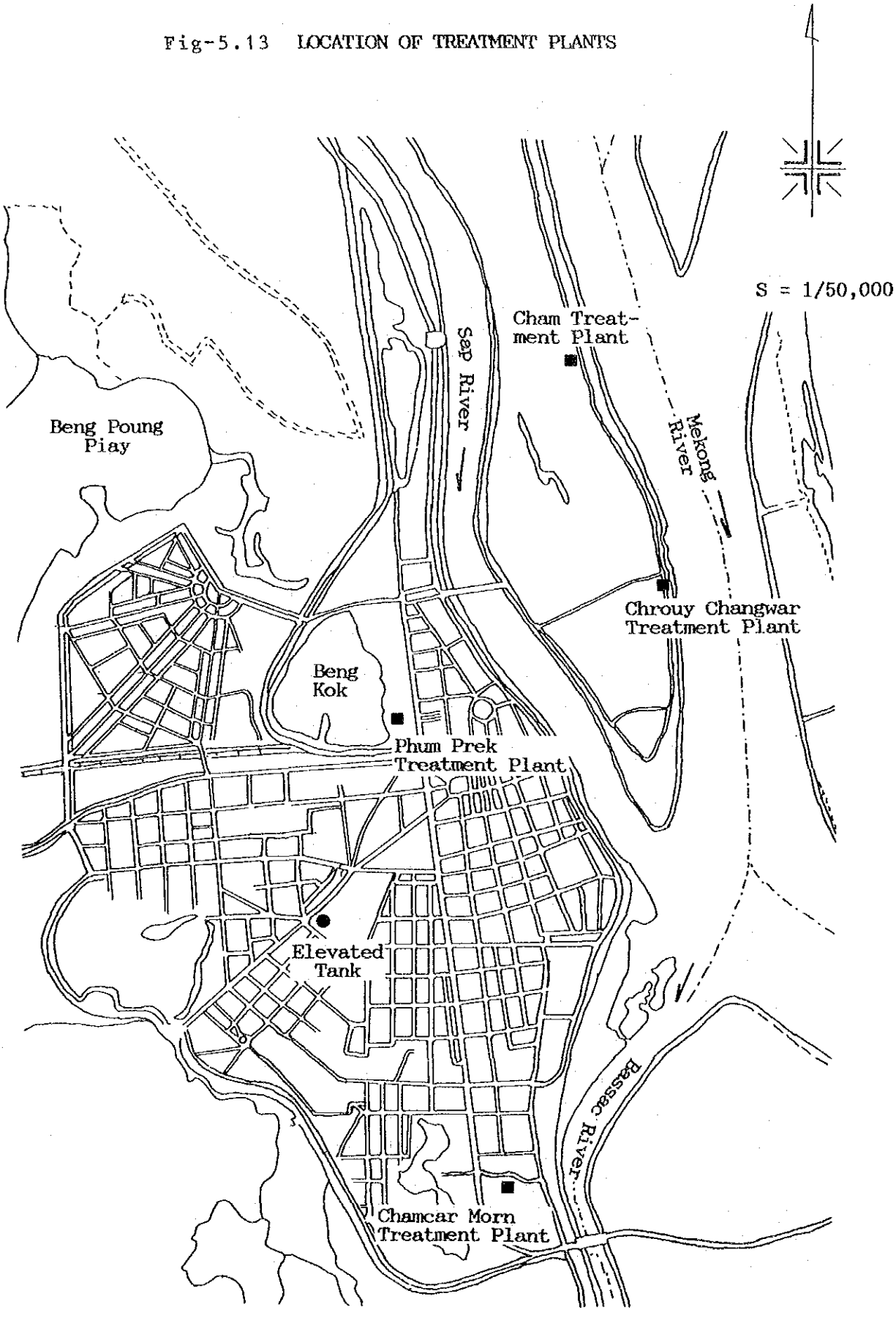
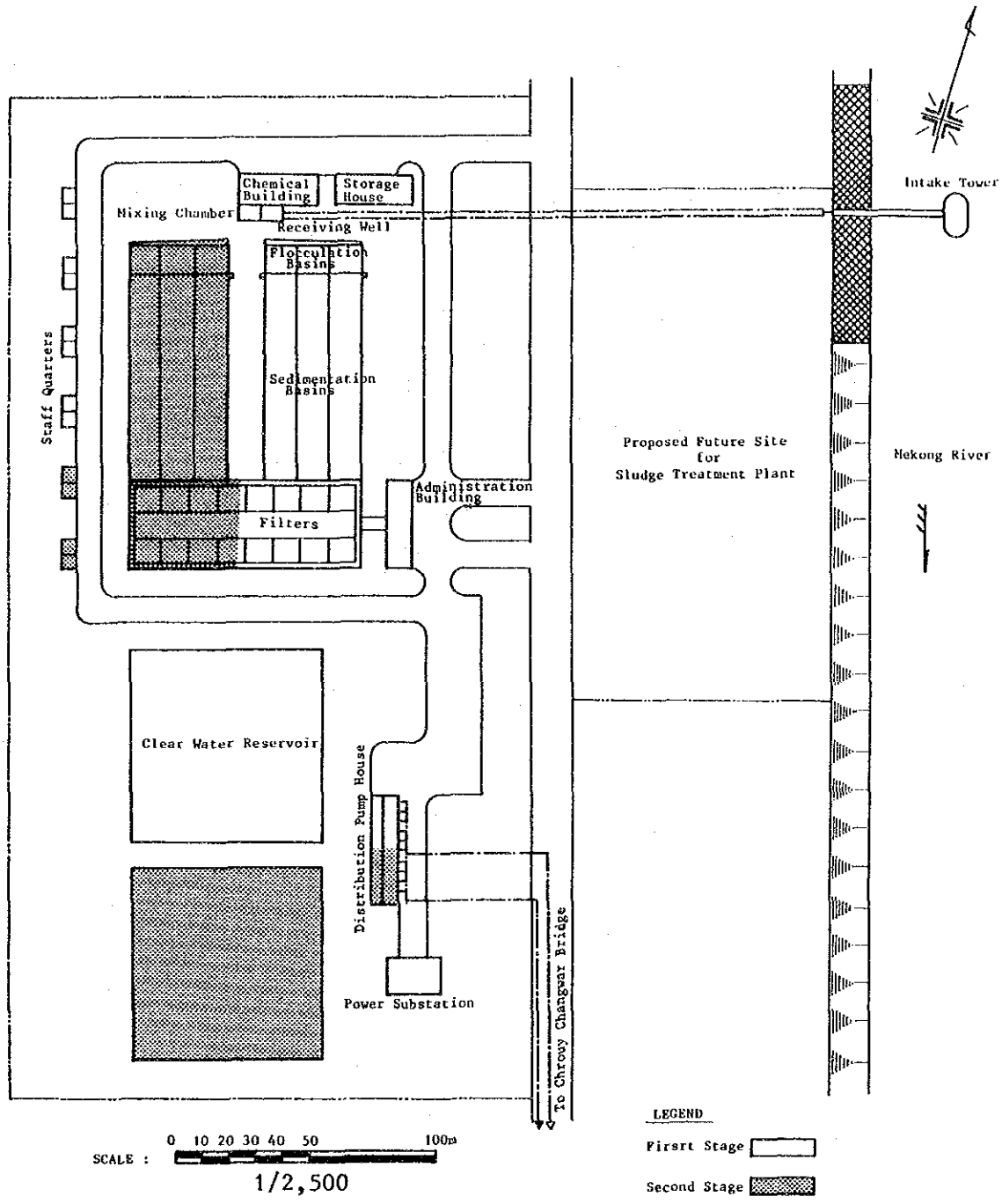


Fig-5.14 GENERAL PLAN OF CHAM TREATMENT PLANT



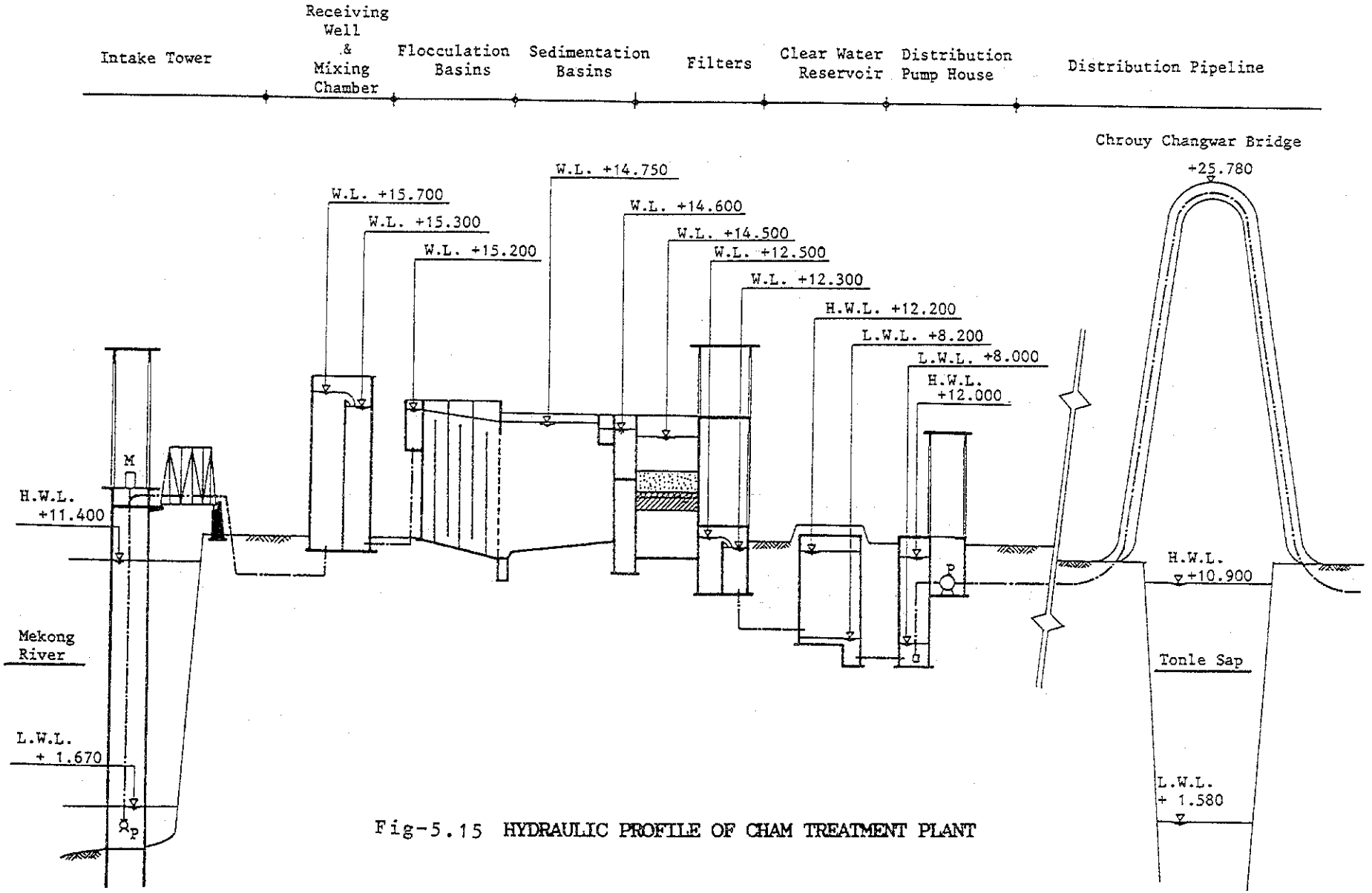


Fig-5.15 HYDRAULIC PROFILE OF CHAM TREATMENT PLANT

Table-5.13 CLEANING AND LINING DISTRIBUTION PIPE

Diameter (mm)	Pipe Length Total (m)	Remarks
800	1,000	
700	3,400	
600	750	
500	2,650	
450	3,350	
400	4,650	
350	4,200	
300	14,550	
Total	34,550	

Table-5.14 REPLACEMENT OF DISTRIBUTION PIPE

Diameter (mm)	Pipe Length Total (m)	Remarks
250	23,750	
200	18,050	
150	28,900	
100	131,850	
Total	202,550	

Note:
Except French Aid

Table-5.15 VALVE, AIR VALVE, FIRE HYDRANT AND WASHOUT

VALVE

Diameter (mm)	Valve (pieces)	Remarks
800	1	
700	3	
600	1	
500	3	
450	3	
400	5	
350	8	
300	29	
Total	53	

AIR VALVE

Diameter (mm)	Air Valve (pieces)	Remarks
800	1	
700	3	
600	1	
500	3	
450	3	
400	5	
350	8	
300	29	
Total	53	

FIRE HYDRANT

Diameter (mm)	Fire Hydrant (pieces)	Remarks
350	8	
300	29	
Total	37	

WASHOUT

Diameter (mm)	Washout (pieces)	Remarks
800	1	
700	3	
600	1	
500	3	
450	3	
400	5	
350	8	
300	29	
Total	53	

5.6 Operation and Maintenance Issues under the Master Plan

5.6.1 Improvements of Facilities by the Master Plan

The service population in 1992 of 532,000, will grow to 752,000 and 1,254,000 in the years 2000 and 2010, respectively.

Accordingly, the supply capacity of the Phnom Penh water supply system is planned to be increased in three stages, viz., under the Urgent Rehabilitation Works (URW) between 1993-1996, the first stage of the master plan between 1999-2003 and the between 2006-2010.

For this capacity increase, rehabilitation and expansion of the production, distribution and service facilities, are planned as summarized in Table-5.16 below. Reduction of leakage resulting from rehabilitation and expansion are also shown in the table.

Table-5.16 CHANGES IN PRODUCTION AND DISTRIBUTION FACILITIES

Facilities	URW(Phase 1	1st Stage	2nd Stage	Total
1. PRODUCTION (m^3/d)				
Phum Prek WTP	150,000	-	-	150,000
Chamcar Morn WTP	20,000	-	-	20,000
Cham WTP	-	65,000	65,000	130,000
Production Total	170,000	65,000	65,000	300,000
2. DISTRIBUTION FACILITIES (km)				
Transmission Pipe	2.4	-	-	2.4
Distribution Main	2.7	125.7	85.1	213.5
Service Pipes	116.0	143.1	-	251.0
3. LEAKAGE RATIO (%)	50	40	30	

Note; (*1) from 1993 to 2000
(*2) from 2000 to 2010

The present production capacity of 110,000 m^3/d, will be roughly tripled by 2010 and the length of the trunk and distribution mains will also be tripled so as to enable the distribution network to cope with the increase in flow.

5.6.2 Envisioned Changes in the PPWSA

Changes expected to take place in the PPWSA, from 1993 to 2000 and then to 2010, could be described as below:

5.6.2.1 Condition of Water Supply

If expansion of the production and distribution capacity of the PPWSA's water supply system is realized as listed in Table-5.20, benefits obtained from improved water supply will be remarkable. The consumption, including losses through leakage, will be 135 lpcd (liter/capita/day) in 2000, 175 lpcd in 2005 and 200 lpcd in 2010, despite the estimated sharp increase in the served population. The present consumption is 100 lped.

5.6.2.2 Financial Condition

The financial condition of the PPWSA will be largely improved after 1996 with increased supply capacity, efficient use of personnel, energy and other resources, and use of an appropriate water tariff structive. As a result, a sizable amount of surplus would be generated every year. A more detailed discussion is given in Section 6.6.1.

The present financial condition is far from one of self-reliance. The revenue from water sale covers only a part of the operating costs such as personnel costs, power costs and administrative expenses, but not depreciation and interest. The present accounting system was formed under the socialistic economic set up, and the basic concept of accounting was not embodied in the system.

Self-reliance means sufficient revenue to cover all the costs. The revenue should be based on water sales including connection fees. The cost items to be covered by the revenue should include (1) operating costs such as personnel costs, energy costs, maintenance costs, administrative expenses and depreciation, and (2) non-operating expenses such as interest. Since the revenue and the expenses are presently not balanced, the water tariff structure should be set so as to balance the cumulative revenue and the expenses for a long term frame of 10 to 15 years.

The present water tariff is unreasonably low. It is apparent that consumers can afford higher water charges; this is evident from the fact that there are quite a few people who buy water from owners of a legal connection and pay the latter far more than the original cost based on the official rate.

The water tariff should be raised to a reasonable level even before the completion of the proposed project. The long-term water, tariff structure must be made based on the foregoing accounting concept.

5.6.2.3 Organization Structure

The proposed organizational structure of the PPWSA is shown in Fig-4.1. Under the director, there are three assistant directors, three deputy directors, 10 departments including the Chief Engineers office, and 31 divisions. However, the roles of three assistant directors-budget and finance, special projects, and audit and safety-shall be handed over to the departments in the near future so as to avoid duplication and to improve efficiency. The structure will not be changed much in the foreseeable future except for a few minor ones.

5.6.3 Improvement of Personnel Affairs of the PPWSA

5.6.3.1 Staffing Plan

Cambodia is a young nation. In contrast, the PPWSA is full of aged employees.

By 2010, the target year of this master plan, more than half of the present employees would have retired from the PPWSA.

A staffing plan to improve the age distribution of the employees should be provided and implemented so that smooth transfer takes place.

1) Projected Decrease of Employees' Number by Retirement

The numbers of employees in the categorized age group, described in Section 4.1.2. are: 30 in age group 21-31, 93 in age group 31-40, 99 in age group 41-50 and 41 in the 50 age group at present.

The number of people reaching the retiring age of 55 years could be estimated from the above figures. In 1996, three years from now, 14 persons out of 44, (one third) in the over 50 years group, will retire. In 2003, seven years from now, all 44 persons in the over 50 years group and 20 of the 99 persons (20 %) in the 41-50 age group will retire. In 2010, seventeen years from now, all 41 persons in the over 50 group, and all 99 in the 41-50 age group and 19 persons out of 93 (20 %) in the 31-40 age group will retire.

In summary, the number retiring are:14 by 1996, another 61 by 2003 and another 159 by 2010.

2) Projection of Staff Size of Each Unit

a) Production Department

The Production Department, presently staffed by 78 persons, will need more employees after the URW to operate the new plant planned to produce 65,000 m^3/day and 130,000 m^3/day, respectively, in the 1st and 2nd stages. The new plant, similar to Phum Prek in output, will be managed by about 30 operators.

The estimated increase in staff members required will be 30 during the 1st stage and none during the 2nd stage.

b) Distribution Department

The Distribution Department, staffed by 42 persons after the URW, for maintaining 230 km long trunk and distribution mains will need more employees for the extended mains of lengths 392 km and 691 km, respectively, in the 1st and the 2nd stages. Considering improvements in transportation and workers' efficiency with better tools, 30 % increase at each stage will be reasonable.

The estimated increase in staff members required will be 13 during the 1st stage and 16 during the 2nd stage.

c) Chief Engineer's Office

The Chief Engineer's Office, staffed by 35 persons after the URW should be strengthened both in numbers and in the qualifications of the staff. In addition to ordinary engineering works, this office will have to function as the training center to raise the technical capabilities of all the PPWSA staff and as the source of trained personnel to be provided to other units.

The increase in staff members required will be 15 during the 1st stage and 20 during the 2nd stage.

d) Technical Department, Customer Services

The Technical Department of the Customer Services, staffed by 50 persons after the URW, will have to be expanded in response to the projected increase in the number of customers which will be 608,000, 752,000 and 1,254,000 in 1995, 2003 and 2010. At each stage, 30 % increase in the staff size will be necessary.

The increase in staff members required will be 15 during the 1st stage and 20 during the 2nd stage.

e) Billing and Collection Departments

The Billing and Collection Department of the Customer Service, staffed by

62 persons after the URW, will be expanded in proportion to the number of customers, firstly because of the above-mentioned reasons and secondly due to the anticipated rapid increase in the number of connections. The staff size shall be increased by 30 % at each stage.

The increase in staff members required will be 15 during the 1st stage and 50 during the 2nd stage.

f) Accounting Department

The Accounting Department, staffed by 17 persons, will have to be improved by computerization and the employment of commercial accounting systems.
The character of this department should be changed from simple accounting to financial planning and budget control in future, and, therefore, more qualified personnel will be required.

The increase in staff members required will be 5 during the 1st stage and 7 during the 2nd stage.

g) Stores Department

The Stores Department, staffed by 12 persons, can be managed without sizable increase in the number of staff members. Efficiency of store-keeping and inventory-control will be significantly improved by computerization and, if the social and commercial environment is improved, private suppliers will be able to keep stock of materials and goods for PPWSA.

Moreover, as the city area and the PPWSA grow, many more stores managed under other departments will be located at various sites and the works of this department will change from handling goods to processing papers. In other words, the department shall only handle procurement and will forward the purchased goods to other departments, which have their own stores. In this sense, the Department should be renamed as the Procurement Department.

The increase in staff members required will be 2 each the 1st and during the 2nd stages.

h) Administration Department

The Administration Department, staffed by 20 persons, will have to undergo qualitative changes, such as strengthening of the Legal Division and the Properties Division.

The increase in the staff members required will be 4 during the 1st stage and 3 during the 2nd stage.

i) Personnel Department

The Personnel Department, staffed by 15 persons, will have to undergo qualitative changes as well as moderate staff increase.

Intensification and elaboration of training programs, recruitment plans and upgrading the personnel management system in cooperation with the Legal Division will be needed.

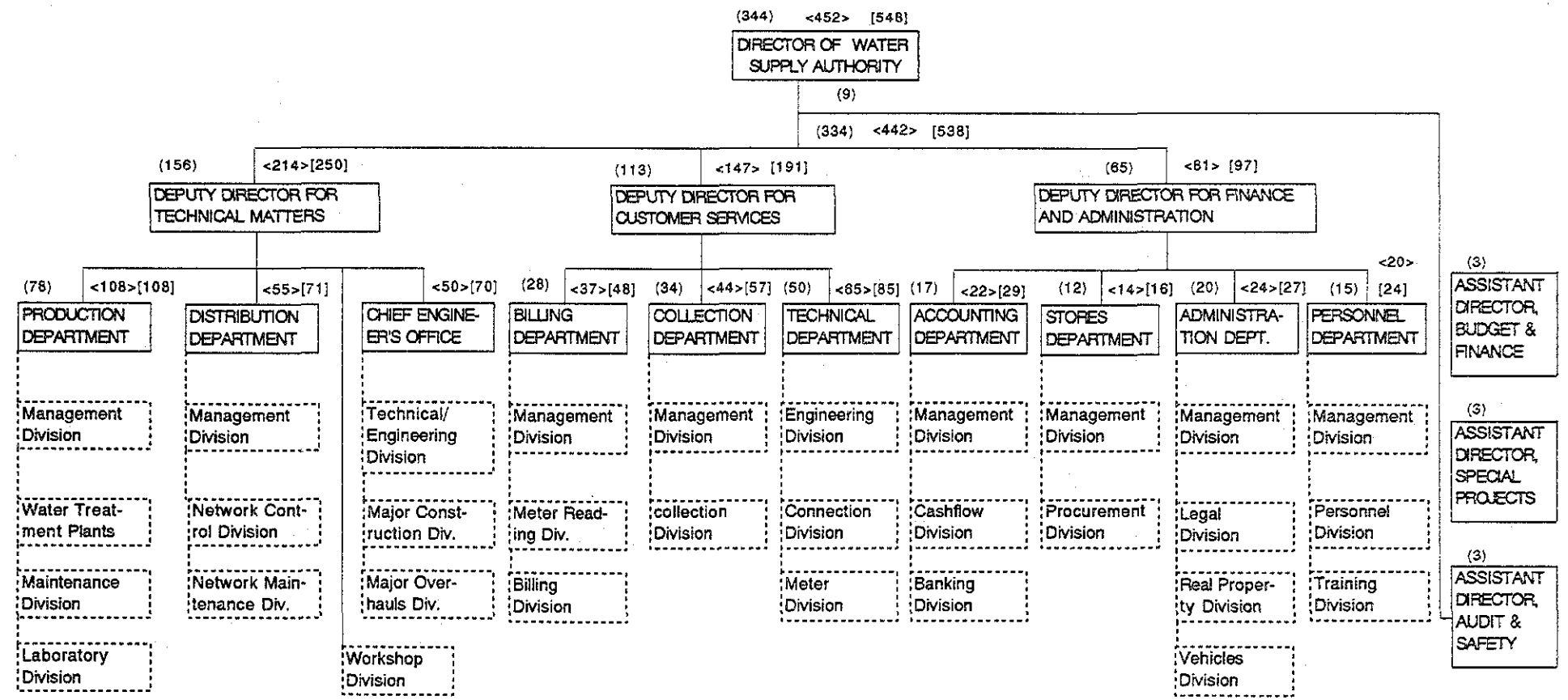
The increase in the staff members required will be 5 during the 1st stage and 4 during the 2nd stage.

The number of staff members required at each stage is summarized in Table-5.17.
Fig-5.16 shows the number of personnel in each unit during the 1st and 2nd stages.

Table-5.17 NUMBER OF STAFF IN THE PPWSA

Unit	After URW (1996)	1st Stage (2003)	2nd Stage (2010)
Production	78	108	108
Distribution	42	55	71
Chief Engineer's Office	35	50	70
(Customer Service)			
Technical Department,	50	65	85
Billing Dept.	28	37	48
Collection Dept.	34	44	57
Accounting	17	22	29
Stores	12	14	16
Administration	20	24	27
Personnel	15	20	24
Directory/Deputy Directory/ Assistant Director	13	13	13
Total	344	452	548

Fig -5.16 GROWTH IN NUMBER OF EMPLOYEES, FROM URW TO MASTER PLAN STAGE



Note : ( ) After URW
< > Stage 1 , Master Plan
[ ] Stage 2 , Master Plan

3) Required Number of New Recruits

The number of PPWSA personnel belonging to existing units, after URW, and during 1st and 2nd stage is summarized below.

The number of employees to be newly recruited is 58 for 1993-1997, 169 for 1997-2003 and 255 for 2003-2010.

	Present	URW	Stage 1	Stage 2
Number of Persons	300	344	452	548
Required Increase		44	108	96
Retiring		14	61	159
Required Recruitment		58	169	255

4) Improved Productivity

The anticipated productivity improvement is shown below:

Table-5.18 PRODUCTIVITY IMPROVEMENTS

	After URW (1996)	Stage 1 (2003)	Stage 2 (2010)
Water produced (m^3/day)	170,000	235,000	300,000
No. of employees in Three Technical Units (*1)	155	213	249
Water produced (m^3/day) Per Person	1,096	1,103	1,205

Note:(*1) Production, Distribution, and Chief Engineer's Office

5) Number of Personnel in Technical and Non-technical Units

The number of personnel in the technical units (Departments of Production, Distribution, Chief Engineer's Office, Technical Dept. of Customer Services) and the non-technical units (Departments of Billing Collection of Customer Services, Accounting, Stores, Administration and Personnel) will change as shown below and the present status of overstaffing of non-technical units will be corrected.

	After URW (1996)	Stage 1 (2003)	Stage 2 (2010)
No. of Personnel, Technical Units	205	278	334
No. of Personnel, Non-technical Units	139	174	214

5.6.3.2 Recruiting Qualified Persons

From the foregoing discussion, a large number of new recruits is needed to fill vacancies due to retirement and the positions to be created under the master plan.

At present, a dearth of qualified personnel such as engineers, technicians and other ex perts on accounting, office and personnel administration, etc. is seriously affecting normalization and improvement of operations in all the PPWSA departments and divisions.

According to the table entitled "Personnel de la Regie des Eaux de Phnom Penh (May 1992)", of the 419 permanent and temporary employees of PPWSA, only 7 are classified as engineers and 6 as Cadres, i.e. , core staff (qualified staff and non-technical expert).

There is evidence that, in the past, when 575 persons belonged to the PPWSA as described in Section 4.1.2, far more qualified staff were managing the technical and non-technical units.

In future, while the number of unskilled, unqualified people increases, recruiting

skilled, qualified and competent persons will become more and more difficult, because of foreseeable imbalance of demand and availability of such persons.

A recruitment policy and strategy that includes human resource development should be established by the PPWSA.

5.6.3.3 Staffing Key Positions with Qualified Personnel

Many of the present senior officials occupying management posts in the PPWSA are capable within the scope of their authority and responsibility.

At the URW stage, selected staff members will participate in the implementation of projects under the deputy director's control, and cooperate with foreign counterparts.

5.6.4 Training for Higher Level Operations

Training programs shall be reviewed, updated and upgraded, in connection with improvements in socio-economic and political conditions.

Socio-economic and political changes will be:

1) Political and administrative powers centralized in the state will be relaxed, deregulated and delegated to provincial and municipal legislative and administrative bodies. Provincial and municipal councils, for making rules adaptable to local legislative matters, may be established to check local administration and public services.

   The city council will exert more efforts to check the performance of the PPWSA.

2) As a general trend, under capitalistic market principles, competition of productivity and performance will become the rule for the public sectors, similar to private sectors and, individuals, organizational units and whole organizations will be assessed by the foregoing rules.

   Unproductive state enterprises and public services will be closed down and/or privatized.

3) As the peoples' living conditions and educational levels improve, consciousness of social justice will strengthen and, public servants will be questioned on matters relating to ethical issues.

Constabulary and legislative actions against violations of laws and rules will be intensified.

4) Quality improvement in goods and services will be required. Water supply service will have to provide, good quality water, effective meter-reading, billing and revenue collection, and quicker service for repair and installation.

Improvement in workers' skill and discipline for daily operations and capability of staff members managerial matters will be demanded. If necessary, institutional and organizational changes in the PPWSA will be called for.

5.6.4.1 Approach to Further Improvements

1) Operation and Maintenance of Facilities

Proper operation and maintenance of the completed facilities are essential at the implementation stage of the URW.

For good operation and maintenance, plant operators and maintenance staff must be knowledgeable and pay attention to current and potential changes in operational factors, know how to maintain facilities on a day-to-day basis, and know what is required at the time of mechanical failure. The concept of preventive maintenance is especially important. To realize such operation and maintenance, manuals both for the plant as a whole and for each equipment should be provided, and the results of operation and maintenance should be recorded in accordance with the specified formats.

At the implementation stage of the master plan, large groups of new, mostly young recruits will join the PPWSA, who will have better academic background than their predecessors, but lack in experience. They should, therefore, receive systematic and intensive training. In this regard, training programs must be provided together with textbooks and training materials that are not directly imported, but prepared to suit the local conditions.

2) Operations related to Non-technical Affairs

At the URW stage, training programs based on the same, basic concepts for the technical personnel should be provided for non-technical personnel. The programs should include an on-the-job training component for budgetary planning and control as well as routine operations.

Also, the staff members must be familiar with basic legislative, administrative and jurisdictional matters.

At this stage, to improve efficiency and productivity, computer training for all key personnet is essential.

5.6.4.2 Production Department, Distribution Department, Chief Engineer's Office, and Customer Services Units

1) Production Department

Analysis of unit operation and overall operations of the plant will be very useful for optimization of operation in terms of hydraulic loading of the plant and use of chemicals and energy.

Manuals for operational procedures under ordinary and extra-ordinary conditions should be established and familiarized by operators.

More attention should be paid to maintaining water quality. Therefore, systems for water treatment operation and monitoring should be established.

Meetings shall be held regularly among operational units for exchanging information, improving coordination between them, and for planning future actions.

Maintenance work based on checklists shall be practiced regularly and the concept of preventive maintenance shall be introduced.

2) Distribution Department

Records of patterns of distributed quantity and pressure distribution under various conditions must be collected. After analysis this data shall be used for optimization of water production and distribution systems to accommodate changes in conditions. Such optimization will result in functional and reliable operation and, lead to savings in manpower and energy.

Leakage detection and repair must be promoted for curbing water loss. Manpower and funds must be increased as required.

To make the above activities functional, distribution network maps shall be provided as early as possible.

3) Chief Engineer's Office

Manuals, specifications, standards, other technical documents and materials for training of technical personnel for technical operations shall be reviewed and updated.

Technical support by the office to the Production and the Distribution Departments and customer services units for their daily routine work shall also be strengthened.

4) Customer Services Unit

Application for a new connection shall be processed without delay and connections shall be given quickly so long as the condition of the distribution network allows. Quick response to customers' complaints about water supply and water quality is very important. A standard processing system for complaints shall be formed and practiced.

Standardization of service materials and equipment, and methods of design and installation shall be established. Since the major portion of leakage occurs on service lines, they must be regularly checked for leakage.

Entering customer data, meter reading, billing and collection shall be computerized.

Detailed maps of service connections shall be prepared.

5.6.4.3 Accounting, Stores, Administration, Personnel

The targets to be attained and achieved are described in Section 6.6.3.
Essential matters are discussed here.

1) Accounting Department

Under the guidance of the deputy director for finance and administration, the Accounting Department shall exercise, financial control over the revenue plan including tariff structure and schedule of capital expenditure in future in addition to day-to-day accounting works. Financial self-reliance of the PPWSA will be realized only by such ef forts.

Computerization of all accounting procedures is necessary.

2) Store Department

The Procurement Division must have sufficient information on specifications of materials, machines, equipment and tools to be purchased by all the units of the PPWSA.

Inventory control in relation to corporate accounting system and store management shall be introduced. As most rehabilitation and expansion projects will be financed by external aid agencies, regulations imposed by such agencies for procurement must be thoroughly understood by the Department.

3) Administration

Legal affairs for attaining full autonomy must be pushed forward vigorously.

4) Personnel Department

As discussed earlier, recruiting new employees, selecting qualified persons, and training them are the most important matters to be tackled by this department.

5.6.4.4 Information Management

Flow of necessary and useful information through the right channels is indispensable to promote cooperation and functional relationships among different units.

Publicizing information about the activities of the PPWSA at the right time will be beneficial in gaining the trust of customers and the public in general.

To improve internal information exchange for better functioning and relations with relevant external agencies and the public, the PPWSA should set up an efficient information management system.

5.7 Project Cost and Implementation Schedule

5.7.1 Project Cost

1) Price Level and References

Price Level : Costs are valued at 1993 prices.
Unit Cost : The unit costs contracted by the Water Supply Authority are generally used. Where such prices are not available, the prevailing market prices are used.

2) Division of Project Cost

The project cost is divided into two parts, to be estimated separately, as given below.

a) Construction costs including land cost, and
b) Other associated costs such as engineering and administrative costs, inclusive of physical and price contingencies.

Construction costs were estimated for all facilities to be constructed in three stages, namely URW, First and Second Stages, up to 2010. The cost of acquiring land for facilities is included in the construction costs.

The cost of engineering services, inclusive of detailed design, soil investigation, field survey, and supervision is estimated together with administrative cost, physical and price contingencies, as shown below. The percentages used in the calculation are taken from the widely accepted figures presently.

(A) : Construction Cost, and
(B) : Engineering Services Cost,
Detailed Design (D/D)= (A) x 7 %
Soil Investigation and
Field Survey = D/D x 12%
Supervision = (A) x 5 %
Administrative Cost (C) = (A + B) x 1 %
Price Contingencies (D) = (A + B + C) x 3 %
Physical Contingencies(E) = (A + B + C+ D) x 7 %
Price escalation per annum for the construction period.

Project costs estimated based on the procedures mentioned above and breakdown of each proposed work are summarized in Table-5.19 through Table-5.21.

Table-5.19 COST ESTIMATION SUMMARY

(Unit : Thousand U.S.Dollars)

Description	URW	Stage 1 Works	Stage 2 Works	Total
(A) Construction of New Water Supply System	34,350	171,520	149,720	355,590
(B) Engineering Services	2,480	17,590	15,760	35,830
Sub-Total (X) = (A) + (B)	36,830	189,110	165,480	391,420
(C) Administration Cost [1% of Sub-Total (X)]	-	1,900	1,670	3,570
Sub-Total (Y) = (X) + (C)	36,830	191,010	167,150	394,990
(D) Price Contingency [3% per annum of total yearly disbursements]	-	51,960	93,370	145,330
Sub-Total (Z) = (Y) + (D)	36,830	242,970	260,520	540,320
(E) Physical Contingency [7% of Sub-Total (Z)]	-	17,010	18,230	35,240
Grand Total [(Z) + (E)]	36,830	259,980	278,750	575,560
(F)Land Acquisition	-	5,760	-	5,760

5.7.2 Implementation Schedule

5.7.2.1 Target Year

The development project considered in the Master Plan is phased into three stages; the URW targeted for 1996, the Stage 1 and the Stage 2, targeted for 2003 and 2010, respectively, because of the following considerations:

Prior to the commencement of the Stage 1 and Stage 2, a feasibility study for this stage will be necessary, together with a review of the project, considering all other study reports and the actual growth of the city.

a) Implementation in three stages including the URW will be appropriate from the view point of the size of investment, and

b) Other municipal plans for the future set the target year between 2000 to 2010, and the Stage 2 should be considered together with these plans.

5.7.2.2 Implementation Schedule of URW.

The implementation period of URW is proposed as two years for Phase 1 and Phase 2.

5.7.2.3 *Implementation Schedule of the Stage 1*

The construction period of the treatment plant for the Stage 1 is expected to take two years considering the extent of work to be carried out. The period of time is three years for laying the total length of the pipelines.

After completion of the URW, which is explained in Chapter 6, it is necessary to rehabilitate and improve the distribution system, especially secondary pipes, and public service taps. The stage 1 and stage 2 are expected to last for 14 years.

5.7.2.4 Implementation Schedule of Stage 2

To meet the expected demand of potable water in 2010, the construction work of the treatment plant and pipelines must start by 2006. The period of detailed design is estimated as 1 year for the Stage 2 project.

For cleaning and lining of pipes, 7 years will be required to execute the total length of 35 km. For installation of stop valves, air valves, fire hydrants and washouts, about 3 years will be required.

The implementation schedule estimated for the work is shown in Fig-5.17.

Table - 5.20 BREAKDOWN OF PROPOSED WORKS FOR THE COST ESTIMATION (1/2)

No.	Description	Unit	Quantity																				Remarks
			Total	Urgent Rehabilitation Works	Stage 1	Stage 2	Urgent Rehabilitation W.				Stage 1							Stage 2						
							Year																	
							1 1993	2 1994	3 1995	4 1996	5 1997	6 1998	7 1999	8 2000	9 2001	10 2002	11 2003	12 2004	13 2005	14 2006	15 2007	16 2008	17 2009	18 2010	
A	Urgent Rehabilitation Works																							
1	Reservoir (C=10,000m3)	unit	1	1				1																
2	Electric Facilities	lot	1	1				1																
3	Transmission and Distribution Pump	sets	5	5				5																
4	Transmission Pipe (500mm)	km	2.41	2.41				2.41																
5	Elevated Tank	lot	1	1				1																
6	Intake Pump	sets	2	2					2															
7	Raw Water Main Pipe (700mm)	km	1.14	1.14					1.14															
8	Extension of Purification Facilities (Q=50,000m3/day)	lot	1	1					1															
9	Distribution Pipe (200mm-250mm)																							
	200mm	km	1.31	1.31					1.31															
	250mm	km	1.34	1.34					1.34															
10	Water Meter (30mm-50mm)																							
	30mm	Pieces	1,500	1,500					1,500															
	40mm	Pieces	1,000	1,000					1,000															
	50mm	Pieces	500	500					500															
B	Water Supply System																							
11	New Water Treatment Plant(Q=130,000m3/day)																							
	Q=65,000m3/day	lot	2		1	1									1						1			
C	New Distribution System																							
12	Distribution Main Pipe (300mm-1000mm)																							
	300mm	km	12.20		8.00	4.20									8.00						4.20			
	400mm	km	7.90		6.40	1.50									6.40						1.50			
	500mm	km	8.45		4.45	4.00									1.00	3.45					4.00			
	600mm	km	4.20		2.50	1.70										2.50					1.70			
	700mm	km	2.60		0.00	2.60																2.60		
	800mm	km	4.90		3.75	1.15										2.00	1.75					1.15		
	900mm	km	1.30		1.30	0.00											1.30							
	1,000mm	km	7.40		2.20	5.20											2.20					1.40	3.80	
13	Distribution Pipe (100mm-250mm)																							
	100mm	km	92.80		55.70	37.10									18.50	18.50	18.70				12.30	12.30	12.50	
	150mm	km	23.80		14.30	9.50									4.70	4.70	4.90				3.10	3.10	3.30	
	200mm	km	30.20		18.10	12.10									6.00	6.00	6.10				4.00	4.00	4.10	
	250mm	km	15.00		9.00	6.00									3.00	3.00	3.00				2.00	2.00	2.00	
D	Rehabilitation for Distribution System																							
14	Cleaning and Lining of pipe (300mm-800mm)																							
	300mm	km	14.55			14.55																7.00	7.55	
	350mm	km	4.20			4.20															1.00	3.20		
	400mm	km	4.65			4.65															2.65	2.00		
	450mm	km	3.35			3.35														2.50	0.85			
	500mm	km	2.65			2.65													1.00	1.65				
	600mm	km	0.75			0.75													0.75					
	700mm	km	3.40			3.40												1.70	1.70					
	800mm	km	1.00			1.00												1.00						

Table - 5.20 BREAKDOWN OF PROPOSED WORKS FOR THE COST ESTIMATION (2/2)

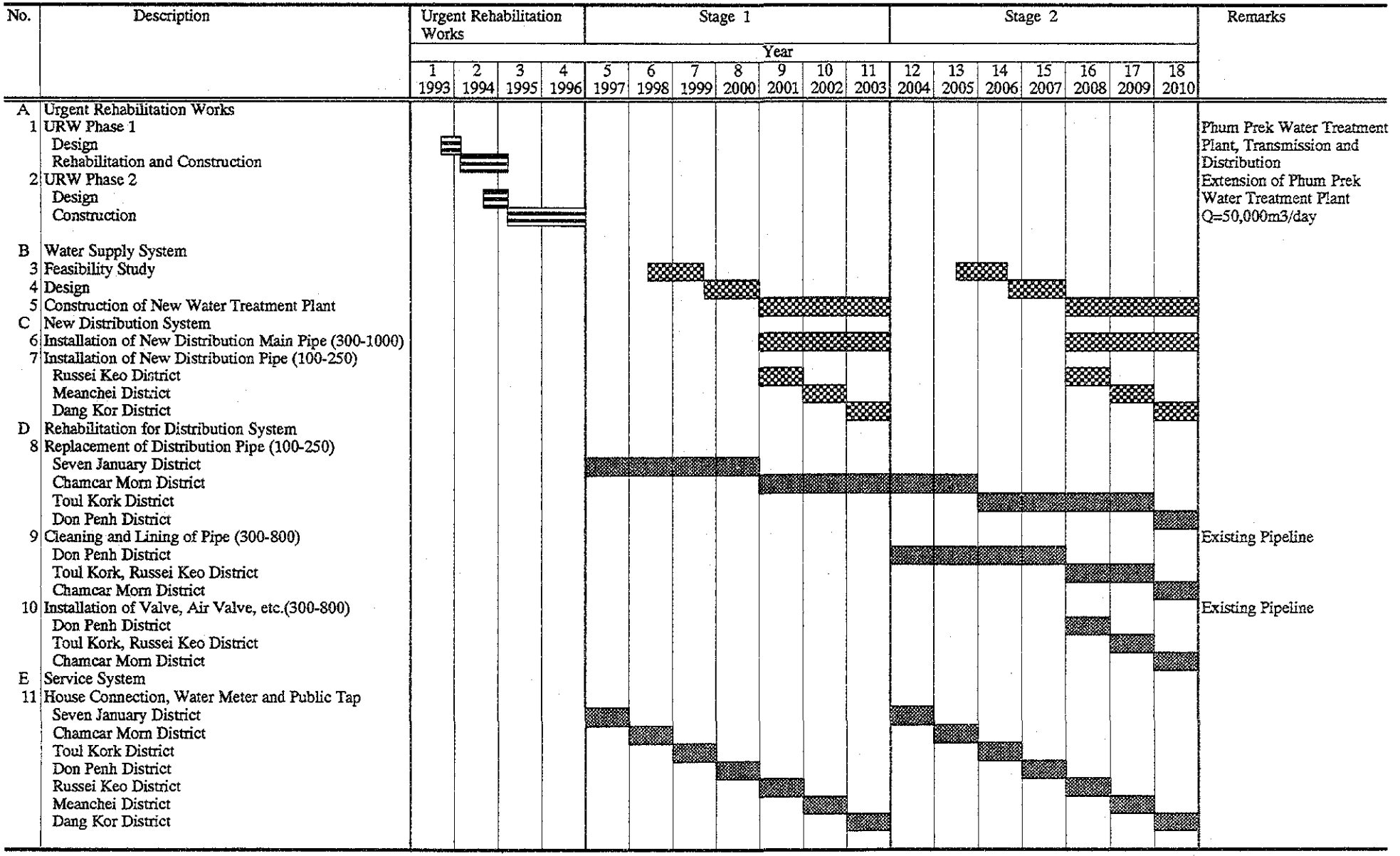
No.	Description	Unit	Quantity																				Remarks
			Total	Urgent Rehabi-litation Works	Stage 1	Stage 2	Urgent Rehabilitation W.				Stage 1							Stage 2						
							Year																	
							1 1993	2 1994	3 1995	4 1996	5 1997	6 1998	7 1999	8 2000	9 2001	10 2002	11 2003	12 2004	13 2005	14 2006	15 2007	16 2008	17 2009	18 2010	
15	Replacement of Distribution Pipe (100mm-250mm)																							
	100mm	km	131.85		65.80	66.05					9.40	9.40	9.40	9.40	9.40	9.40	9.40	9.40	9.40	9.40	9.40	9.40	9.65	
	150mm	km	28.90		14.00	14.90					2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.90	
	200mm	km	18.05		9.10	8.95					1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.15	
	250mm	km	23.75		11.90	11.85					1.70	1.70	1.70	1.70	1.70	1.70	1.70	1.70	1.70	1.70	1.70	1.70	1.65	
16	Installation of Valve (300mm-800mm)																							
	300mm	pieces	29			29																	29	
	350mm	pieces	8			8																	8	
	400mm	pieces	5			5																	5	
	450mm	pieces	3			3																3		
	500mm	pieces	3			3																3		
	600mm	piece	1			1																1		
	700mm	pieces	3			3															3			
	800mm	piece	1			1															1			
17	Installation of Air Valve (300mm-800mm)																							
	300mm	pieces	29			29																9	20	
	350mm	pieces	8			8																8		
	400mm	pieces	5			5															2	3		
	450mm	pieces	3			3															3			
	500mm	pieces	3			3															3			
	600mm	piece	1			1															1			
	700mm	pieces	3			3															3			
	800mm	piece	1			1															1			
18	Installation of Fire Hydrant (300mm-400mm)																							
	300mm	pieces	29			29															11	11	7	
	400mm	pieces	8			8															2	2	4	
19	Installation of Washout (300mm-800mm)																							
	300mm	pieces	29			29																	29	
	350mm	pieces	8			8																8		
	400mm	pieces	5			5																5		
	450mm	pieces	3			3																3		
	500mm	pieces	3			3															1	2		
	600mm	piece	1			1															1			
	700mm	pieces	3			3															3			
	800mm	piece	1			1															1			
20	Installation of Water Meter																							
	20mm	pieces	70,000		35,000	35,000					5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	
	25mm	pieces	4,000		2,800	1,200					400	400	400	400	400	400	400	171	171	171	171	171	174	
	30mm	pieces	3,000		2,100	900					300	300	300	300	300	300	300	128	128	128	128	128	132	
	40mm	pieces	2,000		1,400	600					200	200	200	200	200	200	200	85	85	85	85	85	90	
	50mm	pieces	1,000		700	300					100	100	100	100	100	100	100	42	42	42	42	42	48	
B	Provisional Service System																							
21	Public Tap (20mm)	pieces	13,497		10,823	2,674					1546	1546	1546	1546	1546	1546	1547	382	382	382	382	382	382	

Table -5.21 PROJECT COST

Unit: million U.S. Dollars

No.	Description	Amount																				Remarks
		Total	Urgent Rehabilitation Works	Stage 1	Stage 2	Urgent Rehabilitation W.				Stage 1							Stage 2					
						Year																
						1 1993	2 1994	3 1995	4 1996	5 1997	6 1998	7 1999	8 2000	9 2001	10 2002	11 2003	12 2004	13 2005	14 2006	15 2007	16 2008	17 2009	18 2010	
A	Urgent Rehabilitation Works																					
1	Reservoir (C=10,000m3)		3.33				3.33															
2	Electric Facilities		6.60				6.60															
3	Transmission and Distribution Pump		2.58				2.58															
4	Transmission Pipe (500mm)		1.65				1.65															
5	Elevated Tank		1.30				1.30															
6	Intake Pump		2.55					2.55														
7	Raw Water Main Pipe (700mm)		1.43					1.43														
8	Extension of Purification Facilities (Q=50,000m3/day)		11.51					11.51														
9	Distribution Pipe (200mm-250mm)		1.17					1.17														
10	Water Meter (30mm-50mm)		2.24					2.24														
	Sub-total (1-10)		34.35				15.46	18.89														
E	Water Supply System																					
11	New Water Treatment Plant (Q=130,000m3/day)	85.15		51.39	33.76									25.34	26.05					16.87	16.89	
C	New Distribution System																					
12	Distribution Main Pipe (300mm-1000mm)	52.01		27.40	24.61									9.13	9.13	9.14				8.20	8.20	8.21
13	Distribution Pipe (100mm-250mm)	49.08		29.45	19.63									9.81	9.81	9.83				6.54	6.54	6.55
	Sub-total (12-13)	101.09		56.85	44.24									18.94	18.94	18.97				14.74	14.74	14.76
D	Rehabilitation for Distribution System																					
14	Cleaning and Lining of pipe (300mm-800mm)	13.75			13.75												1.96	1.96	1.96	1.96	1.96	1.99
15	Replacement of Distribution Pipe (100mm-250mm)	60.37		30.17	30.20					4.31	4.31	4.31	4.31	4.31	4.31	4.31	4.31	4.31	4.31	4.31	4.31	4.34
16	Installation of Valve (300mm-800mm)	0.72			0.72															0.24	0.24	0.24
17	Installation of Air Valve (300mm-800mm)	0.70			0.70															0.23	0.23	0.24
18	Installation of Fire Hydrant (300mm-400mm)	0.45			0.45															0.15	0.15	0.15
19	Installation of Washout (300mm-800mm)	1.88			1.88															0.62	0.62	0.64
	Sub-total (14-19)	77.87		30.17	47.70					4.31	4.31	4.31	4.31	4.31	4.31	4.31	6.27	6.27	6.27	6.27	7.51	7.51	7.60
E	Service System																					
20	Installation of House Connection and Water Meter(20mm-50mm)	45.72		23.94	21.78					3.42	3.42	3.42	3.42	3.42	3.42	3.42	3.11	3.11	3.11	3.11	3.11	3.12
F	Provisional Service System																					
21	Public Tap (20mm)	11.41		9.17	2.24					1.31	1.31	1.31	1.31	1.31	1.31	1.31	0.32	0.32	0.32	0.32	0.32	0.32
	Total (1-21)	355.59	34.35	171.52	149.72		15.46	18.89		9.04	9.04	9.04	9.04	53.32	54.03	28.01	9.70	9.70	9.70	9.70	42.55	42.57	25.80	
22	Engineering Fee (12%) (11)	10.20		6.16	4.04								3.60	1.28	1.28					2.36	0.84	0.84		Including Study of
23	Engineering Fee (12%) (12-19)	21.47		10.45	11.02					0.52	0.52	0.52	0.52	2.79	2.79	2.79	0.75	0.75	0.75	0.75	2.67	2.67	2.68	Survey and Soil
24	Design Fee (3%) (20-21)	1.68		0.98	0.70					0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.10	0.10	0.10	0.10	0.10	0.10	0.10	
	Total (22-24)	35.83	2.48	17.59	15.76		1.18	1.30		0.66	0.66	0.66	4.26	4.21	4.21	2.93	0.85	0.85	0.85	3.21	3.61	3.61	2.78	
25	Administrative Cost (1%)	3.57	*	1.90	1.67		*	*		0.10	0.10	0.10	0.13	0.58	0.58	0.31	0.11	0.11	0.11	0.13	0.46	0.46	0.29	
26	Price Escalation (3%)	145.33	*	51.96	93.37		*	*		1.23	1.56	1.90	3.09	15.50	17.93	10.75	4.10	4.54	4.99	6.68	26.01	28.20	18.85	
27	Physical Contingency (7%)	35.24	*	17.01	18.23		*	*		0.77	0.80	0.82	1.16	5.15	5.37	2.94	1.03	1.06	1.10	1.38	5.08	5.24	3.34	
	Grand Total (1-27)	575.56	36.83	259.98	278.75		16.64	20.19		11.80	12.16	12.52	17.68	78.76	82.12	44.94	15.79	16.26	16.75	21.10	77.71	80.08	51.06	

Fig.- 5.7 IMPLEMENTATION SCHEDULE



5.8 Fund Requirements

5.8.1 Introduction

The fund reserved for PPWSA is nominal and the revenue does not cover the costs, as seen in Chapter 4.3. Obviously, the cash position of PPWSA is always tight and depends on subsidies from the Municipality. For example, the deficit in 1992 was 809 million Riels. From the analysis in Chapter 4.3, internal financing for even a portion of this in vestment program is out of the question at the moment.

The PPWSA must show its willingness and capability to improve the present financial situation, before it approaches external agencies for grants or soft loans.

5.8.2 Schedule of Investment

Table-5.22 below shows the overall investment schedule for the master plan. In terms of water production under the master plan, the original capacity of 110,000 m^3/day is scheduled to be restored in the year 1996, the 65,000 m^3/day plant scheduled to start supply from the year 2003, and the other 65,000 m^3/day plant from the year 2010.

Table-5.22 INVESTMENT SCHEDULE

Year	Water Production Volume (m^3/day)	Capital Cost (Million U.S. Dollars)	O/M Cost (U.S. Dollors)
1994	63,000	20.86	1,108,521
1995	73,000	20.19	1,273,693
1996	154,000	0.00	2,619,288
1997	163,000	6.18	2,767,934
1998	170,000	6.18	2,883,369
1999	170,000	6.18	2,883,369
2000	170,000	9.78	2,883,369
2001	170,000	54.01	2,883,369
2002	170,000	54.65	2,883,369
2003	219,000	27.42	3,716,468
2004	229,000	7.35	3,881,150
2005	235,000	7.35	3,980,539
2006	235,000	7.35	3,980,539
2007	235,000	9.71	3,980,539
2008	235,000	42.96	3,980,539
2009	235,000	55.08	3,980,539
2010	300,000	32.83	5,074,430
2011	300,000	0.00	5,074,430
2012	300,000	0.00	5,074,430
2013	300,000	0.00	5,074,430
2014	300,000	0.00	5,074,430
2015	300,000	0.00	5,074,430
2016	300,000	0.00	5,074,430
2017	300,000	28.17	5,074,430
2018	300,000	0.00	5,074,430
2019	300,000	0.00	5,074,430
2020	300,000	0.00	5,074,430
2021	300,000	0.00	5,074,430
2022	300,000	0.00	5,074,430
2023	300,000	0.00	5,074,430
2024	300,000	30.59	5,074,430
2025	300,000	7.46	5,074,430
2026	300,000	0.00	5,074,430
2027	300,000	0.00	5,074,430
2028	300,000	0.00	5,074,430
2029	300,000	0.00	5,074,430
2030	300,000	0.00	5,074,430
2031	300,000	0.00	5,074,430
2032	300,000	28.17	5,074,430
2033	300,000	0.00	5,074,430

O/M : Operation and Maintenance

O/M cost includes cost of power, chemicals, salaries, repairs, and office supplies.

5.9 Financial Analysis

The main purpose of this section is to examine the feasibility of the Project from the financial viewpoint. The fund procurement, the water tariff level, the improvement in efficiency of billing for water, etc. are examined. The following assumptions are made before the financial analysis.

1.	Project Life	40 years	
2.	Monetary Unit	U.S. Dollars	
3.	Base Year	1994	
4.	Exchange Rate	1 U.S.Dollars=2,500 Riels (May 1993)	
5.	Leakage Ratio	1994-1995	50%
		1995-2000	48%-40%
		2001-2005	38%-30%
		2004-2010	28%-20%
		2011	20%
6.	Life of Facilities	Structure	40 years
		Pipe	40 "
		Machine	15 "
		Electric Equipment	15 "

7. Salvage values are set as 0, since the remaining values of project facilities and equipments can not be used for other purposes.

5.9.1 Fund Procurement

Due to the negative financial position shown in Table-4.6, PPWSA has no spare funds for improving the water supply system. Therefore, in order to promote this project, PPWSA must find fund sources for covering the construction cost of this Project. Since Cambodia is not in a position to provide money to any domestic organization, funds must sought from international lending agencies or foreign aid donors. The following are potential fund sources for the capital investment of this Project;

1. General loans from international lending agencies
   General conditions of loan:

Interest rate	7.5 - 12 % (included commission fee)
Repayment period	10-30 years with 2-7 years grace period

2. Soft loan from foreign countries
Loan with soft lending conditions:

Interest rate	2.7 %
Repayment period	30 years with 10 years grace period

3. Credit to Least Less Development Countries (LLDC) from international lending agencies
Loan conditions;

Interested rate	0.75 % (included commission fee)
Repayment Period	35-40 years

4. Grant aid from foreign countries
Fund is supplied free of charge

On the other hand, the cost for strengthening the management capability and upgrading operation and maintenance standards shall be covered by PPWSA. A subsidy from the Municipality for this purpose is desirable for decreasing the burden on the low income class.

The financial analysis is described below, assuming the mentioned fund sources.

5.9.2 Tariff Level

(1) Income Distribution in the Project Area

For smooth and continued operation of the water supply after the completion of the Project, it is necessary to raise adequate revenue from the improved water supply system. The amount of this revenue is determined based on the water tariff level. However, this level must be low, to lessen the financial burden of each household, considering that many low income households live within the project area of this Study.

Generally, there is an upper limit payable for the water consumption for residents. Table-5.23, estimated by the Study Team, shows the income distribution within the project area. According to this Table, the weighted average of the monthly income is calculated as 267 dollars/month per household. However, considering that the number of family members with a household income of 50 US dollars or less accounts for 50% of the total number of households, the tariff level must be examined, focusing on the low income group.

Table-5.23 Income Distribution within Project Area

Category	No.of family members		Income USDollars
Richest Income Group	14,000	(3.5 %)	2000
Rich Group	58,000	(14.4 %)	1000
Middle Group	129,000	(32.1 %)	100
Lower Group	127,000	(31.6 %)	50
Lowest Group	74,000	(18.4 %)	30

Note : Estimated by the Study Team

(2) Maximum Water Tariff Level

In general, the ratio of the monthly income of the family in economically developed countries is less than 1% (in Japan this ratio is about 0.6%). However, from the financial internal rate of return (FIRR), it is clear that PPWSA cannot operate at this water tariff level, as shown in section 5.9.4.

In developing countries this ratio is expected to be 3 - 5%. Based on this ratio, a family with a monthly income of 100 US Dollars can pay for water charges with a unit tariff of 600 Riels/m^3, since the above ratio is calculated as 4.3%, according to the following equation;

$$\frac{100(\text{l/person}) \times 6(\text{person}) \times 600(\text{Riels/m}^3)}{\text{U.S.Dollars } 100 \times 2{,}500(\text{Riels/U.S.Dollars})} \times \frac{100}{1000} = 4.3$$

Unit water supply for one person	100 l/person/day
Average family members	6 persons
Monthly income	100 U.S.Dollars

On the other hand, for a household with a monthly income of 50 dollars, a current unit water tariff 300 riels/m^3 is desirable, from the above same equation.

(3) Future Water Tariff Level

Since the political situation is stabilizing rapidly in Cambodia, the Cambodian economy is expected to continue to grow steadily hereafter. The household income will increase together with the economic growth, therefore, some part of the households with an income of 50 dollars or less will be able to pay for the water charge at a 5% level in future. Although future economic growth rate is not clear, the Study Team assumed a growth rate of 5% per anum until 2010 and 4% thereafter. Of course, for this economic growth, the tariff level should be revised also. A 10% increase in water tariff every three years will be reasonable.

Table-5.24 shows the ratio of the monthly water charge to the monthly income by income group assuming 100 liters as the water consumption per person per day in the above equation. Each income group can pay for the water consumption from the year mentioned in the table below.

Household Income per month (US Dollars)	Unit Tariff ($Riels/m^3$)	Year when the household can pay for the water change
100 or more	400	1994 -
	500	1994 -
50	400	1995 -
	500	2005 -
30	400	difficult
	500	difficult

Table-5.24 Ratio of Monthly Water Payment to Household Income by Income Group

Year	G1 $	G2 $	G3 $	T1 $	T2 $	C1 %	C2 %	C3 %	C4 %	C5 %	C6 %
1992	30	50	100								
1993	32	53	105								
1994	33	55	110	0.16	0.20	8.7	6.2	2.6	10.9	6.5	3.3
1995	35	68	116	0.16	0.20	8.3	5.0	2.5	10.4	6.2	3.1
1996	36	61	122	0.16	0.20	7.9	4.7	2.4	9.9	5.9	3.0
1997	38	64	128	0.18	0.22	8.3	5.0	2.5	10.3	6.2	3.1
1998	40	67	134	0.18	0.22	7.9	4.7	2.4	9.9	5.9	3.0
1999	42	70	141	0.18	0.22	7.5	4.5	2.3	9.4	5.6	2.8
2000	44	74	148	0.19	0.24	7.9	4.7	2.4	9.8	5.9	2.9
2001	47	78	155	0.19	0.24	7.6	4.5	2.2	9.4	5.6	2.8
2002	49	81	163	0.19	0.24	7.1	4.3	2.1	8.9	5.3	2.7
2003	51	86	172	0.21	0.27	7.5	4.5	2.2	9.3	5.8	2.8
2004	64	90	180	0.21	0.27	7.1	4.3	2.1	8.9	6.3	2.7
2005	57	94	189	0.21	0.27	6.8	4.1	2.0	8.5	5.1	2.5
2006	59	99	198	0.23	0.29	7.1	4.3	2.1	8.9	5.3	2.7
2007	62	104	208	0.23	0.29	6.8	4.1	2.0	8.5	5.1	2.5
2008	65	109	218	0.23	0.29	6.4	3.9	1.9	8.0	4.8	2.4
2009	69	115	229	0.26	0.32	6.7	4.0	2.0	8.4	5.1	2.5
2010	72	120	241	0.26	0.32	6.4	3.9	1.9	8.0	4.8	2.4
2011	75	125	250	0.26	0.32	6.2	3.7	1.9	7.7	4.6	2.3
2012	78	130	260	0.28	0.35	6.5	3.9	2.0	8.2	4.9	2.5
2013	81	135	271	0.28	0.35	6.3	3.8	1.9	7.9	4.7	2.4
2014	84	141	282	0.28	0.35	6.0	3.6	1.8	7.6	4.5	2.3
2015	88	146	293	0.31	0.39	6.4	3.8	1.9	8.0	4.8	2.4
2016	91	152	305	0.31	0.39	6.1	3.7	1.8	7.7	4.6	2.3
2017	95	158	317	0.31	0.39	5.9	3.5	1.8	7.4	4.4	2.2
2018	99	165	329	0.34	0.43	6.2	3.7	1.9	7.8	4.7	2.3
2019	103	171	343	0.34	0.43	6.0	3.6	1.8	7.5	4.5	2.3
2020	107	178	356	0.34	0.43	5.8	3.5	1.7	7.2	4.3	2.2
2021	111	185	370	0.38	0.47	6.1	3.7	1.8	7.6	4.6	2.3
2022	116	193	385	0.38	0.47	5.9	3.5	1.8	7.3	4.4	2.2
2023	120	200	401	0.38	0.47	5.6	3.4	1.7	7.1	4.2	2.1
2024	125	208	417	0.41	0.52	6.0	3.6	1.8	7.5	4.5	2.2
2025	130	217	433	0.41	0.52	6.7	3.4	1.7	7.2	4.3	2.2
2026	136	226	451	0.41	0.52	5.5	3.3	1.7	6.9	4.1	2.1
2027	141	234	469	0.46	0.57	5.8	3.5	1.8	7.3	4.4	2.2
2028	146	244	488	0.46	0.57	5.6	3.4	1.7	7.0	4.2	2.1
2029	152	254	507	0.46	0.57	5.4	3.2	1.6	6.8	4.1	2.0
2030	158	264	527	0.50	0.63	6.7	3.4	1.7	7.1	4.3	2.1
2031	165	274	548	0.50	0.63	6.5	3.3	1.6	6.9	4.1	2.1
2032	171	285	570	0.50	0.63	5.3	3.2	1.6	6.6	4.0	2.0
2033	178	297	593	0.55	0.69	5.6	3.4	1.7	7.0	4.2	2.1

Note:
- G1 Income of lowest income group
- G2 Income of low income group
- G3 Income of middle income group
- T1 Water tariff level of 0.16US$/$m^3$ in the initial year
- T2 Water tariff level of 0.20US$/$m^3$ in the initial year
- C1 Ratio of T1 to G1
- C2 Ratio of T1 to G2
- C3 Ratio of T1 to G3
- C4 Ratio of T2 to G1
- C5 Ratio of T2 to G2
- C6 Ratio of T2 to G3

From the Table above, the following facts can be gleaned:

a. The lowest income group (30 USDollars per month) cannot pay for the water charge at the tariff levels of 400 Riels/m^3 (0.16 USDollars/m^3) and 500 Riels/m^3 (0.20 USDollars/m^3).

b. With a tariff of 400 Riels, the low income group (50 USDollars per month) can pay for the water charge from 1995. However, if the tariff is 500 Riels/m^3 (0.20 USDollars/m^3) this group can pay from the year 2005.

5.9.3 Improvement of the Bill Collection Ratio

Currently, the bill collection is poor. The ratio is less than 20%. To improve the financial condition of PPWSA, this ratio must be improved.

A 100% water bill collection is desirable. However, it is seen from Table-5.24 that the low income group can pay for the water charge at the unit tariff of 400 Riels/m^3(0.16US Dollars/m^3) after 1995. Therefore, 80% of water bills can be collected at this tariff after 1995, considering the household ability to pay for water.

On the other hand, the lowest income group cannot afford to pay for the water charge even in future at the water tariff of 300 Riels/m^3 (0.12 US Dollars/m^3). The PPWSA has the duty of providing water to all households. Therefore, PPWSA cannot collect water charge from these lowest income-level households. However, water charge must be collected from all household (including the lowest income households) as far as possible, because if the water is provided free, the water consumption is likely to be wasted.

Therefore, improvement in the bill collection ratio can be made by adopting the following basic ideas, considering the ability of low and lower income households to pay for the water.

1) All families having a water meter should pay for water consumption.

2) 18% of the water bills should be collected from households without a water meter in 1994. This should be gradually increased to 85% in 2009.

The bill collection scheme is set as shown in Table-5.25.

Table-5.25 Improvement in Efficiency of Water Bill Collection

No.	Year	Total		Water Meter								Estimation					Total	
		Population	Number of houses	Existing	French	UNDP	Japan	PPWSA	Total	Number of houses	Collection Ratio	Collected houses	Number of No Meter houses	Collection Ratio	Collection houses	Number of collected houses	Collection Ratio
1	1992	532,100	87,278	2,300					2,300	2,300	100	2,300	84,978	18	15,296	17,596	20
2	1993	557,344	91,370		250				250	2,550	100	2,550	88,820	18	15,988	18,538	20
3	1994	582,526	95,460		250	2,400			2,650	5,200	100	5,200	90,260	18	16,247	16,247	22
4	1995	607,710	99,552			2,400	1,500		3,900	9,100	100	9,100	90,452	18	16,281	25,381	25
5	1996	636,590	104,273			2,500	1,500		4,000	13,100	100	13,100	91,173	40	36,469	49,569	48
6	1997	665,590	108,999					5,400	5,400	18,500	100	18,500	90,499	45	40,725	59,225	54
7	1998	694,531	113,722					5,400	5,400	23,900	100	23,900	89,822	50	44,911	68,811	61
8	1999	723,472	118,443					5,400	5,400	29,300	100	29,300	89,143	55	49,029	78,329	66
9	2000	752,411	123,168					5,400	5,400	34,700	100	34,700	88,468	60	53,081	87,781	71
10	2001	793,412	129,853					5,400	5,400	40,100	100	40,100	89,753	65	58,339	98,439	76
11	2002	834,414	136,538					5,400	5,400	45,500	100	45,500	91,038	70	63,727	109,227	80
12	2003	875,414	143,226					5,400	5,400	50,900	100	50,900	92,326	75	69,245	120,145	84
13	2004	916,416	149,912					5,171	5,171	56,071	100	56,071	93,841	75	70,381	126,452	84
14	2005	957,417	156,597					5,171	5,171	51,242	100	61,242	95,355	75	71,516	132,758	85
15	2006	1,016,762	166,720					5,171	5,171	6,413	100	66,413	99,857	80	79,886	146,299	88
16	2007	1,076,105	175,942					5,171	5,171	71,584	100	71,584	104,358	80	83,486	155,070	88
17	2008	1,135,454	185,616					5,171	5,171	76,755	100	76,755	108,861	80	87,089	163,844	88
18	2009	1,194,797	195,287					5,171	5,171	81,926	100	81,926	113,361	85	96,357	178,283	91
19	2010	1,254,142	204,959					5,174	5,174	87,100	100	87,100	117,859	85	100,180	187,280	91
				2,300	500	7,300	3,000	74,000									

Note: Collected Ratio = Numberr of collected houses/Number of houses

5.9.4 Calculation of Financial Internal Rate of Return

Considering the investigation above the financial internal rate of return (FIRR) is calculated as shown in Table-5.26

Table-5.26 Summary of FIRR

Unit Rate Riel/m^3(USDollars/m^3)	FIRR	
	URW by Loan	URW by Grant Aid
200 (0.08)	-	-
300 (0.12)	-	0.7
400 (0.16)	2.7	3.8
500 (0.20)	4.9	6.4
600 (0.24)	6.7	8.9
700 (0.28)	8.4	11.3
800 (0.32)	10.0	13.8
900 (0.36)	11.4	16.7
1000 (0.40)	12.9	20.1

From the above table, the following points are confirmed;

a. The "URW by Grant Aid" case shows better values of FIRR than the "URW by Loan" case.

b. For procurement of the project funds from international lending agencies, the tariff level should be more than 700 Riels/m^3 (0.28 USDollars/m^3) for "URW by Loan" and more than 600 Riels/m^3 (0.24 USDollars/m^3) for "URW by Grant Aid", which means procurements of these funds are not feasible, since the water tariff level is far greater than the minimum level paid by low and lowest income groups.

c. For a tariff level of 300 Riels/m^3 (0.12 USDollars/m^3) or less, this project is not feasible if the project cost is financed by loans, because the FIRR is less than the minimum interest rate of 2.7% for the assumed soft loan.

d. In case the credit is borrowed, it is not possible to undertake the project at the unit water tariff of 300 Riels/m^3(0.12 US Dollars/m^3), since the FIRR is less than 0.75%. On the other hand, at the unit tariff of 400 Riels/m^3 (0.16 USDollars/-m^3), both "URW by Loan" and "URW by Grant Aid" are feasible, since both values of FIRR are more than 2.7%. However, to ensure feasibility in the financial situation even if the data used in this calculation changes, "URW by Grant

Aid" is preferable to "URW by Loan".

e. The most desirable tariff level is 400 Riels/m^3 (0.16 US Dollars/m^3) for "URW by Grant Aid".

The cost and revenue is shown in Table-5.27(1) and (2) for the 400 Riels/m^3 (0.16US Dollars/m^3 tariff level for "URW by Loan" and "URW by Grant Aid", respectively.

5.9.5 Conclusion

The results can be summarized as follows:

a. Special loan or soft loan is recommended for the Project.

b. 400 Riels/m^3 (0.16 USDollars/m^3) is recommended as the unit tariff rate.

c. The water tariff must be increased by 10% every three years.

d. The bill collection ratio should be improved from 22% in the initial year to 91% in 2009.

e. It is desirable to get grant aid for URW

In addition a progressive tariff rate is recommended from the viewpoint of income redistribution and cross-subsidy instead of the current flat rate.

Table-5.27(1) Cost and Revenue - URW by Loan -

Year	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Invest cost (Mil. US $)	20.86	20.19	0.00	6.18	6.18	6.18	9.78	54.01	54.65	27.42	7.35	7.35	7.35	9.71	42.96	55.08	32.83	0.00	0.00	0.00
Structure	6.25	6.14						21.94							14.70					
Pipe	2.41	6.59		6.18	6.18	6.18	9.78	32.07	26.48	27.42	7.35	7.35	7.35	9.71	28.26	24.49	25.37			
Machinary	3.83	7.46							16.90							14.86	7.46			
Electric Equipment	8.37								11.27							15.73				
Supplied Water (Mil. m3)	11.50	13.32	29.23	32.13	34.75	35.99	37.23	38.47	39.71	52.76	56.84	60.04	61.76	63.47	65.19	66.90	87.60	87.60	87.60	87.60
Loan (Mil. US $)	20.86	20.19	0.00	6.18	6.18	6.18	9.78	54.01	54.65	27.42	7.35	7.35	7.35	9.71	42.96	42.88	25.37			
Grant Aid (Mil. US $)																				
Own Fund (Mil. US $)																12.20	7.46			
Water tariff (US $/m3)	0.16	0.16	0.16	0.18	0.18	0.18	0.19	0.19	0.19	0.21	0.21	0.21	0.23	0.23	0.23	0.26	0.26	0.26	0.28	0.28
Revenue (Mil. US $)	0.40	0.53	2.24	3.05	3.73	4.18	5.12	5.66	6.15	9.44	10.17	10.87	12.73	13.08	13.44	15.69	20.54	20.54	22.60	22.60
Operating Cost (Mil. US $)	1.11	1.27	2.62	2.77	2.88	2.88	2.88	2.88	2.88	3.72	3.88	3.98	3.98	3.98	3.98	3.98	5.07	5.07	5.07	5.07
Chemicals	0.30	0.35	0.74	0.79	0.82	0.82	0.82	0.82	0.82	1.05	1.10	1.13	1.13	1.13	1.13	1.13	1.44	1.44	1.44	1.44
Electricity	0.63	0.73	1.54	1.63	1.70	1.70	1.70	1.70	1.70	2.20	2.30	2.36	2.36	2.36	2.36	2.36	3.01	3.01	3.01	3.01
Maintenance	0.11	0.13	0.26	0.28	0.29	0.29	0.29	0.29	0.29	0.37	0.39	0.40	0.40	0.40	0.40	0.40	0.51	0.51	0.51	0.51
Salary	0.05	0.05	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.09	0.09	0.09	0.09
Administrative Cost	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Net Revenue (Mil.US $)	-21.56	-20.93	-0.37	-5.89	-5.33	-4.88	-7.55	-51.23	-51.38	-21.70	-1.06	-0.46	1.40	-0.61	-33.50	-43.37	-17.36	15.47	17.52	17.52

Year	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Invest cost (Mil. US $)	0.00	0.00	28.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	30.59	7.46	0.00	0.00	0.00	0.00	0.00	0.00	28.17	0.00
Structure																				0.00
Pipe																				0.00
Machinary				16.90							14.86	7.46							16.90	0.00
Electric Equipment				11.27							15.73								11.27	0.00
Supplied Water (Mil. m3)	87.60	87.60	87.60	87.60	87.60	87.60	87.60	87.60	87.60	87.60	87.60	87.60	87.60	87.60	87.60	87.60	87.60	87.60	87.60	87.60
Loan (Mil. US $)																				
Grant Aid (Mil. US $)																				
Own Fund (Mil. US $)				28.17							30.59	7.46							28.17	
Water tariff (US $/m3)	0.28	0.31	0.31	0.31	0.34	0.34	0.34	0.38	0.38	0.38	0.41	0.41	0.41	0.46	0.46	0.46	0.50	0.50	0.50	0.55
Revenue (Mil. US $)	22.60	24.86	24.86	24.86	27.34	27.34	27.34	30.07	30.07	30.07	33.08	33.08	33.08	36.39	36.39	36.39	40.03	40.03	40.03	44.03
Operating Cost (Mil. US $)	5.07	5.07	5.07	5.07	5.07	5.07	5.07	5.07	5.07	5.07	5.07	5.07	5.07	5.07	5.07	5.07	5.07	5.07	5.07	5.07
Chemicals	1.44	1.44	1.44	1.44	1.44	1.44	1.44	1.44	1.44	1.44	1.44	1.44	1.44	1.44	1.44	1.44	1.44	1.44	1.44	1.44
Electricity	3.01	3.01	3.01	3.01	3.01	3.01	3.01	3.01	3.01	3.01	3.01	3.01	3.01	3.01	3.01	3.01	3.01	3.01	3.01	3.01
Maintenance	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51
Salary	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
Administrative Cost	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Net Revenue (Mil.US $)	17.52	19.78	19.78	-8.39	22.27	22.27	22.27	25.00	25.00	25.00	-2.58	20.55	28.01	31.32	31.32	31.32	34.95	34.95	6.78	38.96

Table-5.27(2) Cost and Revenue - URW by Grand Aid -

Year	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Invest cost (Mil. US $)	20.86	20.19	0.00	6.18	6.18	6.18	9.78	54.01	54.65	27.42	7.35	7.35	7.35	9.71	42.96	55.08	32.83	0.00	0.00	0.00
Structure	6.25	6.14						21.94							14.70					
Pipe	2.41	6.59		6.18	6.18	6.18	9.78	32.07	26.48	27.42	7.35	7.35	7.35	9.71	28.26	24.49	25.37			
Machinary	3.83	7.46							16.90							14.86	7.46			
Electric Equipment	8.37								11.27							15.73				
Supplied Water (Mil. m3)	11.50	13.32	29.23	32.13	34.75	35.99	37.23	38.47	39.71	52.76	56.84	60.04	61.76	63.47	65.19	66.90	87.60	87.60	87.60	87.60
Loan (Mil. US $)	0.00	0.00	0.00	6.18	6.18	6.18	9.78	54.01	54.65	27.42	7.35	7.35	7.35	9.71	42.96	42.88	25.37			
Grant Aid (Mil. US $)	20.86	20.19																		
Own Fund (Mil. US $)																12.20	7.46			
Water tariff (US $/m3)	0.16	0.16	0.16	0.18	0.18	0.18	0.19	0.19	0.19	0.21	0.21	0.21	0.23	0.23	0.23	0.26	0.26	0.26	0.28	0.28
Revenue (Mil. US $)	0.40	0.53	2.24	3.05	3.73	4.18	5.12	5.66	6.15	9.44	10.17	10.87	12.73	13.08	13.44	15.69	20.54	20.54	22.60	22.60
Operating Cost (Mil. US $)	1.11	1.27	2.62	2.77	2.88	2.88	2.88	2.88	2.88	3.72	3.88	3.98	3.98	3.98	3.98	3.98	5.07	5.07	5.07	5.07
Chemicals	0.30	0.35	0.74	0.79	0.82	0.82	0.82	0.82	0.82	1.05	1.10	1.13	1.13	1.13	1.13	1.13	1.44	1.44	1.44	1.44
Electricity	0.63	0.73	1.54	1.63	1.70	1.70	1.70	1.70	1.70	2.20	2.30	2.36	2.36	2.36	2.36	2.36	3.01	3.01	3.01	3.01
Maintenance	0.11	0.13	0.26	0.28	0.29	0.29	0.29	0.29	0.29	0.37	0.39	0.40	0.40	0.40	0.40	0.40	0.51	0.51	0.51	0.51
Salary	0.05	0.05	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.09	0.09	0.09	0.09
Administrative Cost	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Net Revenue (Mil.US $)	-0.70	-0.74	-0.37	-5.89	-5.33	-4.88	-7.55	-51.23	-51.38	-21.70	-1.06	-0.46	1.40	-0.61	-33.50	-43.37	-17.36	15.47	17.52	17.52

Year	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Invest cost (Mil. US $)	0.00	0.00	0.00	28.17	0.00	0.00	0.00	0.00	0.00	0.00	30.59	7.46	0.00	0.00	0.00	0.00	0.00	0.00	28.17	0.00
Structure																				0.00
Pipe																				0.00
Machinary				16.90							14.86	7.46							16.90	0.00
Electric Equipment				11.27							15.73								11.27	0.00
Supplied Water (Mil. m3)	87.60	87.60	87.60	87.60	87.60	87.60	87.60	87.60	87.60	87.60	87.60	87.60	87.60	87.60	87.60	87.60	87.60	87.60	87.60	87.60
Loan (Mil. US $)																				
Grant Aid (Mil. US $)																				
Own Fund (Mil. US $)				28.17							30.59	7.46							28.17	
Water tariff (US $/m3)	0.28	0.31	0.31	0.31	0.34	0.34	0.34	0.38	0.38	0.38	0.41	0.41	0.41	0.46	0.46	0.46	0.50	0.50	0.50	0.55
Revenue (Mil. US $)	22.60	24.86	24.86	24.86	27.34	27.34	27.34	30.07	30.07	30.07	33.08	33.08	33.08	36.39	36.39	36.39	40.03	40.03	40.03	44.03
Operating Cost (Mil. US $)	5.07	5.07	5.07	5.07	5.07	5.07	5.07	5.07	5.07	5.07	5.07	5.07	5.07	5.07	5.07	5.07	5.07	5.07	5.07	5.07
Chemicals	1.44	1.44	1.44	1.44	1.44	1.44	1.44	1.44	1.44	1.44	1.44	1.44	1.44	1.44	1.44	1.44	1.44	1.44	1.44	1.44
Electricity	3.01	3.01	3.01	3.01	3.01	3.01	3.01	3.01	3.01	3.01	3.01	3.01	3.01	3.01	3.01	3.01	3.01	3.01	3.01	3.01
Maintenance	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51
Salary	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
Administrative Cost	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Net Revenue (Mil.US $)	17.52	19.78	19.78	-8.39	22.27	22.27	22.27	25.00	25.00	25.00	-2.58	20.55	28.01	31.32	31.32	31.32	34.95	34.95	6.78	38.96

5.10 Identification of High Priority Projects

The first stage works is identified as a high priority project immediately after the Urgent Rehabilitation Works. Technical, financial and economic feasibility of the first stage works should be studied immediately after the completion of the Urgent Rehabilitation Works.

Within the next few years, general conditions of the city are expected to become stable. Other studies on the various projects related to infrastructure are under way or will start soon.

From these studies the trend of development will become clear and can be incorporated into the feasibility study.

The outline of the basis for the feasibility study plan that has been prepared present is given below.

Service Area	: 77.75 km^2 (as shown in Fig-5.6)
Target Year	: A.D. 2003
Served Population	: 845,000 people in 2003
Water Demand	: 216,000 m^3/day in 2003 (daily average)
First stage works	: Intake facilities, raw water main, treatment facilities and distribution pipelines

5.11 Initial Environmental Examination

5.11.1 General

(1) The environmental effects of the implementation of water supply project for the Phnom Penh Municipality must be examined.
In the master plan study, Initial Environmental Examination (IEE) is required.

(2) Before the IEE, screening and scoping were carried out. The results showed no large scale environmental impacts.

(3) PPWSA should take measures necessary to mitigate or prevent the environmental impacts which might be caused by the implementation of the projects.

5.11.2 Environmental Impacts

(1) Resettlement of residents

It is necessary to purchase new land of about 115,000 m^2 for the treatment plant in Cham village in Chroy Chang war subdistrict along the west bank of the Mekong River.
The area is part of a sandbank of the Mekong river whose natural condition is better than that of inland areas. The land is used for cultivation of fruits. There are about 25 families and about 150 inhabitants in the area, who are now engaged in fishery.

(2) Pollution of surface water due to wastewater from treatment plants.

In the operation of treatment plants, desludged water, and washing water of filters amounts to about 0.06 m^3/sec for producing 1.0 m^3/sec of distributed water. This means that about 6 - 7% of wastewater will be generated at the plant.
Pollutions in wastewater are turbidity included in raw water, and coagulated alum, they are non-toxic.
The minimum flowrate of Mekong river, which in dry season was 1,250 m^3/sec in 1961, is considerably greater than the discharge from the treatment plant, therefore, the impact to the water quality of the river is negligible even in dry season, when flowrate of the river is very small.

From the technical point of view, the wastewater can be treatmed, however this will incur investment, operation, and maintenance cost.
Considering the present service level of water supply and financial difficulties of PPWSA, higher priorty to the rehabilitation and expansion of facilities rather than to wastewater treatment is justified.
When the treatment capacity is expanded in future and the pollution loading becomes appreciable necessary action must be taken to keep the river water in good quality in the dry season.

(3) Sewerage and Drainage

The drainage system of the city was constructed based on a reclamation plan.
The storm water is planned to be discharged to the river by gravity, in the eastern part of the city along the Sap river and Bassac river but in other parts of the city, the wastewater and storm water have to be pumped outside the bankroad surrounding the urban area. There are seven pumping stations on the side of the banks, but at present only three stations are in operation. The total length of sewers is estimated as 37 km, but cleaning and rehabilitation of the conduit is unsatisfactory. In the rainy season, the roads of the city are frequently flooded, the flood lasting for three or four day. This not only causes traffic problems, but also causes infiltration of polluted water into the water supply pipes.
Domestic and commercial wastewater flows to the low level swamps, BENG KAK in the north and BENG TRABEKTHOM in the south where it is discharged by pumps. These lakes serve as oxidation ponds and organic loads are reduced naturally.
In the rainy season, the lake also serves as a reservoir tank storing storm water runoff. The amount of waste water will increase substantially according to the increase in service level of water supply system. The assumed rate of generation of waste water from supplied water will be 80%.
Environmental impacts on people in Phnom Penh and water pollution of Mekong river and Tonle river due to inadequate development of sewerage and drainage facilities are estimated to be large.

5.11.3 Recommendations

(1) Resettlement of residents

PPWSA should take the necessary measures for the following issues in the Feasibility Study of the project.

1) To confirm the compensation to the residents to be moved, with the residents.

2) To select a new plant treatment facility site which has little environmental impact.

3) To prepare appropriate and careful plans, design, and layout of treatment facilities.

4) To prepare necessary measures to insure good living conditions for the residents, including resettlement area and economic activities.

(2) Pollution of surface water by water discharged from the treatment plants.

PPWSA should take necessary measures to the following issues in the Feasibility Study of the project.

1) To monitor the water quality of Mekong and Sap Rivers.

2) When the exsention of the treatment plant has considerable impact on the water quality, it is necessary to mitigate impacts on river water quality by constructing wastewater treatment facilities.

(3) Sewerage and Drainage

Phnom Penh People's Committee and PPWSA must adopt the necessary measures for the following issues:

1) To start a water quality monitoring program for the public water receiving bodies that might be affected by storm water drainage and waste-water discharge from urban areas.

2) To establish immediate rehabilitation program for drainage facilities in frequently flooded urban areas.

3) To establish a master plan for the sewerage and drainage system of Phnom Penh.

CHAPTER 6

URGENT REHABILITATION WORKS

6. URGENT REHABILITATION WORKS

6.1 Background

Water supply facilities constructed between 1895 to 1960 are considerably timeworn by now and, moreover, they remained non-operational during the civil war. These facilities were given minimals grants by the former USSR and NGO in 1980's, resume operation but there were a limitations.

The poor condition of the power supply has worsened the condition of the water supply facilities and the current supply capacity is about half the capacity 140,000 m^3/day, before the civil war. This has resulted in reduced service area and a number of citizens are compelled to use unsanitary water, such as sold water, river water, rain water, or pond water. Also, reduction of the supply capacity has caused considerable reduction in water the supply pressure. Together people frequently cut a pipeline or drill a hole in it, to let the water flow into a pit for their use. As a result, the water supply condition now is as follows:

a) Population without access to water supply in the city is about 60,000 in the inner area and about 130,000 in the suburban area.
b) Water pressure in the range of 0~2.5 m in service pipes accounts for about 76% of the area and service population.
c) Mean water consumption is only 100 lpcd and the leakage ratio in the system is estimated to be about 50%.
d) The number of existing house connections is only 25,000 and only 2,300 are metered. Unmetered connections are charged based on estimated consumption.
e) The ratio of collected revenue to issued bills and that of issued bills to customer accounts is 46% and 60% respectively.
f) The 1991 revenue and expenditure was 87.8 and 561.9 million Riels, respectively, and the collection ratio was about 19%.

To restore the severe water supply situation immediately and for a medium and long term improvement, the existing water supply facilities now in a mostly ruined condition must be rehabilitated.

The Phum Prek treatment plant has the largest purification capacity among the three existing plants in the city. Therefore, rehabilitating the plant and its distribution facilities as well as rehabilitating the transmission facilities from the plant to the elevated tank located at the center of the city will help improve the water supply condition. Further-

more, this rehabilitation work will serve as the first step to achieve the goal of the master plan.

6.2 Objectives

The objectives of the Urgent Rehabilitation Works (URW) are as follows:

- To supply drinking water to the residents in Phnom Penh city satisfying minimum basic human demand and

- To improve the quality and quantity of the water supply urgently, with the close co-operation of donor agencies,

6.3 Strategy

The strategy of the URW is as follows:

- To achieve the objectives mentioned above, and to improve the existing condition within a short period,

- To emphasize measures to utilize the existing production facilities to the maximum,

- To emphasiz emeasures to utilize the existing distribution facilities to the maximum,

- To emphasize measures to utilize the existing service pipes and facilities to the maximum, and

- Finally, to formulate measures to expand the existing facilities.

6.4 Approach to the URW

6.4.1 To Adopt Measures to Utilize the Existing Plant Capacity to the Maximum

a) To adopt measures to operate PPWTP round the clock
b) To rehabilitate the intake and the treatment facilities of PPWTP
c) To rehabilitate the electrical facilities of PPWTP
d) To rehabilitate the facilities of Chamcar Morn WTP

6.4.2 To Adopt Measures to Utilize the Existing Distribution Facilities to the Maximum

a) To rehabilitate the distribution facilities of PPWTP
b) To utilize the existing elevated tank

6.4.3 To Adopt Measures to Utilize the Distribution Facilities and Service Pipe Facilities to the Maximum

a) To rehabilitate the distribution system to the minimum level required for satisfactory operation
b) To fix valves
c) To fix meters

After the completion of the above mentioned measures:

6.4.4 To Expand the Existing Water Production Facilities

a) To expand the capacity of PPWTP to 50,000 m^3

6.5 Target

6.5.1 Target Year

To achieve the objectives of the URW, the target year for completion of the URW is set as 1996, assuming commencement in 1993.

6.5.2 Service Area

The service area for 1996 is the same as the present area, which is shown in Fig-6.1. The service area includes the inner circular area of 28.70 km^2 and the outer circular area of 49.05 km^2 where only main distribution pipes and secondary pipes exist . This is because during the rehabilitation period, existing facilities must be improved and upgraded, rather than expand the service area.

6.5.3 Projection of Population Served and Water Demand

The total population to be served in 1996 is estimated as shown in Table-6.1 and Appendix C.

Table-6.1 PROJECTION OF POPULATION TO BE SERVED

District	Service Area (km^2)	Population Served		Population of PP Municipality	
		1992	1996	1992	1996
DON-PENH	7.60	106,907	118,005	106,907	118,005
CHAM CAR MORN	9.50	111,301	135,223	111,301	135,223
TOUL KORK	9.25	96,022	116.966	96,022	116,966
7 JANUARY	2.35	87,840	91,407	87,840	91,407
Inside Total	28.70	402,070	461,601	402,070	461,601
MEAN CHEY	17.01	54,025	72,479	97,377	130,740
RUSSEY KEO	26.67	65,355	81,048	120,108	161,830
DANG KOR	5.37	10,710	17,095	63,381	83,970
Suburb Total	49.05	130,090	170,622	280,866	376,477
Grand Total	77.75	532,160	632,223	682,936	838,078

Per capita consumption in 1992 is assumed to be 100 lpcd from Table-3.11, and estimated as 120 lpcd in 1995 and 150 lpcd in 2000. 126 lpcd is assumed for 1996.
Leakage ratio in 1992 is calculated as 44%, as shown in Table-3.11, but it is assumed as 50% in 1992 in the URW and 48% in 1996 for planning purposes. The daily average demand is estimated as 106,432 m^3/day in 1992 and 153,192 m^3/day in 1996.

The daily maximum demand is assumed to be 1.3 times the daily average demand. The daily maximum demand is 138,362 m^3/day in 1992 and 199,150 m^3/day in 1996. The daily average is used for treatment plant design, and the daily max flow is used for distribution pipe design. The results are shown in Fig-6.2.

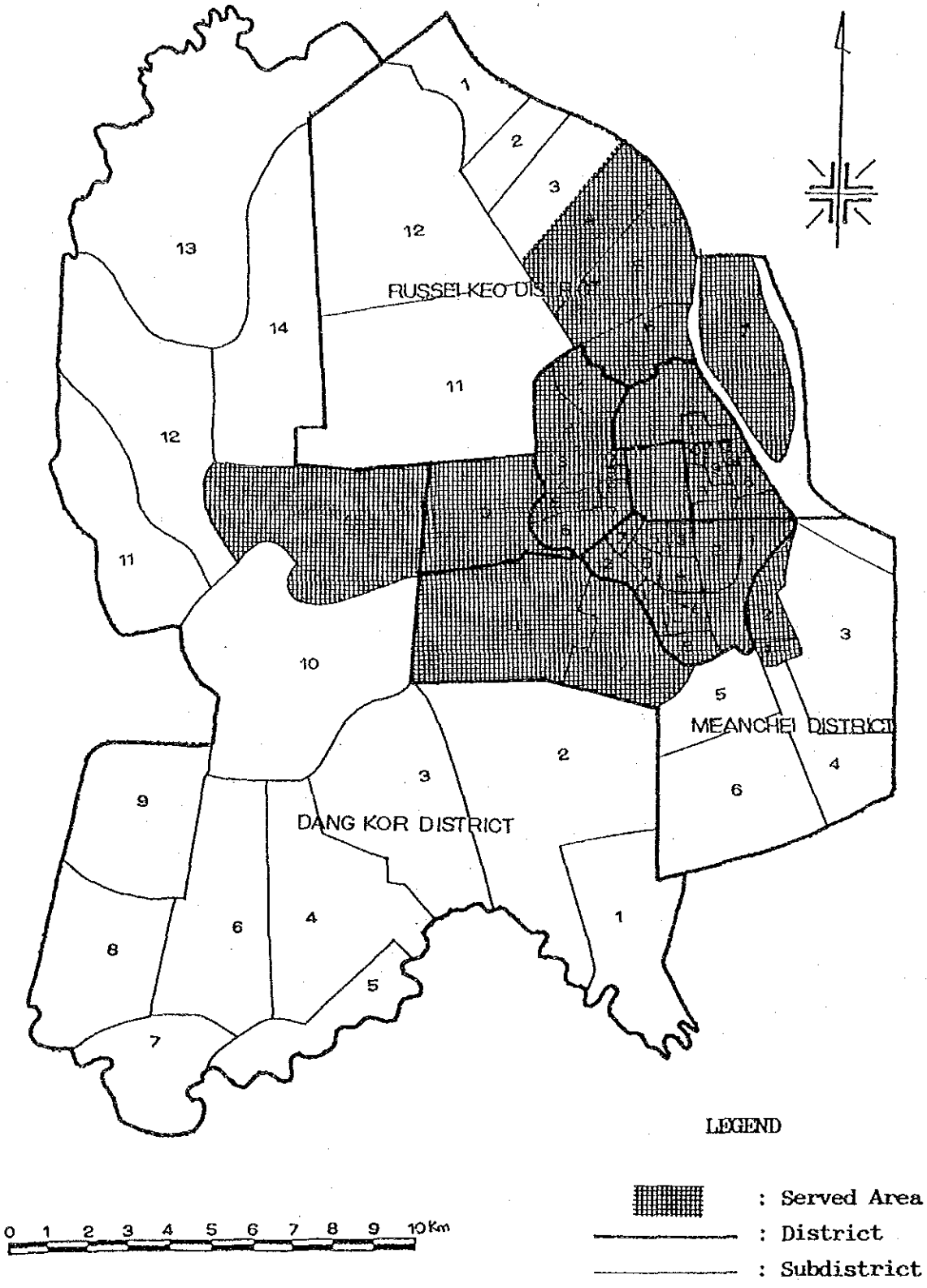
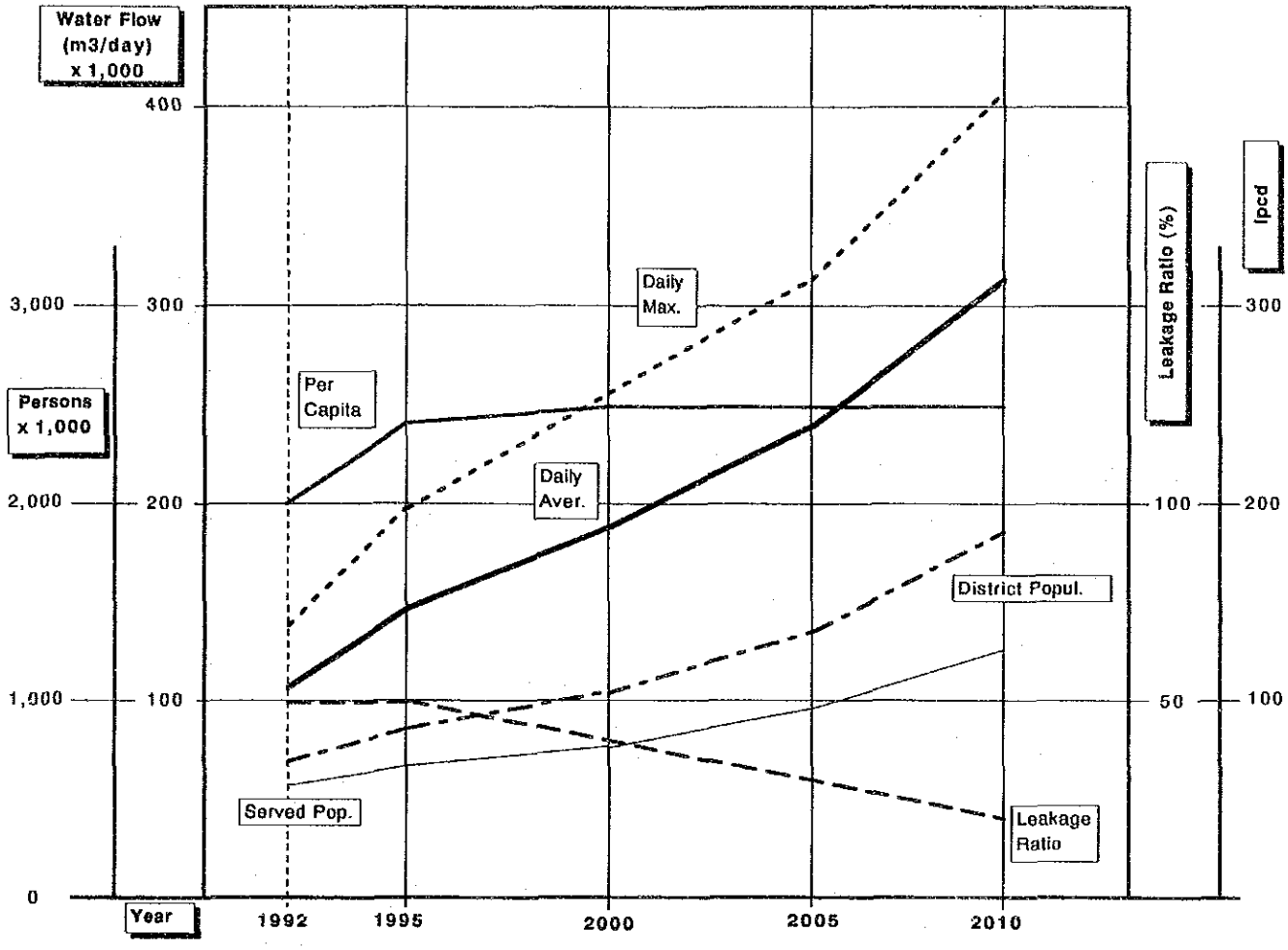


Fig-6.1 SERVED AREA IN 1996

Fig-6.2 POPULATION AND WATER DEMAND



Leakage Ratio(%)	50	50	40	30	20
Daily Max. (m3/day)	136,382	189,605	244,533	311,161	407,598
Daily Aver. (m3/day)	106,432	145,850	188,103	239,355	313,536
Per Capita Dem. (lp	200	240	250	250	250
Served Population	532,160	607,710	752,410	957,418	1,254,143
District Population	682,936	793,635	1,020,500	1,352,796	1,851,458

6.6 Selection of Urgent Rehabilitation

6.6.1 Urgent Rehabilitation Works

The following approaches and criteria are used for the URW:

a) To restore the supply capacity.
b) To increase the supply capacity to meet the minimum demand.
c) To take effect immediately after completion of the URW.
d) To be appropriate in size, and
e) Time for construction should be reasonable.

As stated previously, most facilities of the Phum Prek and Chamcar Morn systems are in need of repair and/or replacement. The items to be urgently rehabilitated and improved, including administrative and operational aspects, are broadly classified as follows: (refer to Table-6.2)

a) Expansion and rehabilitation of the Phum Prek system,
b) Rehabilitation of the Chamcar Morn System,
c) Distribution facilities and service connections
d) Renovation of metering systems, and
e) Manpower development and reorganization of the administrative system.

The URW for the Phum Prek plant consists of the following, 1) rehabilitation of electric facilities, 2) improvement in distribution by using the existing elevated tank located beside the National Sports Complex, 3) extension of transmission facilities consisting of pumps and a transmission main, and 4) construction of a new reservoir.

Of the facilities to be rehabilitated in the Phum Prek treatment plant, the most important work will be the electrical facilities. Without supply of electrical parts, operation of the plant may stop suddenly.

In addition to the works described above, the distribution and service connection facilities should be improved to make the overall operation of the system efficient. To improve the low distribution pressures a large numbers of distribution mains and house connections are included in the URW. These are major obstacles to efficient distribution, and thus their rehabilitation should be undertaken. To control the supply pressure and enable easy repairs, rehabilitation works should include repair, replacement of valves, and installation of additional valves.

To improve customer services, and at the same time, to improve the financial condition, rehabilitation of the metering system is also required. Meters and their appurtenances will be supplied under the URW for a portion of certain selected areas.

To improve the system efficiency, not only construction works but improvements in the administrative system are essential. The framework, in this regard, will include measures such as staff training, formation of leakage protection teams, a section for meter reading, billing and collection, and the provision of regulations and legislative procedures.

6.6.2 Selected Works

Based on the basic approach stated in the previous section, the selected projects for the Urgent Rehabilitation Works are listed below:

a) Rehabilitation of Phum Prek electric facilities,
b) Extension of treatment plant (50,000 m^3/day),
c) Extension of reservoir (10,000 m^3 capacity),
d) Extension of transmission facilities (transmission pipeline and pumps),
e) Installation of additional distribution facilities (pipelines D250 mm x 1.34 km and D200 mm x 1.31 km),
f) Improvement in valve arrangement, and
g) Rehabilitation of the metering system.

The priority of the schemes of the URW is given in Section 6.6.5 "Priority of the Schemes". The URW is separated in 2 phases according to the strategy. The extension of the treatment plant is scheduled in Phase 2 and other works are included in Phase 1.

The extension of Phum Prek treatment plant is excluded from the Urgent Rehabilitation Project Portion because it was not requested by Cambodia and also because there is apprehension about the ability of Cambodia to implement the extension works, including financial management and technical staff arrangement after start-up.

Table-6.2 URGENT REHABILITATION WORKS (1/5)

No.	Name of URW	Components	Objectives	POA on URW	Expected Effect and Impact	Priority	Expected Country/Agency
1. PHUM PREK SYSTEM (EXPANSION)							
1.1	Expansion of Treatment Plant	To strengthen supply capacity	Capacity : 50,000 m^3/day	URW 2.5,4.2-7.7 : previously conducted	To improve/-strengthen supply condition	High	
1.2	Expansion of Transmission Facilities	To improve supply condition using elevated tank	Pump : 2 units(Q17.5 m^3/min) Pipeline : D500 DIP x 2.4 km	- do -	To improve supply condition	High	Japan (Study)
1.3	Expansion of Reservoir	To increase supply capacity	Capacity : 10,000 m^3	Item 2 : previously constructed	Expected capacity to be increased : 500 m/r	High	- do -
1.4	Expansion of Electric Room of Intake Facilities	To improve safety in operation	6 m x 11 m	URW 2.4-2.5 :	To improve safety condition	High	- do -
1.5	Expansion of Distribution Facilities	To improve distribution capacity	Pump 2 units (Q17.5 m^3/min)	URW 2.4-2.5	To improve distribution condition	High	- do-
2. PHUM PREK SYSTEM (REHABILITATION							
2.1	Rehabilitation of Intake Facilities	to provide stand-by pump and keep raw water clean	Repair of stand-by pump, & Partition Wall construction to prevent drain water		To keep stand-by pump, and prevent contamination	Middle	---
2.2	Rehabilitation of Filter	To get good filtered water	Repair of filter media		To get good filtered water	High	France

Table-6.2 URGENT REHABILITATION WORKS (2/5)

No.	Name of URW	Components	Objectives	POA on URW	Expected Effect and Impact	Priority	Expected Country/Agency
2.3	Rehabilitation of Machinery & Equipment	To ensure treatment	A number of machinery, valves and gates are not always in good condition	URW 2.4-2.5 : previously constructed	To ensure treatment	High	France, for machinery reland to filtering
2.4	Rehabilitation of Electric Facilities	To ensure operation of treatment plant	Almost all electric facilities are in critical condition	URW 2.5 : previously constructed	To ensure treatment	High	Japan (Study)
2.5	Renewal of Power Supply Facilities for Plant	To improve power supply	Power supply cables and receiving facilities		To estabilish plant operation	High	Cambodia
2.6	Rehabilitation of Distribution Facilities	To improve operation	Removal of pumps : 4 units (Q15.0 m^3/min)		To make operation easy	High	Japan (Study)
2.7	Rehabilitation of Distribution Facilities	To improve distribution capacity	Rehabilitation of pumps : 4 units (Q35.0 m^3/min)	URW 2.4-2.5 :	To rehabilitate pump capacity	High	- do -
3. CHAMCAR MORN SYSTEM							
3.1	Rehabilitation of Plant	To ensure operation	Rehabilitating deteriorated equipment		Plant improvement and increasing water supply	High	France
4. DISTRIBUTION FACILITIES AND SERVICE INSTALLATION							
4.1	Installation of additional	To improve supply	Items to be constructed :		To improve supply	High	Japan (Study)

Table-6.2 URGENT REHABILITATION WORKS (3/5)

No.	Name of URW	Components	Objectives	POA on URW	Expected Effect and Impact	Priority	Expected Country/Agency
4.2	Improvement in Distribution Facilities	To reduce leakage (Don Penh) (Chamcar Morn) (Toul Kork) (7 January)	Prevention of leakage and illegal utilization of water supply system	Combined with URW 7.1-7.7	Leakage prevention, Protect/maintain water quality, Improving accounted for water ratio	High (1st)	Partly by France
4.3	Improvement in Distribution Facilities	To reduce leakage (Chamcar Morn)	Purchasing cover joints : D80 - D250 mm : 420 sets	- do -	- do -	High	- do -
4.4	Improvement in Service Installation	To reduce leakage (Don Penh)	- do -	- do -	Leakage prevention, Protect/maintain water quality, Improving account-ed-for-water ratio	High (1st)	
4.5	New Installation of Valve Arrangement	Reduce leakage (7 January)	Leakage reduction 114 units (D80 - D300 mm)	- do -	- do -	High (1st)	Partly Japan (Study)
5. NEW INSTALLATION							
5.1	Improvement in Valve Arrangement	To make operation easy and reduce leakage (Don Penh) (Chamcar Morn) (Toul Kork) (7 January)	Easy operation/maintenance and leakage reduction 52 units in total (D150 mm - 400 mm)	- do -	- do -	High (1st)	- do -

Table-6.2 URGENT REHABILITATION WORKS (4/5)

No.	Name of URW	Components	Objectives	POA on URW	Expected Effect and Impact	Priority	Expected Country/Agency
6. RENOVATION OF METERING SYSTEM							
6.1	Rehabilitation of Metering System	To improve customer service & financial condition (Don Penh) (Chamcar Mork) (Toul Kork) (7 January)	Purchasing water meters : D30 mm - D50 mm : 3000 sets	Combined with URW 7.1-7.7	Elimination of water retail practice Revenue increase, Improving accounting-for-water ratio	High	Partly Japan (Study)
6.2	Rehabilitation of Metering System	To improve customer service & financial condition	Warehouse & test/repair shop construction	- do -	- do -	High	
7. SETTING-UP OF ADMINISTRATIVE SYSTEM							
7.1	Staff Training	To increase trained staff	Necessary staff : Treatment Plant : 55 pr. Leakage Protect : 10 pr. Service Instal. : 5 pr. Bill. & Charge :20 pr. Administration : 5 pr. Accounting : 10 pr.	Leakage prevention, Protect/keep water quality, Improving accounted-for-water ratio Setting-up stable system of Authority	High	UNDP	

Table-6.2 URGENT REHABITATION WORKS (5/5)

No.	Name of URW	Components	Objectives	POA on URW	Expected Effect and Impact	Priority	Expected Country/Agency
7.2	Set-up of Leakage Protection Team	To reduce leakage from pipelines & service inst.	7 Teams: Every team consists of: Team leader : 1 pr. Meter Operator : 2 pr. Detector : 1 pr. Car Driver : 1 pr.	After URW 7.1-7.3 :	- do -	High	
7.3	Set-up of Service Installation	- do -	Qualified service Pipe contractor 8 x 3 teams = 24 groups	Combined with URW 7.1 :	- do -	High	
7.4	Set-up of Bill and Charge System	Improvement in revenue collection procedures	10 persons, 5 computers for billing, revenue recording, maintenance customer' list	Finishing training processing of customer's	Faster and more precise service	High	Partly UNDP
7.5	Set-up of Administration Team	Improvement in administrative functions	5 pr.3 computers for personnel,planning, general affairs	Finishing training URW 7.1	Faster and more precise processing of managertial matters	High	UNDP
7.6	Purchase & Stock of Materials & Spare Parts	To reduce leakage from pipelines & service inst.	Pipes,Valves, Machinery and Electric parts, & Vehicles		Leakage prevention, Protect/maintain water quality, Improving accounted-for-water ratio, Setting-up stable system of Authority	High	Partly UNDP
7.7	Setting-up of Regulation & Procedures	To establish administration system	Setting-up of regulation & procedures, provision of fund		- do -	High	Cambodia

6.6.3 Description of the Selected Schemes

6.6.3.1 Rehabilitation of Electrical Facilities at the Phum Prek WTP

The electrical system of the Phum Prek treatment plant is in critical condition. One example is the exposed electric panels, which have severely deteriorated.

As the electrical system has superannuated and has been on the whole poorly maintained, it will be impractical to renovate it by only partial repairs of the system. With the deteriorated system, all systems may come to a halt suddenly due to electrical troubles. Therefore it is necessary to repair all parts of the plant's electrical system as stated below:

a) The high-tension power system,
b) The low-tension power system, and
c) High tension supply system in the plant

6.6.3.2. Expansion of the Treatment Plant

In 1996, the target year of the URW, the daily maximum and daily average demands are estimated as 199,000 and 153,000 m^3/day, respectively.

For the expansion of the Phum Prek plant, the daily average water demand is used as the basis for design. The reasons for this are as follows.

1) Minimizing the initial investment cost

The construction cost of the system can be divided into the construction cost of the plant and that of the distribution mains, and their ratio is roughly estimated as 2:8. If the construction cost for the treatment facilities(50,000m^3/d) is U.S.Dollar 14.3 million, the total construction cost is estimated as U.S.Dollar 71.6 million, with U.S.Dollar 57.3 million for the distribution mains.

Considering the magnitude of the total construction cost, the project should be phased out so that financing arrangements become easier for an external aid agency.

2) Utilization of private storage tanks

Most consumers have their own storage tank and this custom will not change immediately considering the supply condition in the near future. As long as such tank are used, peak water demand will reduce to some extent.

Based on the time required for the formulation and construction of a project through external aid, a plant with an output of 50,000 m^3/day can be completed in 1996. The total output of water treatment plants of 170,000 m^3/day, including output from the existing ones can meet the daily maximum water demand of 170,000 m^3/day in 1996 as shown in Fig-6.3. The components of the new plant are shown in Appendix G, and its layout in Fig-6.5.

6.6.3.3 Extension of the Service Reservoir

The storage capacity of the existing service reservoir is about 11,000 m^3, and this corresponds to about 2.6 hours of the design output of the plant. At present, the hourly peak demand compared to the daily demand is expected to be small, as observed during the field survey conducted by the Study Team.

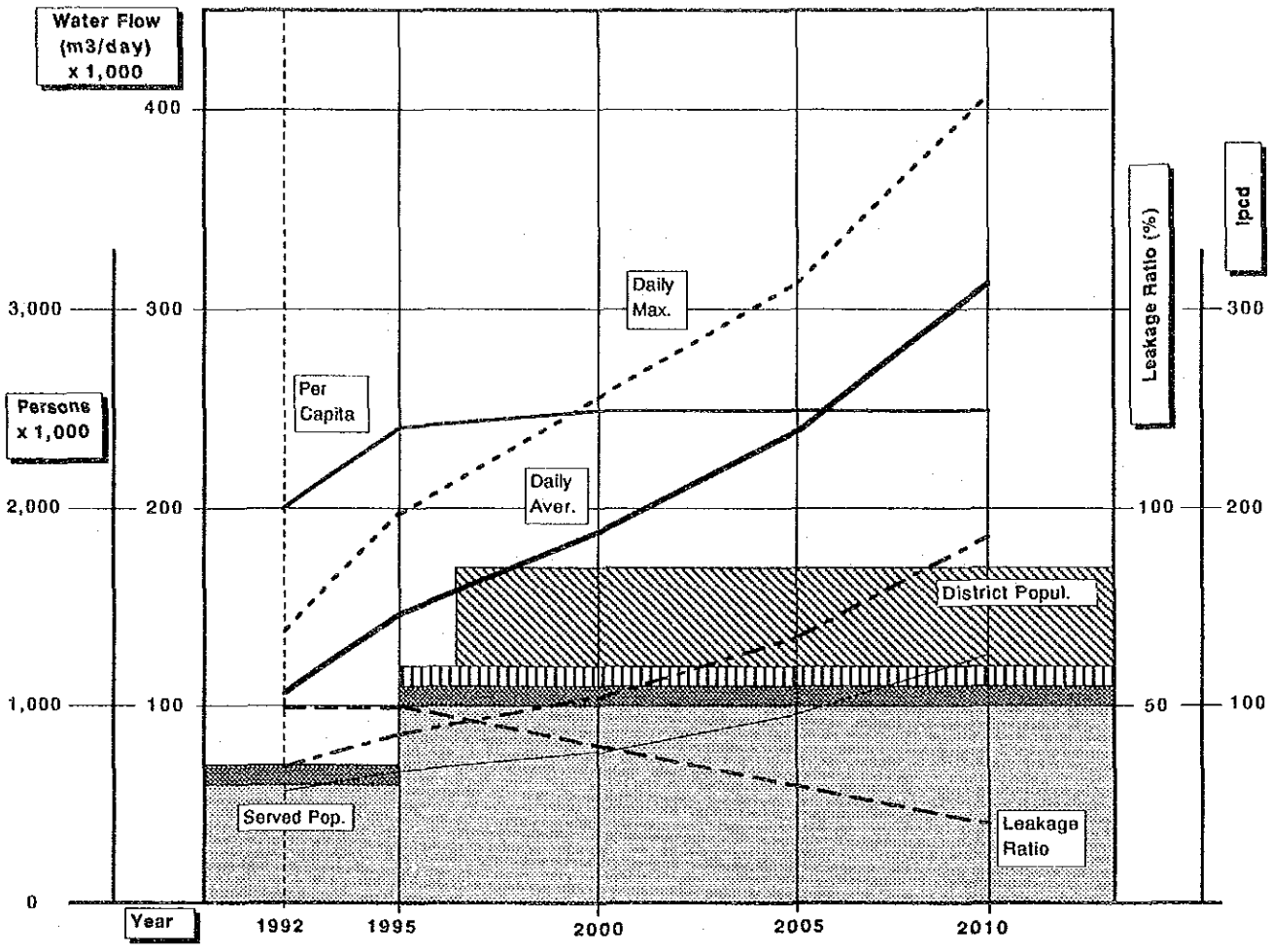
After completion of the transmission main, the service reservoir of the plant will have two functions; (1) a service reservoir to deal with the peak demand for treated water, and (2) a suction well for the transmission pumps.

Presently, there is a grossly inadequate output of treated water. When the operation is resumed early in the morning, the water level of service reservoir rapidly decreases to a water level where air intake into the outlet pipe occurs. To improve this condition, the PPWSA has a plan to construct additional reservoir(s).

Considering the condition after completion of URW, increased supply will be possible by combining pump installations, as described in Appendix-G, and additional reservoir(s) constructed in the rehabilitation stage. The required additional capacity of the reservoir(s) is 10,000 m^3.

On account of the condition after the rehabilitation in terms of effective utilization of facilities, the construction of a new 10,000 m^3 service reservoir will be included in the URW.

FIG-6.3 WATER DEMAND AND PLANT CAPACITY

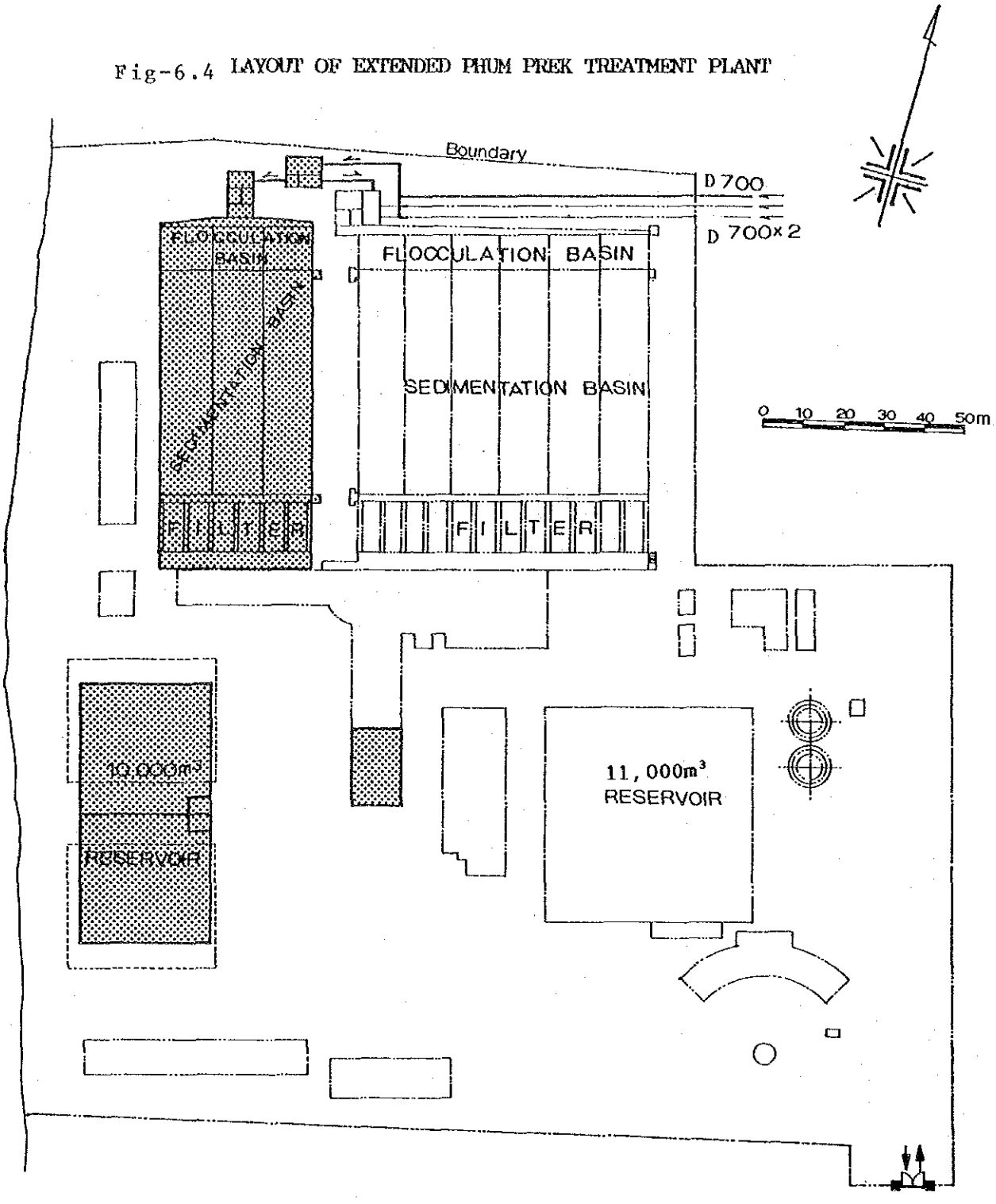


Leakage Ratio(%)	50	50	40	30	20
Daily Max. (m3/day)	138,362	189,605	244,533	311,161	407,598
Daily Aver. (m3/day)	106,432	145,850	188,103	239,355	313,536
Per Capita Dem. (lpcd)	200	240	250	250	250
Served Population	532,160	607,710	752,410	957,418	1,254,143
District Population	682,936	793,635	1,020,500	1,352,796	1,851,458

LEGEND

Symbol	Facility	Capacity (m3/day)	Symbol	Facility	Capacity (m3/day)
	Phum Prek (Expansion)	50,000		Existing Chamcar Morn	7,000 → 10,000
	Chamcar Morn (Expansi	10,000		Existing Phum Prek	56,000 → 100,000

Fig-6.4 LAYOUT OF EXTENDED PHUM PREK TREATMENT PLANT



6.6.3.4 Extension of Transmission Facilities

The present supply condition, especially the distribution pressure, is shown in Fig-3.17 which is obtained from simulation using the network model. The areas where the water pressure in secondary distribution main is less than 2.5 m, cover almost one third of the service area.

The supply condition will improve when one transmission main, from the Phum Prek plant to the existing elevated tank, is put into commission. Computer simulation reveals that the areas where the supply pressure is less than 2.5 m, will be almost eliminated under the following conditions.

a) Per Capita Consumption	: 100 lpcd in 1993
b) Condition of Demand Peaking	: No peak hourly flow
c) Inflow to the Tank	: 1,000 m^3/hr (24,000 m^3/day)
d) Outlet Pressure Head	: LWL + 30.0 m at least

There are still low pressure areas as shown in the figure. These are isolated areas or areas where the pipeline capacity is extremely small.

According to the simulation, increasing the inflow to the elevated tank will be less effective in improving the supply condition. Instead, strengthening parts of the distribution network and provision of more inlet points will be more effective, as described below.

The installation of additional transmission pipeline is highly effective if included in the URW. The expected size and the length are:

D500 DCIP x 2,410 m

To convey the treated water at a rate of 1,000 m^3/hr or equivalent at 24,000 m^3/day from the Phum Prek plant to the existing elevated tank, at least two transmission pumps will be necessary in the plant. The specifications of the pumps are described below.

a) Transmission Pumps	: Q17.5 m^3/min x 2 units
b) Additional Pump House	: W8.0 m x L18.0 m x H6.0m
c) Suction Pit	: 1 set
d) Electrical crane gears	: 1 unit
e) Appurtenances	: Connecting Pipes and Valves

The additional pump house is to be constructed beside the existing pump house. A suction pit and appurtenant pipelines and valves are also to be installed. After the completion of URW, the central area of the city, where high demand exists, will see a remarkable increase in water tariff revenue collected from consumers.

6.6.3.5 Installation of Additional Distribution Facilities

The installation of the transmission main from the Phum Prek plant will improve the supply condition as stated above. However, supply to the area where the museum exists, still remains poor because of insufficient capacity in the feeder mains. The northern area along the Sap river is also another such area, despite the proximity to the plant.

To improve supply to such areas effectively, installation of additional distribution mains are planned as shown in Fig-6.5. The planned mains are as follows:

a) D250 x Length 1,340 m for the Northern Area, and
b) D200 x Length 1,310 m for the Central Area.

To improve distribution pressure in service area, installation of new distribution pumps and improvement in the existing distribution pumps are necessary, as given below.

Distribution Pumps:

a) Q17.5 m^3/day x 42 m x 180 kw x 2 units - new installation
b) Q35.0 m^3/min x 42 m x 325 kw x 4 units - improvement
c) Q15.0 m^3/min x 28 m x 132 kw x 4 units - removal

Cover joints are effective in repairing distribution pipes. The number of units required is estimated as: ϕ80 - ϕ120 mm x 420 unit.

6.6.3.6 Improvement in Valves in the distribution Network

As a result of the augmented distribution pressure, leakage from deteriorated facilities will increase. Action for leakage protection is not likely to be introduced before the completion of the URW. To ensure leakage protection in future, it is necessary to install valves on distribution mains for pressure control in ordinary operation, and for isolation of part of network for the leakage detection.

The required valves and their sizes are shown in Appendix G, and summarized below:

	Valve Dia. (mm)	Quantity (set)	Remarks
Isolating Valve	ϕ80 - ϕ300	114	For south district around the existing elevated tank
Pressure control isolating Valve	ϕ150 - ϕ400	52	
Total		166	

6.6.3.7 Rehabilitation of Metering System (in part)

The financial condition of the PPWSA is one of the main problems that needs to be improved. To decrease the leakage ratio while simultaneously increasing water tariff revenues, the use of water meters is indispensable for rational and effective billing. Water meters and equipment related to service connections will be supplied in selected areas.

The number of meters are listed below:

Item	Dia.	Quantity	Remarks
Water Meter	30 mm	1,500	
	40 mm	1,000	
	50 mm	500	
	Total	3,000	

6.6.4 Cost Estimation

On the basis of the facilities described in the previous section, the costs are estimated as shown below.

Item of URW		Unit: 1,000 U.S.Dollars
1.	Rehabilitation and Construction of New Water Supply System	34,350
2.	Engineering Service	2,480
	Total Cost	36,830

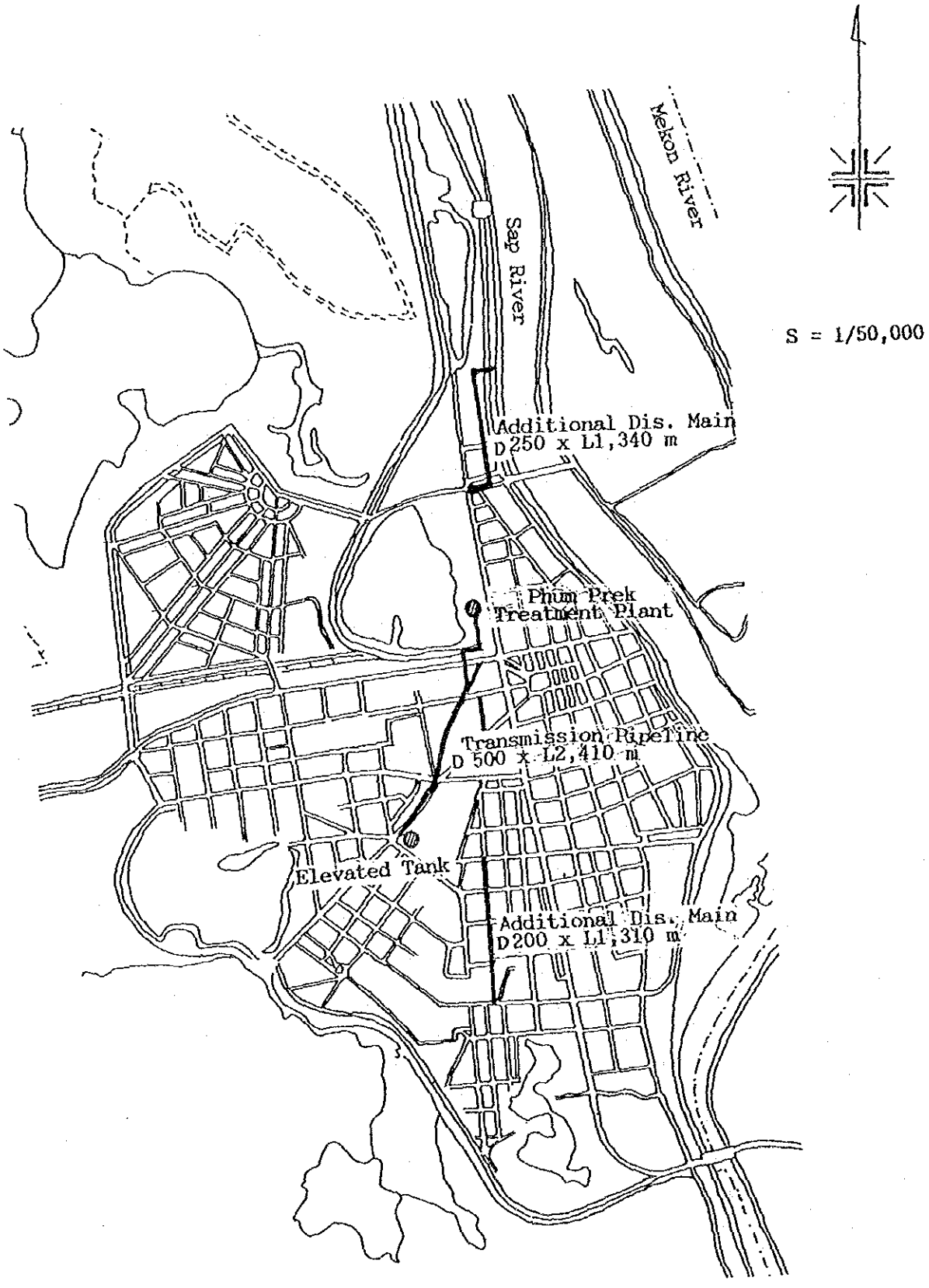


Fig-6.5 TRANSMISSION PIPELINE AND
ADDITIONAL DISTRIBUTION MAINS

6.6.5 Priority of the Schemes

The priority of the URW is based on the need for the schemes and the work sequence.

1) First Priority Work : Rehabilitation of Phum Prek Electrical Facilities

All electrical systems in the Phum Prek treatment plant have deteriorated or partly damaged, and all activities of the plant may stop due to electrical troubles. Furthermore, high-tension lines are wired under in the premises such that operators are exposed to risks all the time. Considering these conditions, the rehabilitation of the electrical facilities is selected as the first priority work.

2) Second Priority Work : Expansion of the Phum Prek Treatment Plant

To meet the future water demand, an additional plant is to be constructed. The existing Phum Prek treatment plant was designed and constructed with future expansion in mind, and the premises of the plant have sufficient space available for expansion. Therefore, this work is selected as the second priority work.

3) Third Priority Work : Expansion of Reservoir

To supply surplus treated water in the night time, the supply capacity of 500 m^3/hr in the daytime is to be increased with a combination of pumps. The capacity of the reservoir is to be increased for the same purposes. This is the reason for selecting the expansion of the reservoir as the third priority work.

4) Fourth Priority Work : Expansion of Transmission Facilities

The poor supply condition shown in Fig-3.17 will be improved remarkably by conveying treated water at the rate of 1,000 m^3/hr to the elevated tank and supplying water through the tank. Work on the transmission pipeline and pumps for conveying water is selected as the fourth priority work.

5) Fifth Priority Work : Installation of Additional Distribution Facilities

6) Sixth Priority Work : Improvement in Valve Arrangement

7) Seventh Priority Work : Rehabilitation of Metering System

6.6.6 Implementation Schedule

As the construction of the water supply system is one of the important public works, it is imperative that reliable construction work be completed within the shortest practical period.

Therefore, the construction work under the Urgent Rehabilitation Works should adopt common construction methods widely practiced in Phnom Penh and Cambodia, so that steady construction work can be implemented easily and the period can be shortened.

Considering the construction work size and the period of the Urgent Rehabilitation Works, the works are divided into two phases as follows:

1) Phase 1 Works

a) Rehabilitation of the Phum Prek plant electrical facilities,
b) Expansion of reservoir (10,000 m^3 capacity),
c) Transmission pipeline, pumps and pump house,
d) Installation of distribution pipelines,
e) Improvement of valve arrangement (in part), and
f) Rehabilitation of metering system (in part).

2) Phase 2 Works

a) Expansion of the treatment plant (50,000 m^3/day) and improving the existing chemical dosing equipment.

The timing for the implementation of Phase 1 Works is set as follows:

Phase 1 is planned to be completed in 1994 fiscal year (end of March 1995). The detailed design period for the Urgent Rehabilitation Works is estimated to take about 4 months, judging from the work load. Tendering and evaluation period require 2 months. The construction period is estimated as 1 year.

6.6.7 Effect of URW

The URW deals with expansion of the Phum Prek water treatment plant, improving the Phum Prek water treatment plant, transmission and distribution facilities in the city of Phnom Penh, and also supplying water meters and cover joints (bands) for repairing pipes. On the other hand, the scope of a project sponsored by the French government is

to rehabilitate the filtration basin in Phum Prek water treatment plant, rehabilitate and extend Chamcar Morn water treatment plant, and also to supply distribution pipelines, service pipes and water meters in the Don Penh area. The scope and time of each project so that they do not overlap with each other. The restored volume of water as a result of rehabilitation of the plant will be supplied to the users through transmission and distribution facilities. The following describes the possible effects resulting from this project.

1) Effect on Phum Prek water treatment plant

The plant is operating only for 13 hours now,but 24-hours operation will be feasible because electric power will be restored. As a result, the volume of treated water will increase by about 80%, from 56,000 m^3/day to 100,000 m^3/day. In addition, more stable supply can be expected because the timeworn facilities will be replaced with new ones. Further, expansion of the plant will increase supply capacity by 50,000 m^3/day.

2) Effect on transmission, distribution and service facilities

The water pressure will increase as a result of rehabilitating the above facilities. This will make it no longer necessary for the users to receive the service water in the pit first, as is necessary at present, and enables them to receive water through taps inside the houses. The served water quality is contaminated in the rainy season because sanitary sewage enters the service pipe through this pit or through openings in the distribution pipe. This will be eliminated and clean water will be supplied.

Leakage will be reduced by using the supplied cover joints (bands) for repairing pipes and installing isolating valves in the distribution system, allowing effective use of the supplied water.

3) Effect on water work management

Increase in the volume of treated water and distribution water and decrease in the volume of leakage water will add to the volume of supplied water for effective use. Besides, installing the water meters will make it possible to collect water charges properly accoding to the consumption. Thus, increase in income from the water charges can be anticipated.

4) Benefits

The aforementioned effects will bring about the following benefits:

a) Expansion of supplied area and increase in served population

At present, no water service is provided in a 5.45 km^2 area (about 60,000 population) within Phnom Penh and 49.05km^2 (about 130,000) in the suburbs of the city. As a result of the increased volume of the treated water, distribution, and increased water pressure, it is possible to supply water to a part of the suburbs.

b) Increased water supply per person

People have to forego service water and buy from a merchant or bring it into house from other placers because they cannot receive it inside the building. Restoration of the water supply allows them to use as much water as they require.

c) Stable water quality

In areas where the pressure is lower than the ground level (804 ha, about 84,500 population) people receive water in a pit, and sanitary sewage enters the supplied water through the pit. Increased water pressure will prevent pollution by sewage.

d) Expansion of service hours

As the capacity of the treatment plant is restored, operating hours of the plant will be extended from 13 hours to 24 hours a day.

6.7 Operation and Maintenance of Facilities Under URW

6.7.1 Requirements for Normal Operation and Maintenance

As outlined in 4.2.2 the present level of operation and maintenance work is too low.

6.7.1.1 Production (Intake and Treatment Plant)

A UNDP/IBRD expert on production is assigned to this unit for 24 months and training and other works will be undertaken under his guidance and advice.

As for water quality management, the U.N. laboratory chemist will assist the local chemists in improving testing procedures.

1) Operation

Recording is needed for operations of all units, namely intake pumping, chemical and chlorine dosing and consumption, filter run and backwashing, power consumption, etc. which must be measured by time, weight, flow, pressure, water level, water volume, kilowatt-hour,etc.

For this purpose, training of operators is necessary and, operation manuals and format for recording data must be prepared.

The operators must regularly report recorded data to the control room. The control room operator while coordinating all data, must instruct the operators to optimize the overall plant operation.

In order to facilitate the above, provision of a communication system by phone and organization of a team of operators at the engineer/technician level are necessary. They will be stationed in the control center room and placed under the direct command of the plant chief.

2) Maintenance

Regular checkup of major equipment like motors, pumps, meters, gauges, etc. must be practiced.

In order to achieve this, training of operators capable of troubleshooting is necessary. A maintenance manual should be prepared.

Ledgers for major equipment must be maintained and all information such as technical specifications, record of repairs, changing spare parts, overhaul, etc. must be entered.

6.7.1.2 Distribution (Network)

A UNDP/IBRD expert and a U.N. volunteer technician are assigned to this unit and training and other works will be undertaken under their guidance and advice.

1) Operation

Valve operation for equalizing water distribution must be taught to the operators. The delicate trick of pressure regulation by controlling valves will be learnt on site and by experience.

Leakage detection and repair will become the most important and the most time-consuming, manpower-intensive operation of the distribution unit (Network Office).

For this, intensive training is needed and tools and equipment for leakage detection must be provided.

2) Maintenance

All existing distribution network maps and drawings will be renewed because of the valve installation works undertaken in this project.

Regular patrolling for checking the water pressure and water level in the elevated tank, and recording/reporting the collected pressure data in a standard format is needed. For this, a number of pressure gauges will be provided and a standard report format prepared.

The above-mentioned operations and distribution works, while requiring higher skills on the part of the present employees, also require recruitment of more workers (about16) and strengthening of the administrative staff.

6.7.1.3 Customer Service (House Connection)

Presently, house connections and meter installation jobs are the responsibility of the Distribution Unit (Network Office), disconnection works the responsibility of the Revenue Collection Unit and meter repair works the responsibility of the Exploitation Office.

Since all these works requiring handling of various materials, gadgets and tools, are interrelated, they should be integrated into a new unit, by re-organization them as Customer Service Unit.

Further, meter reading, billing and revenue collection works, presently the responsibility of the Exploitation Office and the Revenue Collection Unit, are to be transferred to and integrated into the Customer Service Unit.

1) Operation

Water meters of Japanese, Chinese and Thai-make are presently in use. Pipes and fittings are procured from the market regardless of any standard specification.

As far as possible, pipe materials, meters, fittings, valves and cocks must be standardized. Design of house connections and installation methods involving tapping, pipelaying, joining, etc. also must be standardized.

The present practice of accepting applications for new house connections will be abolished, and the acceptance and cost estimation shall be regulated.

For achieving this, training of workers under the initiative of the Technical Office is needed.

2) Maintenance

Efforts for persuading installation of water meters at the premises of existing customers, for detecting illegal connections and for finding leakage from house connections are necessary.

Setting up of an incentive system and training of workers are desirable.
Meter reading, billing and revenue collection, as well as maintenance of customer lists must be computerized.

Computers and printout formats are to be provided and training is necessary.

6.7.1.4 Technical Office

Two U.N. volunteer technicians who are specialists in maintenance and civil works are assigned to this unit for 24 months.

All training described here are to be carried out with the cooperation of UNDP experts and the Technical Office.

A variety of courses in different disciplines and levels must be planned, programmed and coordinated. Curriculum, textbooks and documents, tools for training, classrooms and sites must be prepared.

For normalized operation and maintenance, manuals, formats, standards, etc. must be

prepared by this Office. The large work volume necessitates employment of additional engineers and technicians.

6.7.1.5 Summary of Requirements

The requirements for normalizing operation and maintenance at the training stage and later, are summarized in Table-6.3.

As the Japanese and French assistance programs do not include necessary inputs at the training stage, materials like printed matter, equipment and tools are to be provided by UNDP, preferably out of the remaining fund for equipment (Table-6.2 Item 40-02).

The UNDP program will probably start in June 1993 when the first group of experts and volunteers arrive in Cambodia. Although a sketch of the Japanese assistance program has been conveyed to UNDP formally by the project team, details have not been conveyed yet.

Early exchange of information involving the contents of this study, between JICA and UNDP, will help the work of the experts and volunteers.

Table-6.3 Requirements for Normalizing Operation and Maintenance

Unit	Training Stage *1	Operation/Maintenance Stage	
Assigned Experts & U.N. Volunteers	Training needed for:	Necessary Preparations: Material, Tools	Necessary Preparations: Organizational
Production (Intake & Treatment Plant) Production Superintendant, Laboratory Chemist	Recording of all data for operation Reporting of data to control center Regular checkup and finding abnormality	Operation manual, record formats Phone system, record formats Maintenance manual, ledgers	*1 control center team recruitment new operators
Distribution (Network Office) Distribution super-intendant, Distribution, Technician	Operating valves to regulate flow Detecting and repairing leakage	Distribution maps & drawings, pressure gauges, report formats Equipments & tools	*1 Recruitment of new operators, strengthening administrative staffs
Customer Service (House Connection) Revenue & Collection Advisor			Reorganization of Network and Exploitation Office, Revenue Collection
	Carrying out works as standardized	Works standards, material standards, design & cost estimation standards	*1 Recruitment of new operators,
	Promoting installation meters,		Introduction of reward system
	Detecting illegal connections		- ditto -
	Detecting & repairing leakage		- ditto -
	Use of computer	Computers, printout formats, customers list	*1
Technical Office	Making trainers from Technical Office staff for training operators		*1
Maintenance Technician, Civil Works Technician, Computerization Export		Manuals, formats, standards, etc. for production, distribution, customer service	Recruitment of new engineering & Technicians

Note: *1 extensive and intensive involvement by Technical Office

6.8 Organization and Management System Associated with Implementation of URW

6.8.1 Required Changes in the Organizational Structure of PPWSA

6.8.1.1 Proposed Restructuring of PPWSA

The proposed organizational structure of the PPWSA is shown in Fig-6.6.

In comparison with the present structure shown in Fig. 4.1, the following changes are noted:

1) Direct control by the director on three deputy directors in the line of management. The three assistant directors perform as the staff.
Presently, one inspector, one vice director and four office chiefs under the director's control are all in the line of management.
By delegation of power, the director's workload on miscellaneous matters will be substantially relieved.

2) The number of office-level units will not change, but the lower units, divisions and sub-divisions, will decrease in number.

3) The levels of management will only be three, namely deputy director, department chief and division chief.

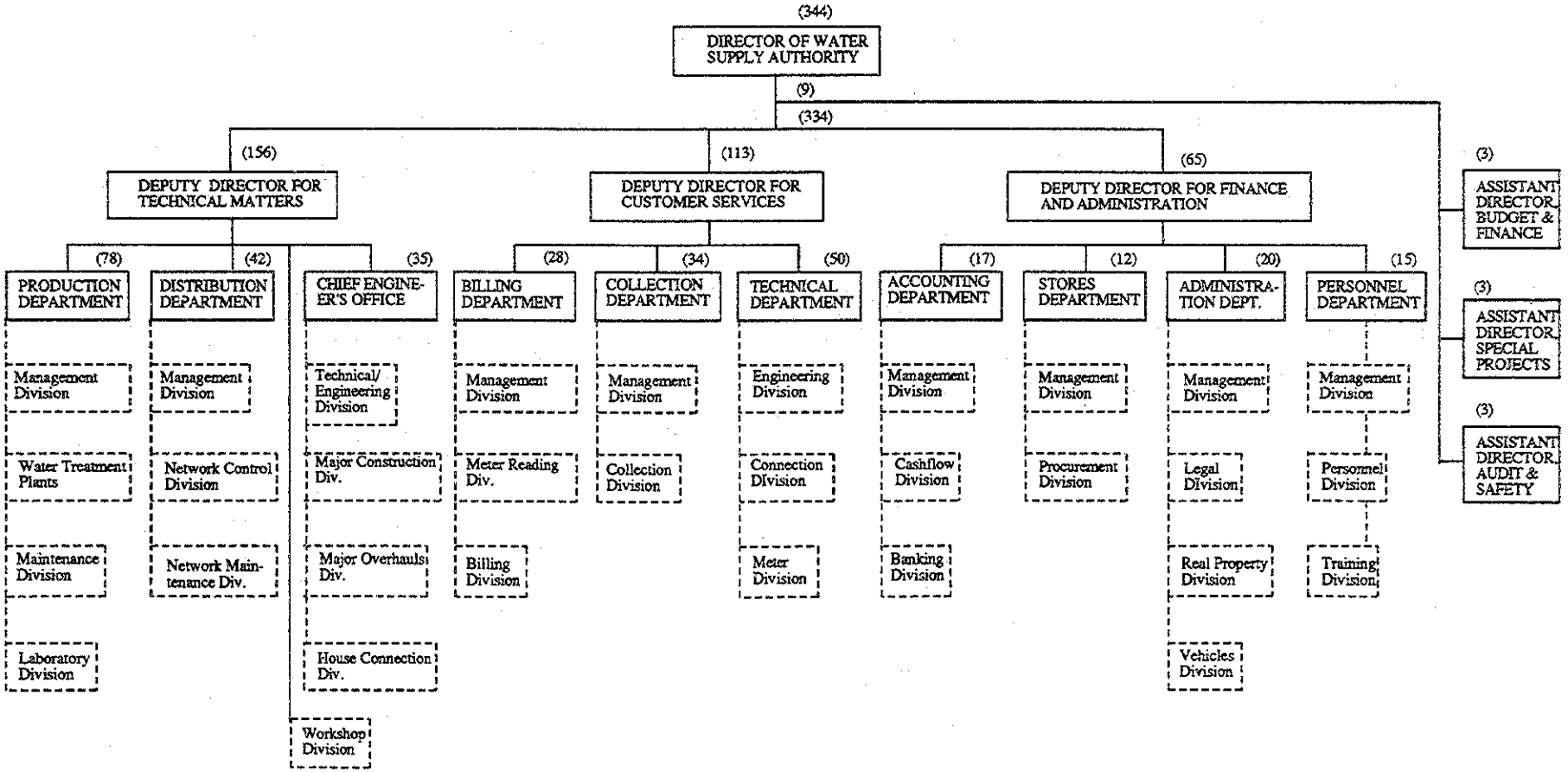
4) Separation of line and staff function is introduced for the first time.

5) Meter reading, billing, collection, house connection and meter maintenance will be managed by a single entity.

The mainframe of the proposed structure was prepared by Mr. David G. Hunter, consultant for Water and Power Technical Assistance Project, World Bank/UNDP Cambodia. It was proposed officially to the PPWSA in May 1993. A copy was given to the present JICA study team.

The JICA team, while maintaining the consultant's original concept, monthly made a few modifications.

Fig.-6.6 NEW STRUCTURE OF PHNOM PENH WATER SUPPLY AUTHORITY ORGANIZATION



6.8.1.2 Duties of Deputy Director and Assistant Director

To assist the Director, three deputy directors for line positions and three assistant directors for staff positions will be appointed.

The deputy director for technical matters is responsible for production, distribution and other technical/engineering matters. He should cooperate closely with the deputy director for customer relations regarding technical/engineering aspects of customer services. His cooperation with the assistant director for special projects is indispensable for implementing the URW projects.

The deputy director for finance and administration is responsible for accounting, store keeping, administration and personnel management. His constant cooperation with the assistant director for budget and planning is the key to the successful achievement of self-reliance of PPWSA.

Billing and revenue collection are coordinated and integrated under the deputy director for customer relations, based upon a completely different concept from the former Exploitation Office which read meters, make bills and collect money.

In this context, the director for customer relations is responsible for not only providing better services to customers but also for publicizing its role to the public.

The assistant director for budget and planning is responsible for preparing regular short- and long-term plans and budget.

The assistant director for special projects is an officer who liaisons with external aid agencies, on project matters. For execution of the URW, competent staff will participate and cooperate with foreign experts in their respective professional disciplines, under the assistant director's control.

The assistant director for audit and safety is a newly proposed position. He is responsible for carrying out audit on all financial transactions and for supervising the safety of the customers, PPWSA personnel and contractors working for PPWSA.

In the original plan, the laboratory was under the supervision of the chief engineer's office, but in the new plan, it is moved to the production department.

In all departments except the office of the chief engineer, a management division is organized for administering all the divisions of each department and coordinating with other divisions.

6.8.1.3 Other Changes Accompanying Restructuring

1) Appointment of Department Directors and Divisional Managers

Abolishing the present seniority and experience-oriented system and introducing a new responsibility and capability-oriented system are indispensable. Promotion and assignment of capable staff to the department-level and division-level chief position should be considered.

2) Recruitment of More New Staff and Workers

As shown in Table-6.3, all the production, distribution, engineering and customer services departments must recruit more staff and workers.

The same could be said of the accounting, stores, administration and personnel departments.

Recruitment of additional staff and workers will be discussed later.

3) Reform on Administration, Finance

Presently, 161 persons of the total 300 PPWSA employees belong to the administration, finance and exploitation offices. If nine persons working in the meter repair shop and 16 in the disconnection division are deducted, there are 138 employees, i.e., a little less than a half the total 300 employees are doing non-technical jobs.

In the proposed restructuring plan, strengthening several functions including personnel management, legal control, budget planning and control is given special attention.

6.8.2 Administrative and Financial Operations in the Restructured PPWSA

6.8.2.1 First Step toward Autonomy

Authorization of the municipal government to manage electricity supply some years ago has been returned to the state in May 1991, by an order of the Council of Ministers, the highest state administrative organ.

Decree 32 must be honored and the first step toward autonomy must be taken on the occasion of completion of the URW projects.

6.8.2.2 Accounting

When the URW projects are implemented, this department will have to cope with the work-load associated with large expenditures. The UNDP/IBRD finance/accounting advisor must be given authority to manage the work.

Management, cash flow and banking divisions are set up in the department.

The management division is in charge of administrative matters of the department, and financial records/reports/statements, accounts payable and receivable, maintenance and disposition of solid and liquid assets.

The cash flow division handles all cash flows, internal as well as external, such as payment on contracts and revenue from customers.

The banking division handles all transactions between the PPWSA and banks.

The department is also responsible for assisting the assistant director in preparing the budget plans and budgetary auditing.

6.8.2.3 Stores

During the implementation of the URW projects and after their completion, this department will have to accept, stock, supply and perform inventory-control of a huge amount of materials and goods. The U.N. volunteer experienced in store management must be given authority for managing them.

Two divisions, namely management and procurement divisions are set up in the department.

The management division is in charge of administrative matters of the department and most of the above mentioned work except acceptance of materials and goods.

The procurement division is responsible for checking the quality and quantity of delivered materials and goods before acceptance. The staff shall have a working knowledge of contract documents.

In the PPWSA compound at Phum Prek, many pipes and valves which will not be used in future are occupying space. Selling them and clearing the site will be the first necessary step.

6.8.2.4 Administration

After the general election, the new national assembly will prepare the new constitution which will bring about many changes in the existing administrative structure and procedures. In addition, restructuring the PPWSA, as planned and proposed herein, will also require a great deal of administrative work.

This department has to cope with these changes.

Four divisions, management, legal, real estate and transportation, are set up in the department.

The management division must design inter-departmental procedures for processing documents beside administrative matters of the department. All records will be kept and maintained by this division.

The legal division must prepare legislative and administrative approaches and processes for establishing the PPWSA as an autonomous public enterprise, under the framework of the new legislation and administration. Besides, it must design internal regulations to define the duties and responsibilities of each department/division. The UNDP/IBRD expert is assigned to devote himself to building the institutional structure and regulatory framework, in cooperation with this division.

The real estate division shall take immediate action to check the PPWSA properties.

Effective management of vehicles by the Transportation division helps the performance of units and staff in the implementation of the URW projects.

6.8.2.5 Personnel

For successful implementation of the URW projects, normal operation and maintenance of the completed facilities, and improvement in administrative and financial capabilities enabling autonomy for PPWSA is important. The importance of personnel management and training of PPWSA staff and employees also cannot be over-emphasized.

The UNDP/IBRD expert is assigned to this department for preparing a master plan of the human resources development.

Three divisions, management, personnel and training, are set-up in the department.

The management division, beside administrative matters of the department, must maintain all employees' personal history, evaluate their performance, recommend promotion/demotion and incentives/sanctions, plan organizational reforms, etc.

The personnel division is responsible for recruiting new employees, preparing evaluation and recommendation procedures, planning salary and bonus systems, etc.

The training division shall be the key unit in planning training programs, selecting trainers and trainees, monitoring progress, evaluating effects and utilizing them for personnel management.

6.8.2.6 Relocation of Redundant Employees of Non-technical Units to Technical Units

Down-sizing of non-technical units can be made possible in two ways:

1) Standardization of Formats

At present, official documents to be used for similar purposes, for instance organizational charts, are made in many different formats, probably because they were written mostly by hand and copying documents by machine is not much prevalent.

To improve the situation, a certain number of formats to be used commonly in the PPWSA will be standardized and the standardized formats will be printed for common use.

A great deal of manpower input in handwriting will be saved.

2) Use of Computer

As the JICA team found, computers were not even used for technical and engineering matters, let alone for non-technical purposes.

Coupled with the standardization of formats, the use of computers for processing financial and administrative documents as well as customer service data will reduce the present work volume drastically.

For example, by using computers, sequential work of meter reading, billing, money collection will be processed far more easily and more quickly than before and the number of people engaged in the work can be reduced.

By the down-sizing of non-technical units, about one third of the present 152 employees could possibly be reduced.

3) Estimated Increase in Technical Units

As listed in Table-6.3, all of the production, distribution, and customer service departments as well as the technical offices (Chief Engineer's Office in Fig-6.2) need staff expansion.

Estimates of additional employees needed are as follows:

a) Production (Water treatment plants)

For 150,000 m^3/day production at the Phum Prek Plant, the existing 39 employees will increase to 46 and for 20,000 m^3/day production at Chamcar Morn Plant, and the present 23 employees will be increased to 27.

The increase for production is thus 11 persons.

b) Distribution (Network Office)

As described before, normal operation of controlling valves to regulate pressure and flow has not been carried out, as the supply pressure is extremely low and there are few operable valves.

Normalized operations will involve valve control, leakage detection and repair, pressure data collection and preparation of distribution networks maps.

As 26 of the 42 networks are engaged in house connection and meter installation, they will be reassigned to do the above mentioned jobs.

For distribution, no increase is deemed necessary.

c) Customer Service

This unit does not exist presently.
Technical jobs in the normalized operation are:

a) maintenance service of the existing 25,000 connections plus new ones.
b) installation of 25,000 meters for the present and new connections,
c) making new customer connections at a rate of 3,000 to 4,000 per year,
d) detecting and dealing with illegal connections and leakage.

Nine (9) employees of the exploitation department and 16 employees of the revenue collection department, engaged in customer service-related work will be transferred to this department and 25 more employees will be recruited from the non-technical units.

Altogether, the increase will be 50 persons.

d) Chief Engineer's Office (Technical Office)

The present staff of 20 persons including professionals and less qualified staff, is too small. 15 more persons will be needed as assistants for engineers and technicians.

The increase is 15 persons.

e) Summary

The estimated increases in the number employees in technical units are summarized as follows:

Unit	Present	Increase	After URW
Production	67	11	78
Distribution	42	0	42
Customer Service	25	25	50
Chief Engineer's	20	15	35
Total	154	51	205

4) Decrease and Increase in Staff of Non-Technical Units

Presently, 25 employees of administration, 22 employees of finance, 39 employees of revenue collection and 50 employees of exploitation, altogether 136 employees are engaged in non-technical jobs.

By undertaking staff-reduction measures, the present 89 employees for meter reading, billing and revenue collection will be reduced by 30 % or 27 persons. The remaining 62 persons will be relocated to the customer service unit to do the same job.

The newly founded non-technical units-accounting, stores, administration and personnel inheriting most of the existing staff, shall be subjected to the change given below:

Unit	Present	Increase	After URW
Accounting (Finance)	22	- 5	17
Stores	0	12	12
Administration (Admini.)	25	- 5	20
Personnel (Admini.)	0	15	15
Exploit'n & Revenue	89	- 27	62
Total	136	- 10	126

From the two tables, the total will be 331 employees, with an increase of 41 employees . The technical and non-technical employees will be 205 and 126 respectively. The numbers are given in Fig-6.9.

The training programs shall take into account the relocated personal, as they will have to be familiarized with their new jobs as soon as possible.