Chapter 9. Drainage, Sewerage and Sanitation Systems

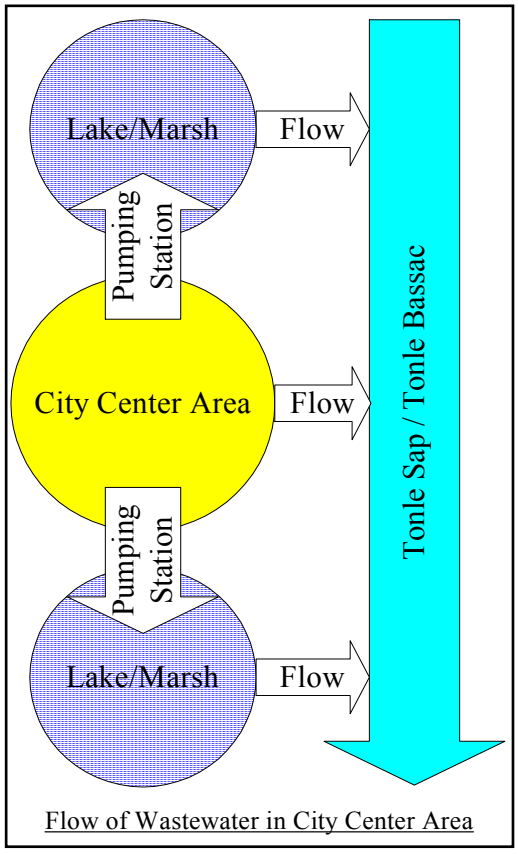
Chapter 9. Drainage, Sewerage and Sanitation Systems

This chapter presents the results of the survey conducted by the Study Team on the existing drainage, sewerage and sanitation conditions in the Study Area.

9-1 Outline and Zoning of Drainage and Sewerage Systems in the Study Area

In terms of drainage, sewerage and sanitation systems, the Study Area can be divided into the City Center Area (37 km^2) and the Outskirts Area (451 km^2).

The City Center Area of the Municipality of Phnom Penh (MPP) is composed of five areas as shown in Figure 9.1 and Table 9.1. The City Center Area developed as a series of polders linked to the natural levee, protected from flooding by artificial ring dikes. The drainage system in the City Center Area carries both wastewater and rainwater via a combined sewer network to drainage channels ending in lakes and marshes that serve as natural retention basins. Generally, pumping stations drain wastewater and rainwater to the outside of the dikes.



Flow of Wastewater in City Center Area

The Outskirts Area of MPP is composed of seven areas as shown in Figure 9.1 and Table 9.1. Drainage channels drain wastewater and rainwater from these areas into lakes and marshes or directly into rivers by gravity flow.

The present conditions of drainage facilities, land use, land development and inundation are described in the Supporting Report (SR-6.1).

Table 9-1 List of Drainage and Sewerage Area

City Center Area (37.1 km^2)			Outskirts Area (450.9 km^2)		
No.	Name	Area	No.	Name	Area
1	Trabek Area	12.5 km^2	1	Pochentong Area	16 km^2
2	Tumpun Area	17.5 km^2	2	Northeast Area	41 km^2
3	Tuol Kouk Area	3.8 km^2	3	Northwest Area	87 km^2
4	Boeng Kak Area	2.1 km^2	4	Southeast Area	56 km^2
5	Wat Phnom Area	1.2 km^2	5	Southwest Area	136 km^2
			6	East Area	83 km^2
			7	Preak Pnov Area	31.9 km^2

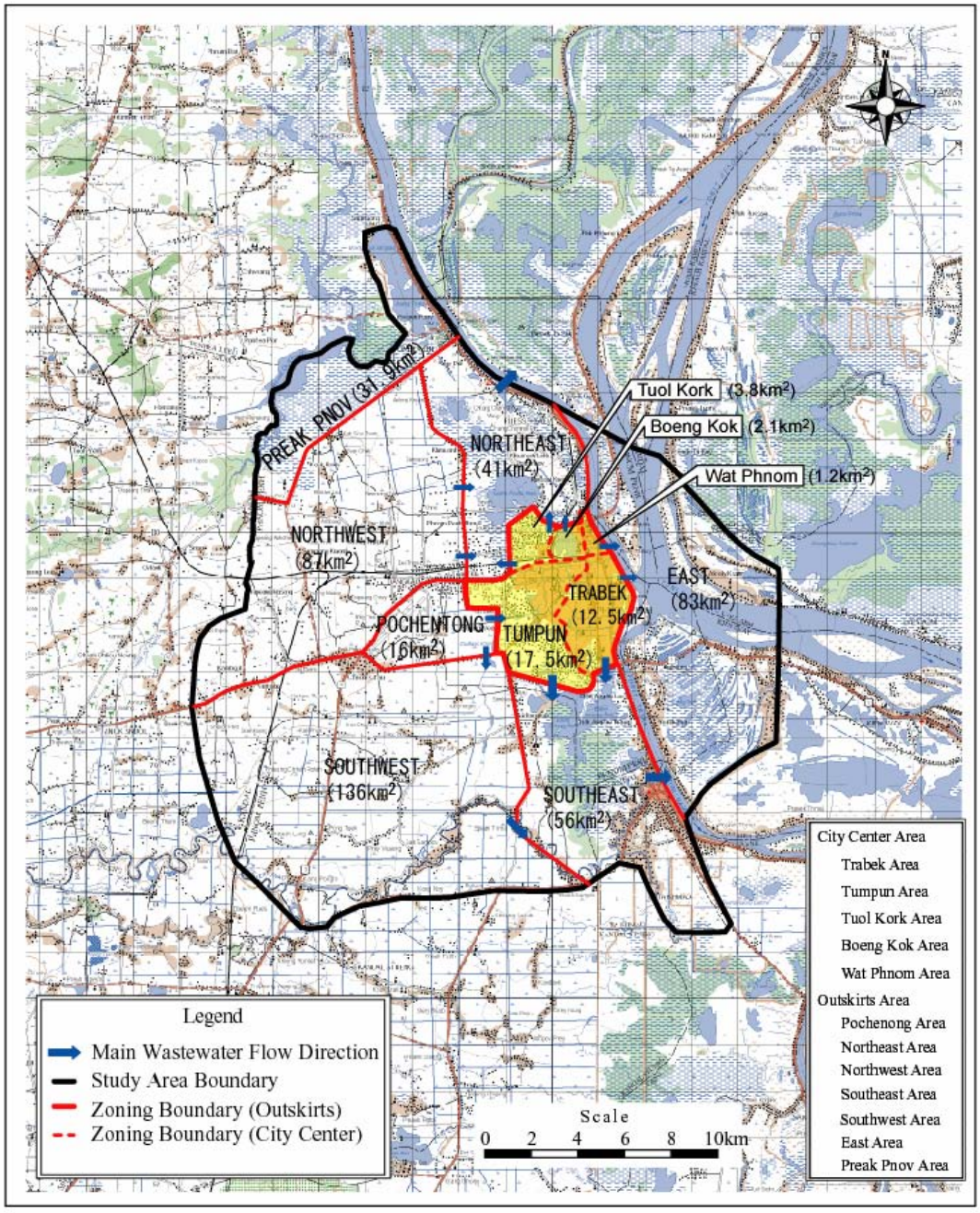


Figure 9-1 Zoning for Drainage and Sewerage System

9-2 Geodetic Survey on the Present Condition of Lakes and Marshes

9-2-1 Survey Location of Lakes and Marshes

There are two areas of extensive lakes and marshes (hereinafter referred to as “Lakes/Marshes”) in the Study Area that act as purification ponds for wastewater discharged from urban MPP.

Therefore, the detailed surveys of lakes/marshes, such as image analysis and bathymetric survey, were focused on lakes and marshes in the northeast and southeast areas. These lakes/marshes are defined as follows:

- Lake/marsh in northeast area (hereinafter referred to as "North Lake/Marsh") consists of Boeng Poung Peay, Boeng Reacheaksei, Boeng Kbal Damrei and Boeng Veaeng.
- Lake/marsh in southeast area (hereinafter referred to as "South Lake/Marsh") consists of Boeng Cheung Aek and Boeng Andaer.

Field surveys and analyses of satellite images were carried out to survey the pace of land reclamation and establish the present conditions of the North and South Lakes/Marshes. Their areas and volumes were determined based on the survey results. The current volumes of the North and South Lakes/Marshes were surveyed by conducting a bathymetric survey.

The survey results will be utilized to evaluate the purification ability of the North and South Lakes/Marshes.

9-2-2 Image Analysis and Swamp Area Survey

(1) Satellite Image Analysis

Analysis of SPOT 5 satellite imagery, taken in November 2004 and January 2003, was carried out for the North and South Lakes/Marshes. Lake, marsh, lands and fishponds were identified and each area was measured through image analysis. The results of the image analysis are described in the Supporting Report (SR-6.2).

(2) Swamp Area Survey (Bathymetric Survey)

In January and February, 2005, a bathymetric survey with 300m meshes was carried out to identify water depth in the North and South Lakes/Marshes. The current volume of the North and South Lakes/Marshes are calculated based on the bathymetric survey.

9-2-3 Present Condition of the North and South Lakes/Marshes

Based on the results of the field survey, image analysis and bathymetric survey, the present surface area and volume of the North and South Lakes/Marshes were estimated as shown in the following table:

Table 9-2 Surface Area and Volume of North & South Lakes/Marshes

Lake/Marsh	2003 (Photo taken in Jan. 2003)	2005 (Present) (Photo taken in Nov. 2004)	
	Area	Area	Volume
North	13.3 km^2 (100%)	6.5 $km^{2\,(*)}$ (49%)	7,133,000 m^3
South	15.3 km^2 (100%)	14.0 km^2 (92%)	16,807,000 m^3

(*) Area of North Lake/Marsh in 2005 excludes isolated areas that are not considered to be purification ponds.

(1) North Lake/Marsh

The water level in the North Lake/Marsh is not affected by river water in the rainy season. Much land development and reclamation is being carried out in the North Lake/Marsh, and the surface

area of North Lake/Marsh has decreased dramatically. The surface area of the North Lake/Marsh has decreased by almost half in the past two years alone.

(2) South Lake/Marsh

The water level in this area is linked with river water levels and thus is high in the rainy season. Land development in this area is more difficult than in the North Lake/Marsh because of high water levels. Therefore, there are few land developments in this area at present. Such land developments as there are have reclaimed only a small part of the South Lake/Marsh.

9-3 Water Quality Survey for Drainage and Sewerage

9-3-1 Standards for Wastewater Effluents

The Government of Cambodia stipulated standards for effluent discharge from any source of pollution in the *Sub-Decree on Water Pollution Control* (No: 27 ANRK.BK) issued by the Council of Ministers on April 06, 1999 (Article 4, Chapter 2: Provisions on waste and hazardous discharge; and Annex 2: Effluent standard for pollution sources discharging wastewater to public water areas or sewer). This effluent standard gives allowable limits for pollutant substance discharge to "protected public water areas" and "public water areas and sewers." A translated extract of the effluent standard is provided in the Supporting Report (SR-6.3).

9-3-2 Water Quality Survey for Drainage and Sewerage Water

In February, 2005, the Study Team carried out a water quality survey for drainage and sewerage water in order to collect water quality data on drainage and sewerage facilities and investigate water pollution conditions. The water quality survey also focused on lakes and marshes in the northeast and southeast areas. The survey results were utilized to evaluate present pollution conditions and purification capabilities of the North and South Lakes/Marshes.

(1) Description of Sampling Points

The sampling areas are located in Greater Phnom Penh as shown in the figure below.

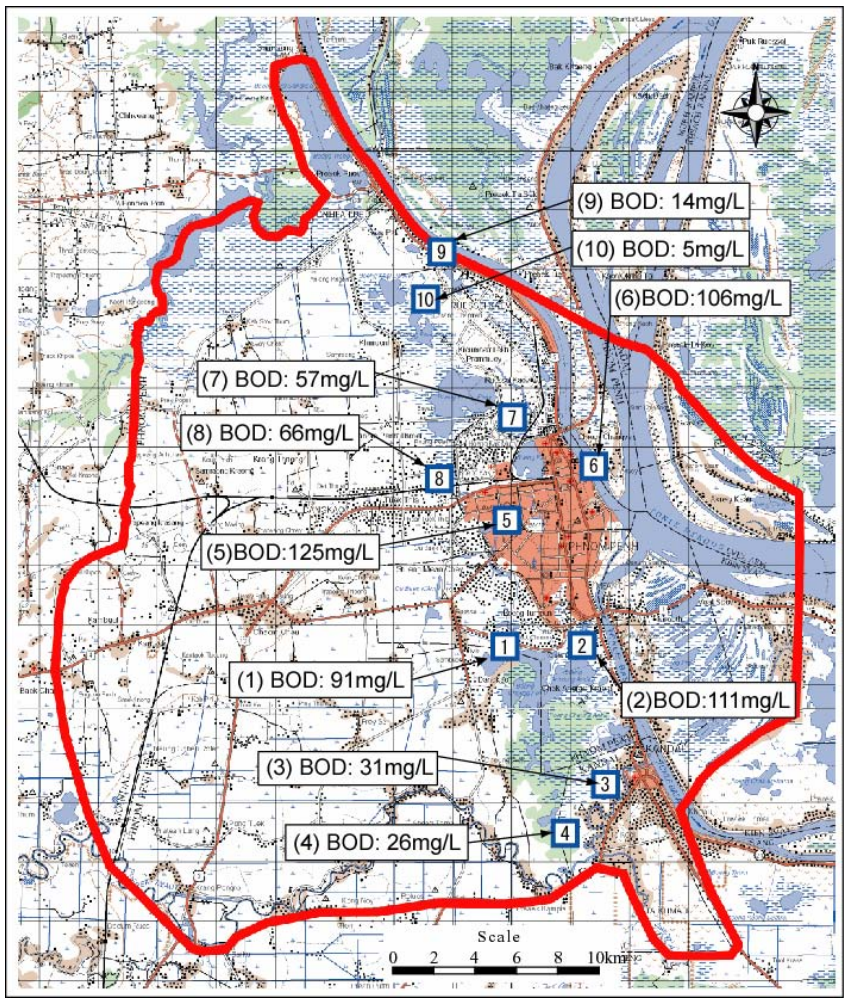


Figure 9-2 Wastewater Sampling Points

Drainage/sewerage water from public water bodies was collected at ten sampling points during February, 2005, including the inlets/outlets of the North and South Lakes/Marshes.

Table 9-3 Sampling Points for Drainage and Sewerage Water

No.	Location	Intention
1 (Tumpun)	Inlet of Boeng Tumpun Pumping Station	Inlet of South Lake/Marsh
2 (Trabek)	Inlet of Boeng Trabek Pumping Station	Inlet of South Lake/Marsh
3 (St.Chrau)	Stoeng Chrau river	Outlet of South Lake/Marsh
4 (P.Reussey)	Small creek in Prek Reussey	Outlet of South Lake/Marsh
5 (Salang)	Boeng Salang, at St.230	Marsh in urban area
6 (Ph.Chas)	Outlet to Tonle Sap, at St.108	Direct discharge into Tonle Sap
7 (T.Kork II)	Inlet of Tuol Kork II Pumping Station	Inlet of North Lake/Marsh
8 (T.Kork I)	Inlet of Tuol Kork I Pumping Station	Inlet of North Lake/Marsh
9 (Sv.Pak SW)	Svay Pak Drainage Sluiceway	Outlet of North Lake/Marsh
10 (Sv.Pak Up)	Upstream of Svay Pak Drainage SW	Lowest part of North Lake/Marsh

(2) Measurement Indices for Drainage/Sewerage Water

Each sample of drainage water was analyzed for the following 28 indices: Temperature, pH, conductivity, turbidity, color, alkalinity, oil and grease, E-coli., biological oxygen demand

(BOD5), chemical oxygen demand (COD), suspended solid (SS), sodium (Na), potassium (K), sulfate (SO4), chloride (Cl-), total-phosphorous, cadmium (Cd), cyanide (CN), lead (Pb), total-chromium (Cr), chromium VI(Cr6+), arsenic (As), cupper (Cu), zinc (Zn), iron (Fe), manganese (Mn), total nitrogen (T-N) and mercury (Hg).

(3) Results of Water Quality Survey for Drainage/Sewerage Water

The results of the water quality survey for drainage and sewerage water are summarized in the following table.

Table 9-4 Results of Water Quality Survey – Principal Water Pollution Indices

Location	Sample No.	BOD [mg/L]	COD [mg/L]	T-P [mg/L]	T-N [mg/L]
	MOE Standard (*)	**<30[mg/L]**	**<50[mg/L]**	**-**	**-**
Inlet of lake/marsh	1 (Tumpun)	91	157	5.0	22.1
	2 (Trabek)	111	165	5.1	23.4
	7 (T.Kork II)	57	74	1.9	15.8
	8 (T.Kork I)	66	129	5.8	18.2
Urban area	5 (Salang)	125	306	2.2	7.0
	6 (Ph.Chas)	106	208	1.9	21.0
Outlet of lake/marsh	3 (St.Chrau)	31	94	2.3	3.6
	4 (P.Reussey)	26	43	0.2	2.2
	9 (Sv.Pak SW)	14	24	0.2	5.9
	10 (Sv.Pak Up)	5	8	<0.1	2.8

(*)MOE Standard: "Effluent standard for pollution sources discharging wastewater to public water areas or sewers [Protected public water area]"

All samples from the lake/marsh inlets (WW1, WW2, WW7, WW8) and urban areas (WW5, WW6) exceed MOE standards for BOD and COD. All samples from lake/marsh outlets (WW3, WW4, WW9, WW10) show better quality on all indices compared with the inlets and urban areas. This finding clearly demonstrates the purification effects of the North and South Lakes/Marshes.

9-4 Water Pollution Analysis for Drainage and Sewerage Water (Present and Future)

Water pollution analysis for drainage and sewerage water was carried out for present and future conditions based on the survey results.

9-4-1 Methodology of Water Quality Simulation

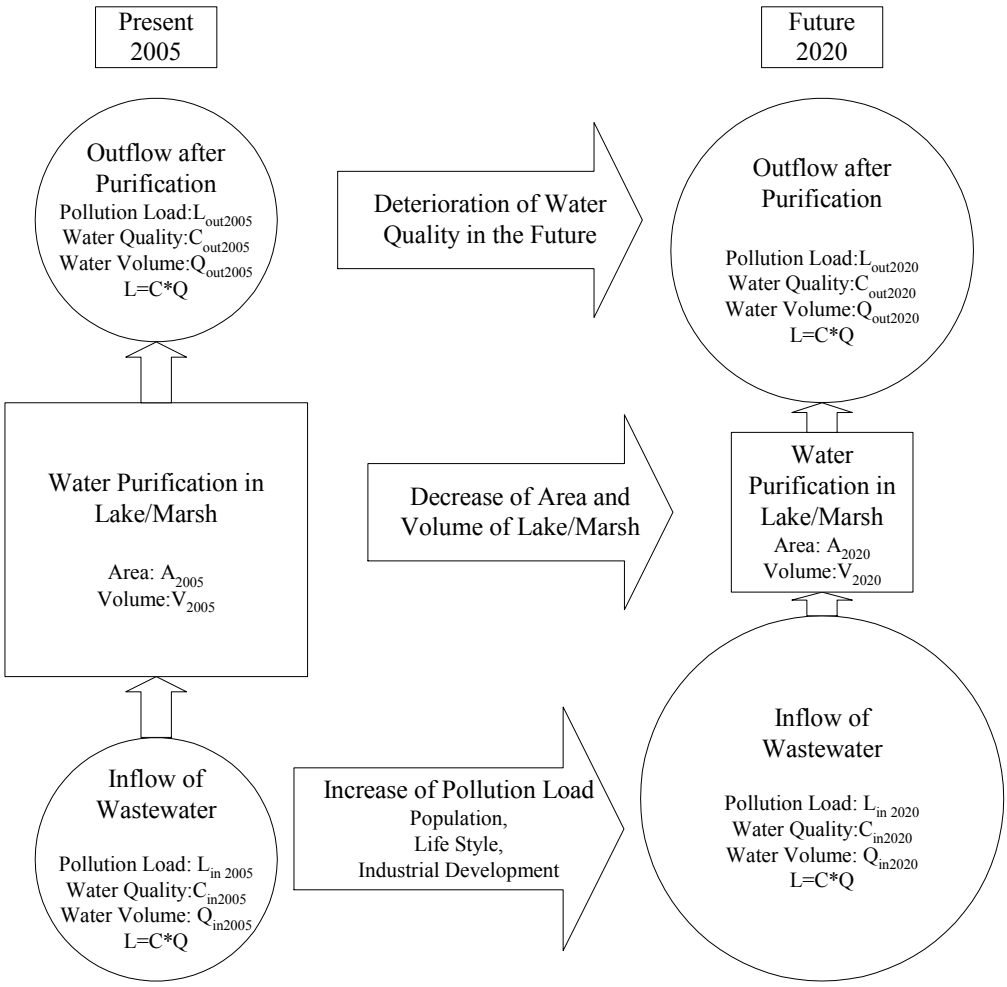
(1) Natural Purification System of Lakes/Marshes

The pollution loads generated in the city enter the North and South Lakes/Marshes by means of pumping stations and drainage channels. The pollution loads entering the North and South Lakes/Marshes are directly discharged into the Tonle Sap or Tonle Bassac rivers after the metabolic processes of the lakes/marshes treat them. The metabolic processes of the lakes/marshes include decomposition, settling on the bed, absorption by aquatic plants and release from the bed. The concentration of pollution loads in the outflow from the North and South Lakes/Marshes is decreased by the metabolic process in the lakes/marshes. The quality of

the future outflow from the North and South Lakes/Marshes is estimated considering the calculated purification effects of the lakes/marshes.

(2) Water Quality Simulation

A schematic model of the water quality simulation is shown in the following figure.



Where,

C: Water quality (Concentration of Pollution load) (mg/L)
L: Pollution load (kg/day)
Q: River flow (m^3/s) (m^3/day)
A: Area of lake/marsh (km^2) (m^2)
V: Volume of lake/marsh (m^3)

The Water Quality Deterioration Index is calculated with the following formula:

Water Quality Deterioration Index = C_{2020}/C_{2005}

Where,

C_{2005}: Water Quality in 2005 (Concentration of Pollution load) (mg/L)
C2020: Water Quality in 2020 (Concentration of Pollution load) (mg/L)

Inflow volume, inflow water quality, outflow volume, outflow water quality, surface area and volume of the North and South Lakes/Marshes under present conditions were measured by field survey. The purification ability per area/volume of the North and South Lakes/Marshes under present conditions was estimated with measured data.

In the future, inflow volume will increase due to increased water supply volume. On the other hand, area and volume of the North and South Lakes/Marshes will decrease from city growth and the purification capacity of the North and South Lakes/Marshes will decrease. As a result, outflow water quality will deteriorate in the future.

Inflow volume, outflow volume, surface area and volume of the North and South Lakes/Marshes in the future are estimated according to the water supply and land development plans. Based on these estimates, future outflow water quality of the North and South Lakes/Marshes was simulated. The parameters used in the water quality simulation were BOD, COD, T-N (Total Nitrogen) and T-P (Total Phosphorus).

The following assumptions were made in the simulation:

(a) Purification ability per area/volume of the North and South Lakes/Marshes is constant over time.

(b) Inflow water quality (concentration of pollution load) of the North and South Lakes/Marshes also remains constant.

9-4-2 Inflow and Outflow Water Quality (Present)

The quality of water flowing into the North and South Lakes/Marshes, consisting of wastewater from sewerage and drainage systems, and the quality of outflows to the rivers, are estimated based on the observed BOD, COD, T-N and T-P concentration data collected by the Study Team. Present inflow and outflow water quality of the North and South Lakes/Marshes are calculated as shown in the table below.

Table 9-5 Present Inflow and Outflow Water Quality of Lakes/Marshes

Parameter	Unit	MOE (*1)	North Lake/Marsh		South Lake/Marsh	
			Inflow	Outflow	Inflow	Outflow
BOD_5	mg/l	<30	66	14	102	30
COD	mg/l	<50	129	24	161	88
T-N	mg/l	-	18.2	5.9	22.9	3.5
T-P	mg/l	-	5.8	0.2	5.0	2.1

(*1)MOE: "Effluent standard for pollution sources discharging wastewater to public water areas or sewers [Protected public water areas]"

9-4-3 Inflow and Outflow Volume of Lakes/Marshes (Present/Future)

(1) Inflow Volume

The inflow volumes of the North and South Lakes/Marshes are estimated based on comparison of wastewater discharge volume, water distribution volume and water demand in the catchment area.

According to the results of the field survey, wastewater discharge volumes of pumping stations in the Trabek and Tumpun Area were 98 percent of water supply volume in the same areas. It is considered that the discharge rate of 98 percent includes some discharge from ground water and wastewater originated from well water. Based on this relationship, it was estimated that the inflow volume for the South Lake/Marsh is 98 percent of water demand in the same catchment area. In the same manner, it was estimated that inflow volume for the North Lake/Marsh is 90 percent of water demand in the catchment area.

(2) Outflow Volume

Outflow volume of the North and South Lakes/Marshes in the future was estimated based on comparison of present inflow water volume and present outflow volume.

According to the field survey, present outflow volume is approximately 15,000 m^3/day for the North Lake/Marsh. This outflow volume reflects a loss of inflow volume of 0.0005 m^3/day/km^2 for the North Lake/Marsh. Lost inflow volume for the South Lake/Marsh is almost the same as for the North Lake/Marsh, from which outflow volumes of the North and South Lakes/Marshes at present and in the future can be estimated.

The estimated inflow and outflow volumes of the North and South Lakes/Marshes at present and in the future are summarized in the following table:

Table 9-6 Inflow and Outflow Volume of North & South Lakes/Marshes (Present/Future)

Lake/ Marsh	Year	Water Demand in Catchment Area (m^3/day)	Inflow Volume (m^3/day)	Outflow Volume (m^3/day)
North	2005 (Present)	20,600	18,600	15,000
	2020 (Future)	57,700	51,900	50,000
South	2005 (Present)	94,200	92,300	85,400
	2020 (Future)	144,500	141,600	137,000

9-4-4 Inflow Pollution Load of Lakes/Marshes (Present/Future)

Pollution loads are discharged into the North and South Lakes/Marshes through the sewerage and drainage system. Inflow pollution loads into the North and South Lakes/Marshes are estimated based on water quality and inflow volume. Inflow pollution load is calculated by the following equation:

Inflow pollution load of Lake/Marsh: Lin = Cin x Qin

Where,

Lin: Inflow pollution load (g/day) (kg/day)
Cin: Inflow water quality (BOD/COD/T-N/T-P concentration) (mg/L)
Qin: Inflow volume (m^3/day)

Inflow pollution loads in 2020 are estimated based on the following assumptions:

(a) BOD, COD, T-N and T-P concentration (wastewater quality) in the future is the same as the present.

(b) Wastewater quantity in the future can be estimated based on the projected volume of water supply.

Inflow pollution loads for the North and South Lakes/Marshes at present and in the future are summarized in the following table:

Table 9-7 Inflow Pollution Load of Lake/Marsh (Present/Future)

Parameter	Unit	North Lake/Marsh		South Lake/Marsh	
		2005 (Present)	2020 (Future)	2005 (Present)	2020 (Future)
BOD_5	kg/day	1,200	3,400	9,500	14,500
COD	kg/day	2,400	6,700	14,900	22,800
T-N	kg/day	340	950	2,110	3,240
T-P	kg/day	110	300	470	720

9-4-5 Surface Area and Volume of the North & South Lakes/Marshes (Present/Future)

Based on the field survey and analysis of satellite images, the present area of the North and South Lakes/Marshes was estimated. The future (2020) area of the North and South Lakes/Marshes was estimated based on the land use plan of BAU.

Surface areas of the North and South Lakes/Marshes are shown in the following figures and tables.

Table 9-8 Surface Area of North & South Lakes/Marshes

Lake/Marsh	2003 (Photo taken in Jan. 2003)	2005 (Present) (Photo taken in Nov. 2004)	2020 (Future)
North	13.3 km^2 (100%)	6.5 km^2 (49%)	3.8 km^2 (29%)
South	15.3 km^2 (100%)	14.0 km^2 (92%)	9.3 km^2 (61%)

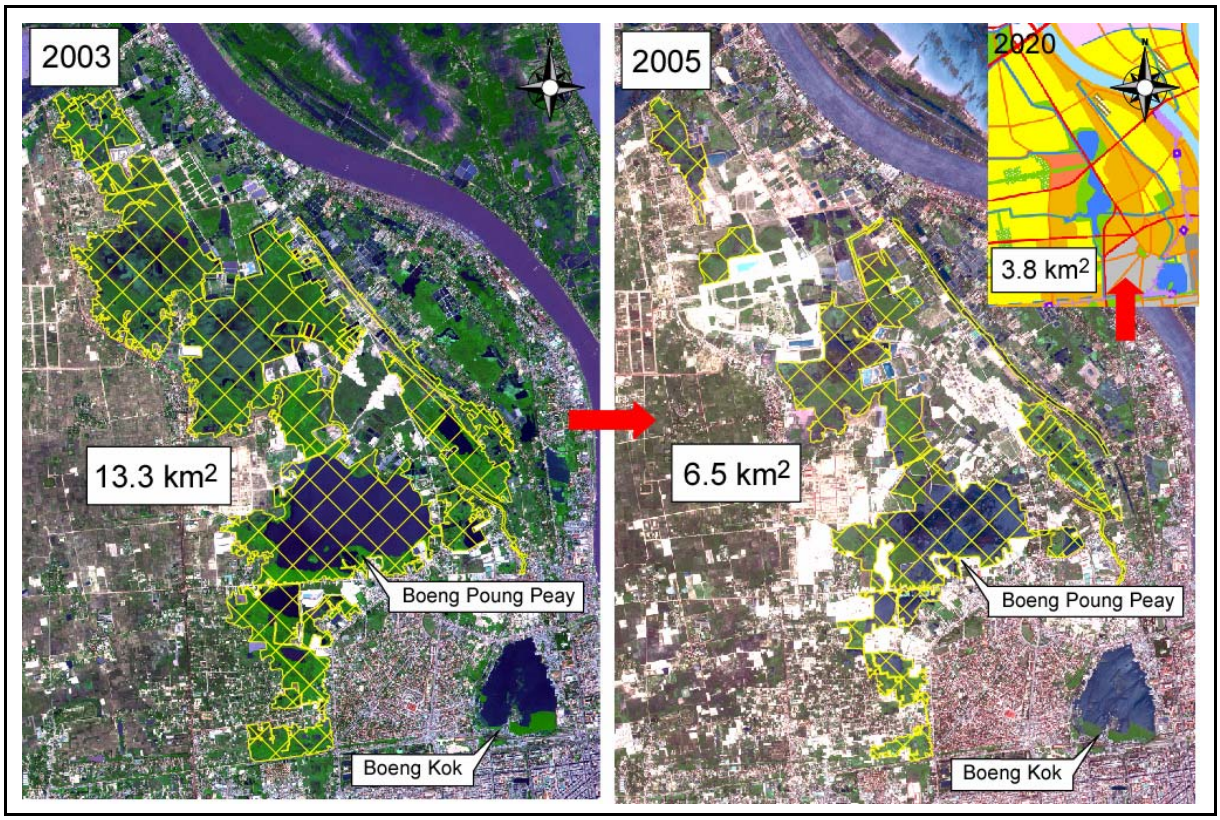


Figure 9-3 Surface area of North Lake/Marsh

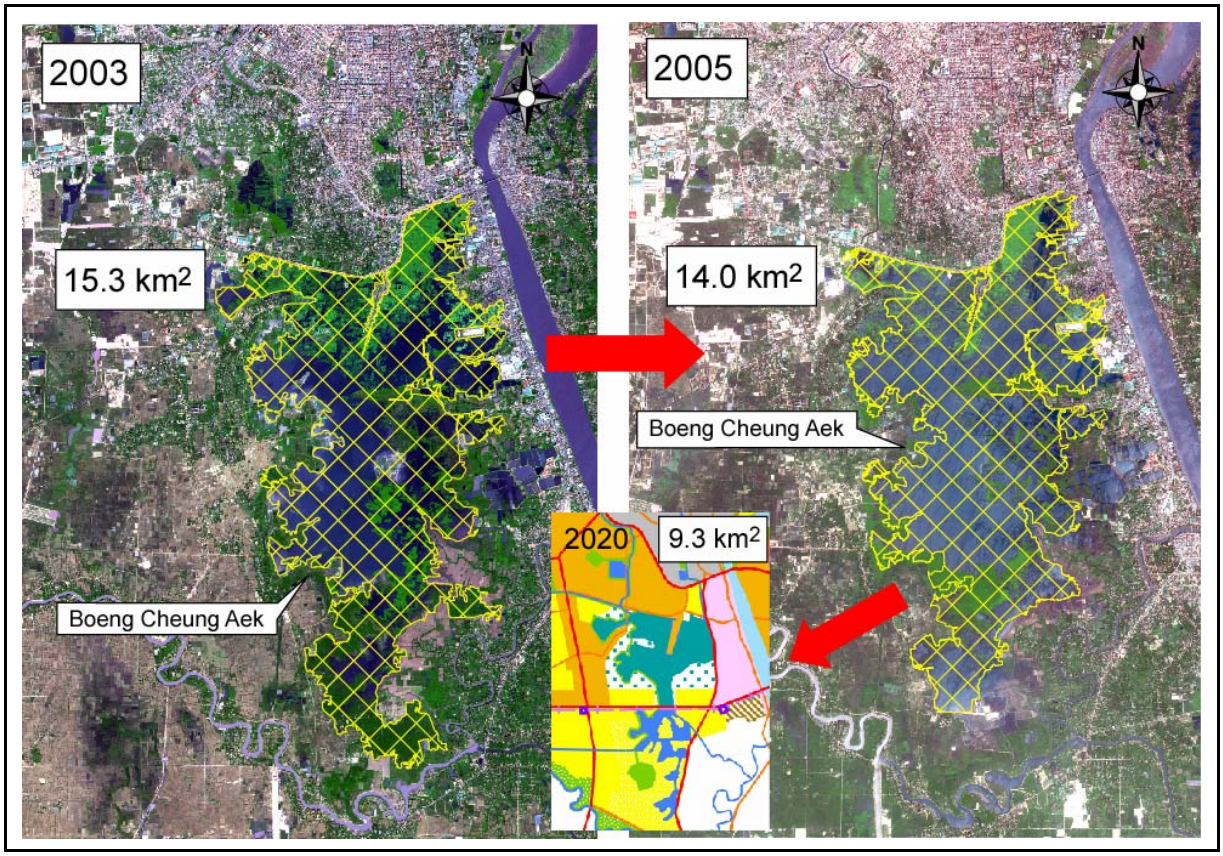


Figure 9-4 Surface area of South Lake/Marsh

Table 9-9 Volume of North & South Lakes/Marshes

Lake/Marsh	2005 (Present) (Photo taken in Nov. 2004)	2020 (Future)
North	7,133,000 m^3 (100%)	4,177,000 m^3 (59%)
South	16,807,000 m^3 (100%)	11,188,000 m^3 (67%)

The surface area of the North Lake/Marsh has decreased by almost half during the past two years. The respective surface area of each lake/marsh in 2020 will be half of the present area for the North Lake/Marsh and 66 percent of the present area for the South Lake/Marsh.

9-4-6 Simulated Outflow Water Quality of Lake/Marsh (Future)

The future quality of water outflows from the North and South Lakes/Marshes to the rivers is calculated by simulation. Details of simulations are shown in the Supporting Report (SR-7.1). The estimated quality of the outflows is shown below.

Table 9-10 Future Lake/Marsh Outflow Water Quality

Lake/ Marsh	Parameter	Unit	MOE (*)	Outflow Water Quality		Deterioration Index C_{2020}/C_{2005}
				2005 (Present)	**2020 (Future)**	
North	BOD_5	mg/l	<30	14	**57**	4.0
	COD	mg/l	<50	24	**110**	4.7
	T-N	mg/l	-	5.9	**16.0**	2.7
	T-P	mg/l	-	0.2	**4.8**	23.9
South	BOD_5	mg/l	<30	30	**72**	2.4
	COD	mg/l	<50	88	**131**	1.5
	T-N	mg/l	-	3.5	**14.8**	4.3
	T-P	mg/l	-	2.0	**3.8**	1.9

(*)MOE: "Effluent standard for pollution sources discharging wastewater to public water areas or sewers [Protected public water areas]"
Note: Underlined values exceed MOE's standard.

Based on these results, it is clear that the quality of outflow from the North and South Lakes/Marshes will soon fail to meet the MOE standard. Moreover, if the fluctuation of water quality at present is considered, outflow water quality in South Lake/Marsh may already be worse than MOE's standard.

The rate of deterioration of outflow water quality of the North and South Lakes/Marshes is evaluated based on the results above. For the North Lake/Marsh, it is estimated that the outflow BOD level will exceed the MOE Standard in 2006. In the South Lake/Marsh, it is estimated that the outflow BOD level will exceed the MOE Standard in 2010.

9-5 Flood/Inundation Control Function of Lake/Marsh in the Future

9-5-1 North Lake/Marsh (Northeast Area)

Storm water in this area, including runoff from the northwest area and northern part of the urban area, is presently drained through the Svay Pak drainage sluiceway located under NR-5 to the

Tonle Sap when the river water stage is low. In the reverse case it is just stored in the lakes/marshes in this area. Water level in this area during the rainy season is not linked with river water level but depends on rainfall.

The area of the North lake/marsh is rapidly decreasing due to land development and reclamation; it will be much smaller in the future. There is thus a high possibility of flood in the future due to lack of retention pond capacity.

Flood conditions for this area in the future are analyzed based on the following conditions:

(1) Condition of Calculation

(a) Rainfall and Evaporation

Average rainfall during the high river water stage (6 months from July to December) is 1,022 mm and average evaporation for 6 months is 644 mm.

(b) Catchment area

Catchment areas of North Lake/Marsh are as follows:

- northwest area: 52 km^2 of Agricultural land (= 60% of entire area = 87 km^2 x 60%)
- northeast area: 21 km^2 of Agricultural land, 10 km^2 of water surface and 10 km^2 of loose/mixed activity area
- Tuol Kork area: 3.8 km^2 of high residential area
- Boeng Kak area: 2.1 km^2 of water surface

(c) Runoff Volume

Runoff volume stored in the North Lake/Marsh is summarized in the following table. Rainfall runoff is calculated by formula of [(Average rainfall in 6 months) x (Catchment Area) x (Runoff Coefficient)]. Evaporation from the lakes/marshes and fishponds is calculated by the formula of [(Average evaporation in 6 months) x (Area)].

Table 9-11 Runoff Volume Stored in North Lake/Marsh in the Future

Area	km^2	Land Use	Runoff Coefficient	Rainfall Runoff	Evaporation (*2)	Runoff Volume
Northwest area	52	Agricultural land	0.05	2.7 x 10^6 m^3	-	15.0 x 10^6 m^3
Northeast area	10	Lake/marsh, fishpond	1.0	10.2 x 10^6 m^3	6.4 x 10^6 m^3	
	10	Loose activity area	0.35	3.6 x 10^6 m^3	-	
	21	Agricultural land	0.05	1.1 x 10^6 m^3	-	
Tuol Kork area	3.8	Urban area	0.80	3.1 x 10^6 m^3	-	
Boeng Kak area	2.1	Lake/marsh, fishpond	1.0	2.1 x 10^6 m^3	1.4 x 10^6 m^3	

Note: (*1) Runoff Volume = (Rainfall Runoff) – (Evaporation)
(*2) Evaporation is considered only in the lakes/marshes and fishpond

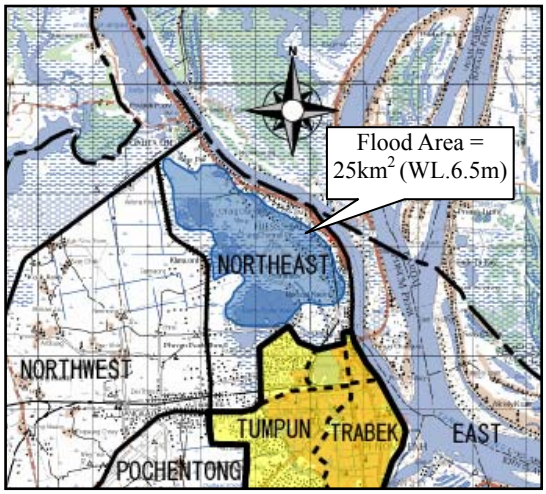
The balance between the rainfall runoff and evaporation in the lakes/marshes and fishpond, which is estimated as 15.0 x 10^6 m^3, is stored in the North Lake/Marsh and its surrounding area.

(2) Calculated Flood Condition in the Future

Assuming the water level of the North Lake/Marsh before the rainy season is 5.5 meters, based on the field survey results, the volume between 5.5 and 6.0 meters will be the storage capacity of the North Lake/Marsh. The future storage capacity of the North Lake/Marsh is approximately 3.6 x 10^6 m^3, which was calculated based on the bathymetric survey result.

The balance between the water volume and the storage capacity, which is 11.4 x 10^6 m^3 (= 15.0 x 10^6 m^3 – 3.6 x 10^6 m^3), will spread out over the surrounding area. 11.4 x 10^6 m^3 is approximately the same as the volume of the northeast area between the water level of 6.0 and 6.5 meters.

In the future, the final inundation water level will be 6.5 meters. Approximately 25 km^2 of the northeast area will be inundated to a depth of 0 to 0.5 meters during the rainy season in the future.



Once the water level of the North Lake/Marsh rises in the rainy season, it floods the surrounding areas. The water level of 6.5 meters means that water will be spread over 60 percent of the northeast area, affecting residents, houses, fishponds, etc. At present, the damage is not so serious because it is not an urbanized area. However, once this area becomes urbanized, flood damage will be serious. The storage capacity of the North Lake/Marsh is not enough to control the flooding in this area. It will be desirable to provide pump facilities in this area to prevent such inundation in the future.

9-5-2 South Lake/Marsh (Southeast Area)

South Lake/Marsh is linked with the rivers through streams. Water level in this area depends on the river water level. There will therefore be no change of flood control function of the South Lake/Marsh as a result of reclamation or land development in the future.

9-6 Recommendations for Provision of Drainage, Sewerage and Sanitation Systems

9-6-1 Control and Observation of Land Development in Lake/Marsh

A lot of land occupation, land development and reclamation is being carried out in the lakes and marshes around Phnom Penh without any authorized regulation or authorized city development

plan. It is clear those activities will seriously affect not only deterioration of the water environment but also the flood control function of lakes and marshes.

It is strongly recommended that MPP make an authorized city development plan and then monitor and control land development based on the authorized city development plan with the cooperation and support of the national level. All land development should be approved, licensed and registered by MPP. EIA procedures should be strictly applied for all land development and MPP should approve the land development applications based on EIA results. Unapproved, unlicensed or uncontrolled land development should be banned and punished under legislative measures implemented by MPP.

9-6-2 Strengthen of DPWT's Authority over Drainage and Sewerage Issue

MPP should vest DPWT with stronger authority over drainage and sewerage issues including wastewater treatment. Appropriate budget allocation with discretionary powers to DPWT and building their capacity with respect to wastewater treatment are of utmost priority.

9-6-3 Water Pollution Control

It is estimated that the BOD level of outflows from the North Lake/Marsh will exceed the MOE standard in 2006. In the South Lake/Marsh, it is estimated that the BOD level of outflow will exceed the MOE standard in 2010. If the present fluctuation of water quality is considered, outflow water quality from the South Lake/Marsh may already be worse than the MOE's environmental standard.

Water pollution control has become an urgent issue. It is recommended to take additional measures against water pollution beginning with wastewater discharged from Phnom Penh.

9-6-3-1 Water Quality Monitoring

It is recommended to carry out periodic monitoring of water quality, focusing on wastewater and monitor compliance with MOE's effluent standards. DPWT of MPP should establish a wastewater quality monitoring system in cooperation with MOE and PPWSA. Wastewater quality should be monitored periodically to confirm the status of the lake/marsh environments. Monitoring parameters should include BOD and COD. Monitoring locations should include the inlets and outlets of the lakes and marshes. MPP should allocate appropriate budget with discretionary powers to DPWT to conduct the recommended monitoring.

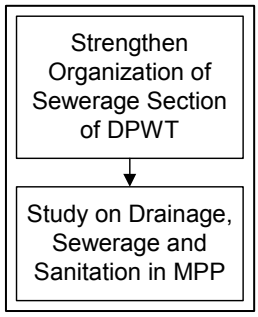
9-6-3-2 Wastewater Treatment in the Future

Considerating the land use plan of BAU, the preservation of the North and South Lakes/Marshes in their present condition is impractical. It is clear that their area and purification capacity will decrease and neither will be able to treat wastewater adequately by natural purification processes. Deterioration of outflow water quality from the lakes/marshes is unavoidable without additional

measures. In particular, deterioration of outflow water quality from the North Lake/Marsh will cause negative impacts on the Tonle Sap, which in affects water quality at the intake of the Phum Prek Water Treatment Plant.

It is recommended to preserve the North and South Lakes/Marshes as much as possible as natural wastewater purification ponds. But it is inevitable to consider measures against water pollution with additional forms of wastewater treatment. It is very urgent to study development of the sewerage system for Greater Phnom Penh.

The sewerage section of DPWT needs to be strengthened in terms of finance and technical capacity of staff first, then a comprehensive master plan –type study on drainage, sewerage and sanitation should be carried out.



A proposed sewerage system concept is shown below to illustrate measures to conserve the water environment.

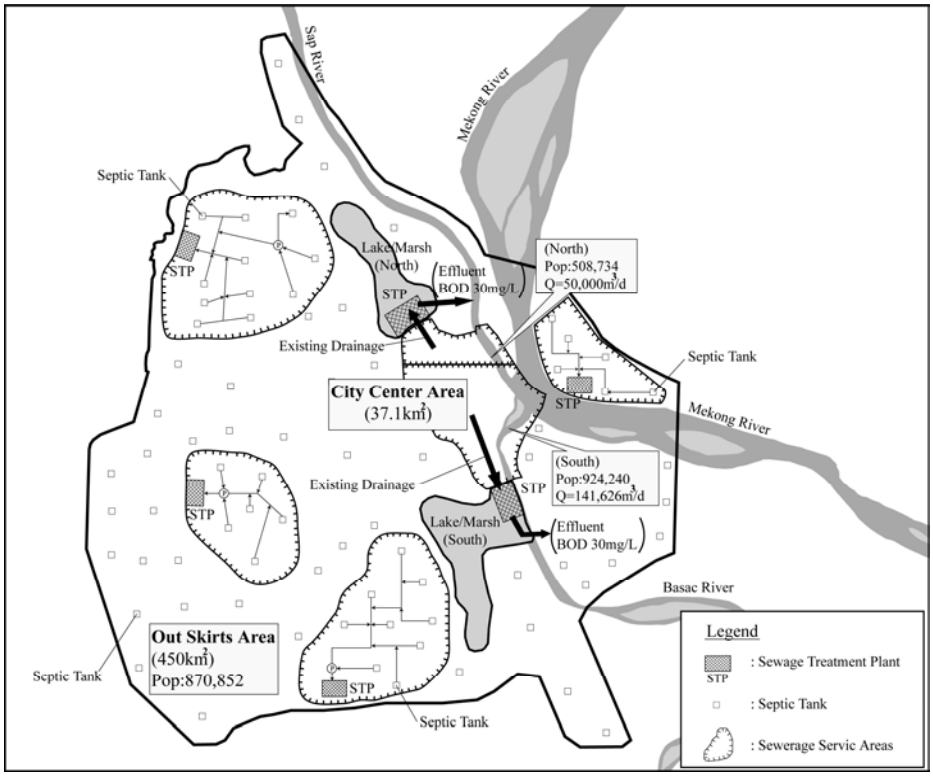


Figure 9-5 Proposed Concept of Sewerage/Sanitation System

The following research works and studies are necessary to implement planning for a sewerage/sanitation system along the lines shown in the figure above.

Study for Target Area of Sewerage/Sanitation System

- Present condition of wastewater sources and collection/treatment systems
- Present land use and land use plan in the future

- Existing drainage and existing sewer pipe
- Zoning and classification of sewerage service area
- Investment effectiveness

Study for Scale of Sewerage/Sanitation System

- Sewerage service population
- Effluent water volume from sewerage
- Securing site of sewage treatment plant

Study for Wastewater Treatment Method

- Applicable technology
- Water quality of sewer and river
- Availability of land, lake or marsh
- Operation and maintenance technique

Study for Countermeasure for Rainfall Runoff

- Estimation of inflow at the time of rain
- Water quality of sewer at the time of rain

Study for Legal and Institutional Aspects

- Existing and recommended legal and institutional framework
- Existing and required institutional capacities, institutional development plan
- Implementation modalities (public/private, central/local, community participation)
- Implementation sequencing and staging
- Financing options and strategies

9-6-4 Flood Control

9-6-4-1 Preservation of Lakes and Marshes in City Center Area

It is essential that the Municipality of Phnom Penh preserve the lakes/marshes in the City Center area, such as Boeng Trabek, Boeng Tumpun and Boeng Salang, in their present condition as flood regulation/retention ponds. Failure to preserve them may have serious consequences for flooding of residential areas. Any land development in these lakes/marshes must be banned and closely monitored.

9-6-4-2 Flood Control in Northeast Area

Storage capacity of the North Lake/Marsh is not enough to control flooding in this area. Floods will surely occur in the future. The scale of flood damage will depend on the degree of urbanization in the northeast area. It is recommended to provide a drainage system with pump facilities in the northeast area to prevent flood damage in the future.

Chapter 10. Initial Environmental Evaluation

Chapter 10. Initial Environmental Evaluation

10-1 Target Projects for Initial Environmental Evaluation (IEE)

The target projects of this IEE are listed in Table 10-1.

The Cambodian EIA procedure is explained in the Environmental Impact Assessment (EIA) chapter of the accompanying Feasibility Study.

Table 10-1 Target Projects for IEE

Master plan component		Target projects for IEE
Urban water supply development plan	Water production development	Construction of new water treatment plant
	Water transmission and distribution development plan	Construction of new distribution pipe network
Peri-urban water supply development plan		Well construction project

10-2 Alternative Analysis

10-2-1 Without Project Option

10-2-1-1 Urban Area

Without the additional water treatment plant, the daily maximum water demand will surpass the water production capacity by year 2015. (Table 10-2)

Table 10-2 Water Production and Water Demand Without Project

Year	2005	2010	2015	2020
Water Production Capacity (m^3/d)		235,000	300,000*	
Daily Ave. per capita water demand (lpcd)	80	86	95	104
Peak Day per capita water demand	104	111	123	135
Daily Max. per capita demand (lpcd)	122	131	144	158
Total population	1,529,999	1,774,891	2,034,868	2,303,826
Served population	1,035,931	1,244,738	1,491,113	1,866,102
Coverage (%)	67.7	70.1	73.3	81.0
Daily Ave. water demand (m^3/d)	133,402	166,529	209,292	271,093
Daily Max. water demand (m^3/d)	204,027	254,691	**320,094**	**414,612**
Served households	105,870	136,540	180,736	247,712
Non-domestic connections	15,517	18,729	21,640	25,011
Total connections	121,387	155,269	202,376	272,723

*: Production capacity increase by expansion of Chrouy Changva Treatment Plant (65,000 m3/d)

In such case, the following difficulties may occur to the households in Phnom Penh.

Before 2015:

1) Water pressure or supply hours will decrease during high demand (dry) seasons
2) Expansion of distribution pipes will be discouraged because of lower pressure.

3) Increase of per capita water demand will be unmet for some and inequity among the residents regarding water use will be wider.

After 2015:

4) It will be difficult for PPWSA to increase the number of connection because of the water shortage.

10-2-1-2 Rural Area

In rural areas without existing PPWSA service, residents will maintain their current condition of water supply, relying on deep wells, shallow wells, private water suppliers or water vendors.

Without proper provision of deep wells and water quality monitoring, hygiene conditions of the residents will stay poor, and arsenic poisoning may remain unnoticed.

In the areas where industrial development is underway, exploitation of groundwater by private companies is foreseeable if there is no provision for piped industrial water.

10-2-2 Alternative Sites for New Water Treatment Plant

Two aspects of water production alternatives are considered - water source and water treatment plant site.

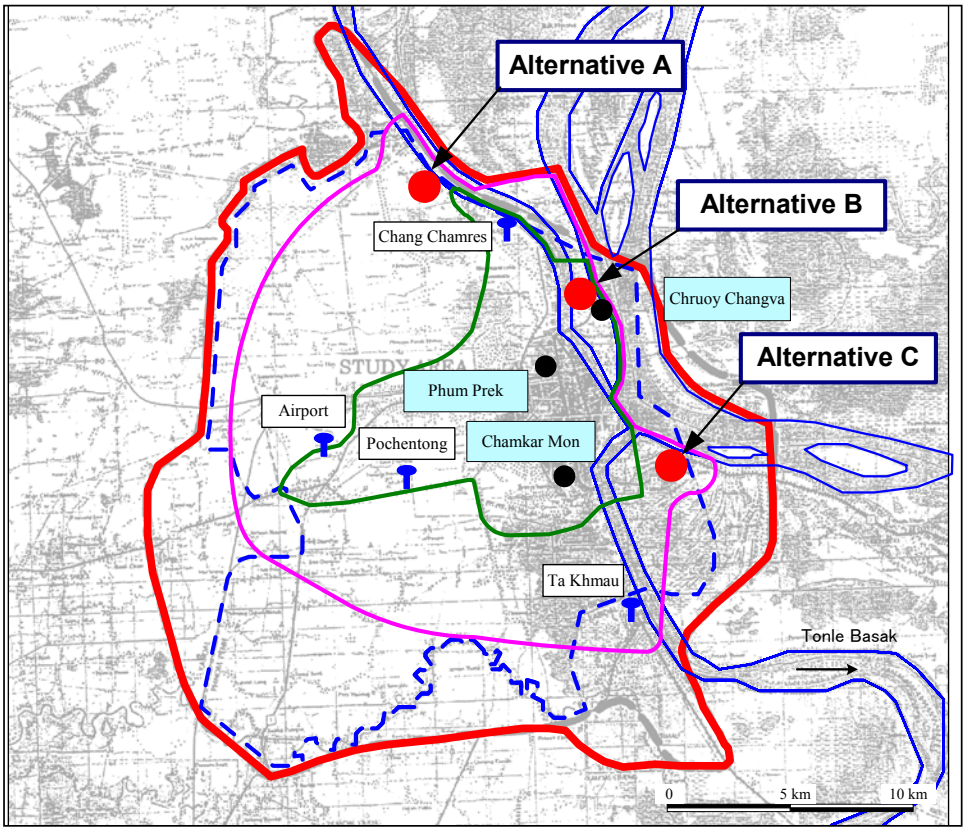
As for water sources, the Tonle Bassac cannot be an alternative because of the lack of flow and heavier contamination compared to Tonle Sap and Mekong River.

Table 10-3 Alternative Sites for New Water Intake and Treatment Plant

	Water Intake Location	Future Water Quality	Land Condition of the Area	Other Characters of the Area
Alternative A: Svay Pak	Tonle Sap	Poor	Land west of National Road is mostly used for grazing and fish ponds. River bank is developed with residential houses.	* Close to National Road 5. * Close to large village created by governmental relocation program. * Close to large scale development project and landfill site.
Alternative B: Chrouy Changva	Mekong River - Upstream	Good	Land west of National Road is mostly left as wetlands with many small landowners. River bank is used by the Navy and a ferry company.	* Close to National Road 6. * Houses of squatters are built along a branch road.
Alternative C: Nirouth	Mekong River - Downstream	Good	Land is mostly left as wetlands and some parts are used for grazing and fish ponds. Lands close to Mekong River are owned by private companies.	* Close to National Road 1.

The water treatment plant is best located close to the water source and intake station, as well as the populated area, to minimize the cost and energy consumption for transportation of the water.

Considering the above conditions, three alternative sites were selected as shown in Table 10-3, and Figure 10-1.



● : Existing Water Treatment Plant — : Current Service Area of PPWSA
— : Proposed Central Distribution System by 2020 ····· : Municipality of Phnom Penh
— : Study Area

Figure 10-1 Alternative Sites for New Plant

10-2-3 Technical Alternatives for New Water Treatment Plant

Technology used at the intake and for water treatment are assumed to be the same for all alternative sites. The amount of chemicals used for treatment will differ based on the quality of raw water source.

10-3 Scoping and Key Impacts Identified

In the process of scoping of environmental impacts (Table 10-5), ten environmental items were identified as affected by the implementation of the Plan. (Table 10-4)

Table 10-4 Key Impacts Identified

Cause of the Impacts / Affected Environmental Items	Planning Phase			Construction Phase		Operation Phase			
	Spatial Occupancy	Use of Resource	Distribution of Resource	Reclamation And Spatial Occupancy	Operation of Construction Equipment and Vehicles	Spatial Occupancy	Operation of Vehicles, Ships and Airplanes	Operation and Maintenance of Associated Facilities	Accumulation of people and Goods
The poor, indigenous of ethnic people	Y								
Resettlement	Y								
Existing social infrastructures and services				Y	Y				
Public Health Condition					Y			Y	
Noise and vibration					Y				
Waste								Y	
Water contamination								Y	
Groundwater								Y	

Table 10-5 Scoping Checklist

	Environmental Items	Evaluation	Reason
1	Resettlement	B	The M/P will attempt to minimize involuntary resettlement. Land acquisition, however, may be necessary depending on the choice of facility locations. Procedures for public land acquisition and compensation are not established in the society. The Team observed examples in news papers of speculative purchases of land and protests from the residents of the properties claiming they are not receiving proper compensation.
2	Local Economy such as employment and livelihood	C	Minor impact may occur to small shop-stalls and road-side businesses during construction works. Impact may be avoided if information is well provided to the owners about the date and duration of the construction works. Further study is necessary in the future project phase to determine the level of impacts.
3	Existing social infrastructures and services	B	In Cambodia, there is a custom of 30 m rights-of-way of NR No. 1, 2, 3, 4, 5, 6… in the town area the ROW is 20 m. The government has rights to use roadside for public purposes such as underground pipes. National Route 3 and 4 seems to have enough space reserved for such use on both side of the roads. Traffic congestion caused by road works was observed on National Route 1. National Route 2 may also have difficulty. In the Interview Survey, however, at least ten factories interviewed answered those impacts from the construction for a few weeks works would be tolerable.
4	Land use and utilization of local resources	C	Detailed information is necessary, and project site need to be decided to assess the type and level of impact.
5	Social institutions such as social infrastructure and local decision-making institutions	C	Existing community organization for well management will have great potential for communal water management in the future. Since PPWSA is transferred from municipality institution to a part of national institutions under Ministry of Industry, Mines and Energy, the Team needs to be updating information whether the transfer causes local decision making procedures. New well management organization will be formed in the target villages of the Well Development Project.
6	The poor, indigenous or ethnic people	C	No serious impact is expected by new water supply system. The Team observed one of the three resettlement housing areas in north Phnom Penh. The residents were relocated from the central city after big fires. The residents use well water. The Team would better give consideration on the best way for such communities to provide sufficient access to safe water.
7	Misdistribution of benefit and damage	C	No serious impact is expected by new water supply system, since the service will be provided to where demand exists. PPWSA must, however, closely

Environmental Items		Evaluation	Reason
			monitor in the future that low income households are provided with safe water at payable cost, and the water is distributed to those who has most difficulty in obtaining water. Those who may be affected negatively by the projects are those who are selling their piped water to neighbors. According to the Interview Survey, residents' use of private water vendor seemed low.
8	Local conflict of interests	D	No impact is expected
9	Gender	D	(positive impact is expected)
10	Children's rights	D	(positive impact is expected)
11	Cultural Property	D	No impact is expected
12	Water Rights and Rights of Common	C	The M/P proposes intake from river. Consultation with national Mekong Commission will be necessary. The proposed amount of intake, however, will be small compared with the water flow in the rivers. The Team needs to closely monitor the handling of proposed Water Law in the Parliament, and clarify necessary procedure regarding the negotiation with the national Mekong Commission.
13	Public Health Condition	B	The sanitary condition will be improved by clear water supply increase, but may impact water quality of public water bodies because the volume of sewerage water may increase in proportion to water supply. The amount of increase, however, will be small compared with the rainfall in wet season, and with the water flow in the rivers. The Team has impression that reclamation of wetlands in the city will decrease retention capacity in wet season. By the decrease, the city could be more susceptible for flooding with raw waste water.
14	Infectious diseases such as HIV/AIDS etc.	D	No impact is expected
15	Waste	B	The M/P proposes new water treatment plants, or expansion of the existing ones. In that case, proper disposal of inorganic sludge from those facilities must be taken into consideration. In Phnom Penh, large scale solid waste disposal site is under construction. This is out of the scope of the M/P, but the Team finds necessity of long term monitoring of ground water quality around the site.
16	Hazards (Risk)	B	Construction vehicles may cause traffic jam and increase of traffic accidents.
17	Topography and geology	C	Depending on the site selection for the new water treatment site, landfill may be necessary and existing low wetland may be altered.
18	Soil erosion	D	No large scale construction is expected
19	Groundwater	C	Water supply system using groundwater may be considered in the M/P. In that case, IEE may better be conducted. The Team would need to consider life span of wells, existing and planned, possibility of arsenic pollution, and measures to prevent health damage.
20	Lake/River	C	The M/P propose new intake from rivers. The volume of sewerage water released to rivers may also increase in proportion to water supply. The amount of the intake and therelease, however, will be small compared with the rainfall in wet season, and with the water flow in the rivers. No serious impacts are expected to the habitat of rivers. The wetlands in the city are used for natural treatment and retention pond. The volume of sewerage water may also increase in proportion to water supply. The Team has impression that reclamation of wetlands in the city may cause rise of water level at such wetlands in wet season. There are other ponds and lakes in the Study Area. Also, some areas are planned to be flooded by irrigation dams. These are out of scope of the M/P.
21	Sea/Coastal zone	N/A	N/A
22	Flora and Fauna	C	Depending on the site selection for the new water treatment site, existing flora and fauna may be destroyed.
23	Climate	D	No large scale construction is expected
24	Landscape	D	No large scale construction is expected
25	Air pollution	B	Construction works may occur close to settlement and social infrastructure.
26	Water contamination	B	The M/P proposes new water treatment plants, or expansion of the existing ones. In that case, proper disposal of inorganic sludge from those facilities

Environmental Items		Evaluation	Reason
			must be taken into consideration.
27	Soil contamination	D	No impact is expected
28	Noise and vibration	B	Traffic congestion, noise, and vibration may occur during the construction period.
29	Ground subsidence	D	Water supply system using groundwater may be considered in the M/P. The Team interviewed many local managers of existing wells, and did not find occurrence of ground subsidence.
30	Offensive odor	D	No serious impact is expected by new water supply system. In the sewerage and drainage section of the M/P, living condition around the existing wetlands in the city may be assessed considering that reclamation of such wetland will certainly increase, and the surrounding area would be more susceptible for flooding with raw waste water.

Reference: "Environmental Guidelines for Infrastructure Projects", JICA, 1992 (some modifications)

Note : Evaluation classification

A : Expected serious impact
B : Expected somewhat impact
C : Not clear
D : IEE or EIA is not necessary (no expected impact)
( ): Evaluation in the Preparatory Study.

10-4 Evaluation and Mitigation of Key Impacts

10-4-1 Planning and Pre-Construction Phase

10-4-1-1 Poor, Indigenous, Ethnic people

(1) Evaluation of Impacts

If there are relatively poor communities along the river bank near the water intake, the residents may be temporarily affected by the construction works.

(2) Comparison of Alternative Sites

Implementation at Svay Pak may cause the largest impact on poor and ethnic people.

Table 10-6 Comparison of Site Inhabitants

Svay Pak	The bank of Tonle Sap is densely inhabited. Impacts may be the largest compared to the other two sites.
Chrouy Changva	There are no residents on Mekong River bank in the section.
Nirouth	There are a small number of houses built separately on Mekong River bank in this section.

(3) Mitigation Measures

The selection of intake location and design of facilities must be decided to minimize the number of affected residents and significance of impacts.

PPWSA must follow proper utility construction arrangements with local community and residents regarding provision of information and excavation and traffic managements during the construction period.

10-4-1-2 Resettlement

(1) Evaluation of Impacts

Land acquisition will be necessary for new intake and water treatment plant.

(2) Comparison of Alternative Sites

Svay Pak area is the most populated among the three. Nirouth area is most sparsely populated and impacts will be the smallest.

Table 10-7 Comparison of Resettlement Possibility at Proposed Sites for New WTP

Svay Pak	The area is relatively populated compared to other two sites. Necessity of compensation arrangement for the loss of farming land may be higher compared to other two sites.
Chrouy Changva	There are a few areas populated by squatters. If the site affects their residence, resettlement will be necessary.
Nirouth	Most of the area is used as grazing land and open spaces without residents are available. Impact regarding resettlement may be the smallest among the three sites.

(3) Mitigation Measures

The selection of facility location and design of facilities must be decided to minimize the number of affected residents and significance of impacts.

If resettlement is not avoidable, PPWSA must follow proper procedures for negotiation and resettlement arrangements with local communities, individual residents and any related institutions.

10-4-2 Construction Phase

10-4-2-1 Existing Social Infrastructures and Services

(1) Evaluation of Impacts

Construction of pipes in front of social infrastructure such as schools and hospitals may affect the users of the facilities by noise, vibration, and existence of machinery and ditches.

Traffic congestion may occur at places where the width of roadside open space is not wide enough to store construction equipment and materials.

(2) Comparison of Route of Major Pipelines

Field survey was conducted to count the number of public facilities along the National Roads for the sections where main water pipe is not yet installed.

According to the results, there are a number of schools along National Road 2.

Table 10-8 Comparison of National Roads Regarding Social Infrastructure

	NR 1	NR 2	NR 3	NR 4	NR 5	NR 6
Studied Distance (km)	**3.3**	**7.2**	**10.5**	**4.0**	**5.8**	**4.2**
Kindergartens and Schools	4	10	4	2	4	2
Clinics, Hospitals and Health Centers	0	1	1	0	2	0
Governmental Office (commune/ Sangkat, district/ Khand, Army…etc)	3	5	2	2	0	0
Pagodas, Mosques	2	4	3	2	4	1

(3) Mitigation Measures

PPWSA must provide information to every affected institution about the starting and ending date of the construction work. If there is any change in work schedule, the change must also be notified to the local institutions. The work hours or holidays must be designed based on negotiation with such institutions to minimize the impacts on their functions.

To minimize the noise and vibration, construction vehicles and machinery must be properly maintained. Construction machines and materials must be stored properly to avoid accidents. Excavated ditches must be covered or the locations must be clearly marked to avoid accidents during night time.

Regarding the construction of smaller distribution pipes, PPWSA should follow regular procedure of consultation and distribution of information for the residents nearby.

10-4-2-2 Public Safety (Traffic Accidents)

(1) Evaluation of Impacts

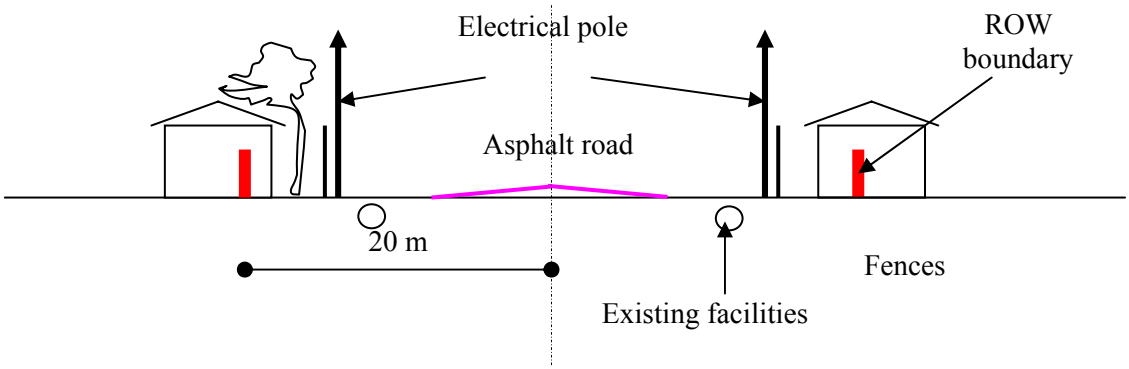
The possibility of traffic accidents may increase in the section where the width of roadside open space is not wide enough to store construction equipment and materials for construction of pipe networks.

(2) Comparison of Route of Major Pipelines

Field survey was conducted to observe the condition of rights-of-way along National Roads.

It was found that no matter the regulated width of rights-of-way, people build their house behind electric poles in most areas (Figure 10-2). Therefore, the distance between the edge of the asphalt road and the electric pole was measured along National Road sections where main water pipe is not yet installed.

Construction of main water pipe will require ditch width of about 5 m. Sections with roadside open space narrower than 5 meters were recorded. Table 10-9 explains the summary. Most roadside areas along National Roads 1, 2, 5, and 6 are narrower than 5 m. Where the open space is narrow, there will be higher risk of traffic accidents during the construction of distribution pipes.



Note: the existing facilities can be water supply pipelines, cable optic telephone lines, electrical lines, Drainages etc…

Figure 10-2 Sketch of Roadside Condition

Table 10-9 Comparison of Open Space along National Roads

	Space along the road
National Road 1	Narrower than 5 m in general.
National Road 2	Narrower than 5 m in general.
National Road 3	Wider than 5 m in general.
National Road 4	Wider than 5 m in general.
National Road 5	Narrower than 5 m in general.
National Road 6	Narrower than 5 m in general.

(3)Mitigation Measures

To avoid traffic accidents, PPWSA must use enough traffic control signs for vehicles and pedestrians at proper locations.

PPWSA must observe the local traffic condition and choose work hours and holidays so as to minimize traffic congestion.

10-4-2-3 Noise and Vibration

(1) Evaluation of Impacts

Traffic congestion, noise, and vibration may occur during the construction period due to construction of water treatment plant and pipe networks.

(2) Comparison of Alternative Sites

Svay Pak is more inhabited and the number of affected population may be larger compared to other proposed sites.

Table 10-10 Comparison of Alternative Sites Regarding Impacts from Noise and Vibration

Svay Pak	The area is relatively populated compared to other two sites. Noise impacts from water treatment plant may affect larger number of residents.
Chrouy Changva	Relatively small impact compared to Svay Pak.
Nirouth	Relatively small impact compared to Svay Pak.

Noise and vibration from the construction of distribution pipes may affect the function of public facilities listed previously in Table 10.8. National Road 2 has more schools compared to other National Roads.

(3) Mitigation Measures

To minimize the noise and vibration, construction vehicles and machinery must be properly maintained.

10-4-3 Operation Phase

10-4-3-1 Waste

(1) Evaluation of Impacts

Disposal of inorganic sludge from those facilities will increase.

(2) Comparison of Alternative Sites

No difference between the sites.

(3) Mitigation Measures

It is inevitable that a water treatment plant dispose of inorganic sludge as waste. In the long term, PPWSA must follow the proper procedures for disposal of industrial waste. In the meantime, it will be the responsibility of PPWSA as the project operator to study the amount and chemical characteristics of the sludge in preparation for proper disposal.

10-4-3-2 Water contamination

(1) Evaluation of Impacts

The inorganic sludge disposed from sedimentation ponds of existing and newly constructed water treatment plants increase the turbidity of public water bodies.

(2) Comparison of Alternative Sites

When sludge is disposed to public water body, the Tonle Sap will be affected more compared to the larger Mekong River. Svay Pak has a weakness in this regard.

(3) Mitigation Measures

In the long term, PPWSA must follow the proper procedure for disposal of industrial waste. In the meantime, it will be the responsibility of PPWSA as the project operator to study the amount and chemical characteristics of the sludge in preparation for proper disposal.

Table 10-11 Comparison of Alternative Sites Regarding Water Contamination

Svay Pak	Sludge will be released to Tonle Sap. Since the amount of water in the river is smaller than Mekong River, impact will be relatively large compared to other two alternatives.
Chrouy Changva	Relatively small impact compared to Svay Pak Site.
Nirouth	Relatively small impact compared to Svay Pak Site.

10-4-3-3 Groundwater

(1) Evaluation of Impacts

Arsenic pollution of groundwater is observed in the Study Area. Negative impact may occur if the contaminated water is used without monitoring of water quality.

(2) Mitigation Measures

As the groundwater development is included in the PPWSA Master Plan, PPWSA will be responsible for monitoring the water quality together with other related institutions. Once poisonous contamination is confirmed, PPWSA or other relevant agency must secure the termination of the use of the well.

10-4-3-4 Public Health Condition (Sanitary Condition, Indirect Impact)

(1) Evaluation of Impacts

The sanitary condition near the existing lagoon may worsen because the volume of sewerage water may increase in proportion to water supply and the area become more susceptible to flooding with raw waste water.

(2) Comparison of Alternative Sites

No difference between sites.

(3) Mitigation Measures

Appropriate coordination with PPWSA and the Department of Public Works and Transport of Phnom Penh is necessary to ensure proper management of wastewater.

10-4-4 Other Recommended Measures to Prevent Potential Minor/Temporary Impacts

10-4-4-1 Construction Phase

(1) Local economy such as employment and livelihood

Small businesses that operate on roadsides may be affected temporarily by installation of pipes. Therefore, temporary disturbance of side walks must be notified to the business owners well in advance of commencement of construction. PPWSA must provide information about the starting and ending date of the construction work. If there is any change in work schedule, the change must also be notified.

Those who are selling their piped water to neighbors would lose income if their clients decide to use PPWSA water. For the water vendors or private suppliers, PPWSA may need to open a consultation table for the business owners to arrange business plan for transitional phase before all their customers change their water source to PPWSA system.

(2) Air pollution

Exhaust gas from construction equipment may be offensive for residents nearby. To minimize air pollution, construction vehicles and machinery must be properly maintained.

(3) Water contamination

Soil erosion may occur during the landfill construction at the water treatment plant site. Eroded soil or sand may contaminate the surrounding water. Therefore, the perimeter of the landfill must be designed to avoid soil erosion.

10-4-4-2 Construction and Operation Phase

(1) Topography and geology (hydrology)

New landfill at the new water treatment site may disturb drainage of surrounding areas, which may be used as farm land. Therefore, the base and facilities must be designed after the study of existing drainage systems in the surrounding areas so the impact on existing upstream and downstream drainage systems is minimized.

10-4-4-3 Operation Phase

(1) Offensive odor

The chemicals used at water treatment plants may cause offensive odor to surrounding residents and workers at the facility. Therefore, chemicals used at water treatment plants must be handled properly to avoid occurrence of offensive odor. It is the responsibility of PPWSA that all the workers including those who transport the chemicals to PPWSA facilities must be properly informed and educated about the proper handling of the chemicals.

10-5 Comparison of Alternative Sites for New Water Treatment Plant

10-5-1 Engineering Considerations

Summary of site comparison from engineering viewpoint is shown in Table 10.12.

Table 10-12 Comparison of Alternative Sites in View of Engineering

Item	Svay Pak	Chrouy Changva	Nirouth
Water Intake Location	Tonle Sap	Mekong River Upstream	Mekong River Downstream
Future water quality	Poor	Good	Good
Construction Cost (US$ millions)	95.8	75.1	77.8
Water Treatment Plant Power consumption (Distance to network)	6.18 km/m3 (114 %)	6.28 km/m3 (116 %)	5.43 km/m3 (100 %)
Chemicals	High	Fair	Fair

10-5-2 Environmental and Social Considerations

Summary of site comparison from environmental and social viewpoint is shown in Table 10-13.

Table 10-13 Comparison of Alternative Sites in View of Environmental and Social Factors

Svay Pak	
Land Condition	Land west of National Road is mostly used for grazing and fish ponds. River bank is developed with residential houses.
Other Characters	* Close to National Road 5. * Close to large village created by governmental relocation program. * Close to large scale development project and landfill site.
Strength(s)	* Close to poor communities.
Weakness(es)	**Planning and Pre-Construction Phase:** **The poor, indigenous or ethnic people:** The bank of Tonle Sap is densely inhabited. Impacts may be the largest compared to those of other two sites. **Resettlement:** The area is relatively populated compared to other two sites. Necessity of compensation arrangement for the loss of farm land may be higher compared to other two sites. **Noise and vibration:** The area is relatively populated compared to other two sites. Noise impacts from water treatment plant may affect large number of residents. **Operation Phase:** **Water contamination:** Sludge will be released to Tonle Sap. There is sufficient water in the river that the impact will be minimal, as in the case of the other two alternatives.
Chrouy Changva	
Land Condition	Land west of National Road is mostly left as wetlands with many small landowners. River bank is used by the Navy and a ferry company.
Other Characters	* Close to National Road 6. * Houses of squatters are built along a branch road.
Strength(s)	* Environmental and social impact will be limited compared to Svay Pak site.
Weakness(es)	**Planning and Pre-Construction Phase:** **Resettlement:** There are a few areas populated by squatters. If the site affects their residence, resettlement will be necessary.
Nirouth	
Land Condition	Land is mostly left as wetlands and some parts are used for grazing and fish ponds. Lands close to Mekong River are owned by private companies.
Other Characters	* Close to National Road 1.
Strength(s)	* Environmental and social impact will be limited compared to Svay Pak site.
Weakness(es)	* Land price may be higher than Chrouy Changva site because of the proposed private development plan.

10-6 Precautions for Extension of Transmission Pipes

Roadside conditions that require special care at construction work are summarized in Table 10-14.

Table 10-14 Comparison of Conditions along National Roads in Suburbs

National Road	Public Facilities	Width of Roadside Space
NR 1	-	Narrow
NR 2	Many schools and government offices	Narrow
NR 3	-	-
NR 4	-	-
NR 5	-	Narrow
NR 6	-	Narrow

10-7 Consultation

10-7-1 First Stakeholders Meeting: Consultation with Dept. of EIA, Ministry of Environment

10-7-1-1 Date and Time

2005.5.10 10：00 ～ 11：30

10-7-1-2 Attendants

Ms. Chou Sokphany, Director of EIA, HP:012-818-078, Fax:023-212-540,

email:SokphanyChou@yahoo.com

One other staff MOE

PPWSA, Mr. Phalla

JICA Team Ms. Ide

10-7-1-3 Agenda and Discussion

(1) Introduction of the Master Plan framework

Mr. Phalla explained about the outline of the Master Plan Study and Feasibility Study.

Ms. Ide explained about the framework of the major facilities expected to be proposed in the Master Plan and Feasibility Study.

(2) Discussion on possible impacts

1) How were these two sites chosen as alternatives? Ms.Sokphany

Engineers looked at; water quality, absence of residents, proximity to locations for water demand: Ide

2) At the intake, facilities must be designed to prevent erosion of river bank: Ms. Sokphany

3) For the southern alternative, it is prefereble to limit the width of pipe construction as narrow as possible, since existing right-of-way is only about 8 meters: Ms. Sokphany

4) Residents along the street would be affected by dust and other causes. PPWSA must place proper number of signs to inform residents about the construction period and other related issues: Ms. Sokphany

5) If the water pipes cross the river, the pipes are better set underground so as to not obstruct the water flow.

Ide will inform the Engineers in the Team about your suggestions: Ide

(3)Request for comments on scoping

1) Scoping check list has already been submitted to JICA EIA Office, and JICA agreed about the evaluation. Ide is currently conducting study on selected target environment items: Ide

2) Ide asked Ms. Sokphany to review two tables and make comments on them by May 13.

Ms. Sokphany agreed.

10-7-2 Second Stakeholders Meeting: Consultation with Related Institutions

10-7-2-1 Date and Time

2005.6.6　6：00　～ 12:00

10-7-2-2 Venue

PPWSA conference room

10-7-2-3 Attendants

Various departments of PPWSA as well as government agencies concerned including Phnom Penh Municipality, and external (donor) agencies and consultants were represented as shown in Table 10-15.

Table 10-15　Attendants at 2nd Stakeholder Meeting

No.	Name	Position	Institution
1	CHIEK ANG	Deputy Director	Phnom Penh Municipality Environment Department
2	CHOU KIMTRY	Deputy Chief Public Work Affairs	Phnom Penh Municipality Department of Public Works and Transportation
3	TAN SOKCHBA	MIME	MIME
4	DIM KIMHON	Officer	Council for Development of Cambodia
5	BUN VEASNA	Officer	World bank
6	SIMKHENGLIN	DIR	Commerccal Dept of PPWSA
7	Roeun Navy	Chief of Office	PPWSA
8	Kheet Veelhiarilh	Director	PPWSA
9	LONG NARO	Deputy General Director	PPWSA

10	Res Kim Coang	AOC Dept	PPWSA AOC Dept
11	Samreth Sovithia	DIRECTOR	PPWSA Technology & Planning Dept.
12	Toru Yagi	Engineer	JICA Study Team
13	WILFRIDO BARREIRO	CKSPE	JICA Study Team
14	Iwane Misuno	NJS	JICA Study Team
15	Chito Sun	NJS	JICA Study Team
16	Peter Ide	NJS	JICA Study Team
17	T.Matsushita	UTI	JICA Study Team
18	G. Stetten	NJS	JICA Study Team
19	MENG Chan Vibal	JICA	JICA Cambodia office
20	Yamamoto Keiko	Project chief adviser	JICA Project
21	Atsushi Toyama	Engineer	JICA Study team

10-7-2-4 Presentation

In accordance with the above-mentioned agenda, the Study Team made a series of presentations summarizing the draft Interim Report. The presentations are described in the attached PowerPoint Slides.

10-7-2-5 Summary of Discussion

Questions and answers regarding environmental and social factors are summarized in Table 10-16.

Table 10-16 Questions and Answers at 2nd Stakeholder Meeting

1	Q	Ms. Yamamoto, JICA Capacity Building Team Leader: Regarding examination of 3 alternatives for WTP site and intake, were environmental impact and resettlement taken into consideration in making your recommendation?
	A	Mr. Osaka: Although the Study Team did not include an environmental expert in this meeting, we recognized this issue and are including an Initial Environmental Assessment for the proposed site.
2	Q	Mr. Chiek Ang, Deputy Directory, Environment Dept., MPP/MOE: Mekong also deteriorates during rainy season, what is the issue of water quality between the Tonle Sap and Mekong River?
	A	Mr. Osaka: Turbidity of course rises during rainy season but is not such a problem from treatment perspective, the problem for treatment is BOD and other biological and chemical contaminants associated with human activity, which are much higher overall in Tonle Sap and sometimes cause problems for Phum Prek. Mekong is a better choice of water source for new plant.
3	Q	Mr. Meng Chan Vibol, Program Officer, JICA: How to draw the line between who gets pipe service versus wells?
		Mr. Osaka: Naturally everyone would like to have piped service, but network must be extended efficiently. Policy goal is to supply safe water for all, but economy and efficiency considerations make it difficult to serve all with pipe, so well and other local source development is necessary and appropriate up to a certain level of development considering local situation. Community wells may be most likely solution but some areas could also enjoy small network.
4	Q	MIME: How about water quality and treatment of well water?
	A	Mr. Osaka: Some well sources do need treatment. JICA project studies and data are available. PPWSA may prioritize extension of CDS to areas with well water quality problem and sufficient population.
5	Q	Mr. Veasna Bun, Infrastructure Operations Officer, World Bank: Important to note regarding water quality that 65 million people live in the Mekong River Basin, growing 2% per annum, so water quality will inevitably go down. Also, some underground water is contaminated by arsenic, need to check carefully, not all laboratories are equipped to detect.
	A	Mr. Osaka: We did so some groundwater sampling and we will clearly describe this issue in the report.

10-7-3 Study of Willingness-to-Connect

An interview survey was conducted in the initial phase of the Master Plan Study to examine the willingness-to-connect of the residents who live outside of the current PPWSA service area. Two hundred households and 10 factories were chosen for interview as shown in the table below.

Table 10-17 Target Communities and Number of Samples for Non-Service Area Survey

Location	District	Commune	Number of Households	Number of Large Factories
Road No. 2	Ta Khmau	Ta Khmau	10	
Road No. 2	Kandal Stueng	Preaek Kampis	10	
Road No.2,21	Ta Khmau	Kampong Samnanh	10	2 Factories
Road No. 5	Ponhea Lueu	Preaek Pnov	10	
Road No. 5	Ponhea Lueu	Samrong	10	
Branch 5	Ruessei Kaev	Khmuonh	10	2 Factories
Road No. 4	Angk Snoul	Kamboul	10	
Road No. 4	Angk Snoul	Baek Chan	10	
RN 4	Angk Snoul	Kantaok	10	2 Factories
Road No. 1	Mean Chey	Nirouth	10	
Road No. 1	Kien Svay	Preaek Aeng	10	
Road No.1Branch	Kien Svay	Preaek Thmei	10	1 Factory
Road No. 3	Dang Kao	Chaom Chav	10	
RN.3, 4	Mean Chey	Stueng Mean Chey	10	
Branch RN.3	Dang Kao	Prey Sa	10	1 Factory
Branch 3, 4	Ruessei Kaev	Phnom Penh Thmei	10	
Branch 4	Angk Snoul	Snao	10	
Road No. 3	Dang Kao	Krang Pongro	10	1 Factory
Road No. 6A	Ruessei Kaev	Preaek Lieb	10	1 Factory
Branch 3	Dang Kao	Dangkao	10	
Total			200	10

Ninety-three per cent of the households answered that they wish their house to be connect to the PPWSA water system. (Table 10-18)

Table 10-18 Willingness to Have Connection

Yes	No	No Idea
177	14	0

Among the fourteen households that do not wish connection, 12 answered that connection fee is too expensive, 10 answered they have enough water. Two answered that the PPWSA water is bad quality. (Table 10-19)

Table 10-19 Reasons for Not-Wishing Connection (Multiple Choice)

Enough water	Bad quality	Too expensive tariff	Connection too expensive	No information	Others
10	2	6	12	0	1

When asked about how much they would pay for piped water, 67 households (35%) answered 10,000 to 20,000 Riels/month. Forty nine households (26%) answered 5,000 to 10,000 Riels/month. (Table 10-20) It seems that the households are willing to accept slightly higher cost of water compared to what they are paying now (8,292 Riels/month).

Table 10-20 Maximum Payable Amount for New Water Supply (Riels/Month)

<2000	2000 - 5000	5000 - 10000	10000 - 20000	>20000
1	21	49	67	40

About 82 % of the households did not know about the time payment system for the connection fee. (Table 10-21) Better and frequent informational campaign will help those residents to support the PPWSA projects.

Table 10-21 Do You Know about the Time Payment for the Connection Fee?

Yes	No
24	157

Factories interviewed included ones in food industry, garment industry, and machinery industry. The area of factories varies greatly. Also, the length of operation varies from 15 years (No.8) to one year (No.6). (Table 10-22)

Table 10-22 Basic Information of the Interviewed Factories

No.	Water Source	Product	Area m^2	Date of Commencement
1	D,W	Cigarette	2,400	Jan. 2000
2	D	Cigarette	7,000	Jan. 1994
3	W	Garments	3,000	Dec. 2003
5	W	Motorcycle	9,000	Jan. 1999
6	W	Sweater	30,000	Jan. 2004
7	S	Garment Washing	2,000,000	Jul. 1998
8	S	Alcohol-Wine	150,000	Jan. 1990
9	S	Garments	12,000	Jan. 1998

Water Source: P: PPWSA, D: DPWSA, W: Well, S: Surface (River, Lake)

Four factories wish to connect to public water supply. Two are against connection, and the reason is that they now have enough water. If water resource law is implemented, all factories would agree to connect to the public water system (Table 10-23).

Table 10-23 Willingness to Connect

No.	Source	Wish to connect			Reason for No Answer						Change if connected		Change if water law implemented	
		Yes	No	No idea	Enough water	Quality is bad	Tariff too expensive.	Connection fee too expensive.	No information	Other	Yes	No	Yes	No
1	D,W	1									1		1	
2	D	1									1		1	
3	W		1		1							1	1	
5	W			1	1							1	1	
6	W	1									1		1	
7	S	1									1		1	
8	S		1		1							1	1	
9	S			1								1	1	

Water Source: D:DPWSA, W:Well, S:Surface (River, Lake)

The Survey revealed that it is expected that as PPWSA extends its service, residents will take action to connect their house to the service using the existing install payment system for the connection fee. There was no large difference of the willingness between the regions. Extension of the service area, therefore, should follow the trend of urban development and increase of population in the Greater Phnom Penh area. Above consideration is included in the proposal of the Master Plan.

Increasing industries may have a negative impact in the future on preservation of groundwater resource. PPWSA is expected to play the educational role to encourage the factories to change water source in order to avoid this negative impact, once the Water Law comes to action and regulates the use of ground water.

10-8 Environmental Management Plan

10-8-1 Environmental Mitigation Plan

Environmental mitigation actions are summarized in Table 10-24 to Table 10-26.

Table 10-24 Environmental Mitigation: Planning and Pre-Construction Phase

Environmental Items	Mitigation Measures	Responsibility
(1) Poor, indigenous, ethnic people	The selection of intake location and design of facilities must minimize the number of affected residents and significance of impacts. PPWSA must follow proper utility construction arrangements with local community and residents regarding provision of information and excavation and traffic managements.	PPWSA, Supporting consultants
(2) Resettlement	The selection of facility location and design of facilities must minimize the number of affected residents and significance of impacts. If resettlements are not avoidable, PPWSA must follow proper procedure of negotiation and resettlement arrangements.	PPWSA, Supporting consultants
(3) Water Rights and Rights of Common	The PPWSA needs to closely monitor the handling of proposed Water Law in the Parliament, and clarify necessary procedure regarding the negotiation with the national Mekong Commission.	PPWSA, Supporting consultants

Table 10-25 Environmental Mitigation: Construction Phase

Environmental Items	Mitigation Measures	Responsibility
(1) Existing social infrastructure and services	PPWSA must provide information to every affected institution about the starting and ending date of the construction work. Construction vehicles and machinery must be properly maintained. The work hours or holidays must be designed based on negotiation with such institutions. Construction machines and materials must be	PPWSA, Supporting contractors

Environmental Items	Mitigation Measures	Responsibility
	stored properly to avoid accidents. Excavated ditches must be covered or the locations must be clearly marked to avoid accidents.	
(2) Public health condition (Traffic Accidents)	PPWSA or relevant agency must use enough traffic control signs for vehicles and pedestrians at proper locations. PPWSA must observe the local traffic condition and choose the work hours and work holidays to minimize traffic congestion.	PPWSA, Supporting contractors
(3) Noise and vibration	Construction vehicles and machinery must be properly maintained.	PPWSA, Supporting contractors MOE
Minor or temporary impacts		
1) Local economy such as employment and livelihood	Temporary disturbance of side walks must be notified to the business owners well in advance of commencement of construction. For the water vendors or private suppliers, PPWSA may need to open a consultation table for the business owners to arrange business plans for transitional phase.	PPWSA, Supporting contractors
2) Air pollution	Construction vehicles and machinery must be properly maintained.	PPWSA, Supporting contractors MOE
3) Water contamination	The perimeter of the landfill must be designed to avoid soil erosion.	PPWSA, Supporting contractors
4) Topography and geology (hydrology)	The base and facilities must be designed to minimize the impact on existing drainage systems.	PPWSA, Supporting contractors

Table 10-26 Environmental Mitigation: Operation Phase

Environmental Items	Mitigation Measures	Responsibility
(1) Waste	PPWSA must study the amount and chemical characters of the sludge in preparation for proper disposal.	PPWSA
(2) Water contamination	In the long term, PPWSA must follow the proper procedure for disposal of industrial waste. PPWSA needs to study the characteristics of current wastes to design proper disposal measures.	PPWSA MOE
(3) Groundwater	PPWSA will be responsible for monitoring the water quality together with other related institutions. Once poisonous contamination is confirmed, PPWSA or other relevant agencies must secure the termination of the use of the well.	PPWSA Ministry of Rural Development MOE
(4) Public Health Condition (Sanitary Condition, Indirect	Appropriate coordination with PPWSA and the Department of Public Works and Transport of Phnom Penh is necessary to	PPWSA DPWT

Environmental Items	Mitigation Measures	Responsibility
Impact)	ensure proper management of waste water.	
Minor or temporary impacts		
1) Topography and geology (hydrology)	The base and facilities must be designed to minimize the impact on existing drainage system.	PPWSA
2) Offensive odor	Chemicals used at water treatment plants must be handled properly to avoid occurrence of offensive odor. PPWSA must educate all the workers including those who transport the chemicals about the proper handling of the chemicals.	PPWSA

10-8-2 Environmental Monitoring Plan

To monitor environmental impact and effectiveness of mitigation actions, the monitoring actions listed in Table 10-27 to Table 10-29 will be necessary.

Table 10-27 Environmental Monitoring: Planning and Pre-Construction Phase

Environmental Items	Monitoring Activities	Responsibility
(1) The poor, indigenous or ethnic people	Monitor if the land acquisition was planned to minimize the impacts on residents, and if PPWSA followed proper utility construction arrangements.	MIME, Other managing committee of PPWSA, Funding institutions
(2) Resettlement	Monitor if resettlement was minimized and if PPWSA followed proper procedure of negotiation and resettlement arrangements.	MIME, Other managing committee of PPWSA, Funding institutions

Table 10-28 Environmental Monitoring: Construction Phase

Environmental Items	Monitoring Activities	Responsibility
(1) Existing social infrastructure and services (2) Public Safety (Traffic Accidents) (3) Noise and vibration	PPWSA must conduct regular on-site inspections to secure the mitigation measures are properly operated.	PPWSA, MOE
Minor or temporary impacts		
1) Local economy such as employment and livelihood	Monitor if any serious complaints are raised against the construction.	MIME, Other managing committee of PPWSA, Funding institutions
2) Air pollution 3) Water contamination 4) Topography and geology (hydrology)	PPWSA must conduct regular on-site inspections to secure the mitigation measures are properly operated.	PPWSA, MOE

Table 10-29 Environmental Monitoring: Operation Phase

Environmental Items	Monitoring Activities	Responsibility
(1) Waste	PPWSA must prepare record of study the amount and chemical characters of the sludge.	PPWSA
(2) Water contamination	PPWSA must consult with related ministries regarding the proper procedure of disposal of industrial waste. PPWSA must conduct regular on-site inspections to secure the mitigation measures are properly operated.	PPWSA MOE
(3) Groundwater	PPWSA or other relevant agencies must conduct regular monitoring of the water quality together with other related institutions. Once poisonous contamination is confirmed, PPWSA or other agency concerned must secure the termination of the use of the well.	PPWSA Ministry of Rural Development MOE
(4) Public Health Condition (Sanitary Condition, Indirect Impact)	PPWSA and the Department of Public Works and Transport of Phnom Penh together monitor the level of waste water in the lagoons.	PPWSA DPWT
Minor or temporary impacts		
1) Topography and geology (hydrology) 2) Offensive odor	PPWSA must conduct regular on-site inspections to secure the mitigation measures are properly operated.	PPWSA

Chapter 11. Institutional Development Plan

Chapter 11. Institutional Development Plan

11-1 Future Direction of the Institution (External Considerations)

PPWSA up to the present has remained tightly focused on providing water to the residents of Phnom Penh. A basic premise of the following discussion is that the core mission of PPWSA must be protected and not diluted. At the same time, there are growing expectations for PPWSA to play a role in urban sanitation for Phnom Penh City, and there are additional pressures for PPWSA to contribute to improving water supply (and possibly sanitation) nationwide. As a public and publicly-minded institution with unique strengths in service provision, PPWSA has a duty to respond to the demands of society. Both of these added dimensions, discussed below, need to be taken into consideration in relation to outlining a future vision of PPWSA.

(1) PPWSA's National Role

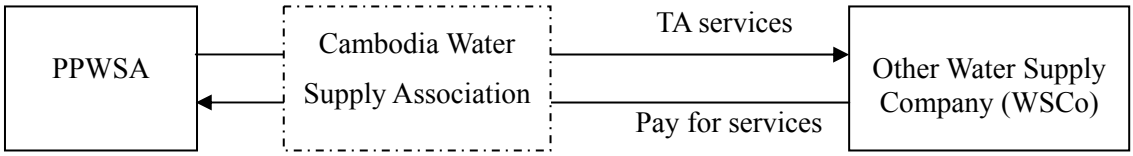
PPWSA occupies a special and unique position as the pre-eminent water services provider in the country and the supplier to the principal city and capital of the country. In terms of sheer volume alone, all of the other water supply systems in the country combined provide a low percentage of what PPWSA delivers in Phnom Penh. PPWSA is the key repository of technical and managerial expertise in the water sector in Cambodia. Therefore, it is natural that the Cambodian government, especially MIME, and the Cambodian people, have certain expectations for PPWSA to expand its role and contribute its knowledge and expertise to helping improve the conditions of urban water supply, and possibly sanitation, throughout the country. Significant sector reform and restructuring are currently under consideration in Cambodia, which will invariably impact on PPWSA and place new demands on the institution. There are many critical issues to be considered, such as speed and timing of introduction of new functions, sources of financing to ensure sustainability, structural and legal dimensions, and the objective assessment of PPWSA's capacity to respond. Assuming that the pressure for PPWSA to expand its role will ultimately become inescapable, the question then arises... how?

In the following paragraphs, a range of possible modalities are described for sharing and replication of PPWSA's capabilities to support other water services providers in Cambodia. These modalities include technical assistance, twinning, joint venture/franchising and direct management/operation of other facilities.

Technical assistance in the form of advisory and consulting services is useful for problem solving and completion of specific tasks. Provision of consulting services could even become a meaningful source of revenue for PPWSA, especially where donor/lender resources to strengthen

weaker service providers are available for services than can be competitively sourced by PPWSA (exceptions to usual donor-lender procurement rules may be required in some cases to permit PPWSA to compete with the private sector). PPWSA has considerable experience with implementation of donor/lender-financed projects and could conceivably put together teams to offer a level of project management services that would be both adequate and cost-effective for smaller projects. However, among the drawbacks to bear in mind is that such activity would entail a significant diversion from PPWSA's core function of service provider for Phnom Penh. From the other service provider's point of view, as PPWSA knows from its own past experience, consultants can bring a certain degree of useful technical expertise to bear on specific problems or the completion of particular, specialized tasks, but overall it will be up to the initiative and self-help efforts of the receiving institution to effectively utilize the assistance provided to strengthen itself.

Model 1: Technical Assistance Arrangement

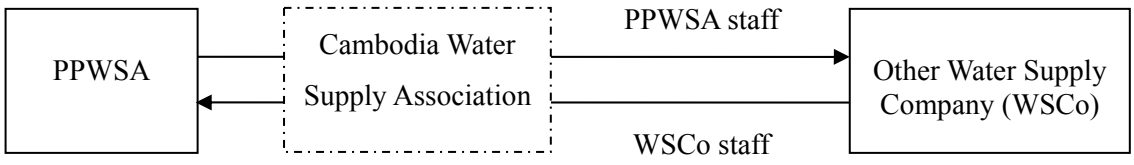


Implementation: A Technical Assistance contract is made between PPWSA and another (specific) WSCo based on clear Terms of Reference. PPWSA provides the services; other WSCo (or third party such as aid donor agency) pays for the services based on contract. PPWSA acts like a consultant providing various forms of managerial and technical improvement advice, systems and other services for fees that reflect the actual costs and quantities of the services provided (thus protecting PPWSA's financial condition). As a variation, should the concept of direct contracting prove to be difficult, arrangements may be intermediated by a proposed Cambodia Water Supply Association to which all water companies are envisaged to be members of.

Twinning is a form of on-the-job-training (OJT) in which personnel from a more experienced utility are paired with their functional counterparts in a weaker utility in order to train the latter. Twinning may take place onsite at either utility, or typically at both. Although PPWSA enjoyed a relatively successful twinning experience with an Australian utility some years ago, twinning between public utilities has limited potential over the long run due to the generally low level of commitment and accountability between the parties, at least once the novelty of working together has worn off, and the relatively high labor intensity of the process, which makes it potentially quite time consuming and expensive. Nevertheless, twinning arrangements between PPWSA and other service providers in Cambodia may be very helpful under specific circumstances, especially

where the receiving staff may lack the educational background to learn effectively through more formal classroom-style training.

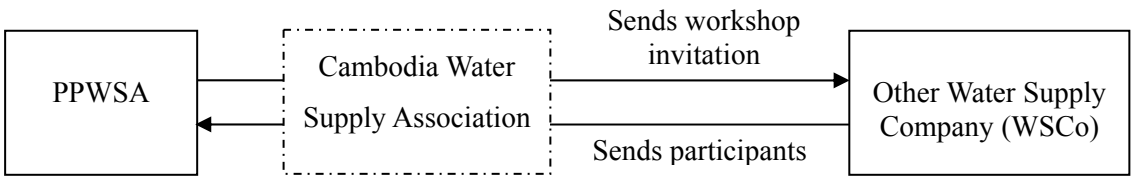
Model 2: Twinning Arrangement



Implementation: A Memo of Agreement (or Twinning Agreement) is made between PPWSA and another (specific) WSCo providing terms for the exchange of staff for the purpose of both formal and on-the-job training. During the period of exchange, staff will do actual work with the other company. Fees charged by PPWSA would again reflect the actual costs and quantities of human and other resources required to implement the specific agreement. As in model 1, this arrangement may also be intermediated and facilitated through the proposed Cambodia Water Supply Association.

As a training service provider, the PPWSA, through its Training Center (and possibly, the proposed Cambodia Water Supply Association) can extend invitations for staff of other water service providers to attend its regular training activities. With appropriate (financial and technical) external support, PPWSA's nascent, existing, internal training center could serve as the genesis for this initiative. Sources of revenue would need to be identified (e.g., tuition fees) to allow such an activity to become sustainable. This "Center of Excellence" might affiliate with other Cambodian institutions of vocational or higher learning in order to promote water sector-specific training, with general skills development courses in engineering, accounting, information technology, etc. It might also develop linkages with other relevant regional and international institutions.

Model 3: Training Organizer Arrangement



Implementation: The PPWSA, through its Training Center and the proposed Cambodia Water Supply Association, invites other WSCo's to send participants to the relevant courses organized primarily for PPWSA staff. Attendance fees may, or may not, be charged by PPWSA, as appropriate. Other WSCo's would provide for travel and accommodation expenses for their staff.

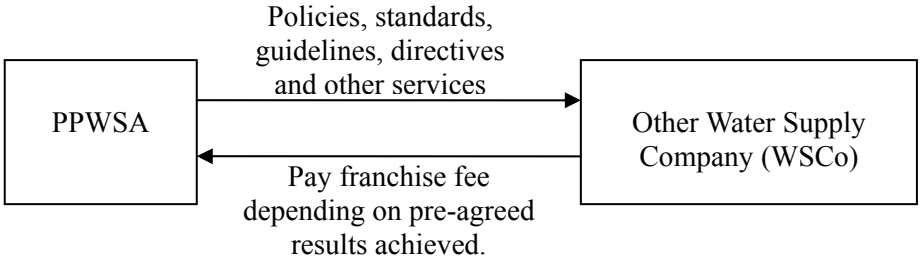
Joint Ventures and Franchises provide high levels of involvement, commitment, and risking-sharing among institutions. However, "joint venture" in its traditional sense implies a level of financial commitment to other markets that PPWSA may not be able to afford or sustain, not to mention a major distraction from its core business of serving Phnom Penh. A recent World Bank paper proposes the joint-venture-like notion of "franchising" in the water sector,[4] which could be a workable model for PPWSA replication. As the concept might apply in Cambodia, PPWSA would be the "franchisor" (think of McDonalds headquarters) and other water companies would be the "franchisees" (the hamburger shops). The other water companies could be autonomous entities under existing public enterprise law, either individually constituted or consolidated under a public holding company with a single board of directors but separate management, staff and accounts for each (sub-)enterprise. In any event, through formulas specified in the "franchise agreement," PPWSA would also have a financial stake in the provider concerned (e.g., share of "profit" or share of risk of losses) and would therefore be highly motivated to assure its success. The agreement would give PPWSA the right to intervene in management of the local enterprise under certain conditions. In addition, PPWSA would provide comprehensive assistance with establishing/developing the local enterprise and bringing it up to full operational status, including construction/project management, thorough staff training, and transfer of its own technologies and methods down to the lowest possible level of detail, including such things as procedure and operating manuals, customer information and accounting systems, software, even uniforms and other elements of "corporate culture" that have played a subtle but important role in PPWSA's own history. In some instances, PPWSA could provide additional ongoing services where the local enterprise is simply too small or remote to maintain the capacity to efficiently carry out certain tasks, such as periodic major maintenance, bulk purchasing of spare parts and chemicals, sourcing of external financing, preparation of year-end financial statements, etc. In any event, so long as the JV/Franchise Agreement remains in effect, PPWSA would closely monitor the financial and operational performance of the local system to assure that financial targets are met and service quality and efficiency standards are upheld, and it would continue to retain certain rights to intervene, if necessary.

PPWSA's contract-based monitoring of financial and operational performance standards could later be transferred to the sector regulator that is expected to be established in the future under the proposed sector law, if and when it is finalized and approved. In fact, as the key repository of such

[4] van Ginneken, Meike; Ross Tyler and David Tagg. *Can the Principles of Franchising be used to Improve Water Supply and Sanitation Services? – A Preliminary Analysis.* Water Supply And Sanitation Sector Board Discussion Paper Series, Paper No. 2, January 2004. Available online from <http://www.worldbank.org/watsan/publications.html>

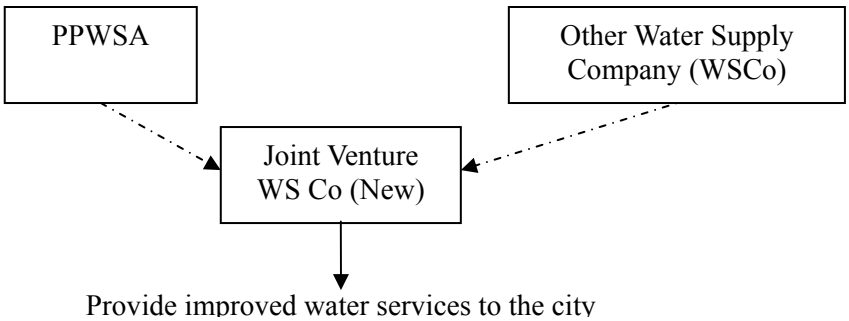
expertise in the country, it might make sense for PPWSA to begin developing an external monitoring capability that could later become the genesis, in combination with existing regulatory elements in MIME, of the new regulatory entity. In the meantime, this monitoring capacity would function as a component of a PPWSA Technical Assistance / Franchise Group that would engage in assisting other service providers along the lines of the various modalities described above.

Option 4A: Franchise Arrangement



Implementation: A franchise agreement is made between the boards of PPWSA and a specific WSCo. Under this franchise agreement, PPWSA is given the power and authority (based on previous agreement with and on behalf of the Board of the WSCo) to intervene directly in order to "protect PPWSA's reputation" and maintain the high "PPWSA service quality standards." Under a franchise arrangement, PPWSA would have a financial incentive to achieve good results but most of the risk would fall on the WSCo.

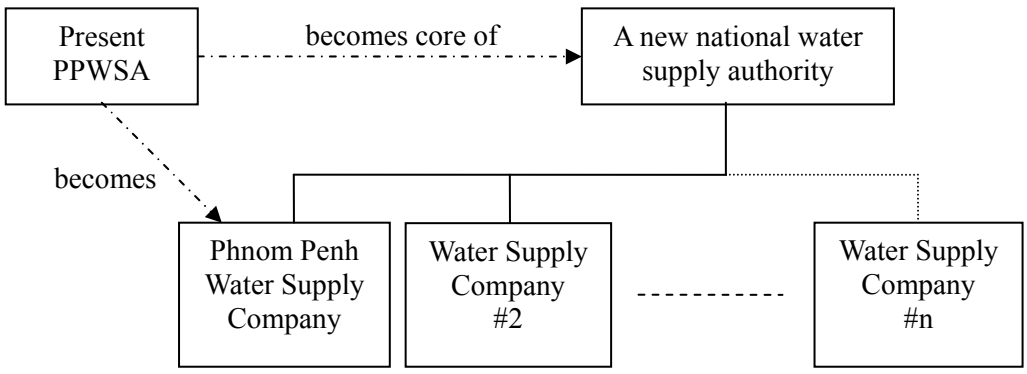
Option 4B: Joint Venture Arrangement



Implementation: The boards of PPWSA and another WSCo enter into a joint venture agreement to form a new company to manage the water services in the city. The JV company acts on behalf of the WSCo. The other WSCo continues to exist legally. It is not abolished and stays on as a partner company. PPWSA has financial commitment, risk and power in accordance with its share of the JVC and the terms of the JV agreement. [Note: other parties, like local private investors, may also be included in the JVC.]

Direct Operation or takeover of other systems entails a higher degree of risk for PPWSA in terms of diversion from its core mission and dispersion of its strength. Furthermore, such a deep level of engagement may be inconsistent with the principles of decentralization. Water and sanitation services are inherently local and enjoy limited economies of scale. In the world as a whole there are relatively few examples of successful national multi-system operators. If PPWSA is obliged to become directly involved in the operation of other systems around Cambodia, it is essential that they be treated as arms-length subsidiaries with separate accounts and personnel, even if for legal reasons they must share the same board. Consolidating subsidiary enterprises could jeopardize all that PPWSA has thus far achieved. If the subsidiaries are losing money at the outset, sources of subsidy need to be identified and transparently provided to compensate for operating losses without putting PPWSA equity at risk. There is a great danger that, once embarked on this path, PPWSA could come to be seen as the "operator of last resort" in Cambodia and would gradually accumulate responsibility for every dysfunctional system in the country, becoming itself dysfunctional in the process. On the other hand, should PPWSA voluntarily pursue what it sees as viable quasi-commercial opportunities to take over and improve existing systems or establish new ones, there is no particular reason to restrain it from doing so and trying to make a reasonable rate of return in the process. However, a separate license should be issued for each subsidiary, providing for locally relevant tariffs and service levels that accord with local conditions, demand and affordability.

Option 5: Direct Supervision Arrangement



Implementation: In the direct supervision model, a new national water supply body with responsibility to promote development of services nationwide is established to provide policy guidelines and direct supervision over all other water companies. Each water company exercises some level of autonomy. PPWSA is split into 2 bodies – one, as the national authority; and the other, as the water utility for Phnom Penh.

(2) Sewerage and Sanitation

The urban core of Phnom Penh faces a growing need for sewerage infrastructure, which should be connected to organized wastewater treatment facilities, of which there are presently none. Although the official policy has not been settled, there is some degree of inevitability in the expectation that PPWSA will eventually be brought into the field of sewerage and wastewater treatment. Some of the relevant technologies are already its area of distinctive competence and the combination of water supply and sewerage services is a commonplace throughout the world. At the same time, the challenge of providing sanitation services will require PPWSA to become larger and to gain new competencies in wastewater collection, treatment and disposal (of sludge and septage). In Cambodia, it is logical to anticipate the adoption of pond-type wastewater treatment technologies as being among the most appropriate and cost-effective solutions under the conditions. One implication worth noting in passing is that, to prepare for this eventuality, sufficient lands of suitable type and location need to be identified and acquired, preferably sooner rather than later, as the surrounding suburbs continue to expand and land values have been rising faster than inflation.

Compared with water supply, sanitation typically entails a greater and more diverse mix of onsite solutions, decentralized community systems, and centralized reticulated systems. Where appropriate, especially in outlying areas, local treatment solutions utilizing simple biological processes may prove to be significantly more cost effective than centralized systems. Distributing the costs in a manner that drives rational behavior and investment decisions can be quite complex, with the need to consider a variety of subsidy mechanisms to support local solutions. In addition, reuse options for agricultural application may be considered. Institutions other than PPWSA would be more appropriate to lead and coordinate such efforts, perhaps the Ministry of Health working with MPWT and MRD as appropriate, in any case with PPWSA focusing on those areas to be served by the primary sewage system, pumping and treatment. Policy formulation and detailed planning involving many stakeholders will be essential, including preparation of a master plan. PPWSA will need to collaborate more extensively with other concerned institutions than it presently does in the field of water supply.

(3) Privatization (through concession) of PPWSA

The Study conducted a survey on the current status of water systems of many towns and cities in 13 Asian countries which have taken up concession or BOT arrangements in recent years. A note on private sector participation is provided in the Supporting Report (SR-10.1).

By the end of 2000, at least 93 countries globally had partially privatized water or wastewater services or were in the process of doing so. Privatization has appeared in all regions of the world – in 23 countries in Latin America and the Caribbean, 20, in Europe, 30, in Africa and the Middle

East, and 17 in Asia. Private water companies now serve vast numbers of consumers. The two largest companies, Suez and Vivendi, each provide water and/or wastewater services to about 110 million people.

At present, however, many private operators, involved in BOT and concession arrangements for water supply, are struggling with existing contracts. Tariffs have had to rise to reflect the elimination of subsidies (and higher cost of operations for PSP involving multinational companies). Since the anticipated savings or increase in revenues have not, in most cases materialized. Improved access of poor to improved services has been minimal or questionable. The rate of privatization activities in Asia has, expectedly, been on the decline (since its height in the mid-1990s), except in China.

Opinions about the best management model for the water sector vary significantly. The first key issue revolves around the classification of water as a basic right versus a commodity or a service, the merits and de-merits of public sector reform versus privatization, and market pricing of water versus subsidization.

This survey offers many important lessons for Cambodia (since it is considering the promotion of concessions and BOT's in the water sector). It is important to develop the overall development strategy first and organize practical regulatory arrangements (including tariff review and adjustment procedures, operational performance standards for the private sector, environmental standards to be maintained by the private operator, including procedures, provisions and facilities for their enforcement and penalties for non compliance with covenants, etc.).

In Phnom Penh, the outsourcing and management contract options, mostly to the local private sector businesses, are most promising. This will enable PPWSA to concentrate on its core business.

At this point in its development, it is difficult to make a case for opening PPWSA for concessions and higher forms of PSP. Conditions do not seem to exist warranting such responses. Many reports have, in fact, cited that cities such as Phnom Penh, run by effective public sector water managers, can clearly provide lessons for other water undertakings in Asia.

The higher forms of PSP (concessions and BOT) may, in fact, be an impediment to achieving economic development objectives. This occurs when:

- Consumers are charged excessively in correspondence of deteriorating quality;
- Commercial considerations distort development priorities, such as service coverage to low-income urban areas;
- Guarantees offered by governments and local authorities to water multinationals reintroduce debt-like obligations;

- Multinationals' strategy subordinate investment in local water systems to cross-subsidizing speculations in other countries and sectors.

Notwithstanding the bases for each of the PSP options, it is essential to keep in mind the objectives which each should attempt to achieve. The ultimate objective should be to provide a service that is efficient and equitable. Investments have to be made in water sector infrastructure so that it is technologically modern, extensive, and without leaks and O&M problems. Secondly, PPWSA must ensure the service reaches the poorest of the poor and is affordable. Moreover, PPWSA must put in place transparent and accountable systems whereby they respond to both consumer demands and governmental regulations. Thirdly, water provision and supply must be conducted in an environmentally sound manner so as to meet the public health needs of existing and future users. Principles of conservation and preservation must also be given priority. Setting an equitable tariff structure is another challenge. Considering water to be a right, governments usually subsidize water provision or put in place cross-subsidies whereby costs borne by the poorer segments of the population are off-set and met by higher income earners. The financial management of water sector calls for effective revenue collection and timely financial investment in order to ensure it meets the growing demands and varied needs of its consumers. These objectives cannot be achieved without first having in place a water management structure which has the human and capital resources to run an efficient, responsive, and effective system. Governments have to invest human and financial capital.

This Study concludes that efficiency in water systems management does not necessarily come through private sector management. We need to take a balanced view of the success and failures of both the private-public partnership (PPP) model and the public sector model. Research has shown that water and sanitation utilities work best when they are governed with the active and constructive participation of their staff, are held accountable to consumers and elected representatives through a system of public meetings and reporting, where consumers have access to information, and where management is autonomous.

(4) Future Vision of PPWSA

In the future, a possible vision of PPWSA consists of the following elements:

- Water services provider for the Greater Phnom Penh area;
- Constructor and Operator of reticulated sewage collection and wastewater treatment systems for the core Phnom Penh City urbanized zone
- Home of Cambodia Center of Excellence (training and learning facility) for Water Supply and Sanitation Technology and Management
- Strategic Investor (franchisor/co-manager/technical assistance provider) in selected subsidiary systems serving other markets (outside of Greater Phnom Penh).

(5) Next Steps

The issues and vision described above will require more consensus building (since it involves many other stakeholders) and possibly further testing. The Study recommends that during the Feasibility Study, exploratory discussions and testing be conducted with another water authority, Siem Reap for example, to structure and implement a suitable arrangement involving some form or combination of technical assistance, twinning, training organizer, franchise, joint venture, direct supervision, or other arrangement deemed appropriate by the parties concerned. Different WSCo's may require different forms of "arrangements" depending on the situation.

11-2 Institutional Assessment of PPWSA

Notwithstanding the preceding discussion on long-run vision for PPWSA, the institutional analysis, institutional development strategy and strengthening activity packages presented under the following institutional development component of the master plan are limited to PPWSA's present functions and mission.

PPWSA's present mission, as clearly stated in its Business Plan, is to "*continuously and adequately satisfy the needs of the residents of Phnom Penh to have 24-hour per day access to clean water and to expand its coverage to the peri-urban areas and the areas bordering Phnom Penh City*."

11-2-1 Institutional Strengths and Weaknesses

The Business Plan (2004-2009) presents an identification of perceived internal strengths and weaknesses as well as external opportunities and threats facing the company. The Study reviewed this SWOT assessment and made a number of additions and clarifications resulting in the following, adopted from the Business Plan:

Table 11-1 Institutional Strengths and Weaknesses of PPWSA

Internal Factors	Strengths	Weaknesses
Management	▪ Capable and experienced leadership and management team. ▪ Plan-driven approach. ▪ Clear accountability for results and standards of performance. ▪ Transparency is important in the PPWSA "culture".	▪ Absence of a "back-up" (or understudy) system. ▪ Delegation of duties to lower levels can be improved.
Water demand and production	▪ Balanced. ▪ Sufficient water produced. ▪ New facilities.	▪ O&M procedures and standards not written and documented. ▪ Limited operation skills. ▪ Untested maintenance systems and skills.
Distribution	▪ New facilities. ▪ 100 % metered connections.	▪ O&M procedures and standards under preparation ▪ Data management and analysis can be improved. ▪ Untested maintenance systems and skills
Water loss	▪ Policies and loss monitoring program effective.	▪ Data monitoring and telemetry system is new.
Customer service	▪ Good water quality and pressure delivered. ▪ Service available 24-hours. ▪ Strong commercial orientation. ▪ Awareness of need to be financially sustainable pervades in the organization. Good public education program.	▪ Human errors in meter reading. ▪ Some low-income residents still cannot afford to connect (min of $112; equivalent to about 2-3 months salary)
Finance	▪ AMIS functioning and integrates key functions.	▪ Financial analysis skills limited.
Human resources	▪ High sense of ownership by staff ▪ Highly motivated staff. ▪ Comparatively well-compensated staff. ▪ Performance-based incentive and reward systems in place.	▪ Lack of long-term human resources development plan. ▪ Training plans still under preparation.
Information system	▪ Reliable and timely information available.	▪ Limited familiarity with information systems and information technology.

External Factors	Opportunities	Threats
National/urban economy	▪ Strong urban growth rate.	▪ Downturn in the economy will have adverse effects on PPWSA (directly) and its consumers ability to pay. ▪ Increased water supply leads to increased wastewater; environmental health risks.
Government policy	▪ Financial autonomy of PPWSA. ▪ Monopoly of service	▪ Expansion into sewerage functions or other expanded mandate without financial safeguard threatens PPWSA viability. ▪ Uncertainties with imple-mentation of formal regulatory arrangements.
Access to external finance and technical assistance	▪ Strong support from interna-tional financial institutions. ▪ Continued good reputation of PPWSA.	▪ May reduce as PPWSA has become financially viable. ▪ May reduce as rural water supply (or other social sectors) takes priority.
Consumers	▪ High all-around satisfaction from domestic and commercial and government customers.	▪ Expansion of service area lowers effective tariff.
Social	▪ Recognition of need to serve poor	▪ Pressure to exceed mandate
Electricity	▪ Good service from power supply company.	▪ Critical cost driver in PPWSA operating margin; Cam power gen depends on imported fuel; high/rising world energy costs go straight to bottom line.
Water resources	▪ Adequate volume of raw water at sources.	▪ Deterioration of raw water quality near the intakes.

11-2-2 A Framework for Organizational Growth

PPWSA is a relatively young and growing organization. Such organizations tend to move through a series of recognizable phases. One widely respected typology[5] suggests that institutions typically go through cycles of **evolution**, during which they enjoy stable growth, and **revolution**, when the accumulating deficiencies and inadequacies of the prior evolutionary period rise to the

[5] Following based on the seminal work of Larry Greiner, first presented in "Evolution and Revolution as Organizations Grow," *Harvard Business Review,* 1972.

surface, producing managerial crisis and, for the survivors, change. There is no single management style or system that is right for all circumstances, an approach that seems ideal for an organization at a certain phase in its evolution may be inappropriate when applied to the same organization in another phase. The process is dialectic in the sense that every management style sows the seeds of its own destruction; what is at first appropriate, ultimately proves inadequate in the face of evolving organizational needs arising from both internal (historical) and external forces. Such managerial adaptation may occur gradually, but more typically, a period of sustained and stable growth is followed by a relatively acute period of managerial crisis and revolutionary change, characterized by self-examination, structural reorganization and the adoption of new managerial systems and practices. The principal evolutionary/revolutionary phases thus far identified (and illustrated in the figure below) are:

- Creativity and the Leadership Crisis - ideas and creativity are the driving force. A simple entrepreneurial structure is appropriate. Eventually the organization cannot cope and a revolutionary crisis of leadership leads to a need for direction.
- Direction and the Autonomy Crisis - systems and procedures provide direction through a functional structure. However, these procedures eventually stifle creativity, which leads to a crisis of autonomy. Systems cannot cope with individuality; the way out of the crisis is through delegation and decentralization.
- Delegation and the Control Crisis - decentralized decision making gives more autonomy. People can use their own initiative to make and take decisions quickly. But when decision-makers in each unit go their own way the result is a crisis of control which leads to fragmentation. If they are brought into line through recentralization, this only exacerbates the problem back to growth through direction.
- Coordination and the Red-Tape Crisis – coordination and monitoring from the center of the organization (through a divisional structure) allow decision-makers to operate freely while the organization maintains overall control. Eventually these co-ordination methods accumulate and create a crisis of “red tape” (cumbersome bureaucratic procedures).
- Collaboration and the ??? Crisis (phase 5 and beyond not yet known – Growth through collaboration means working together in small teams to accomplish tasks. A matrix structure may be appropriate. Other crises may occur, psychological saturation for example, the process (and model) is still evolving.

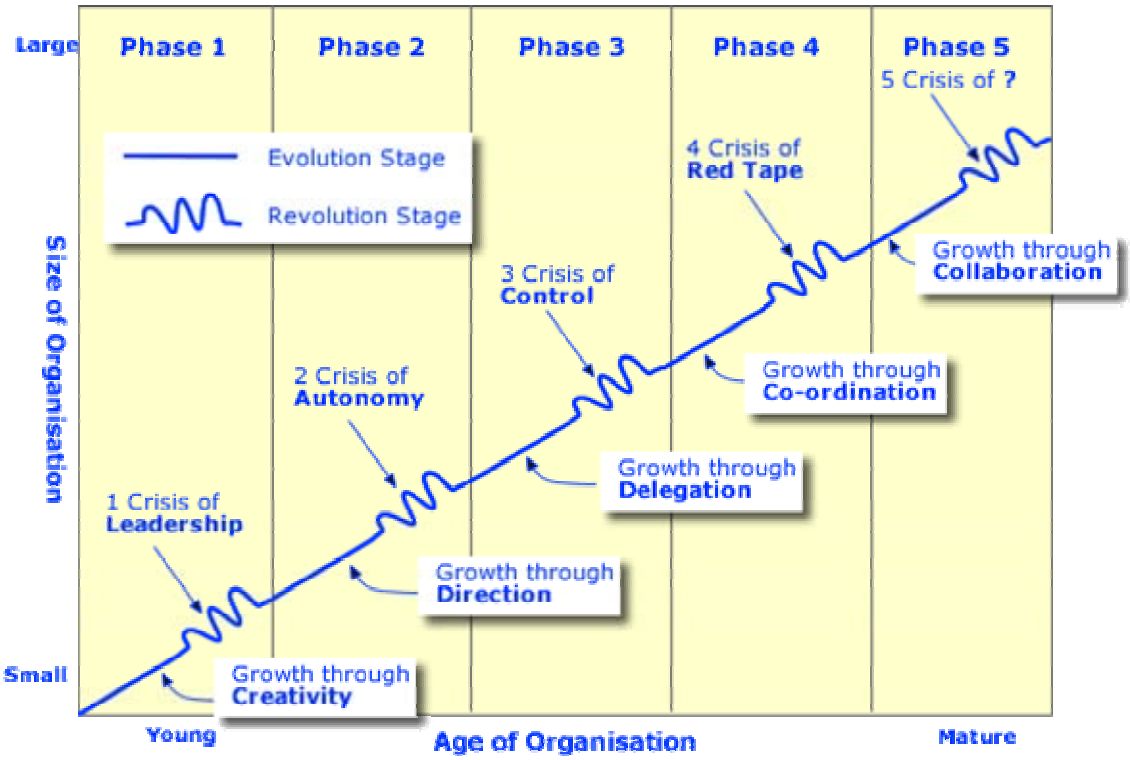


Figure 11-1 Phases of Institutional Growth

PPWSA is clearly identifiable in the early phases of this typology. The institution as we know it today is still operating under its original leadership, whose energy and vision continue to drive the organization's daily operations. Interestingly, the management style today can be fairly described as both creative and directive. PPWSA is in a sense already passing into the second phase, growth through direction. With continued effort and adequate preparation, perhaps it can avoid the crisis of leadership that would otherwise mark its graduation from the first phase. However, this remains to be seen, the issue of succession at the top of the organization is an acknowledged and unresolved concern among PPWSA supporters. In the meantime, PPWSA needs to continue its efforts to strengthen its internal management systems, develop its administrative policies and systematize its operating procedures. These are the focal elements of the Institutional Development Plan, whose central themes are sharpening organizational **direction**, strengthening management **systems** and, looking ahead, promoting more **delegation** of duties and responsibilities.

11-3 Framework and Approach for Institutional Strengthening

In order to prepare for and to move to the next stage in its growth, PPWSA needs to have a systematic framework for assessing its internal condition and for evolving a institutional development plan. The framework for Institutional Strengthening is presented as a model for how the assessment and planning for institutional strengthening can be done systematically.

The framework describes the organization in terms of key parts or elements. It suggests that organizational weaknesses are due to deficiencies in at least one or a combination of the elements. Addressing the weaknesses implies interventions into that element or combination of elements. These interventions are then compiled into an Institutional Development Plan.

This section presents the overall strategy and framework for the strengthening of the PPWSA institutional systems over the Master Plan period based on the assessments. To establish a comprehensive and integrated approach for strengthening of PPWSA, it is useful to view the strengths and weaknesses in the wider context of an organization consisting of parts or systems, as follows:

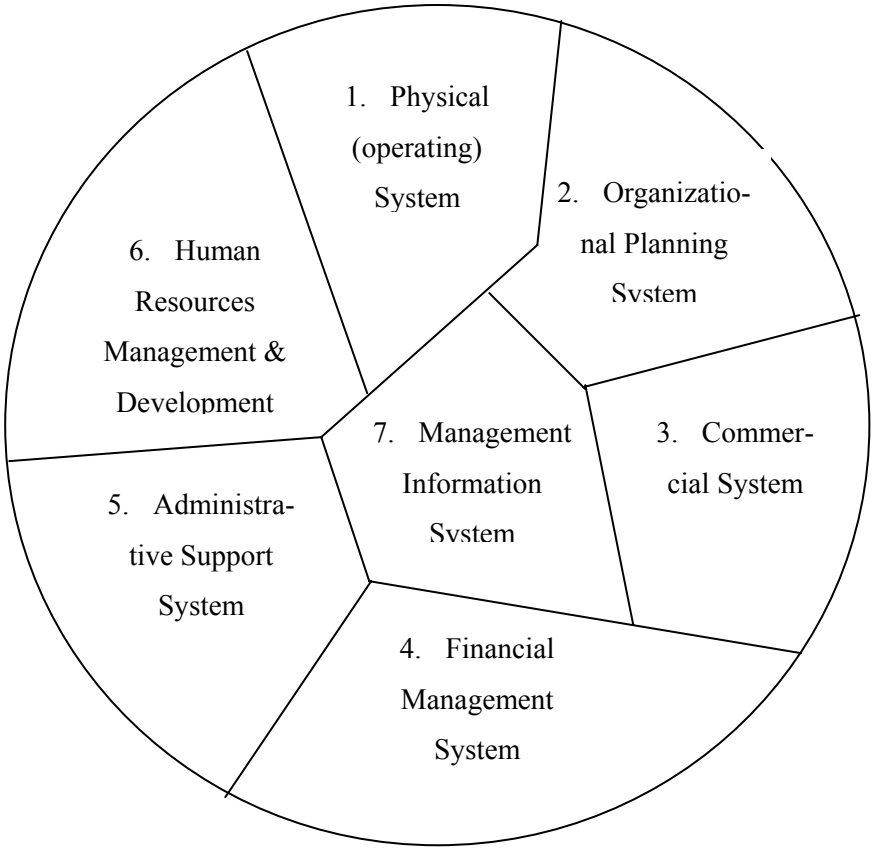


Figure 11-2 Institutional Strengthening Framework

11-3-1 Core Function – Operating/expanding the physical system

The operating system (physical) of PPWSA includes all the resources and activities needed for the preparation of technical plans and designs, implementation of construction, the operation of water supply facilities and the maintenance of installations and equipment. The operational system functions through its subsystems for design and construction management, water operation, and installations and equipment. This is the core function of PPWSA at present.

The assessment mentions that O&M systems and procedures are only partially documented and written and that major maintenance competencies in production and distribution are still largely untested since most of the facilities are still new.

11-3-2 Organizational Planning Processes

This system begins with analysis of the problems and solutions by comparing PPWSA's current services with targets set according to social, economic, environmental and regulatory policies under which it must function.

Using this frame of reference, the planning system must aim at effective accomplishment of the objectives of PPWSA in the long-, medium- and short-term. The planning system must make sure all parts of PPWSA work efficiently to meet targets so that PPWSA delivers the services (safe drinking water) required by the city. This system generates physical expansion and institutional development programs. Supported by the management information system, the planning system establishes feasibility of the objectives, plans and programs and controls their implementation.

The assessments indicate that the planning levels can be better delineated and may benefit from input from more management and staff – and even consumers, to more objectively reflect service conditions and expectations of the customers. Wider participation in the planning process will also increase the sense of ownership of the plan by the staff.

11-3-3 Commercial System

The commercial system is a strategic element for attaining the objectives of PPWSA (meeting drinking water demands within regulatory requirements). It is a tool for the promotion and sale of services and for recovery of the cost of delivering those services to the users. This enables PPWSA to be financially self-sufficient. PPWSA performs its function according to policies, standards and plans established in the light of consumer demands and official regulations. The commercial system includes subsystems related to consumption measurement (for water supply), billing and collection, consumer registration and marketing.

At present, the assessments indicate a high level of customer complaints on meter reading. PPWSA assessment also refers to “human errors” in meter reading. Tariff structuring, which is not exclusively a commercial system issue, may also need to be addressed.

11-3-4 Financial Management System

This includes all policies and standards established by PPWSA to carry out its financial tasks, together with the procedures used for recording and evaluating financial operations and reporting on their results. These activities are found in the financial administration and accounting subsystems.

The overall assessment of the financial management and control system is largely positive. The only area that may presently require some improvement is in the area of forecasting of revenues.

11-3-5 Administrative Support System

The administration support system includes four subsystems – for supplies administration, asset management, transport administration and social communication. Each of these is a virtual system within itself and is made up of a variety of smaller parts.

The *supplies administration subsystem* is PPWSA's set of policies, standards and procedures, together with goods and services, for the construction, operation and maintenance of the water supply system. It functions through stock management and control, procurement administration, and storage and distribution of materials (tools, spares, chemicals, etc.).

The *asset management subsystem* takes care of the inventory, custody and control of the property assets of PPWSA.

The *transport administration subsystem is* responsible for the management, operation and maintenance of the vehicles used by PPWSA.

The *social communication subsystem* comprises PPWSA's activities at different levels aimed at giving the community an appropriate image of PPWSA in line with senior management policy. External activities include enlisting the support and participation of the community in the preparation and execution of PPWSA's plans, while internal activities include maintaining good relations with and between the employees. Important aspects of the communication subsystem include its influence on decision-makers and on the general public. Decision-makers and politicians need to be aware of the importance of supporting financially the operation and maintenance of drinking-water supply. Many employees of PPWSA interact directly or indirectly with the public so they are also responsible for the public image of PPWSA. The professionalism, behavior and effectiveness of its staff shape the public perception of PPWSA. The public also needs to recognize PPWSA’s vital role in the urban environment and health.

11-3-6 Human Resources Management & Development Systems

This comprises all policies, standards and procedures which ensure that PPWSA has the personnel it needs at the right time and that the personnel are appropriately trained. To this end, a plan of human resources demand and supply should be drawn up. This system carries out several

key functions and responsibilities, including: job design, classification and grading, staff selection and recruitment, deployment of staff, training; administrative control of staff; and human relations activities through social welfare and benefits, work safety and workers' health.

The need for an understudy system has been highlighted by the ongoing JICA Capacity Building Project. This Master Plan study fully concurs with this finding and the proposed action. The Study suggest that the understudy (or back-up) system be designed at 2 levels – a management understudy system and a technical (specialist) understudy system. Activities should include the setting aside of a regular time (every week, say last hour of Fridays) where the lead and his understudies hold a discussion/review of experience session. The Study also suggest that the back up system should be done on at least 1:2 ratio (i.e., one lead to at least two understudies) and should avoid having a 1:1 arrangement since this unduly raises expectations that the back-up is "destined" to take over in the future. The Study further adds that the broader and longer-term issue of succession planning, particularly in management levels, has to be considered.

11-3-7 Management Information System

The management information system defines the flow of information within the organization to support the planning and decision-making processes of PPWSA, as illustrated in the figure below. Each of earlier systems produce financial and operating information and data which are fed into and processed by the MIS for management planning and decision making, as shown in the following figure. The assessment indicates that PPWSA performance can improve with better and systematic information management that cuts across the department lines. This improvement may take the form of building on and expanding applications of the existing Navision program or switching over to new software.

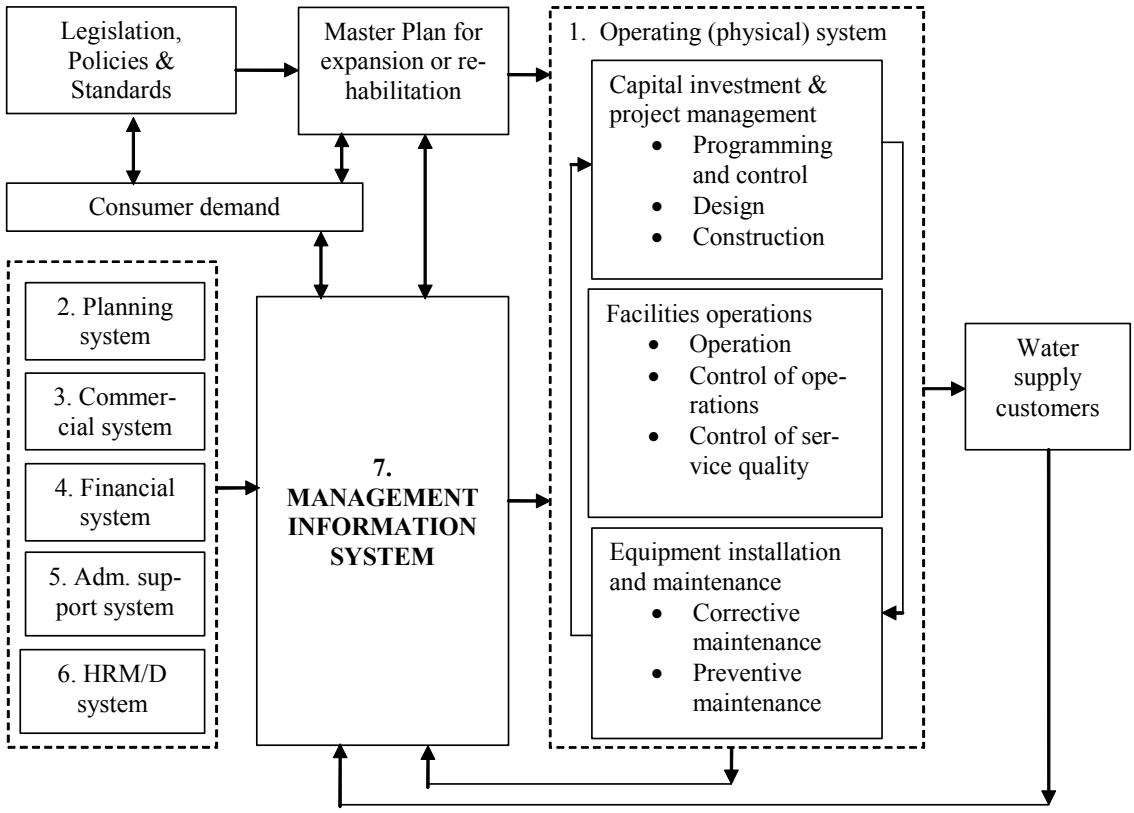


Figure 11-3 Integration of Management Information System

11-4 Framework for Human Resources Management

The basis for the human resources development is the organization design and the human resource plans. The organization design deals with the identification of the tasks, which are allocated to the departments/sections and jobs. The human resource planning goes one step further and determines the number of staff types required, inventories the available manpower, and plans for actions to resolve the imbalances.

The job design/description and job performance appraisal serve as a necessary inputs to training need assessments, by comparing the required and the actual capability of the various staff types. The gap between the required and actual capability represent the basis for training plans and programs. But, job performance not only depends on the staff ability, but on the motivation as well. Staff motivation can be enhanced through a range of incentives, such as extra pay, career opportunities etc.

In this framework for developing human resources, major attention shall be given to the following objectives:

- Further detaining of PPWSA job descriptions to include skill and competency requirements. Job descriptions serve as the necessary reference material for staff recruitment and staff appraisal;
- Staff planning and staff recruitment and deployment, which are, on the one hand, meant to attract the right people and on the other hand, to re-train and re-deploy staff;
- Further strengthening of the in-company training delivery system to improve the basic skills necessary for proper execution of PPWSA activities;
- Further improvement of staff incentives to obtain and retain adequate number of suitably qualified people, and to encourage better performance.

11-4-1 Human Resource Planning

The primary objectives of planning are to meet PPWSA's demand for labor adequately and to promote efficiency in the use of human resources. Human resource planning involves the planning for the right numbers and kinds of staff to perform the tasks of the organization. It generally involves three main types of activities:

- the assessment of the human resource requirements;
- the inventory of the human resources;
- the planning of interventions to come to the adequate staffing situation.

11-4-2 Human Resource Requirements

The determination of staffing requirements for the management, operation and maintenance of water supply operations should ideally be based on detailed job analysis. It should take the technologies employed, e.g. extent of mechanization, technical processes tools and equipment used, institutional arrangement (outsourcing), into account. Alternatively key senior staff of the various departments within the company can be interviewed to estimate manpower requirements. Disadvantage of this method is however, that inefficiencies in the use of human resources might be overseen by the staff or that requirements for new tasks might not be known.

Although desirable to determine staffing requirements based on detailed job analysis, it may be difficult and too time consuming to estimate staffing requirements in the initial instance in this way. It is therefore suggested that the initial assessment of the human resources is made, using comparable staffing ratios (by function).

The staffing ratios for the various types of functions within the companies can be related to:

- specific quantifiable indicators for workload such as the number of connections/customers (currently in use on a total aggregate basis) or the length of the networks;
- the number and location of the facilities to be managed, particularly in view of the new facilities to be brought online in the coming years (for example, no of WTP operators per production line), or number of pipe technicians per km of pipeline, or per km2 of distribution network area);
- the service provided and technology employed;

- the contracting arrangements (some tasks may, for efficiency reasons, be contracted).

The new tasks related to the new more decentralized set up (and other future innovations) and the expected rise in productivity should be taken as well in determining the staffing requirements.

This method can be supplemented with interviews of the key senior staff to ensure that local conditions in the service area are properly reflected. The results should also be included, for example, in the detailed Operation and Maintenance Guidelines (OMG).

11-4-3 Job Performance Appraisal and Motivation

Training alone will not be sufficient to improve staff performance. The implementation of an incentive scheme, linked to performance, is an important factor to motivate staff. This section presents the approach for performance appraisal and motivation concepts – factors which affect job performance, considerations for the use of the job performance related incentive system.

Job performance assessment aims to determine whether the amount and quality of staff efforts meet the standards laid down in some prior analysis of their work. It tries to answer the question whether the amount of work effort put in by the staff is adequate or satisfactorily in relation to the established performance standards.

It can be used to assess the staff incentives, but equally as important to assess training needs. When used, one should recognize that there are many other causes for poor job performance, including shortage of staff, lack of skills, lack of knowledge, lack of staff motivation, inadequate procedures, inadequate task division, lack of guidance/control, lack of equipment & tools, lack of materials, lack of transport, etc. Evidently, only performance deficiencies due to a lack of skills or knowledge can be remedied by training. Other performance constraints will have to be addressed by other means, in order to improve results.

The term 'incentive' here refers **not** to basic wage or salary, but to extra benefits for extra effort or contribution. To get the employees to do more or to contribute more, it may be necessary to offer appropriate incentives over basic wages or salaries.

It is important to develop and implement a simple and practical job performance appraisal system (i.e. using performance indicators easy to measure and understand by managers and staff). The system should also make performance appraisal more transparent. The system can also be used to assess individual training needs in addition to the determination of the incentives.

The implementation of performance related incentives requires three types of action:

- the identification of the tasks to be performed, together with the criteria to be used to measure performance;
- the measurement of the job performance;
- the determination of the amount of incentive to be given;

In the design of the system a balance should be pursued between group indicators to promote the co-operation and teamwork among staff within the sections and job specific criteria, allowing for individual differences in job performance among group members. Group indicators can also be justified in case results are not readily identifiable or measurable to the achievements of an individual. The group performance indicators can be derived from company performance indicators provided that indicators are attributable to staff efforts. Job specific indicators can be derived from the job descriptions as well as from an evaluation of general performance indicators commonly used in job performance appraisal.

11-5 Framework for Human Resources Development

11-5-1 Approach to Technical Training

Following the job descriptions and the job analyses conducted, a framework for the technical training for PPWSA engineers, technical staff and operators is presented in this section. This framework has been put together to ensure that all aspects of operations, maintenance and engineering are dealt with in a systematic manner. The training approach envisages a wide mix of approaches and methods – from on-job program to formal training sessions; from in-country to overseas programs; and, from short-courses to long term scholarship programs. It is further envisaged that these training activities will be led by the PPWSA Training Center directly under the General Director.

Levels and Categories

There will be three (3) levels of training, roughly following the functional level.

1) *Introductory-level training* is intended for non-technical managers and supervisors and policymakers. This training will provide a broad overview of the facilities and their operation and maintenance standards and requirements, impressing upon the importance of operation and maintenance on the overall business. In general, it is envisaged that those taking this training will develop an appreciation of the key issues affecting operation, maintenance and project development.
2) *Professional-level training* is intended for engineers and other professional-level or highly experienced technical staff. The level assumes that the trainees have a reasonably sound basic engineering and technology background gained from formal education, previous training or work experience. These programs would generally start with a review of concepts, principles and fundamentals. The core of this training consists of practical tools and techniques involving the application of the principles to current operation, maintenance or design problems or situations.
3) *Operator-level training* is intended for technician and operator level staff. This training assumes that the trainees have some level of practical field experience and have an appreciation of the day-to-day problems encountered. These workshops generally start with a review and assessment of current practices and operating problems. The core of this training consists of developing practical skills for using tools and equipment, methods and techniques (including safety precautions) for performing the required tasks, including troubleshooting. Where some basic understanding of principles are required (i.e., tasks where the operators are required to take certain operating decisions), these shall be provided.

Briefly, the technical training envisaged for PPWSA consists of two (2) broad categories – Operation and Maintenance, and Project Development (including Construction), as follows:

1) Operation and Maintenance Modules will cover all facilities operation and maintenance aspects for water supply (production, chlorination, storage, distribution). In the future, training for sewerage (sewage collection, treatment and disposal, including sludge) operation may also be needed.
2) Project Management Modules will cover all aspects of project development from identification, project studies, design, bidding and award, construction.

Operation & Maintenance Modules

A summary of identified O&M training module titles (preliminary list) is listed in the following table.

Introductory Level	Professional Level	Operator Level
• Introduction to Water Production and Treatment • Introduction to Water Distribution • Introduction to Wastewater Management and Environmental Health	• Principles of Operation of Centrifugal Pumps • Principles of Operation of Electric Motors • Principles of Operation of Diesel Engines & General Arrangements for Pumping Stations • Storage Principles • Chlorination Principles and Safety Aspects • Network Hydraulics and Distribution System Control • O&M Requirements of the Distribution System • Control of Water Losses and Assessment of Distribution Systems • Introduction to Water Chemistry and Microbiology • Quality Standards • Electrical Controls • Instrumentation and Controls Principles • Handling Emergencies and Disaster Preparedness	• O&M of Wells, Pumps and Motors • O&M of Reservoirs • O&M of Chlorinators • Water Pipe Maintenance and Repair • O&M of Valves • O&M and Repair of Water Meters • Installing Water Service Connections • Laboratory Methods (Water) • Maintenance of Electrical Equipment • Maintenance of Control Panels and Tele-metering Devices • Safe Practice

It is envisaged that other specific operator-level training needs such as: vehicle maintenance, diesel engines, air compressors, welding, basic electrical skills, lathe operations, carpentry, etc. will be prioritized and addressed in cooperation with technical or vocational schools.

On a special note, the Capacity Building Project cites that there are some current PPWSA staff with very little or no formal education making formal and on-job training more difficult. The Study suggests that in some specific instances, special programs may be launched by the Personnel Department to conduct counseling with the staff and to design a job which the staff may have aptitude or natural talents for. This is a special approach of fitting a job to the person; instead

of the more common approach of finding the right person to fit a preset job description. Needless to say, the new job designed should have relevance to PPWSA's operations.

Project Management Modules

The Project Management Modules, on the other hand, are detailed in the following table.

Introductory Level	Professional Level	Technician (Inspector) Level
• Introduction to the Project Cycle, Elements of a Project Study • Contract Preparation, Bidding and Award	• Project Identification & Project Studies I (Technical & Environmental Aspects) • Project Studies II (Financial, Economic, Institutional & Social Aspects) • Design of Pipeline Extension (This is first of a technical design series) • Construction Supervision and Monitoring • Procurement of Goods (including delivery inspection and acceptance) • Overview of Technical Specifications for Construction & Installation	• Inspection of Equipment Installation • Inspection of Pipeline Installation and Rehabilitation • Inspection of Well Drilling Operations • Inspection of Civil Works Construction • Inspection of Electrical Works Installation • Preparation of Contract and As-built Drawings

Water Quality Management

PPWSA is currently monitoring 35 key water quality parameters following the WHO guideline and/or the Cambodian drinking water standards values. Samples are taken of raw water, treated water and tap water following a regular schedule (daily, weekly and monthly). The PPWSA takes great pride that the water produced meets WHO Guidelines for Drinking-water Quality and the Cambodian standards.

The Ministry of Environment has the broader mandate for environmental monitoring and is capable of handling a broader range of monitoring and testing services.

The earlier editions of the WHO Guidelines were used as the basis for regulation and standard setting to ensure the safety of drinking-water. The Guidelines recognized the priority that should be given to ensuring microbial safety and provided guideline values for many chemical pollutants.

The current 2004 edition of the WHO Guidelines has been comprehensively updated to take account of developments in risk assessment and risk management. Instead of focusing on the water quality standards, the Guidelines describe a "framework for drinking water safety". The new Guidelines also emphasize the need to particularly ensure the microbial safety of drinking water through comprehensive system-specific "water safety plans".

The Guidelines continue to provide a range of supporting information, including microbial aspects, chemical aspects, radiological aspects and acceptability aspects. WHO, however, admits

that the detection of these constituents in both raw water and supplied water is often slow, complex and costly, which limits early warning capability and affordability. The WHO Guidelines also concede that – "Reliance on water quality determination alone is insufficient to protect public health. As it is neither physically nor economically feasible to test for all drinking-water quality parameters, the use of monitoring effort and resources should be carefully planned and directed at significant or key characteristics."

Over the long-term therefore, the Study recommends that:

a. PPWSA adopt the broader framework for ensuring safe drinking water, as recommended in the Guidelines. This implies the establishment and regular updating of "water safety plans". In addition to meeting the guideline values for the water quality parameters, these plans are needed for PPWSA to continue to claim that it meets international WHO standards.

b. Promote stronger interagency coordination, particularly with the Ministry of the Environment, on a broad range of areas, including analysis services, training and advisory cooperation.

c. Continue building up the capacity of its current central laboratory services – staff, equipment, methods and technology.

11-6 Organizational Structure

11-6-1 Organization Structuring Principles

A sound organization structure is needed to ensure that all the responsibilities are covered and the working relationship among the various work groups is clearly established.

Standardizing at three basic (3) management levels is recommended: the senior management level; the middle management level; and the operational management level. Generally, each of these levels of management can be defined based on broad level of scope and responsibility and differences in area of discretion and authority. The composition of these management levels, their common areas of managerial responsibility and authority and their working inter-relationships can be clearly defined, in succeeding stages of this Study.

11-6-2 Organization Restructuring and Staffing

This section describes the organizational transformation over the Master Plan period. The organization changes proposed mainly consider the overall growth strategy described in this Master Plan (facilities, customers, etc) and the progressive shifts in organizational focus and priorities described in this chapter. This discussions assume that the core function of PPWSA as the water supply utility for Phnom Penh. Clearly, changes to this proposal may be required as other future decisions are taken about PPWSA's mission. The following Table presents, in broad terms, the organization structure goals to be attained (or the shifts needed) up to 2020.

Table 11-2 Organization Structure Goals

	Goals to be accomplished/facilitated by the structure & key changes envisaged
Stage I	**Theme: Directions, Systems, Delegation** Increased accountability at lower levels, particularly field operations – distribution and commercial. • Full establishment of field "Revenue Zone" offices for billing and collection. • Organization for Chrouy Changva 2 WTP operation & maintenance. Establishment of a Corporate Planning/MIS Office and a Public Information Office Separate Engineering from Operations. Establish an operation review function for the Engineering Department.
Stage II	**Theme: Decentralization** • Organization for Nirouth 1 WTP operation & maintenance. • Expansion of the Revenue Zone office to a PPWSA Customer Service Center for billing/collection, customer service requests – connection/disconnection applications, complaints, etc.; for public awareness & community relations programs. • Introduction of cost center concepts for WTP; Piloting decentralized management of the treatment plants. • Delineate clearly staff functions from the line functions; define working relationship.
Stage III	**Theme: Consolidation and Renewal** • Organization of Nirouth 2 WTP for operation & maintenance. • PPWSA Customer Service Center expanded to become a PPWSA Branch Office (added function includes: network maintenance and NRW control) – a mini PPWSA. • Main function of PPWSA Headquarters becomes policy directions and capital investment planning and technical support to the Branch Offices. Each Branch Office becomes a "marketing & distribution company" buying bulk water from HQ (or the treatment plants) and selling to customers. • Generally, staff size at HQ will gradually shrink; as more functions are moved to the Branch offices. A matrix organization may emerge which clearly defines the working relationships between HQ and the branch offices.

11-6-3 Projected Staffing Requirements

The Plan envisages that a staffing ratio is maintained at 3.8 staff per thousand connections. Significantly, however, an annual increase in basic salary of about 20 percent until 2008 is included in the financial analysis (which should translate to a 20 percent increase in staff productivity). This productivity increase represents the expectation to be achieved by the capacity building program. It may also represent the scale at which outsourcing of some PPWSA functions will be pursued.

Should the functions of PPWSA be expanded, further adjustments to this staffing projection will be required. A projection of PPWSA staffing requirements will be presented in the Feasibility Study to fulfill the requirements for implementation and operation of the facilities expansion plan.

11-7 Institutional Development Master Plan

This section provides a broad summary of the development objectives and the approach. More detailed descriptions of the proposed interventions for Stage I are presented in the Feasibility Study.

11-7-1 Proposed Institutional Development & Capacity Building Plan Stage 1 (2006-2010)

The broad theme for the institutional development and capacity building plan will focus on sharpening organizational **directions**, strengthening management **systems** and promoting more **delegation** of duties and responsibilities. More of the current systems will have to be formalized and standardized as the PPWSA expands. Skill specialization and defining and refining of roles and responsibilities of the working teams will be pursued. The detailed description of the proposed Stage I Plan is described in Part B of this Volume.

11-7-2 Proposed Institutional Development & Capacity Building Plans for Stage 2 and Stage 3

The succeeding capacity building plans in the next stages will have to be defined immediately before the end of the previous stage. The formulation of the plan will have to follow the framework explained in this chapter to ensure a proper balance between meeting the technical (operation and maintenance) development needs as well as, the non-technical needs – principally strengthening of the customer service system, the financial management and control system and the human resources management and development system.

In Stage 2, the prevailing capacity building theme should shift towards further **decentralization** to be closer to the customers. Coordination among the decentralized and "more autonomous" units will have to be carefully monitored. While the operation and maintenance emphasis will likely have to continue, PPWSA should now shift more long-term attention to its market and focus on short-term customer service. The Revenue Zone offices, earlier established at the field level to handle billing and collection, can be upgraded into a full-scale PPWSA Customer Service Center handling all types of customer service requests for the zone. With a computerized data base in place, this flexibility would be possible. Monitoring and evaluation systems will play a greater and more significant role during this stage.

In the third stage, the theme shifts to increasing **collaboration** among the PPWSA working units and **expansion** of services. For example, the Customer Service Centers can be further expanded to take responsibility for network distribution maintenance functions. This envisages the gradual evolution of the PPWSA branch office in the field. The role which PPWSA main office will likely maintain will be on strategic planning and water production.

Chapter 12. Implementation Plan

Chapter 12. Implementation Plan

12-1 Staged Implementation Plan

12-1-1 Implementation Plan

The project is planned to be implemented over three stages based on the design target years of 2010 (Stage I) for the feasibility study, 2015 (Stage II) for the intermediate development plan and 2020 (Stage III) for the long term development plan. The stages have the following production capacity requirements, as shown in Table 12-1.

Table 12-1 Staging of the Project

Basic Parameter	Stage I	Stage II	Stage III
Target Year	2010	2015	2020
Total Treatment Capacity *)	300,000 m^3/day	400,000 m^3/day	500,000 m^3/day

*) Total Treatment Capacity includes existing WTP capacity.

In connection with the target years for this Study, Stage I is an urgent and priority project and is expected to be completed by the end of 2010, while Stages II and III to complete the overall project are to be achieved by the end of 2015 and 2020 respectively.

Stage I (2005 to 2010)

2005	Preparation of Project
2005-2006	Detailed Design, Bidding
2006	Commencement of Construction & Procurement of Equipment
2007-2009	Construction for Urban Water Supply Projects
2008-2010	Construction for Peri-Urban Water Supply Projects
2009-2010	Commencement of Operation

Stage II (2009 to 2015)

2009-2010	Preparation of Project
2010-2011	Detailed Design, Bidding
2011	Commencement of Construction & Procurement of Equipment
2012-2014	Construction for Urban Water Supply Projects
2011-2015	Construction for Peri-Urban Water Supply Projects
2014-2015	Commencement of Operation

Stage III (2015 to 2020)

2015-2016	Preparation of Project
2016-2017	Detailed Design, Bidding
2017	Commencement of Construction & Procurement of Equipment

2018-2020 Construction for Urban Water Supply Projects

2016-2020 Construction for Peri-Urban Water Supply Projects

2020 Commencement of Operation

The project implementation schedule is presented in Figure 10.1.

12-1-2 Components of the Project

Key project components consist of Chrouy Changva WTP - 2nd Stage expansion, construction of Nirouth WTP in two Stages with intakes and transmission/distribution pipes, and well facility development, as shown in Table 12-2.

Table 12-2 Project Components

Stage	Code	Component	Reference
100: Stage I		**<Urban Water Supply Projects>**	
	110	Chrouy Changva WTP -2nd Stage	
	111	Intake Tower (for Chrouy Changva WTP)	For Q=130,000m^3/d
	112	Raw Water Transmission Pipe	For Q=65,000m^3/d
	113	Chrouy Changva WTP -2nd Stage	
	120	Water Tank	
	121	Ta Khmau Water Tank	
	113	Booster Pump for Existing Water Tank	
	130	Transmission/Distribution Pipe	
	131	Transmission/Distribution Pipe (Dia 63 to 600)	
	132	Transmission/Distribution Pipe (Dia 700 to 1200)	
	140	Rehabilitation of Mechanical & Electrical Equipment	
		<Peri-Urban Water Supply Projects>	
	150	Well Facility	
200: Stage II		**<Urban Water Supply Projects>**	
	210	Nirouth WTP -1st Stage	
	211	Intake Tower (for New WTP)	For Q=200,000m^3/d
	212	Raw Water Transmission Pipe	
	213	Nirouth WTP -1st Stage	For Q=100,000m^3/d
	215	Clear Water Reservoir Expansion in Phum Prek WTP	
	220	Transmission/Distribution Pipe	
	221	Transmission/Distribution Pipe (Dia 63 to 600)	
	222	Transmission/Distribution Pipe (Dia 700 to 1200)	
	230	Sludge Treatment Facility for Chrouy Changva & Phum Prek WTP	
	240	Rehabilitation of Mechanical & Electrical Equipment	
		<Peri-Urban Water Supply Projects>	
	250	Well Facility	

300: Stage III		**<Urban Water Supply Projects>**	
	310	Nirouth WTP –2nd Stage	
	311	Intake Tower (for Nirouth WTP)	Mechanical, Electrical Work only
	312	Raw Water Transmission Pipe	
	313	Nirouth WTP -2nd Stage	For Q=100,000m^3/d
	320	Transmission/Distribution Pipe	
	321	Transmission/Distribution Pipe (Dia 63 to 600)	
	322	Transmission/Distribution Pipe (Dia 700 to 1200)	
	330	Sludge Treatment Facility for Chamker Mon WTP	
	340	Rehabilitation of Mechanical & Electrical Equipment	
		<Peri-Urban Water Supply Projects>	
	350	Well Facility	

Note: Transmission/Distribution Pipe (Dia 63 to 600) and Rehabilitation of M&E Equipment is estimated to be implemented by PPWSA's own budget.

12-1-3 Mode of Implementation

The funds required for project implementation will be provided through the budget of the national government of Cambodia assisted by external loans from cooperating countries or agencies. The major cost items are the following:

- Construction Cost of Facilities
- Land Acquisition and Compensation Costs (local cost)
- Engineering Services Expenses for Design and Construction Supervision
- Administration Expenses for the Cambodia Government (local cost)
- Institutional Development
- Physical Contingencies
- Price Contingencies

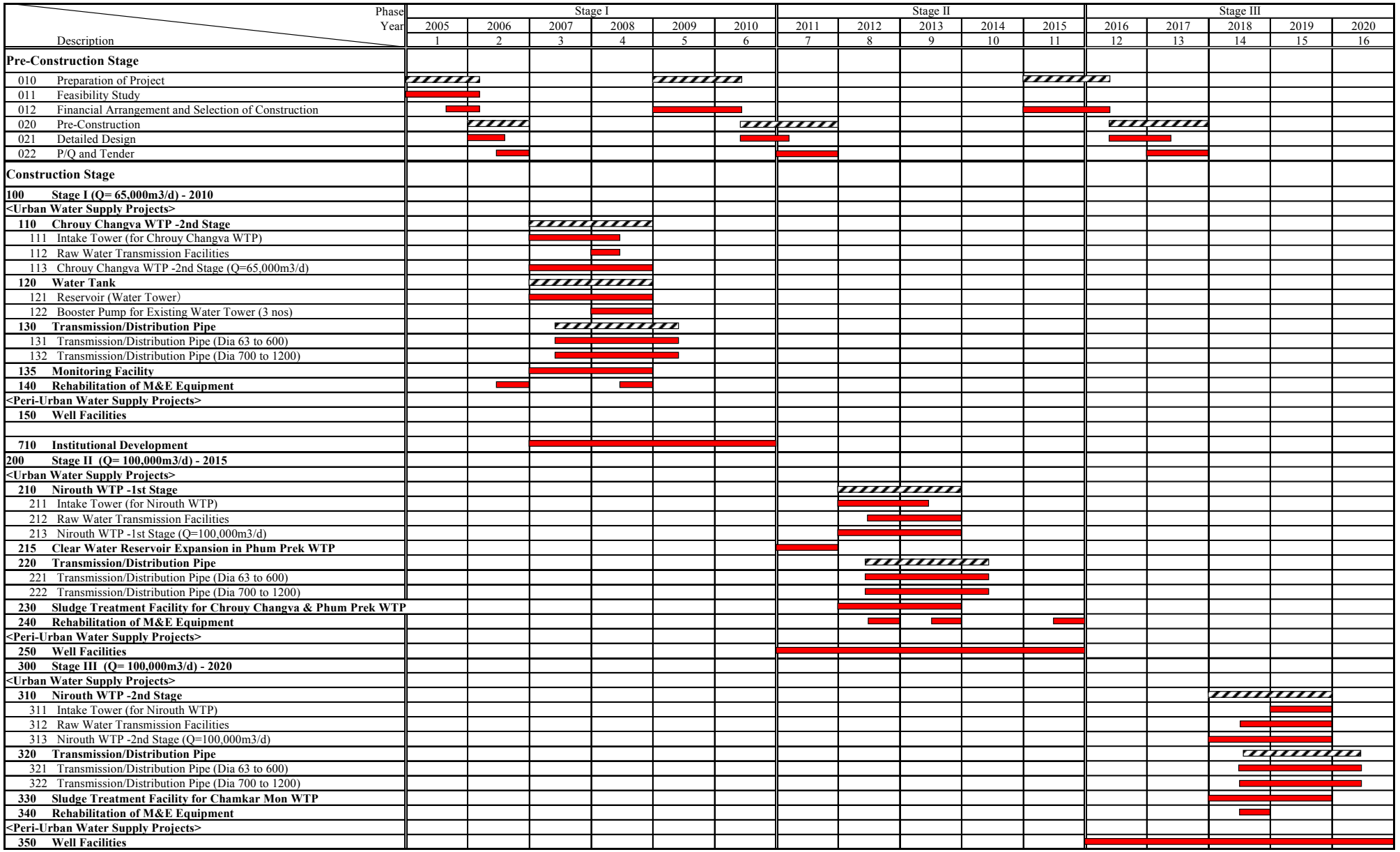


Figure 12-1 Implementation Schedule

12-2 Construction Plan and Schedule for Urban Water Supply Projects

12-2-1 Intake Tower

Two intake facilities will be constructed for Chrouy Changva WTP and for the Nirouth WTP.

(1) Intake Tower for Chrouy Changva WTP

Intake Tower for Chrouy Changva WTP of capacity 130,000m^3/day will be newly constructed. The existing intake tower with capacity of 65,000m^3/day will be used for backup.

Construction Period:	Stage I (2007 – 08)
Capacity:	130,000 m^3/day
Location:	Nearby Existing Chrouy Changva WTP along the Mekong River
Facility:	Intake Tower, Connection Bridge

(2) Intake Tower for New WTP

The intake tower for the new WTP will be constructed in two steps for Stage II and Stage III. For Stage II, a structure with capacity of 200,000 m^3/day (1st Stage + 2nd Stage) will be constructed. At each Stage, mechanical/electrical equipment with capacity of 100,000 m^3/day will be installed.

Construction Period:	Stage II (2012 – 13) and Stage III (2018 – 19)
Capacity:	200,000 m^3/day
Location:	Along the Mekong River in Nirouth
Facility:	Intake Tower, Connection Bridge, Sub-Station/Electrical House

12-2-2 Raw Water Transmission Facilities

(1) Raw Water Transmission Pipe for Chrouy Changva WTP

Construction Period:	Stage I (2008)
Diameter:	Dia 1200mm x 1
Material:	Ductile Cast Iron Pipe
Total Pipe Length:	Approximately 140m
Location:	Between Existing Chrouy Changva WTP and Mekong River

(2) Raw Water Transmission Pipe for Nirouth WTP

Construction Period:	Stage II (2012 – 13) and Stage III (2018 – 19)
Diameter:	Dia 1200mm x 1 (for Stage II), Dia 1200mm x 1 (for Stage III)

Material:	Ductile Cast Iron Pipe
Total Pipe Length:	Approximately 500m x 1 = 500m (for Stage II)
	Approximately 500m x 1 = 500m (for Stage III)
Location:	Between Nirouth WTP and Intake Tower along the Mekong River

12-2-3 Water Treatment Facilities

Two Water Treatment Facilities will be constructed in Stage I, II and III.

(1) Chrouy Changva WTP –2nd Stage

Water Treatment Facility of capacity 65,000m^3/day (2nd Stage) will be constructed at the existing Chrouy Changva WTP site.

Construction Period:	Stage I (2007 – 08)
Capacity:	65,000m^3/day
Location:	Existing Chrouy Changva WTP site
Facility:	Receiving Well, Sedimentation Tank, Rapid Sand Filter, Clear Water Reservoir (V= 20,000m^3)

(2) Nirouth WTP

New water treatment facility with capacity of 100,000 m^3/day (1st Stage) for Stage II and with additional capacity of 100,000 m^3/day for Stage III (Nirouth 2nd phase) will be constructed in Nirouth.

Construction Period:	Stage II (2012 – 13) and Stage III (2018 – 19)
Capacity:	Stage II 100,000 m^3/day, Stage III 100,000 m^3/day, Total 200,000m^3/day
Required Land Area:	Approximately 12 hectares
Location:	Nirouth
Facility:	Receiving Well, Flocculation Basin, Sedimentation Tank, Rapid Sand Filter, Chemical Building, ClearWater Reservoir (Stage II: V= 20,000m^3, Stage III: V= 20,000m^3), Clear Water Pump Building, Sludge Lagoon, Administration Building, Sub-Station

(3) Clear Water Reservoir Expansion

Clear Water Reservoir will be expanded in Phum Prek WTP site for Stage II.

Construction Period:	Stage II (2011)
Capacity:	V=5,000m^3
Location:	Phum Prek WTP site

12-2-4 Transmission/Distribution Facilities

Total length of 442 km transmission/distribution pipe will be installed in Phnom Penh city and suburbs as follows:

Installation Period:	Stage I (2007 - 09), Stage II (2012 – 14), Stage III (2018 – 20)
Diameter:	Dia 63mm to 1200mm
Material:	High Density Polyethylene Pipe (HDPE) for Dia 63mm 225mm, Ductile Cast Iron Pipe (DCIP) for Dia 200mm - 1200mm
Total Pipe Length:	Stage I: Approximately 131 km
	Stage II: Approximately 118 km
	Stage III: Approximately 193 km
	Total: Approximately 442 km
Location:	Phnom Penh city and suburbs

12-2-5 Rehabilitation Works

In addition to the new construction projects mentioned above, regular rehabilitation works are required for the existing and newly constructed facilities, especially for mechanical and electrical equipment. This type of work will be implemented by project or as a part of major maintenance works funded by PPWSA's own budget.

12-3 Construction Plan and Schedule for Peri-Urban Water Supply Projects

867 wells in total will be constructed in Phnom Penh city and suburbs as follows:

Installation Period:	Stage I (2008 - 10), Stage II (2011 – 15), Stage III (2016– 20)
Well Depth & Number:	Stage I: 229 wells of depth 60m
	Stage II: 71 wells of depth 40m; 197 wells of depth 60m
	Stage III: 201 wells of depth 40m; 169 wells of depth 60m
	Total: 867 wells
Equipment:	Well, Hand Pump
Location:	Phnom Penh City and its Suburbs

Chapter 13. Project Cost

Chapter 13. Project cost

13-1 Composition of Project Cost

The project financial cost comprises the following cost items.

1) Construction Cost

2) Land Acquisition and Compensation Costs

3) Government's Administration Expenses

4) Engineering Services Expenses

5) Procurement of Equipment Cost

6) Institutional Development

7) Physical Contingency

8) Price Contingency

13-2 Conditions and Assumptions for Cost Estimate

(1) Price Level

The price level at the time of site investigation for the project cost estimate is October 2005.

(2) Foreign Exchange

The US dollar is widely circulated in Cambodia and is used for most major transactions. Accordingly, project costs are estimated in US dollars.

The exchange rate is set as follows, based on international financial statistics as of October 2005.

US$ 1.0 = Yen 111.73

	Oct '05	Sep '05	Aug '05	Jul '05	Jun'05	May '05	Average
Yen/US$	115.91	112.09	111.79	112.95	109.72	107.94	111.73

(3) Devaluation

No devaluation is considered, since project cost is estimated in US dollars.

(4) Implementation Schedule

Stage I: 2005 - 2006 Tender Design, P/Q and Tender
2007 - 2010 Construction for Urban Water Supply Projects
2008 - 2010 Construction for Peri-Urban Water Supply Projects

Stage II: 2010 - 2011 Tender Design, P/Q and Tender
2012 - 2014 Construction for Urban Water Supply Projects
2011 - 2015 Construction for Peri-Urban Water Supply Projects

Stage III: 2016 - 2017 Tender Design, P/Q and Tender
2018 - 2020 Construction for Urban Water Supply Projects
2016 - 2020 Construction for Peri-Urban Water Supply Projects

13-3 Estimation Approach

13-3-1 Construction Cost

The estimated construction costs of Stage I, Stage II and Stage III are classified into the following groups of respective facilities, as shown in Table 13-1.

Table 13-1 Grouping of the Construction Cost

Cost Code	Construction Cost Items
100	**Stage I (Q= 65,000m^3/d) - 2010**
	<Urban Water Supply Projects>
110	**Chrouy Changva WTP -2nd Stage**
111	Intake Facilities (for Chrouy Changva WTP) - Civil Works - Building works - Mechanical Works - Electrical Works
112	Raw Water Transmission Facilities - Supply and Delivery Cost for Pipe and Fittings - Laying Cost Including Road Reinstatement Cost
113	Chrouy Changva WTP -2nd Stage, (Q= 65,000m^3/d) - Civil Works - Building Works - Mechanical Works - Electrical Works
120	**Water Tank**
121	Ta Khmau Water Tank - Civil Works - Building Works - Mechanical Works - Electrical Works
121	Booster Pumps for Existing Water Tanks (2) - Mechanical Works - Electrical Works
130	**Transmission/Distribution Pipe**
131	Transmission/Distribution Pipe (Dia 63 to 600) - Supply and Delivery Cost for Pipe and Fittings - Laying Cost including Road Reinstatement Cost
132	Transmission/Distribution Pipe (Dia 700 to 1200) - Supply and Delivery Cost for Pipe and Fittings - Laying Cost including Road Reinstatement Cost

Cost Code	Construction Cost Items
140	**Rehabilitation of Mechanical & Electrical Equipment**
	<Peri-Urban Water Supply Projects>
150	**Well Facilities**
	- Well Pipe Works
	- Installation of Hand Pump
200	**Stage II (Q= 100,000m^3/d) – 2015**
	<Urban Water Supply Projects>
210	**Nirouth WTP -1st Stage**
211	Intake Facilities (for Nirouth WTP)
	- Civil Works
	- Building Works
	- Mechanical Works
	- Electrical Works
212	Raw Water Transmission Facilities
	- Supply and Delivery Cost for Pipe and Fittings
	- Laying Cost Including Road Reinstatement Cost
213	Nirouth WTP -1st Stage, (Q= 100,000m^3/d)
	- Civil Works
	- Building Works
	- Mechanical Works
	- Electrical Works
215	**Clear Water Expansion in Phum Prek WTP**
	- Civil Works
220	**Transmission/Distribution Pipe**
221	Transmission/Distribution Pipe (Dia 63 to 600)
	- Supply and Delivery Cost for Pipe and Fittings
	- Laying Cost including Road Reinstatement Cost
222	Transmission/Distribution Pipe (Dia 700 to 1200)
	- Supply and Delivery Cost for Pipe and Fittings
	- Laying Cost including Road Reinstatement Cost
230	**Sludge Treatment Facility for Chrouy Changva and Phum Prek WTP**
	- Civil Works
	- Building Works
	- Mechanical Works
	- Electrical Works
240	**Rehabilitation of Mechanical & Electrical Equipment**
	<Peri-Urban Water Supply Projects>
250	**Well Facilities**
	- Well Pipe Works
	- Installation of Hand Pump
300	**Stage III (Q= 100,000m^3/d) - 2020**
	<Urban Water Supply Projects>
310	**Nirouth WTP –2nd Stage**
311	Intake Facilities (for Nirouth WTP -2nd Stage)
	- Mechanical Works
	- Electrical Works

Cost Code	Construction Cost Items
312	Raw Water Transmission Facilities
	- Supply and Delivery Cost for Pipe and Fittings
	- Laying Cost Including Road Reinstatement Cost
313	New WTP –2nd Stage, (Q= 100,000m^3/d)
	- Civil Works
	- Building Works
	- Mechanical Works
	- Electrical Works
320	**Transmission/Distribution Pipe**
321	Transmission/Distribution Pipe (Dia 63 to 600)
	- Supply and Delivery Cost for Pipe and Fittings
	- Laying Cost including Road Reinstatement Cost
321	Transmission/Distribution Pipe (Dia 700 to 1200)
	- Supply and Delivery Cost for Pipe and Fittings
	- Laying Cost including Road Reinstatement Cost
330	**Sludge Treatment Facility for Chamkar Mon WTP**
	- Civil Works
	- Building Works
	- Mechanical Works
	- Electrical Works
340	**Rehabilitation of Mechanical & Electrical Equipment**
	<Peri-Urban Water Supply Projects>
350	**Well Facilities**
	- Well Pipe Works
	- Installation of Hand Pump

Note: Distribution Pipe (Dia 63 to 600) and Rehabilitation of M&E Equipment is estimated to be implemented by PPWSA's own budget.

The construction cost is estimated by the following approach. The contractor's site expenses, overhead and profit have been included into the respective cost items stipulated below.

(1) Civil Works

The construction costs for civil works are estimated by unit cost basis. The unit construction costs of respective work items are presented in the Supporting Report (SR-11.1). These were determined by referring to contracts recently awarded, and other data that were collected, examined and analyzed during the site investigation. Each unit cost includes 1) labor cost, 2) construction material price, 3) construction equipment cost, 4) contractor's overhead/profit and 5) tax.

(2) Pipes and Fittings (Dia 63 to 600)

Unit price for diameter 63mm to 600mm pipe is adopted from the cost estimate done by PPWSA. They have installed pipeline by themselves and have a track record of installing 100 km of pipe in one year.

(3) Pipe and Fittings (Dia 700 to 1200)

PPWSA lacks the ability to execute more than 700mm diameter pipe installation and they have no experience with that kind of pipe work. Pipe work exceeding 700mm diameter will be contracted by international tender financed by loan or grant aid. The cost of large-diameter pipe work is estimated on the basis of unit prices, as described below.

Ductile cast iron pipe has been used for more than 700mm diameter pipe in Cambodia, which is mainly imported from Japan and China. The cost of pipe material is decided by past construction cost and circulating price in Cambodia.

Unit price for pipe installation is estimated by past construction cost and quotation.

Unit prices for excavation, backfilling, pipe base work and asphalt pavement are estimated by quantity survey and stated in terms of length in meters.

(4) Mechanical and Electrical Works

Major pumps for Intake Station, Distribution Tank and Pump Station are decided by quotation basis. The other costs of mechanical and electrical equipment are based on past construction cost of Phum Prek WTP and Chrouy Changva WTP.

(5) Building Works

The cost for building works is estimated by unit cost basis per square meter.

(6) Rehabilitation of M&E Equipment

Existing and proposed mechanical and electrical equipment for intake tower, water treatment plant and booster pump station will be rehabilitated at regular intervals. Rehabilitation cost is estimated as follows;

First ten years:	20 percent of M&E Cost
Second ten years:	30 percent of M&E Cost
Third ten years:	50 percent of M&E Cost

13-3-2 Land Acquisition Costs

Land Acquisition Costs are based on market price in the area of the construction site with consideration for price escalation.

13-3-3 Equipment Procurement Cost

Some equipment will be required for proper operation and maintenance of water supply facilities, such as Intake Tower, Water Treatment Plant, Pipeline and Water Tank. This equipment will contribute to a higher level of efficiency in operation and management and help the company

maintain staffing at the minimum level. For this purpose, one percent of the construction cost is added to the project cost to procure the required equipment.

13-3-4 Engineering Services Expenses

The engineering services expenses are estimated in proportion to the construction cost to cover the tender design and construction supervision for the respective stage. The figure of ten percent of the construction cost is applied.

13-3-5 Government's Administration Expenses

The Government's administration expenses for project implementation are added to the construction cost. Five percent is applied and incorporated into the construction cost for respective stage. These expenses include mitigation costs for social and environmental impacts, such as resettlement, water rights.

13-3-6 Institutional Development Cost

The institutional development cost is to support external technical assistance. Three percent is applied.

13-3-7 Physical Contingency

The physical contingency is provided to cover minor differences in actual and estimated quantities, omissions of minor items of work incidental to pay items, difficulties unforeseeable at the site, possible changes in plans, and other uncertainties. Ten percent of base cost is applied.

13-3-8 Price Contingency

The price contingency is calculated by averaging the average consumer price index (CPI) of Japan during the last three years, which was two to four percent.

Price contingency of three percent is applied for each year.

13-3-9 Interest During Construction

No interest during construction was taken into account.

13-4 Project Cost

13-4-1 Urban Water Supply Projects

The total project cost for Urban Water Supply Projects is US$ 319,952,000, which has been worked out as summarized in Table 13-2.

Among the project financial costs, the construction cost is estimated at US$ 51,865,000 for Stage I, US$ 100,462,000 for Stage II and US$ 44,767,000 for Stage III. The project cost for each

stage is shown in Tables 11.3, 11.4 and 11.5 respectively. Itemized statements for each stage are shown in the Supporting Report (SR-11.2).

Table 13-2 Summary of Project Cost for Urban Water Supply

	Cost Item	Cost (US$)	
		Breakdown	Total
	<Construction Cost>		
	Stage I (2010)		**51,865,000**
110	Chrouy Changva WTP -2nd Stage	22.630,000	
120	Water Tank	2,555,000	
130	Transmission/Distribution Pipe	11,880,000	
135	Monitoring Facility	5,000,000	
140	Rehabilitation of M&E Equipment	9,800,000	
	Stage II (2015)		**100,462,000**
210	New Intake & WTP -1st Stage	40,106,000	
215	Clear Water Reservoir Expansion in Phum Prek WTP	1,184,000	
220	Transmission/Distribution Pipe	23,923,000	
230	Sludge Treatment Facility for Chrouy Changva & Phum Prek WTP	18,849,000	
240	Rehabilitation of M&E Equipment	16,400,000	
	Stage III (2020)		**44,767,000**
310	New Intake & WTP -2nd Stage	25,982,000	
320	Transmission/Distribution Pipe	7,238,000	
330	Sludge Treatment Facility for Chamkar Mon WTP	3,347,000	
340	Rehabilitation of M&E Equipment	8,200,000	
	Total of Construction Cost		**197,094,000**
400	Land Acquisition Cost		**3,600,000**
500	Equipment Procurement Cost		**1,971,000**
600	Engineering Service Expense		**19,709,000**
700	Government's Administration Expense		**9,855,000**
710	Institutional Development Cost		**2,062,000**
	Sub Total		**234,291,000**
800	Physical Contingency		**23,429,000**
900	Price Contingency		**62,232,000**
	Total Project Cost		**319,952,000**

Table 13-3 Project Cost for Stage I (Q= 65,000 m^3/d) – 2010 for Urban Water Supply

Code	Cost Item	Cost (US$)	
		Breakdown	Total
100	Construction Cost (Stage 1)		
110	**Chrouy Changva WTP -2nd Stage**		**22,630,000**
111	Intake Tower (for Chrouy Changva WTP)	3,962,000	
112	Raw Water Transmission Facilities	219,000	
113	Chrouy Changva WTP -2nd Stage (Q=65,000m^3/d)	18,449,000	
120	**Water Tank**		**2,555,000**
121	Ta Khmau Water Tank	1,667,000	
122	Pump for Existing Water Tank	888,000	
130	**Transmission/Distribution Pipe**		**11,880,000**
131	Transmission/Distribution Pipe (Dia 63 to 600)	9,126,000	
132	Transmission/Distribution Pipe (Dia 700 to 1200)	2,754,000	
135	**Monitoring Facility**		**5,000,000**
140	**Rehabilitation of M&E Equipment**		**9,800,000**
100	Total of Construction Cost		**51,865,000**
400	Land Acquisition Cost		**0**
500	Equipment Procurement Cost		**519,000**
600	Engineering Service Expense		**5,187,000**
700	Government's Administration Expense		**2,593,000**
710	Institutional Development Cost		**2,062,000**
	Sub Total		**62,225,000**
800	Physical Contingency		**6,223,000**
900	Price Contingency		**3,957,000**
	Total Project Cost (Stage I)		**72,405,000**

Table 13-4 Project Cost for Stage II (Q= 100,000m^3/d) – 2015 for Urban Water Supply

Code	Cost Item	Cost (US$)	
		Breakdown	Total
200	Construction Cost (Stage 2)		
210	**New WTP -1st Stage**		**40,106,000**
211	Intake Tower (for New WTP)	4,384,000	
212	Raw Water Transmission Facilities	783,000	
213	New WTP -1st Stage (Q=100,000m^3/d)	34,939,000	
215	**Clear Water reservoir Expansion in Phum Prek WTP**		**1,184,000**
220	**Transmission/Distribution Pipe**		**23,923,000**
221	Transmission/Distribution Pipe (Dia 63 to 600)	5,207,000	
222	Transmission/Distribution Pipe (Dia 700 to 1200)	18,716,000	
230	**Sludge Treatment Facility for Chrouy Changva & Phum Prek WTP**		**18,849,000**
240	**Rehabilitation of M&E Equipment**		**16,400,000**
200	Total of Construction Cost		**100,462,000**
400	Land Acquisition Cost		**3,600,000**
500	Equipment Procurement Cost		**1,005,000**
600	Engineering Service Expense		**10,046,000**
700	Government's Administration Expense		**5,023,000**
	Sub Total		**120,136,000**
800	Physical Contingency		**12,014,000**
900	Price Contingency		**31,655,000**
	Total Project Cost (Stage II)		**163,805,000**

Table 13-5 Project Cost for Stage III (Q= 100,000m^3/d) - 2020 for Urban Water Supply

Code	Cost Item	Cost (US$)	
		Breakdown	Total
300	Construction Cost (Stage 3)		
310	**New WTP -2nd Stage**		**25,982,000**
311	Intake Tower (for New WTP)	1,664,000	
312	Raw Water Transmission Facilities	783,000	
313	New WTP -2nd Stage (Q=100,000m^3/d)	23,535,000	
320	**Transmission/Distribution Pipe**		**7,238,000**
321	Transmission/Distribution Pipe (Dia 63 to 600)	7,238,000	
322	Transmission/Distribution Pipe (Dia 700 to 1200)	0	
330	**Sludge Treatment Facility for Chamkar Mon WTP**		**3,347,000**
340	**Rehabilitation of M&E Equipment**		**8,200,000**
300	Total of Direct Construction Cost		**44,767,000**
400	Land Acquisition Cost		**0**
500	Equipment Procurement Cost		**448,000**
600	Engineering Service Expense		**4,477,000**
700	Government's Administration Expense		**2,238,000**
	Sub Total		**51,930,000**
800	Physical Contingency		**5,193,000**
900	Price Contingency		**26,620,000**
	Total Project Cost (Stage III)		**83,743,000**

13-4-2 Peri-Urban Water Supply Projects

The total project cost for Peri-Urban Water Supply Projects is US$ 35,691,000, which has been worked out as summarized in Table 11.6.

The construction cost for well facility is estimated at US$ 6,305,000 for Stage I, US$ 6,762,000 for Stage II and US$ 8,696,000 for Stage III. Itemized statements for each stage are shown in the Supporting Report (SR-11.2).

Table 13-6 Summary of Project Cost for Well Facility for Peri-Urban Water Supply

Cost Item	Cost (US$)			
	Stage I	**Stage II**	**Stage III**	**Total**
Construction Cost				
150 250 Well Facility 350	6,305,000	6,762,000	8,696,000	21,763,000
Total Construction Cost				**21,763,000**
500 Equipment Procurement Cost	63,000	68,000	87,000	218,000
600 Engineering Service Expense	631,000	676,000	870,000	2,176,000
700 Government's Administration Expense	315,000	338,000	435,000	1,088,000
Sub Total	7,314,000	7,844,000	10,088,000	25,245,000
800 Physical Contingency	731,000	784,000	1,009,000	2,525,000
900 Price Contingency	848,000	2,125,000	4,949,000	7,921,000
Total Project Cost	**8,893,000**	**10,753,000**	**16,044,000**	**35,691,000**

13-5 Disbursement Schedule

A disbursement schedule for the project costs for Urban Water Supply Projects and Peri-Urban Water Supply Projects are provided as tabulated in Table 13-7 and Table 13-8 on the basis of the proposed implementation schedule.

Table 13-7 Disbursement Schedule for Urban Water Supply

		Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Disbursement Schedule		Total Cost (US$ 1000)	**Stage I: 72,405**						**Stage II: 163,805**					**Stage III: 83,743**				
100-300	Construction Cost	197,094	0	7,500	18,613	22,782	2,970	0	1,184	37,858	44,339	5,981	11,100	0	0	23,712	19,246	1,810
400	Land Acquisition Cost	3,600							3,600									
500	Equipment Procurement Cost	1,971	0	75	186	228	30	0	12	379	443	60	111	0	0	237	192	18
600	Engineering Service Expense	19,709	0	2,968	931	1,139	149	0	5,082	1,893	2,217	299	555	746	1,492	1,186	962	90
700	Government's Administration Expense	9,855	0	375	931	1,139	149	0	59	1,893	2,217	299	555	0	0	1,186	962	90
710	Institutional Development Cost	2,062			518	518	518	508										
800	Physical Contingency	23,429	0	1,092	2,118	2,581	381	51	994	4,202	4,922	664	1,232	75	149	2,632	2,136	201
900	Price Contingency	62,232	0	180	1,059	2,180	458	80	1,931	9,798	13,444	2,087	4,396	299	665	12,946	11,528	1,183
Total of Annual Disbursement		**319,952**	0	12,190	24,356	30,567	4,654	638	12,862	56,023	67,581	9,389	17,949	1,120	2,306	41,897	35,027	3,392

*) Detailed design cost for Stage 2 in 2010 is included in Engineer Service cost in 2011.

Table 13-8 Disbursement Schedule for Peri-Urban Water Supply

		Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Disbursement Schedule		Total Cost (US$ 1000)	**Stage I: 8,893**						**Stage II: 10,753**					**Stage III: 16,044**				
100-300	Construction Cost	21,763	0	0	0	2,102	2,102	2,102	1,352	1,352	1,352	1,352	1,352	1,739	1,739	1,739	1,739	1,739
400	Land Acquisition Cost								0									
500	Equipment Procurement Cost	218	0	0	0	21	21	21	14	14	14	14	14	17	17	17	17	17
600	Engineering Service Expense	2,176	0	315	0	105	105	105	406	68	68	68	68	232	377	87	87	87
700	Government's Administration Expense	1,088	0	0	0	105	105	105	68	68	68	68	68	87	87	87	87	87
800	Physical Contingency	2,525	0	32	0	233	233	233	184	150	150	150	150	208	222	193	193	193
900	Price Contingency	7,921	0	5	0	197	280	365	357	350	410	472	536	831	989	950	1,042	1,137
Total of Annual Disbursement		**35,691**	0	352	0	2,763	2,846	2,932	2,381	2,001	2,061	2,123	2,187	3,114	3,432	3,073	3,165	3,260

*) Detailed design cost for Stage 2 in 2010 is included in Engineer Service cost in 2011.

13-6 Operation and Maintenance Cost

13-6-1 Summary of Operation and Maintenance Cost for Urban Water Supply Projects

These costs represent anticipated yearly expenditures for:

- Personnel Expense;
- Cost of facilities, equipment, operating costs, materials and supplies; and
- Cost of repairs.

Annual operation and maintenance cost for the Urban Water Supply Projects is estimated at US$ 1,099,000, US$ 2,234,000 and US$ 3,735,000 per year at each level of expansion capacity, that is 2010 (65,000 m^3/day), 2015 (165,000 m^3/day) and 2020 (265,000 m^3/day) respectively, as shown in Table 13-9. This operation and maintenance cost is explained below with reference to cost data of Phum Prek WTP, Chrouy Changva WTP -2nd Stage and Chamkar Mon WTP, prevailing market prices, present purchase prices of PPWSA and others following the proposed program.

Table 13-9 Annual Operation and Maintenance Cost for Urban Water Supply Projects

O&M Cost Items	2010 (Q= 65,000m^3/d)		2015 (Q= 165,000m^3/d)		2020 (Q= 265,000m^3/d)	
	O&M Cost	Ratio	O&M Cost	Ratio	O&M Cost	Ratio
- Personnel Expense	29	2.6%	91	4.1%	125	3.3%
- Power Cost	752	68.4%	1,447	64.8%	2,528	67.7%
- Chemical Cost	90	8.2%	215	9.6%	396	10.6%
- Repairs	78	7.1%	228	10.2%	296	7.9%
- Date Base/ Training	50	4.5%	50	2.2%	50	1.3%
- Other	100	9.1%	203	9.1%	340	9.1%
Total	1,099	100.0%	2,234	100.0%	3,735	100.0%

(1000 US$/year)

The breakdown of operation and maintenance cost is shown in the following tables and in the Supporting Report (SR-11.3).

13-6-2 Personnel Cost

Estimated annual personnel expense of PPWSA for each stage is shown in Table 13.10.

Table 13-10 Annual Personnel Cost

O&M Cost Items	2010 (Q= 65,000m^3/d)	2015 (Q= 165,000m^3/d)	2020 (Q= 265,000m^3/d)
Chrouy Changva WTP	3	3	3
New WTP	0	50	63
Booster Pump Station	12	12	12
Pipe Maintenance Staff	14	26	47
Total	**29**	**91**	**125**

(1000 US$/year)

13-6-3 Power Cost

The estimated annual power cost for electrical equipment is shown in the following table. Power tariff is based on PPWSA's records for 2005.

Table 13-11 Annual Power Cost

O&M Cost Items	2010 (Q= 65,000m^3/d)	2015 (Q= 165,000m^3/d)	2020 (Q= 265,000m^3/d)
Chrouy Changva WTP	499	470	539
New WTP	0	724	1,658
Booster Pump Station	253	253	332
Total	**752**	**1,447**	**2,529**

(1000 US$/year)

13-6-4 Chemical Cost

Annual chemical cost for Alum, Lime and Chlorine in the WTP is shown in the following table.

Table 13-12 Annual Chemical Cost

O&M Cost Items	2010 (Q= 65,000m^3/d)	2015 (Q= 165,000m^3/d)	2020 (Q= 265,000m^3/d)
Chrouy Changva WTP	71	169	310.500828
New WTP	0	0	0
Booster Pump Station	19	47	86
Total	**90**	**215**	**396**

13-6-5 Repair

The repair cost is estimated for mechanical and electrical facilities and equipment after the completion of the project. These costs assume 0.15 percent of construction cost for each year, as shown below.

Repair Cost per year

2010: US$ 78,000 per year

2015: US$ 228,000 per year

2021: US$ 296,000 per year

13-6-6 Data Base

The cost to make a database for Phnom Penh water supply system, including data updating and purchase/renewal of computer and software is estimated on a lump sum basis at US$ 50,000 every five years, that is, in 2010, 2015 and 2020. In addition, the cost for ongoing data renewal and research is estimated at US$ 10,000 per year.

13-6-7 Other Costs

These costs are for transportation, fuel, lubricants, environmental monitoring and others, which were estimated at 10 percent of total O&M cost as broken down below.

Other Cost per year

2010: US$ 100,000 per year

2015: US$ 203,000 per year

2020: US$ 340,000 per year

13-6-8 Summary of Operation and Maintenance Cost for Peri-Urban Water Supply Projects

These costs represent anticipated yearly expenditures for:

- Personnel Expense;
- Cost of facilities, equipment, operating costs, materials and supplies; and
- Cost of repairs.

Annual operation and maintenance cost for the Peri-Urban Water Supply Projects is estimated at US$ 101,000, US$ 220,000 and US$ 384,000 for each year of capacity expansion, that is, 2010 (229 wells), 2015 (497 wells) and 2020 (867 wells) respectively, as shown in Table 13-13.

Table 13-13 Annual Operation and Maintenance Cost for Peri-Urban Water Supply Projects

O&M Cost Items	2010 (229 wells)		2015 (497 wells)		2020 (867 wells)	
	O&M Cost	Ratio	O&M Cost	Ratio	O&M Cost	Ratio
- Hand Pump	98	97.0%	214	97.2%	373	97.1%
- Other	3	3.0%	6	2.8%	11	2.9%
Total	101	100.0%	220	100.0%	384	100.0%

(thousand US$/year)

The breakdown of operation and maintenance cost is shown in the Supporting Report (SR-11.3).

Chapter 14. Financial Analysis

Chapter 14. Financial Analysis

14-1 Urban Water Supply

The proposed Master Plan project for the urban water supply sector will involve a large amount of capital investment on the part of PPWSA and the Government of Cambodia. Financial analysis has therefore been undertaken to determine the financial viability of the proposed project. As part of the analysis, the following have been conducted:

- Reviewed the past and present financial performance and condition of PPWSA. The review assessed PPWSA's financial capability to contribute counterpart funding, implement the proposed project; and provide adequate funds to operate and maintain the new infrastructure on a sustainable basis together with its existing assets and on-going projects;
- Identified possible sources of funding and proposed the appropriate financing mix;
- Analyzed the current tariff structure and level, proposed the appropriate level during the operation of the project and tested its affordability; and
- Conducted detailed financial projection and analysis to examine the financial viability of the proposed project; calculated the Financial Internal Rate of Return (FIRR) and performed sensitivity analysis.

14-1-1 Review of Past Financial Performance

The PPWSA's audited financial statements for the years 2000 to 2003 and its un-audited financial statements for the year 2004 were reviewed. The objective of the review is to determine the results of the financial performance of PPWSA for the past 5 years.

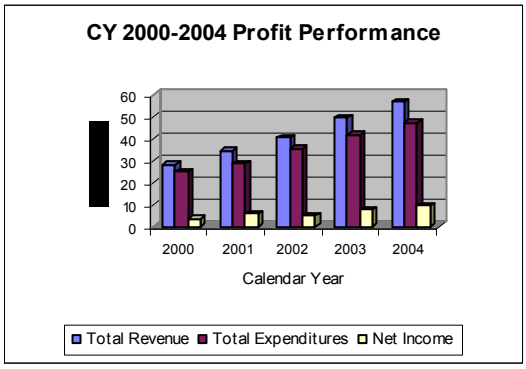
14-1-1-1 Results of Operations

The Income Statements of PPWSA for the five-year period (CY 2000-2004), which summarize the results of the Authority's operations in financial terms during the period, are presented in Table 14-1.

Table 14-1 Income Statement (Million Riels)

Item	Audited				Unaudited
	2000	2001	2002	2003	2004
Operating Revenue					
Water Sales	21,975	26,390	30,997	38,509	47,193
House Connection	3,324	3,462	5,018	5,706	5,540
Other Operating Revenue	1,078	1,288	1,010	3,401	1,589
Total Operating Revenue	**26,377**	**31,140**	**37,024**	**47,616**	**54,322**
Operating Expenses					
Personnel	2,696	3,243	4,028	4,502	4,867
Power	3,692	4,253	5,212	5,918	6,554
Materials	3,108	2,950	4,027	4,546	3,840
Chemicals	995	878	1,073	869	1,569
Maintenance	973	775	519	555	950
Taxes and Duties	15	18	28	23	68
Other Operating Expenses	1,883	1,251	1,140	1,689	1,327
Total Operating Expenses	**13,362**	**13,369**	**16,027**	**18,101**	**19,175**
Income before Depreciation	13,016	17,771	20,997	29,515	35,147
Depreciation	8,452	8,489	10,441	14,448	18,787
Net Operating Income	4,564	9,283	10,557	15,066	16,361
Other Income	2,088	3,264	3,536	1,863	2,579
Income before Interest Expense	6,652	12,546	14,092	16,930	18,940
Interest Expense	2,255	5,361	7,807	7,221	7,309
Income before Tax	4,396	7,186	6,286	9,709	11,631
Income Tax	927	1,431	1,240	2,100	2,255
Net Income	**3,470**	**5,754**	**5,046**	**7,609**	**9,376**
Key Ratios and Indicators					
Return on Revenues (%)	13.2	18.5	13.6	16.0	17.3
Return on Fixed Assets in Service (%)	1.5	2.4	1.6	1.8	2.3
Return on Equity (%)	1.3	2.1	1.8	2.0	2.4
Working Ratio (%)	50.7	42.9	43.3	38.0	35.3
Operating Ratio (%)	82.7	70.2	71.5	68.4	69.9
Average Tariff (Riel/m^3 invoiced)	776	942	947	987	965
Average Cost (Riel/m^3 invoiced)	740	841	923	897	849

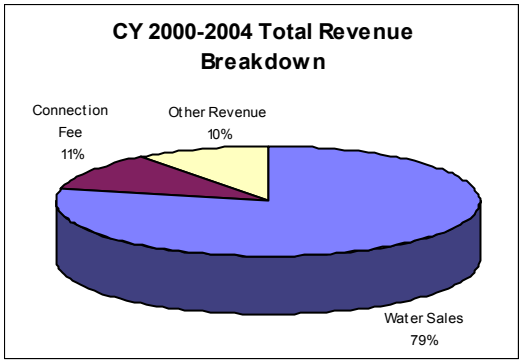
Source: PPWSA Finance Department

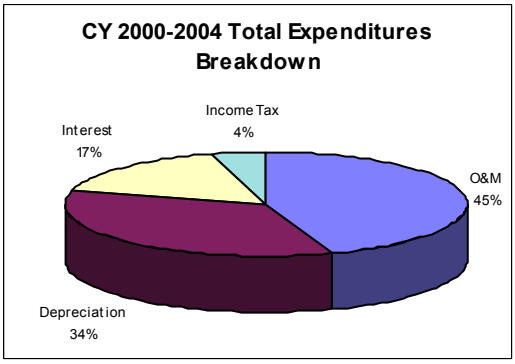


During the five-year period, Total Revenues grew at an average annual rate of 21 percent while Total Expenditures (O&M, depreciation, interest and income tax) grew at an average annual rate of 17 percent. With Total Revenues outgrowing Total Expenditures, Net Income grew significantly from Riels 3.4 billion in 2000 to Riels 9.376 billion in 2004 or an average annual growth rate of 28 percent over the period. Return on Revenues, defined as the ratio of Net Income to Operating Revenue, grew from 13.2 percent in 2000 to 17.3 percent in 2004. Return on

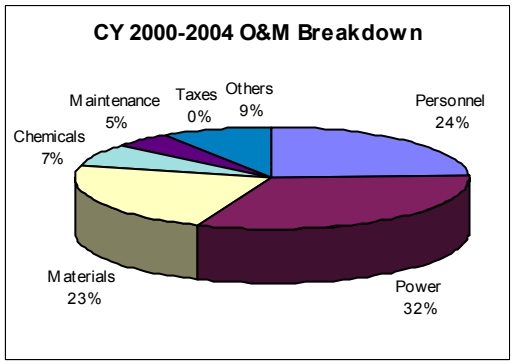
Net Fixed Assets in Service grew from 1.5 percent in 2000 to 2.3 percent in 2004 while Return on Equity also grew from 1.3 percent in 2000 to 2.4 percent in 2004.

Water sales accounted for 79 percent of Total Revenue during the period while house connection fee and other revenue contributed 11 percent and 10 percent, respectively. With regards to Total Expenditures, O&M cost accounted for 45 percent, depreciation for 34 percent, interest expense was 11 percent and income tax was 4 percent.





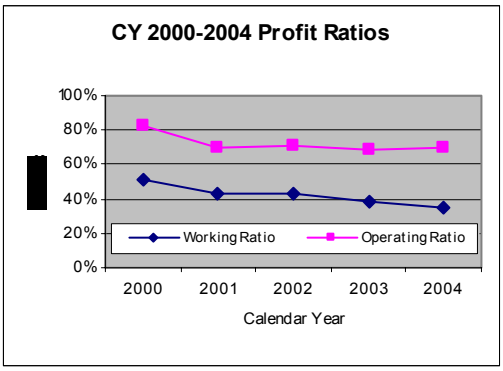
During the five-year period, Power cost was the biggest expense at 32 percent of total O&M costs followed by Personnel cost at 24 percent and Materials expense at 23 percent. Chemical expense accounted for 7 percent of O&M cost during the period while Maintenance expense contributed 4 percent. Other Operating Expenses contributed 10 percent while Taxes and Duties accounted for 0.1 percent.



The outstanding results of PPWSA's operations in financial terms could be attributed to the Authority's success in reducing Non-Revenue Water (NRW) during the period. Because NRW was significantly reduced from about 49 percent in 1999 to about 14 percent in 2004, more water became available for distribution and consumption. With more water available, the Authority was able to increase the number of its customers at an average annual rate of 24 percent and volume of water sold at 31 percent over the period. The actual number of customers and water sold together with the NRW for each year are presented below.

Year	NRW (%)	Water Sold ('000 m^3)	Number of Customers		
			Metered	Non-Metered	Total
2004	13.86	48,997	121,522	0	121,522
2003	17.01	40,134	105,777	0	105,777
2002	21.52	32,667	88,570	1	88,571
2001	22.85	28,086	74,940	5	74,945
2000	35.47	28,327	66,905	111	67,016
1999	48.50	20,313	60,096	383	60,479
1998	58.13	16,419	49,162	2,245	51,407

Source: PPWSA Commercial Department



With NRW successfully reduced, the Working Ratio, which is the ratio of Operating Expenses to Operating Revenue, improved over the period from 50.7 percent in 2000 to 35.3 percent in 2004. Operating Ratio, defined as the ratio of O&M cost plus Depreciation to Operating Revenue, also improved from 82.7 percent in 2000 to 69.9 percent in 2004. Average Profit per m3 of water sold increased three times more from Riels 37 per m3 in 2000 to Riels 116 per m3 in 2004.

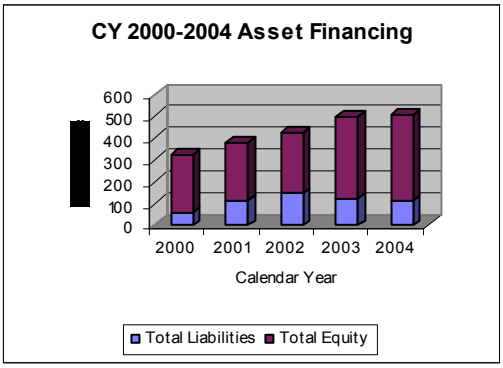
14-1-1-2 Financial Positions

The Balance Sheets of PPWSA for the five-year period (CY 2000-2004), which summarize the Authority's financial positions during the period, are presented in Table 14-2.

Table 14-2 Balance Sheet (Million Riels)

Item	Audited				Unaudited
	2000	2001	2002	2003	2004
ASSETS					
Fixed Assets					
Land	19,684	20,235	20,618	20,618	22,709
Plant in Service	242,234	248,748	337,961	447,278	466,666
Less : Accumulated Depreciation	22,949	31,360	41,785	56,197	74,607
Net Fixed Assets in Service	238,969	237,623	316,794	411,698	414,768
Construction in Progress	23,414	75,103	23,671	28,163	24,906
Total Fixed Assets	**262,384**	**312,725**	**340,465**	**439,861**	**439,674**
Current Assets					
Cash on Hand & at the Bank	22,142	29,188	45,819	25,555	40,389
Accounts Receivable	3,725	4,465	5,432	2,509	3,867
Accrued Income	6,035	5,280	5,685	9,637	7,650
Inventories	13,490	16,252	18,883	19,439	14,274
Advances Receivable	11,951	8,123	2,377	714	621
Receivable from Government	414	414	414	414	414
Bank Interest Receivable	683	1,201	1,241	347	633
Other Current Assets	359	455	624	732	500
Total Current Assets	**58,800**	**65,377**	**80,474**	**59,345**	**68,346**
TOTAL ASSETS	**321,183**	**378,102**	**420,939**	**499,206**	**508,020**
LIABILITIES & EQUITY					
Current Liabilities					
Accounts Payable	1,232	1,719	2,817	1,587	1,122
Refundable Deposits	3,849	4,345	5,258	6,926	8,913
Taxes Payable	1,788	1,971	3,246	2,854	158
Deferred Credit	798	756	0	0	131
Sewer Maintenance Payable	915	1,561	1,729	1,921	376
Interest Payable	2,217	2,960	8,288	2,402	2,513
Other Current Liabilities	826	3,073	1,982	1,524	1,889
Current Maturity of Long Term Loans	0	0	32,788	9,000	9,000
Total Current Liabilities	**11,625**	**16,384**	**56,110**	**26,214**	**24,103**
Long Term Liabilities					
ADB	15,103	29,909	38,051	39,168	39,168
IDA	28,417	56,293	41,888	44,879	43,507
Exchange rate difference	4,134	7,674	9,101	9,122	8,706
Total Long Term Liabilities	**47,653**	**93,876**	**89,040**	**93,168**	**91,381**
Total Liabilities	**59,278**	**110,260**	**145,149**	**119,382**	**115,484**
Equity					
Capital	257,342	258,324	258,324	357,514	359,964
Grants	129	220	2,878	202	200
Capital reserve	122	284	528	970	1,207
Retained earning	4,313	9,014	14,060	21,137	31,164
Total Equity	**261,905**	**267,842**	**275,790**	**379,824**	**392,536**
TOTAL LIABILITIES & EQUITY	**321,183**	**378,102**	**420,939**	**499,206**	**508,020**
Key Ratios and Indicators					
Average Collection Period (days)	61	61	63	23	29
Working Capital (months)	42	44	18	22	28
Current Ratio	5.1	4.0	1.4	2.3	2.8
Long Term Debt - Equity Ratio	0.2	0.4	0.3	0.2	0.2

Source: PPWSA Finance Department



During the five-year period, the Authority's Total Assets grew from Riels 321 billion in 2000 to Riels 508 billion or an average annual growth rate of 12 percent. During the same period, its Total Liabilities grew from Riels 59 billion in 2000 to Riels 115 billion in 2004 or an average annual growth rate of 18 percent and its Total Equity grew from Riels 262 billion in 2000 to Riels 393 billion in 2004 or an average annual growth rate of 11 percent. Although Total Liabilities outgrew Total Equity in percentage terms during the period, the Authority's asset build-up or acquisitions were financed more, in monetary terms, through equity as reflected by its low debt-equity ratio (0.2 to 0.4) during the period.

The Authority's financial position had been very liquid during the past five years. Except for the drop to 1.4 in 2002, its Current Ratio had been remarkably high at 2.3 to 5.1 during the period. The Working Capital (Current Assets minus Current Liabilities) level during the period was lowest also in 2002 at 18 months of cash operating expenses. However, the 18 month level is still considered a significantly high level of Working Capital.

The reason for the drop of its Current Ratio and Working Capital in 2002 was the Authority's decision to prepay its long-term loan as discussed in the next section. With the prepayment decision, the portion of the long-term loan which would mature in one year had been shown in the Balance Sheet as Current Liability instead of Long-Term Liability under international financial reporting standards.

The liquid financial position of the Authority during the period could be attributed to its success in implementing an efficient billing and collection system. The Average Collection Period of its customers' accounts during the period had been remarkably short at 23 to 63 days.

14-1-1-3 Cash Flow

The Funds Flow Statements of PPWSA for the five-year period (CY 2000-2004), which summarize the Authority's cash flow during the period, are presented in Table 14-3.

Table 14-3 Funds Flow Statement (Million Riels)

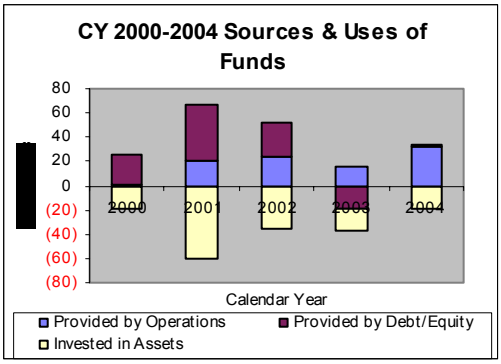
Item	Audited				Unaudited
	2000	2001	2002	2003	2004
Cash Flows from Operating Activities					
Net Income	3,470	5,754	5,046	7,609	9,376
Add: Depreciation	8,452	8,489	10,441	14,448	18,787
Prior year adjustment	104			(532)	
Loss (gain) on fixed asset disposal	5	108	(4)	34	
Fixed asset transfers		270	0		
Changes in Operating Assets and Liabilities:					
Decrease (Increase) in:					
Accounts Receivable	(514)	(740)	(967)	2,924	(1,359)
Accrued Income	(3,578)	755	(405)	(3,952)	1,987
Inventories	710	(2,762)	(2,630)	(557)	5,166
Advances Receivable	(11,270)	3,829	5,746	1,662	94
Receivable from Government	0	0	0	0	0
Bank Interest Receivable	(168)	(517)	(40)	895	(286)
Other Current Assets	293	(96)	(168)	(108)	232
Increase (Decrease) in:					
Account Payable	(663)	486	1,099	(1,231)	(464)
Refundable Deposits	712	496	914	1,668	1,987
Taxes Payable	607	182	1,275	(392)	(2,696)
Deferred Credit	478	(42)	(756)	0	131
Sewer Maintenance Payable	146	646	169	192	(1,546)
Interest Payable	1,325	743	5,328	(5,887)	112
Other Current Liabilities	156	2,247	(1,001)	(458)	365
Cash Provided By Operating Activities	**264**	**19,847**	**24,045**	**16,316**	**31,884**
Cash Flows from Investing Activities					
Purchase of fixed assets	(18,173)	(59,208)	(38,180)	(14,688)	(18,223)
Proceeds from sale of fixed assets			4		
Investment of reserve funds	(1,443)	(1,053)			
Government grants	129	92	2,568	(2,676)	(2)
Cash Used In Investing Activities	**(19,487)**	**(60,170)**	**(35,609)**	**(17,364)**	**(18,225)**
Cash Flows from Financing Activities					
Proceeds from long term liability	21,178	42,682	26,526	13,282	8,779
Repayment of loans	0	0	0	(32,963)	(9,876)
Exchange rate difference	2,102	3,541	1,426	21	(416)
Proceeds from capital stock	2,035	982	0		2,450
Retirement fund reserve	122	162	244	443	237
Cash Used In Financing Activities	**25,436**	**47,368**	**28,195**	**(19,217)**	**1,175**
Cash Increase (Decrease) During the Period	**6,213**	**7,045**	**16,632**	**(20,265)**	**14,834**
Cash at the Beginning of Period	15,929	22,142	29,188	45,819	25,555
Cash at the End of Period	**22,142**	**29,188**	**45,819**	**25,555**	**40,389**
Key Ratios and Indicators					
Debt Service Coverage Ratio	6.3	3.7	3.0	0.7	2.1
Self-financing Ratio	0.7	0.2	0.4	(0.7)	1.0

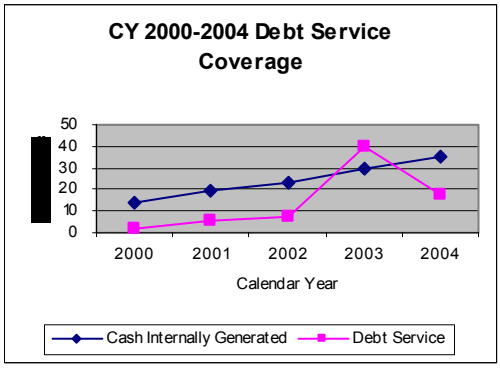
Source: PPWSA Finance Department

The Authority's sources and uses of funds during the five-year period showed significant funding contribution from operations for asset investment. This was due to the remarkable improvement of the Authority's internal cash generation capability which grew at an average annual rate of 26 percent during the period. With improved internal cash generation, the Authority's Debt Service Coverage Ratios (DSCR) of 2.1 to 6.3 and Self-Financing Ratios (SFR) of 0.2 to 1.0 during the

period were significantly high except that in 2003. The Authority's prepayment in 2003 of its loan not yet due lowered the DSCR and SFR for the year.

Because of its liquid cash position resulting from an efficient billing and collection system, the Authority decided in 2002 to prepay its International Development Association (IDA) loan (Credit No. 3041 KH) and shorten its repayment period from the original of 34 semi-annual installments (17 years) to 12 semi-annual installments (6 years) commencing from 15 September 2002. The Ministry of Economy and Finance (MEF) accepted the Authority's early repayments on 17 March 2003.





14-1-2 Review of Existing Tariff

14-1-2-1 Characteristics

The existing water tariff of PPWSA which took effect in 2001 is presented below together with the 1997 tariff for comparison.

Table 14-4 Water Tariff (Riels/ m^3)

Category	Consumption (m^3/month)	Effective 1997	Effective 2001
Domestic	0 to 7	300	550
	8 to 15	300	770
	16 to 30	620	1,010
	31 to 50	940	1,010
	51 to 100	940	1,270
	> 100	1,260	1,270
Administration & RDE		940	1.030
Industrial and Commercial	0 to 100	940	950
	101 to 200	1,260	1,150
	201 to 500	1,580	1,350
	> 500	1,900	1,450

Source: PPWSA Commercial Department

As per the schedule, PPWSA has 3 customer categories: domestic, administration (i.e. government institutions) and industrial/commercial.

The rising consumption blocks of the domestic category have been reduced from 6 in 1997 to 4 blocks effective 2001. Industrial/commercial category has remained the same at 4 consumption blocks. Each consumption block has a different rate per m^3. As the customers' consumption increases, the rate per m^3 increases. The administration category is charged a flat or single rate.

14-1-2-2 Tariff Level

The average tariffs for the overall and each customer category since the existing tariff took effect in 2001 are presented below.

Table 14-5 Average Tariff (Riels/m^3 Sold)

Category	2001	2002	2003	2004
Domestic	851	855	857	874
Commercial	1,101	1,102	1,134	1,158
ADM	1,030	1,030	1,030	1,030
RDE-wholesaler	1,030	1,030	1,030	1,030
Overall Average	943	943	954	973

Source: PPWSA Commercial Department

During the same period, the average costs per m^3 sold were as follows:

Table 14-6 Average Cost (Riels/m^3 Sold)

2001	2002	2003	2004
841	923	897	849

Source: PPWSA Finance Department

In 2002 and 2003, the domestic consumers were cross-subsidized by the other consumers. The average tariffs for domestic consumers during those years were lower than the average costs to produce and deliver water supply service.

From the cost recovery viewpoint, the tariff at present is considered a full cost recovery tariff as shown by the profitable operations of PPWSA. In addition to being a full cost recovery tariff, it is also considered an affordable one. The average monthly household water bill (Riels 20,000) is just 2 percent of the average monthly household income (Riels 1.14 million) in Phnom Penh. The generally accepted guideline on affordability is that the water supply charges should not exceed 4 percent of household income. To arrive at the average monthly household water bill of Riels 20,000, the existing number of persons per household connection of 9.5 and the current average domestic consumption of 80 lpcd were used.

PPWSA charges connection fee in accordance with the customer's meter size and distance from PPWSA pipe. The connection fees are as follows:

Table 14-7 Connection Fee (Riels)

Distance from PPWSA pipe to residence	Meter Size				
	15 mm	20 mm	25 mm	30 mm	40 mm
0 to 10 m	338.400	407.700	549.100	779.800	1.138.700
>10 to 20 m	340.800	516.200	673.500	924.750	1.313.900
>20 to 30 m	527.000	582.200	797.800	1.072.600	1.489.700
>30 to 40 m	624.300	690.700	922.300	1.220.800	1.665.400
>40 to 50 m	720.900	799.400	1.046.600	1.368.800	1.841.200

Source: PPWSA Commercial Department

Thus, the minimum cost to the customer for applying for a 15-mm service for example, will be:

Basic fee, includes service lines		338,400	
VAT (10%)		33,840	
Deposit		75,480	
	Total	447,720	about $112

The existing connection fees are relatively high and unaffordable to low income households. To enable the poor families to have access to the Authority's piped water system, PPWSA has introduced starting in 1999 a scheme allowing poor families to get house connections through payment of connection fees in installment (10, 15 or 20 months) under certain eligibility requirements. Since its implementation, the installment payment scheme has already installed new connections to 9,514 poor families as follows:

Table 14-8 Poor Households Connected under Installment Payment Scheme

1999	2000	2001	2002	2003	2004	Total
101	474	2,134	1,257	2,742	2,806	9,514

Source: PPWSA Finance Department

From 1999 to 2004, PPWSA's new domestic connections totaled 62,204. The number of poor households connected through the installment payment scheme is remarkably significant as it represented about 15 percent of new domestic connections during the period.

Under IDA Grant No. H034-KH, PPWSA is currently implementing a program that will subsidize the cost (30%-50%-70%) of new house connections for poor households under certain eligibility requirements. PPWSA has allotted US$ 272,000 under the program.

14-1-2-3 Sewerage and Sanitation

PPWSA presently collects a sewerage surcharge from its customers at the rate of 10 percent of the water bill. The surcharge is not recorded as revenue of PPWSA but is treated as a liability to the Department of Public Works and Transport of the Municipality of Phnom Penh.

14-1-3 Financing Scheme

14-1-3-1 Existing Sources

In line with its mandate, the sources of finance for PPWSA are water and related charges collected from its customers, capital infusion and grants from the Government of Cambodia, grants and loans from the multilateral and bilateral financial institutions.

As of December 31, 2004, the total equity of PPWSA amounted to Riels 392.536 billion and outstanding long-term liabilities amounted to Riels 91.675 billion. The outstanding long-term liabilities are due to the Asian Development Bank at Riels 39.168 billion and the World Bank at Riels 52.507 billion.

The Authority is currently using funds from the World Bank soft loan (IDA Credit No. 3746-KH and Grant No. H034-KH) and grant from the French Agency for Development (AFD Grant No. 1055) for the expansion of the Water Supply System in Phnom Penh peri-urban areas. The Japan International Cooperation Agency (JICA) is supporting through grant the Project on Capacity Building of Water Supply System in Cambodia that focuses on Long-Term Human Resources Development Program.

14-1-3-2 Future Possible Sources

The sources of finance for the Master Plan project would possibly come from capital infusion and grant from the Government of Cambodia, PPWSA's generated funds from operations, loan and grant from multilateral and bilateral financial institutions such as the World Bank, the Asian Development Bank, the Japan Bank of International Cooperation and the French Agency for Development. Through the years, the Government of Cambodia with assistance from the various international financial institutions has strongly supported PPWSA's plan for the expansion of its production capacity and distribution network.

Based on PPWSA's financial condition and capability to contribute counterpart funds, the proposed Master Plan project is assumed to be funded through 60 percent loan and 40 percent equity. For financial analysis purpose, the loan is assumed to carry an interest rate of 8.5 percent per annum with a repayment period of 25 years, inclusive of a 5-year grace period.

Table 14-9 Urban Water Supply Financing Scheme (in Millions)

Sources	Stage 1		Stage 2		Stage 3		Total	
	Riels	US$	Riels	US$	Riels	US$	Riels	US$
Loan	175,944	43.44	398,046	98.28	203,494	50.25	777,484	191.97
Equity	117,296	28.96	265,364	65.52	135,663	33.50	518,323	127.98
Total Sources	293,240	72.40	663,410	163.80	339,157	83.74	1,295,807	319.95
Project Cost	293,240	72.40	663,410	163.80	339,157	83.74	1,295,807	319.95

14-1-4 Financial Projections

14-1-4-1 Assumptions

The assumptions used in the financial projections are discussed below. The assumptions are categorized into General, Income Statement, Balance Sheet and Cash Flow items.

(1) General Assumptions

a) Local inflation factor is assumed at 3 percent.

b) The exchange rate used for converting the capital cost estimates from US$ to Riels is Riels 4,050. No currency devaluation is assumed in the projection.

c) Past performance of PPWSA has been taken into consideration in formulating realistic assumptions for revenues and expenses and balances of assets and liabilities.

d) The projected financial statements (Income Statement, Balance Sheet and Funds Flow Statement) are presented in million Riels and in current prices. The financial statements cover the overall operations of the PPWSA, including the on-going (funded by the Agence Française de Développement [AFD] and the World Bank) and the proposed Master Plan investment projects with their associated financing schemes.

e) The estimated economic life of each project in the proposed Master Plan is assumed at 25 years. With the estimated completion of the Master Plan's Stage 3 project in year 2020, the projection period is up to year 2045.

(2) Income Statement

a) The volumes of water produced and sold, non-revenue water, including the growth in service connections, are based on the water demand analysis.

b) Average tariff used in 2005 for each customer category is equivalent to the 2004 average tariff with no increase. Every year up to 2020, tariff is assumed to increase at a rate equivalent to inflation. Startng 2021, tariff is assumed to increase at 1 percent above inflation rate.

c) New connection fee is assumed to remain at the current level to encourage non-PPWSA customers to shift to PPWSA piped system.

d) Interest income is calculated at 6 percent of interest-earning deposit balance at the start of the year.

e) Penalties and fines are calculated at 0.1 percent of water sales.

f) Operation and maintenance costs are based on PPWSA current cost and operating efficiency levels. Their unit costs are assumed to increase each year equivalent to inflation. The bases for their computation are as follows:

Item	Basis of Calculation
Chemicals	Riels 28 per m^3 of water produced
Power	0.24 KwH per m^3 of water produced up to year 2008; thereafter at 0.27 KwH per m^3 of water produced at Riels 490 per KwH.
Transport Maintenance	Riels 5.4 million per vehicle; 77 vehicles in 2005 increasing thereafter by 5 every 5 years.
Facilities Maintenance	0.14% of Net Fixed Assets value; percent increasing by 5% each year.
Personnel (Salary, Allowance and Bonus)	Riels 4.78 million net salary per employee increasing each year by 20% up to year 2009 then thereafter at inflation rate; Riels 6.58 million other allowances per employee increasing each year at inflation rate; 450 employees in 2005 increasing thereafter at the ratio of 3.5 employees to 1,000 service connections. Bonus is 25% of annual net salary (equivalent to 3 months net salary).
General and Administrative	Riels 1.5 million per employee
Bad Debts	1% of Accounts Receivable balance at the start of the year
Other Operating Expenses	Riels 6,619 per service connection

g) Depreciation is calculated using a composite rate of 3 percent on the gross value of Fixed Assets in Service.

h) Exchange rate difference refers to the exchange gain recorded by PPWSA on loan repayments. This situation has occurred since PPWSA's loan obligations are fixed at the exchange rate prevailing at the date of withdrawal of loan proceeds while the Ministry of Economy and Finance bears the foreign exchange risk at the time of repayment. The exchange rate difference is amortized over the useful life of the asset financed by the loan as per PPWSA accounting policy. Amortization is assumed at 4 percent or 25 years, the assumed economic life of the asset.

i) Interest expense is calculated based on the individual (outstanding and proposed) loans' debt service schedule and interest rate.

j) Income tax is computed at 20 percent on net income before tax in accordance with the Cambodian income tax rules.

(3) Balance Sheet

a) Additions to Construction Work in Progress are based on the disbursement schedule of the on-going and proposed Master Plan projects.

b) Additions to Fixed Assets in Service are based on the completion schedule of the on-going and proposed Master Plan projects.

c) Interest during construction is not capitalized in accordance with PPWSA's accounting policy that all borrowing costs are expensed to the Income Statement.

d) Cash is assumed at 3 months operating expenses.

e) Accounts Receivable is assumed at 1.3 months (40 days) of water sales.

f) Prepaid Items and Advances are assumed at 3 percent of Construction Work in Progress.

g) Inventories and Spares are assumed at 3 months of chemicals, transport and facilities maintenance and other operating expenses.

h) Interest Receivable is assumed at 3 months of interest income.

i) Connection and Other Receivable is assumed at 3 months of installation charges.

j) Accrued Income – Unbooked Consumption is assumed at 1 month of water sales.

k) Accounts Payable is assumed at 2 months of operating expenses.

l) Sewerage Surcharge Payable is assumed at 2 months of 10 percent of water sales.

m) Taxes Payable is assumed at 3 months of income taxes.

n) Interest Payable is assumed at 6 months of interest expense.

o) Guarantee Deposit is equivalent to the deposit balance at the start of the year plus the three months deposit of new customers at the prevailing tariff during the year.

p) Other Payables are assumed at 2 months of salary and allowances.

q) Outstanding balances of long term loans are calculated based on their individual repayment schedule.

r) Capital investment financing for the Master Plan projects is assumed at 60 percent equity and 40 percent loan. Loan repayment period is assumed at 25 years, including 5 years grace period, at an interest rate of 8.5 percent per annum.

(4) Cash Flow

a) The Working Capital Needs are based on the increases/decreases in the balances of the working capital items as per their assumed balances during the year.

b) The debt service payments are based on the individual loan debt service schedule.

c) The capital investment requirements are based on the individual projects disbursement schedule.

d) The financing requirements are based on the individual projects disbursement schedule and the financing scheme (loan-equity ratio) arranged for each individual project.

14-1-4-2 Results of Financial Projection

The results of the financial projection containing the Income Statement, Balance Sheet, Funds Flow Statement, Summary of Key Financial Indicators, Investment Program, Borrowings Summary, Water Demand and Production and Operating Costs from 2005-2045 are presented in detail in the Supporting Report (SR-12). Table 14-10 below is a summary of the results at 5-year interval from 2005-2045.

The following are the key observations on the results of the financial projection:

- During the projection period (2005-2045), PPWSA would have net profit each year. This indicates that PPWSA's tariff level during the projection period is a full cost recovery tariff. PPWSA's projected tariff could recover the full cost of its operations plus depreciation and financing charges as long as the tariff keeps pace with inflation.
- PPWSA's financial condition during the projection period is healthy and it is able to repay its debts as they fall due. Should PPWSA be able to secure financing schemes with better conditions in terms of lower interest rate and longer repayment period that those assumed in the financial projection, PPWSA would have a much healthier financial condition. With lower interest rate, financing charges are reduced. With longer repayment period, the annual amount of loan principal repayment is reduced.
- PPWSA can implement on a sustainable basis the proposed Master Plan project, together with its existing assets and on-going projects, with no negative impact on its financial condition even without the benefit of a tariff increase in real terms till 2020.

Table 14-10 Summary of Key Financial Indicators

	2005	2010	2015	2020	2025	2030	2035	2040	2045
OPERATING RESULTS									
Operating Revenues	47,338	68,203	98,532	146,463	224,477	345,078	439,025	546,843	681,140
Operating Expenses	15,407	25,097	37,244	56,312	81,792	116,299	137,193	158,515	182,539
Net Income	10,127	7,114	3,452	18,357	67,211	161,599	271,467	423,385	636,767
Cash from Operations	31,411	40,893	59,407	83,893	128,687	209,775	310,360	457,109	670,058
Operating Ratio	60%	60%	62%	54%	50%	40%	33%	26%	21%
Total Assets	529,093	748,574	1,304,066	1,553,750	1,581,342	2,009,594	2,998,759	4,756,003	7,506,051
Working Capital	45,491	8,038	5,611	17,564	90,026	634,653	1,726,198	3,591,743	6,487,092
Working Capital (Days)	1,063	115	54	112	396	1,965	4,530	8,157	12,794
OPERATING EFFICIENCY									
Service Connections	124,902	159,760	208,218	280,575	354,988	437,116	445,742	445,742	445,742
Average Tariff (Riels/m^3)	972	1,122	1,290	1,480	1,833	2,271	2,830	3,525	4,391
Growth in Connections (%)	2.9%	4.6%	4.9%	5.4%	4.8%	2.5%	0.0%	0.0%	0.0%
Water Sold ('000 m^3)	48,692	60,783	76,392	98,949	122,450	151,950	155,125	155,125	155,125
Non-Revenue Water (%)	15%	15%	15%	15%	15%	15%	15%	15%	15%
Capacity Utilization (%)	67%	65%	62%	64%	79%	98%	100%	100%	100%
FINANCIAL PERFORMANCE RATIOS									
Accounts Receivable (Days)	40	40	40	40	40	40	40	40	40
Current Ratio	3.59	1.28	1.13	1.28	2.18	7.38	16.71	30.05	45.80
Debt/Equity Ratio	0.21	0.44	0.70	0.60	0.31	0.10	0.01	0.00	0.00
Debt Service Coverage	1.98	1.18	1.18	1.19	1.91	4.67	8.70	43.09	0.00
Self Financing Ratio	0.94	4.79	0.23	2.03	1.0				
Return on Revenues	21.4%	10.4%	3.5%	12.5%	29.9%	46.8%	61.8%	77.4%	93.5%
Return on Assets	2.4%	1.6%	0.6%	3.2%	9.0%	23.7%	47.7%	94.8%	227.4%
Return on Equity	2.4%	1.4%	0.5%	2.0%	6.0%	9.5%	9.6%	9.1%	8.7%

Source: Consultant's Financial Projections

14-1-4-3 Affordability by the Poor

With the proposed Master Plan project, the average domestic water consumption is envisaged to increase from the current level of 80 lpcd to 104 lpcd in 2020 while the tariff would increase equivalent to inflation rate. As a result of higher water consumption, the monthly household water charges will naturally rise. An analysis has therefore been undertaken to determine if the beneficiaries, in particular the low-income families, could afford to pay their estimated monthly water bills in 2020. The generally accepted guideline is that the charges for water supply should not exceed 4 percent of household income.

The overall average consumption of 104 lpcd in 2020 translates to an average monthly household consumption of 23 m^3 using year 2020's targeted size of 7.3 persons per house connection. There are no statistics data available for water consumption by income group. For purpose of the analysis, it is assumed that the lowest 20 percent income group (poorest) would consume an average of 70 lpcd, which is 75 percent more than the minimum human needs of 40 lpcd. The second quintile is assumed to consume 20 percent more (84 lpcd) than the lowest income group, the third quintile at 50 percent more (105 lpcd), the fourth quintile at 75 percent more (123 lpcd) while the highest quintile (rich families) at 100 percent more (140 lpcd) than the poorest. In 2020, the proposed average domestic tariff is Riels 1,363/m^3 at current price. Stated at constant 2005 price, the year 2020 proposed average domestic tariff is Riels 888/m^3. The average household income gathered in the socio economic survey in 1999 by the National Institute of Statistics, Ministry of Planning has been used in the analysis. It is considered that the survey data, which are conservative for the purpose of the analysis, are still applicable at the current time. The result of the affordability test is shown in Table 14-11.

Table 14-11 Household Affordability Test

Income Group	Average HH Income * Riels/mo.	Water Used in 2020 (m^3/mo.)	Water Bill in 2020 at Constant 2005 Price	
			Riels/mo.	% to HH Income
Lowest 20%	425,295	15	13,660	3.2%
Second Quintile	651,284	18	16,392	2.5%
Third Quintile	832,545	23	20,490	2.5%
Fourth Quintile	1,115,767	27	23,905	2.1%
Highest Quintile	2,669,104	31	27,320	1.0%
All Groups	1,139,553	23	20,229	1.8%

The above affordability test shows that the proposed tariffs during the implementation of the proposed project are within the 4 percent affordability limit and would still be affordable to the beneficiaries, including the low-income families.

In addition to an affordable proposed tariff, the current connection fee is proposed to remain at the same level during the implementation period, as reflected in the financial projection, to make it

affordable to the low-income families and encourage the shift to the PPWSA piped system. Apart from not increasing the connection fee, PPWSA is encouraged to continue and expand the system of installment payment of the connection fee by low-income families.

14-1-5 Recommendations and Proposals

14-1-5-1 Collection Efficiency

The Authority's existing collection efficiency of customers' accounts is very remarkable with Accounts Receivable balance at 29 days of water sales. The Authority should continue with its efforts not only to maintain but to improve its collection efficiency. With government institutions' accounts dragging down the Authority's efficiency, PPWSA should try to explore a payment mechanism with the MEF wherein government institutions' long over due accounts with PPWSA could be settled out of the government institutions' unreleased budget funds from the government.

14-1-5-2 Project Loans

Although the financial projections have demonstrated that PPWSA can afford loans with repayment period of 25 years inclusive of a 5-year grace period at an interest rate of 8.5 percent, PPWSA should try to secure loans for its Master Plan projects with better repayment conditions. The Japan Bank for International Cooperation is one possible source that could provide longer repayment period (40 years inclusive of 10-year grace period) and lower interest rate (1 percent).

14-1-5-3 Tariff

The current rising block tariff scheme is well-intended to cross-subsidize poorer households. However, it may actually be perversely subsidizing the affluent consumers instead. The theoretical reason for this is that all households receive the same subsidized blocks but the average size of poor households is considerably larger than affluent households. Therefore, on a per capita basis, the affluent receive a disproportionate share of the subsidy, regardless of who pays for it. The scheme is based on the unverified assumption that affluent household accounts have larger water bills and will therefore wind up paying for the subsidy even though they themselves also enjoy it. However, not only is the average poor household larger, it is also more likely to share a common connection with other families, potentially resulting in larger bills and thus a greater portion of total consumption charged at the "overpriced" rather than subsidized rates. In other words, poor people may very well be financing a subsidy which is disproportionately enjoyed by affluent individuals. The objective facts of this matter are not clearly established.

More detailed investigation is necessary to fully reveal the actual distribution of the costs and benefits of the rising block tariff scheme and the possible alternatives that might be considered to improve the efficiency and targeting of the subsidy to poor people.

PPWSA is already providing direct subsidies for reducing the initial cost of connection (about $112) for poor households. Applicants must apply for the subsidy and their application is checked by PPWSA against specific eligibility criteria. This subsidy is means-tested and effectively targeted. It may therefore be recommendable to increase and expand it, perhaps as an offset to reducing or eliminating altogether the untargeted subsidy provided unevenly to all consumers under the rising block scheme. Consideration could also be given to a targeted "rebate" scheme, whereby poor households that have would qualify for a subsidized connection can bring their paid bills to PPWSA at the end of the year and apply for a retroactive discount. Eventually, such a scheme could be integrated or packaged with other means-tested basic needs or welfare assistance programs (food, electricity, health, education, etc.). In general, however, the monthly bill is not understood to be such a heavy burden on poor households, rather, the problem is the connection fee. This proposition also needs to be tested.

14-2 Peri-Urban Water Supply

The Government of Cambodia has recently adopted the Rural Water Supply and Sanitation (RWSS) policy. The policy outlines the government's vision for the sector, the roles and responsibilities of the different stakeholders, the planning process, standards, private sector participation, and monitoring and evaluation system in the sector. The following items are provisions in the policy document that are relevant to the economic and financial aspects of the peri-urban water supply component in the proposed Master Plan:

- Water has both an economic and social value;
- Special consideration must be given in project design to ensure that those community members with limited ability to pay are not excluded from the basic level of service but are supported through appropriate incentives and/or subsidies;
- Specific roles of the central government shall include, among others: secure financing for the sector; provide rural water supply services to poor community in an emergency case and in any area where the private sector do not have possibility to supply;
- The Government can help poor communities acquire the basic level of service through targeted subsidies that will help such communities afford the investment;
- The community's roles and responsibilities shall include, among others: establish water and sanitation user groups (WSUG) for the transparent and sustainable operation and management of water services; contribute to the implementation and the construction of water supply and sanitation facilities, including financing, labor, materials and other forms of contribution;

- The primary responsibility of the WUSG is to ensure the sustainability and transparency of RWSS services at the community level, through system planning, management, operation and maintenance, and promoting a sense of ownership;
- The capital costs of RWSS services should partly be borne by the community;
- Communities shall pay all recurrent costs of RWSS services.

14-2-1 Financial Projections

Consistent with the policy of the government for the RWSS sector, the following are the assumptions used in the financial projections:

- The WSUG shall be responsible for arranging the counterpart contribution from the community for the capital investment, operation and management of the facilities, the collection of water charges from the beneficiaries and the management of finances.
- The estimated capital investment shall be financed through grant (88 percent of capital investment) from the government and 12 percent equity from the beneficiaries in the form of labor and local materials. It is assumed that the government will secure financing for the grant portion of the investment either in the form also of a grant from bilateral or multilateral institutions or a soft loan having a long repayment period (35 to 40 years) and low interest rate (1 percent or less).

Table 14-12 Peri-Urban Water Supply Financing Scheme (in Millions)

Sources	Stage 1		Stage 2		Stage 3		Total	
	Riels	US$	Riels	US$	Riels	US$	Riels	US$
Grant	31,865	7.868	38,325	9.463	57,182	14.119	127,372	31.450
Equity	4,151	1.025	5,226	1.290	7,798	1.925	17,175	4.241
Total Sources	36,016	8.893	43,551	10.753	64,980	16.044	144,547	35.691
Project Cost	36,016	8.893	43,551	10.753	64,980	16.044	144,547	35.691

- Based on the affordability limit of 4 percent of monthly household income of Riels 170,447 (average monthly income of poorest 20 percent of rural households), the proposed monthly water charge is Riels 6,500 per household, about 3.8 percent of household income. This is projected to increase at the inflation rate of 3 percent annually.
- The average annual operation and maintenance (O&M) cost per well is estimated at about Riels 1.8 million. This is projected to increase at the inflation rate of 3 percent annually.

14-2-2 Conclusion and Recommendation

Based on the above assumptions, the proposed water charge can recover 100 percent of the O&M cost and about 20 percent of the annual depreciation charges. The amount collected from the partial recovery of depreciation charges shall be deposited and accumulated for future use in the rehabilitation of the well facility to ensure sustainability of operations.

Chapter 15. Evaluation of the Master Plan

Chapter 15. Evaluation of the Master Plan

15-1 Technical Evaluation

Served population will reach 2.08 million or 90.4 percent of total population in the area at 2020 by PPWSA and well water supply, and 1.87 million or 81.0 percent of population in the area by PPWSA piped supply only.

Total production capacity will be enlarged to 500,000 m^3/day, which will satisfy the projected maximum daily demand of 414,600 m^3/day in 2020. Water tank and distribution pipes will be extended and enforced to secure 24-hour/day water supply.

Safe and clean water meeting the National Water Standard will be supplied by the existing and new water treatment plants with proper and affordable treatment processes.

The water supply development plan can fulfill the target securing stable water supply up to the year 2020.

In the course of executing the Master Plan, PPWSA should continue to monitor the following:

1) Periodic review of water supply framework

Since the water demand projection uses some assumptions based on past data and trends, it is necessary to confirm the actual consumption, review the demand projection and, if necessary, for adjust the development plan.

2) Protection of water sources

Some water sources for water supply are deteriorating due to rapid population growth and urbanization in the area. It is strongly recommended to set up a water sources protection program to minimize the contamination of water sources in the future.

3) Proper maintenance and periodic replacement/rehabilitation

New construction or expansion projects can be done using assistance of international donor or bilateral funds, but daily maintenance or periodic replacement/rehabilitation is sometimes difficult to implement due to limited local fund. This daily maintenance or periodic replacement/rehabilitation is indispensable to secure the performance of the existing facilities.

4) Establishment of supplied water quality control

Supplied water at user's end point will deteriorate due to longer transmission. Therefore, it is recommended to monitor water quality at the tap to fully achieve the National Drinking Water Standard.

15-2 Environmental Evaluation

JICA categorized this Master Plan project as Category B. The proposed Master Plan project will have mostly beneficial impacts. Although some adverse impacts will occur during the construction and operation stage of the project, minimization of environmental disturbances such as noise and dust during construction will be considered in the detailed design, and appropriate environmental management requirements will be incorporated in the specifications of construction contracts. All contractors will be required to reinstate affected areas to their original or better condition. Adequately planned preventive maintenance programs will be developed for all facilities constructed under the Project, and safe working practices at international standards will be adopted in both the construction and operational phases.

In order to assure that the proposed mitigation plan, described in section 10-8-1, Environment Mitigation Plan will be adequately conducted, the related agencies should monitor those activities as recommended in section 10-8-2 “Environmental Monitoring Plan”.

15-3 Socio-Economic Evaluation

The Cambodia Millennium Development Goals (CMDGs) establish the key underlying coverage targets for the development of this Master Plan. Actually, the Master Plan envisages exceeding the CMDG with respect to urban coverage ratio in the Phnom Penh City center, which will continue to be supplied as at present with PPWSA safe water at a level of approximately 100 percent. The peri-urban and rural areas will attain average clean water coverage in excess of 80 percent, which also meets or exceeds the relevant CMDGs. In this sense the Master Plan fully complies with the relevant national and international targets.

Although difficult to measure, the benefits of improved water supply will be significant in both quantitative and qualitative terms. The economic evaluation presented later in this chapter provides a limited quantification of the benefits of executing the Master Plan, but this must be considered an underestimation in relation to the many unquantifiable benefits to the health and quality of life of the beneficiaries.

The expected benefits from achieving the CMDG clean water coverage targets include improved public health overall and reduction of infant and maternal mortality associated with water-born disease. Improved water supply in rural areas also reduces the burden of fetching water that typically falls on women and children, which may contribute indirectly to greater rural labor force productivity and improved school attendance and educational achievement of children.

In urban and peri-urban areas, improved water supply from the Central Distribution System (CDS) is an aid to industrial development. Water supply is among the critical infrastructure requirements for the types of labor-intensive, light manufacturing industries that the RGC has

targeted for promotion in its industrial policy, and such infrastructure expansion is among the specific RGC objectives for supporting the industrial sector.

On the negative side, it must be mentioned that expanded water supply inevitably results in greater production of wastewater. Preparation and implementation of a parallel Master Plan for drainage and sewerage in the Study Area is urgently necessary, in particular to ensure that the health benefits from improved water supply are not lost on account of deterioration in sanitary and environmental conditions. Chapter 7 of the present study documented the dramatic loss of lake and marsh areas, especially in the northern area, that have traditionally provided a certain level of natural treatment of wastewater flowing from the City through the lake/marsh areas to the Tonle Sap and Tonle Bassac rivers, which surround the City. The treatment capacity of these natural bodies is already on the verge of exhaustion. Combined with steady growth in population and probable continued loss of these critical habitats, the quality of the water bodies themselves, as well as the effluent flowing from them into the afore-mentioned rivers, can be expected to deteriorate very significantly during the coming years. Planning and preparation of counter-measures, in addition to those already undertaken previously with JICA's assistance, should begin as soon as possible.

15-4 Financial Evaluation

The financial viability of the Master Plan project is assessed by comparing the project's Financial Internal Rate of Return (FIRR) with the Financial Opportunity Cost of Capital (FOCC). As proxy for the FOCC, the Weighted Average Cost of Capital (WACC) of the project in real terms is used. FIRR is the discount rate that equalizes the present values of costs and revenues over the project life while the WACC represents the cost incurred to implement the project. If the project's FIRR is higher than its WACC, the project is considered financially viable.

15-4-1 Urban Water Supply

The WACC of the proposed project is 3.84 percent (real terms). The calculation of the WACC is shown in the table that follows.

Table 15-1 Weighted Average Cost of Capital

Particulars	Loan	Grant	Equity	Total
Weight (%)	60.00%	0.00%	40.00%	100.00%
Nominal Cost (%)	8.50%		9.00%	
Tax Rate (%)	20.00%		20.00%	
Tax Adjusted Nominal Cost (%)	6.80%		7.20%	
Inflation Rate (%)	3.00%	3.00%	3.00%	
Real Cost (%)	3.69%	0.00%	4.08%	
Weighted Component of WACC (%)	2.21%	0.00%	1.63%	
Weighted Average Cost of Capital (Real)				3.84%

The assumptions and approach used in the calculation of the FIRR include:

- All revenues and costs are stated at constant May 2005 prices. Price contingencies in the capital cost estimates, interest income and interest expense have been excluded in the analysis.
- All revenues and costs are calculated on an incremental basis, i.e. difference between "with project" and "without project" situations.
- Capital expenditures are recognized at the time they are incurred.
- Replacement costs for equipment have been included every 10 years.

Sensitivity analyses have also been carried out to determine the possible effects of adverse changes on the project. These adverse changes are:

- 10 percent increase in capital costs
- 10 percent increase in O&M costs
- 10 percent decrease in revenues

15-4-1-1 FIRR and Sensitivity Analysis

The details of the FIRR calculation and sensitivity analyses are shown in the Supporting Report. The results of the calculation and analyses are summarized in the table below.

Table 15-2 FIRR and Sensitivity Analysis

Particulars	NPV @ WACC Million Riels	FIRR (%)	SI *	% Change
Base Case	184,284	5.19%	-	-
10% Increase in Project Costs	115,576	4.64%	1.18	10%
10% Increase in O&M Costs	135,896	4.85%	0.70	10%
10% Decrease in Revenue	48,760	4.22%	2.29	10%

* SI – Sensitivity Indicator

Under the base case scenario, the project's FIRR is higher than its WACC. With its FIRR higher than its WACC, the project is considered financially viable.

The results of the sensitivity analysis show that under the three adverse changes (increase in capital and O&M costs and decrease in revenues), the project's financial viability is not greatly affected as the project's FIRR is still higher than the project's WACC. Among the adverse changes, the project's financial viability is most sensitive to decrease in revenues.

If lower cost financing from highly concessional funding sources such as the Japan Bank for International Cooperation can be obtained, the WACC will be considerably reduced (from 3.84% to potentially as little as 0.35% in the case of a long-term loan at 1%, as shown in the Supporting Report) and the result will be a significant improvement in the FIRR. This would provide an additional margin of financial security to PPWSA ensuring the financial viability of the project and the institution.

15-4-1-2 Project Sustainability

The results of the financial projection (in chapter 14) show that the proposed Master Plan project can be implemented, together with PPWSA's existing assets and on going projects, on a sustainable basis. Throughout the economic life of the proposed project, PPWSA can generate sufficient revenues to cover the costs of operating and maintaining the proposed project, together with the existing assets and on going projects, and repay all its debt service obligations as they fall due.

15-4-2 Peri-Urban Water Supply

The proposed project, just like other peri-urban water supply projects, is not financially viable as reflected in the government's policy for the sector. Due to consideration of affordability by the beneficiaries, the water charges cover only the O&M cost and part of the depreciation charges. Under such situation, its FIRR is negative. The proposed project, however, is recommended for implementation on the basis of its economic viability as discussed in the next section.

15-5 Economic Evaluation

The economic analysis is an evaluation of the effectiveness of the proposed project in terms of socio-economic factors not considered in the financial analysis. The analysis aims to assess the attractiveness of the project in terms of both the quantifiable and non-quantifiable benefits and costs that may accrue with its implementation.

With the implementation of the proposed project, significant benefits, both direct and indirect, could be attained. Direct benefits are the delivery of water in greater quantity on a more reliable basis, better water quality, improved health and environmental conditions, and increase in consumer satisfaction. Indirect benefits, on the other hand, are increased productivity of the residents in the service area, employment and livelihood opportunities for the residents of the municipality and outlying areas, increase in land values in the service area, increase in the marketability of housing and real estate properties in the service area, and reduction in or avoidance of fire damages in the service area.

Correspondingly, the realization of the project will incur, besides costs of the investment and of operating and maintaining the water supply system, other direct and indirect costs. The households that will switch from private water supplier to PPWSA's piped system must pay PPWSA water charges. As large quantities of imports (equipment) are required for the proposed project, the economy of the country must incur foreign exchange costs.

15-5-1 Urban Water Supply

Some of the benefits mentioned are difficult to quantity due to absence of reliable basis for measurement. In the economic analysis, therefore, the benefits of the proposed project which

have been quantified are limited to the following items:

- Resource cost savings by new customers from the existing volume of private water supply replaced by PPWSA's piped water, measured in terms of the difference in price between the private supplier (assumed at Riels 2,500/m^3) and PPWSA;
- Expenditure for piped water supply by new customers, measured in terms of PPWSA price; and
- Time saved by new customers in collecting water. This is assumed at 30 minutes per day per household, based on the survey on residents' needs, at daily wage rate of Riels 8,000.

The economic costs of capital works and annual operation and maintenance are calculated from the financial cost estimates on the following basis:

- Price contingencies are excluded but physical contingencies are included because they represent real consumption of resources;
- Import duties and taxes (estimated at 10 percent of capital costs) are excluded because they represent transfer payments;
- The existence of unemployment and under-employment for unskilled workers within the Cambodian economy means that the opportunity cost of unskilled labor can be considered to be lower than its wage rate – a conversion factor of 0.80 of the market wage rate is used to estimate the shadow wage rate. Investment and O&M costs are estimated to include about 7 percent in unskilled labor cost.
- The market wage rate for skilled labor and the acquisition cost of land are considered to represent opportunity costs, as both factors are in demand.

The effects of loss of access and other types of disruption to residents due to works during the construction phase have been excluded because of the difficulties of measurement. Based on the above factors, the conversion factor to translate capital investment from financial value to economic value is 0.88. O&M cost has a conversion factor of 0.98.

The economic viability of the project is assessed by comparing the project's EIRR with the economic opportunity cost of capital (EOCC) in real terms, which is assumed at 10 percent for water supply projects.

Sensitivity analyses have also been carried out to determine the possible effects of adverse changes on the project. These adverse changes are:

- 10 percent increase in investment costs
- 10 percent increase in O&M costs
- 10 percent decrease in benefits

15-5-1-1 EIRR and Sensitivity Analysis

The details of the EIRR calculation and sensitivity analyses are shown in the Supporting Report. The results of the calculation and analyses are summarized in the table below.

Table 15-3 EIRR and Sensitivity Analysis – Urban Water Supply

Particulars	NPV @ EOCC Million Riels	EIRR (%)	SI *	% Change
Base Case	184,046	13.31%	-	-
10% Increase in Investment Costs	145,351	12.45%	0.69	10%
10% Increase in O&M Costs	170,967	13.09%	0.17	10%
10% Decrease in Benefits	113,867	12.13%	0.97	10%

* SI – Sensitivity Indicator

Under the base case scenario, the project's EIRR is higher than the EOCC. With its EIRR higher than the EOCC, the project is considered economically viable.

The results of the sensitivity analyses show that under the 3 adverse changes (increase in capital and O&M costs and decrease in benefits), the project's economic viability is not greatly affected as the project's EIRR is still higher than the project's EOCC. Among the adverse changes, the project's economic viability is most sensitive to decrease in benefits.

15-5-2 Peri-Urban Water Supply

The economic benefits which have been quantified in the proposed peri-urban water supply project are limited to the following items:

- Resource cost savings by the beneficiaries measured in terms of the cost of alternative source of water from vendors assumed at Riels 3,750/m^3;
- Time saved by the beneficiaries in collecting water since the proposed well facility will be constructed near houses within a radius of less than 250 meters. This is assumed at 45 minutes per day per household at daily wage rate of Riels 8,000.

The results of the EIRR calculation and sensitivity analyses are summarized in the table below.

Table 15-4 EIRR and Sensitivity Analysis – Peri-Urban Water Supply

Particulars	**NPV @ EOCC Million Riels**	**EIRR (%)**	**SI ***	**% Change**
Base Case	31,682	20.12		-
10% Increase in Investment Costs	27,332	17.94	1.21	10%
10% Increase in O&M Costs	31,049	19.91	0.10	10%
10% Decrease in Benefits	23,530	17.52	1.48	10%

* SI – Sensitivity Indicator

Under the base case scenario, the project's EIRR is higher than the Economic Opportunity Cost of Capital (EOCC) of 10 percent. With its EIRR higher than the EOCC, the project is considered economically viable.

The results of the sensitivity analyses show that under the three adverse changes (increase in capital and O&M costs and decrease in benefits), the project's economic viability is not greatly affected as the project's EIRR is still higher than the project's EOCC. Among the adverse changes, the project's economic viability is most sensitive to decrease in benefits.