MINISTRY OF INDUSTRY, MINES AND ENERGY
SIEM REAP WATER SUPPLY AUTHORITY
THE KINGDOM OF CAMBODIA

THE PREPARATORY STUDY
ON
THE SIEM REAP WATER SUPPLY EXPANSION PROJECT
IN
THE KINGDOM OF CAMBODIA

FINAL REPORT 1

VOLUME II

MAIN REPORT

JANUARY 2011

JAPAN INTERNATIONAL COOPERATION AGENCY

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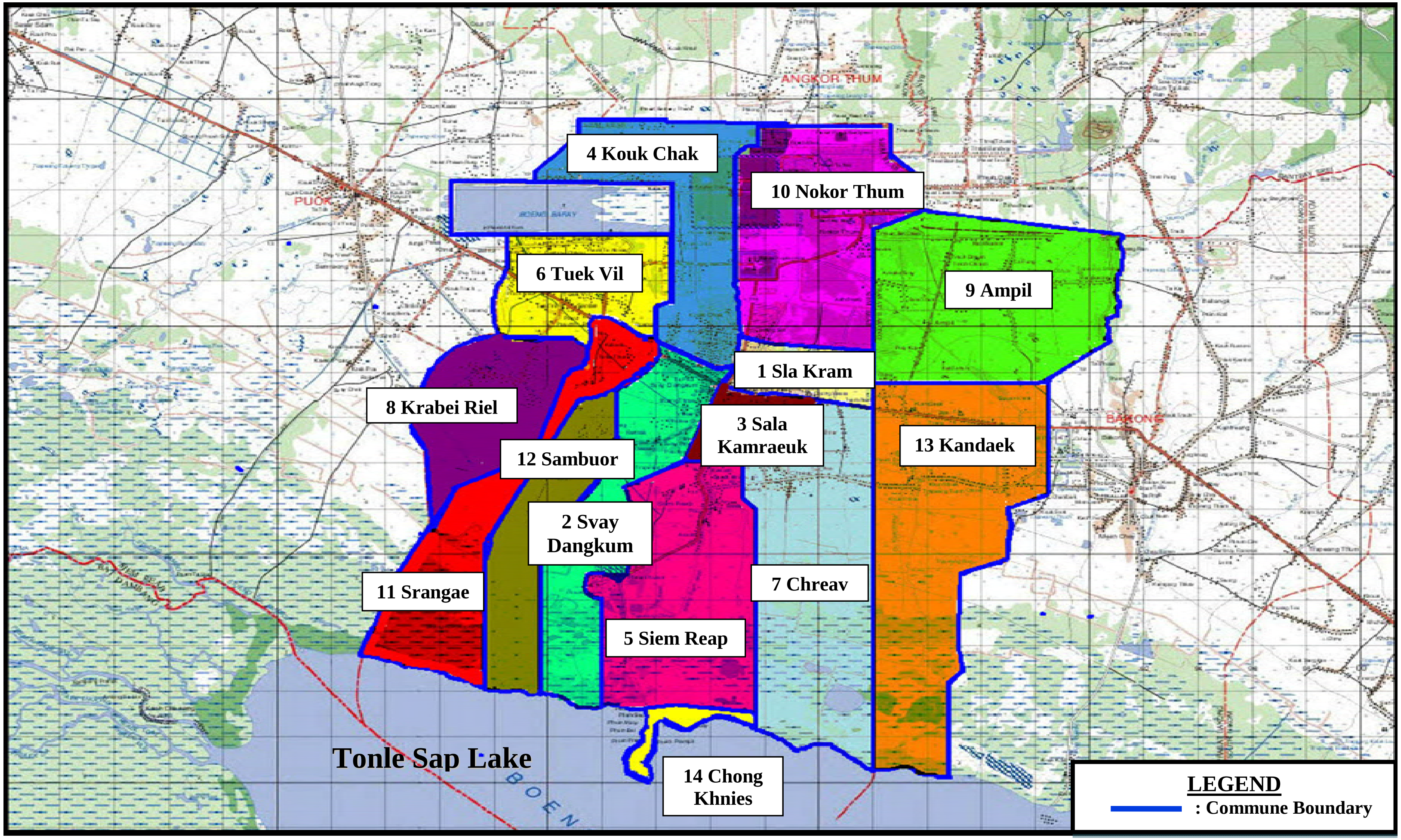


STUDY AREA (Siem Reap City + 1 adjacent commune)

PHOTOS OF THE STUDY AREA

Photo-1:Tonle Sap Lake
(Line of the green belt is the line of lowest water level)

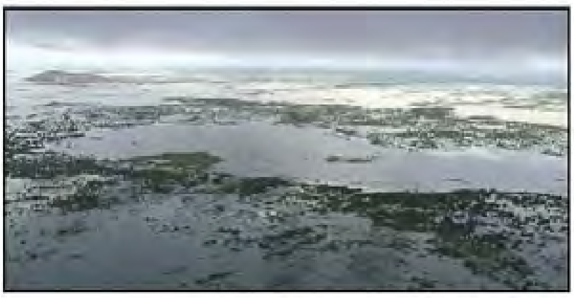


Photo-2:Tonle Sap Lake in rainy season
(Upper-Left;Phnum Kraom, Upper-Right; Siem Reap Town)

Photo-3: Overview of the candidate WTP site
(Upper-side; Tonle Sap Lake, Lower-side; Siem Reap town)

Photo-4:West Baray Lake

Photo-5: Existing Temple in Tonle Sap Lake

Photo-6: East-side of Siem Reap City

Photo-7: West-side of Siem Reap City

Photo-8: Whole view of Angkor Wat

EXECUTIVE SUMMARY

1. Project Framework

1.1 Proposed Service Areas

The service area covers the central urbanized areas and the peri-urban areas in the SRWSA jurisdiction area. The service area of the SRWSA is comprised of all communes except for Chong Khnies of the Siem Reap City and one fringe commune Kandaek in Prasat Bakong District. Remaining part of the study areas will be supplied by individual wells or some other measures.

Proposed Service Areas

Item	Communes	Item	Communes
1	Sla Kram	8	Krabei Riel
2	Svay Dangkum	9	Ampil
3	Sala Kamraeuk*	10	Nokor Thum
4	Kouk Chak	11	Srangae
5	Siem Reap	12	Sambuor
6	Tuek Vil	13	Kandaek
7	Chreav		

Notes: 1) All communes are in Siem Reap City, except for Kandaek commune which belongs to Prasat Bakong District.
2The entire area of Sala Kamraeuk* commune is included in the proposed service area, however, the other communes are partly covered by the SRWSA water supply systems
3) Chong Khnies will be excluded from the proposed service areas due to its location.

1.2 Population and Tourist Projection

Population projection in the proposed service areas was carried out by applying the exponential curve trend analysis which can be applicable for ordinary cities with moderate development. Projected population and calculated population growth rate are shown below:

Projected Populations and Growth Rate in the Study Area, 2010-2030

Year	2010	2015	2020	2025	2030
Projected Population	178	221	265	312	359
Growth rate	3.72% to 4.24%	4.11% to 3.65%	3.55% to 3.19%	3.10% to 2.82%	2.71%

Note: Population is shown in thousand.

Tourist projection was carried out by applying a time series trend analysis which can be applicable for estimation of growing aspect with a uniform rate for a certain period of time. In the calculation, tourist growth was modeled at the annual constant growth rates of 3 percent.

Projected Tourists, 2010-2030

Year	2010	2015	2020	2025	2030
Projected tourists	2,323	2,693	3,122	3,619	4,196
Rate for 2008	1.03	1.19	1.38	1.60	1.86

Note: 1) Unit in thousand.
2) Rate for 2008 means that the rate between the projected figures and actual record of 2,255,134 in 2008.

In calculating the water demand projection, the average length of stay for both local and international visitors was pegged to 3.5 days, allowing enough room for future increase of tourists' water demand.

1.3 Proposed Supply Coverage

The proposed supply coverage is considered in reference to the CMDGs target coverage 80 percent in 2015 and practical project implementation schedule as summarized below:

Proposed Supply Coverage

Year	2010	2015	2020	2025	2030
Resident	30 %	55 %	80 %	85 %	90 %
Tourist	30 %	55 %	80 %	95 %	100 %

1.4 Population Served

Applying the proposed coverage and the projected population, the population served was estimated to be over 200 thousand in 2020 and 300 thousand in 2030, respectively.

Population Served

Year	2010	2015	2020	2025	2030
Projected Population* (a)	178	221	265	312	359
Coverage (%) (b)	30 %	55 %	80 %	85 %	90 %
Population Served* (a x b)	54	122	212	265	323

Note: Unit is x 1000.

1.5 Tourists Served

Applying the proposed coverage and the projected population, the number of tourists served daily was estimated to be over six thousand in 2020 and eleven thousand in 2030, respectively.

Tourists Served

Year	2010	2015	2020	2025	2030
Coverage (b)	**30 %**	**55 %**	**80 %**	**95 %**	**100 %**
Projected Yearly Tourists (a)	2,323	2,693	3,122	3,619	4,196
Projected Daily Tourists (a/365)	6.4	7.4	8.6	10.0	11.5
Daily Tourists Served (a x b)	1.9	4.1	6.9	9.5	11.5

Note: Unit in x 1000.

1.6 NRW Reduction

Past experience confirms that the NRW of SRWSA can be controlled and maintained below 10 percent after the target year of 2020.

Proposed NRW Reducing Plan

Year	2010	2015	2020	2025	2030
NRW	17 %	12 %	10 %	10 %	10 %

2. Water Demand Projection

2.1 Applied Unit Water Consumption Rate for Domestic Water Use

In the unit consumption rate projection, the following assumptions were made:

⇒ Baseline for the unit consumption rate in 2010 is set at 110 lpcd to prevent overestimation. The 110 lpcd of unit consumption rate includes the administrative water use in the water demand projection; and

⇒ Based on past experience in Siem Reap and from other countries, growth in per capita consumption is being modeled applying respective annual growth rates of 2 lpcd towards 150 lpcd in 2030.

Domestic Unit Consumption Rate 2010-2030

2010	2015	2020	2025	2030
110	120	130	140	150

2.2 Domestic Water Demand Projection

Average daily domestic water demand was obtained as shown hereunder:

Average Daily Domestic Water Demand (m^3/d)

Year	2010	2015	2020	2025	2030
Projected population*	178	221	265	312	359
Population Served*	54	122	212	265	323
Proposed coverage	30 %	55 %	80 %	85 %	90 %
Water Demand (m^3/d)	5,900	14,600	27,500	37,100	48,400
Unit consumption rate	110	120	130	140	150

Note: Figures are rounded in x 1000, based on population projection.

2.3 Applied Unit Consumption Rate for Commercial Water Use

In the unit consumption rate projection, the following assumptions were made:

Unit Consumption Rate of Tourist 2010-2030 (lpcd)

2010	2015	2020	2025	2030
300	310	320	330	340

⇒ Baseline for the unit consumption rate for tourists in 2010 was set at 300 lpcd which includes a 10 percent allowance for unforeseen situations to the surveyed average unit consumption rate as the water demand projection;

⇒ Annual growth in per capita consumption is being modeled applying 2 lpcd, and

⇒ The increasing scenarios were set, provided that miscellaneous water use such as gardening, car washing, and laundry services at hotel business in the hotel zone grows towards target year 2030.

2.4 Commercial Water Demand

Average daily commercial water demand was obtained as shown below:

Average Daily Commercial Water Demand (m^3/d)

Year	2010	2015	2020	2025	2030
Projected tourist (x1000)	6.37	7.38	8.56	9.92	11.50
Tourist Served (x1000)	1.91	4.06	6.85	9.42	11.50
Proposed coverage	30 %	55 %	80 %	95 %	100 %
Unit consumption rate (lpcd)	300	310	320	330	340
Average length of stay (days)	3.5				
Water Demand (m^3/d)	2,000	4,400	7,700	10,900	13,700

2.5 Total Water Demand Projection

The water demand will be increased from 9,500 m^3/d in 2010 to 69,000 m^3/d in 2030 on a daily average basis and from 11,900 m^3/d in 2010 to 86,300 m^3/d in 2030 on a daily maximum basis.

Total Water Demand Projection

Descriptions/Year	2010	2015	2020	2025	2030
Domestic water demand (m^3/d)					
Projected Pops. (x1000)	178	221	265	312	359
Coverage	30 %	55 %	80 %	85 %	90 %
Population served (x1000)	54	122	212	265	332
Water Demand (m^3/d)	5,900	14,600	27,500	37,100	48,400
Commercial water demand (m^3/d)					
Projected tourists per year (per day in parenthesis)					
Projected tourists (x 1000)	2,323 (6.4)	2,693 (7.4)	3,122 (8.6)	3,619 (10.0)	4,196 (11.5)
Coverage	30 %	55 %	80 %	95 %	100 %
Average length of stay	3.5				
Water Demand (m^3/d)	2,000	4,400	7,700	10,900	13,700
Total water demand (domestic +commercial; m^3/d)					
Scenario 2 (m^3/d)	7,900	19,000	35,200	48,000	62,100
NRW	17 %	12 %	10 %	10 %	10 %
Average water demand (m^3/d)					
Scenario 2 (m^3/d)	9,500	21,500	39,100	53,300	69,000
Peak factor	1.25				
Maximum water demand (m^3/d)					
Scenario 2 (m^3/d)	**11,900**	**26,900**	**48,900**	**66,600**	**86,300**

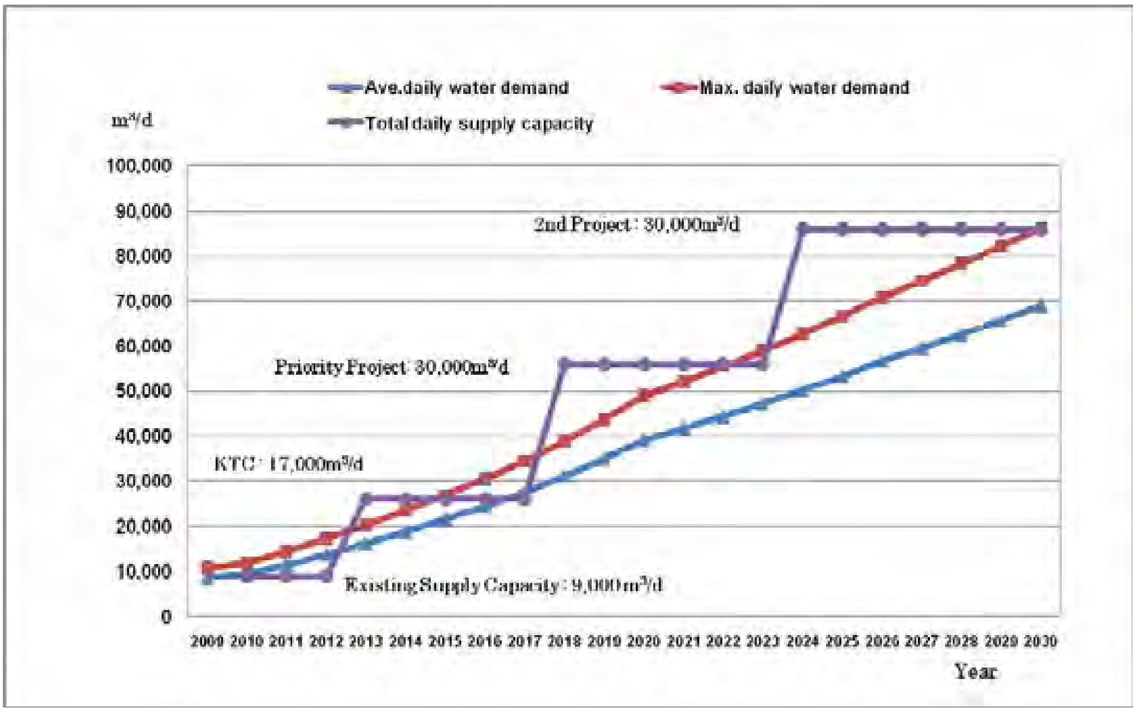
2.6 Proposed Long Term Development Plan

The required production capacity at each phase up to 2030 is illustrated in the following figures in accordance with the proposed daily average and maximum water demand.

The present nominal design capacity of 8,000 m^3/d is obviously inadequate against the estimated water demand. The implementation of the urgent projects to expand the existing capacity of SRWSA by increasing numbers of wells producing 1,000 m^3/d (bringing total production capacity to 9,000 m^3/d) and the KTC project of 17,000 m^3/d, provides a total production capacity of 26,000 m^3/d in 2011 or 2012. This meets the estimated water demand through the year 2016 at average water demand basis.

The water supply development plan will have a total water production capacity of 86,000 m^3/d in the target year 2030 to include: (i) the existing production capacity of 9,000 m^3/d, (ii) 17,000 m^3/d by KTC project, and (iii) 60,000 m^3/d to be implemented in two phases under the Project.

Priority Project is then recommended to develop 30,000 m^3/d as an urgent project by year 2016 or 2017 to supplement to the current water production capacity, and the expected KTC production capacity to meet the projected maximum water demand in 2022. The second project, which will see completion in 2022, will provide another 30,000 m^3/d where the final daily production capacity is 86,000 m^3 fulfilling the expected maximum water demand through 2030.



Water Demand and Production Capacity

3. Selection of Raw Water Source

Tonle Sap Lake, West Baray and Groundwater were selected as target water source for the proposed system.

As a result of detailed comparison in technical, economical, and environment as summarized in the following table, **Tonle Sap Lake** was recommended to be employed as the most appropriate raw water source for the proposed water supply development scheme.

Selection of the Proposed Water Source

Water Source	Tonle Sap Lake	West Baray	Ground Water
Structural Design and Work Plan	✓ **Possible long term plan** ✓ **Ideal water supply scheme from existing WEST and proposed EAST WTPs.** Issues and Concerns - Intake chamber and pump station are needed. - Water level fluctuation of the lake is to be considered. - Location of intake pumping station is to be considered. - Proposed WTP site is close to those areas where major water demand increase is projected. - Easy access to the existing distribution network. - Conventional water treatment process is needed.	✓ **Short term plan only** ✓ **Rehabilitation of the existing weirs and environmental issues** ✓ **Overlapped WTSs in west** Issues and Concerns - Land acquisition is troublesome. - Weir for water level control is necessary. - Rehabilitation for existing facilities such as weir is needed. - Far from the eastern part where major increase in future demand is expected. - Available water is limited but future expansion is impossible. - Conventional water treatment process is needed.	✓ **Short term plan only** ✓ **Considerable numbers of wells and connection pipelines** ✓ **Unavoidable environmental issues** Issues and Concerns - Considerable number of wells are needed. - Monitoring facilities for ground water and land subsidence are needed. - Conventional water treatment process excluding the sedimentation basin. - Land acquisitions for each well are difficult. - Site can be located in the southern part of town. - Easy access to the existing distribution network.
Construction Method and Schedule	✓ **Careful construction due to water level fluctuation** Issues and Concerns - Construction schedule for intake chamber shall be considered. - Seasonal water level changes shall be considered.	✓ **Permission from related agencies** ✓ **Land acquisition** Issues and Concerns - Permission for rehabilitation of the existing facilities is required from many agencies concerned. - Land acquisition for the water treatment plant is troublesome.	✓ **Long ACCESS ROAD to wells** ✓ **Land acquisition** Issues and Concerns - Construction period is long due to the considerable number of wells. - Access roads to each wells are necessary.
Construction, Operation and Maintenance Costs	✓ **Careful O&M** ✓ **Annual O&M cost is estimated USD1.6 Mill.** ✓ **Comparative cost is estimated US$99 Mill.** Issues and Concerns - Careful operation for seasonal water quality fluctuation is required. - Land price is reasonable.	✓ **Careful O&M** ✓ **Annual O&M cost is estimated USD1.7 Mill.** ✓ **Comparative cost is estimated US$100 Mill.** Issues and Concerns - Operation for the water level fluctuation of West Baray and canal is troublesome. - Long distribution/transmission pipelines to the city are necessary and costly. - Land acquisition is tedious and costly.	✓ **Well water level monitoring** ✓ **Security for numerous scattered wells** ✓ **Annual O&M cost is estimated USD2.2 Mill.** ✓ **comparative cost is estimated USD104 Mill.** Issues and Concerns - Raw water conveyance pipelines are long and costly. - Tough O & M for many wells. - O & M for monitoring facilities is must. - Security for many wells is required.
Evaluation	**Generally good for short/long term plan**	**Not applicable for long term plan**	**Not applicable for long term plan**

4. Feasibility Study on Priority Project

4.1 Scope of Work

The Priority Project will provide a new intake facility, a treatment plant, a transmission/distribution systems to supply additional water required for the existing Siem Reap service area, elevated water tank with clear water lifting pump facilities, distribution pipelines from the proposed elevated water tank to the existing distribution system, and expansion of distribution network to un-served areas.

From the long-term water supply development plan proposed in the previous chapter, it is concluded that the nominal design capacity for the Priority Project is 30,000m^3/d which will meet the water demand in 2022.

Key indicators in 2022, the target year of F/S for the long-term water supply development plan are summarized below:

	Domestic	Tourists
· Water use	Domestic	Tourists
· Projected Pops./Tourists	283,290	9,073
· Coverage	82 %	86%
· Pops./Tourists served	232,300	7,803(*27,300)
· Unit consumption rate (lpcd)	134	324
· Water demand (m^3/d)	31,128	8,848
· Total daily water demand (m^3/d)	39,976	
· NRW (%)	10	
· Ave. daily water demand (m^3/d)	44,420	
· Peak factor	1.25	
· Max. daily water demand (m^3/d)	55,530 (=43,230 + 12,300)	
· Available water supply capacity (m^3/d)	26,000 (= existing 9,000+KTC17,000)	
· Development capacity (m^3/d)	30,000	

Notes: Details are referred to **S.R.3.2-2**

*Daily actual numbers of tourists are calculated to be 7,803 x 3.5 =27,300, in applying 3.5 days of stay.

After completion of the Priority Project, water production capacity of the Project will be 30,000m^3/d. However, main part of raw water conveyance pipelines, water intake structure, and administrative common facilities will be sized for the long-term water supply development plan capacity, which nominal design capacity would be 60,000m^3/d. Ten percent allowances will be added to design the works for loss through the works. Distribution of water to Siem Reap service areas under the Priority Project will be for those communes as Sla Kram, Svay Dangkum, Sala Kamraeuk, Kouk Chak, Siem Reap, Chreav, and Nokor Thum.

a)	Raw water conveyance pipelines	:	Capacity of raw water conveyance pipelines will be 66,000 m^3/d including 10% allowances for the nominal design capacity for second project;
b)	Raw water intake pump station	:	Space of the pump station is sized for second project. Priority facilities includes only for capacity of 33,000 m^3/d (additional pumps will be expanded in 2nd Project);
c)	Raw water intake pipe	:	Pipes used for raw water transmission main from raw water

			transmission pump station to WTP should be of 800 mm dia. DI pipes of 3,400 m length to satisfy a capacity of 33,000 m^3/d (additional pressure main will be expanded in 2nd Project);
d)	WTP	:	Production capacity of 30,000 m^3/d;
e)	Clear water pumps	:	Deliver 30,000 m^3/d to the elevated water tank;
f)	Clear water pump station, chemical building, administration building, etc.;		
g)	Elevated water tank	:	1,000 m^3 will be allocated in WTP
h)	Distribution main from treatment plant to service areas	:	Approximately 21 km. of distribution main system. DI pipes with diameters from 250 mm to 800 mm and PE pipes with diameters from 50 mm to 200 mm will be used;
i)	Distribution pipelines	:	In the distribution system 14 km of DI pipes and 325 km of PE pipes will be used, dependent on pipe sizes;
j)	Communication and power supply to intake, pumping station and WTP; and		
k)	Plant and equipment necessary for operation and maintenance.		

4.2 Design of Priority Project

The aim of a water supply system is to basically assure users of a constant supply of hygienic, safe and clean water at their service taps, free from trouble regarding the quality of water or other inconveniences. The use of proven water treatment plant technologies commonly utilized in other countries, particularly those where land is unavailable and where an excellent high-technology service support infrastructure exists, may be inappropriate. For example, fully automated operation of the plant may not necessarily be appropriate for the Project as this is capital intensive and, when there is an abundance of unskilled labor this makes labor-intensive operation more attractive. However automatic control of systems could be installed at a later date if considered necessary and desirable.

Thus, the following technical principles are applied in the preliminary design of water treatment equipment and facilities for the Project;

- to the extent possible, the use of mechanical equipment should be limited to that produced locally for easy operation and low maintenance cost;
- hydraulically based devices that use gravity for such work as rapid mixing, flocculation, and filter rate control are preferred over mechanized or automated equipment, but subject to the hydraulic head requirement;
- mechanization and automation are appropriate only where operations are not readily done manually, or where they greatly improve reliability to assure safe and stable water supply;
- indigenous materials and manufactured goods that allow easy and safe construction should be used to reduce costs and to assist the local economy and expand industrial development.

The following hydraulic design horizon is adopted. These are summarized in the following Table and include for ten percent production loss for the design of the intake facilities, receiving well/distribution chamber, flocculation basins, sedimentation basins, filter units, and chemical, and chlorination facilities.

Design Horizon

Facilities	Priority Project
1) Intake Chamber	66,000 m^3/day
2) Raw Water Conveyance Pipeline	66,000 m^3/day
3) Raw Water Transmission Pipeline	33,000 m^3/day
4) Raw Water Intake Pump Station	33,000 m^3/day
5) Distribution Chamber	33,000 m^3/day
6) Flocculation Basins	33,000 m^3/day
7) Sedimentation Basins	33,000 m^3/day
8) Filter Units	33,000 m^3/day
9) Clear Water Reservoir	33,000 m^3/day
10) Distribution pipelines	*56,000 m^3/day

Notes:* Hourly peak factor will be applied to 56,000m^3/d in design of the distribution pipelines.

5. Priority Service Areas for the Priority Project

The population served by the Priority Project is estimated to be 232 thousand residents and 27 thousand tourists, respectively.

F/S Priority Service Areas and Population Served

Item	Commune / Village	F/S	Item	Commune / Village	F/S	Item	Commune / Village	F/S
1.	**Sla Kram**	**81,070**	**5.**	**Siem Reap**	**21,030**	**9.**	**Ampil**	**0**
1-1	Slor Kram**	○	5-1	Pou	△	9-1	Kouk Chan	×
1-2	Boeng dunpa*	○	5-2	Phnom krom	×	9-2	Thnal Chak	×
1-3	Chong Kavsu*	△	5-3	Pror Lay	×	9-3	Tanot	×
1-4	Dork pou*	○	5-4	Korkragn	△	9-4	Trapang Run	×
1-5	Bantay chas**	○	5-5	Kra Sangroleung	×	9-5	Ta Pang	×
1-6	Trang*	△	5-6	Spean Chreav	△	9-6	Prei Kuy	×
1-7	Mondol 3**	○	5-7	Arragn	△	9-7	Bang Koung	×
2.	**Svay Dangkum**	**59,130**	5-8	Treak	×	9-8	Kiri Manon	×
2-1	Pngea Chei	×	**6.**	**Tuek Vil**	**0**	9-9	Bos Tom	×
2-2	Kantrork	×	6-1	Kouk doung	×	9-10	Trach Chrom	×
2-3	Kouk Krasang	×	6-2	Sandan	×	**10.**	**Nokor Thum**	**0**
2-4	Svay Chrei	×	6-3	Chrei	×	10-1	Rohal	×
2-5	Pou Bos	×	6-4	Prayut	×	10-2	Sras srang	×
2-6	Tmei	△	6-5	Bantay Cheu	×	10-3	Sras srang	×
2-7	Svay Dangkum*	○	6-6	Teuk Vil	×	10-4	Kravan	×
2-8	Salakanseng*	○	6-7	Pri Chas	×	10-5	Arak svay	×
2-9	Krous*	△(○)	6-8	Tuek Tla	×	10-6	Ang Chang	×
2-10	Vihear Chin*	○	6-9	Pri Tmei	×	**11.**	**Srangae**	**3,370**
2-11	Steng Tmei*	△(○)	6-10	Chei	×	11-1	Kasikam*	△
2-12	Mondol 1**	○	**7.**	**Chreav**	**7,190**	11-2	Tnal	×
2-13	Mondol 2**	○	7-1	Chreav	×	11-3	Roka Thom	×
2-14	Ta Phoul**	○	7-2	Knar	△	11-4	Prei Thom	×
3.	**Sala Kamraeuk**	**45,100**	7-3	Bos Kralang	×	11-5	Srangie	×
3-1	Vat Bo**	○	7-4	Ta Chek	×	11-6	Chanlong	×
3-2	Vat Svay	○	7-5	Veal	×	11-7	Ta Chouk	×
3-3	Vat Damnak*	○	7-6	Kra Sang	×	**12.**	**Sambuor**	**0**
3-4	Sala Kam reak	○	7-7	Boeng	×	12-1	Pnouv	×
3-5	Chun long	△	**8.**	**Krabei Riel**	0	12-2	Sambour	×
3-6	Ta Vean	○	8-1	Ta Ros	×	12-3	Veal	×
3-7	Trapang Treng	○	8-2	Roka	×	12-4	Chrei	×
4.	**Kouk Chak**	**15,410**	8-3	Prei Pou	×	12-5	Ta kong	×
4-1	Trapang Ses*	△	8-4	To Tear	×	**13.**	**Kandaek**	**0**
4-2	Veal*	△	8-5	Krasang	×	13-1	Kouk Tlouk	×
4-3	Kasin tabong*	○	8-6	Popil	×	13-2	Trapang Tem	×
4-4	Kouk Chan	×	8-7	Trapang Veng	×	13-3	Khun Mouk	×
4-5	Khatean	×	8-8	Kouk Doung	×	13-4	Chras	×
4-6	Kouk Beng	×	8-9	Boeng	×	13-5	Ou	×
4-7	Kouk Tanot	×	8-10	Prorma	×	13-6	Spean Ka Ek	×
4-8	Nokor krav	×	8-11	Khnar	×	13-7	Trang	×
Notes	○: all areas prioritized		8-12	Prei Kroch	×	13-8	Chrei	×
	△: partial areas prioritized		**: all areas covered by the existing systems			13-9	Kouk Tanot	×
	×: all areas not covered		*: partial areas covered by the existing systems			13-10	Lo Ork	×
Total Population Served for F/S							**232,300**	

6. Institutional Development

The SRWSA institutional development plan follows the timeline of the three physical improvements plans being proposed in this Study, as follows: (i) the availability of KTC Bulk Water in 2012-13, (ii) the completion of the facilities under the Priority Project in 2017, and (iii) the completion of the facilities under 2nd Project in 2022.

6.1 Organization Structure for each Growth Phase

The institutional development plan recommends the most optimum organization structure and number of human resources for each phase as shown in the Table below:.

TIME FRAME	# DGD	DEPARTMENT	OFFICE	SECTION (OPTIONAL)
Current 2010	1	1 – Administration and Financial	Administration and Human Resources	None
			Financial and Accounting	
	1	2 – Production and Distribution	Water Production	
			Water Distribution	
			Customer Service	
		3 – Planning and Technical	Planning	
			Technical and Project	
KTC Bulk 2012-2013	1	1 – Administration and Finance	Administration and Human Resources	
			Accounting and Finance	
	1	2 – Production and Distribution	Water Production	
			Water Distribution	
			Service Connection	
		3 – Planning and Technical	Planning and Design	
			Technical and Project	
	Under the General Director		Commercial Operations	
Priority Project 2016-17	1	1 – Administration	Administrative Services	Procurement and Property Management
				General Services
			Human Resources	Compensation, Benefits and Performance Appraisal
		2 – Finance	General Accounting	None
			Finance and Budget	None
	1	3 – Water Supply Operations	Production	Operation and Maintenance
				Water Quality
			Distribution	Network Installation and Maintenance
				Leakage Reduction
			Service Connection	Water Meter Repair and Maintenance
		4 – Planning and Development	Planning and Design	None
			Project Management	None
	Under GD	5 – Commercial Operations	Customer Accounts	None
			Customer Service	None
	Under GD			Management Services
2nd Project 2022-23	1	1 – Administration	Administrative Services	Procurement and Property Management
				General Services
			Human Resources	Recruitment, Selection and Placement
				Compensation, Benefits and Performance Appraisal
		2 –Finance	Accounting	General Accounting

				Bookkeeping and Cashiering
			Budget and Treasury	Cash Management
	1	3 – Commercial Operations	Customer Accounts	Meter Reading
				Billing and Collection
			Customer Service	Water Services Processing
				Customer Relations and Marketing
	1	4 – Water Supply Operations	Water Production	Operation and Maintenance
				Water Quality
				Stores Management
			Water Distribution	Network Installation and Maintenance
				Leakage Reduction
			Service Connection	Connections and Disconnections
				Water Meter Repair and Maintenance
		5 – Planning and Development	Planning and Design	None
			Project Management	None
	Under the General Director		Management Services	None

6.2 Human Resources Requirement for Each Phase

The organization should be manned with the right number and quality of human resources, in keeping with the organization structures proposed for each phase. The staff productivity index, a measure of staff productivity and a predictor / indicator of organizational efficiency, was utilized to ensure that the size of the organization is kept to the minimum. The proposed SPI for SRWSA was arrived at by comparing it with other Asian utilities of the same size in each growth phase, and is below the utilities' averages (or below SPI 5 per 1,000 connections) as shown below:

Year	Phase	Production Volume (m^3/day)	Projected Number of Connections	Projected Number of Employees		Staff Productivity Index
				By Phase	Total	
2010	Current Facilities	8,000	4,525	40	40	8.83
2012-13	Bulk Water from KTC	17,000	16,218	38	78	4.80
2017-18	Start of Phase 1	30,000	27,318	63	141	5.16
2022-23	Start of Phase 2	30,000	41,331	42	183	4.42

6.3 Capacity Building Program

To keep pace with the requirements and responsibilities of a growing water utility, capacity building is required for all SRWSA staff in the short and medium term. Thus, training that will be made to cover the entire organization, by department and offices based on unit functions and responsibilities, and by individual employee based on job function and position held. Training methodologies (counterpart coaching, mentoring, on-the-job, seminar-workshop) will be customized to fit the participants' needs and levels to optimize learning.

A multi-discipline team of international consultants will undertake the capacity building program that will run on a staggered basis from 2012 to 2014, for a total of 25 man-months. After an in-depth training needs assessment, eight specialized training courses will be conducted aimed at equipping, upgrading and honing employee knowledge and skills. These will be run for five days to two weeks and funded either through grant or through the SRWSA internal budget, and conducted by the PPWSA Training Center, or by local training institutions with a reputable track record, or by training subject matter experts (SME) or consultants.

6.4 Project (Operation) Implementation System

It is proposed that the Steering Committee earlier organized for the preparatory study be reconstituted to become the *Project Coordinating Committee for the Implementation of the Siem Reap Water Supply Expansion Project*, but with increased membership to include the representative of the ministers of MOEF and MOWRAM. JICA will no longer be part of the PCC, as it becomes the financing institution of the Project.

MIME will supervise over SRWSA and has wider experience in implementing ODA projects compared to SRWSA, which still has to develop this type of institutional capacity. As the supervising agency, MIME has its own set of responsibilities, which will be detailed in the Loan Agreement.

As the project beneficiary, and ultimately the institution responsible for repaying the loan, SRWSA will be the *project implementer and manager*. For this purpose, it will establish a project management unit (PMU) within its Department of Planning and Technical for the duration of project implementation. It will also be in this department that the project consultants' team (PCT) will be lodged to provide consulting and advisory services for project implementation as specified in the Loan Agreement.

The Project will, therefore, be coordinated, monitored, and managed by three project organizations, as shown:

Project Organization	Level	Membership or Institution / Department	Role in Project Implementation	Responsibility
Project Coordination Committee	Inter-Agency Level	MIME, MOEF, MOWRAM, SRWSA, APSARA, Provincial Government	Over-all **strategic inter-agency coordination** and provision of policy guidelines of Project implementation	General Financial Implementation Legal
Project Monitoring	Ministry Level	MIME *Department of Water Supply*	Over-all responsibility for **monitoring Project implementation** against technical and financial	Monitoring Reporting
Project Management Unit	Institution Level	SRWSA *Department of Planning and Technical*	Directly responsible for **project execution and for undertaking actual field supervision and management** of Project implementation	General Project Implementation Project Closure

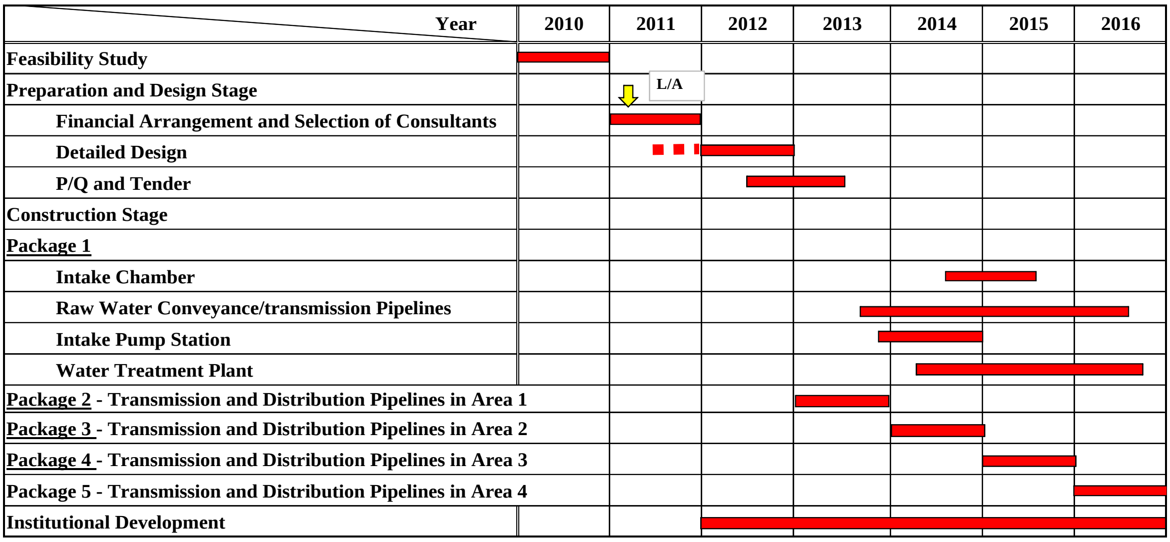
7. Implementation Plan

The construction works for the Priority Project should be carried out by selected contractor/s upon international/local competitive bidding (ICB/LCB) on the following tender package which has been decided taking into account the advantages in technical and economical aspects. The major consideration in packaging was put on the nature of works, the size of contract and to avoid less attractive to the international construction companies

- Package 1 : Construction of Intake Chamber, Raw Water Conveyance Pipeline, Intake Pump Station, and WTP (ICB)
- Package 2 : Construction of Transmission and Distribution Network Area 1 (LCB)
- Package 3 : Construction of Transmission and Distribution Network Area 2 (LCB)
- Package 4 : Construction of Transmission and Distribution Network Area 3 (LCB)
- Package 5 : Construction of Transmission and Distribution Network Area 4 (LCB)

The pre-qualification of tenders will be carried out for all the packages to select the qualified construction firms with sufficient capacity in terms of financial, technical and staffing.

The implementation schedule is shown in the following table.



8. Project Cost

A total project cost was estimated approximately US$ 81 million, including direct construction costs for the new water supply systems, engineering services, institutional development, land acquisition, physical contingency, and price contingency.

Priority Project Cost

Item	Cost(1,000US$)				
	FC	TAX(FC)	LC	TAX(LC)	Total
Civil Works	**16,932**	**0**	**23,399**	**2,340**	**42,672**
Intake Chamber	16	0	132	13	162
Water Conveyance Pipe	1,448	0	11,710	1,171	14,328
Intake Pump Station	555	0	739	74	1,368
Water Treatment Plant	2,507		5,627	563	8,697
Elevated Water Tank	228	0	553	55	836
Transmission/Distribution Pipelines	12,178	0	4,638	464	17,280
Mechanical/Electrical Works	**8,148**	**0**	**1,136**	**114**	**9,397**
Intake Pumping Station	2,086	0	259	26	2,371
Water Treatment Plant	6,062	0	877	88	7,027
Direct Construction Cost : (A)	**25,080**	**0**	**24,535**	**2,454**	**52,069**
Physical Contingency (10%) for (A) : (A)'	**2,508**	**0**	**2,454**	**245**	**5,207**
Price Contingency (FC:1.8%, LC;7.9%) for (A)+(A')	**2,215**	**0**	**11,423**	**1,142**	**14,780**
Engineering Services : (B)	**4,200**	**0**	**954**	**96**	**5,250**
Physical Contingency (5%) for (B) : (B')	**210**	**0**	**48**	**5**	**263**
Price Contingency (FC:1.8%, LC;7.9%) for (B)+(B')	**278**	**0**	**304**	**30**	**612**
Institutional Development : (C)	**860**	**0**	**55**	**5**	**920**
Physical Contingency (5%) for (C) : (C')	**43**	**0**	**3**	**0.3**	**46**
Price Contingency (FC:1.8%, LC;7.9%) for (C)+(C')	**68**	**0**	**22**	**2**	**91**
Land Acquisition : (D)	**0**	**0**	**273**	**27**	**300**
Physical Contingency (10%) for (D) : (D')	**0**	**0**	**27**	**3**	**30**
Price Contingency (FC:1.8%, LC;7.9%) for (D)+(D')	**0**	**0**	**24**	**2**	**26**
Social Compensation; (E)	**0**	**0**	**83**	**8**	**91**
Price Contingency (FC:1.8%, LC;7.9%) for (E)	**0**	**0**	**7**	**1**	**7**
Administration Cost (1.5% of the above total)	**0**	**0**	**864**	**86**	**951**
Total Project Cost	**35,461**	**0**	**41,074**	**4,108**	**80,642**

9. Financial and Economic Aspects of the Project

The evaluation on the financial and economic aspects was accomplished by looking into the following aspects:

a. The past financial performance and condition of SRWSA which provides valuable insights on the financial capacity of SRWSA to provide the requisite financial resources;

b. The required full cost recovery water tariffs that satisfy affordability and acceptability considerations of both households and businesses in Siem Reap.

c. Financial desirability in terms of SRWSA's capacity to sustain the financial requirements of the Project in terms of equity contribution and the debt servicing requirement; and,

d. The economic impact of the project as it involves substantial support from the central government.

<u>Summary of Findings</u>

The evaluation of the past and present financial performance and condition shows the following highlights.

a. Financial status and condition is financially sound, stable and very solvent. It is awash with cash – equivalent to 9 months of its operating budget. Working capital is even more substantial at the equivalent of 11.8 months of its operating budget. Liabilities are practically none existent at only 10% of total assets amounting to a little less than KHR20 million as of year-end 2009. SRWSA's only liabilities are the guarantee deposits of its customers and short-term credits from its suppliers/and service providers. Given this picture of financial condition, the authority can leverage its financial resources to secure long-term debt capital for its expansion needs.

b. Operational and financial performance shows contrasting outcome during the past 3 years. Operational performance indicators relating to NRW and staff productivity show improving efficiency while financial performance on collection, cost control and profitability show declining efficiency.

    i. Last year, NRW went down to 14 percent from 20 percent of total production in 2007.

    ii. Staff productivity has improved from 14 personnel per 1,000 connections in 2007 to 11 personnel per 1,000 connections in 2009.

    iii. Collection performance has gone down as reflected by the increasing amount of unpaid water bills. Last year, total customer accounts receivable has increased not only in terms of amount but also in the equivalent number of days in terms of total water sales. In 2009, customer receivable turn over went up to 40 days, which was only 15 days in 2007.

    iv. Operational ratio, which measures how much of total revenue is eaten up by operating expenses, has gone up to a precarious proportion. From only 75 percent in 2008, this has shot up to 97 percent last year.

v. Obviously, the profitability of SRWSA was affected by the rising cost of operations. Return on revenue or that portion of revenue that is transformed into profit fell down to only 9% from the 20 percent ROR of the previous year.

vi. SRWSA has however recognized the declining profitability of its operation as it implemented an increase in its water tariff starting last November 2009. With the new water tariff, the financial projection shows an improvement in profitability beginning this year.

The existing water tariff schedule of SRWSA is a single unified tariff for all connection categories. It is based on a rising price structure composed of 4 levels, as shown below.

1 – 7 m^3	:	KHR1,100.00 per m^3
8 – 15 m^3	:	KHR1,500.00 per m^3
16 – 30 m^3	:	KHR1,800.00 per m^3
Over 30 m^3	:	KHR2,000.00 per m^3

Financial evaluation of the of the Priority Project shows that the existing water tariff needs to be adjusted to sustain the growing financial needs of the water utility.

a. Average tariffs per cubic meter that would sustain the financial efficiency of SRWSA are: KHR1,999 per m^3 in 2012, KHR2,541 per m^3 in 2017 and KHR2,624 per m^3 in 2022 onwards.

b. Said tariffs meet affordability and acceptability tests parameters of residents and businesses.

The financial desirability of the Priority project was ascertained on the basis of financial efficiency parameters relating to:

a. Financial Autonomy – SRWSA will not require equity infusion by the RGC during and after project implementation; and

b. Creditworthiness - debt service coverage ratio is more than one throughout the study period.

The economic benefit-cost analysis shows that the project shall be economically beneficial to the local economy with an economic internal rate of return (EIRR) of 37 percent and a benefit-cost ratio of 4.5. The economic benefits considered attributable to water supply projects are consumer surplus, health cost savings and tourism multiplier effects. Economic costs on other hand consisted of the project cost, replacement cost of mechanical /electrical equipment and operating cost.

Conclusion

Based on the above findings, the Priority Project is viable – both financially attractive and economically beneficial.

a. The required water tariffs are affordable and acceptable to both residential users and commercial establishments.

b. The forecast of the operations of SRWSA shows it can sustain the financial requirements for debt servicing of the JICA loan and cost recovery objectives of the central government for SRWSA as an autonomous public enterprise.

vii. Cash position will not be affected during construction. SRWSA shall not require additional capital infusion from the government.

viii. Debt service ratio or the ability to meet maturing loan obligations does not go below 1.0 throughout the study period.

c. The project is economically beneficial with benefit-cost ratio of 4.5 and an economic internal rate of return of 37 percent, which is higher than the 12 percent social cost of capital for infrastructure projects.

Recommendation

Following on the positive findings on the financial and technical aspects of the Project, implementation of the expansion of the water supply system of Siem Reap Province is thereby recommended.

10. Drainage, Sewerage and Sanitation System in the Study Area

10.1 Current Status of Drainage & Wastewater Master Plan for Siem Reap

The following are three major wastewater management plans available for Siem Reap City:

1. Mekong Tourism Development Project Part A1 : Siem Reap Wastewater Management Final Design Report (MTDP SRWM: ADB Loan No. 1969-CAM (SF), April 2006)

   This project was completed in December 2009 and its service area is the city center area located west of Siem Reap River. The major scope of work was the reconstruction of Town Center Drain (TCD), the construction of the interceptor sewer system, the construction of the pumping station, and the installation of force mains and construction of a wastewater treatment plant.

2. Feasibility Study Report on the Siem Reap Sewerage System and Improvement of Siem Reap River in the Kingdom of Cambodia (KOICA, July 2008)

   This project is scheduled to be completed in 2015. The service area covers the city core area surrounding ADB service area. The major scope of work is the installation of a sanitary sewer, the construction of a pumping station, the expansion of ADB pumping station and the expansion of a wastewater treatment plant.

3. Siem Reap Urban Development Project Drainage & Sewerage Master Plan for the District of Siem Reap Priority Works Draft Master Plan (SRDSMP: AFD, December 2009)

   This Draft Master Plan was completed in December 2009. Its proposed service area covers almost the whole urban and peri-urban area of Siem Reap City.

10.2 Potentials in Japanese Grant Aid Assistance

Even the KOICA project is completed, there will still be a portion of the urban area which will not be served by the sewerage system. This situation is similar to the drainage system. As the remaining area is huge, the results are a higher estimated system development cost and a longer construction period. The majority of remaining area is peri-urban area where centralized system might not always be feasible.

Considering the relevance of the Japanese Grant Assistance, the Study Team proposes a supporting project aimed at maintaining the existing system including septic tanks and sewer network. The following is the proposed scope of work for this project:

- Provision of Sewer Cleaning Equipment
- Provision of Septage Collection Vacuum Tanker Truck
- Construction of Septage Treatment Facility
- Technical Assistance Project for Capacity Building towards Counterpart Agency

11. Environmental and Social Considerations

The Siem Reap City is surrounded with the World Heritage sites of Angkor and other protected areas where conservation measures of natural resources are imperative. Therefore, these protected areas should be taken into account when implementing the water supply system expansion project.

Local people have been having difficulty with getting safe water for drinking because the well water is most times not suitable for drinking and should be boiled and/or filtered. The provision of safe water for drinking and other domestic uses is a pressing issue for the local people and is an important ingredient to raising their standard of living. The lack of safe and potable water has also its own impact on the tourism sector. Yearly, about two million tourists visit the city and to service the influx of tourists, new hotels have been sprouting and digging wells to supply itself of much needed water. This has resulted in uncontrolled abstraction of groundwater sources and the heritage sites are under threat of land subsidence. Therefore, the expansion of the water supply system is an urgent necessity.

In this Study, the alternatives of water supply from groundwater, west baray, river and Tonle Sap Lake were examined and finally surface water from Tonle Sap Lake was selected as a water source because little impact would be expected on World Heritage of Angkor. From intake in the Tonle Sap Lake to pump station, conveyance pipes go through several protected areas and some impacts cannot be set aside, while the impacts can be minimized by paying attention for adoption of mitigation measures of minimization of construction site in protected areas, and the project, as a sustainable development, will be able to support local people to improve their living and livelihood condition.

12. Evaluations

12.1 Socio-Economic Evaluation

The *Cambodia Millennium Development Goals* (CMDGs) establishes the key underlying coverage targets for the development of water supply sector and, therefore, becomes one of the viable guides in evaluating the project. There are two main quantitative evaluation indicators utilized – water supply coverage[1], and served population[2]. The long-term water supply development plan envisages exceeding the CMDG with respect to urban coverage ratio in the Siem Reap City and its surroundings by a five-year delay in 2020, which will continue to be supplied as at present with SRWSA safe water at a level of 90 percent in 2030. As for water supply to tourists, 80 percent coverage will be achieved in the same year as domestic water supply in 2020 and 100 percent in 2030. In this sense, the long-term water supply development 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 provides a limited quantification of the benefits of executing the Priority Project, 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 overall health of the project beneficiaries, measured by evaluation indicators as the reduction of water diseases' outbreaks and the reduction of infant and maternal mortality associated with water-borne diseases. Improved water supply in the areas also reduces the burden of fetching water that typically falls on women and children, contributing indirectly to greater rural labor force productivity and improved school attendance and educational achievement of children.

Improved water supply from the Central Distribution System (CDS) aids the development of the tourism industry in Siem Reap City, particularly in the tourism-related service businesses such as hotels and restaurants. In this connection, the growing number of hotels and guesthouses in the service area are waiting to be connected to the system. Water supply is also among the critical infrastructure requirements for labor-intensive, light manufacturing industries that the RGC has targeted for promotion in its industrial policy.

Expansion of water supply inevitably results in greater production of wastewater. Preparation and implementation of the Priority Project for drainage and sewerage in the Study Area is urgently necessary, to ensure that the health benefits from improved water supply are not lost on account of

[1] Water supply coverage (%) = [population served] x 100 / [total population in the present service area] is an important evaluation indicator because any water utility is mandated to serve a given and defined service area.

[2] Served population is the production/population (m3/d/c) = [annual production volume (m3) /365] / [number of people served]. It shows the capacity of the present system to supply water to all types of customers in its service area.

deterioration in sanitary and environmental conditions. 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 Tonle Sap Lake, 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.

12.2 Technical Evaluation

By the Priority Project, which includes construction of raw intake facilities, water treatment plant, and clear water transmission/distribution pipelines, a daily total water supply capacity of 56,000 m^3 will be achieved in early 2022. The project will secure the supply capacity to meet the water demand up to the year 2022. The jurisdiction of SRWSA water supply is expanded to 33.6 km^2 in the proposed Priority Project, approximately five times the area compared to 6.9 km^2 of the current water supply covering areas.

Served population will reach 233 thousand or 82 percent as well as 7.8 thousand or 86 percent of tourists of the projected population in 2022 in the long-term water supply development plan in cooperate with the existing water supply systems. Water tank and distribution pipes will be extended and enforced to secure 24-hour/day water supply. The number of service connections will reach approximately 41,000 connections, from approximately 4,500 at present.

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

It is noteworthy that the coverage will be achieved with continued efforts to control non-revenue water[3] at the level of 10 percent through 100 percent metering of all service connections[4], well organized operation and maintenance efforts on the transmission/distribution pipelines, including optimization of supplied pressure and making use of the proposed supplied water monitoring system to reduce annual operation and maintenance costs[5]. Preservation of raw water quality is another important issue for both drinking water quality control and minimization of production cost.

12.3 Financial Evaluation

Financial soundness is a key element for pursuing and attaining the CMDGs for the water supply sector. With the implementation of the project and the financial support of the MOEF by way of the JICA loan, SRWSA can attain full financial autonomy as envisioned in the National Water

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[3] Non revenue water (%) = [total annual production (m3) - total billed consumption (m3)] x 100/[total annual production (m3)]
[4] No. of metered connections (%) = metered connection / unmetered connections
[5] Unit production cost (US$/m3) = [annual O&M cost (US$)] / [total annual production (m3)]

Sector Policy and incorporated in the sub-decree creating SRWSA as an autonomous public enterprise. This can be achieved by having a water tariff[6] that is pro- poor, but balances the need for SRWSA to be financially viable as an institution. Periodic adjustment of water tariffs is, however, a necessary consequence due to increasing cost as well as supporting the repayment of the loan. The required tariffs proposed in this study are found to be affordable to both residential and commercial customers. With the water tariffs adjusted on a regular basis, the financial effectiveness of SRWSA may be sustained.

The implementation of the project widens the customer base, which can boost the revenue potential of SRWSA, thus cost per service connection[7] should be affordable to all types of customers. In addition, collection efficiency[8] of water fees must be sustained at the highest levels possible. The result would be a low operating ratio[9] that will indicate the efficiency of SRWSA as an institution.

12.4 Institutional Evaluation

Institutional development is inherently difficult as this is only achieved over the long-term. One project, therefore, may not immediately achieve the capacity building objectives. However, this priority project provides clear avenues to jumpstart building organizational capacity of the SRWSA, as well as the capacities of its staff. Training undertaken by SRWSA personnel can be measured by the actual number of training hours, or cost of training per employee; however, the "return on training" has always been difficult to quantify and measure. Translating the training investment into impacts will have to go beyond traditional measures.

The staff productivity index[10] is, therefore utilized as one indicator of organizational efficiency. It not only was used in planning the number of SRWSA personnel in each important development phases, where accompanying organization structures are recommended, but also in targeting organizational efficiency when comparing SRWSA with other Asian water utilities of the same size.

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[6] Average tariff (US$/m3) = [total annual billing (US$)] / [total annual consumption (m3)]
[7] Capital expenditure/connection (US$) = [total capital expenditure over the last 5 years (US$) / 5] / [number of utility connections]
[8] Collection efficiency (%) = [total annual collections (US$) / total annual billings (US$)] x 100
[9] Operating ratio = [annual O&M cost (US$)] / [annual revenue (US$)]
[10] Staff/1,000 connections ratio = [number of utility staff] / [number of utility connections/1,000]

13. Conclusion and Recommendations

The Project aims to meet the existing and projected shortfall in water supply with the immediate construction of the Project facilities. Thus, the Project offers not only tangible impacts, but also intangible benefits, such as:

- Improving the quality of life of the people of Siem Reap, particularly those in the service area, by (i) supplying potable water, therefore reducing health problems brought about by unsafe water, and (ii) providing reliable 24/7 water service, thereby contributing to better productivity of the residents in the service area.
- Stimulating the growth of the local economy with the enhancement / development of the present and future tourism-related businesses and light industries, all of which will rely mainly on safe and adequate water from SRWSA, especially when the extraction of groundwater will be discontinued to protect the Angkor Wat heritage area.
- Contributing to the growth of the national economy by increased tourism arrivals, which will impact on job generation and higher levels of education.
- Supporting the policies set out in the CMDG, particularly in reducing “poverty rates in urban and more accessible rural areas” and improving “urban access to safe water and rural access to improved sanitation”.

It can also be concluded that the proposed Priority Project is viable – both financially sustainable and economically beneficial. The required water tariffs are affordable and acceptable to both residential users and commercial establishments. The forecast of the operations of SRWSA shows it can sustain the financial requirements for debt servicing of the JICA loan and cost recovery objectives of the central government for SRWSA as an autonomous public enterprise. Infusion of additional equity capital by the RGC is not required during construction of the project. The average debt service coverage ratio is more than 1.2, which exceeds the minimum requirement of 1.0.

Furthermore, the project is economically beneficial with an benefit-cost ratio that is more than 4 and an economic internal rate of return of not less than 30 percent at all scenarios tested in the economic analysis- the EIRR being higher than the widely accepted 12 percent social cost of capital for infrastructure projects.

Consequently, it would be imperative and urgent for the Project to be implemented with loan assistance from the Government of Japan. It should be realized that in the course of executing the long-term water supply development plan, the following important activities should be prioritized.

13.1 Before the Project Implementation

1) Project organizations

The project organizations, such as *Project Coordinating Committee* (PCC), the *Project Management Unit* should be set up to be ready to discharge their roles and functions according to the requirements of the Project.

In addition, the office of the *Project Consultant Team* should be organized to mark the start of the tendering phase upon completion of detailed design review stage.

2) Land acquisition

Necessary land acquisition for the project sites should be carried out by the project organizations as soon as possible before the Project be implemented.

3) Clearance of the relevant laws and regulations

SRWSA/MIME should facilitate the required clearances needed for the Project implementation in accordance with the relevant laws and regulations in Cambodia.

4) Protection of water sources

Tonle Sap Lake 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.

5) Project monitoring and reporting system

The development of a tri-level project monitoring and evaluation system is essential to maintain efficient work relationships among the project organizations, and to minimize conflicts among project partners.

13.2 During the Project Implementation

6) Manpower hiring schedule and staff review and assessment

The SRWSA institutional development plan follows the timeline of the three physical improvements plans being proposed in this Study and recommends the most optimum organization structure and number of human resources for each phase, as follows: (i) the availability of KTC Bulk Water in 2012-13, (ii) the completion of the facilities under the Priority Project in 2017, and (iii) the completion of the facilities under Phase 2 in 2022. The need is translating this into a manpower-hiring schedule based on actual requirements after a thorough staff review and assessment to ensure proper matching of qualifications with job functions of the present personnel.

7) Orientation and/or Training

Aside from the trainings recommended under the capacity building program, there is a need to provide the following: (i) orientation training to all employees to prepare them for Project implementation; (ii) training on the monitoring and evaluation system, and (iii) training on the disbursement procedures.

8) Proper maintenance and periodic replacement/rehabilitation

New construction or expansion projects can be done using Japan's ODA loan and/or assistance of international donor, 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 including the groundwater and land subsidence monitoring facilities.

9) 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 Cambodia Drinking Water Standards.

10) Regulation over the exploitation of groundwater sources

RGC in cooperate with the *Project Coordinating Committee* (PCC) should enact regulatory measures with regard to the control of future groundwater development and imposition of sanctions to continued groundwater extraction in Siem Reap City once the Project is implemented.

11) Water tariff

SRWSA should keep sound financial background so that a consumption-based tariff structure that is fair for all – residential, commercial/business and industrial consumers should be retained. The revenue from tariffs will cover O&M costs, capital development plus debt servicing properly to achieve operational and financial viability.

13.3 After the Project Implementation

12) 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.

13) Improvement of drainage, sewerage, and sanitation in the study area

The proposed "Drainage, Sewerage, and Sanitization Project" should be implemented as scheduled to preserve the public water bodies clean and eventually to connect to prevent the Tonle Sap Lake be in good condition as raw water source of the public water supply systems.

FINAL REPORT 1

THE PREPARATORY STUDY ON THE SIEM REAP WATER SUPPLY EXPANSION PROJECT IN THE KINGDOM OF CAMBODIA

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ABBREVIATIONS

ADB	**:**	**Asian Development Bank**
APSARA	**:**	**Authority for the Protection and Management of Angkor and the Region of Siem Reap**
BOD	**:**	**Biological Oxygen Demand**
BOT	**:**	**Built, Operation, and Transfer**
CDC	**:**	**Council for Development of Cambodia**
COD	**:**	**Chemical Oxygen Demand**
CNMC	**:**	**Cambodia National Mekong Committee**
DI	**:**	**Ductile Iron Pipe**
DO	**:**	**Dissolved Oxygen**
DOA	**:**	**Siem Reap Provincial Department of Agriculture**
DOE	**:**	**Siem Reap Provincial Department of Environment**
DOFi	**:**	**Siem Reap Provincial Department of Fisheries**
DOFo		**Siem Reap Provincial Department of Forest**
DPWT	**:**	**Department of Public Works and Transport**
DSD	**:**	**Drainage and Sewerage Division**
EdC	**:**	**Electricite du Cambodge**
EIA	**:**	**Environmental Impact Assessment**
F/S	**:**	**Feasibility Study**
GDP	**:**	**Gross Domestic Product**
GNP	**:**	**Gross National Product**
GOJ	**:**	**The Government of Japan**
IEE	**:**	**Initial Environmental Examination**
IEIA	**:**	**Initial Environment Impact Assessment**
IUCN	**:**	**International Union for Conservation of Nature and Natural Resources**
JICA	**:**	**Japan International Cooperation Agency**
MIME	**:**	**Ministry of Industry, Mines and Energy**
MIS	**:**	**Management Information System**
MOE	**:**	**Ministry of Environment**
MOAFF	**:**	**Ministry of Agriculture, Forest and Fisheries**
MOP	**:**	**Ministry of Planning**
MPWT	**:**	**Ministry of Public Works and Transport**
MWRM	**:**	**Ministry of Water Resources and Meteorology**
NPRD	**:**	**National Programme for Rehabilitation and Development of Cambodia**
NRW	**:**	**Non Revenue Water**
PPWSA	**:**	**Phnom Penh Water Supply Authority**
PVC	**:**	**Polyvinyl Chloride Pipe**

RGC	**:**	**The Royal Government of Cambodia**
SEDP II	**:**	**Second Five Year Socioeconomic Development Plan 2001-2005**
SRWSA	**:**	**Siem reap Water Supply Authority**
SS	**:**	**Suspended Solid**
TA	**:**	**Technical Assistance**
TSA	**:**	**Tonle Sap Authority**
TSBR	**:**	**Tonle Sap Biosphere Reserve**
UNDP	**:**	**United Nations Development Program**
US$	**:**	**United States Dollar**
WB	**:**	**World Bank**
WTP	**:**	**Water Treatment Plant**

Chapter 1.
Background of the Project

Chapter 1. Background of the Project

1-1 Authorization

The Study on the Preparatory Study on the Siem Reap Water Supply Expansion Project in the Kingdom of Cambodia is in pursuance of the Scope of Work, signed on 29th January 2009, between the Ministry of Industry, Mines and Energy (MIME), the Siem Reap Water Supply Authority (SRWSA), and Japan International Cooperation Agency (JICA). JICA has organized a study team ("the Study Team") consisting of experienced specialists of NJS Consultants Co., Ltd in association with Kokusai Kogyou Co., Ltd. in the fields required for the study.

The Study started in May 2009, and completed in December 2010. During the approximately 20-month period, the Study Team has undertaken the study in close cooperation with the MIME and SRWSA counterpart officials.

This **Final Report 1** compiles the results of the activities implemented during the period from May 2009 to December 2010, based on the agreement for the scope of works for Feasibility Study confirmed in the Steering Committee held on 27 May 2010.

1-2 Background

The city of Siem Reap, the object area of this Study, with a population of over 200 thousand in 2009 is situated approximately five kilometers south of the Angkor World Heritage Site and about two million tourists visit the city yearly. The existing water treatment facility which was constructed under Japanese grant aid in 2006 has a nominal design capacity of 8,000m^3/d. This water supply capacity is too small compared with 43,200m^3/day which is the water demand in 2015 projected by SRWSA. In addition, Siem Reap is under threat of land subsidence which is a social problem, caused largely by obstruction of underground water by the many hotels operating around the heritage site coupled with a sharp increase in tourism related industries, which has resulted in uncontrolled abstraction of groundwater sources in the area.

As a result of the circumstances mentioned above, JICA conducted the pre-preparatory study in January 2009 and the Minutes of Meeting (MM) was signed in cooperation with the Cambodian authorities regarding the necessity of expanding the water supply system, together with a Feasibility Study (F/S) whose scope included groundwater management, and other related matters.

In fulfillment of this agreement, JICA decided to conduct this Study for the expansion of the water supply system in Siem Reap City.

1-3 Objectives of the Study

The objectives of the Study are:

1) To select new water source(s) for an efficient and sustainable water supply system in Siem Reap;
2) To conduct surveys of existing wells and assess the potential yield of groundwater;
3) To identify an urgent water supply expansion project to satisfy the estimated water demand for Siem Reap up to a selected target year of the Project;
4) To conduct a feasibility study for the proposed water supply expansion project, provided that the Project is to be implemented under a finance by the Japan's ODA loan;
5) To formulate a long-term water supply development plan up to year 2030; and
6) To pursue technology transfer to the Cambodian counterpart during the course of the Study.

1-4 Study Area

The Study Area covers all the communes of the newly established Siem Reap City and one adjacent commune of the City, a total of 14 communes as shown in the map of the Study Area.

1-5 Target Year

The target year for Feasibility Study (F/S) in this study is set at year 2022 taking into consideration of the projected water demand and the proposed water supply development plan which targets year 2030 as agreed between the JICA mission for the preparatory study and Cambodian side in January 2009.

1-6 Study Organization

The methodology envisaged by the Study Team in their Inception Report has been maintained. Since the Study has been conducted in three phases, as described below, several reports have been prepared during each phase in the course of the Study.

Phase 2 was conducted based on the agreement on the result of Phase 1 which was confirmed in the steering committee held on 9th December 2009.

Phase 3 has been conducted in parallel to Phase 1 and Phase 2 activities.

- **Phase 1** — **Alternative study on water sources and intake methods.**
- **Phase 2** — **Preparation of facility development plans and the Feasibility Study**
- Phase 3 — Study on groundwater uses conditions

1-7 Contents of the Final Report

This Final Report 1 deals with the result of the study for Phase 1 and Phase 2.

1-8 Study Team Organization

It has been the basic understanding between JICA and MIME/SRWSA that the Study should be undertaken with close coordination between both parties. SRWSA has created a Counterpart Team soon after the commencement of the Study in Cambodia. Since then, vital assistance has been provided to the Study Team by all the departments of SRWSA related to the Study.

The Study Team consists of the following 15 members:

JICA Study Team:

	Position		Name
1.	Team leader/Water supply plan	:	Yoshihiko **SATO**
2.	Water source for water supply		Hiroshi **OKADA**
3.	Hydro-geology 1		**LEI** Peifeng
4.	Hydro-geology 2		Naoki **YASUDA**
5.	Drilling		Roland A. **GROSPE**
6.	Groundwater analyses		Kenji **TAKAYANAGI**
7.	Design of Intake facility		Nobuki **ABE**
8.	Design of water treatment plant		Kentaro **SATO**
9.	Design of Pipelines		Atsushi **KANAYA**
10.	Design of mechanical facilities		Yasuaki **KONDA**
11.	Sewerage/drainage planning		Takashi **WATANEBE**
12.	Construction plan and cost estimate		Satoshi **YAMAMOTO**
13.	Institutional study and O & M management		Consuelo B. **ESTEPA**
14.	Economic and financial analyses		George M. **CALDERON**
15.	Environmental and social considerations		Shinya **KAWADA**

SRWSA Counterpart Team:

	Position		Name
1.	General Director/Water Supply Planning	:	Mr. Som **KUNTHEA**
2.	Deputy General Director/Water Supply Facilities		Mr. Cheav **CHANNY**
3.	Deputy general Director/Financing	:	Mr. Chan **SENGLA**
4.	Department Manager/Administration and Finance	:	Mr. Yay **MONIRATH**
5.	Department Manager/Production and Water Supply	:	Mr. Kong **SOKVAN**
6.	Production chief/Water treatment &pipelines		Mr. Kot **NIMOL**
7.	Laboratory staff/Water quality		Mr. **MONOROM**

Chapter 2.
Project Framework

Chapter 2. Project Framework

2-1 Planning Framework

The basic principle for the expansion of the water supply scheme of the study areas was finalized taking into consideration the projected water demand in the priority supply areas in five year intervals up to the target year. The basic design policy includes the following:

1) Set up of the service areas

Based on the priority analysis of the service areas in consultation with SRWSA counterparts, the service areas to be extended in addition to the existing service areas are finally established. The high-priority regions for water supply are studied taking into consideration city planning for the future preservation of the water environment, needs of residents/business and the efficiency of service improvement.

2) Population served

The total service population is computed according to the finalized service areas and their population projections. Number of tourists visiting to the study areas is analyzed based on the past trend and future economic growth expectation in the Study Area.

3) Unit consumption rate

The unit consumption rates are determined based on analyses on realistic water consumption analyses in order to aim at improving the water supply service level in comparison with the existing and planned water supply capability in the service areas.

4) Supply coverage

Water supply coverage is determined using the comparison study between the supply capability and the goals established in the Cambodia Millennium Development Goals.

5) Service level

As to the existing service areas, the improvement of the water supply service, such as increasing the water supply pressure, is considered. As to the non-supplied areas, a piped water supply system is planned targeting to cover the greatest number of people as possible at its earliest stage in consideration of the respective areas' social and economic importance as well as the investment efficiencies therein.

6) Projection of water demand

On the basis of the determined population served including tourists and unit consumption rate by categories of users (domestic and commercial), the proposed water demands in the priority areas are computed up to the target year.

2-2 Proposed Service Areas

The current water supply conditions in the Study Area under the SRWSA jurisdiction vary from commune to commune. Only the central communes such as Sla Kram, Svay Dangkum, Sala Kamraeuk, Kouk Chak, and Srangae communes are supplied by the SRWSA water supply system, while the rest of the commune is yet to be served by SRWSA.

However, the long-term water supply development plan is very specific that the entire population should have access to a water supply system that provides safe and adequate water at reasonable costs by the year 2030. Such water supply system should be a reasonable water supply system that can be economically and efficiently managed, thus a careful examination on the facility construction plan should also be made.

The service area covers the central urbanized areas and its peri-urban areas in the SRWSA jurisdiction area. The service area of the SRWSA is thus comprised of all the communes except for Chong Khnies of the Siem Reap City and fringe areas of the peri-urban areas as listed in Table 2.1 and illustrated in Figure 2.1.

Remaining part of the study areas will be supplied by individual wells or other methods.

Table 2.1 Proposed Service Areas

Item	Communes	Item	Communes
1	Sla Kram	8	Krabei Riel
2	Svay Dangkum	9	Ampil
3	Sala Kamraeuk*	10	Nokor Thum
4	Kouk Chak	11	Srangae
5	Siem Reap	12	Sambuor
6	Tuek Vil	13	Kandaek
7	Chreav		

Notes: 1) All communes are in Siem Reap City, except for Kandaek commune which belongs to Prasat Bakong District.
2) All area of Sala Kamraeuk* commune is included in the proposed service area, however, the other communes are partly covered by the SRWSA water supply systems
3) Chong Khnies was excluded from the proposed service areas due to its location.

2-3 Population Projection

Population is one of the most important factors in determining the scope of the water supply project. Prior to design of the water supply systems, it is necessary to determine the population within the Study Area. Population projection was conducted in its entirety of the study area in Siem Reap City plus Kandaek commune in Prasat Bakong district to be applied for the water demand projection.

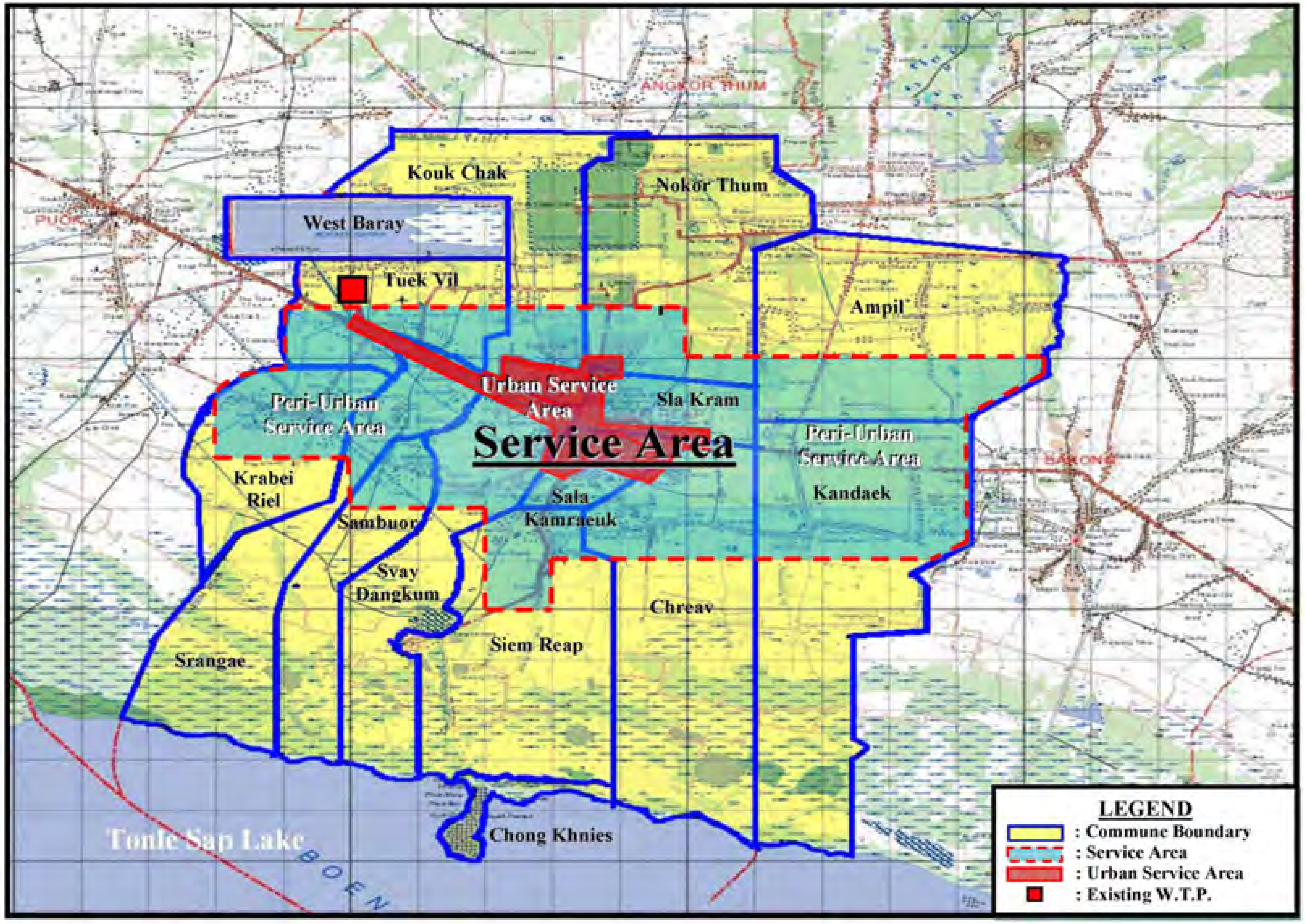


Figure 2.1 Proposed Service Areas

The General Population Census of Cambodia 1998, which was the first census conducted in 36 years, produced a variety of data. All these data required in-depth study to produce a series of reports, which then disseminated for the use of programmers, planners and researchers.

In July 2000, National Institute of Statistics, Ministry of Planning published "Report 6 on Population Projections 2001- 2021" under series of analysis of census results. The first revision, population projections for Cambodia 1998-2020 was published by updating the said projections. The development and publication of the projections are justified by the changes observed in fertility through the Cambodia Demographic and Health Survey undertaken in 2000.

The population projection for Siem Reap Province is extracted as shown in Table 2.2. The recorded population data in 2008 shows 896,443 population and the present population is estimated to be approximately 1.3 million.

Table 2.2 Population Projection 1998-2020, Siem Reap Province

Year	2000	2005	2010	2015	2020
Projected population	767,768	861,214	970,666	1,094,897	1,229,432
Growth rate	2.4%	2.5%	2.6%	2.5%	N/A

Note: Population projections for Cambodia 1998-2020, NIS, MOP

The report notes that the projection of administrative sub-areas is the weakest part of a projection exercise. The cause is that migration is quite unpredictable due to that lack of detailed data in particular reliable data on migration into sub-areas is not available.

The population projection of the Study Area predicts a population of two hundred thousand in 2020 in the "Study on Integrated Master Plan for Sustainable Development of Siem Reap (JICA 2004-2006)". This result, however, was based on the population data of 2004. From 2004 to 2006, there was a significant growth of the population in Siem Reap City, which has to be taken into account for updating the population scenarios. The present level of population is virtually above this level and consequently the predictions for the region are under-estimated. Therefore, population projection for the Study Area is based on the analysis of past trends from 2003 through 2009 census data given by the Department of Planning Siem Reap Province.

Table 2.3 presents the recorded data from 2003 through 2009 of 13 communes of Siem Reap City plus one adjacent commune Kandaek commune in Prasat Bakong District in the Study Area. The data shows the population increase trend of the City is quite different from that of the province. The population growth rate varies from 2.8 percent to 7.8 percent dependent on status of each commune, which is much higher than 2.4 to 2.5 percent of the Provincial growth rate. For example, the populations in Sla Kram commune and Svay Dangkum commune have increased over 14 thousand and 10 thousand or 7.7 percent and 6.5 percent of annual average growth rate, in the last six years. A total of 53,000 populations and an average of 4.9 percent in the Study Area have increased from 2003 through 2009. This trend shows a typical population increase in urban areas in Cambodia. The population increase is caused by migration into Siem Reap City due to the fact that sharp increase of economic activities through tourism industries would be taken place in the Study Area.

Table 2.3 Recorded Population in the Study Area, 2003 to 2009

No.	Commune/Year	2003	2004	2005	2006	2007	2008	2009	2003-2009
1	Sla Kram	26,079	26,550	27,910	31,130	33,824	38,475	40,473	14,394
2	Svay Dangkum	24,493	27,333	26,267	26,985	27,630	34,778	34,878	10,385
3	Sala Kamraeuk	14,960	15,655	17,319	17,781	18,293	20,435	21,600	6,640
4	Kouk Chak	16,228	16,523	18,068	18,230	18,578	19,214	19,367	3,139
5	Siem Reap	14,374	14,654	14,820	16,756	17,018	17,296	17,564	3,190
6	Tuek Vil	7,568	7,854	8,285	8,629	8,934	9,514	9,890	2,322
7	Chreav	7,402	7,607	7,790	7,907	9,407	9,164	9,492	2,090
8	Krabei Riel	6,464	7,152	6,919	6,958	7,357	7,464	7,604	1,140
9	Chong Khnies	4,678	5,812	6,057	6,210	5,857	6,167	6,866	2,188
10	Ampil	5,705	5,946	6,065	6,055	6,062	6,412	6,788	1,083
11	Nokor Thum	4,259	4,612	5,332	5,752	6,072	6,279	6,644	2,385
12	Srangae	4,822	5,109	5,165	5,391	6,405	6,153	6,430	1,608
13	Sambour	2,796	2,965	3,160	3,316	3,295	3,487	3,553	757
14	Kandaek	10,142	10,674	11,027	11,472	11,468	11,960	12,334	2,192
Total		**149,970**	**158,446**	**164,184**	**172,572**	**180,200**	**196,798**	**203,483**	**53,515**

Source : Department of Planning Siem Reap Province.

Table 2.4 Recorded Population Growth Rate of Communes in the Study Area, 2003 to 2009

No.	Commune/Year	2003	2004	2005	2006	2007	2008	2009-2003 Ave
1	Sla Kram	1.8%	5.1%	11.5%	8.7%	13.8%	5.2%	7.7%
2	Svay Dangkum	11.6%	-3.9%	2.7%	2.4%	25.9%	0.3%	6.5%
3	Sala Kamraeuk	4.6%	10.6%	2.7%	2.9%	11.7%	5.7%	6.4%
4	Kouk Chak	1.8%	9.4%	0.9%	1.9%	3.4%	0.3%	3.0%
5	Siem Reap	1.9%	1.1%	13.1%	1.6%	1.6%	1.5%	3.5%
6	Tuek Vil	3.8%	5.5%	4.2%	3.5%	6.5%	4.0%	4.6%
7	Chreav	2.8%	2.4%	1.5%	19.0%	-2.6%	3.6%	4.4%
8	Krabei Riel	10.6%	-3.3%	0.6%	5.7%	1.5%	1.9%	2.8%
9	Chong Khnies	24.2%	4.2%	2.5%	-5.7%	5.3%	11.3%	7.0%
10	Ampil	4.2%	2.0%	-0.2%	0.1%	5.8%	5.9%	3.0%
11	Nokor Thum	8.3%	15.6%	7.9%	5.6%	3.4%	5.8%	7.8%
12	Srangae	6.0%	1.1%	4.4%	18.8%	-3.9%	4.5%	5.1%
13	Sambour	6.0%	6.6%	4.9%	-0.6%	5.8%	1.9%	4.1%
14	Kandaek	5.2%	3.3%	4.0%	0.0%	4.3%	3.1%	3.3%
Total		**5.7%**	**3.6%**	**5.1%**	**4.4%**	**9.2%**	**3.4%**	**4.9%**

Source : Department of Planning Siem Reap Province.

It is difficult to predict the actual population growth, in particular the number of people seeking employment and therefore migrating from other districts or provinces into Siem Reap City. It is then anticipated that the average growth rate of over five percent in the past six years will not continue in the same way toward target year 2030, due to such reasons as global economic crises outbreak in 2008, epidemics of bird flu and swain flu, and the border conflict between Thailand and Cambodia. The speed of growth will slow down to possibly four percent to two percent but will be higher than the average population growth in Cambodia.

For population projection, thus the formula utilized therefore is the exponential curve trend analysis. This formula can be used for ordinal cities with moderate development.

$$y = y_0 + Ax^a$$

where,
y : population after x-year from the reference year
y_0: population of the reference year
x : number of years after the reference year
a, A : constants

Projected figures show an estimated total population of 256 thousand in 2015, of 303 thousand in 2020, of 350 thousand in 2025, and of 399 thousand in 2030, respectively for the whole Study Area. The population of the Study Area will grow at the rate of 3.01 percent to 3.89 percent (2010-2014), 3.76 percent to 3.32 percent (2015-2019), 3.23 percent to 2.89 percent (2020-2024), and 2.82 percent to 2.56 percent (2025-2029) as summarized in Table 2.5. By the long term development plan target year of 2030, the population in the whole study area is projected to be 399 thousand or 1.90 times of the current population level. Total increase of population will be 189 thousand.

Table 2.5 Projected Populations and Growth Rate in the Study Area, 2010-2030

Year	2009	2010	2015	2020	2025	2030
Projected Population	203*	210	256	303	350	399
Growth rate	N/A	3.01% to 3.89%	3.76% to 3.32%	3.23% to 2.89%	2.82% to 2.56%	2.50%

Note: Population is shown in thousand. * data in 2009 is of Department of Planning, Siem Reap province

As same manner as the population projection in the whole Study Area, population projection in the proposed service areas was made by reducing the whole population of Chong Khnies Commune and those fringe areas' population as resided out of the proposed service areas from the projected population in the whole Study Area.

Table 2.6 Projected Populations and Growth Rate in the Proposed Service Areas, 2010-2030

Year	2010	2015	2020	2025	2030
Projected Population	178	221	265	312	359
Growth rate	3.72% to 4.24%	4.11% to 3.65%	3.55% to 3.19%	3.10% to 2.82%	2.71%

Note: Population is shown in thousand.

Projected figures show an estimated total population of 221 thousand in 2015, of 265 thousand in 2020, of 312 thousand in 2025, and of 359 thousand in 2030, respectively for the proposed service areas. The population of the proposed service areas will grow at the rate of 3.72 percent to 4.24 percent (2010-2014), 4.11 percent to 3.65 percent (2015-2019), 3.55 percent to 3.19 percent (2020-2024), and 3.10 percent to 2.82 percent (2025-2029) as summarized in Table 2.6. By the long term development plan target year of 2030, the population in the proposed service areas is projected to be 359 thousand or 2.02 times of the current population level. Total increase of population will be 181 thousand.

2-4 Tourist Projection

Tourism statics report consisting of significant data on the status of international visitors' arrivals and their average length of stay, domestic tourists, and tourism services is annually complied and published by the Department of Statistics and Tourism Information of the Ministry of Tourism (MOT).

The latest statistics report summarises that the semester of 2008 the visitor arrival to Cambodia indicated a growth of 12.6 percent and conversely the second semester showed -1.2 percent decrease compared to the same period of 2007. The report analyses that the global economic and financial crisis brought about September 2008 had particular impact to the tourism industry of Cambodia.

The annual report 2008 details the number of tourists' arrival to Siem Reap province as shown in Table 2.7.

In 2008, there were approximately 1.20 million of local tourists and 1.05 million of international tourists, a total of 2.25 million of tourists. Local tourists were increased more than double compared to the previous years in 2003 and 2005 dependent on the local economic growth. The growth rate of international tourists keeps relatively stable between 20 to 40 percent except for in 2002 and 2007 as summarized in Table 2.7 and illustrated in Figure 2.2.

Table 2.7 Yearly Tourist Arrival to Siem Reap Province, 2002 - 2008

Year	2002	2003	2004	2005	2006	2007	2008
Local	93,942	109,186	384,201	209,524	782,895	892,226	1,195,264
Growth rate	16.2%	251.9%	-45.5%	273.7%	14.0%	34.0%	N/A
International	453,148	402,780	560,947	692,004	856,157	1,120,586	1,059,870
Growth rate	-11.1%	39.3%	23.4%	23.7%	30.9%	-5.4%	N/A
Total	547,090	511,966	945,148	901,528	1,639,052	2,012,812	2,255,134
Growth rate	-6.4%	84.6%	-4.6%	81.8%	22.8%	12.0%	N/A

Source: Tourism Statistics, Ministry of Tourism Annual Report

Recognizing the above situations, it is again difficult to predict the growth of tourism industries in the future which is highly fluctuated dependent on an international economic growth and the other unforeseen problems.

The Study Team is then anticipated that two-digit average growth rate in the past six years will not continue in the same way toward the target tear 2030, as same reasons as the population projection due to such as global economic crises outbreak, epidemics of bird flu and swain flu, and the border conflict between Thailand and Cambodia. Actually the growth of tourist arrivals has already slowed significantly in 2009, reflecting the economic weakness in US, Europe and Korea particularly.

The Asian Development Outlook 2009 published by the Asian Development Bank (ADB) expects four percent GDP growth in 2010 in Cambodia. Then, the speed of growth will slow down to possibly four percent to two percent in average toward the target year 2030.

For the projection of tourist growth, a time series trend analysis was conducted and the following trend analysis formula is applied. This formula is used for estimation of growing aspect with a uniform rate for a certain period of time.

$$y = y_0 (1+r)^x$$

where,
y : tourists after x-year from the reference year
y_0 : tourists of the reference year
x : number of years after the reference year
r : yearly growth rate

In the tourist projection, the following assumptions are made:

⇒ Based on the past experience in Siem Reap and from other countries, tourist growth is modeled according to three scenarios, low, medium and high, applying respective annual constant growth rates of 2%, 3%, and 4%;

⇒ Tourist arrivals in 2009 is assumed to be the same as recorded in 2008.

Projected figures in scenario 1 show an estimated total tourist of 2.8 million in 2020 and of approximately 3.4 million in 2030 or 1.51 times of that of year 2008. Scenario 2 shows in between 2015 and 2020 tourists' arrivals to Siem Reap will be of 3 million and reach at 4 million in between 2025 and 2030. The projected tourist in 2030 in scenario 2 will be 1.86 times of that of 2008. Scenario 3 indicates that tourists will exceed by 3 million after 2015 and 4 million after 2020 and reach at 5 million before 2030. Under scenario 3, the projected tourist in 2030 will be more than double of 2008. Comparison of three scenarios are shown in Figure 2.3.

Table 2.8 Projected Tourists 2010-2030

Year	2010	2015	2020	2025	2030
Scenario 1	**2 % growth**				
Projected tourists	2,282	2,520	2,782	3,072	3,391
Rate for 2008*	1.02	1.12	1.24	1.37	1.51
Scenario 2	**3 % growth**				
Projected tourists	2,323	2,693	3,122	3,619	4,196
Rate for 2008	1.03	1.19	1.38	1.60	1.86
Scenario 3	**4 % growth**				
Projected tourists	2,327	2,831	3,445	4,191	5,099
Rate for 2008	1.04	1.26	1.53	1.87	2.27

Note: 1) Unit in thousand.
2) Rate for 2008 means that the rate between the projected figures and actual record of 2,255,134 in 2008.

Average length of stay in Cambodia illustrated in Figure 2.4 increases more than one day from 5.2 in 1998 to 6.65 in 2008 according to the Tourism Statistics, Annual Report 2008. 49.87 percent visitors visited Siem Reap and 50.1 percent visited Phnom Penh and the rest visited other destinations. Particularly for international visitors to Siem Reap, group tour spent a 3.62 day, individual tour spent 3.98 day, and an average length of stay in Siem Reap is 3.76 days.

In preparation of water demand projection, an average length of stay for both local and international visitors is accounted to be 3.5 days which should allow enough room for future increase of tourists' water demand.

Figure 2.2 Growth Rate of Tourist Arrival to Siem Reap Province 2002-2008

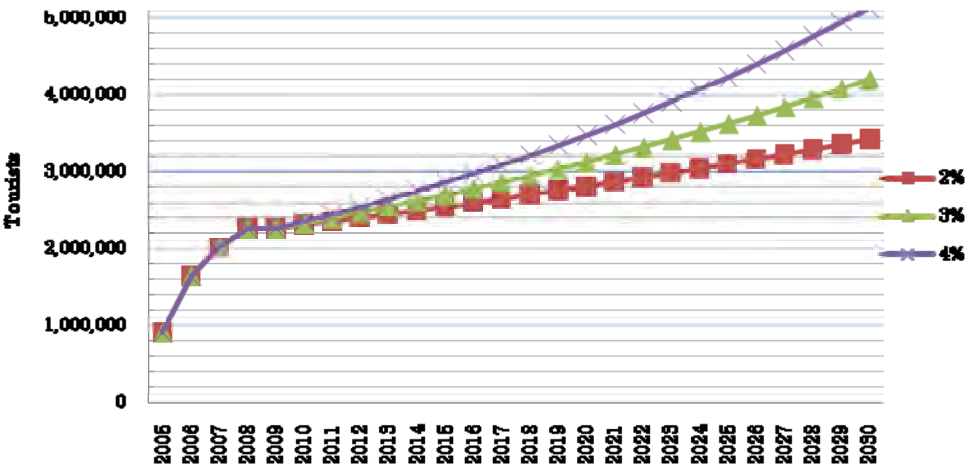


Figure 2.3 Tourist Projection by Scenarios

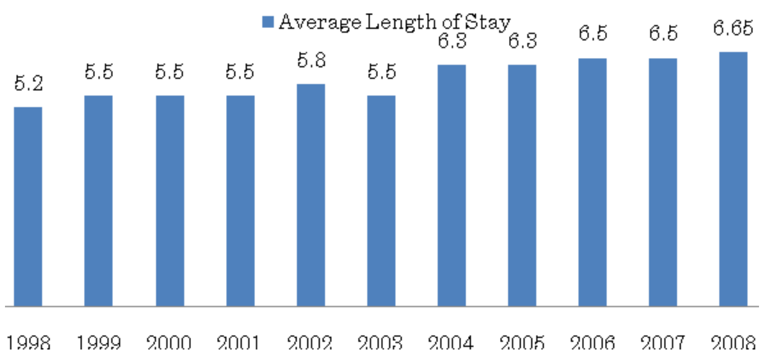


Figure 2.4 Average Length of Stay in Cambodia 1998-2008

Water use by other commercial industries is very small in scale compared to the tourism industries in Siem Reap. Small businesses other than tourism industries then should be accounted as a part of domestic water use. According to the surveys on hotel water use conducted by the Study Team suggested that the hotel water use amount includes not only for tourists' consumption but also miscellaneous water consumption by the hotel employees. The miscellaneous hotel employees' water consumption should be accounted as domestic water use to avoid overestimate in the water demand projection. The details will be discussed in the following chapter.

The existing capacity of accommodations available in Siem Reap is summarized in the following table. The data shows main accommodations are situated along with the national road No. 6 and its surrounding communes.

Table 2.9 Existing Hotels and Guesthouses and Their Capacity in Siem Reap City (Dec. 2008)

No.	Commune	Nos. of Hotels	Capacity of Hotels (beds)	Nos. of Guest Houses	Capacity of Guest of House (beds)	Total of Hotels and Guest Houses	Total Cap. (beds)
1	Sla Kram	32	2,909	47	998	79	3,907
2	Svay Dangkum	58	8,859	111	2,327	169	11,186
3	Sala Kamraeuk	17	1,140	41	787	58	1,927
4	Kouk Chak	1	378	4	75	5	453
5	Siem Reap	0	0	1	16	1	16
6	Tuek Vil	0	0	0	0	0	0
7	Chreav	0	0	3	99	3	99
8	Krabei Riel	0	0	0	0	0	0
9	Chong Khnies	0	0	0	0	0	0
10	Ampil	0	0	0	0	0	0
11	Nokor Thum	5	1,414	1	13	6	1,427
12	Srangae	0	0	0	0	0	0
13	Sambour	0	0	0	0	0	0
14	Kandaek	0	0	0	0	0	0
Total		**113**	**14,700**	**208**	**4,315**	**321**	**19,015**

Source : Ministry of Tourism, Siem Reap Tourism Department.

2-5 Proposed Supply Coverage

2-5-1 Present Supply Coverage and Unit Consumption Rate

The current water supply for domestic use is estimated by using the latest water production and selling records of SRWSA in connection to the registered number of house connections in May 2009 as summarized in Table 2.10.

Table 2.10 Water Production/Sell and Connections in May 2009

Daily Water Prod.(m^3)	Daily Water Sell (m^3)				Connection			
	Domestic	Commercial	Admin.	Total	Domestic	Commercial	Admin.	Total
9,007	4,890	2,800	143	7,833	3,374	495	24	3,893

The current population supplied by direct house connection is usually estimated by number of house connections and a current average size of household of 5.7. According to the data on household size provided by Department of Planning, Siem Reap province shows that Siem Reap City had 191,149 population with 33,659 households in 2009 (191,149/33,659≒5.7). The service population in May 2009 is then calculated as shown below:

Service population = 3,374 house connections x 5.7 average size of a house hold
= 19,232

In applying 19,232 as service population against the daily water consumption by residents of 4,890 m^3/day recorded in May 2009 as referred to Table 2.10, unit consumption rate per capita per day (lpcd) is computed to be of 255 lpcd (=4,890 m^3/d/19,232 pops.), which is too high rate compared to the same scaled water supply systems in the other Asian countries as well as PPWSA record of 80 lpcd in 2004 as mentioned in the 2006 JICA Master Plan study..

To clarify this issue, the Study Team referred results of a social survey for residents in the service areas of SRWSA conducted by the Study Team. The result summarized in Table 2.11 shows that unit consumption rates are 52 lpcd for low income level, 92 lpcd for middle income level, and 150 lpcd for high income level, respectively. An average number of populations for one house connection are computed to be 7.3, much higher than 5.7 of an average size of household.

Table 2.11 Social Survey Result on Unit Water Consumption Rate in Service Areas

Income Class	Surveyed connections (a)	Total pops. used the connections (b)	Served pops. per connection (b/a)	Total water consumption (m^3) (c)	**Unit consumption rate (lpcd:c/b))**
Low	27	127	4.7	6.5	52
Middle	38	224	5.9	20.5	92
High	35	383	10.9	57.3	150
Average	100	734	7.3	84.3	115

Note: lpcd indicates litter per capita per day.

This is attributable to the fact that customer meters registered under domestic water use are not necessarily used for one household in the service areas; rather, they are frequently shared by multiple households and their relatives staying together with the household, because that request for new service connections are stagnated without execution. SRWSA mentions that house connections registered under domestic water use is sometimes used for commercial like guest house.

In applying the estimated unit consumption rate of middle income level of 92 lpcd, say 100 lpcd, service population is roughly estimated to be 48,900 (= 4,890 m^3/d/100 lpcd) or 24 percent of the total population of 203 thousand. Hotel water use survey conducted by the Study Team suggested that the current water consumption rate for tourists including hotel employees are 418 to 435 lpcd dependent on seasons, say 430 lpcd, tourists' served is roughly estimated to be 1,860 tourists (=2,800 m^3/d/430 lpcd /3.5) or approximately 30 percent of the recorded tourists arrivals in Siem Reap, assuming that all the commercial water use of 2,800 m^3/d were consumed by the tourists.

2-5-2 Planned Supply Coverage

In preparing the target supply coverage, three plans are considered. The first plan is Second Socio-Economic Development Plan 2001 to 2005 (SEDP II 2001 to 2005). The second is the Cambodia Millennium Development Goals (CMDGs), which aims to increase coverage up to 80 percent by the target year of 2015. The third is envisioned in the SRWSA business plan which was realigned by SRWSA.

Table 2.12 SEDP II Water and Sanitation Targets

Objective and Indicator	Baseline (year)	Target for 2013
Share of the population with access to safe drinking water		
Rural	29 (1999)	40
Urban	69.5 (1999)	87

Source: SEDP-II

Second Socio-Economic Development Plan - prepared in 2001 and approved by the National Assembly in 2002, SEDP-II is a five-year plan covering 2001 to 2005. Under SEDP-II, the RGC committed to a long-term goal of providing access to potable drinking water and environmental sanitation for the entire population as shown in Table 2.12. This principle was succeeded to the National Strategic Development Plan for 2006 and 2010 in targeting poverty reduction as a top priority and progress towards achieving CMDGs targets by 2015.

The development targets for water and sanitation in the Global and Cambodian Millennium Development Goal 7 are shown in Table 2.13. The targets are also reflected in the government's Poverty Reduction Strategy Paper (PRSP), prepared in 2003 in fulfillment of World Bank and IMF requirements for accessing their concessional resources. SEDP-II is considerably more ambitious than the CMDGs described below. Note that the CMDGs were established later and may be considered more realistic, even though they also are considered to be highly ambitious, particularly with respect to rural targets.

Table 2.13 Cambodia Millennium Development Goal 7

Global MDG7	Cambodia MDG7
Target 10: Halve by **2015** the proportion of people without sustainable access to **safe drinking water**	Overall target 14: Halve by **2015** the proportion of people without sustainable access to **safe drinking water**
Indicator 29: Proportion of population with sustainable access to an **improved water source**	Indicator 7.10: Proportion of **rural** population with access to **safe water source**
	Indicator 7.11: Proportion of **urban** population with access to **safe water source**

Source: Cambodia Millennium Development Goals Report 2003

The Millennium Development Goals (MDGs), unanimously adopted by the UN General Assembly in 2000, have been localized with specific targets for Cambodia. The RGC has adopted and localized the MDGs into the Cambodia MDGs (CMDGs). MDG Seven aims to reverse the loss of environmental resources, maintain forest coverage, promote access to safe drinking water and secure land tenure. Table 2.14 shows the quantitative benchmarks and targets for the relevant CMDG7 indicators.

Table 2.14 CMDGs Indicators, Benchmarks and Targets

Indicators	Benchmarks		**Targets**		
	Value	Year	2005	2010	**2015**
7.11: Proportion of urban population with access to **safe water source**	60%	1998	68%	74%	**80%**

Source: Cambodia Millennium Development Goals Report 2003

SRWSA prepared its business plan toward 2015 which follows the CMDGs in its policy and strategy with revisions in the coverage and served population in reflection to their estimated population data.

However, there are still so many constraints in the SRWSA plan to fulfill the target in the year 2015. For example, considerable delay in the provision of distribution pipelines, water source and water treatment plant augmentation, as well as a relative high NRW level, in addition to other institutional, managerial, and financial constraints.

Table 2.15 SRWSA Plan and Present Supply Coverage

Descriptions	Target Year	Rate	Served Population 1)
Supply Coverage in 2009	N/A	24 % 1)	Estimated 48,900
SRWSA	2015	90 %	N/A

Notes : Estimated by a social survey result conducted by the Study Team.

2-5-3 Proposed Supply Coverage

In targeting the year 2030, the following scenario is shown in proposing a useful plan which provides a realistic guideline for the expansion of water supply service in the study area.

Applied scenario is based on a pessimistic view of the SRWSA plan in respect to the implementation schedule, taking into consideration delays in development of water source, water treatment plant, and the expansion of necessary distribution network as water demand increases. Under this scenario, the residential coverage of 80 percent is delayed from the year of 2015 in CMDGs to a target year 2020. Then, five percent increase in every five years will be improved to be 90 percent towards the target year 2030. Location of the hotels is concentrated in the central areas of the City so that the water supply coverage for tourist may achieve much faster than that of domestic water supply by reinforcing the existing distribution pipelines. However, expansion of water supply to the commercial water use for the hotel business will contribute to the financial strengthening of SRWSA, the supply coverage to commercial use is assumed to follow the same trend as the residential coverage up to 2020 in a conservative manner, considering delay in switching from their own water supply systems to the proposed water supply system and then accelerate to 100 percent by the year 2026. Allocation of the commercial coverage in 2020, 2025, and 2030 are then set at 80 percent, 95 percent and 100 percent, respectively.

The supply coverage in year 2015, which is the SRWSA' target year, is proposed to be 55 percent, taking into realistic development progress from the based year 2010 which is estimated at 30 percent taking into the current situation of SRWSA's supply coverage.

Allocation of the supply coverage to each commune, which was carried out during F/S study in Phase 2, will still be based on priority.

Table 2.16 Proposed Supply Coverage

Year	2009	2010	2015	2020	2025	2030
Resident	24%*	30 %	55 %	80 %	85 %	90 %
Tourist	30%*	30 %	55 %	80 %	95 %	100 %

Notes: *The supply coverage in 2009 was estimated based on the social survey results conducted by the Study Team

2-6 Population/Tourists Served

Two categories of served population are applied in preparation of preliminary water demand projection, namely: 1) domestic water use by the direct house connection to the residents and 2) commercial water use for the tourists by the guest houses and hotels.

Population served by direct house connection is derived by multiplying the projected population and the proposed coverage in each planned year. Tourist served is derived in the same manner as the population by multiplying the projected tourists and its proposed coverage in each planned year.

2-6-1 Population Served

A population projection is made as the basis for estimating future water demand in the service area as summarized in Table 2.6. Applying the proposed coverage and the projected population, population served is summarized in Table 2.17.

The population served in 2020 is estimated to be over 200 thousand and 300 thousand in 2030, respectively.

Table 2.17 Population Served

Year	2010	2015	2020	2025	2030
Projected Population* (a)	178	221	265	312	359
Coverage (%) (b)	30 %	55 %	80 %	85 %	90 %
Population Served* (a x b)	54	122	212	265	323

Note: Unit is x 1000.

2-6-2 Tourists Served

A tourist projection is made as the basis for estimating future water demand in the service area as summarized in Table 2.8. Applying the proposed coverage and the projected tourists' arrivals, tourist served is shown in Table 2.18.

The tourists served in 2020 are estimated to be over six thousand and 9 thousand in 2030, respectively. The applied scenario is selected based on additional scenario in unit consumption rate of tourist in the following section.

Table 2.18 Tourists Served

Year	**2010**	**2015**	**2020**	**2025**	**2030**
Coverage (b)	30 %	55 %	80 %	95 %	100 %
Scenario 1 (2% growth)					
Projected Yearly Tourists (a)	2,282	2,520	2,782	3,072	3,391
Projected Daily Tourists (a/365)	6.3	6.9	7.7	8.5	9.3
Daily Tourists Served (a /365x b)	1.9	3.8	6.1	8.0	9.3
Scenario 2 (3% growth)					
Projected Yearly Tourists (a)	2,323	2,693	3,122	3,619	4,196
Projected Daily Tourists (a/365)	6.4	7.4	8.6	10.0	11.5
Daily Tourists Served (a/365 x b)	1.9	4.1	6.9	9.5	11.5
Scenario 3 (4% growth)					
Projected Yearly Tourists (a)	2,327	2,831	3,445	4,191	5,099
Projected Daily Tourists (a/365)	6.4	7.8	9.5	11.5	14.0
Daily Tourists Served (a /365x b)	2.0	4.3	7.6	11.0	14.0

Note: Unit in x 1000.

Chapter 3.

Water Demand Projection and Proposed Long-Term Water Supply Development Scheme

Chapter 3. Water Demand Projection and Proposed Long-Term Water Supply Development Scheme

3-1 General

Water demand projection serves as the fundamental basis for selection of raw water source and preparing the long-term water supply development plan, targeting year 2030. The projection is largely dependent on the past trend which forecasts the future from past experience. However, the existing water supply systems with a nominal design capacity of 8,000 m^3/d has been just operated since April 2006 and the water demand projection is based on the actual water use trends recorded by SRWSA and is adjusted using those data given by a social survey work conducted by the Study Team. The social survey were conducted to find out i) actual amount of low medium, and high water consumptions in the service areas and non service areas, ii) peoples' willingness to connect to the proposed water supply systems in non service areas, and iii) actual water consumption and affordable water rates.

Classification by use is categorized into domestic and commercial in preparation of the water demand projection. Administrative water use, which is only 2.9 percent of the domestic water use as recorded in 2008, as well as small business sector are assumed to be a part of the domestic water use. Other water use such as industrial water use is minimal in the study areas so that commercial water use is regarded to include all the remaining water use, except for the domestic water use.

In addition to this classification, the estimated NRW will be summed up for the total water demand. Peak factor will be applied to an average water demand to secure the maximum water demand projection.

3-2 Unit Consumption Rate of Domestic Water Use

In general, there has been considerable debate over the amount of water people need for domestic purposes and the amount that they actually use. It has often been stated that it depends on the life style of the region; namely, people in hot countries may need to bathe several times in a day, which is not necessarily wasting water. It also often happens that people manage with less water when it is in short supply. However, at around 100 lpcd, consumers in Seam Reap appear to use water relatively efficiently, due to the limited availability of the present water supply capacity.

Water use in the present water supply study areas is estimated to be an average of 115 lpcd through a field survey results conducted by the Study Team as referred to **SR 3.1.**

While in non service areas, according to the social survey, water use in dry season is slightly higher than that of in rainy season due to that people consume their well water for gardening and raising domestic animals in addition to the general water use purposes such as cooking, washing, bathing, and drinking. The survey results shows that water use trend in non service areas is generally same level as the service areas.

It is noted that high income level in both service and non service areas uses almost 150 lpcd, while the low income level in the service areas, consuming only 52 lpcd compared to 99 to 108 lpcd of that of non service areas, is considered to save their water expenses due to their economic reasons.

Table 3.1 Estimated Unit Consumption Rate of Residents in Non Service Areas

Income level	Low	Medium	High
Dry season			
Ave. water use	108	120	146
Rainy season			
Ave. water use	89	92	117

Note: Unit in litter per capita per day

While the “Water in Asian Cities, Utilities’ Performance and Civil Society Views” published by the Asian Development bank (ADB) based on data provided by the selected utilities in 12 Asian cities for 2001 or 2001/2002 fiscal year shows that an average per capita consumption rate was 122 lpcd, varying 68 in Kathmandu to 197 in Karachi as listed below.

Cities	Rate (lpcd)	Cities	Rate (lpcd)
Karachi (58 %)	197	Dhaka (72 %)	115
Ho Chi Minh (84 %)	167	Delhi (69 %)	110
Chengdu (83 %)	138	Vientiane (63 %)	110
Kuala Lumpur (100 %)	127	Phnom Penh (84 %)	104
Manila (58 %)	127	Jakarta (51 %)	77
Colombo (69 %)	119	Kathmandu (83 %)	68

Note: Percentage shows the supply coverage of each city. The figures in parentheses are service coverage.

Thus, in the unit consumption rate projection, the following assumptions are made:

⇒ Baseline for the unit consumption rate in 2010 is set at 110 lpcd to prevent overestimation. The 110 lpcd of unit consumption rate is regarded to include the administrative water use in the water demand projection.

⇒ Based on past experience in Siem Reap and from other countries, growth in per capita consumption is modeled according to three scenarios, low, medium and high, applying respective annual growth rates of 1lpcd, 2 lpcd, and 3 lpcd, respectively.

Table 3.2 Applied Scenarios for Domestic Unit Consumption Rate 2010-2030

2010	**2015**	**2020**	**2025**	**2030**
Scenario 1 : 1 lpcd growth per year				
110	115	120	125	130
Scenario 2 : 2 lpcd growth per year				
110	**120**	**130**	**140**	**150**
Scenario 3 : 3 lpcd growth per year				
110	125	140	155	170

Based on the estimated unit consumption level of 110 lpcd in 2010, unit consumption in the target year 2030 is computed at three consumption levels; namely 130, 150, and 170 lpcd in accordance with the applied constant annual growth rate of 1lpcd, 2 lpcd, or 3 lpcd as shown in Table 3.2.

Baseline for the 110 lpcd unit consumption rate is translated as shown below in applying 80 percent of the field survey data for tourists' water consumption rates conducted by the Study Team. 110 lpcd is sufficient for shower, toilet, washing, cooking, and miscellaneous use like car washing and gardening. For example, in 1973, Tokyo Metropolitan Waterworks Bureau advanced 20 l of shower, 20 l of toilet, 21 l of washing, 12 l of cooking, and 12 l of miscellaneous uses, totaling 85 lpcd as a basic water consumption rate in targeting a water conservation, which supports 110 lpcd is sufficient in supporting the life of people and appropriate level as baseline of the unit water consumption rate for the Siem Reap water supply scheme.

Water consumption	Rate (lpcd)	vs.	Tokyo Metropolitan Gov.
Shower	0.17 l/s x 5 min. x 0.8* = 40	>	20
Toilet	10 l/s x 3.76 times x 0.8* = 30	>	20
Washing	8 (JWWA)	<	21
Cooking	21	>	12
Miscellaneous	11	≒	12
Total	**110 lpcd**	**>**	**85 lpcd**

Note: 80 % of shower and toilet water use of the tourists are applied.

3-3 Domestic Water Demand Projection

Total domestic water demand in average was obtained for each scenario as shown in Table 3.3.

- Population Served
  = Projected population in each commune in each year x Coverage (%)
- Domestic water demand
  = ∑(Population Served) x unit consumption rate in each year as shown in Table 3.2.

Table 3.3 Average Daily Domestic Water Demand (m^3/d)

Year	2010	2015	2020	2025	2030
Projected population*	178	221	265	312	359
Population Served*	54	122	212	265	323
Proposed coverage	30 %	55 %	80 %	85 %	90 %
Scenario 1	5,900	14,000	25,400	33,000	42,000
Unit consumption rate	110	115	120	125	130
Scenario 2	5,900	14,600	27,500	37,100	48,400
Unit consumption rate	110	120	130	140	150
Scenario 3	5,900	15,200	29,700	41,000	54,800
Unit consumption rate	110	125	140	155	170

Note: Figures are rounded in x 1000, based on population projection.

3-4 Unit Consumption Rate of Commercial Water Use

In preparation of the existing water supply systems, 300 lpcd to 500 lpcd was applied based on a field survey result conducted under its feasibility study in 2000. The Study on Integrated Master

Plan for Sustainable Development of Siem Reap/Angkor Town came up with a unit water consumption rate for tourist of 250 to 300 lpcd in reference to the Japanese Standard of Architecture facilities Design Standard in 2006.

To verify the unit consumption rate by the tourists, the Study Team conducted a field survey at the selected five hotels, including two large scaled hotels and three small scaled hotels. The unit water consumption rate for the tourists is confirmed based on information/data collected through an interview/questionnaire on water consumptions on the exiting water supply system of hotels during the field survey.

The water supply facilities provided with the hotels shows a relatively large capacity for drinking, washing, bathing, and miscellaneous water uses. High unit consumption rate per hotel guest results from that the hotels have fairly large number of employees working during the day time and some of them stay overnight at the hotel, who consume the water and eventually double counted with the domestic water consumption, in addition to the water consumption for swimming pools and gardening water consumptions especially during the dry season at the large scaled hotels.

As a result, the amount of water consumed daily per tourist was estimated to be an average of 276 lpcd. Each data obtained is summarized in Table 3.4. The estimation is conducted based on the discharge data from shower heads and faucets that are fully open and thus the results are a conservative estimation in terms of water demand.

Table 3.4 Surveyed Data on Average Water Use by Tourist

Descriptions	Shower	Bath	Toilet	Wash basin	Remarks
Duration (min)	8.05	N/A	N/A	0.25	duration of water flowing
Times per day	2.13	0.26	3.76	7.76	4 times use of basin plus at time of rest room use
Discharge (l/s)	0.17	NA	10	0.14	measured with faucet fully open standard toilet tank assumed
Tub volume (l)	NA	181.3	NA	NA	measured
Total daily use (l)	**174.9**	**47.1**	**37.6**	**16.3**	**= 276 lpcd**

Thus, in the unit consumption rate projection, the following assumptions are made:

⇒ Baseline for the unit consumption rate of tourist in 2010 is set at 300 lpcd which includes 10 percent allowances for unforeseen situation in the future to the surveyed average unit consumption rate as the water demand projection;

⇒ As same manner as the domestic water use, growth in per capita consumption are modeled according to three scenarios, low, medium and high, applying respective annual growth rates of 1lpcd, 2 lpcd, and 3 lpcd towards 320 lpcd, 340 lpcd, and 360 lpcd, respectively; and

⇒ The increasing scenarios are set provided that miscellaneous water use such as gardening, car washing, and laundry services at hotel business in the hotel zone grows towards target year 2030.

Table 3.5 Applied Scenarios for Unit Consumption Rate of Tourist, 2010-2030

2010	2015	2020	2025	2030
Scenario 1 : 1 lpcd growth per year				
300	305	310	315	320
Scenario 2 : 2 lpcd growth per year				
300	**310**	**320**	**330**	**340**
Scenario 3 : 3 lpcd growth per year				
300	315	330	345	360

3-5 Commercial Water Demand Projection

Total commercial water demand in average was obtained for each scenario as shown in Table 3.6.

- Tourist Served
  = Projected tourist in each year x Coverage (%)
- Commercial water demand
  = ∑(Tourist served) x unit consumption rate in each year as shown in Table 3.5 x average day of stay (= 3.5)

Table 3.6 Average Daily Commercial Water Demand (m^3/d)

Year	2010	2015	2020	2025	2030
Proposed coverage	**30 %**	**55 %**	**80 %**	**95 %**	**100 %**
Scenario 1 (m^3/d)	2,000	4,000	6,700	8,900	10,400
Projected yearly tourists (x 1000)	2,282	2,520	2,782	3,072	3,391
Projected daily tourists (x 1000)	6.3	7.0	7.7	8.5	9.3
Daily tourist served (x 1000)	1.88	3.80	6.10	8.00	9.29
Unit consumption rate (lpcd)	300	305	310	315	320
Scenario 2 (m^3/d)	**2,000**	**4,400**	**7,700**	**10,900**	**13,700**
Projected yearly tourists (x1000)	2,323	2,693	3,122	3,619	4,196
Projected daily tourists (x1000)	6.37	7.38	8.56	9.92	11.50
Daily tourist served (x 1000)	1.91	4.06	6.85	9.42	11.50
Unit consumption rate (lpcd)	300	310	320	330	340
Scenario 3 (m^3/d)	2,000	4,800	8,800	13,200	17,600
Projected yearly tourists (x1000)	2,327	2,831	3,445	4,191	5,098
Projected daily tourists (x1000)	6.38	7.76	9.44	11.48	13.97
Daily tourist served (x 1000)	1.92	4.27	7.55	10.91	13.97
Unit consumption rate (lpcd)	300	315	330	345	350

3-6 NRW Reduction

Non-revenue water was a nagging problem for SRWSA before 2006 when the existing water supply systems were commenced under the grant aid by the Government of Japan. The issues and problems concerning NRW are described as follows:

- Maximum utilization of limited water sources

  It is difficult and costly to develop water sources as well as treatment and distribution systems. All efforts, including cost and time, will be wasted if NRW is a significant portion of water production.

- Improvement of financial condition

  NRW represents the loss of produced water which includes the manpower, chemical, and power costs. The increase of NRW will aggravate the financial position of the waterworks system.

- Improvement of supplied water pressure and quality as well as prevention of supplied water contamination

  Leakage will cause low and inadequate water supply. Low pressure will further contribute to the deterioration of distributed water quality due to the inflow of contaminated water from outside. This is a breach of the important aims of the public water supply body.

- Prevention of traffic accident due to road depressions caused by pipe damage

  Leaked water floods the residential areas. Pipe damage will cause a depression of road as well as traffic congestion.

The following figures present the details of distributed water in 2008 by SRWSA. The current NRW, which SRWSA defines as a ratio of unbilled water against the total production water amount, hit 12.7 percent as shown in Figure 3.1, compared to 19 percent NRW recorded in 2007.

- Production volume 3,169,208 m^3/year
- Water sold 2,766,178 m^3/year
- NRW volume 403,030 m^3/year
- NRW ratio 12.7 percent (yearly average)

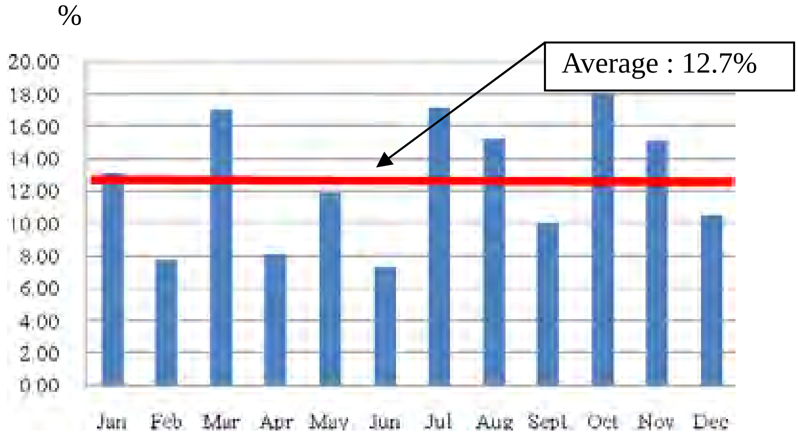


Figure 3.1 NRW in 2008

Future projects shall include pipe replacement/renovation to renew old and defective distribution components, adoption of stricter quality control and quality assurance of construction activities, and research and development of new pipe materials, techniques and technologies to lengthen the useful life of distribution facilities. Past experience confirms that it is reasonable to assume that the NRW of SRWSA can be controlled and maintained below 10 percent after the target year of 2020, assuming 17 percent of NRW in 2010.

Table 3.7 Proposed NRW Reducing Plan

Year	2010	2015	2020	2025	2030
NRW	17 %	12 %	10 %	10 %	10 %

3-7 Peak Factor

(1) Peak Day Demand Factor

Table 3.8 and Table 3.9 present the monthly water supply from the existing water treatment plants in 2007 and 2008. The monthly variation of distributed water is small due to the limited water supply capacity against the demand. In both years, the distribution amount is gradually increased as the water meters are connected to the residential and hotel users.

Maximum day demand factor varies from 0.79 to 1.28, with the average at 1.00 in the year 2007 and 2008. 1.28 of the monthly variation recorded in December 2007 can be translated to be 0.92 variations only in applying an average daily distribution of 8,683 m^3 in 2008.

Table 3.8 Monthly Water Distribution Trend in 2007

Month	Daily Average (m^3/d)	Monthly Variation (%)	Month	Daily Average (m^3/d)	Monthly Variation (%)
Jan.	4,875	0.79	Jul.	6,310	1.02
Feb.	5,023	0.81	Aug.	6,666	1.07
Mar.	5,511	0.89	Sept.	6,687	1.08
Apr.	5,677	0.91	Oct.	6,697	1.08
May	5,640	0.91	Nov.	7,367	1.19
Jun.	6,020	0.97	Dec.	7,925	1.28
Daily average	6,207 m^3/d		Max. Variation (%)	1.28	
Year Total	2,265,545 m^3/year		Min. Variation (%)	0.79	

Source: Production data from SRWSA

Table 3.9 Monthly Water Distribution Trend in 2008

Month	Daily Average (m^3/d)	Monthly Variation (%)	Month	Daily Average (m^3/d)	Monthly Variation (%)
Jan.	8,167	0.94	July	8,433	0.97
Feb.	8,893	1.02	Aug	8,892	1.02
Mar.	8,897	1.02	Sept	8,707	1.00
Apr.	8,412	0.97	Oct	9,155	1.05
May	8,514	0.98	Nov	9,062	1.04
Jun.	8,110	0.93	Dec	8,956	1.03
Daily average	8,683 m^3/d		Max. Variation (%)	1.05	
Year Total	3,169,208 m^3/year		Min. Variation (%)	0.93	

Source: Production data from SRWSA

Due to the limited distribution capacity against the increasing water demand in Siem Reap, it is not appropriate to derive the maximum day demand factor from the past trend.

Meanwhile, the following table summarizes a water consumption trend of a large scaled hotel located in a central area of the City. The peak factor shows from 0.84 to 1.29 in 2007, 0.85 to 1.19 in 2008, and 0.76 to 1.40 in 2009, respectively. Average peak factors fluctuate from 0.83 to 1.23.

Therefore, 1.25 will be applied for the maximum day demand factor. The loading ratio, reciprocal number of the maximum day demand factor, is computed to be 80 percent. The Japan Water Works Association (JWWA) explains in its design criteria that the loading ratio is dependent on the scale of cities. Larger city is generally larger loading ratio, illustrating that 80 percent is applicable for the cities with population of 50 to 100 thousand and 84.5 percent is applicable for the cities with 100 to 250 thousand populations.

In the event of that the water consumption exceeds the water production capacity, the consumers especially for commercial water use should take self-defensive measures by using their own water storage tanks, etc. to cope with that short-term water interruption is possibly happens.

Table 3.10 Water Consumption Trend of A Hotel in Siem Reap, 2007 to 2009

Year	2007			2008			2009			Ave. of Peak factor
Des-criptions	Monthly m^3/mon.	Daily Ave. m^3/d	Peak factor	Monthly m^3/mon.	Daily Ave. m^3/d	Peak factor	Monthly m^3/mon.	Daily Ave. m^3/d	Peak factor	
Jan.	10,977	354	1.13	10,328	333	1.04	10,762	347	1.34	1.17
Feb.	11,279	403	**1.29**	9,094	325	1.02	9,336	333	1.29	1.20
Mar.	10,700	345	1.10	11,760	379	**1.19**	11,214	362	**1.40**	**1.23**
Apr.	11,349	378	1.21	9,609	320	1.00	7,874	262	1.01	1.08
May	9,324	301	0.96	9,113	294	0.92	6,803	219	0.85	0.91
Jun.	8,011	267	0.85	8,505	284	0.89	5,933	198	**0.76**	**0.83**
Jul.	8,407	271	0.87	8,447	272	**0.85**	6,817	220	0.85	0.86
Aug.	8,682	280	0.90	8,967	289	0.91	6,758	218	0.84	0.88
Sept.	7,863	262	**0.84**	8,582	286	0.90	5,886	196	0.76	0.83
Oct.	9,434	304	0.97	10,105	326	1.02	7,327	236	0.91	0.97
Nov.	8,600	287	0.92	11,174	372	1.17	7,435	248	0.96	1.01
Dec.	9,431	304	0.97	10,964	354	1.11	8,472	273	1.05	1.04
Yearly Total	114,057	m^3/year		116,648	m^3/year		94,617	m^3/year		
Daily Ave.	312	m^3/d		320	m^3/d		259	m^3/d		

Source: Data was collected form a large scaled hotel in Siem Reap by the Study Team

3-8 Total Water Demand Projection

Summarizing the above study, the three scenarios in improving domestic water consumption, the three scenarios in targeting tourists' growth related to improvement of commercial water consumption, and other scenarios such as improving water supply coverage and reduction of NRW by the target year of 2030, provides us with three scenarios, which is summarized in Table 3.11 and illustrated in Figure 3.2. Details are referred to **SR 3.2**.

Each scenario is characterized as shown below:

Scenario 1 is conservative scenario in improving the domestic water unit consumption rate to 130 lpcd in 2030. The growth rate of tourists is limited at two percent only which is pessimistic scenario adopted in consideration of delay in recovery of world economy and development of the basic infrastructures such as the international airport in Siem Reap.

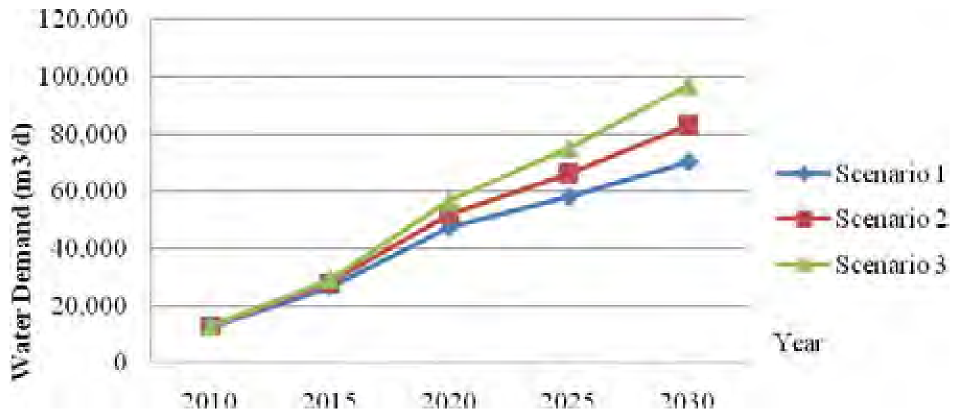


Figure 3.2 Maximum Daily Water Demand Increase by Scenario

Table 3.11 Summary of Water Demand Projection in the Proposed Service Area

Year	**2010**	**2015**	**2020**	**2025**	**2030**
Domestic water demand (m^3/d)					
Projected Pops. (x1000)	**178**	**221**	**265**	**312**	**359**
Coverage	**30 %**	**55 %**	**80 %**	**85 %**	**90 %**
Population served (x1000)	**54**	**122**	**212**	**265**	**323**
Scenario 1 (m^3/d)	5,900	14,000	25,400	33,000	42,000
Scenario 2 (m^3/d)	**5,900**	**14,600**	**27,500**	**37,100**	**48,400**
Scenario 3 (m^3/d)	5,900	15,200	29,700	41,000	54,800
Commercial water demand (m^3/d)					
Projected tourists per year (per day in parenthesis)					
Scenario 1 (x 1000)	2,282 (6.3)	2,520 (7.0)	2,782 (7.7)	3,072 (8.5)	3,391 (9.3)
Scenario 2 (x 1000)	**2,323 (6.4)**	**2,693 (7.4)**	**3,122 (8.6)**	**3,619 (10.0)**	**4,196 (11.5)**
Scenario 3 (x 1000)	2,327 (6.4)	2,831 (7.8)	3,445 (9.5)	4,191 (11.5)	5,099 (14.0)
Coverage	30 %	55 %	80 %	95 %	100 %
Average length of stay	3.5				
Scenario 1 (m^3/d)	2,000	4,000	6,700	8,900	10,400
Scenario 2 (m^3/d)	**2,000**	**4,400**	**7,700**	**10,900**	**13,700**
Scenario 3 (m^3/d)	2,000	4,700	8,700	13,200	17,600
Total water demand (domestic +commercial; m^3/d)					
Scenario 1 (m^3/d)	7,900	18,000	32,100	41,900	52,400
Scenario 2 (m^3/d)	**7,900**	**19,000**	**35,200**	**48,000**	**62,100**
Scenario 3 (m^3/d)	7,900	19,900	38,400	54,200	72,400
NRW	**17 %**	**12 %**	**10 %**	**10 %**	**10 %**
Average water demand (m^3/d)					
Scenario 1 (m^3/d)	9,500	20,500	35,600	46,500	58,200
Scenario 2 (m^3/d)	**9,500**	**21,500**	**39,100**	**53,300**	**69,000**
Scenario 3 (m^3/d)	9,500	22,500	42,600	60,200	80,500
Peak factor	**1.25**				
Maximum water demand (m^3/d)					
Scenario 1 (m^3/d)	11,800	25,600	44,600	58,200	72,800
Scenario 2 (m^3/d)	**11,900**	**26,900**	**48,900**	**66,600**	**86,300**
Scenario 3 (m^3/d)	11,900	28,200	53,400	75,300	100,700

Scenario 2 is technically encouraging and financially moderate scenario, including improvement of the domestic water unit consumption rate to 150 lpcd and three percent growth of tourists which targets three million tourists in 2020 and over four millions of tourists in 2030. A permanent reduction in leakage losses is expected to be achievable through the prevention of

leakage occurrence. This implies pipeline renewal before the end of its useful life in addition to expansion of new distribution network. So, 10 percent NRW level, which could be achievable and will be set as a target level for the year 2017 when the proposed water supply systems be commenced.

Scenario 3 is very much optimistic in improving the domestic water unit consumption rate and growth of tourism so that it will be financially heavy burden in comparison to scenario 1 and 2 .

As a conclusion, **Scenario 2** is the most practical recommendation for the long-term water supply development plan as it fulfills the national sector plans by delaying five years. The following analysis regarding the development plan will be based on the conditions assumed in Scenario 2. Thus, the water demand will be increased from 9,500 m^3/d in 2010 to 69,000 m^3/d in 2030 on a daily average basis and from 11,900 m^3/d in 2010 to 86,300 m^3/d in 2030 on a daily maximum basis. Supply coverage of the population in the study area will be improved to 90 percent in the long-term water supply development plan target year 2030 from 30 percent in 2010; while NRW ratio will be reduced from 17 percent in 2010 to 10 percent in 2030, which will contribute to improvement of financial soundness of SRWSA.

3-9 Long-Term Water Supply Development Plan

Long-term water supply development plan is to achieve the mission of SRWSA set as shown below:

SRWSA Mission

To produce, supply and distribute safe and potable water supply and reliable water service to the population of Siem Reap town, and other areas within the political jurisdiction of Siem Reap province.

In the urban and peri-urban areas, water supply service refers to a pipe system with which individual house connections will be applied. The general definitions of water supply service can also include these aspects: supply pressure, supply amount, and convenience to accessing water.

A development gap still exists in the service areas, when compared between the existing service areas and non-service areas. This long-term water supply development plan focuses on how to extend the Central Distribution System (CDS) toward the farthest reaches of the service areas which have a population of 203 thousand in 2009. In the long term, a sophisticated water supply system, as studied in this report, drawing from a surface water source would be the best choice.

Water supply should be on a 24-hour basis. Intermittent water supply or fluctuation of pressure causes operational problems. It is also one of the causes of unsafe water.

This long-term development plan will discuss four ways of improving water supply service for providing a 24-hour potable water supply:

- the reinforcement of the existing water supply system;
- the possibility of extension from the existing water supply system;
- the existing distribution areas whose water supply sources will be switched from groundwater to the existing or a newly developed piped water supply system; and
- the expansion of water supply network dependent on the population increase in connection to a new water supply systems to be developed.

As to the existing service areas, water service will be improved by increasing water pressure. In the non-supplied areas, completion of a piped water supply will mean serving the most number of people within the shortest time frame giving due attention to the areas' social and economic importance as well as its investment efficiency and effectiveness.

The required production capacity at each phase up to 2030 is illustrated in Figure 3.3 in accordance with the daily average and maximum water demand.

The first Steering Committee held on 22nd October 2009 proposed that the Project is to be implemented in three phases with incremental supply capacity of 22,000 to 25,000 m^3/d each phase to meet the requirement of increasing water demand. However, the implementation plan was decided to be optimized taking into consideration of the 17,000 m^3/d KTC project in the second Steering Committee held on 9th December 2009. The basis of minimizing the phasing plan are:

- To reduce the initial cost investment for the proposed intake pipelines,
- To secure sufficient time, that is preferably more than five years to prepare the second phase project following to the implementation of the first phase project. The preparation for the second phase will include financial arrangement , capacity building, expansion of related transmission and distribution network, etc. and
- To reduce a total project cost for the long-term water supply development plan targeting 2030.

Therefore, a 30,000 m^3/d water supply development plan per phase is proposed to be implemented in two phases. A total water production capacity in the target year 2030 will be of 86,000 m^3/d including the existing production capacity of 9,000 m^3/d, which is 1,000m^3/d overloading to the nominal design capacity of 8,000 m^3/d, 17,000 m^3/d by KTC project, and 60,000 m^3/d to be expanded in two phases under the Project. This will meet the projected water demand in 2030.

Table 3.12 Indicators Achieved by the Priority Project in 2022

Water use	Projected pops/tourists (daily basis)	Coverage (%)	Served Pops./ tourists	Unit consumption rate (lpcd)	Water demand (m^3/d)
Domestic	283,290	82	232,300	134	31,128
Commercial	9,073	86	7,803	324	8,848

Priority project is then recommended to develop 30,000 m^3/d as an urgent project by year 2016 or 2017 to supplement to the current water production capacity of 9,000 m^3/d and the expected KTC production capacity of 17,000 m^3/d, totaling 56,000 m^3/d to meet the projected maximum water demand in 2022. The indicators shown in Table 3.12 are achieved in the Priority Project._

The incremental addition of production capacity in the following phase is recommended completing in 2022 with a capacity of another 30,000 m^3/d in order to ensure that will cover the growth towards the end of the proposed long-term water supply development plan. It is a suitable size to develop as a similar project as the Priority Project, considering efficient project preparation and physical issues such as extension of related transmission and distribution network. The final daily production capacity will be a total of 86,000 m^3 that fulfills the expected maximum water demand through 2030 at the projected maximum water demand basis.

The water transmission and distribution system will be expanded in parallel with the development of additional production facilities, paying close attention to the patterns of demand from the growing areas and the long term hydraulic requirements of the system set by the long-term water supply development plan.

The objectives of the transmission and distribution pipelines expansion plan are therefore to 1) serve for the additional demand, while 2) enhancing overall system performance. The strategy for accomplishing these objectives incorporates the following critical concepts: a) division of the network into discrete zones, permitting more intensive and flexible control of flow and pressure, b) creation of distribution network loops for greater redundancy and pressure balancing options, and c) completion of the distribution system, as at present, metered blocks.

The transmission and distribution system expansion proposed here covers two phases ending in years 2017 as the Priority Project and 2022 as the 2nd Project to fulfill the requirements of the proposed long-term water supply development plan. The concept-level designs were developed utilizing the WaterCad system modeling software incorporating all available, relevant, actual and forecast data. Hydraulic analyses were carried out in order to identify the required distribution connections and distribution reinforcement where water demand will increase during each stage. The strategy for achieving the objective of efficient system management is three-pronged and entails:

- ✓ division of the system into zones,
- ✓ creation of loops, and
- ✓ distribution by closed blocks.

Zoning

In the long-term water supply development plan, the proposed water service areas will be separated into three zones, namely West, Central, and East Zones. In each Zone, pressure can be independently regulated by the proposed water elevated tank with a fill and draw system and the requirement to maintain high pressure at the water treatment plants (WTPs) will be reduced.

Loop

The looping strategy will be applied to expansion of the existing distribution network. The rationale of this scenario is to join the existing main distribution pipelines in order to form loops that will, with limited investment under KTC, enabling the following:

- to supply the water from the existing WTP, the proposed KTC WTP, and the proposed WTP under the Priority Project,
- to cover a radiated expansion areas, namely Block Q1(northwestern area), Block Q2 (southwestern area) , Block Q3 (northeastern area), and Block Q4 (southeastern area),
- to ensure in covered areas the benefits of a meshed system to better balance system pressure and provide alternate routes to supply water in the event of one branch or plant are temporarily disabled.

The completion of the loops in the Central Zone will be carried out under the Priority Project. This scenario extends the above effects in the Central Zone, creating a loop across the most populated suburban areas. Outlining the service areas along with the ring main road, it would hence create the main line loop. This loop would further improve the meshed pipeline of the network, while enabling the efficient extension of the service area toward the outer skirt of the Central Zone during Priority project and the following second project.

Blocks

The third prong of the efficiency strategy is blocking. This is to continue the existing practice of completing the distribution system with closed and telemetered blocks, providing detailed control and management of consumption and water loss at the consumer end of the system. The existing telemetering layout is shown in the figure below. Distribution by closed blocks is essential for effective control of NRW. However, one result compared to an open distribution system is that the network has less absorptive/reactive capacity and is thus subject to greater fluctuations in pressure throughout the day as demand rises and falls and the plants attempt to accommodate. In other words, the blocking strategy requires a higher level of pressure management overall, which in turn necessitates implementation of the above-described Zoning and Looping strategies. The three strategy are thus inter-connected and inter-dependent. Implemented together, the result will be an ideal network structure.

To achieve easy operation and maintenance of the distribution networks, the proposed service area will be separated into three zones, namely West Zone, Central Zone, and East Zone towards 2030. Each Zone will be supplied by an independent elevated water tank with a fill and draw system to which necessary amount of clear water will be transmitted. The Central Area will be further separated into four blocks, Q1 (Northwestern block), Q2 (Southwestern block), Q3

(Northeastern block), and Q4 (Southeastern block) in consideration of the existing water supply block system and geographical conditions of the City which is separated north and south by the national road No. 6 and west and east by the Siem Reap river. East Area will be further separated into Q5 (North block) and Q6 (South block). Each block includes the following communes as detailed in **S.R 4.16 and 17 ,**Water Demand Allocation.

The water demand of Central Zone, East Zone, and West Zone will be 69,380 m^3/d, 5,930 m^3/d, and 10,940 m^3/d, respectively. In year 2030, referring to Figure 3.4, allocated water supply amounts to each block are summarized in Table 3.13.

Table 3.13 Max Daily Water Demand for Each Block in 2030

Blocks	Water use	Population Served (Nos.)	Water Demand (m^3/d)	Belonging Communes*
Q1	Domestic	56,610	11,790	Sla Kram, Svay Dangkum, Kouk Chak, Tuek Vil, Srangae
	Commercial	9,360	4,420	
	Sub Total	**65,970**	**16,210**	
Q2	Domestic	60,100	12,520	Svay Dangkum, Sala Kamraeuk, Siem Reap, Srangae
	Commercial	7,220	3,410	
	Sub Total	**67,320**	**15,930**	
Q3	Domestic	48,460	10,090	Sla Kram, Nokor Thum
	Commercial	18,190	8,590	
	Sub Total	**66,650**	**18,680**	
Q4	Domestic	78,320	16,320	Sla Kram, Sala Kamraeuk, Siem Reap, Chreav
	Commercial	4,750	2,240	
	Sub Total	**83,070**	**18,560**	
Total of Central Zone	Domestic	243,490	50,720	
	Commercial	39,520	18,660	
	Total	**283,010**	**69,380**	
Q5	Domestic	25,000	5,210	Ampil, Kandaek
	Commercial	0	0	
	Sub Total	**25,000**	**5,210**	
Q6	Domestic	3,460	720	Kandaek
	Commercial	0	0	
	Sub Total	**3,460**	**720**	
Total of East Zone	Domestic	28,460	5,930	
	Commercial	0	0	
	Total	**28,460**	**5,930**	
Q7 (West Zone)	Domestic	50,890	10,600	Svay Dangkum, Tuek Vil
	Commercial	710	340	
	Sub Total	**51,600**	**10,940**	
Grand Total	Domestic	322,840	67,250	*The detailed allocation in each commune is referred to **S.R5.14.**
	Commercial	40,230	19,000	
	Total	**363,070**	**86,250**	

Notes: 322,840(residents)= 358,710 x 90%; 40, 230 (tourists) =11,494 x 3.5

The population served is estimated in each block in applying 90 percent of uniform coverage to the projected population in the proposed service areas. Daily tourists' served are computed in applying 11,494 of the projected daily tourists and 3.5 days of average length of stay. Numbers of tourists are allocated in the existing hotels and guest houses as listed in Table 2.9, then surplus tourists projected in the long-term water supply development plan are assumed to allocated in the proposed hotel zone located in Sla Kram commune. The hotel zone is proposed to be developed in second phase (2010-2020) in the land-use plan for Siem Reap District prepared by the District Master Plan Team Siem Reap. The applied unit consumption rates in water demand calculation for resident and tourist are 150 lpcd and 340 lpcd , respectively.

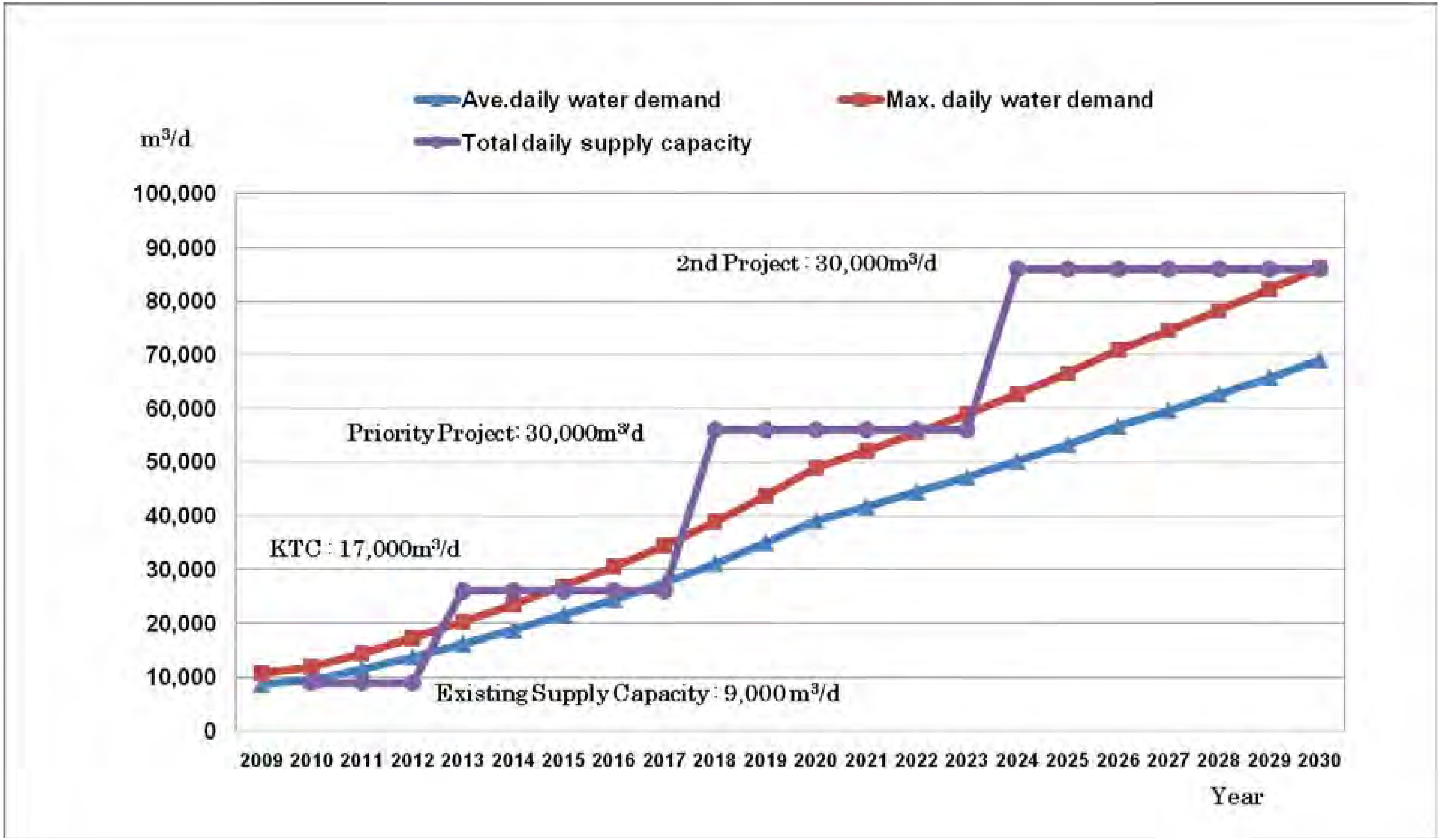


Figure 3.3 Maximum/Average Water Demand and Production Capacity

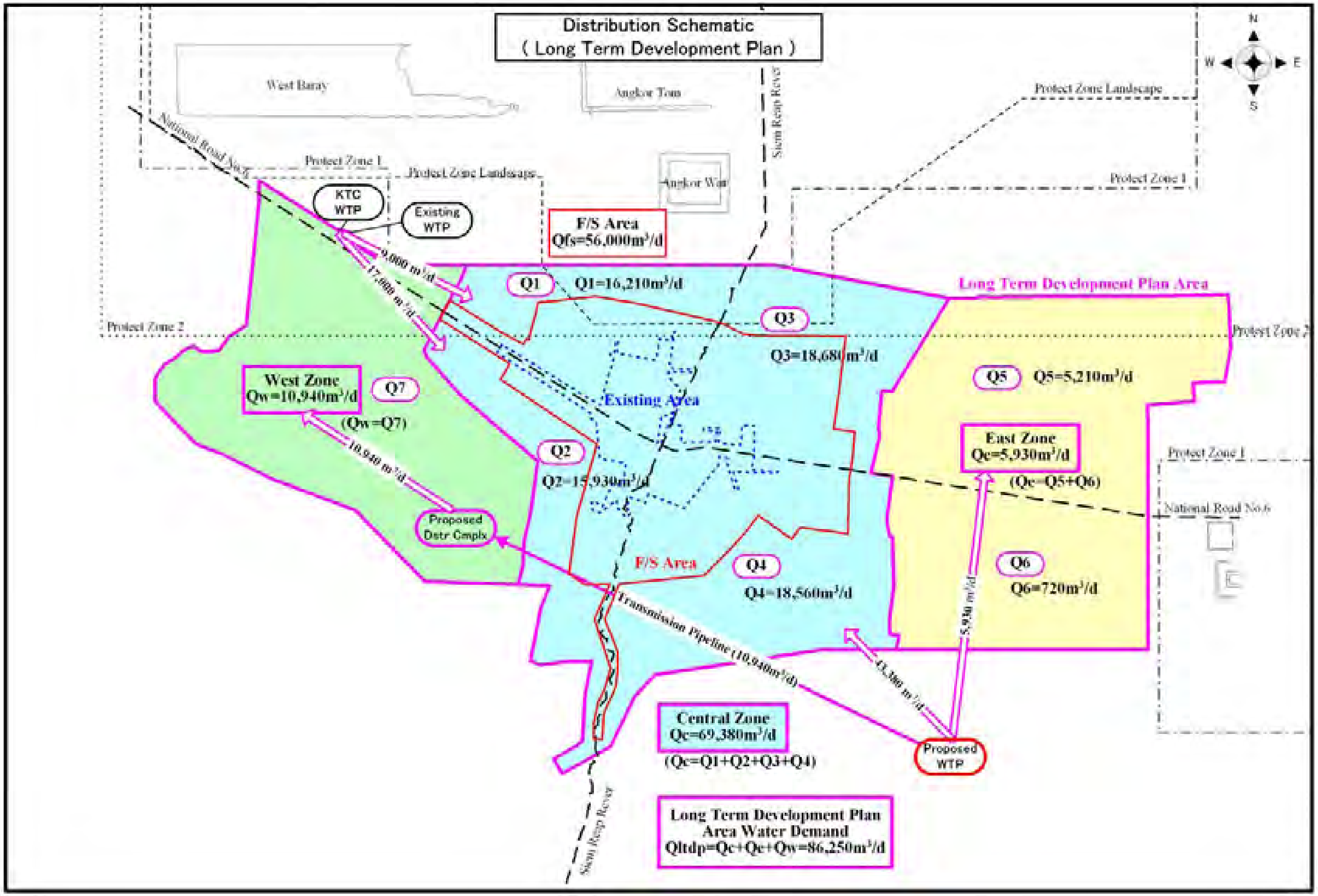


Figure 3.4 Long-Term Water Supply Development Plan

Chapter 4.
Feasibility Study on Priority Project

Chapter 4. Feasibility Study on Priority Project

4-1 Scope of Work

Priority Project (The Project) shall provide a new intake facility, a treatment plant, a transmission/distribution systems to supply additional water required for the existing Siem Reap service area, elevated water tank with clear water lifting pump facilities, distribution pipelines from the proposed elevated water tank to the existing distribution system, and expansion of distribution network to non-served areas.

From the long-term water supply development plan proposed in the previous chapter, it is concluded that the nominal design capacity for the priority project is 30,000m^3/d which will meet the water demand in 2022.

Key indicators in 2022 of the long-term water supply development plan are summarized below:

･Water use	Domestic	Tourists
･Projected Pops./Tourists	283,290	9,073
･Coverage	82 %	86%
･Pops./Tourists served	232,300	7,803(*27,300)
･Unit consumption rate (lpcd)	134	324
･Water demand (m^3/d)	31,128	8,848
･Total daily water demand (m^3/d)	39,976	
･NRW (%)	10	
･Ave. daily water demand (m^3/d)	44,420	
･Peak factor	1.25	
･Max. daily water demand (m^3/d)	55,530 (=43,230 + 12,300)	
･Available water supply capacity (m^3/d)	26,000 (= existing 9,000+KTC17,000)	
･Development capacity (m^3/d)	30,000	

Notes: Details are referred to **S.R.3.2-2**

*Daily actual numbers of tourists are calculated to be 7,803 x 3.5 =27,300, in applying 3.5 days of stay.

After completion of the priority project, water production capacity of the Project will be 30,000m^3/d. However, main part of raw water conveyance pipelines, water intake structure, and administrative common facilities will be sized for the long-term water supply development plan capacity, which nominal design capacity would be 60,000m^3/d. Ten percent allowances will be added to the design caapcity for loss through the works. Distribution of water to Siem Reap service areas under the Priority Project will be for those communes as Sla Kram, Svay Dangkum, Sala Kamraeuk, Kouk Chak, Siem Reap, Chreav, and Nokor Thum.

a) Raw water conveyance pipelines : capacity of raw water conveyance pipelines will be 66,000 m^3/d including 10% allowances for the nominal design capacity for the long-term water supply development plan;

b) Raw water intake pump station : space of the pump station is sized for the long-term water supply development plan. The Project facilities includes only for capacity of 33,000 m^3/d (additional pumps will be expanded for the long-term water supply development plan);

c)	Raw water intake pipe	:	pipes used for raw water transmission main from raw water transmission pump station to WTP should be of 800 mm dia. DI pipes of 3,400 m length to satisfy a capacity of 33,000 m^3/d (additional pressure main will be expanded in the long-term water supply development plan);
d)	Water treatment plant (WTP)	:	production capacity of 30,000 m^3/d;
e)	Clear water pumps	:	deliver 30,000 m^3/d to the elevated water tank;
f)	Clear water pump station, chemical building, administration building, etc.;		
g)	Elevated water tank	:	1,000 m^3 will be allocated in WTP
h)	Distribution main from treatment plant to service areas	:	approximately 32 km. of distribution main system. DI pipes with diameters from 250 mm to 800 mm and PE pipes with diameters from 50 mm to 200 mm will be used;
i)	Distribution pipelines	:	in the distribution system 19 km of DI pipes and 433 km of PE pipes will be used, dependent on pipe sizes;
j)	Communication and power supply to intake, pumping station and WTP; and		
k)	Plant and equipment necessary for operation and maintenance.		

4-2 Target Year of the Project

The target year for the Feasibility Study is set at 2022 in accordance with the long-term water supply development plan for the proposed service areas.

4-3 Priority Service Areas for the Feasibility Study and Population Served

Priority analysis is conducted based on land use planning and water supply scheme. Said analysis classifies the urgency of development and allocates weighted distribution amount as detailed in **S.R. 5.15** Water Demand Allocation (F/S). It should be noted that water consumption is likely to increase even in such areas not prioritized on the point of view of the priority analysis given. Also, the amount of water being supplied to an area is not directly proportional to that in the prioritized areas. But, the areas given the highest priority to be connected to the existing or new piped system are prioritized in the land use plan for Siem Reap District prepared by District Master Plan Team Siem Reap[1], taking the following geographical conditions into consideration:

- Boundary of communes and villages,
- Existing road arrangement, and

[1] Technical report on the final draft land-use plan for Siem Reap District was prepared in October 2007 by District Master Plan Team Siem Reap supported by Ministry of Interior, Ministry of land Management, Urban Planning and Construction, German Development Service, Konrad Adenauer Foundation, and Asia Urban Project 3.

- Existing rivers

In analyzing supply amount, water demand projected in the long-term water supply development plan is considered. Then, the distribution amount is derived. This figure considers the amount of unit consumption rate set by the long-term water supply development plan and water supply efficiency such as NRW level and peak factors.

Table 4.1 summarizes selected priority service areas for the F/S study. Most of the areas in Sla Kram and Sla Kamraeuk communes located in the central area of the City will be covered by the F/S new water supply scheme. Other communes such as Svay Dangkum, Kouk Chak, Siem Reap, and Chreav will be covered partially in applying the following long-term water supply development policy as discussed in the previous sections.

- the reinforcement of the existing water supply system;
- the possibility of extension from the existing water supply system;
- the existing distribution areas whose water supply sources will be switched from groundwater to the existing or a newly developed piped water supply system; and
- the expansion of water supply network dependent on the population increase in connection to a new water supply systems to be developed.

The population served by the F/S Project will be 232 thousand of residents and 27.3 thousand of tourists, respectively as mentioned in the key indicators. The proposed population served for the F/S is tabulated in Table 4.1, and delineated in Figure 4.1 which is detailed in **SR 4.16** and **17**.

4-4 Preliminary Design Drawings

Preliminary design drawings for raw water intake chamber, raw water conveyance pipelines, raw water transmission pump station, water treatment plant, and transmission/distribution pipelines are attached in **SR 4.15** which are the basis of the Engineers' Cost Estimates.

Table 4.1 F/S Priority Service Areas and Population Served

Item	Commune / Village	F/S	Item	Commune / Village	F/S	Item	Commune / Village	F/S
1.	**Sla Kram**	**81,070**	**5.**	**Siem Reap**	**21,030**	**9.**	**Ampil**	**0**
1-1	Slor Kram**	○	5-1	Pou	△	9-1	Kouk Chan	×
1-2	Boeng dunpa*	○	5-2	Phnom krom	×	9-2	Thnal Chak	×
1-3	Chong Kavsu*	△	5-3	Pror Lay	×	9-3	Tanot	×
1-4	Dork pou*	○	5-4	Korkragn	△	9-4	Trapang Run	×
1-5	Bantay chas**	○	5-5	Kra Sangroleung	×	9-5	Ta Pang	×
1-6	Trang*	△	5-6	Spean Chreav	△	9-6	Prei Kuy	×
1-7	Mondol 3**	○	5-7	Arragn	△	9-7	Bang Koung	×
2.	**Svay Dangkum**	**59,130**	5-8	Treak	×	9-8	Kiri Manon	×
2-1	Pngea Chei	×	**6.**	**Tuek Vil**	**0**	9-9	Bos Tom	×
2-2	Kantrork	×	6-1	Kouk doung	×	9-10	Trach Chrom	×
2-3	Kouk Krasang	×	6-2	Sandan	×	**10.**	**Nokor Thum**	**0**
2-4	Svay Chrei	×	6-3	Chrei	×	10-1	Rohal	×
2-5	Pou Bos	×	6-4	Prayut	×	10-2	Sras srang	×
2-6	Tmei	△	6-5	Bantay Cheu	×	10-3	Sras srang	×
2-7	Svay Dangkum*	○	6-6	Teuk Vil	×	10-4	Kravan	×
2-8	Salakanseng*	○	6-7	Pri Chas	×	10-5	Arak svay	×
2-9	Krous*	△(○)	6-8	Tuek Tla	×	10-6	Ang Chang	×
2-10	Vihear Chin*	○	6-9	Pri Tmei	×	**11.**	**Srangae**	**3,370**
2-11	Steng Tmei*	△(○)	6-10	Chei	×	11-1	Kasikam*	△
2-12	Mondol 1**	○	**7.**	**Chreav**	**7,190**	11-2	Tnal	×
2-13	Mondol 2**	○	7-1	Chreav	×	11-3	Roka Thom	×
2-14	Ta Phoul**	○	7-2	Knar	△	11-4	Prei Thom	×
3.	**Sala Kamraeuk**	**45,100**	7-3	Bos Kralang	×	11-5	Srangie	×
3-1	Vat Bo**	○	7-4	Ta Chek	×	11-6	Chanlong	×
3-2	Vat Svay	○	7-5	Veal	×	11-7	Ta Chouk	×
3-3	Vat Damnak*	○	7-6	Kra Sang	×	**12.**	**Sambuor**	**0**
3-4	Sala Kam reak	○	7-7	Boeng	×	12-1	Pnouv	×
3-5	Chun long	△	**8.**	**Krabei Riel**	0	12-2	Sambour	×
3-6	Ta Vean	○	8-1	Ta Ros	×	12-3	Veal	×
3-7	Trapang Treng	○	8-2	Roka	×	12-4	Chrei	×
4.	**Kouk Chak**	**15,410**	8-3	Prei Pou	×	12-5	Ta kong	×
4-1	Trapang Ses*	△	8-4	To Tear	×	**13.**	**Kandaek**	**0**
4-2	Veal*	△	8-5	Krasang	×	13-1	Kouk Tlouk	×
4-3	Kasin tabong*	○	8-6	Popil	×	13-2	Trapang Tem	×
4-4	Kouk Chan	×	8-7	Trapang Veng	×	13-3	Khun Mouk	×
4-5	Khatean	×	8-8	Kouk Doung	×	13-4	Chras	×
4-6	Kouk Beng	×	8-9	Boeng	×	13-5	Ou	×
4-7	Kouk Tanot	×	8-10	Prorma	×	13-6	Spean Ka Ek	×
4-8	Nokor krav	×	8-11	Khnar	×	13-7	Trang	×
Notes	○: all areas prioritized/included		8-12	Prei Kroch	×	13-8	Chrei	×
	△: partial areas prioritized/included		**: all areas covered by the existing systems			13-9	Kouk Tanot	×
	×: all areas not covered		*: partial areas covered by the existing systems			13-10	Lo Ork	×
Total Population Served for F/S							**232,300**	

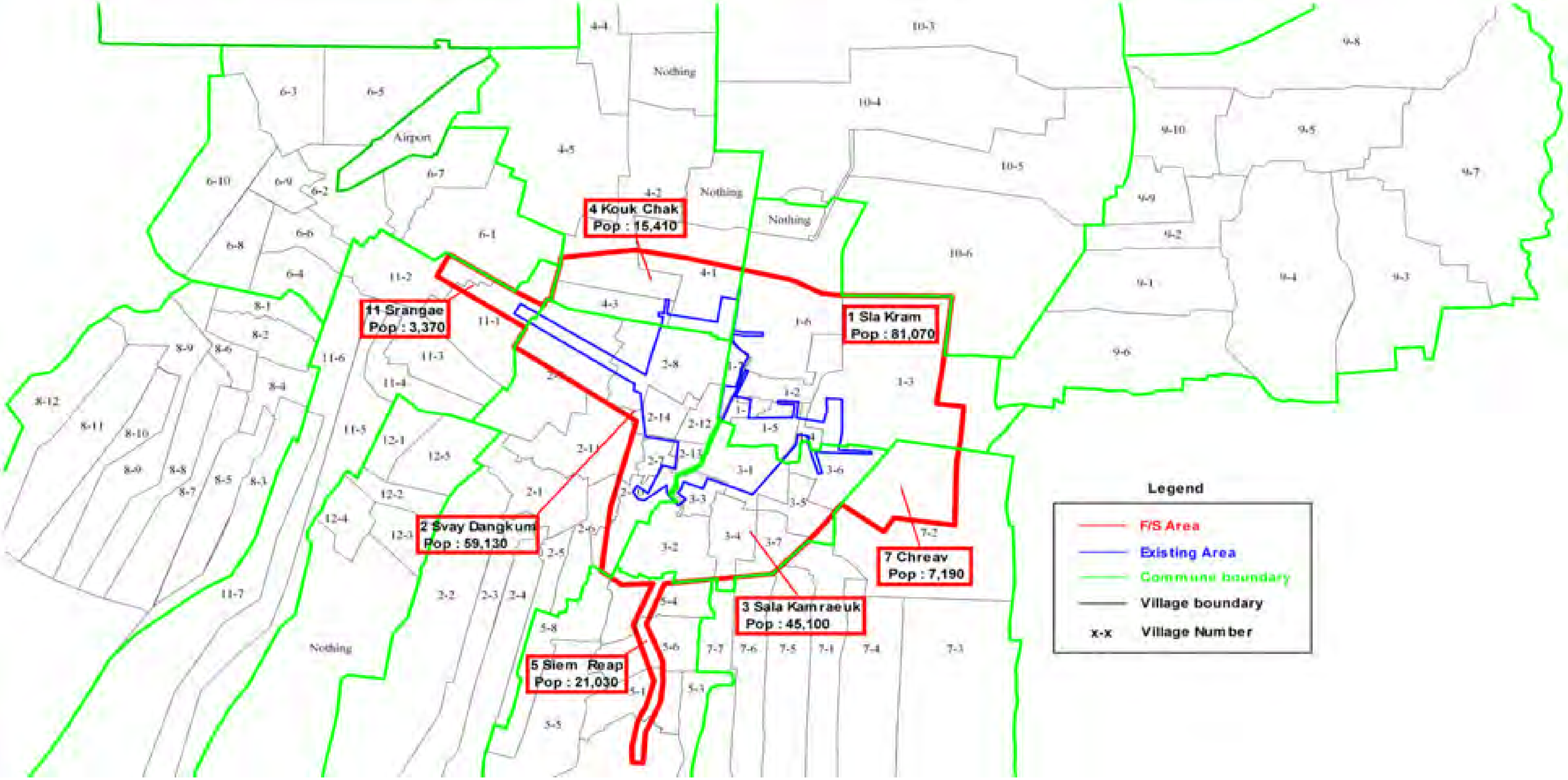


Figure 4.1 F/S Water Supply Service Areas and Population Served

4-5 Design of Priority Project

The aim of a water supply system is to basically assure users of a constant supply of hygienic, safe and clean water at their service taps, free from trouble regarding the quality of water or other inconveniences. The use of proven water treatment plant technologies commonly utilized in other countries is recommended. However, these technologies adopted in the regions where land is unavailable and an excellent high-technology service is obliged to be adopted may not be appropriate. For example, fully automated operation of the plant may not necessarily be appropriate for the Project as this is capital intensive and, where abundant unskilled labor is available labor-intensive operation is more attractive. However automatic control of systems could be installed at a later date if considered necessary and desirable.

Thus, the following technical principles are applied in the preliminary design of water treatment equipment and facilities for the Project;

- ♦ to the extent possible, the use of mechanical equipment should be limited to the products produced locally for easy operation and low maintenance cost;
- ♦ in hydraulically based devices such as rapid mixing, flocculation, and filter rate control, are preferable to mechanized or automated type, but subject to the hydraulic head requirement;
- ♦ mechanization and automation in the system are recommended only where operations are not readily done manually, or where they greatly improve reliability to assure safe and stable water supply;
- ♦ indigenous materials and manufactured goods that allow easy and safe construction should be used to reduce costs and to assist the local economy and expand industrial development.

The design criteria are summarized in Table 4.2 which include ten percent production loss for the design of the facilities.

Table 4.2 Design Horizon

Facilities	Phase I
1) Intake Chamber	66,000 m^3/day
2) Raw Water Conveyance Pipeline	66,000 m^3/day
3) Raw Water Transmission Pipeline	33,000 m^3/day
4) Raw Water Intake Pump Station	33,000 m^3/day
5) Distribution Chamber	33,000 m^3/day
6) Flocculation Basins	33,000 m^3/day
7) Sedimentation Basins	33,000 m^3/day
8) Filter Units	33,000 m^3/day
9) Clear Water Reservoir	33,000 m^3/day
10) Distribution pipelines	*56,000 m^3/day

Notes:* Hourly peak factor will be applied to 56,000m^3/d in design of the distribution pipelines.

4-6 Selected Raw Water Source

4-6-1 Recommendation for the Raw Water Source for the Project

As a result of Stage 1 and Stage 2 selection processes as shown in the following sections, **Tonle Sap Lake water** was selected as the most appropriate raw water for the proposed water supply development scheme.

The Project aims stable water supply without interruption of water supply, with drinkable water quality to meet the Cambodia drinking water standards, and with reasonable cost (water tariff). To achieve the target as public water supply systems, the **Tonle Sap Lake** water is most suitable water source for the Project. It is inevitable that the raw water intake facility from the Lake passes through the environmental restricted areas under control of the relevant authorities so that the practical measures should be taken properly to mitigate such impacts with close coordination with the relevant authorities concerned. Details are referred to Section 10-5 Environmental Impact Analysis and Mitigation Measures.

Groundwater source is at present utilized solely for the current water supply systems of SRWSA. There are no signs identified scientifically till now to prove the impact to the Angkor heritages. However, still many organization and/or groups even including SRWSA are afraid of the impact to the heritages to be caused in the future if the large scaled groundwater exploitation keeps going on. The Study Team recommends that only those people reside in the remote areas away from the urbanized City area where the public water supply is not applicable due to the economic and technical efficiencies should be allowed to use the groundwater source independently.

Another possible raw water source for the Project is the water from the **West Baray**, however the availability of water amount is not in stable as a public water supply system. The Study Team recommends applying a limited amount of the water as urgently supplements the water needs against the increasing water demand in a short term basis.

4-6-2 Selection Flow of New Water Sources

Selection of the proposed water source was conducted in two stages. Details are referred to **SR 4.1**.

Stage 1

A wide range of alternatives of new water sources was identified as preliminary screening by means of rough comparative study to come up with selected alternatives for Stage 2.

Table 4.3 presents evaluation of alternatives new water sources. Among seven alternative water sources in Stage 1, the rough evaluation based on engineering consideration concludes that the following four alternatives are not competitive, especially on the cost and water volume availability, in comparison with the selected three (3) alternatives of Tonle Sap Lake, West Baray and Groundwater for Stage 2.

- Siem Reap River
- Other rivers
- Other existing barays/ponds/reservoirs
- Reservoirs to be newly constructed

Table 4.3 Evaluation of Alternative New Water Sources

Water source		Water quantity	Water quality	Construction (Cost and Difficulty)	O&M (Cost and Difficulty)	Overall Judgment
Alt. 1	Tonle Sap Lake	Sufficient	Acceptable	Not sure	Not sure	**Selected**
Alt. 2	West Baray Reservoir	Acceptable	Good or Acceptable	Low or Medium	Low	**Selected**
Alt. 3	Groundwater	Sufficient or Acceptable	Good or Acceptable	Low or Medium	Low or Medium	**Selected**
Alt. 4	Siem Reap River	Insufficient	Acceptable or Not suitable	Low or Medium	Low or Medium	**Not Selected**
Alt. 5	Other Rivers	Insufficient	Good or Acceptable	Medium or High	Medium or High	**Not Selected**
Alt. 6	Other Existing Barays/ Ponds/ Reservoirs	Insufficient	Good or Acceptable	Medium or High	Low or Medium	**Not Selected**
Alt. 7	Reservoir to be newly constructed	Sufficient or Acceptable	Good or Acceptable	Medium or High	Low or Medium	**Not Selected**

<u>Stage 2</u>

Stage 2 carried out detailed and accurate comparative study to identify a short list from the long list prepared in Stage 1.

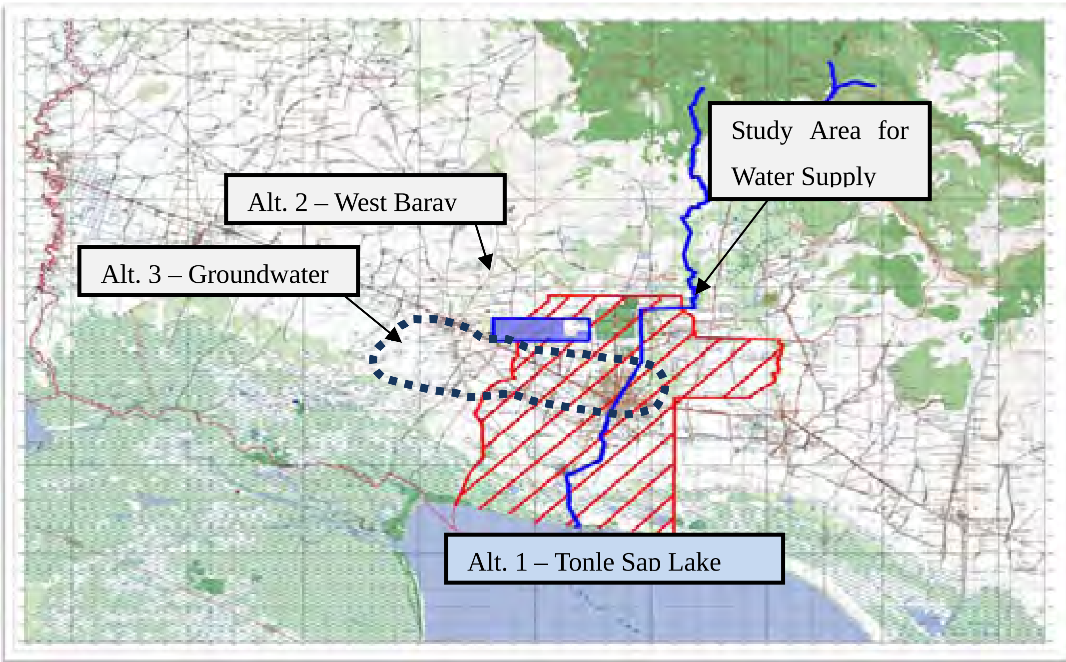


Figure 4.2 Location of Alternative Water Sources

4-6-3 Stage 1 Selection of New Water Sources and Intake Methods

Selected water sources for Stage 1 were Tonle Sap Lake, West baray, and Groundwater sources in combination with the following intake methods.

Water Source	Location of Intake	Intake Method
Tonle Sap Lake	Water body within the Lake	Intake tower
		Intake frame box
		Collecting pipe
	Canal connected to the Lake (Newly constructed)	Intake tower
		Intake gate + Culvert
West Baray Reservoir	Existing canal	Diversion weir +Intake gate
Groundwater	Groundwater in the lake side	Well
		Well + collecting pipes

Stage1-Step 1 process was for evaluation of the significant issues for each candidate raw water source as public water supply systems which was related to stable water supply with reasonable water quality in consideration of the capital investment cost with easy O&M.

Stage1-Step 2 process focused on evaluation of legal issues for implementation of the project and environmental issues as summarized below:

Stage 1 Selection Parameters:

Stage 1-Step 1 evaluation : Significant/Priority Parameters

1) Water volume for intake
2) Water quality
3) Construction Cost (including difficulties)
4) Operation & Maintenance Cost (including difficulties)

Stage 1-Step 2 evaluation : Other Parameters Confirmed

5) Water management laws/acts (including water right)
6) Relation with the other purposes of water uses
7) Impacts to archeological sites
8) Impact to ecology
9) Impact to life and land uses of inhabitants
10) Land acquisition and resettlement
11) Related organization/ group

The intake methods were narrowed down by means of the following parameters.

General Parameters :

1) Capacity of intake volume
2) Flexibility to variation of water level
3) Construction cost and difficulties
4) O & M Cost and difficulties
5) Future expansion
6) Archeological site
7) Environmental impacts

Special parameters in case of Tonle Sap Lake

1) Water level fluctuation (large)
2) Lake shoreline movement
3) Shallow water level

4) Fishery, Tourism, Navigation
5) Related organization

4-6-4 Stage 2 Selection of New Water Source

Stage 2 selection was in depth analysis by 2 steps, Part A and Part B to select most appropriate water source for the Project.

Part A: Detailed study on the fundamentals as public water supply systems, including stability and availability of water amount, raw water quality, environmental aspects such as protected area/legal restriction, ground subsidence in the heritage sites, and opinion from related organizations/groups.

Water volume of the Tonle Sap Lake is sufficient. The designed intake capacity of the F/S is 33,000 m^3/d or 112,045 thousand m^3/year which is equivalent to approximately 0.1 percent of the water volume of Tonle Sap Lake, assuming an yearly average water depth is 4 m and surface area is 2,500 km^2 in dry season and 0.01 percent assuming an average yearly water depth is 8 m and surface area is 15,000 km^2 in rainy season on conditions that water inflow and outflow are ignored.

The results summarized in the following:

Parameter	**Water Source Alternatives**		
	Tonle Sap Lake	**West Baray (canal)**	**Groundwater (lake side)**
Water Volume	A	N/A	N/A
Water Quality	B	B	B
Protected Area	B	N/A	N/A
Ground Subsidence (Historical heritages)	A	A	N/A
Impacts to Ecology	B	A	A
Impacts to Land acquisition and Resettlement	B	B	B
Other Environmental Impacts	B	B	B
Opinion by Organizations	B	B	N/A

A: Sufficient, good, or no-impacts
B: Acceptable or, no significant adverse impacts
C: Not acceptable or significant adverse impacts
N/A: Reliable evaluation is difficult without further study or confirmation

Part B: Detailed study on reality of the total water supply systems including structural & work plan/design, construction method and schedule, construction cost, and O&M cost.

The summary of **Part B** analysis is summarized in the following Table 4.4:

Table 4.4 Part B, Stage 2 Selection of New Water Source

<table>
<tr><th>Water Source</th><th>Tonle Sap Lake</th><th>West Baray</th><th>Ground Water</th></tr>
<tr><td>Structural Design and Work Plan</td><td>✓ Possible long term plan
✓ Ideal water supply scheme from existing WEST and proposed EAST WTPs.

<u>Issues and Concerns</u>
- Intake chamber and pump station are needed.
- Water level fluctuation of the lake is to be considered.
- Location of intake pumping station is to be considered.
- Proposed WTP site is close to those areas where major water demand increase is projected.
- Easy access to the existing distribution network.
- Conventional water treatment process is needed.</td><td>✓ Short term plan only
✓ Rehabilitation of the existing weirs and environmental issues
✓ Overlapped WTSs in west

<u>Issues and Concerns</u>
- Land acquisition is troublesome.
- Weir for water level control is necessary.
- Rehabilitation for existing facilities such as weir is needed.
- Far from the eastern part where major increase in future demand is expected.
- Available water is limited but future expansion is impossible.
- Conventional water treatment process is needed.</td><td>✓ Short term plan only
✓ Considerable numbers of wells and connection pipelines
✓ Unavoidable environmental issues

<u>Issues and Concerns</u>
- Considerable number of wells are needed.
- Monitoring facilities for ground water and land subsidence are needed.
- Conventional water treatment process excluding the sedimentation basin.
- Land acquisitions for each well are difficult.
- Site can be located in the southern part of town.
- Easy access to the existing distribution network.</td></tr>
<tr><td>Construction Method and Schedule</td><td>✓ Careful construction due to water level fluctuation

<u>Issues and Concerns</u>
- Construction schedule for intake chamber shall be considered.
- Seasonal water level changes shall be considered.</td><td>✓ Permission from related agencies
✓ Land acquisition

<u>Issues and Concerns</u>
- Permission for rehabilitation of the existing facilities is required from many agencies concerned.
- Land acquisition for the water treatment plant is troublesome.</td><td>✓ Long ACCESS ROAD to wells
✓ Land acquisition

<u>Issues and Concerns</u>
- Construction period is long due to the considerable number of wells.
- Access roads to each wells are necessary.</td></tr>
<tr><td>Construction, Operation and Maintenance Costs</td><td>✓ Careful O&M
✓ Annual O&M cost is estimated USD1.6 Mill.
✓ Comparative cost is estimated US$99 Mill.

<u>Issues and Concerns</u>
- Careful operation for seasonal water quality fluctuation is required.
- Land price is reasonable.</td><td>✓ Careful O&M
✓ Annual O&M cost is estimated USD1.7 Mill.
✓ Comparative cost is estimated US$100 Mill.

<u>Issues and Concerns</u>
- Operation for the water level fluctuation of West Baray and canal is troublesome.
- Long distribution/transmission pipelines to the city are necessary and costly.
- Land acquisition is tedious and costly.</td><td>✓ Well water level monitoring
✓ Security for numerous scattered wells
✓ Annual O&M cost is estimated USD2.2 Mill.
✓ comparative cost is estimated USD104 Mill.
<u>Issues and Concerns</u>
- Raw water conveyance pipelines are long and costly.
- Tough O & M for many wells.
- O & M for monitoring facilities is must.
- Security for many wells is required.</td></tr>
<tr><td>Evaluation</td><td><u>Generally good for short/long term plan</u></td><td>Not applicable for long term plan</td><td>Not applicable for long term plan</td></tr>
</table>

4-7 Raw Water Intake

4-7-1 Water Level of Tonle Sap Lake

The water level remarkably has been changing and the daily/monthly fluctuation of water level is considerably different by year. The planning of facilities and works for the project has to be made taking the water level changes into account. The study on water level of Tonle Sap Lake was to be carried out from the viewpoint of water levels for the facility design and seasonal change of water level for proper construction schedule.

(1) High Water Level and Low Water level in the past records

The datum for levels in Cambodia is Mean Sea Level at Ha Tien in Vietnam. In preparation of new national base maps assisted by JICA (late 1990s), a network of first order of benchmarks relative to Ha Tien was established. Since then, this datum has been referred to in various studies/projects.

Among them, the water level of Tonle Sap Lake has been reviewed in "Chong Kneas Environmental Improvement Project, Draft Final Report (February 2004)" prepared under Technical Assistance by ADB. At present this report has been referenced in other study/project.

Lake levels have been recorded over a period of 49 years at Kampong Luong (KL) by the Mekong River Commission (MRC) using a fixed gauge readings. Daily records have been kept from 1924 to 1965 and from 1996 to 2002 with only a few years having incomplete data. The benchmark to which the gauge is referenced has been tied in to Ha Tien datum by Survey Department of Ministry of Public Work and Transportation. The key water levels recorded at KL are as follows:

- Highest recorded high water level (HHWL) : + 11.09 masl (1952)
- High water level (HWL) : + 10.36 masl (2000)
- Mean high water level (MHWL) : + 9.62 masl
- Mean low water level (MLWL) : + 1.19 masl
- Low water level (LWL) : + 1.19 masl (2002)
- Lowest recorded low water level (LLWL) : + 1.03 m (1998)

(2) Design Water Level by Frequency Analysis

The return periods of the high water levels and low water levels are significant in selecting a design value for the facility. The above "Chong Kneas Environmental Improvement Project, Draft Final Report (February 2004)" shows the following water levels.

Return Period	High Water Level	Low Water Level
10 year	+10.50 masl.	+1.25 masl.
20 year	+10.65 masl.	+1.20 masl.
50 year	+10.77 masl.	+1.15 masl.

For instance, 50 year flood level of +10.77 masl has been adopted for structural design of pumping station in the detailed design of "Siem Reap Wastewater Management" (March 2006).

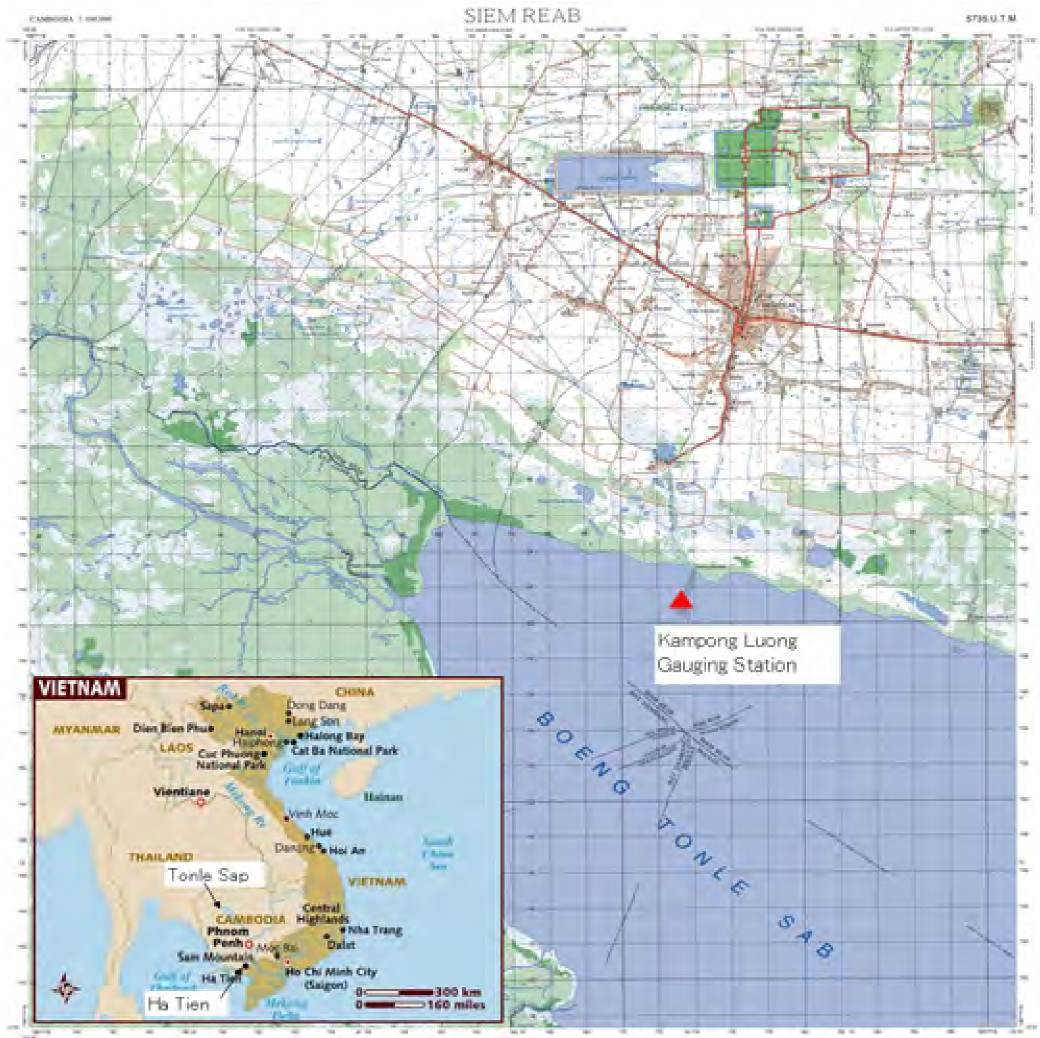


Figure 4.3 Location of Kampong Gauging Station and Ha Tien

Base on the above, the design HWL and LWL for the preliminary design of the proposed project in F/S were determined as below:

- Design HWL : +11.00 m (masl)
- Design LWL : +1.00 m (masl)

(3) Seasonal Change of Water Level of Tonle Sap Lake

At present, water level of Tonle Sap Lake is being measured by Department of Water Resources and Meteorology (DORAM), Siem Reap Province on daily basis. To illustrate the fluctuation, Figure 4.5 shows mean high water level and mean low water level of last 6 years (2004 - 2009) having a complete set of data.

Table 4.5 and Figure 4.4 present the monthly maximum and minimum water levels of Tonle Sap Lake for recent 10 years (2000 - 2009), although the records for 2000-2003 are incomplete. The highest water level of 10.33 m was recorded in September 2000, which almost coincides with 10.36 masl described above. Thus, water levels measured by DOWRAM are considered to be also tied in to Ha Tien datum.

To illustrate the fluctuation, Figure 4.5 shows mean high water level and mean low water level of last 6 years (2004 - 2009) having a complete set of data.

Table 4.5 Tonle Sap Lake Monthly Max. and Min. Water Level (masl.)

Year	Max/Min	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
2000	Max	na	na	na	na	na	na	na	na	10.33	10.31	9.90	8.32
	Min	na	na	na	na	na	na	na	na	9.10	9.96	8.37	6.46
2001	Max	na	na	na	na	1.30	1.30	5.95	8.50	9.65	9.66	9.10	7.76
	Min	na	na	na	na	1.30	1.30	4.35	6.28	8.56	9.14	7.81	6.03
2002	Max	na	na	na	na	1.30	3.14	5.79	8.29	9.98	10.03	9.18	7.65
	Min	na	na	na	na	1.30	1.33	2.20	3.99	6.09	7.71	5.97	4.24
2003	Max	na	na	na	na	1.30	2.18	3.38	6.04	7.89	8.15	7.63	5.90
	Min	na	na	na	na	1.30	1.30	2.21	4.00	6.10	7.72	5.98	4.25
2004	Max	4.01	2.70	1.89	1.40	1.28	2.70	4.29	7.22	9.08	9.10	7.91	6.01
	Min	2.75	1.89	1.48	1.21	1.15	1.16	2.80	4.45	7.47	7.97	6.10	4.38
2005	Max	3.97	2.60	1.92	1.49	1.19	1.38	4.29	7.30	9.10	9.34	8.62	7.08
	Min	2.95	2.00	1.48	1.22	1.17	1.17	1.42	4.54	7.29	8.67	7.12	5.31
2006	Max	5.23	3.66	2.44	1.67	1.41	1.68	4.54	7.50	8.47	9.20	8.97	7.17
	Min	3.68	2.47	1.67	1.43	1.27	1.27	1.69	4.63	7.61	8.42	7.24	5.31
2007	Max	5.28	3.55	2.43	1.65	1.90	2.10	3.68	6.40	7.68	8.76	8.60	7.30
	Min	3.61	2.47	1.66	1.30	1.20	1.85	2.09	3.66	6.45	7.70	7.36	5.52
2008	Max	5.45	3.80	2.46	1.82	2.99	3.40	5.05	7.48	8.42	8.54	8.25	7.37
	Min	3.85	2.50	1.86	1.26	1.27	2.03	3.45	5.08	7.55	8.21	7.42	5.78
2009	Max	5.70	4.05	2.57	1.96	1.75	3.00	4.65	7.20	8.21	9.16	8.81	7.13
	Min	4.10	2.60	1.98	1.45	1.46	1.78	3.05	5.39	7.21	8.30	7.20	5.22
2010	Max.	5.70	3.42	2.38	1.58	1.36	na	na	na	na	na	na	na
	Min.	4.10	2.41	1.60	1.35	1.25	na	na	na	na	na	na	na

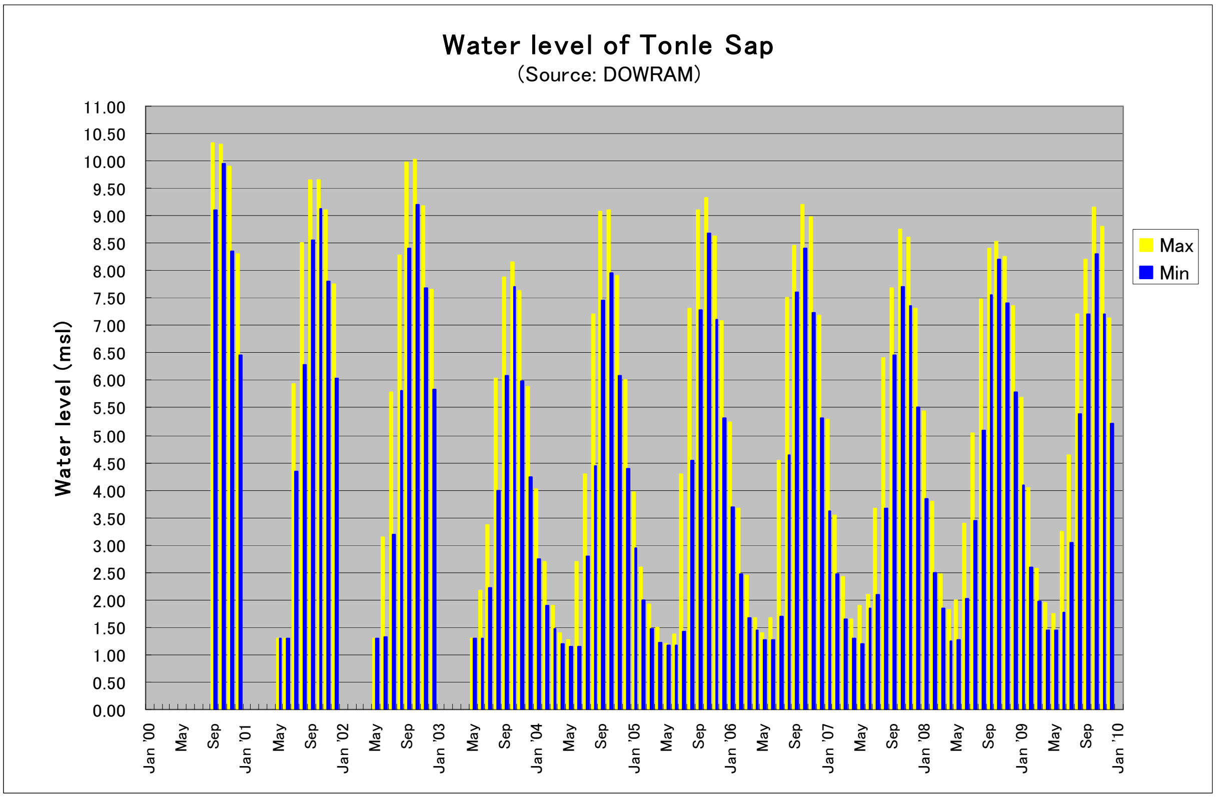


Figure 4.4 Monthly Max. and Min. Water Level of Tonle Sap Lake (2000-2009)

Thus, the tendency of water level fluctuation will be a basic data for planning appropriate construction period of the concerned facilities.

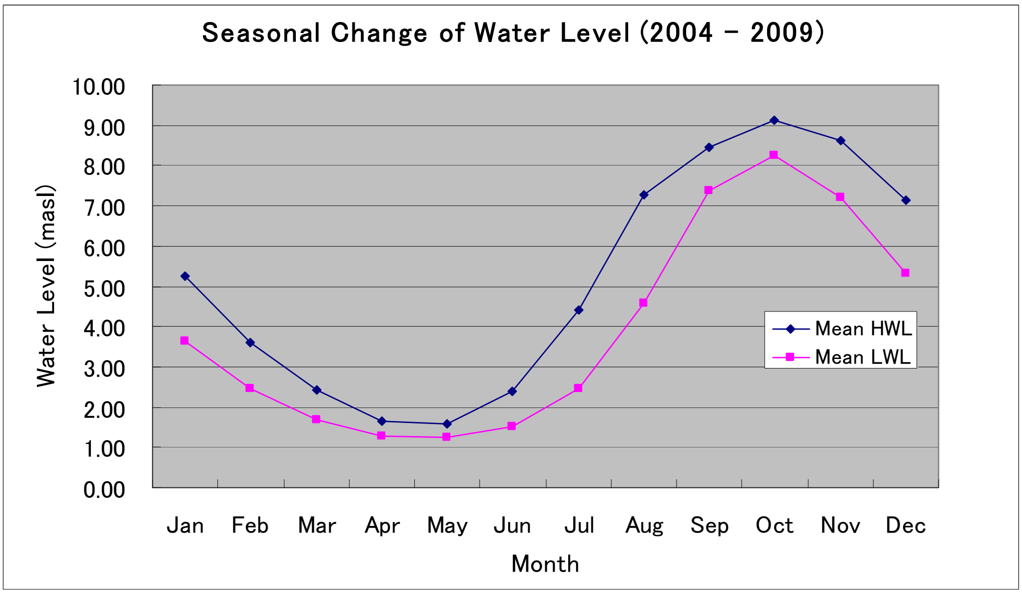


Figure 4.5 Seasonal Change of Water Level

4-7-2 Optimum Location of Pumping Station

Figure 4.6 shows the location of the proposed facility from intake to WTP in the priority project.

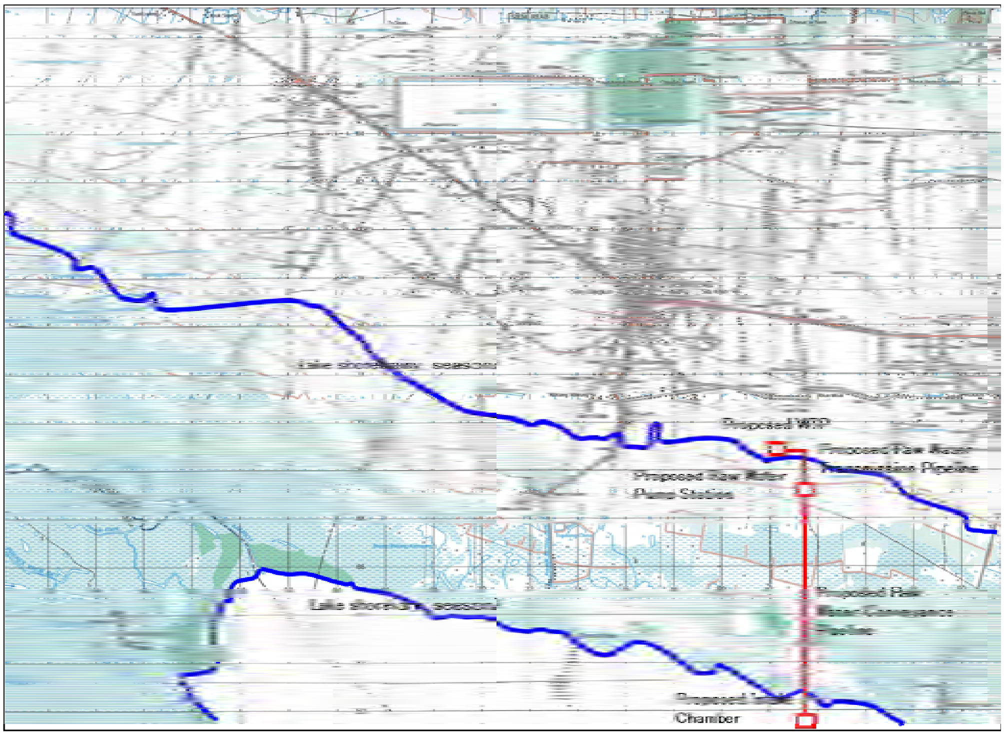


Figure 4.6 Location of the Proposed Facility

In selection of raw water pump station site, the construction cost of overall intake facilities by different locations of the pump station were examined and it revealed that the least construction cost can be realized at the pumping station where locates around 6 km away from the intake site as shown in Figure 4.7. Detailed analysis is referred to **SR 5.3** and **SR 5.4**.

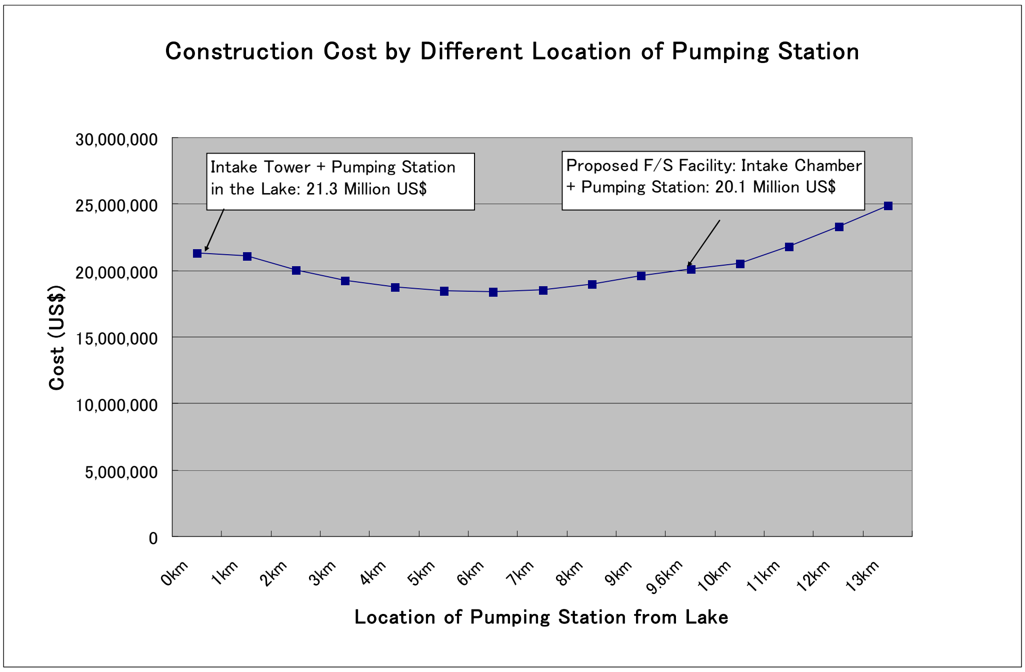


Figure 4.7 Construction Cost Variations by Locations of Pump Station

However, though the location of the pumping station shall be determined by the Cambodian side, land acquisition is not yet completed during the study period. Thus, the Study Team preliminarily designed the pump station be located 9.6 km away from the proposed intake site, based on series of discussions with SRWSA.

On the other hand, at the 3rd steering committee, the Cambodian side mentioned that the construction of intake tower together with pumping station in the water body of the Tonle Sap Lake will realize the lowest construction cost.

With regard to this, the comparison was made for the above two kinds of intake method as shown in Table 4.6.

The Study Team strongly recommends that the intake chamber should be constructed in the Lake and the pump station should be constructed more than 6 km away from the proposed intake site, taking advantage of introducing raw water by gravity without power cost and easier O&M due to easy access to the pump station. Selective raw water intake is not necessarily advantageous because sludge, if accumulates on the bottom of the Lake, can be introduced at the beginning of dry season. Likewise, intake tower with pump station, which needs permanent station of O&M staff on the Lake, will possibly bring about impact to the environment of the Lake.

Table 4.6 Comparison of Intake Facility

Item	Intake Chamber + Pump Station (Study Team recommendation)	Intake Tower + Pump Station (Idea mentioned at 3rd Steering Committee)
Structural Design	• Intake chamber introducing raw water at the bottom of chamber • Platform be provided for O&M (gate operation as required and cleaning in dry season) as well as avoiding fishery boat approaching	• Intake tower introducing raw water at selective water depth • Electrical & mechanical equipment be installed at intake tower
Construction Method and Schedule	• Cofferdam • Construction period will be minimized due to simple structure	• Cofferdam • Long construction period needed due to seasonal change of water level
Construction, O&M Costs	• Construction cost*: 20.1 Million US$ • O&M cost: 182,000 US$/year (power cost)	• Construction cost: 21.3 Million US$ • O&M cost: 267,000 US$/year (power cost)
Easiness of O&M	• No need for O&M of electrical and mechanical equipment except for screen cleaning in dry season • Access to pump station: by land (access road will be constructed) • Easy O&M	• 24 hrs. pump operation needed at intake tower. Operation staff be stationed at intake tower • Daily/periodical check, trouble shooting of electrical and mechanical equipment must be done at intake tower in the lake • Access to intake tower: by boat • Difficult in O&M
Impact to Environment	• No contaminant expected • Change of landscape (plat form) will be minimized	• Possibility of contamination due to staff stationing and accident of the pump operation/repair (oil, etc.) at intake tower • Intake tower may change landscape in the lake compared to intake chamber

Notes: *Construction cost: Required for construction of the facility (intake chamber, raw water conveyance pipeline, raw water pump station and raw water transmission pipeline) to meet the planned intake water volume (66,000 m^3/day) for year 2030. Details are referred to **SR 4.4**.

4-7-3 Raw Water Intake and Conveyance Facility

In Phase 2 study, “route B” situated east was selected as the raw water conveyance route in comparison of route A and route B which were selected as alternatives in Phase 1 study, after discarding “route C” due to difficulty in land acquisition and construction cost required for longer distance to the candidate WTP site.

As for the selection criteria for the route, various regulation/rules on environmental considerations for the Tonle Sap Lake were considered. The candidate routes are situated in the protected areas stipulated by the various agencies/organizations. These are Multiple Use Area by MOE, Strictly Protected Inundated Area Community Fisheries Area by MOAFF, Tonle Sap Biosphere Reserve Area by UNESCO and Provincial Conservation Area by community. Details are referred to Section 10-5 Environmental Impact Analysis and Mitigation Measures.

In comparison between route A and B, route B is situated out of Provincial Natural Conservation Area and Provincial Fish Conservation Area. Thus, “route B” was recommended as the raw water conveyance route to minimize the influence in the said area.

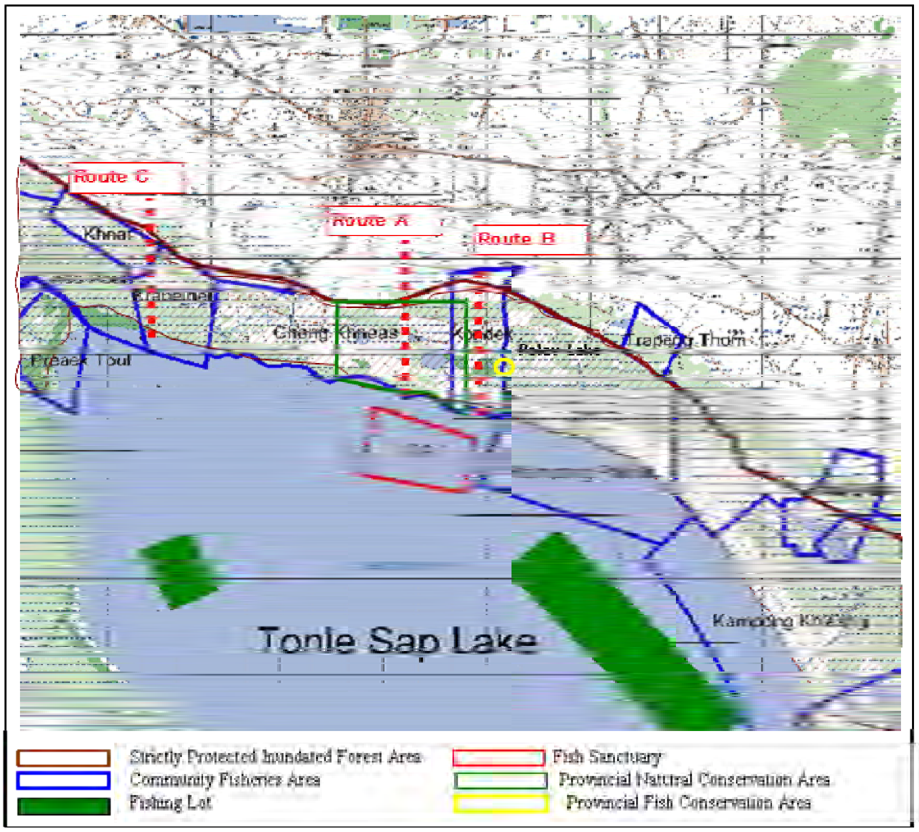


Figure 4.8 Raw Water Conveyance Route

As for intake method, the construction of intake chamber at 1 km away from the lakeshore of dry season and the Intake Pump Station 9.6 km away from the Intake Chamber is recommended based on the comparison as shown in the above Table 4.6. Thus, raw water is to be extracted at fixed level almost same as the lake bed.

Figure 4.9 illustrates the profile of the proposed raw water intake and conveyance facility of the proposed project.

Intake chamber is designed as below.

- Structure: Reinforced concrete intake chamber

  The platform with 3 floors is to be constructed on the intake chamber for gate operation as required and cleaning the screen during the time when water level reaches low enough. This platform is also designed as a sign for protection from fishing boat approaching to the chamber, since the other kinds of sign such as buoy and signpost in the lake are not applicable for operation and maintenance of the intake facility.

- Gate: Manual type gate is to be provided for maintenance purpose.
- Screen: 30 - 50 mm size of screen is to be equipped.
- Dimension of intake chamber: (W) 4.8 m x (L) 7.5 m x (H) 4.5 m
- Height of roof floor of the platform: +14.0 msl.

From intake chamber to pump station, the raw water is to be conveyed by gravity flow. The length is 9.6 km and 1,200 mm diameter of the concrete pipe was determined as shown below.

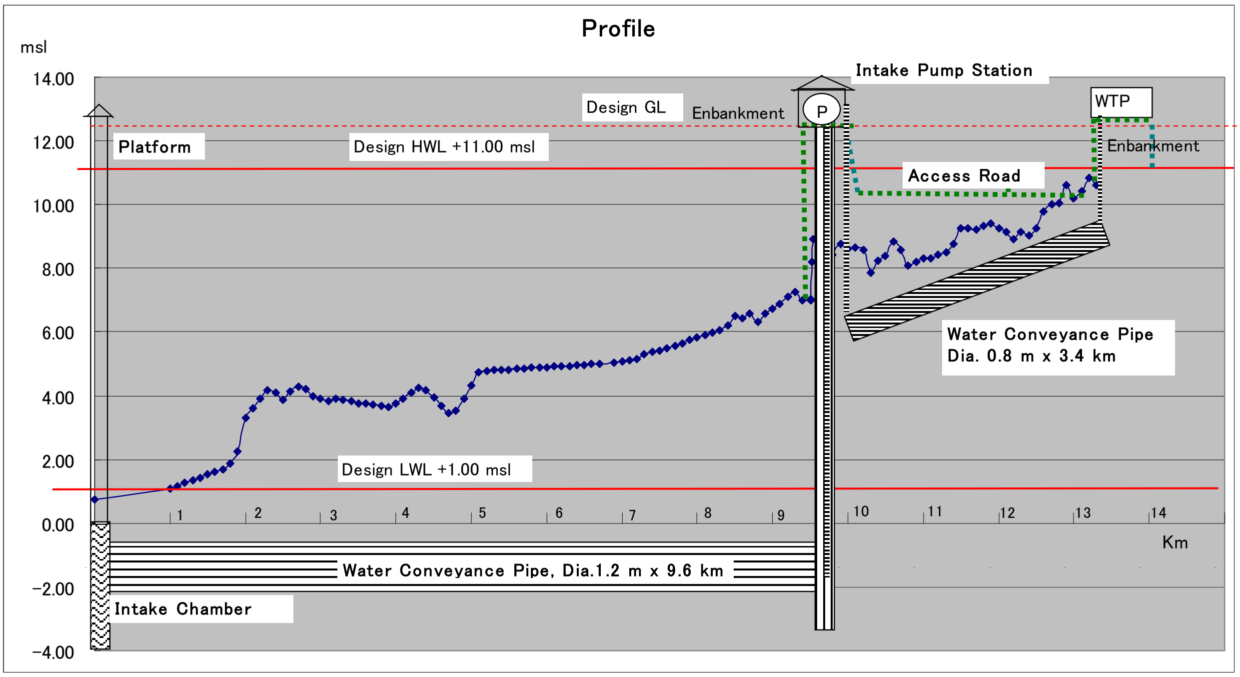


Figure 4.9 Schematic Diagram of the Raw Intake and Conveyance Facility

- Design flow: 66,000 m^3/day for Year 2030

  Maximum water demand of 60,000 m^3/day + 10 % of water loss in the pipeline and WTP

- Pipe material: Concrete pipe

  Concrete pipe will be enough for delivering raw water with lower pressure due to water level of the lake (HWL 11.00 masl – LWL 1.00 masl).

- Pipe diameter and number of pipeline

  In selection of pipe diameter, the required velocity to avoid settling sediments in the pipeline as well as number of pipeline were examined.

  It is recommended that the required capacity for the long term development plan of the water supply will be secured in the Priority Project, because it is considered that technical and environmental risk might be accompanied in implementation of long term development plan, if the additional one be installed close to the pipeline firstly installed in the Priority Project. Furthermore, single pipeline is considered to be more risky if serious accident occurs, compared to the double pipelines especially for the case of water intake from the Tonle Sap Lake. Thus, installation of 2 lines of raw water conveyance pipe in parallel to meet the ultimate water volume (33,000 m^3/day x 2 = 66,000 m^3/day) is recommended.

Table 4.7 shows the comparison of diameter and number of pipeline.

Table 4.7 Comparison of Diameter and Number of Pipeline (Intake – Pump Station)

Diameter	1,200 mm		1,700 mm
Number of pipeline	1	2 (1 for standby)	1
Flow	33,000 m^3/day (0.38 m^3/sec)	33,000 m^3/day (0.38 m^3/sec)	66,000 m^3/day (0.76 m^3/sec)
Head loss (m)*	1.42		0.94
Velocity (m/sec)**	0.34		0.34
Construction Cost	7.8 Million US$	11.6 Million US$	9.6 Million US$

* Formula used for hydraulic calculation: Hazen Williams (H = 10.666 x C^-1.85 x D^-4.87 x Q^1.85 x L)
C: Coefficient = 100 (assumed)
D: Diameter (m)
Q: Flow (m^3/sec)
L: Length (m) = 9,600 m

** Minimum velocity to avoid sediment such as sand: 0.30 m/sec. (Design Guideline for Water Supply 1990, Japan Water Works Association)

On the other hands, 3.4 km length raw water transmission pipeline from pump station to WTP is designed as below.

- Design flow: 33,000 m3/day (for the proposed project)
- Pipe material:
  Either Ductile Iron or Steel pipe will be recommended considering raw water transmission in pumping system, however, Ductile Iron pipe is assumed to be employed in this F/S.
- Pipe diameter:
  800 mm of diameter is recommended due to economical pipe velocity in pumping system.
- Number of pipeline: one line

4-7-4 Raw Water Intake Pump Station

To meet the Project water demands, and those of 2022, it is necessary to have multiple pumps to supply the treatment plant with a constant flow. The pumps installed to meet the 2017 flow however can be used also to meet the 2022 flow. Using a demand project flow of 30,000 m^3/d for the 2022 flow plus ten percent allowance, three units will be required, one as a standby unit. With each unit pumping at 16,500 m^3/d (0.191 m^3/s), two units will meet 33,000 m^3/d flow with a third as standby and space will be left for two more pumps to meet the 2030 demand.

As the Lake water level fluctuates about 10 m during the year, the pump motors need to be safe from the high water level and the pump impeller and suction need to be located below low water level.

The pumping head required is the static head and friction head loss resulting from pumping a maximum of 33,000 m^3/d through the raw water transmission main up to the year 2022. As the length of raw water transmission main is approximately 3.4 km from the raw water intake pump station to the WTP, a 800 mm diameter pipe could be used. The static head will be from the low water level of the suction sump of the pump station to the distribution chamber water level at the WTP. This is approximately 21 m of static head and 5 m of friction head at 2022 flows using a 800 mm raw water main (to be verified during detailed design, dependent on the final locations). Each pump will therefore be about 68 kW for a total installed load of 190 kW at the intake.

Three pump configurations could be suitable for the intake - vertical mixed flow pumps, vertical double volute pumps in a dry well with motors placed above maximum flood level or submersible pumps.

Vertical mixed flow pumps have the advantage over vertical shaft double volute pumps in that bracing across the pump station is not required to support the shafts and couplings and suction piping and fittings are not required. In addition, lubrication by oil at the couplings is not required. However, disadvantages include difficulty in operation and maintenance as the pump is submerged. Also repair or overhaul of the pump is problematic as the long, vertical pipe and shaft must be removed to access the pump impeller.

Submersible pumps include an integral motor and are mounted directly in the wet well. They do not require bracing across the pump station to support the shaft and couplings and suction piping, fittings and valves are not required. However the disadvantages are similar to vertical mixed flow pumps, but in addition maintenance must be carried out at qualified service units for the motor and seal replacement. The seal between the pump and piping can allow leakage thus reducing the efficiency of the pump.

The proposed double suction volute pump will have the following specific advantages;

- Low capital cost ; the cost of horizontal double suction volute pumps is the most inexpensive.
- Horizontal double suction volute pumps are very simple shape. To be compared with other pumps floor for motor and long shaft are not required.
- Easy access ; the pumps are installed in a dry well and operators have thus easy access to monitor pumps for operation and maintenance;
- Easy installation and maintenance ; SRWSA maintenance crews are familiar with the proposed type of pumps, which are of similar type as in the existing facilities. Horizontal double suction volute pumps in the dry well are easy for installation and maintenance because only dismount of upper casing is required for maintanance of impeller, rotor etc. Submersible pump motors are unlikely to be repaired at local workshops, due to lack of skills and facilities.
- high efficiency ; double suction volute pumps have superior efficiencies than submersible pumps and bring about low operation cost.
- Location of motor ; same as the existing Mekong Tourism Development Project (Waste Water). Both motor and pump are installed on the same pump room floor.

The proposed specifications for the Intake Pumps will be as follows;

Number:	:	3 sets (including 1 set for standby), with additional spaces provided for 2set for phase2
Type	:	Horizontal double suction volute pump with dry sump
Capacity:	:	191 l/s each
Head	:	Approx. 26 m (operation range: approx. 16 m to 26 m)

In order to accommodate the wide range of operating heads due to fluctuation of Tonle Sap Lake water level, variable speed pumping is recommended. Three types of alternative flow control systems, namely i) speed control, ii) valve control and iii) operating pump number are in use for the intake pump installations.

Speed control is justified for the following reasons;

- Continuous setting ; the pumps with speed control can be continuously operated against the varying heads within the pre-determined range. Generally the pump number control and motorized valve control have the same performance, but the control system is more complicated and expensive. The pump number control system needs at least two types of lifting capacity pumps while the speed control system accommodates with the fluctuated water level by a single type of pump. Then, the construction cost of the necessary structures/facilities for the pump number control system is 70 percent higher than that of the speed control system. In this case fluctuation of Tonle Sap Lake water level is Max.10 m, speed control type shall be recommended in terms of operate and maintenance.
- low operating cost ; the pumps with speed control has a 10 percent lower operating cost than pump number control and valve control because of the minimum numbers of pump system is needed compared to the pump number control systems.

By providing speed control for the intake pumps and monitoring flow, the flow adjustment of raw water can be accomplished automatically.

Figure 4.10 illustrates the proposed control system.

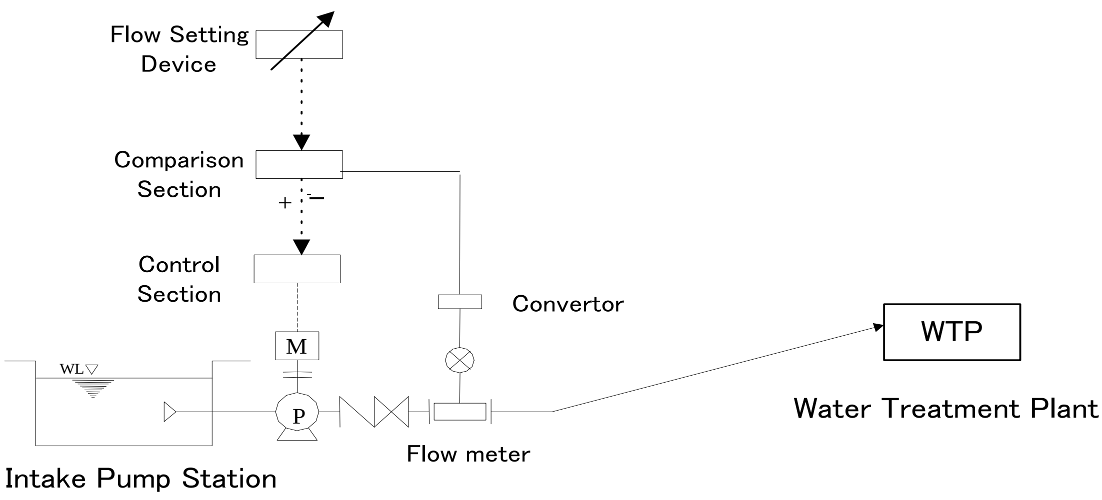


Figure 4.10 Intake Pump Control System

To prevent large debris from entering the raw water conveyance pipes and the pump sumps, the Lake water intake must be screened to limit the size of solids, which could enter the pump. It is proposed to have screening net to be provided with the intake structure in the Lake. The screen is to catch large floating objects above 50 mm or so to limit small objects from reaching the raw water conveyance pipes. The screen would be cleaned manually during dry season as accumulated debris to be removed should be minimal.

The pumps would discharge to a common header connecting to the raw water transmission main connecting to the WTP receiving well or distribution chamber. Each pump discharge would include a check valve to prevent water from escaping from the raw water transmission main and running the pump backwards and a gate valve to isolate the pump for repair. Air and vacuum valves on the header would discharge collected air from inside the header and let air into the header if a vacuum develops, say by a sudden pump stoppage. A small-valved line at the end of the header would drain the header and transmission main, when needed. A flow meter would be installed in the raw water transmission main just inside the intake pump station to measure flows. If needed, a surge control chamber will be connected near the discharge header to protect the piping against water hammer.

The pump room would have a gantry crane across the motors and discharge piping at the ceiling to remove items for repair. The motor control room would also include the motor control panel, alarms, flow indication equipment, and telemetry panels.

Details equipment list are referred to **SR 4.7** through **4.9.**

4-8 Water Treatment Process Design

This Feasibility Study considers the possible treatment process for the Project as either chlorination only, slow sand filtration, or rapid sand filtration based on the raw water quality characteristics. However a clear categorization in selection of these processes by numerical criteria is difficult, since the quality of the raw water varies greatly between seasons. The practical design guidelines for selection of treatment process are recommended by many water organizations in the world. The followings are the general guidelines for selection of basic process design from the Japan Water Works Association (JWWA):

- when the water quality conforms to the standard like E. coli of not more than 50 (in 100 ml, MPN), total colonies not more than 500 (in 1 ml) and other items of quality tests conform to the standard, chlorination only may be applied;
- when raw water quality has annual average turbidity of below 10 NTU, BOD below 2 mg/l, E. coli. below 1,000 (100 ml, MPN) slow sand filtration can be employed. In general, when the average annual turbidity of raw water is below 10 NTU, chemical coagulation is not necessarily effective. Further, the purifying effect of slow sand filtration is good due to absorption and biochemical action, and a certain amount of ammonia, manganese and odour-emitting matter can be removed, resulting in superior water quality to that of rapid sand filtration; and

- ♦ when the quality of raw water does not meet the above two criteria, rapid sand filtration will be better adopted and necessary equipment for pre-treatment such as chemical coagulation must be provided.

The most useful parameter in selection of the optimum water treatment processes is turbidity as illustrated above. Several water quality analysis data of the Tonle Sap is available in various points and in different seasons including those data taken by the JICA Capacity Building Team in 2009, the JICA Study Team on Integrated Master Plan for Sustainable Development of Siem Reap in 2006, and this Study Team. Available monitoring parameters for process water quality control at the existing PPWSA's Phum Prek WTP, which intakes raw water from the Tonle Sap, are turbidity, pH, conductivity, suspended solids, total dissolved solid, total coliform, faecal coliform, etc. of the raw water; pH, turbidity, suspended solids, total dissolved solid, and color of the treated water. The detailed data are attached in **SR 4.2**.

Salient features of the water quality of Tonle Sap Lake are summarized hereunder:

The highest turbidity in the data recorded is over 1000 NTU taken by the JICA Capacity Building Team in 2009. The other turbidity data shows 200 NTU at maximum. The data take by the JICA Capacity Building Team was found to be erroneous due to sampling methods. The samples included stirred bottom sludge in the Lake, which produced unusual results over 1,000 NTU, due to that their sampling boat passed through the sampling points during the Lake was very shallow in the dry season.

Turbidity data

JICA Capacity Building Project	Study Team
(conducted from 25 Mar 2009 through 23 June 2009	(conducted on 29 June and 6 Oct. 2009)
154 to 1860 NTU	3.5 and 200 NTU

pH data showed over 6 and not exceeding 8, showing sometime slightly acidic or neutral values which result in general easy operation of the plant in terms of water treatment without the process of pH control. The water quality in pH is therefore categorized as comparatively good for a water source for the rapid sand filtration process due to its advantages for physico-chemical safety through treatment processes.

pH data

JICA Capacity Building Project	Study Team
(conducted from 25 Mar 2009 through 23 June 2009	(conducted on 29 June and 6 Oct. 2009)
6.6 to 6.9	7.7 and 7.8

Other water quality parameters also corroborated that the rapid sand filtration process is the optimum water treatment process for the Tonle Sap water source as water quality is summarized as:

- ♦ soft with low alkalinity less than 50 mg/l => pH adjustment;

- color showed higher than 50 TCU which is relative high exceeding the maximum permissible level of the drinking water standards => pH adjustment and chlorination;
- iron and manganese showed over 4 mg/l and 0.5 mg/l, respectively which is relative high exceeding the maximum permissible level of the drinking water standards => pH adjustment, chlorination, and manganese sand filter;
- heavy metals are absent or within the maximum permissible level of the drinking water standards;
- phosphate and nitrate levels are detected within the maximum permissible drinking water standards and/or the allowable limits for pollutant substance discharge to protected public water area.
- Algae is included beyond the maximum permissible drinking water standards especially during dry season => chlorination.

As a result of series of Jar Test on the Tonle Sap water made during the Phase 2 study, and the updated data analysis conducted by the Study Team, the proposed principle of treatment process should be a rapid sand filtration system. This treatment is widely used in Cambodia with river sources. The process comprises pre-treatment, such as pH adjustment, pre-chlorination, and coagulation, flocculation, sedimentation, filtration, and disinfection. The details of Jar Test results are referred to **SR 4.3**.

Monitoring of water quality should be continued so that operation of the proposed water treatment plant will be optimized in selection and dosages of chemicals dependent on seasonal changes.

Detailed calculations for the facilities are referred to **SR 4.10** through **4.13.**

4-9 Pretreatment

Coagulation, as a pre-treatment process will be provided in the distribution chamber at the head of the plant so that the destabilization of charges on colloids and suspended solids, including bacteria and viruses, may be achieved. The coagulation process will be achieved by a rapid mixing system which will disperse 10 percent alum sulphate solution, $Al_2(SO_4)_3 \cdot 18H_2O$ as a coagulant uniformly throughout the water as rapidly as possible.

Mechanical mixers are generally propriety devices whose major technical advantages are that mixing is not a function of flow and they are flexible in adjusting the degree of turbulence to suit the particular treatment needs. Distinctive products or types of rapid mixing equipment are available from manufacturers. However in line with the design concepts proposed in the previous section, the intensity of turbulence should preferably be generated through a hydraulic jump formed by weirs to be installed at the distribution chamber. The advantage of hydraulic mixing is to simply apply raw water potential head by the raw water intake pumps. Non-use of mechanical equipment conforms to the general design concept. Likewise, the increase of lifting head can possibly help mitigate operational problems on the intake pump facilities caused by the fluctuation of the Tonle Sap Lake water level.

The mixing energy of the hydraulic jump corresponds to a velocity gradient of not less than 350^{s-1} at a water temperature of 25^0C.

When the alkalinity of the raw water is less than 20 mg/l, pre-lime will be employed at the distribution chamber using 10 percent lime solution as a agent for pH adjustment prior to the coagulation, to ensure the effective coagulation process. In addition, pre-chlorination will be applied from time to time for algae control and removal of iron and/or manganese if those parameters exceed the Drinking Water Standards.

The detention time and effective depth of the mixing chamber will be from 1 to 5 minutes and 4.5 m, respectively. Adequate baffles and surface area, as well as weirs, will be provided within the distribution chamber to ensure proper coagulation and flow measurement.

The preliminary design criteria of the pre-treatment process are:

Type	:	Distribution chamber with hydraulic rapid mixing by weirs, two weirs are duty for Phase I
G value for rapid mixing	:	Approx. 400^{s-1} (>350^{s-1})
Dimensions	:	Receiving well 3.0 m x 3.0 m x 4.0 m depth Mixing chamber 2.0 m x 2.5 m x 2 chambers
Incidental facilities	:	Raw water inflow pipe: 800 DI, Drainage pipe: 300 DI Backwash water return pipe: 250 DI 2 raw water outlet pipe: 500 DI 1-overflow weir, 2-outlet gates
Applied chemicals	:	Pre chlorination Liquid chlorine (99.9 %) pH control Lime (10 % solution) Coagulant Alum (10% solution)

4-10 Flocculation

Flocculation is the process of gentle and continuous agitation, during which suspended particles in the water coalesce into larger masses so that they may be removed from the water in subsequent treatment processes, particularly by sedimentation. Flocculation follows directly after the rapid mix process and, like rapid mixing, the agitation may be induced either by mechanical or hydraulic means.

The most common methods for flocculation are categorized into hydraulic flocculation and mechanical flocculation processes which are further classified into horizontal and vertical flocculation units. Mechanical flocculators are characterized by flexibility for the fluctuating water treatment capacity and controllable mixing intensity because of their greater versatility; that is, the speed of the mechanically operated paddles can be adjusted to suit variations in flow, temperature, or raw water quality. However, the principle elements of mechanical flocculator systems comprise agitator impellers, drive motors, speed controllers and reducers, transmission system, shafts and bearings which increase operation and maintenance procedures.

As discussed in previous section, the provision of the proposed WTP is essential in order to enhance supplies to meet the anticipated increased demands in the Siem Reap City area. Before the commencement of the priority Project, with a production capacity of 30,000 m^3/d, there is a risk of a supply deficit in daily maximum water demand basis being experienced from 2015. Hence the proposed WTP could be operated at full designed capacity immediately from commissioning in 2017 with intermittent operation or adjusting the operating trains. In case of fluctuations of flow for treatment capacity are expected it can be manageable in provision of numbers of treatment trains and the flow rates can easily maintain sufficient head losses in the channel for mixing.

Therefore, as gravity flow is available, the proposed approach for this project is to use hydraulic flocculators that do not require mechanical equipment nor a continuous power supply. They can be built primarily from local materials including concrete, brick, wood, or masonry at relative low cost.

Vertical-flow baffled channel flocculators, which can adjust the velocity by manipulating the opening space, with a detention time of approximately 20 to 30 min are proposed. Two trains will be provided so that in case of lower flows than the designed capacity, or maintenance works, one train may be shut down accordingly to attain a suitable flocculation intensity G-value range from 70 to 10 s^{-1}. The width of the flocculation channels will be sized in thirds to adjust the hydraulically required flocculation intensity from 70 to 10 s^{-1} i.e. higher intensity to gentle mixing towards sedimentation process.

The preliminary design criteria for the flocculation process are:

Type	:	Vertical-flow baffled channels
Number	:	2 trains with 3 staged tapered flocculation
Detention time	:	23 min (20 to 30 min)
G value	:	25 to 75 s^{-1}
Dimensions	:	1.1 m width x 8.0 m length x 3.60 m depth x 2 channels
		1.5 m width x 8.0 m length x 3.65 m depth x 2 channels
		1.9 m width x 8.0 m length x 3.70 m depth x 2 channels
Incidental facilities	:	2- inflow chambers with baffle wall

4-11 Sedimentation

The sedimentation, or clarification, process in water treatment provides for the settling and removal of a majority of the heavier and larger settleable solids and suspended particles from water prior to the filtration process. To maximize the efficiency of the filtration process, the settled water turbidity should, preferably, be less than 2 to 5 NTU. The loading on the filters has a marked influence on their capacity, the length of filter runs in relation to the washing schedules, and the quality of the filtered water. Sedimentation is largely dependent on adequate pretreatment processes including coagulation and flocculation. The efficiency of the sedimentation basin is determined by the surface loading ratio (Q/A) which is the rate of treatment capacity (Q) and the surface area of the sedimentation tank (A).

The sedimentation system is classified into four major types: horizontal flow sedimentation units; up-flow sedimentation units; solids contact/slurry recirculation units; and sludge blanket clarifier units.

Horizontal flow sedimentation is commonly used in municipal water supply system. It is based on gravity flow separation processes in which a settling basin provides a quiescent environment that enables particles of specific gravity greater than water to settle to the bottom of the tank. The outstanding feature of horizontal flow tanks is a flexibility to tolerate shock loads in both quantity and quality of the raw water. In fact, rectangular sedimentation unit can handle 50 to 100 percent higher flow rates than the original design capacity for short periods without a significant deterioration of settled water quality. Consequently the flexibility and predictable performance under most conditions brings about easy and stable operation and low cost maintenance, even though the capital cost may be higher than other systems.

Up-flow sedimentation, which is usually applied to small-scale community plants due to easy operation and maintenance, is recommended when the raw water characteristics and hydraulic rates are stable. The up-flow unit then provides low construction cost and easy operation and maintenance due to its compact and simple structure. The Tonle Sap Lake water is not necessarily stable in quality so that the up-flow sedimentation unit is not recommended.

Sludge contact, or slurry recirculation, is a kind of modified up-flow unit process combining pretreatment processes of coagulation, flocculation, and settling in one tank. The unit circulates high density, and stable, micro-flocs by means of density flow developed by low lift pump blades installed in the coagulation/flocculation zone. The inflowing micro-flocs, developed in the coagulation zone, are absorbed by the circulating flocs and subsequently precipitate in the settling zone (the so called seeding effects). The seeding effects used with a relatively high turbid raw water enable high efficiencies for those pretreatment processes included in the separate compartment formed by steel members provided in the tank. Thereafter a higher rate of surface loading can be applied than in conventional horizontal or up-flow units. Nevertheless, the operation and maintenance is not necessarily easy to control. The optimum operational conditions are dependent on several parameters such raw water turbidity, pH, temperature, alkalinity, and slurry concentration that should be monitored by properly trained, or experienced, skilled operators. The submerged steel members installed inside the tank must be periodically painted to prevent corrosion problems.

In case of constantly highly turbid raw water, sludge blanket clarifiers may be applicable. However the actual turbidity of the Tonle Sap Lake water is not stable and can be high. Inflow suspended solids fed into the slurry zone (the, so called, sludge blanket) are coagulated and adhere within the sludge blanket. The increasing sludge volume is then discharged periodically by operating sludge discharge valves while the separated supernatant flows to the filtration process. The key factor for successful operation is to maintain the sludge blanket in the optimum conditions despite the inevitable fluctuation of turbidity, pH and alkalinity of the raw water and this is difficult to manipulate without experiences. In addition, raw water with algae may be difficult to treat because algae may float, carrying the sludge blanket and flocculated solids to the surface and overflow to the filters. In both solids contact and/or sludge blanket clarifiers, skilled supervision is necessary to realize stable operation because the treatment principle is only secured by the balanced velocity between flocculated particles settling and up-flow.

The Tonle Sap Lake water is a totally new source in the context of the abstraction volume being considered. The likely difficulties in operation to cope with the fluctuation of the Tonle Sap Lake water source and the need to provide a reliable strategic treatment regime in a relatively remote location draw the conclusion that sludge contact and sludge blanket clarifiers are not recommended for the Tonle Sap Lake water source.

Inclined plates are used in sedimentation processes including horizontal flow basins, up-flow basins, reactor clarifiers, and sludge blanket clarifiers. The operation efficiency may possibly improve by 50 to 150 percent in relation to the available allowances in original designs. However, for those water supply bodies in tropical countries, the use of inclined plates should be limited, in most cases, to expand settling basin capacity and/or improving plant effluent quality due to hot and sunny climates promoting algae growth on plates which can bring maintenance problems.

Thus, the sludge contact and sludge blanket clarifiers are not recommended due to their reduced ability to handle shock loads whilst horizontal flow rectangular basins are most stable in unpredictable conditions and serve as the most appropriate sedimentation process.

The available site space is about 4 ha plus fringe areas which allows for construction of a total of 60,000 m^3/d of conventional horizontal flow sedimentation units by means of a full gravity system from pre-treatment to filtration and through disinfection processes.

The preliminary design criteria for the sedimentation process are:

Type	:	Rectangular plug flow
Number	:	2 trains with hydraulic sludge removal pipes
Surface loading	:	23.9 mm/min <30 mm/min
Passing velocity	:	0.358 mm/min < 0.4 m/min
Sludge collection	:	Discharge to sludge discharge tank by gravity

Collecting trough	:	300 mm width x 350 mm depth x 6 m length x 8 nos., 343 m^3/m/d < 400 m^3/m/d
Baffle wall	:	1 for inflow and 1 for effluent of basins
Dimensions	:	8 m width x 60 m length x 4 to 5 m effective depth x 2 trains
Incidental facilities	:	6 sludge extraction pipes 150 mm dia.
	:	1 sludge extraction pipe 250 mm dia.
	:	1 drainage pipe 250 mm dia.

4-12 Rapid Sand Filters

Filtration is the last process in the water treatment system to secure physico-chemical safety through the combination of physical, chemical, and in some instances, biological process for separating the minute impurities carried over in the settled water by passage through porous media. The design variables for rapid sand filtration process include in order of importance: type of filter media and filtration rate; washing arrangements; type of filter rate control and auxiliary arrangements.

4-12-1 Type of Filter Media and Filtration Rate

Rapid sand filters remain the predominant method of filtration, not only in Cambodia, but many countries due to availability, low cost, and satisfactory performance. Filtration efficiency is fully dependent on the conditions of the filter bed. The filter media must be kept at the designated thickness and be durable for the continuous service cycle of filtration and washing.

Dual-media filter beds consisting of anthracite and sand makes possible (i) higher filtration rates than for conventional filters, resulting in a reduction in the total filter area and cost for the given design capacity and (ii) longer filter runs at any given loading. However, an unexpected loss of anthracite took place because of an inconsistent washing schedule using the combined air scouring and water backwash, without wash troughs. The filters eventually did not function properly with a deterioration of the filtered water which resulted in water quality exceeding the Cambodian Drinking Water Standards.

The Phum Prek rehabilitation works, conducted in 1995, provided a 1000 mm thick of single media of sand, of 900 mm thickness and 0.8 to 1.0 mm effective size with a filtration rate of 156 m/day. The subsequent operation results of the Phum Prek WTP show a satisfactory production record to date. The proposed filtration rate is recommended to be conservative taking into consideration of raw water quality fluctuations of the Tonle Sap Lake.

The required filter area and number of units are interrelated. The maximum size of filter bed should be limited less than 150 m^2 so that uneven flow of air scoring and washwater can be avoided. The filter media should be manganese sand which will ensure the contact filtration systems to remove manganese carried over from the settled water tank to the filter units.

The design parameters for filtration are:

Type	:	constant-rate filter with influent splitting and varying water level
Number	:	4 filters
Dimensions	:	8.0 m x 8.5 m (= 68 m^2 per unit)
Total filtration area	:	272 m^2
Filter media	:	800 to 1000mm thickness, E.S. 0.8 mm to 1.0 mm U.C. <1.5, Manganese sand
Filtration rate	:	120 m/d (approx. 161 m/d during washing)

4-12-2 Filter Wash Arrangements

Backwashing is required to remove the suspended materials that have been deposited in the filter bed during the filtration cycle. Thus, the washing arrangements should be compatible with the applied filter bed considering the (i) kind of the applied filter media, (ii) sizes of the filter media, and (iii) thickness of the filter bed. Likewise, it should be remembered that proper backwashing is achieved only through a well-organized auxiliary wash system of surface washing or air scoring.

The proposed deep filter bed is not compatible with surface wash system, even fixed grid or rotating arm types, because the mixing energy provided by the surface wash may not reach towards the deeper portion of the bed where the retained material is clogged. A rotating arm type with dual-arm agitators is available for deep or dual media filters, however this is not recommended due to the more complex structure and the inevitable maintenance of the rotating parts. The air scoring system is applicable in this case and is widely employed in existing plants in Cambodia including Phum Prek WTP.

The rates of backwash need to be high enough to fluidize the filter media, but no higher. The percentage of expansion that accompanies any backwash rate is a function of the sand size, specific gravity and temperature of the water. Considering the relatively high temperatures and the existing conditions, a combination of 0.25 m^3/m^2/min of backwash and 1.0 m^3/m^2/min of air scoring is recommended. Backwash water will be tapped from the clear water reservoir and pumped to in a elevated washing/service water tank.

The preliminary design criteria for the filter wash arrangement are:

Backwash rate	:	0.25 m^3/m^2/min
Auxiliary wash	:	Air-scoring, 1.0 m^3/m^2/min
Backwash water	:	Tapping filtered water stored at the backwash water tank

4-12-3 Type of Filter Rate Control

Typical filter rate controllers are more or less dependent on mechanical or instrumentation systems, except for the self-backwash filter system. However all systems have advantages and disadvantages.

The self-backwash system is applicable in certain circumstances but not in all respects because backwash water has to be provided by at least six to eight other filter units. This increases the total construction cost and it is dependent upon the applied filtration rate. The washing strength not be adjustable unless backwash pump are provided, which writes off the advantages and leads to a more costly works. The structure needs to be deeper and the effluent weirs will not function correctly if not precisely constructed.

An obvious fact for the sustainable operation of filters is to distribute the settled water evenly into each filter and to backwash regularly if the loss of head reaches the designed level or 24 to 48 hours of filter run, dependent on the settled water quality. Unexpected backwashing will be inevitable in cases where the turbidity of the settled water is beyond the desirable level of 5 NTU. Inflow weirs, without filter controllers, are recommended to hydraulically distribute the designed settled water amount evenly to each filter unit. This system still allows the filtration process can be managed easily without control any devices. Thus, the constant-level filtration system, with influent splitting and varying water level system is recommended rather than the other filtration system.

The preliminary design criteria for the filter control system are:

Filtration system	:	Constant rate filtration, level sensor
Inflow/effluent control	:	Weirs

4-12-4 Auxiliary Arrangements

The major requirements for the filter underdrain system are the support of the filter media and the uniform distribution of the scouring air and backwash water across the entire filter bed. In many instances, bases can be reinforced concrete slabs with plastic strainers, precast concrete percolated block, or glass-tube orifices, or simple perforated-pipe lateral systems.

The filter underdrain system will be selected based on the combination of filter media and washing system, from strainers, dual lateral blocks, and precast concrete perforated underdrains, as commonly adopted. The selection criteria are reliability, simplicity of design/construction, durability, and low head loss during washing. For this project, some sort of nozzle type is possibly the most appropriate strainer to provide easy installation and most stable underdrain in combination with the proposed air scouring and washing systems. Supporting gravel is not necessarily required for the strainer underdrain system.

The valves controlling the filtration process will be of the electrically operated type, which are easier for operation and maintenance than the other systems.

The preliminary design criteria for the underdrain system are:

Underdrain system	:	Strainer type
Supporting gravels	:	Not applicable
Valves	:	Electrical operation type

4-13 Chemical Applications and Chlorination

Alum as a coagulant, lime for pH control, and liquid chlorine as a disinfectant and/or oxidant will be employed on the Project, the same as the existing Phum Prek or other PPWSA WTPs. The dosages (in mg/l) and applied points of each chemical will be as shown below based on the jar test results conducted by the Study Team.

Chemicals	Max.	Ave.	Min.	Dosing Points
Alum	60	15	10	Distribution Chamber
Pre- lime	30	10	5	Ditto
Post-lime	30	5	5	Back wash water tank
Pre chlorine	5	2	1	Ditto
Post chlorine	2	1	1	Clearwater reservoir

4-13-1 Alum

Alum will be delivered in bags containing 50 kg of alum sulphate $Al_2(SO_4)\cdot 18H_2O$. According to the operation records at the Phum Prek WTP the maximum dosage is not likely to exceed 50 mg/l, as well as Jar Test conducted by the Study Team showed 50 mg/l of alum dosage was sufficient to coagulate the Lake water. Thus, provisions will be taken to enable the operators to satisfy dosage demands up to 60 mg/l with a 10 percent solution. The flow of alum solution will be manually adjusted according to the alum demand and to the actual raw water flow. The Jar Test results are summarized in **SR 4.3.**

The alum feeding facilities will consist of, at least, two dissolving tanks, having a total net capacity equivalent to at least one or two days retention time at the maximum dosing rate. Two 1.5 m^3 tanks, one for duty and another for stand by, will be built in reinforced concrete or mild steel with suitable acid resistant lining. Each dissolving tank will be provided with a screen, dissolving tray, electrically driven mixer, overflow pipe, drain pipe, solution suction pipe, each with manual diaphragm or ball valve, and level gauge (float and counterpoise along a graduated scale).

4-13-2 Lime

Lime will be delivered in bags, containing 25 or 50 kg of imported hydrated lime. The maximum lime dosage is not likely to exceed 20 mg/l, but provisions will be taken to enable the operator to satisfy dosage demands up to 30 mg/l with a 10 percent solution. The flow of lime slurry will be manually adjusted according to the lime demand and the actual water flow.

Two slurry tanks will be provided, having a total net capacity equivalent to at least one or two days retention time at the maximum dosing rate. Two 1.5 m^3 tanks, one for duty and another for stand by will be built in reinforced concrete or mild steel. Each slurry tank will be provided with a loading hatch with dust removal unit, a screen, an electrically driven mixer, overflow pipe, drain pipe and slurry outlet valve, each with manual diaphragm or ball valve, level gauge (float and counterpoise along a graduated scale).

4-13-3 Storage of Alum and Lime

Alum and lime storage at the treatment plant will be sufficient for at least 30 days of operation at an average dosage of 15 mg/l of alum and 10 mg/l of lime, respectively. The chemical storage for each facility will be provided with suitable loading equipment to accommodate the specified maximum daily consumption of alum and lime.

4-13-4 Chlorine

Chlorine will be supplied in tonne containers of liquid chlorine. The facilities will include all equipment for storage, handling, dosage and injection of chlorine, together with safety equipment. The operation of the chlorinators will be controlled on a “START-STOP” basis according to the level in the distribution chamber and/or clear water reservoir, similar to that detailed for the existing facilities or PPWSA WTPs.

One chlorine drum of each row will be supported on a weighing machine which will be provided with an adjustable tare lever and with supports for the drums. A row of chlorinators will be equipped with one immersion pit, to reduce the damage in case of chlorine leakage. Evaporators may not be necessary as a tonne container can feed evaporated chlorine about 10 kg/hr with no additional heat input or evaporator in premises at 20 to 25^0C. Six chlorine cylinders can be stored in the chlorine cylinder room and which provides a capacity of 30 days use in Phase I. A crane is provided over the storage area to facilitate loading/unloading of the chlorine cylinder.

4-14 Sludge Treatment

Sludge from the sedimentation basins is conveyed to sludge discharge tank by gravity and pumped to sludge drying bed. The dried sludge will be disposed outside of the treatment plant, periodically, by trucks.

The design parameter for the sludge discharge tank are:

Tank Capacity	:	210 m^3
No. Of Tank	:	2 tanks (105 m^3 each)
Dimensions	:	10 m x 5.0 m x 2.1 m effective depth
Discharge Pump	:	0.828 m^3 /min x 2, 1 duty, 1 standby

Five sludge drying bed, of each 25 m x 23 m x 0.6 m effective depth, are provided at the low elevated area of the site. Each bed has a volume of 345 m^3 which allows two month’s storage of sludge. During the first two month, No. 1 bed will receive the sludge from the sludge discharge tank. The following four months will be a period for drying the sludge and extracting the dried sludge. The five drying beds will be served alternatively as receiving sludge or drying and desludging dried sludge.

The design parameters for the drying bed are:

Sludge Drying Bed	:	5- beds: 25 m x 23 m x 0.6 m effective depth
Unit volume of lagoon	:	Approx. 345 m^3 each (total of 1725 m3)

4-15 Clearwater Reservoir

The clear water reservoir, near the entrance to the Plant site, is constructed with two compartments for the Project. The capacity of 5700 m^3 accommodates more than four hours of production and fluctuation of hourly maximum water demand, plus the amount needed for in plant use for mechanical, chemical dissolving, administration, and residential. The same capacity will be constructed in the second Project. The confirmation of detention time analysis is attached in **S.R 4.10.**

A pipe gallery is attached to the clear water reservoir to accommodate installation of the inflow pipe, interconnection pipe, and isolation valves to enable each compartment operated independently. An emergency overflow pipe is provided from each compartment.

The design parameters for the clear water reservoir are:

Detention time	:	4.14 hrs.
No of reservoirs	:	2 reservoirs (2,850 m^3 each)
Dimensions	:	48 m x 12 m x 5 m effective depth x 2

4-16 Clear Water Pumping Station

Similar to the raw water intake pumps, three units will be provided, one as a standby, with a total pumping 1.6 times of 30,000 m^3/d to meet the Phase 1 hourly peak water demand.

The pumping head will consist of approximately 46 m of static head and 3 m of friction head when pumping the maximum flows through a 1000 mm pipeline. Each pump will be about 200 kW for a total connected load of 620 kW at the clear water pump station.

Pumps would discharge to a common header connecting to the clean water transmission main which discharges at the elevated water tank in the premises of the proposed WTP.

Clear water pumps should be operated to meet hourly water demands of the service areas in connection to the water level detected at the elevated water tank. Thus clear water pumps shall be operated on – off due to water level of elevated water tank.

Considering high initial cost of the speed control unit and less energy saving effect for the function of water transmission, it is recommended that pumps for the clear water pump station shall be operated without speed control economically. But flows and operation pressures shall be monitored.

Ancillary facilities such as plant water supply and chlorine booster pumps, as discussed above, are also installed in the pump room.

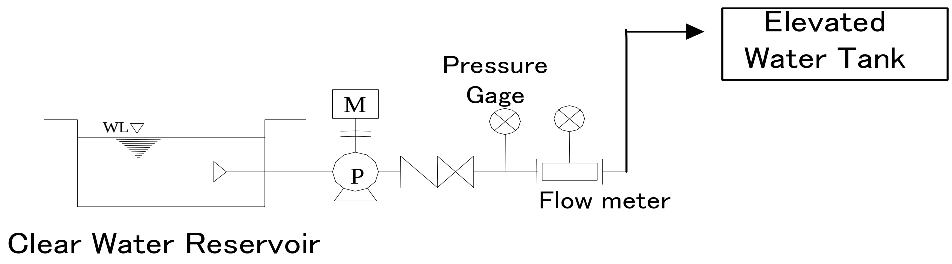


Figure 4.11 Clear Water Pump Control

Horizontal double suction volute pumps are of similar type as the proposed raw water intake pumps as well as the existing facility. The proposed pump has the same superior advantages as listed for the intake pumps. The number of pumps is determined by the availability of low voltage motors up to approx. 400 kW which has advantages that could be locally repaired. The proposed specifications for the clear water pumps areas are as follows;

Number:	:	3 sets (including 1 set for standby)
Type	:	Horizontal double suction volute pump with dry sump
Capacity:	:	283 l/s each
Head	:	48 m

The use of horizontal double suction volute pumps at this location has the advantage of:

- easy access for maintenance;
- because of the short body length the tolerances are easier to maintain (one monolithic shaft);
- more positive lubrication of the bearings;
- lower starting torque.

The main disadvantage of this type of pump is that there is a chance of flooding the motor if a pipe fractures or surface water enters the station. The proposed floor level of the pump station is set at +12.0 m amsl or 1 m above the design high water level of the Tonle Sap Lake. This can be also overcome by installing submersible drain pumps/motors in the dry well and/or fitting flood level warning alarms.

4-17 Elevated Water Tank

To fulfill the requirements proposed by the long-term water supply development plan, an elevated water tank with a fill and draw system will be constructed in the premises of the proposed WTP. The required capacity is of minimal of 1,000 m^3 in corporate with operation of the proposed clear water pump units.

Number:	:	1 tank
Type	:	Fill and draw system
Capacity:	:	1,000 m^3
HWL	:	+53.85 m

4-18 Other Facilities

4-18-1 Sampling of Process Water

Samples of raw, settled, and treated water are pumped to the laboratory in the Administration Building, to enable monitoring of the main parameters of water quality. The raw water sample is taken from the raw water transmission pipe at the raw water flow meter chamber where sufficient water pressure is available without a sampling pump. The settled water is taken from the effluent channel of the sedimentation basins by a sampling pump with a capacity of 1 l/s. The treated water is sampled from the distribution pipe line of the in plant water supply system.

4-18-2 Laboratory Equipment

A plant laboratory is provided in the Administration Building and consists of a physico-chemical area, a biological area, a chemical storage room, and a chemist's office. Sufficient equipment, glassware and chemicals will be provided to enable the determination of the main physical and chemical parameters of the water. Since this plant will be the first major surface water treatment facility using the lake water should be undertaken on optimization of chemical dose rates etc. so as to derive the best operating regime for the plant and to develop essential operating data to assist in the design of the second Project.

4-18-3 Pipework

In-plant piping consists of underground pipes between structures, or process units, carrying liquids used throughout the plant. These include:

Descriptions	Size (mm)	Materials
Raw water	800	DI
Distribution chamber to flocculation/sedimentation basins	500 x 2	DI
Settled water to filter units	700	DI
Filtered water to clear water reservoir	1400	DI
Treated water transmission	1000	DI
Sludge to lagoons	250	DI
Backwash water drainage to backwash water recovery tank	800	DI
Backwash water return to distribution chamber	250	DI
Distribution chamber overflow	800	DI
Sedimentation basin overflow	1000	DI
Clear water reservoir overflow	800 x 2	DI
In-plant water service	150	DI/PVC
Chlorine solution pipe	100	PVC/PE
Alum solution pipe	100	PVC
Lime solution pipe	100	GS/PVC

In addition, electrical distribution, grounding systems and instrumentation wiring are laid underground. They are constructed in designated reserves, generally along the plant access roads, between, and around, structures. manholes, pull boxes or connection chambers for bends, valves, meters, etc are provided.

4-18-4 Standby Power Generation

Electrical power supply to the site comprises one feed, and, therefore, standby power generators are provided for the intake pump station and the treatment plant to ensure continuity and security of water supply. A building is provided for the stand by generators. The building also houses the main power supply to the plant and step-down transformers.

4-18-5 Administration Facilities

A two storey building is located near to the entrance to the plant. The ground floor includes an entrance with receptionist alcove, stairs to the second floor, the laboratory and laboratory chemical storage room, Chemist’s office, a general office area and toilets. Upstairs includes offices for the General and Deputy Director, Department Chief, and Engineers and the plant monitoring room. A conference room, staff meeting room space, a small library for drawings, engineering manuals and archives, an exhibition/training area, toilets and stairs to the lower floor are also provided.

4-18-6 Maintenance Building

The single storey maintenance building includes a garage area, workshop, storage for pipes/fittings and mechanical lockers for operators, showers, toilets, tool storage and an office area on the grand floor. The building has roll-up doors for vehicle access to the workshop and has an adjacent covered parking area for four large vehicles.

4-18-7 Site Infrastructure

Fencing encircles the plant and intake pump station site, and consists of a 2.4 m high fence topped with barbed wire.

Access to the main site is through a new gate and guardhouse area on the new road to the north side of the site. All streets are paved with a storm water drainage system discharging runoff into the adjacent streams.

4-19 Transmission/Distribution Pipelines

The long-term water supply development plan considers zoning and monitored distribution by blocks organized around a redundancy system as the definitive strategy offering an economic and sustainable solution.

The following criteria, based on the long-term plan, have been used to guide system development:

1) Ensure that the agreed level of service be met for all consumers and increase supply security.
2) Use the existing infrastructure efficiently without change.

3) To minimize the construction cost, the system should be planned reasonably to meet the target year 2022 set for the Priority Project.

The concept-level designs were developed utilizing the WaterCad system modeling software incorporating all available, relevant, actual and forecast data. Hydraulic analyses were carried out in order to identify the required distribution connections and distribution reinforcement where water demand will increase during each Phase.

The initial network model incorporates 4 blocks representing a total length of 484 km of distribution pipelines. The analysis focused on pipes with diameters greater than 50 mm up to 800 mm, which increases to a total of 484 km pipelines by 2017, including 32 km of main pipelines from 500 mm up to 800 mm, 91 km of sub-main pipelines between 150 mm and 350 mm, and 361 km of branch pipelines from 50 mm to 100 mm. The detailed distribution networks are referred to the drawings.

Detailed calculations are referred to **SR 4.18**.

4-19-1 Zoning

Water supply to the priority service area in the Central Zone will be distributed by a proposed elevated water tank constructed in the premises of the proposed WTP.

4-19-2 Loop

The looping strategy will be applied to expansion of the existing distribution network in the Central Zone.

4-19-3 Blocks

Major distribution pipelines (500 to 800 mm) will be extended to the north and to the south, encompassing the following expansion areas: Block Q1 for Kouk Chak; Block Q2 for Svay Dangkum; and Block Q3 for Sla Kram and Nokor Thum; and Block Q4 for Sla Kamraeuk and Chreav.

4-19-4 Elevated Water Tank

An elevated water tank with fill and draw system will be constructed in the premises of the proposed WTP site with a minimum detention time of 45 min.

4-19-5 Water Demand Applied for F/S Priority Project

Table 4.8 shows the maximum daily water demand estimated in the long-term water development plan for each block in target year 2022. The details of population and water demand of each block are referred to Supporting Report **SR 4.17**.

The relative part of peripheral zones in the whole water supply coverage will grow from about current 30 percent to over 80 percent in 2022.

Figure 4.12 schematizes the proposed F/S Transmission/Distribution Schematic.

Table 4.8 Max Daily Water Demand for Each Block in 2022

Distribution Blocks	Item	Population (Nos.)	Water Demand (m^3/d)
Qfs1	Domestic	56,360	10,490
	Commercial	6,630	2,990
	Sub Total	**62,990**	**13,480**
Qfs2	Domestic	58,090	10,810
	Commercial	4,810	2,170
	Sub Total	**62,900**	**12,980**
Qfs3	Domestic	46,720	8,700
	Commercial	12,580	5,660
	Sub Total	**59,300**	**14,360**
Qfs4	Domestic	71,130	13,240
	Commercial	3,280	1,480
	Sub Total	**74,410**	**14,720**
Total (F/S Area)	Domestic	232,300	43,240
	Commercial	27,300	12,300
	Total	**259,600**	**55,540**

4-19-6 Distribution Network Analysis

Pipelines were sized to be 150 kPa of the minimum supplied pressure at the end of pipelines using the exponential formula developed by Hazen and Williams shown below in metric unit.

Table 4.9 Applied Design Conditions For F/S Distribution Network

Descriptions	Design	Remarks
Target year	2022	F/S
Design capacity	Q = 56,000 m^3/d	F/S Area daily maximum distribution capacity
Peak factor	K = 1.6	hourly
Design distribution capacity	q = 3,733 m^3/h	Hourly maximum distribution capacity
Elevated water tanks volume and hydraulic grade	Existing T1 : 500 m^3 , +48.00m KTC T2 : 500 m^3 , +53.85m Proposed T3 : 1,000 m^3 , +53.85m	
Applied formula	$H = 10.666 \cdot C^{-1.85} \cdot D^{-4.87} \cdot Q^{1.85} \cdot L$ H : friction loss (m) C : friction coefficient (= 110) D : diameter of pipe (m) Q : rate of flow (m^3/s) L : pipe length (m)	Hazen Williams formula
Minimum hydraulic pressure	＞150 kPa	At the end of distribution pope
Analysis software	WaterCAD V8i Edition	Bentley Systems, Incorporated

Peak factor is set at 1.6 in reference to a trend of PPWSA and a typical fluctuation trends analyzed as “mixed housing area and industrial or commercial area” in the design book of Japan Water Works Association (JWWA).

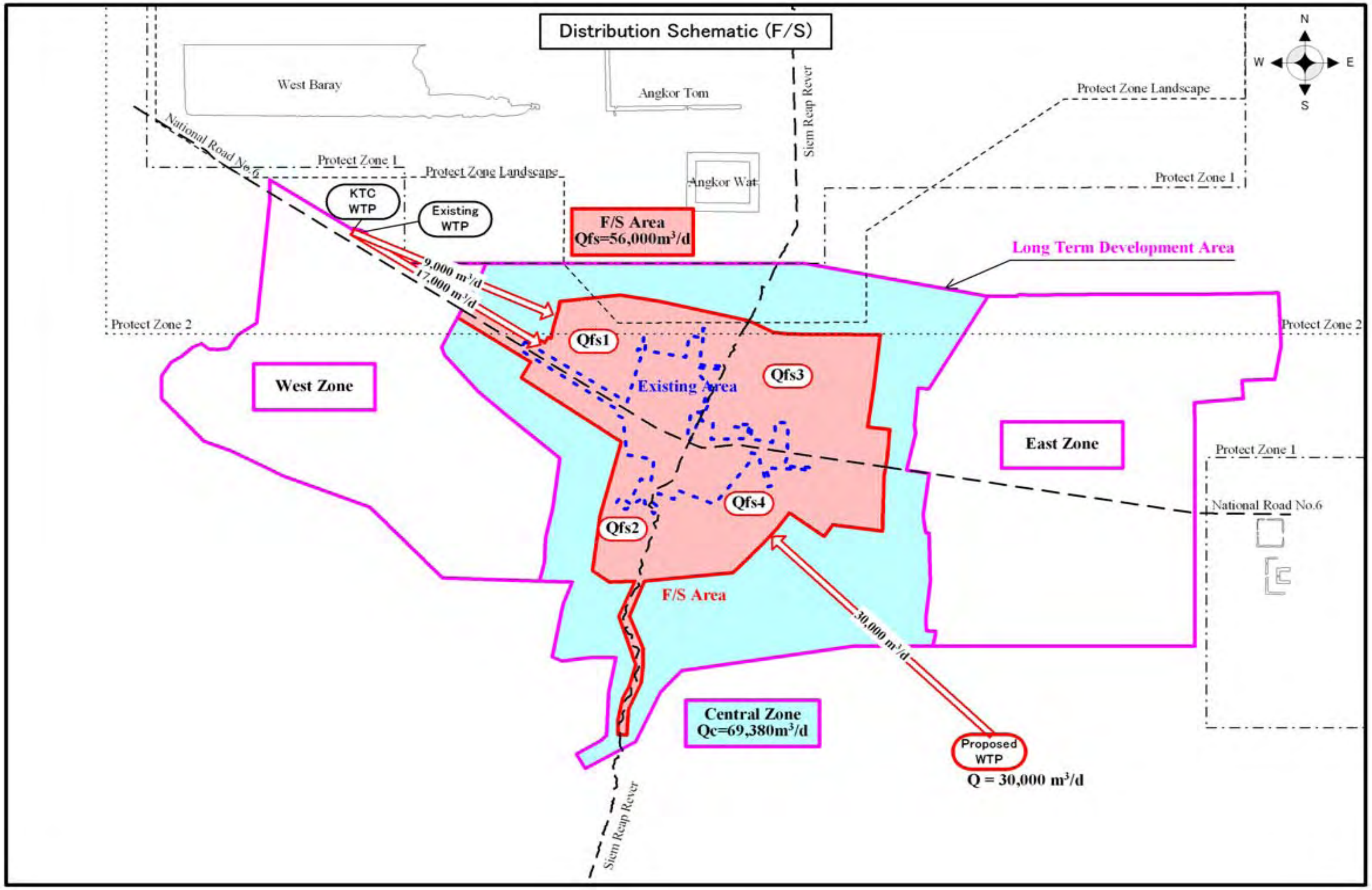


Figure 4.12 F/S Transmission/Distribution Schematic

The details of population and water demand of each village are referred to **SR 4.17**.

Main and sub-main pipe sizes for the priority project and second project are simply segregated to maintain the same hydraulic performance analyzed for the long-term water supply development plan to meet the following design capacity.

Priority Project:	56,000m^3/d	To meet F/S target year 2022
2nd project :	13,380m^3/d	To meet the long term development plan in 2030
Total :	69,380m^3/d	2030 requirements for the Central Zone

The details of pipe length in each block and supply pressures are designed as shown in the following table;

Block	Designed pipe length (m)	Designed supply pressure (kPa)	Area (ha)
Q1	83,680	Max : 380 to Min : 180 > 150	860
Q2	47,040	Max : 430 to Min : 190 > 150	620
Q3	97,700	Max : 390 to Min : 180 > 150	880
Q4	131,350	Max : 420 to Min : 170 > 150	1,000
Total	**359,770**		**3,360**

Categories and materials to be applied of pipelines for the priority project are shown below:

Priority Project	Pipe Sizes (mm)	Designed length (m)	Material
Main Pipe	800	4,450	DI
	700	16,250	DI
Sub Main Pipe	300	20	DI
	250	13,240	DI
	200	10,440	PE
	150	41,820	PE
Branch Pipe	100	1,400	PE
	80	272,150	PE
Total		**359,770 m**	

Chapter 5.
Institutional and Managerial Considerations

Chapter 5. Institutional and Managerial Considerations

This chapter provides the background of SRWSA as an institution and its future organizational growth path or institutional development. It examines SRWSA's current administrative and organizational structure, assesses its ability to fulfill its legal mandate and institutional mission, and provides recommendations on how it can develop itself in the light of processes that would support and facilitate its evolution into an efficiently and effectively run water utility in the short term (2012), medium term (2017) and long term (2022). Institutional development at SRWSA is an internal process that involves people (*human resources*) and developing their capacities to perform at optimum levels. It includes codified policies and procedures (*management systems*) in the major functional areas of water utility management to ensure high standards of efficiency. It entails the appropriate structure (*organization*) that clearly delineates unit and individual authority, responsibility, and accountability, as well as coordinative and communications flows, from the top to bottom (horizontally) and across (vertically) the entire organization spectrum. The recommendations presented cover SRWSA organization structure, human resources, and management systems, including a capacity building plan.

Detailed explanations are referred to **SR 5.1** through **5.7** as supporting report.

5-1 History and Background of SRWSA

In the early 1990s, Siem Reap Water Supply (as it was previously known) suffered from an old and broken system that resulted to poor service and inadequate water supply. Service then was only available twice a day for two hours (one hour in the morning, and another hour in the evening). At that time, Siem Reap Water Supply had seven employees and 350 connections.

By 1995-1996, the AFD (French Government) provided a grant to rehabilitate the water supply system, but this was only sufficient for the rehabilitation of pipelines and the treatment plant. In 1998, the Siem Reap Water Supply borrowed US$15,000 from the provincial department of MIME to improve its distribution / pipe network. As a consequence, Siem Reap Water Supply was able to provide full 24-hour water service to its customers together with its nine employees. However, in 1999 its unaccounted-for-water or non-revenue water (NRW) still stood at 63%.

In 10 January 2007, Siem Reap Water Supply Authority (SRWSA) was established by virtue of Sub-Decree N^{o} 04 ANKr. BK, entitled "The Creation of the Siem Reap Autonomous Water Supply Authority as an Economic Public Establishment (Enterprise)". By this sub-decree, SRWSA became a public legal entity with administrative and financial autonomy. However, SRWSA is covered by the provisions of Royal Code N^{o}. NS/RKM/0695/04 or the *Law on General Statute of Public Enterprises*, promulgated on 17 June 1996, particularly the provisions for "public institutions with economic characteristics," the type of public enterprise SRWSA belongs (the other two types are state company and the joint venture). It has, therefore, been placed under the technical supervision of MIME and under the financial supervision of MOEF, as the "responsible ministry or authority" in compliance with Article 1 of the Sub-Decree Nº 4 and Article 20 of Royal Code Nº NS/RKM/0695/04, respectively.

Today, as it embarks on its fourth year, SRWSA can now boast of having significantly reduced its non-revenue water or NRW from 63% (in 1999) to just 12%. This was largely due to the implementation of the 100% metering program, and the gradual replacement of old and leakage-prone asbestos pipes. The service connection base, on the other hand, has steadily grown to 4,525 connections in 2010. In addition, its number of employees has now reached 40.

5-1-1 The Administrative Structure of SWRSA

The administrative structure of SRWSA is governed by Chapter 2 of Sub-Decree Nº 4, which calls for the establishment of a Council of Administration and the delegation of day-to-day operational matters to a General Director.

(1) Council of Administration

At the apex of the organization structure of SRWSA is the Council of Administration, composed of the following officials/offices: (1) Representative, Ministry of Industry, Mines and Energy (MIME), chairperson; and the members are: (2) Representative, Ministry of Economy and Finance (MOEF); (3) Representative of Council of Ministers; (4) Representative, Siem Reap Provincial Hall; (5) Representative, APSARA Authority; (6) Representative, Employees of SRWSA; and (7) General Director, SWRSA.

On the 27 June 2007, the Prime Minister signed Sub-Decree No 485 ANKr. TT on the appointment of the members to the SRWSA Council of Administration. Each Council member holds office for a term of three years, with an option for renewal (Article 9, Sub-Decree Nº 4). The first members of the SRWSA Council of Administration are as follows:

Name	Office Represented	Position in Council of Administration
H.E. Meng Saktheara	MIME	Chairperson
Mr. Pen Vutha	MOEF	Member
H.E. Kem Viseth	Council of Ministers	Member
Mr. Bun Tharith	Siem Reap Provincial Hall	Member
Mr. Hang Pov	APSARA Authority	Member
Mr. Som Kunthea	General Director, SRWSA	Member
Mr. Yay Monirath	Employees of SRWSA	Member

Authority/Function and Duties of the Council

As the highest policy-making body of SRWSA, the Council is vested with *the authority to determine the objectives of SRWSA and control its management to ensure its efficiency and effectiveness as a public enterprise.*

The Council's important duties to fulfill this function, which are stated in Article 11, Sub-Decree Nº 4, are the following:

- To approve the annual projects (business plan) of the SRWSA, which shall specify the following: (i) Investment program / financing required; (ii) Budget to realize the investment program; (iii) Tariff required to ensure financial viability of SRWSA; (iv) Criteria to measure the economic and financial outcomes of SRWSA; and (v) Capital contributions and/or subsidies from the State, if any:
- In accordance with and as defined by existing and relevant laws and statutes, the Council of Administration can:
    - Decide on SRWSA's management structure, including internal regulations, compensation and other benefits;
    - Enter into contracts, approve contracts and agreements, as well as all conditions and procedures in contracts and agreements;
    - Approve medium and long term loans; and
    - Decide on acquisitions.
- To periodically evaluate the financial and technical operations of SRWSA and make necessary revisions, if needed;
- To approve the balance sheet and annual financial statements of SRWSA, as well as report on its activities to appropriate government Ministries; and
- To approve the sale, purchase of rental of fixed assets.

Reporting

Since SRWSA remains under the technical and financial supervision of MIME and MOEF respectively, the Council is required by law to submit the following reports: (i) All decisions of the Council of Administration, as recorded in the Minutes; (ii) The annual business plan (technical and financial (budgets); (iii) Reports of activities, including the balance and managerial accounts reports; and (iv) Reports of the state controllers.

Meetings

The regular meetings of the Council are held at least once every quarter. However, the Council can meet in special meetings as often as there are urgent matters to discuss. All decisions of the Council of Administration are officially validated only if approved by a simple majority of the Council members present. In case of a tie, the vote of the chairperson, or the meeting chair shall prevail.

(2) The General Director (GD)

The policies enacted by the Council are implemented on a day-to-day basis through the General Director. This delegation of power from the Council is to enable the GD to have sufficient authority to manage SRWSA in accordance with the law and under the supervision of the Council (Article 15, Sub-Decree Nº 4).

The duties of the General Director are the following:

- To prepare and submit documents and regularly report to the Council and implement all its decisions;
- In charge of managing and leading in all technical, financial and administrative tasks of SRWSA;
- To represent SRWSA before all state and private institutions, in all legal cases, and other concerned authorities;
- To hire and dismiss SRWSA employees as well as to manage and control employees in compliance with the decisions of the Council, the personnel rules and regulations, statutes and all relevant laws;
- To delegate fully or partially its authority, including signing authority to an subordinate official in accordance with the terms defined by the Council; and
- To implement all other duties delegated by the Council.

The General Director has a term of three years (Article 14), and the appointment is issued through a Sub-Decree, based on the recommendation of MIME. Mr. Sum Kunthea, formerly the head of administration of the Department of Clean Water (MIME), was appointed as the GD of SRWSA on 27 June 2007 (Sub-Decree Nº 484 ANKr. TT).

(3) The State Controller

One state controller, appointed (and removed) by Sub-Decree through the recommendation by MOEF, is assigned to SRWSA (Article 27, Sub Decree Nº 4). The state controller has the right to participate in all meetings of the Council, but does not have any voting power. He can give comments on the Agenda items, and relative thereto, can request information from, or get access to SRWSA documents or reports.

The state controller assigned to SRWSA exercises economic control by monitoring the following: (i) The fulfillment of SRWSA of its obligations as stipulated in existing laws and regulations; (ii) Implementation of the decisions of the Council of Administration; and (iii) Monitoring the development of SRWSA, as well as its regular activities that may affect the financial condition of SRWSA.

(4) The Deputy General Directors (DGD)

There are two Deputy General Directors who are appointed on a permanent status to SRWSA. The DGDs provide policy, management and supervisory assistance to the General Director in running the day-to-day business operations of SRWSA. One of the DGDs manages the administrative and financial affairs of the institution, while the other DGD is in charge of the technical and engineering side of the water supply authority.

5-1-2 The Organization Structure of SRWSA

The mission of SRWSA is "to produce, supply and distribute safe and potable water supply and reliable water service to the population of Siem Reap town, and other areas within the political jurisdiction of Siem Reap province". To realize this mission, it must improve its production capacity as well as rehabilitate, expand the existing, and/or construct new facilities and distribution networks. It must also manage the system in accordance with universally accepted principles of water supply management and operation.

Having the autonomy to organize its activities to effectively fulfill its mission, SRWSA has divided its functions to three departments, headed by department directors. The department of production and water supply and the department of planning and technical are under the management and supervision of one DGD; while the department of administration and financial, is under the other DGD.

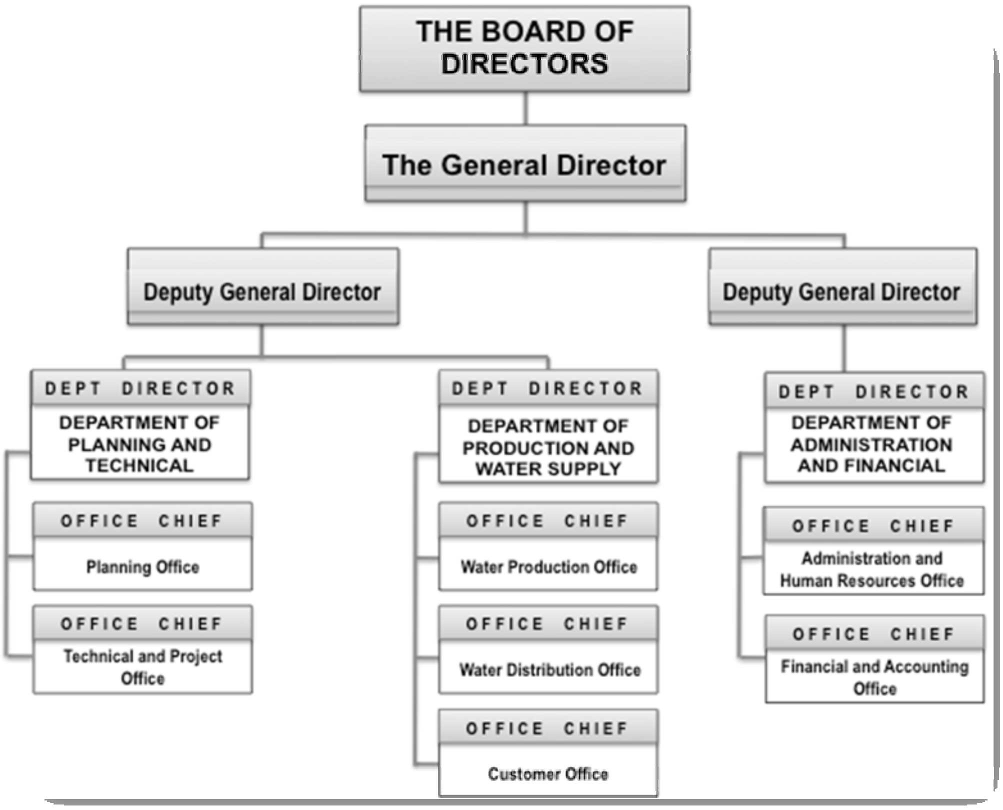


Figure 5.1 Approved Organization Chart of SRWSA, 2008

Under the departments are offices that are managed by office chiefs. There are three offices under the department of production and water supply – the water production office, the water distribution office, and the customer service office; and two offices under the department of planning and technical – the planning office and the technical and project office. Under the department of administration and financial are two offices, namely, the administration and human resources office, and the financial and accounting office. The organization structure of SRWSA, which was approved in 2008 is shown in Figure 5.1.

(1) The Department of Administration and Financial

The Department of Administration and Financial *assists the General Director on the areas of human resource management and development, general administration, security and labor safety, property and inventory management, accounting, and finance*. The following is the specific functions of this Department:

- Manages and develops human resources to match and responds to the current and future needs of SRWSA.
- Performs general administration works.
- Institutes protection measures as well as manages security and safety of SRWSA.
- Regularly maintains a clean and hygienic environment in SRWSA's premises.
- Attends to reception and other ceremonial activities.
- Adheres to Cambodia's accounting standards.
- Provides the general director with monthly financial statements and reports.
- Carries out the process of financial management.
- Proposes the yearly procurement plan for supplies and equipment, furniture and fixtures, and other consumables.
- Performs inventory and asset management / control of SRWSA property and other assets.

There are two offices under this Department – the Office of Administration and Human Resources, whose main function is *to assist in general management, human resource management, general administration, security, and labor safety*; and the Office of Financial and Accounting, whose main function is *to assist on financial and accounting affairs, procurement of supplies and equipment, inventory management, asset management and cashiering*. The specific duties of these offices are as shown in the Table below:

Accounting and Financial Office SPECIFIC DUTIES	Administration and Human Resources Office SPECIFIC DUTIES
1. Adheres to the Cambodian accounting standards.	1. Manages and develops human resources to match and respond to the needs of SRWSA.
2. Safeguards cash collected from customer until this is deposited.	2. Maintains, updates and secures the personnel data sheets (database) of all SRWSA officers and employees.
3. Monitors and controls daily the income and expenditure of SRWSA and compares this with the monthly budget plan. Provides report to the General Director for information and decision-making purposes.	3. Researches on and prepares documents related to infractions of officers, employees, and proposes the penalty to the discipline council.
4. Manages property and other assets of SRWSA and ensures property accountability in terms of changes in location and condition. Reports semi-annually to the General Director on status of materials that kept in storage.	4. Collaborates with all department and office heads on personnel evaluation (based personal and work-related traits, staff rules and regulation, discipline, and existing policies) to support any increase in grade, rank, salary and bonus.
5. Assists the Planning and Technical Department on investments / assets of SRWSA, and on the recording of all project expenses.	5. Prepares HR plan based on position, quantity and qualifications required together with the concurrence of department/office heads due to current and future demand.
6. Disburses salaries to officials and employees, including bonuses and other cash awards based on SRWSA policy, rules and regulations.	6. Improves the competence and capacity of SRWSA human resources by proposing a short term, medium term and long term training and development plan
7. Carries out the process of financial management.	7. Monitors the attendance of all officers and employees based on staff rules and regulations as to overtime and public holidays.
8. Accounts for the timely recording of all SRWSA expenses.	8. Takes action on all work related to the Council of Administration.
9. Checks all supporting documents prior to preparation and release of payments.	9. Follows up the executive’s action that advisory council and general director assigned for department s and practical office and total report to leader.
10. Lists all expenses in the chart of accounts.	10. Performs general administration works.
11. Pays and clears all taxes and duties of SRWSA without delay.	11. Prepares the reports needed to support the officers and employees’ salary based on relevant policies.
12. Analyzes financial statements and balance sheet, and reports to the General Director any changes in financial outlook.	12. Prepares documents and evidences for legal and mediation purposes should conflict arise between SRWSA and any customer.
13. Proposes the business plan and budgets for every year and monitors its financial, technical realization.	13. Prepares the next week’s work schedule of the GD every Friday.
14. Is responsible for preparing contracts and monitoring work attainment until completion.	14. Submits all communications and documents to the GD office.
15. Ensures that stored supplies and materials are secure and in good condition.	15. Is the document file manager of SRWSA and maintains the recording of incoming and outgoing communications with other organizations.
16. Gets new customer account data from Customer Service Office for preparation of customer bill.	16. Controls the use of SRWSA’s seal, stamps and electronic signatures
17. Manages and protects all customer’s account data from attack of virus.	17. Provides important information and communication to internal and external public.
18. Reads the water meters and computes water consumption for bill preparation and delivery.	18. Submits on due date all regular reports to related organizations.
19. Makes reports on non-functioning water meters for replacement or repair.	19. Institutes protection measures as well as manages security and safety of SRWSA.
20. Prepares report on delinquent customers for appropriate action.	20. Regularly maintains a clean and hygienic environment in SRWSA premises.
21. Accepts payment from the customer and prepares regular collection report for submission to the Department Deputy.	21. Attends to reception and other ceremonial activities.

(2) The Department of Planning and Technical Department

The main function of the Department of Planning and Technical is to *assist the general director in setting the short, medium and long term priority water supply development strategies, policies,* *plans and programs of SRWSA*. Just as important are the functions of designing projects for implementation based on approved plans and strategies; evaluating and recommending the implementation of appropriate water supply projects. It is also the over-all in charge of managing and executing SRWSA water supply projects.

The specific duties of the Department are:

- Sets the vision – strategies, policies, plans and programs – for SRWSA's priority water supply development through an analysis of the internal and external environment for the approval of the general director.
- In consultation with the other departments, develops the short, medium and long term water supply investment plan for submission to the general director.
- Disseminates the strategic plans and development programs, as well as involve and coordinate with international development partners to efficiently realize the SRWSA's vision.
- Checks on the accomplishments of its units, and assesses their strengths and weaknesses and recommend countermeasures to the general director. Submits regular evaluation reports developed with the collaboration with other departments and offices.

Planning and Statistics Office **SPECIFIC DUTIES**	**Technical and Project Office** **SPECIFIC DUTIES**
1. Conducts research, collects data and organizes these into useful information to enable forecasting the development of SRWSA's business.	1. Establishes, monitors and checks, on a regular basis, compliance to the technical standards for transmission and distribution pipelines and other water facilities from the planning, design and construction stages of a project.
2. Aligned with the SRWSA's vision, formulates long term priority water supply development strategies taking into account the analysis of SRWSA's micro and macro environment, and submits this to the General Director.	2. Reviews and/or develops the annual investment project for distribution pipes as well as other water supply construction projects.
3. In consultation with other units and in cooperation with national and international institutions, prepares the short, medium and long term water supply development plan for approval of the General Director.	3. Coordinates and manages all construction projects implemented by SRWSA.
4. Disseminates and communicates the vision, strategies, water supply development plans and programs to the entire organization for action/implementation. Also, consults and/or negotiates with international financing institutions and grant aid agencies for plan realization.	4. Verifies, compares and evaluates that the technical standards used in the pipeline service system and other construction projects allow for accountability in project implementation.
5. Checks and evaluates the accomplishments of those involved project execution, based on strengths and weaknesses, and recommends countermeasures for submission to the General Director on a regular (monthly, quarterly, semestral and annual) basis.	5. Keeps and secures both the original detailed plans as well as the as-built (completed) plans of the household distribution pipelines and other water facilities' construction.

There are two offices under the Department – the Planning and Statistics Office, whose main function is to *assist the department deputy in developing the vision, strategies, policies, plans and programs for implementation in the short, medium and long term;* and the Technical and Project Office, whose main function is to *assist the department deputy in developing and adopting technical standards for water supply plans, designs and construction; formulating the water* *supply investment plan; managing the implementation of water supply projects, and ensuring that these comply with the set technical standards*. The specific duties of these offices are as shown in the Table above.

(3) The Department of Production and Water Supply

The main function of the Department of Production and Water Supply is to *assist the General Director in water production and water supply management, and in supplying safe and potable water and reliable water service to SRWSA's service area*. Its specific duties are:

- Establishes the yearly water production plan based on the business objectives of SRWSA;
- Operates and manages the water treatment facilities in order to produce sufficient water to meet current demand, and ensure that water quality complies with the national standard for drinking water;
- Manages water supply production, and ensures water quality and water service;
- Implements the expansion of the water supply system and household distribution pipelines based on the technical plans and standards;
- Oversees the entire water supply system, particularly household distribution pipelines in order to reduce water leakages to a minimum;
- Reads the customer's water meter and compares with average monthly consumption to ascertain if there is any leakage;
- Delivers the monthly water bill to all customers upon receipt of invoice from the Department of Administration and Financial;
- Provides solutions to customer complaints.

The Production Office is in charge of *assisting the Department Deputy in ensuring the proper operation and maintenance of the entire water production system and its facilities – from water source to water treatment – and that water quality conforms to the national drinking standards for water quality*. Its specific duties are as follows:

- Takes care of, protects and secures all water supply sources.
- Takes care of, protects and secures all pumping stations and the production systems / facilities.
- Responsible for the entire water production process and water production facilities before this is distributed to the customers.
- Regularly records production data; checks and examines for, and anticipates problems; reports to the department deputy for solution.
- Repairs and maintains all water production / water treatment facility property, such as machinery and equipment, on a regular basis.
- Monitors the raw materials and other supplies used in the production process, as well as the spares for machineries and equipment.
- Analyzes the water quality in the production process, as well as in the water supply system on a regular basis.

- Observes and monitors the water production systems and processes, and submit conclusions and recommendations to department deputy for solutions and adjustments.
- Performs water quality analysis requested by other institutions with proper charges/costs.
- Repairs and maintains the machineries, equipment, materials and supplies of the water production facilities, water (well) sources, and the laboratory.
- Conserves and sustains water resources in the water production process.
- Prepares weekly, monthly, quarterly, semestral and annual reports to departments and offices.
- Maintains the water sources' surrounding areas and the production facilities' premises.

The function of the Distribution Office is to *assist the Department Deputy in expanding the distribution pipe system in accordance with approved plans and programs; repairs pipe leaks; and studies how to reduce water leakages in the water supply system*. The specific duties of this office are as follows:

- Installs distribution pipelines efficiently, including all other equipment and appurtenances, in accordance with the SRWSA development plans and programs.
- Forms work teams and equip them with necessary tools and materials; develops, sets and follows policies on standard methods of work and abides by safe work practices.
- Completes all documents for the Department of Administration and Financial; provides the as-built construction plan to the Department of Planning and Technical after completion of construction work.
- Checks the water distribution system regularly and works together with other related organizations in preventing and/or solving problems on the water supply service.
- Monitors the entire distribution pipeline, and ensures that all technical standards and policies for pipe pressure, work safety and security have been met, including that for pipe maintenance.
- Repairs water leaks using technical standards and policies for safety and security; studies how to reduce water system losses in the pipeline, and implements such a program based on approved standards and principles.
- Follows a maintenance schedule for all equipment and assets in accordance with technical plans and standards; monitors and manages inventory stocks / supplies.

The Customer Service Office *assists the Department Deputy in getting more customers to be connected to the system; in reading the water meter each customer to ascertain water consumption for bill preparation; and delivering the water bill to the customer*. The specific duties of this Office are:

- Advertises / Promotes the water service being provided by SRWSA and connects the new customer to the water supply system.
- Receives customer requests for new expansion of the pipeline; checks and measures the location; and submits for action to the Department.
- After receiving the approval of the Department, prepares the customer account documents, and connects the water meter of the customer.

- Informs the Department of Administration and Financial, through the Department of Production and Water Supply, of the new customer account at least five days (after connecting the customer to the system) for the preparation of water consumption bill.
- Controls all the documents on customer service connections.
- Manages, monitors, replaces and/or repairs household pipe system according to customer service agreements.
- Disconnects water service of a customer due to non-compliance with SRWSA rules and regulations.
- Reads the water meter of every customer and sends data to the Department of Administration and Financial for official billing; then delivers water bill to the customer.
- Investigates and gives solutions to the complaints of the customers with regard to quality of service, leaks, and quality and quantity of water.

5-2 Assessment of the Present Organization

While SRWSA's predecessor-organization has been providing water to Siem Reap City for many decades now, its "rebirth" as an autonomous economic institution is fairly recent – almost five years to be exact. SRWSA has a new legal personality and administrative structure, and for all intents and purposes, it is, once again, going through the developmental stages of organizational maturity. The institutional development of SRWSA, therefore, should be viewed in the light of processes that would support and facilitate its evolution into an efficiently run water utility. These processes are directed toward strengthening SRWSA's indigenous capacity to perform its mandated functions on a sustainable basis without undermining its responsibilities to its various stakeholders. Since the tangible results of institutional development emerge over time, the approach calls for a long-term perspective; one that is participatory, open and transparent, and one that pays full attention to SRWSA's local cultural context.

Institutional development at SRWSA is not a separate activity, but is an internal process involving each one (at every level of the organization) in the improvement processes. Because institutional processes are cyclical, dynamic and constantly changing, analysis should be on going, recognizing that *how* activities are performed is just as important as *what* they are meant to achieve.

Commitment to a chosen solution is a key ingredient SRWSA's institutional development. Thus, it is important for all relevant stakeholders to be consulted and involved in the process of defining and solving a problem, or clarifying an issue, or answering a question. Decision-making in institutional development must also be clear as to what the rules and procedures are, and how and by whom decisions will be taken.

The institutional development process for SRWSA requires an analysis of its internal organization, synthesized into a plan to enhance the organization's ability to carry out its activities in the best manner possible. This means putting the entire organization in order as a water utility, thereby enabling it to fulfill its mission – that is, to provide safe and adequate water supply and reliable water service to its customers. This shall take into consideration four vital factors: (i) That SRWSA is equipped with the required physical facilities and resultant financial resources to operate the water system; (ii) That SRWSA's organization structure is not only appropriate for each growth phase, but is also functioning properly; (iii) That each one in the organization not only knows his / her place and functions, but also performs based on the standards for the job and aligned with corporate objectives; and (iv) That the laws/sub-decrees, together with the SRWSA's customers, shall define the Authority's product and service quality. It is in these contexts that this section presents the current institutional assessment and recommendations of SRWSA on three main areas – organization structure, human resources, and systems.

5-2-1 Organizational Structure

While the approved organization structure of SRWSA is suitable for its current operations, there would be a need to rationalize the organization structure to cope with the impacts brought about by the imminent increase in SRWSA's customer base as a result of three events: (i) Additional bulk water supply volume of 17,000 cum^3 per day coming from KTC by 2012; (ii) The implementation of Priority Project of Siem Reap Water Supply Expansion Project from 2013-2017; and (iii) The implementation of 2nd Project of Siem Reap Water Supply Expansion Project from 2018-2021. Table 5.1 shows the increasing number of customers based on the three expansion works:

Table 5.1 Projected Number of Connections Based on Three Expansion Works

YEAR	WATER SUPPLY FACILITY	PRODUCTION VOLUME (m^3/day)	PROJECTED NUMBER OF CONNECTIONS
2010	**Current Facilities**	**8,000**	**4,525**
2011-2012	**Increase in number of wells**	1,000	
2013	**Bulk Water from KTC**	**17,000**	**16,186**
2012-2013	**Pre Construction Priority Project**		
2013-2016	**Priority Project Construction**		
	Intake Chamber		
	Water Conveyance Pipeline		
	Intake Pumping Station		
	WTP (1)		
	Water Transmission Pipeline		
	Water Distribution Pipeline		
	Other Facilities		
2017-18	**Start Priority Project Operations**	**30,000**	**27,392**
2017-2019	**Pre-Construction 2nd Project**		
2019-2022	**2nd Project Construction**		
	WTP (2)		
	Water Distribution Complex		
	Water Transmission Pipeline		
	Water Distribution Pipeline		
	Other Facilities		
2022-23	**Start 2nd Project Operations**	**30,000**	**41,159**

Notes: Connections are calculated as d/5.7, based on the water demand projection (d) and 5.7 of average numbers of household.

As shown in the above table, with the increased water supply volume from KTC, around 11.6 thousand new customers can be served by SRWSA from 2012-2013, or a jump of more than 350 per cent. By around the 2013 to 2014, the implementation of Priority Project will start and by its completion in 2017, an additional volume of 30,000 m^3 per day will become available, enabling SRWSA to accommodate around 11.2 thousand more new customers. Then, with the completion of 2nd Project by 2022-23, SRWSA will have additional the water supply capacity to serve around 13.8 thousand more new customers, up to maximum growth potential of over 30 thousand new customers by 2030.

(1) Organization Structure with KTC Bulk Water

Therefore, SRWSA should be prepared to operate the expanded system and serve its growing customers with the appropriate organization structure, and with right number and quality of human resources, and with systems and processes suitable to its size, goals and objectives. This will necessitate changes in SRWSA's current organization structure to meet future needs. Table 5.2 below shows the organizational changes that would take place with KTC bulk water supply, compared to the current structure.

Table 5.2 Comparison of Current Organization Structure with Proposed Structure with Availability of KTC Bulk Water by 2012/13

TIME-FRAME	# DGD	DEPARTMENT	OFFICE	SECTION
Current 2010	1	1 – Administration and Financial	Administration and Human Resources	None
			Financial and Accounting	None
	1	2 – Production and Distribution	Water Production	None
			Water Distribution	None
			Customer Service	None
		3 – Planning and Technical	Planning	None
			Technical and Project	None
KTC Bulk 2012-2013	1	1 – Administration and Finance	Administration and Human Resources	None
			Accounting and Finance	None
	1	2 – Production and Distribution	Water Production	None
			Water Distribution	None
			Service Connection	None
		3 – Planning and Technical	Planning and Design	None
			Technical and Project	None
	Under the General Director		Commercial Operations	None

As shown in the Table above, the key features of the organization structure in 2012-13 with the availability of bulk water from KTC as compared to the current structure are:

(a) Creation of the *Commercial Operations Office* – Commercial operations is a vital water utility function because this is where the revenues are raised. This should be separated from other utility functions so that proper focus can be given to its important functions, especially that the growth in customers for SRWSA during this time will be very rapid. This office shall be directly placed under the Office of the General Director, and will take care of (i) *customer accounts*, particularly meter reading, billing and collection; (ii) the *processing of customer service applications* for new connections and reconnections, and sending of service disconnection notices; (iii) *customer relations*, such as public information and education, and marketing for new connections.

(b) This would mean that the Customer Service Office, under the Production and Distribution

Department, will be renamed *Service Connection Office* and its functions would concentrate on (i) *physically linking or connecting new customers to the water supply distribution system*, including installation of water meters, and disconnecting delinquent customers from the system. This office will also be responsible for (ii) *water meter repair and maintenance work*. All other customer account and customer service functions under the Customer Service Office shall be transferred to the new Commercial Operations Office.

(c) Renaming the Administration and Financial Department to *Administration and Finance Department* without prejudice to its existing functions and duties.

(d) Renaming the Financial and Accounting Office to *Accounting and Finance Office* without prejudice to its existing functions and duties.

(e) Renaming the Planning Office to *Planning and Design Office* without prejudice to its existing functions and duties. This will also be timely as the detailed design and tender phase of the expansion project will be on-going.

The proposed organization structure with the KTC bulk water supply is shown in Figure 5.2.

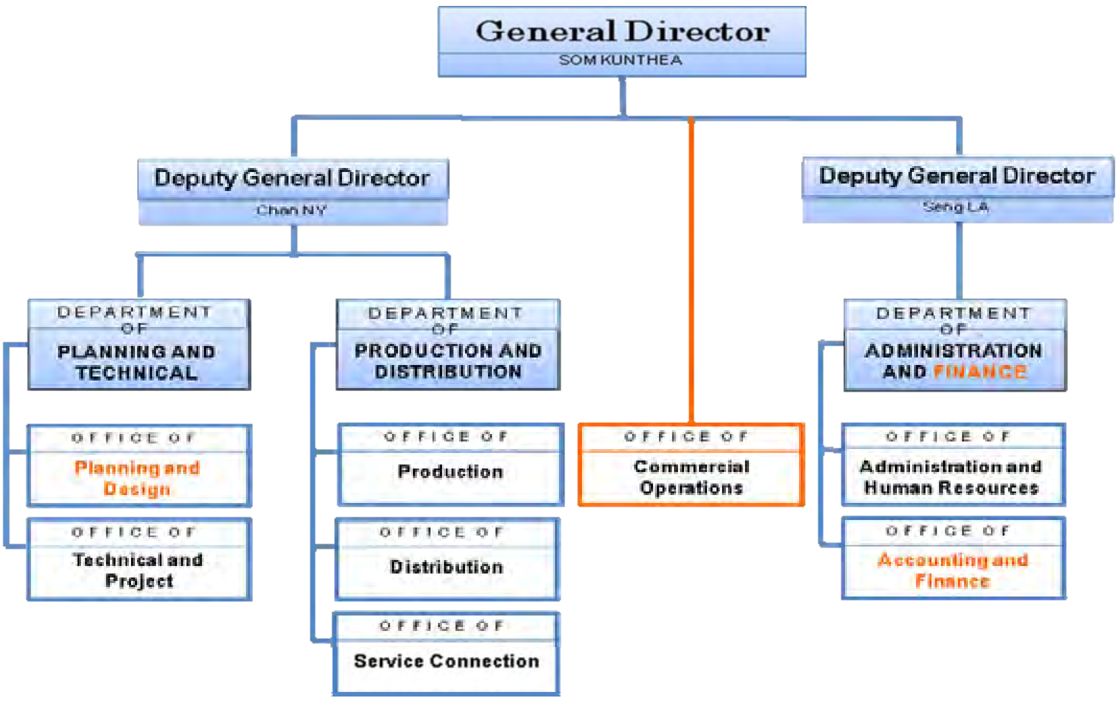


Figure 5.2 Proposed Organogram with KTC Bulk Water (2012/13)

(2) Organization Structure for Priority Project

By the completion of Priority Project, or five years thereafter, SRWSA will be ready to implement a round of other changes in its organization structure, given its capacity to absorb more than 14,000 new customers (or total of over 27,000). Table 5.3 shows the proposed changes in the organogram by 2017.

As shown in the Table, the organization structure, after the completion of Priority Project in 2017, is taking the shape of a mid-sized water utility. At this stage, it is imperative to structure the organization by grouping a “family” of functions to provide for effective communications flow that would support management information and reporting systems. There is a need to establish appropriate checks and balances to ensure sufficient internal control as the organization grows bigger, both in size of the facilities, and in number of personnel. Consequently, there is a need to create smaller organizational units or *sections* to adhere to the management principles of span of control and job specialization, while strengthening unit and individual responsibility and accountability given the growth in the number of employees. Having sections will mean a clearer delineation of unit and individual duties and functions resulting in greater management efficiency and effectiveness. Having sections will also open career paths for deserving employees to go up middle management, while providing the organization with operational stability as SRWSA faces a period of continued growth. The other salient features are:

Table 5.3 Organization Structure after Priority Project (2017)

TIME-FRAME	DGD	DEPARTMENT	OFFICE	SECTION
Priority Project 2016-2017	1	1 – Administration	Administrative Services	Procurement and Property Management
				General Services
			Human Resources	Compensation, Benefits and Performance Appraisal
		2 – Finance	General Accounting	None
			Finance and Budget	None
	1	3 – Water Supply Operations	Production	Operation and Maintenance
				Water Quality
			Distribution	Network Installation and Maintenance
				Leakage Reduction
			Service Connection	Water Meter Repair and Maintenance
		4 – Planning and Development	Planning and Design	None
			Project Management	None
	GD	5 – Commercial Operations	Customer Accounts	None
			Customer Service	None
	GD			Management Services

(a) The *separation of the Administrative and Finance Departments* into the *Finance Department* and the *Administrative Department* to allow for a re-focusing of duties and responsibilities in financial management, budget and treasury, cash management and general accounting. This will enable SRWSA to manage its business operations and work towards sustained financial viability and build up its financial resources to be utilized for future expansion works.

(b) The *upgrading of the Commercial Operations Office* into the *Commercial Operations Department.* The upgrade of Commercial Operations is in keeping with the expanded operations of the department – meter reading, billing and collection, water services processing, customer relations, marketing and public information.

(c) The creation of the *Management Services Office* under the Office of the General Director, bringing to 11 the total number of Offices. The new Management Services Office shall take charge of (i) management information systems, the backbone of technology utilization in water utility operations; and (ii) corporate planning.

(d) The proposed 2017 organization calls for the establishment of total of nine new sections. However, Management will reserve the right and final prerogative whether or not to create these sections, and/or fill in the position of Section Head, depending on actual conditions.

(e) Renaming the Production and Water Supply Department into *Water Supply Operations Department* without prejudice to its current and expanded functions. Also, the Technical and Project Office will be renamed into the *Project Management Office*.

(f) Renaming the Planning and Technical Department into the *Planning and Development Department* without prejudice to its current and expanded functions.

The proposed organization structure upon the completion/implementation of Priority Project is as shown in Figure 5.3.

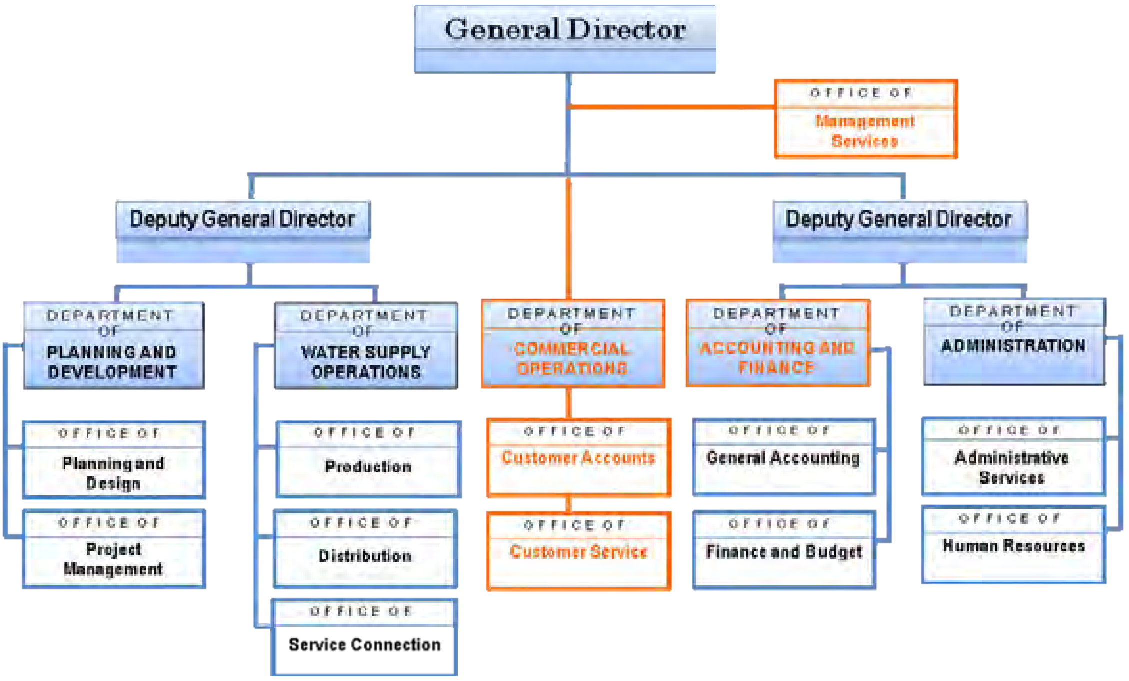


Figure 5.3 Proposed Organogram after Priority Project (2017)

(3) Organization Structure for 2nd Project

By around 2022, 2nd Project implementation will be completed providing an additional water supply capacity of 30,000m^3/d. This would necessitate a few changes in the organization structure to cope with operating and maintaining new facilities, and the increasing number of customers. Table 5.4 shows the proposed organization changes.

As shown in the following Table, the organization structure in 2022 is taking the shape of a larger-sized water utility after the completion of Priority Project. However, the organization structure has already stabilized, in the sense that all the vital functions have been clearly delineated and defined, and have been grouped appropriately. During this time, only fine-tuning will be done as more sections will be established to provide full support to service quality while ensuring SRWSA's sustained technical and financial success. The key features of the organization are:

(a) By this time, the number of employees would have increased and the number customers over would reach around 41,000. The organization will see increasing need to further delineate and specialize work functions. Therefore, it is proposed a third Deputy General Director's position be created, and would lead the Commercial Operations Department. The General Director will focus on setting and implementing SRWSA's strategic objectives with its Management Services Section (to be upgraded to an Office) supporting such efforts.

(b) The creation of nine more sections, bringing to 19 the total number of Sections. Just like in Priority Project, Management will reserve the right and final prerogative whether or not to create these sections, and/or fill in the position of Section Head, or to collapse / join sections depending on actual operating conditions during that time.

Table 5.4 Organization Structure after 2nd Project (2022)

TIME-FRAME	DGD	DEPARTMENT	OFFICE	SECTION
2nd Project 2022-2023	1	1 – Administration	Administrative Services	Procurement and Property Management
				General Services
			Human Resources	Recruitment, Selection and Placement
				Compensation, Benefits and Performance Appraisal
		2 –Finance	Accounting	General Accounting
				Bookkeeping and Cashiering
			Budget and Treasury	Cash Management
	1	3 – Commercial Operations	Customer Accounts	Meter Reading
				Billing and Collection
			Customer Service	Water Services Processing
				Customer Relations and Marketing
	1	4 – Water Supply Operations	Water Production	Operation and Maintenance
				Water Quality
				Stores Management
			Water Distribution	Network Installation and Maintenance
				Leakage Reduction
			Service Connection	Connections and Disconnections
				Water Meter Repair and Maintenance
		5 – Planning and Development	Planning and Design	None
			Project Management	None
	Under the General Director		Management Services	None

The proposed organogram after 2nd Project is shown in the following figure:

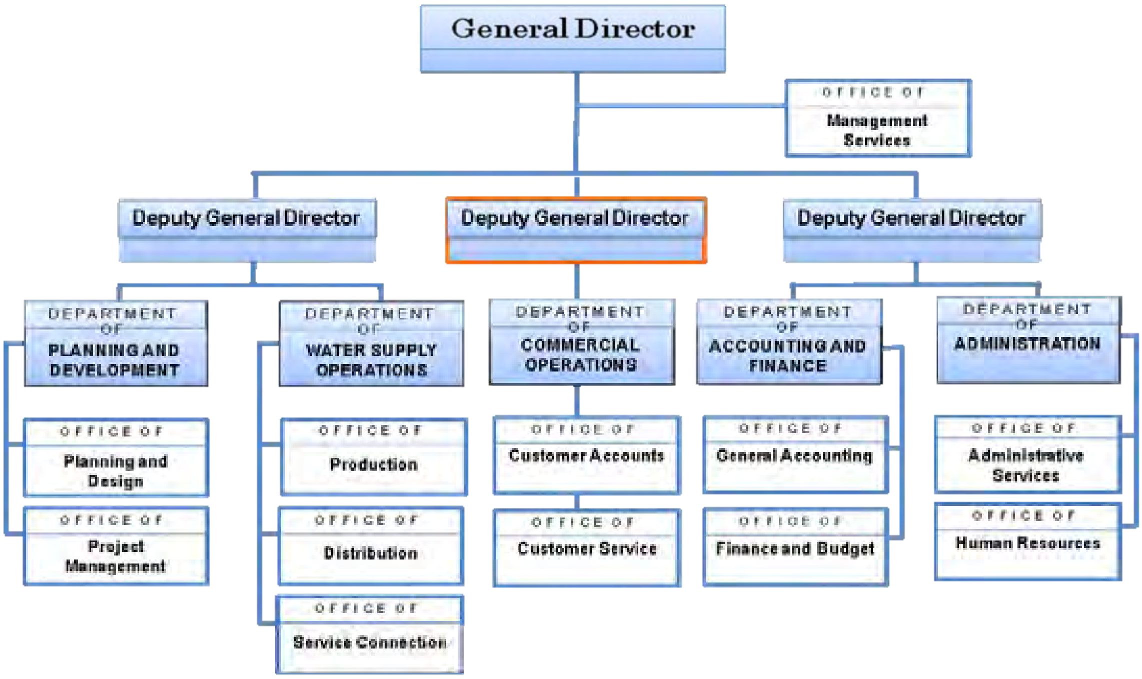


Figure 5.4 Proposed Organogram after 2nd Project (2022)

5-2-2 Human Resources

Much of the success of any water utility, SRWSA included, depends on the quality of its human resources – their knowledge (from education and experience), skills (from training and development), and abilities (character, work ethic and competencies). Equally important, is how human resource potential can be further developed and enhanced to support the growing needs of the organization. To obtain the actual data on SRWSA human resources, a survey was conducted for all personnel. The survey results are shown in **SR 5.6 -** *SRWSA Human Resources Inventory*.

At present, the human resource complement of SRWSA totals 40 personnel. Of this number, 34 are regular employees. The remaining six are contractual employees under the Production and Distribution Department, assisting in leakage reduction and service connection works. The distribution of the personnel based on their employment status per department is shown in Table 5.5

As to the profile of the SRWSA personnel according to age, Table 5.6 shows that the majority of the SRWSA staff, or 17 personnel, belong to the 20-27 at 42.5 percent. This reveals that SRWSA is a relatively "young" organization, and implies that its personnel are just starting to gain work experience. By itself, having young people, or inexperienced personnel in an organization is not a major cause of concern. However, for SRWSA, this situation is compounded with the low educational qualifications of most of its staff. The staff in the 28-35 age bracket, still considered relatively young, totals 10 personnel, or 25.0 percent. This theoretically leaves only one-fourth of the entire personnel staff to be at the "experienced" level, who can be called upon to train its less experienced staff.

Table 5.5 Distribution of SRWSA Personnel according to Status of Employment

U N I T	STATUS OF EMPLOYMENT		TOTAL
	Permanent	Contractual	
Top Management			**3**
General Director	1	0	
Deputy General Director	2	0	
Department of Production and Water Supply			**26**
Department Deputy	1	0	
Office Chief	3	0	
Personnel	16	6	
Department of Planning and Technical			**2**
Department Deputy*	(1)	0	
Office Chief	2	0	
Personnel	0	0	
Department of Administration and Financial			**9**
Department Deputy	1	0	
Office Chief	2	0	
Personnel	6	0	
TOTAL	**34**	**6**	**40**

** Concurrently also the Chief of the Financial Office.*

Table 5.6 Distribution of SRWSA Personnel according to Age

DEPARTMENT	A G E B R A C K E T						NO ANSWER	TOTAL
	20-27	28-35	36-43	44-51	52-59	60+		
Top Management	-	-	-	3	-	-	-	**3**
Production and Distribution	14	6	1	1	1	1	2	**26**
Planning and Technical	-	1	1	-	-	-	-	**2**
Administrative and Financial	3	3	1	2	-	-	-	**9**
%	**42.5**	**25.0**	**7.5**	**15.0**	**2.5**	**2.5**	**5.0**	**100%**
TOTAL	**17**	**10**	**3**	**6**	**1**	**1**	**2**	**40**

The educational qualifications of the SRWSA personnel are shown in Table 5.7. The table reveals that a majority of the staff, 23 personnel or close to 60 percent, does not hold a university degree. Of this number, three or 7.5 percent are college undergraduates, 13 or 32.5 percent are high school graduates / level, and the remainder, seven personnel or 17.5 percent, possess lower than high school education.

Table 5.7 Educational Qualifications Profile of SRWSA Personnel

EDUCATIONAL ATTAINMENT	D E P A R T M E N T				TOTAL #	TOTAL %
	Top Management	Production & Water Supply	Planning and Technical	Administrative and Financial		
Doctorate Degree					0	**0**
Master's Degree	2	1			3	**7.5**
University Degree	1	5	2	3	11	**27.5**
University Undergraduate		2		1	3	**7.5**
High School Level		9		4	13	**32.5**
Secondary Level		3		1	4	**10.0**
Primary Level		3			3	**7.5**
No Answer		3			3	**7.5**
TOTAL	**3**	**26**	**2**	**9**	**40**	**100%**

The educational profile of SRWSA staff, in addition to the lack of job experience, can have a toll on both individual and organizational performance. It can also unduly burden and strain top management in two ways: (i) by not having immediate and / or available technical expertise' support for decision making, and (ii) because of the former, by compelling top management to have to do their staff members' work, giving them less time to concentrate on strategic management matters.

For example, of the university graduates at SRWSA, only three are graduates of engineering – two chemical engineers, and one civil engineer, all of whom belong to the top management level. This leaves engineering-inclined, rather *engineering-required* departments and offices to be led and managed by graduates, albeit not engineering graduates. While it may be argued that certain amount of technical training was given to these personnel, this is can be viewed only a stopgap measure since basic knowledge on engineering as a science, a discipline and a field of practice is virtually missing. Also, training, which is a regular organizational activity, is normally utilized to enhance actual skills, develop potential skills, prepare an employee for bigger responsibilities, change behavior, etc . . . rather than to provide basic knowledge and skills which should have been already present (from education) in the personnel hired for the position.

However, this human resource situation in SRWSA is indicative of a bigger problem. This is reflective of the severe lack of technical and engineering graduates from the country's 38 higher educational institutions of learning. Most of the country's universities, which were established in the early 2000, are situated in Phnom Penh, with only four universities operating in Siem Reap. Of these, only two offer civil, electrical and electronic full degree and associate courses – Build Bright University (est. 2002) and Cambodian University of Specialties (est. 2004). It can be assumed that lucrative offers await licensed engineering graduates, who would more likely seek employment in Phnom Penh than in Siem Reap due to better salary rates in the former.

Presently, SRWSA is in need of a licensed civil/sanitary or a licensed mechanical/electrical engineer to head its Planning and Technical Department considering the number of improvement and expansion works in the pipeline. It also urgently needs a licensed accountant, or at least a graduate of accountancy to strengthen the Accounting and Financial Office, for both its general accounting work, and its other functions in financial management, project feasibility, and budget planning.

The future human resource requirements of SRWSA were projected for the expansion phases (KTC Bulk, Priority Project and 2nd Project) by taking into consideration the earlier-proposed organograms for each phase, the total number of connections and staff productivity index. For the case of Siem Reap, the total number of connections is arrived at by dividing the total population by 5.7, which is the average number of persons per household.

The staff productivity index is a measure of staff productivity and a predictor and indicator of organizational efficiency. Currently, the SPI of SRWSA is 8.83. Table 5.8 shows the computed

SPI and the number of employees based on projected number of connection per phase.

Table 5.8 SPI in each Improvement Phase

Year	Phase	Production Volume (m³/day)	Projected Number of Connections	Projected Number of Employees		Staff Productivity Index
				By Phase	Total	
2010	Current Facilities	8,000	4,525	40	40	8.83
2012-13	Bulk Water from KTC	17,000	16,218	38	78	4.80
2017-18	Start Phase 1 Operations	30,000	27,318	63	141	5.16
2022-23	Start Phase 2 Operations	30,000	41,331	42	183	4.42

Name of Water Supply Country	No. of Connections	No. of Personnel	Staff/1,000 Connections
Water Utilities with less than 6,000 connections			
Tandag Water District Philippines	4,420	26	5.9
Bansalan Water District Philippines	3,876	27	7.0
Siem Reap Water Supply Authority Cambodia	**4,525**	**40**	**8.83**
Water utilities within (more or less) 16,000 connections			
Baliuag Water District Philippines	14,947	64	4.3
Metro Kidapawan Water District Philippines	17,430	99	5.7
Siem Reap Water Supply Authority Cambodia	**16,218**	**76**	**4.69**
Water utilities within (more or less) 27,000 connections			
Son La Water Supply Vietnam	25,200	240	8.3
Bacolod City Water District Philippines	28,263	256	9.1
Siem Reap Water Supply Authority Cambodia	**27,318**	**139**	**5.09**
Water utilities within (more or less) 41,000 connections			
Thanh Hoa Water Supply Vietnam	41,480	439	10.6
San Jose Water District Philippines	46,673	220	4.7
Siem Reap Water Supply Authority Cambodia	**41,331**	**181**	**4.39**

With KTC Bulk, the SPI is computed at 4.8 and it may seem that SRWSA has become more efficient. However, this is a distortion when one notes that augmenting water supply through KTC bulk water would mean that SRWSA would be buying and distributing an additional 17,000 m^3 per day of treated water, *but not producing it.* Thus, with Priority Project operations, SPI expectedly goes up to 5.16:1,000 connections, because SRWSA starts producing and distributing the additional 30,000 m^3 of water, and will need more people to manage, operate and maintain the system. However, SPI goes down by the start of 2nd Project operations, to 4.42:1,000 connections as it is expected that SRWSA should have shortened the learning curve.

Here is a comparison among water utilities in Asia that comes close to the actual and projected size of SRWSA. The data from the other utilities comes from the *Data Book for Southeast Asian Water Utilities* published by the Southeast Asian Water Utilities Network (SEAWUN), with support from the Asian Development Bank. The study assessed the performance of 40 water utilities (using 2005 data) in the Southeast Asia region that could lead to efforts in improving their level of performance.

In this study, the average SPI among the 40 utilities was 7.2. The highest was12.8 and the lowest was 2.6. Note that today, PPWSA has SPI of 3.39:1,000 connections; but this was achieved after a series of improvement programs, staff training, and other interventions over a period of 10 years.

(1) Human Resource Requirement for KTC Bulk Water

The human resource requirements for SRWSA when KTC Bulk water becomes available by 2012/13 will grow by 36 personnel from the current 40, for a total of 78. SRWSA would be billing and collecting from a projected 11,100 more consumers (total of 16,218, including current number of connections), requiring more distribution, customer service (meter readers-billing and collection) and accounting personnel, but not a corresponding number of production-related personnel.

Shown in Table 5.9 is the departmental breakdown of HR requirements, starting with the Department of Production and Water Supply. There will be a marked increase in personnel under the Service Connection Office, obviously to respond to the demand by new customers to be connected to the system due to the availability of water from KTC Bulk. Personnel can be divided into “water service connection teams” based on established water distribution zones. However, if SRWSA aims to limit personnel costs, an option is to outsource service connection works. This decision should be dependent on final cost and practicability.

Shown in the next tables are the planned human resource requirements for the Department of Planning and Technical, Department of Administration and Financial and the proposed Commercial Operations Office with the implementation of KTC Bulk.

As indicated in the Table 5.10, filling up the position of Department Deputy (Department of Planning and Technical) should be a prioritized considering the number of big and small projects SRWSA intends to implement in the near and long term. It is proposed that the main qualifications for this position are: (i) A graduate of engineering (preferably civil and/or sanitary); (ii) Holder of an engineering license; and (iii) At least five years experience in the field of water utility planning and project management.

Table 5.9 HR Requirement for Dept of Production and Water Supply (KTC Bulk, 2012/13)

DEPARTMENT	CURRENT POSITION	PROPOSED POSITION	CURRENT 2010		KTC BULK 2012	
			Sub Total	Break down	Sub Total	Break down
DEPARTMENT OF PRODUCTION AND WATER SUPPLY						
	Department Deputy	Department Deputy	***1***	1		
Water Production Office			***9***		***3***	
	Office Chief	Office Chief		1		
	None	Engineer (Mech)				1
	None	Engineer (Elect)				1
	Production Staff	Operator (Pump)		6		
	Production Staff	Laboratory Assistant		1		
	None	Chemist		0		1
	Worker	Utilityman		1		
Water Distribution Office			***6***		***5***	
	Office Chief	Office Chief		1		
	None	Engineer (Civil/Sanitary)		0		1
	Personnel	Network Assistant		2		1
	Staff	Leakage Surveyor		1		1
	Network Staff	Helper (Leakage)		2		2
Service Connection Office* (previously Customer Office)			***10***		***4***	
	Office Chief	Office Chief		1		
	None	Assistant Engineer		0		1
	Meter Reader	None**		3		
	Customer Service	Svc Connection Staff		2		1
	Personnel / Staff	Helper (Svc Con)		4		2
		TOTAL	**26**		**12**	

* *The "Customer Office" is proposed to be re-named into "Service Connection Office", whose main function is to physically link the new customers to the water supply system, that is, laying of the service connection pipelines and connecting the water meter.*
** *Three Meter Readers will be transferred to the proposed Commercial Operations Office.*

SRWSA should utilize active recruitment techniques, recruiting either from Siem Reap, by inviting hotel-based water supply engineers, part-time faculty members of engineering schools, or top engineering graduates to apply, or by recruiting from Phnom Penh. If a qualified person is not available in Cambodia, then an alternative would be to temporarily hire on a consulting / adviser basis from other Asian countries, such as Vietnam, Thailand or the Philippines.

Table 5.10 HR Requirement for Dept of Planning and Technical (KTC Bulk, 2012/13)

DEPARTMENT	CURRENT POSITION	PROPOSED POSITION	CURRENT 2010		KTC BULK 2012	
			Sub Total	Break down	Sub Total	Break down
DEPARTMENT OF PLANNING AND TECHNICAL						
	Department Deputy	Department Deputy			**1**	1
Planning Office			***1***		***3***	
	Office Chief	Office Chief		1		
	None	Assistant Engineer				1
	Production Staff	Info Tech / CADD				2
Technical and Project Office			***1***		***1***	
	Office Chief	Office Chief		1		
	None	Assistant Engineer				1
		TOTAL	**2**		**5**	

Table 5.11 below shows that the HR requirement of the Department of Administration and Financial will also go up. The positions to be added are that of *accountan*t, preferably a licensed certified or chartered accountant to take charge of general accounting; *budget officer* (graduate of accounting, finance or business management) to take charge of budgeting and treasury functions;

supply clerk, to take charge of supplies inventory, monitoring and control as well as buildings and property management; an *administrative assistant*, to assist in HR functions and other general administrative and management work; and *posting clerks*, to reconcile / post meter reading with billing and collection.

Table 5.11 HR Requirement for Dept of Administration and Financial (KTC Bulk, 2012/13)

DEPARTMENT	CURRENT POSITION	PROPOSED POSITION	CURRENT 2010		KTC BULK 2012	
			Sub Total	Break down	Sub Total	Break down
DEPARTMENT OF ADMINISTRATION AND FINANCIAL						
	Department Deputy	Department Deputy	***1***	1		0
Administration and Human Resource Office			***2***		***2***	
	Office Chief	Office Chief		1		0
	Administration	Administrative Officer		1		0
	None	Supply Clerk		0		1
	None	Admin Assistant		0		1
Financial and Accounting Office			***6***		***4***	
	Office Chief	Office Chief		1		0
	None	Accountant		0		1
	Assistant Accountant	Assistant Accountant		1		0
	Cashier	Cashier		1		0
	None	Budget Officer		0		1
	Employee	Bookkeeper		1		0
	Billing*	None		2		0
	None	Posting Clerks		0		2
		TOTAL	**9**		**6**	

* *Two Billing positions will be moved to the proposed Commercial Operations Office starting 2012/2013.*

At SRWSA, the current ratio of customer service staff (meter readers with billing and collection functions) to number of service connections is 1:1200. This same ratio will be utilized for planning the HR requirements of the new Customer Operations Office. Thus, with the projected 16,218 customers by 2012/13, then around 13.5 personnel will be required, as shown in Table 5.12.

Table 5.12 HR Requirement for new Commercial Operations Office (KTC Bulk, 2012/13)

OFFICE	CURRENT POSITION	PROPOSED POSITION	CURRENT 2010		KTC BULK 2012	
			Sub Total	Break down	Sub Total	Break down
COMMERCIAL OPERATIONS OFFICE			**5**		**8**	
	None	Office Chief		0		1
	None	Customer Relations				1
	Billing*	Customer Service Staff (CSS)		2		6
	Meter Reader**			3		
		TOTAL	**5**		**8**	

* *Billing position from Financial and Accounting Office*
** *Meter reader position from Customer Service Office (Dept of Production and Water Supply)*

(2) Human Resource Requirements for Priority Project and 2nd Project

The HR requirements for Priority Project and 2nd Project will take into consideration a lower trend in staff productivity index, meaning that as SRWSA grows and gains more organizational experience and expertise, higher efficiency and productivity will follow resulting in lower SPI. The HR requirements for Priority Project and 2nd Project will match the organograms earlier presented in this section.

Table 5.13 presents the HR requirements for the Water Supply Operations Department (formerly the Department of Production and Water Supply) after the completion of Priority Project and 2nd Project of the water supply expansion works. It is significant to note that with the completion of Priority Project, SRWSA will be operating both groundwater and surface water sources. The operation the intake facility and one water treatment plant will commence by 2017-18 (Priority Project completion), while the second WTP will be start operation by 2022/23 (2nd Project completion). Logically, more personnel would be required to operate and maintain the expanded system as follows: (i) For the intake facility – three personnel at three shifts per day; (ii) For the WTP (Priority Project and 2nd Project) – two personnel at three shifts per day; (iii) For engineers – assistant engineer by 2017 and one mechanical engineer by 2022; (iv) For new transmission mains, plus additional distribution pipelines – requirement for maintenance and leak detection personnel, including one service connection team of three members, for each of the four distribution zones.

Table 5.13 HR Requirements for Water Supply Operations Department for Priority Project and 2nd Project

DEPARTMENT	POSITIONS (As of 2012/13)	NEW POSITIONS	PRIORITY PROJECT 2017		2ND PROJECT 2022	
			Sub Total	Break down	Sub Total	Break down
WATER SUPPLY OPERATIONS DEPARTMENT						
	Department Deputy	Department Deputy				
Water Production Office			***18***		***9***	
	Office Chief					
	Engineer (Mech)					1
	Engineer (Elect)					
		Assistant Engineer		1		1
	Operator (Pump)					
		Pump Operator (Well)		1		
		Pump Operator (Intake)		9		
		WTP Operator		6		6
	Chemist					
	Laboratory Assistant					
	Utilityman			1		1
	Security*					
Water Distribution Office			***9***		***9***	
	Office Chief					
	Engineer (Civil/San)					
		Assistant Engineer		1		1
	Network Assistant			2		2
	Leakage Surveyor			2		2
	Helper (Leakage)			4		4
Service Connection Office			***6***		***6***	
	Office Chief					
	Assistant Engineer			1		1
	Svc Con Staff			1		1
	Helper (Svc Con)			4		4
		TOTAL BY PHASE	**33**		**24**	

* *Security of the facilities is important; but this service can be outsourced.*

Table 5.14 presents the HR requirements for the Department of Planning and Development (formerly Department of Planning and Technical) after the completion of Priority Project and 2nd Project. As shown in the table, for Priority Project, a tight core of planning people (with only a researcher's position to be filled) will be maintained. For the Project Management Office, an additional Assistant Engineer will be hired to assist the Project Management Unit (PMU), which will be set up for Priority Project implementation.

Table 5.14 HR Requirements for Planning and Development Department for Priority Project and 2nd Project

DEPARTMENT	POSITIONS (As of 2012/13)	NEW POSITIONS	PRIORITY PROJECT 2017		2nd Project 2022	
			Sub Total	Break down	Sub Total	Break down
DEPARTMENT OF PLANNING AND DEVELOPMENT						
	Department Deputy	Department Deputy				
Planning and Design Office			***1***			
	Office Chief					
	Assistant Engineer					
	Info Tech / CADD					
	Researcher			1		
Project Management Office			***1***		***2***	
	Office Chief					
	Project Manager					1
	Assistant Engineer			1		
	Admin Assistant					1
		TOTAL BY PHASE	**2**		**2**	

In 2nd Project, it is proposed that the PMU staff be absorbed as regular personnel to provide SRWSA with project management expertise on board its professional staff. It is expected that in the long term, the SRWSA water supply system will be further improved and expanded.

For Priority Project and 2nd Project, the Administrative and Financial Department will be split into two departments, each having two offices. The growth in number of personnel for these departments is not as dramatic as the other departments; however, specific expertise and experience will be required by the new recruits in fields as general accounting, cost accounting, financial management, human resources management and training. The Commercial Operations Office, which will be upgraded to a full department by Priority Project, and will have two offices – the Customer Accounts and Customer Service offices. The number of personnel for this department will adhere to the ratio of 1:1,200 connections, which in 2022 should be 35 (with approximately 41,331 connections).

Table 5.15 and Table 5.16 provide the breakdown in HR requirements for the Administrative Department and the Finance Department, respectively.

The Commercial Operations Office, which will be upgraded to a full department by Priority Project, and will have two offices – the Customer Accounts and Customer Service offices. The number of personnel for this department will adhere to the ratio of 1:1,200 connections, which in 2022 should be 35 (with approximately 41,331 connections).

Table 5.15 HR Requirements for Administrative Department for Priority Project and 2nd Project

DEPARTMENT	POSITIONS (As of 2012/13)	NEW POSITIONS	PRIORITY PROJECT 2017		2ND PROJECT 2022	
			Sub Total	Break down	Sub Total	Break down
ADMINISTRATIVE DEPARTMENT						
	Department Deputy	Department Deputy				
Human Resource Office			***3***		***1***	
	Office Chief					
		HR Officer		1		
		Training Officer		1		
		HR Assistant		1		1
Administrative Services Office			***3***		***2***	
	Office Chief			1		
	Administrative Officer					1
		Procurement Officer		1		
	Supply Clerk					
	Administrative Assistant					1
	Utilityman			1		
		TOTAL BY PHASE	**6**		**3**	

Table 5.16 HR Requirements for Finance Department for Priority Project and 2nd Project

DEPARTMENT	POSITIONS (As of 2012/13)	NEW POSITIONS	PRIORITY PROJECT 2017		2ND PROJECT 2022	
			Sub Total	Break down	Sub Total	Break down
FINANCE DEPARTMENT						
	Department Deputy	Department Deputy	**1**			
Accounting Office			***3***		***2***	
	Office Chief					
	Accountant					
	Assistant Accountant					1
		Accounts Receivables		1		
		Accounts Payable		1		
	Bookkeeper					
	Cashier			1		
	Posting Clerk					1
Budget and Treasury Office			***1***		***1***	
	Office Chief			1		
	Budget Officer					1
		TOTAL BY PHASE	**4**		**3**	

Table 5.17 gives the breakdown of the HR requirement for the Commercial Operations Department for Priority Project and 2nd Project.

On the other hand, the HR requirement for the Management Services Office to be established by 2017, under the General Director, is as shown in Table 5.18.

Table 5.17 HR Requirements for Commercial Operations Department for Priority Project and 2nd Project

DEPARTMENT	POSITIONS (As of 2012/13)	NEW POSITIONS	PRIORITY PROJECT 2017		2ND PROJECT 2022	
			Sub Total	Break down	Sub Total	Break down
COMMERCIAL OPERATIONS DEPARTMENT						
	Department Deputy	Department Deputy	***1***	1		
Customer Accounts Office			***11***		***7***	
	Office Chief					
		Customer Service Zone Heads		4		
	Customer Service Staff			7		7
Customer Service Office			***2***		***1***	
	Office Chief			1		
	Customer Relations					1
		Public Info Officer		1		
		TOTAL BY PHASE	**14**		**8**	

Table 5.18 HR Requirements for Management Services Office for Priority Project and 2nd Project

OFFICE	POSITIONS (As of 2012/13)	NEW POSITIONS	PRIORITY PROJECT 2017		2ND PROJECT 2022	
			Sub Total	Break down	Sub Total	Break down
MANAGEMENT SERVICES						
	Office Chief		***3***	1	***1***	
		Corporate Planning Specialist		1		
		Info Systems Officer		1		1
		TOTAL BY PHASE	**3**		**1**	

(3) Summary of HR Requirements

The summary of HR requirements for all the phases is shown in the following table. It shows the increase in personnel staff from the current 40 to 76 with KTC Bulk, to 139 with Priority Project (SPI of 5.09) and 181 by 2nd Project (SPI of 4.38).

Table 5.19 Summary of HR Requirements for KTC Bulk, Priority Project and 2nd Project

D E P A R T M E N T	CURRENT	KTC BULK	PRIORITY PROJECT	2ND PROJECT	GRAND TOTAL
	2010	2012/13	2017	2022/23	
Top Management	**3**	**0**	**0**	**1**	**4**
General Director	1				
Deputy General Director	2			1	
Production and Water Supply	**26**	**12**			**38**
Water Supply Operations Department			**33**	**24**	**57**
Department Deputy	1				
Office Chief	3				
Personnel	22	12	33	24	
Department of Planning and Technical	**2**	**5**			**7**
Planning and Development Department			**2**	**2**	**4**
Department Deputy		1			
Office Chief	2				
Personnel	0	4	2	2	
Department of Administration and Financial	**9**	**6**	**0**	**0**	**15**
Administration and Finance Department					
Department Deputy	1				
Office Chief	2				
Personnel	6	6			
Accounting and Finance Department			**4**	**3**	**7**
Department Deputy			1		
Office Chief			1		
Personnel			3	3	
Administrative Department			**6**	**3**	**9**
Department Deputy					
Office Chief			1		
Personnel			5	3	
Office of Commercial Operations		**13**			**13**
Office Chief		1			
Personnel		12			
Commercial Operations Department			**14**	**8**	**22**
Department Deputy			1		
Office Chief			1		
Personnel			12	8	
Management Services Office			**4**	**1**	**5**
Office Chief			1		
Personnel			3	1	
TOTALS	**40**	**36**	**63**	**42**	**181**

5-2-3 Management Systems

Management systems are the backbone of water utility operations, as human resources are the brain of the organization. Not only do management systems link the entire organization, these also ensure higher efficiency and more effective organizational performance. Management systems should reflect the country's water sector policies and laws, and the downstream policies and procedures enacted and approved by the Council of Administration (Board of Directors).

The mission of SRWSA is to produce, supply and distribute safe and potable water supply and reliable water service to Siem Reap town and other areas within the political jurisdiction of Siem Reap province. Thus, it can be assumed that *SRWSA's water policies* are:

- Level of Service – Distribute 24/7 potable water and reliable water service to all households, businesses and institutional consumers within its jurisdiction.
- Conservation of Angkor Heritage Sites – In developing the water supply system, the protection and preservation of the Angkor Heritage sites must be considered.

- Water Sources – Limit the use of groundwater, but maximize the use of surface water, also to protect the Angkor Heritage sites.
- Water Improvements – Aim for interim (short term) improvements and long-term water supply expansion projects that adhere to Cambodia's water resources and other related environmental laws.
- Tariff – Adopt a consumption-based tariff structure that is fair for all – residential, commercial/business and institutional consumers.
- Metered Consumption – Meter all connections to ensure users not only pay on the basis of actual consumption but also urge them to conserve this precious resource.
- Cost Recovery – Aim for operational and financial viability where there is full cost recovery, meaning, revenues from tariffs cover O&M costs, capital development plus debt servicing.
- Service to the Poor – Being poor should not hamper access to safe water; but rather water should be made affordable to the poor.
- Professional Work Force – Aim for a professional highly trained and motivated work force to ensure highest productivity and customer satisfaction.

(1) Human Resources System

Given these water policies, SRWSA does have some policies and procedures in place. For example, human resources policies and procedures are contained in the "SRWSA Staff Rules and Regulations" which govern the following areas: Management/Staff Levels and Hierarchy; Staff selection; Choosing the representative of staff-employee in order to put them in decision council; Instruction; Basic salary, benefits and bonus; Promotion; Punishment; Discipline council; Working hours, Days of work and Holidays; Dismissal and Resignation; and Insurance. Closer examination of the HR rules and regulations reveal these policies:

<u>Hierarchical Classes/Levels</u>: The SRWSA has three hierarchical classes/levels as shown below. This provided for in its Staff Rules and Regulations. The General Director's position is governed by Sub-Decree N°. 04.

Positions	Class/Level	Number	Basis
General Director		1	Sub-Decree N°. 04
Deputy General Director	Departmental Level	5	SRWSA Rules and Regulations
Department Deputy			
Office Chief	Executive Level	7	
Personnel	Operating Level	28	
	TOTAL	**40**	

<u>Salary grades</u>: The Staff Rules and Regulation provides for 11 salary grades, which are divided among three hierarchical levels. Salary grade levels for directors of departments start at 9, and the ceiling is 11; while for chiefs of offices, the lowest is 6 and the highest 9. For all other employees, the base hiring level is 1 and the uppermost level is 5.

<u>Promotion</u>: Promotion is defined two ways – firstly, the vertical movement of personnel from one salary grade level to another as a result of excellent performance; and secondly, the horizontal movement of personnel in the same salary grade level, but from one salary step to a higher salary

step. As shown in the table below, there are only two step increases for all salary grade level. This gives severely restricts the promotional mobility to personnel who may deserve recognition but can no longer move up the salary grade level.

Performance Evaluation: Each employee is evaluated every three months (quarterly). Evaluation is done by the Administration and Human Resources Office in coordination with the Department Directors / Office Chiefs concerned. According to the Staff Condition rules, not more that 80% of the employees can be promoted in any given year.

Training and Development: Training is provided to all employees on a yearly basis following a training needs assessment conducted by the Administration and Human Resources Office.

<table>
<tr><th>Salary Grade</th><th>Hierarchical Class</th><th colspan="2">Two-Step Salary Increases within Each Salary Grade Level</th></tr>
<tr><td>11</td><td rowspan="3">Department Directors</td><td rowspan="11">Step 1</td><td rowspan="11">Step 2</td></tr>
<tr><td>10</td></tr>
<tr><td>9</td></tr>
<tr><td>8</td><td rowspan="3">Office Chiefs</td></tr>
<tr><td>7</td></tr>
<tr><td>6</td></tr>
<tr><td>5</td><td rowspan="5">Operating Employees</td></tr>
<tr><td>4</td></tr>
<tr><td>3</td></tr>
<tr><td>2</td></tr>
<tr><td>1</td></tr>
</table>

Job Functions/Descriptions: The Staff Rules and Regulations rules enumerate the general functions of each department and office, and the broad functions and responsibilities of the department manager and office chief, accordingly. Each department director and office chief then divides these responsibilities to their respective employees. However, there are no written job descriptions, for each kind or type of position, so as to make performance appraisal more objective. Nevertheless, the staff was able to describe their own job.

(2) The Financial Management System

SRWSA follows the Cambodian government accounting system and standards, and covers: (i) General Accounting and Financial Reporting including Chart of Accounts, (ii) Purchasing and Inventory Management; (iii) Receipts and Disbursements and Budgeting; (iv) Fixed Assets, including policies on depreciation. However, all these should be further codified, after which it becomes timely for SRWSA to develop a financial management information system (FMIS) and to link this with the also-to-be-developed commercial practices system and human resources information system to increase efficiency and lower staff costs.

It is important that targets are set, and performance is measured. Therefore, key financial and operational performance indicators and service standards/targets must be established and be made a part of the assumptions in the business plan and financial projections.

(3) Commercial Practices Systems

The implementation of a commercial practices system can begin with the development of a SRWSA Customer Charter that defines the rights and obligations of a customer. In this way, everyone in the SRWSA is aware of and will work towards the provision of safe and potable water and 24-hour water service to all its customers. In like manner, the customers will also know their responsibilities not only to SRWSA but also towards the water resources environment. Thus, it aims not only in information dissemination, but also the education of the consumers on the value of water, the need to conserve water and preserve the environment.

Good customer relations will be promoted by setting up and codifying systems and procedures. These will encompass the processing of customer service connections as well as disconnections and reconnections in the most efficient manner, and acting on customer complaints in the most expeditious manner.

While the billing and collection efficiency in SRWSA in high, there are still improvements that can be implemented, such as having an appropriate system that ensures secure storage of current customer records in a reliable database. Other recommended tasks are: (i) Mapping/zoning of present and potential service areas to confirm the type and number of residential and business customers connected and not yet connected to the system; (ii) Crafting of a strategic communications plan directed not only to actual and potential residential customers, but more so to actual and potential business customers, since the much of the cost of the expansion works will be incorporated in water tariff for business/commercial category; and (iii) Development of a more holistic billing and collection information system that links with the financial management information system (FMIS).

(4) Water Supply Operations Systems

Water production and distribution systems must be codified and/or “manualized”. These include operation and maintenance policies and procedures with regard to water demand and production, water loss and monitoring, water quality, distribution and leakage control, service connection, among others. Also planning and design parameters need to be established. Codifying and writing operations and maintenance manuals become even more imperative considering that many of those in water production and distribution, as well as in planning and technical departments are not engineering graduates, and therefore lack the fundamental skills requirements. Such manuals will allow key and support personnel follow basic standards and procedures in their jobs.

Shown in Figure 5.5 is the management systems framework for SRWSA.

Figure 5.5 Management Systems Framework for SRWSA

5-3 Capacity Building

Based on the SRWSA HR Survey conducted for this study, each employee received, on the average, 15.5 days of training from 2005-2009 or during the last five years. This translates to three days of training annually per employee. Judging from the comments of the staff, training was not sufficient, and many articulated their desire for more specialized training focused on being more proficient in their present jobs. They believed that training will help them perform better at their jobs, and not a few mentioned of their commitment to share what they know to make SRWSA the best it could be as an organization. Presently, the costs of training are presently included in SRWSA's annual training budget. The basis comes from the training needs assessment (TNA) conducted by the Office for HR and Administration, where the names of the candidate-trainees, plus the kind of training to be received, are approved by their immediate supervisors prior to actual training deployment.

The objective of capacity building or development is to prepare SRWSA for the requirements, results and impacts brought about by the upcoming improvement and expansion of its water supply system. As explained earlier, with the expanded system will come new facilities, which will entail the development and implementation of new and/or revised policies, systems and procedures in water supply management and operations. Current SRWSA staff must be ready for this eventuality. However, the resultant rapid growth in the number of customers will necessitate a proportionate increase in the number of staff and a change in SRWSA's organization structure. It is very important, therefore, to provide training to identified key personnel to equip them with skills required to operate the expanded system, as well as to the staff of the new and/or reconstituted departments and offices. SRWSA must be able to transform organizational and individual potentials into actuality.

5-3-1 Capacity Building (Training and Development) Approach

(1) General Approaches

Given the low education attainment profile of the staff, their lack of work experience, and the mismatching of qualifications and positions, the *general approach to training is that all staff will require various types of training* in the short and medium term. Thus, the training should not be designed as a sporadic separate activity but rather should address specific current and emerging needs of the organization.

The general training approach provides for training that will cover (i) The entire organization; (ii) Training by departments / offices based on unit functions and responsibilities, and (iii) individual skills training, based on job function and position held. The latter, however, will require a more in-depth training needs assessment, subjecting the candidate to more detailed review of his qualifications and aptitude, and to ensure the matching of proposed training with job requirements and individual capacity. Until this is done, there is little room for training to be successful.

(2) Specific Approaches

Training methodologies – must also be appropriate to the type of training and its participants, to fully realize the training objectives. Many of the training programs for the short and medium term should utilize mixed methods of *lectures* and *workshops* to impart and/or improve skills; and some can be extended using the *on-the-job* method to ensure that training has the desired long lasting effects on behavioral change that positively impacts on how SRWSA personnel should do their jobs.

Trainer's training – all heads of departments and offices, and key personnel will receive continuous on-the-job training through counterpart-basis with consultants. Towards the end of the training, the officers and key personnel will undergo a short course on how to be effective trainers, and then develop training materials under the supervision of the consultants. These will then translated to Khmer for staff training, and be archived in a knowledge database for future use.

Language of instruction – must be seriously considered, since many of the staff are not proficient in the English language. Training provided by consultants is usually in English, and it would be expected that retention and understanding by trainees would be low, defeating the training objectives. Department managers, office heads, and key staff should undergo English courses (the length of the course depending on their level of proficiency) to maximize any training received. This is also connected to the trainer's training approach.

Advance education – SRWSA can, in the future, provide well-performing staff with opportunity for advanced education in their respective fields, such as diploma courses in engineering overseas, or master's degrees.

Training as an investment – since training of personnel has financial costs, it must be looked upon as an investment, and its "return on investment" must translate into efficiency and effectiveness for the employee/s, in particular, and the organization, in general, which can be measured.

5-3-2 Levels of Training

(1) Organizational and Functional Levels

Training should be designed and developed *organization-wide* or for all SRWSA staff members, to provide them with the big picture or macro perspective on the new SRWSA, which will operate a "mixed-source" water utility, with water coming from groundwater (presently), from KTC Bulk (2012/13), and from surface water (2017 and 2022). Training should also be designed by *functional area* of the organization, or by specific department and/or office. This micro perspective will ensure that the staff of each department truly appreciates the importance of their own department to the SRWSA's total effort / success. But focus should not only be by departmental functions and responsibilities, but also on the importance of coordination and linkages between and among departments, if only to highlight unity of effort and cohesion as ingredients to efficiency and productivity.

(2) Individual (Employee) Level

It is proposed that the training for selected / identified employees commences only after a more detailed training needs assessment. Individual training must be matched with the proposed trainee's qualifications, the job presently held, and the skills needed for the job-holder to perform at minimum acceptable standard of the particular job. This requires three things: (i) the evaluation of all jobs / positions in the organization; (ii) the development of job qualification standards; and (iii) writing job or position descriptions for each job family. Without completing these requirements, training investments will be wasted.

Nevertheless, in the absence of these parameters, it is apparent that training will be needed for the following positions being proposed in the organograms of the Project - electrical, civil-sanitary and mechanical engineers, project manager, assistant engineers, pump operators for the intake facility and water treatment plants, IT Specialist/CADD, network assistants and leakage surveyors, and service connection staff under the department of production and water supply and planning and technical. As for administrative personnel, training should be designed for the following positions – administrative officer, human resources officer, procurement officer, budget officer, accountant and assistant accountant (with the State Controller's Office). For the commercial operations personnel, training should be given to the customer service staff, customer relations officer and the public information officer.

5-3-3 Separate Capacity Development Project

(1) Counterpart Mentoring, Coaching and On-the-Job Training by a Multi-Disciplinary Team of

Consultants

There is a need for a more intensive, in-house and results-oriented capacity building project customized to the training and development needs of SRWSA. This will entail bringing in subject matter and experienced experts and specialists (consultants) to work side-by-side with SRWSA counterparts in developing and codifying the systems, policies and procedures in various functional areas, conducting customized training and workshops, and establishing a knowledge management database by documenting the training through the training materials. Training will no longer be on just *how to do* things, but also on establishing *what to do*. It is proposed that the capacity building project be undertaken shortly before the start of Priority Project implementation or in 2012. Table 5.20 shows the summary of the capacity development program.

The international consultants will: (i) provide the general training concept and over-all supervision over the capacity development project: (ii) prepare the training course (strategic level) and training materials for top management and the trainer's training; (iii) prepare job standards and descriptions for all positions; and (iv) prepare specific training courses and training materials on the basic water utility functional areas. The local consultants will be utilized to translate all the materials prepared by the consultants from English to Khmer, as well as assist in the conduct of the training.

Table 5.20 Summary of Consultants' Tasks and Outputs for SRWSA Capacity Building

INTERNATIONAL CONSULTANTS	BRIEF DESCRIPTION OF WORK	OUTPUT	M/M	YEARS
Team Leader	• Develops the general training approaches on the capacity development project • Has over-all supervision over the implementation of the project	• Inception Report • Interim Report • Final Report	3.0	2012-2014 (Staggered)
Strategic and Business Planning	• Develops SRWSA Medium Term Strategic Business Plan	• SRWSA Strategic Business Plan 2012-2017	3.0	2012
Institution and HR Specialist	• Develops job standards and job descriptions for all positions • Prepares lecture-workshop materials • Conducts the trainer's training program	• The Job Standards, Job Descriptions, Duties and Responsibilities for all positions in SRWSA • Position Description Lecture and Workshop Materials	4.0	2012-2013
Financial Management Specialist	• Codifies the financial management system • Conducts financial management training • Prepares training materials	• Financial Management Manual • Financial Management Course and Training Materials	3.0	2012-2013
Commercial Practices Specialist	• Codifies the commercial practices system • Conducts commercial practices training • Prepares training materials	• Commercial Practices Manual • Commercial Practices Lecture and Training Materials	3.0	2012-2013
Water Supply Specialist (Distribution / Network Installation)	• Conducts water distribution and network installation training • Prepares training materials	• Distribution Manual • Water Distribution Lectures and Training Materials	3.0	2013-2014
Water Supply	• Conducts water utility planning and	• Water Utility Planning	3.0	2013-2014

Specialist (Water Utility Planning)	design training • Prepares training materials	Lectures and Training Materials		
Water Supply Specialist (Production and Treatment)	• Conducts water production and treatment training • Prepares training materials	• Production Manual • Water Production Lectures and Training Materials	3.0	2014
Sub-Total Person-months for International / Regional Consultants			25	
LOCAL CONSULTANTS	**BRIEF DESCRIPTION OF WORK**	**OUTPUT**	**M/M**	**YEAR**
Training Specialist/Translator	• Translates all materials prepared by the consultants from English to Khmer • Assists in the conduct of training courses/lectures	Training materials in Khmer	6	2012-2014 (Staggered)
Sub-Total Person-months for Local Consultants			6	
TOTAL PERSON MONTHS			**31**	

The Terms of Reference for Consultants are given in **SR 5.7** International and Local and **SR 5.4** and **SR 5.5**, Summary of Cost.

(2) Specialized Training

Specialized training courses are hereby conceptualized for SRWSA matching the organizational requirements of the expansion phases. Most of these courses are skills-based training, combining lectures and workshops. These specialized training can either be: (i) a stand alone training; or (ii) incorporated in the consultant's tasks within the proposed Capacity Development Project.

The over-all aim of the specialized training is to equip, upgrade and hone employee knowledge and skills in order for them to better contribute to the attainment of goals and objectives. These training courses can either be funded through grant/s, or through the SRWSA internal budget. These can be conducted by the PPWSA Training Center, or by local educational / training institutions with a reputable track record, or by training subject matter experts (SME) or consultants. The final selection of the training participants will be made after the in-depth training needs assessment.

City Water Utilities Training

Design and Methodology: This 10-day overseas training is designed for the top management team of SRWSA (total of seven participants) on general approaches to water utilities planning through lecture-discussions with water district managers and technical planners and observation of facilities. The participants will study three JICA-funded water districts in the Philippines (Davao, Butuan, Dingle-Pototan) utilizing surface water supply sources and learn from the experiences of these water districts managers. Schedule: Before start of Priority Project (2012-13)

Objective: To examine the different planning approaches such as traditional supply planning, least-cost utility planning, integrated resource planning, and total water management in relation to SRWSA's own water utility context.

Output: At the end of the training, the participants will develop a planning model that best fits the situation of SRWSA.

Strategic Management and Leadership

Design and Methodology: The 5-day local training is designed for 15 participants – the general director, deputy general directors, department director, and office heads on the strategic management principles and process through lecture and workshops. It will present leadership principles and concepts, and through peer discussion, the participants will be made aware of their own management and leadership styles. Schedule: Before start of Priority Project (2012-13)

Objectives: (i) To apply the strategic management process in analyzing the strengths and weaknesses, opportunities and threats to SRWSA and in formulating unit strategies; (ii) To understand own management and leadership styles as the beginning of self-improvement.

Output: At the end of the training, the participants are expected to have: (i) formulated their own unit's functional strategy based on SRWSA's over-all mission; and (ii) been able to articulate their own leadership and management styles.

Customer Service and Customer Satisfaction Training

Design and Methodology: This 5-day local lecture-workshop training is designed for the seven employees of the newly created Commercial Operations Office staff on the revised system and process for new customer application, including reconnections and disconnections. Special topics will include customer service principles and how to measure customer satisfaction. This training will come after the development and codification of the commercial practices system. Schedule: Before start of Priority Project (2012-13)

Objective: To instill and develop customer orientation skills to commercial operations office staff when applying the commercial practices system.

Output: At the end of the training, the participants are expected to develop their own SRWSA Customer Service Guidelines.

Accounting for Non-Accountants

Design and Methodology: This 5-day intensive lecture-workshop for the six personnel of the Finance and Accounting Department will be divided into two parts: (i) the review of the Cambodian system of accounting and auditing, including preparation of reports, and (ii) preparation of financial reports and analyzing financial data for decision-making. This training will come after the codification of the financial management system. Schedule: Before start of Priority Project (2012-13)

Objectives: To make the participants understand the importance of financial management (as part of the entire finance cycle) in the water utility business and of providing decision makers with financial statements that are reliable, and that laws and regulations are complied with, so as to safeguard financial resources for sustainability.

Output: At the end of the training, the participants are expected to develop a model for SRWSA financial reporting.

Inventory and Asset Management

Design and Methodology: This 5-day local training will be for around seven personnel of the administrative and finance, as well as the production and water supply offices involved in procurement, stock and inventory management. This training is will demonstrate the importance of a procurement plan, maintaining a balance between keeping stock low without sacrificing service level, how to obtain better prices by making volume purchases but not ending up with slow-moving inventory, and by ensuring proper storage for and control of stocks since "inventory is money". Schedule: Before start of Priority Project (2012-13)

Objective: To make the participants be aware of, and understand the importance of purchasing, inventory management and control principles and apply this to SRWSA.

Output: At the end of the training, the participants are expected to draw up a procurement plan and select appropriate and proven methods of inventory control for SRWSA.

Project Management

Design and Methodology: A 5-day local training by a project management professional on the discipline of proper planning, organizing, coordinating, managing, executing and controlling, resources to bring about the successful completion of specific project goals and objectives. This training will be for the around seven officers and staff of the Planning and Technical Department, as well as for the technical staff of the Production and Water Supply Department prior to implementation of Priority Project. Schedule: Before start of Priority Project (2012-13)

Objective: To make the participants understand the Project Management Framework as the basic structure for understanding the environment in which the Project operates enabling the project implementers to manage the day-to-day activities of the Project towards its successful completion.

Output: After the end of the training, the participants are expected to design and develop a project management framework for use in the Project.

Operation and Maintenance of Water Supply Facilities

Design and Methodology: A 5-day local training for the entire Water Supply Production Office of around 12 personnel to provide in-depth understanding of the operations and maintenance requirements, systems and procedures of all current and future water sources and water treatment facilities. This training will be conducted before the commissioning of facilities constructed under Priority Project. Schedule: Pre-operation of Facilities of Priority Project (2016-17)

Objective: To enable the participants to be aware of their respective roles and responsibilities in the revised / updated system of operating and maintaining the new (and old) facilities.

Output: After the end of the training, the participants are expected to draw up a revised and/or enhanced system and procedure (including description of responsibilities) in operating and maintaining the new facilities.

Network Installation and Rehabilitation

Design and Methodology: This is a 5-day local training for around 12 personnel of Water Distribution and Service Connection Office staff to better implement network installation and rehabilitation and leakage monitoring and survey works.

Objective: To enable the participants to be aware of their growing responsibilities in the expanded distribution system, as well as new techniques in leakage monitoring and surveys.

Output: At the end of the training, the participants are expected to present a more efficient method of network installation and rehabilitation, as well as updated techniques of reducing leaks, thereby reducing NRW.

(3) Future Directions in Capacity Building

Capacity building programs and activities should be an on-going activity in SRWSA. The number of human resources is expected to grow; new / revised management systems, policies and procedures will be developed and implemented; and more innovative water supply technologies will be adopted. All these will entail training to ensure that staff can keep abreast with these developments by way of knowledge, skills and abilities.

5-4 Project (Operation) Implementation System

5-4-1 General

The implementation of the Siem Reap Water Supply Expansion Project will be funded out of a loan from the Government of Japan (GOJ), through the Japan International Cooperation Agency (JICA), to the Royal Government of Cambodia (RGC). The proposed loan will be guaranteed by the RGC, through the Ministry of Economy and Finance (MOEF), for the Siem Reap Water Supply Authority (SWRSA). Details of this proposed loan would be contained in a "Memorandum of Understanding (MOU)"; and eventually, a "Loan Agreement" that will be signed by the representatives of both the Cambodian and Japanese governments.

Ensuring the successful implementation of the Siem Reap water supply expansion project necessitates setting up a rational project implementation system that would take into consideration the requirements of, and the agreements between, both the lender (GOJ) and borrower (RGC). This section will address setting up the project implementation system, which requires the following: (i) An examination of certain government institutions, focusing on their current mandates, in order to establish their institutional linkage with SRWSA; (ii) Indentifying the key institutions / stakeholders that would be involved in the project implementation, then defining and/or clarifying their roles and responsibilities; and (iii) Setting up project organizations to support smooth project implementation, and ensure successful project completion.

5-4-2 Examining Government Institutions and their Linkage with SRWSA

It is important to have, at this point, a macro perspective of the environment where SRWSA operates by examining the mandates of selected ministries and agencies of government, and determining the extent of the current institutional linkage of these institutions with SRWSA. This will subsequently allow for the identification of the priority stakeholder-institutions when implementing the water supply expansion project, and the definition of their respective roles and responsibilities in project implementation. The linkage is graphically shown in *Figure 5.6:* **S***RWSA's Linkages with Government Institutions*

(1) Ministry of Industry, Mines and Energy (MIME)

Article 6 of the *Law on General Statute of Public Enterprises* dated 22 May 1996 states: "The public enterprise shall be under the technical responsibility of a ministry of public authority depending on the type of the enterprise's activities." The Siem Reap Water Supply System used to operate as a waterworks under the provincial department of MIME until 2007, when it was spun off and became an autonomous economic public establishment with the signing of Sub-Decree Nº 04 in 2007. Therefore, MIME exercises technical supervision over SRWSA. MIME is represented in the Council of Administration of SRWSA, and its representative is, in fact, the board chairman. Certain important decisions of the Council still need the information, confirmation and/or final approval of MIME – future technical plans and projects, water tariffs, budgets, and the annual business plan.

(2) Ministry of Economy and Finance (MOEF)

Article 7 of the *Law on General Statute of Public Enterprises* dated 22 May 1996 states: "Public enterprises shall be under the financial control and inspection of concerned ministries or institutions." It is the MOEF that exercises financial supervision over SRWSA. To strengthen this supervision/monitoring, a representative of MOEF sits as a member of the SRWSA Council of Administration. Important Board decisions that concern allocation of financial resources (investments, water tariff, annual budgets / business plan) as well as audits of various accounts are also submitted to MOEF for information and/or final approval.

(3) Ministry of Water Resources and Meteorology (MOWRAM)

The Ministry of Water Resources and Meteorology is the over-all in charge of water resources management to foster the effective and sustainable management of the water resources of Cambodia to attain socio-economic development and the welfare of the people. It is authorized to manage, lead and supervise the implementation of the *Law on Water Resources Management*, dated 29 June 2007, by establishing mechanisms and frameworks to jointly or severally consult with, address and coordinate work and activities among ministries and other relevant agencies. As such, SRWSA needs the approval of MOWRAM in future plans of utilizing surface or groundwater as its water supply source.

(4) Ministry of Environment (MOE)

The Ministry of Environment is in charge of implementing the Law on Environmental Protection and Natural Resource Management (Royal Kram No.NS/RKM/1296/36 dated December 14, 1996), which aims for the promotion of environmental quality and public health, among others. It also implements Sub-Decree No. 72 ANK/BK dated August 11, 1999, which requires an *Environmental Impact Assessment*, and its approval thereof, for projects especially in protected areas such as Landscape Protected Area, Multiple Use Area and Community Protected Area, among others. Thus, future water supply expansion plans of SRWSA will have to undergo and pass environmental impact assessment and approval by MOE.

(5) Ministry of Fisheries and Forestry (MAFF)

The Ministry of Fisheries and Forestry, through the Department of Fisheries, is responsible for implementing the *Law on Fisheries Management and Administration* (Royal Kram Nº 0506/011 dated 21 May 2006). This law mandates the management of all agriculture, forestry and fishery activities in Cambodia, as well as provides a framework for management, protection, conservation, utilization, exploitation, inundated-reforestation, and development of fisheries to ensure sustainability of the fishery resources in the interest of Cambodia's society, economy and environment. Government ministries, agencies, authorities are required to coordinate with MAFF when tapping protected and controlled areas such as the Tonle Sap Lake for water supply projects, as this might disrupt the livelihood of fisher folk, species of fish found in the lake. In such as case, SRWSA is required to coordinate with the MAFF in its plan to tap Tonle Sap Lake as one of its water supply sources.

(6) APSARA

APSARA is the short name of the *National Authority for the Protection of the Site and Development of the Region of Angkor*, which was established by virtue of Royal Decree NS/RKT/0295/12 dated 19 February 1995. Its mandate is to protect, maintain, conserve and improve the value of the archaeological park, the culture, the environment and the history of the

Angkor region as defined on the World Heritage List. The authority of APSARA was further strengthened with a second decree – Royal Decree NS/RKT/0199/18 dated 22 January 1999 – by refining and applying the master plan on tourist development according to five zones, earlier defined in Royal Decree N° 001/NS dated 28 May 1994, that delineated the zoning and management of the region of Siem Reap/Angkor. With this, APSARA, with the Ministries concerned, acts as an umbrella organization over the agencies responsible for the administration and the management of the region. The reach of APSARA includes the Siem Reap Water Supply Authority if any planned expansion or project sites are within the five APSARA-designated zones, or if found to have impact on the Angkor heritage area.

(7) Tonle Sap Authority (TSA)

The Tonle Sap Authority (Royal Decree dated 30 June 2009) is in charge of preparing policies, plans, projects and activities – in collaboration with relevant ministries and development partners and in coordination, communication and cooperation between and among agencies, local authorities and communities – for the sustainable protection and management of *Tonle Sap Biosphere Reserve.* The latter was established by Royal Decree Nor Sor/Ror Kor Tor/0401/070 dated 10 April 2001. Wherever feasible, TSA also coordinates its ongoing and planned activities/projects with national and international organizations, as well as non-governmental organizations. Therefore, SRWSA is required to coordinate its future plan of tapping Tonle Sap Lake as a source of domestic / business water supply.

(8) Provincial Government of Siem Reap

A representative of the Provincial Government of Siem Reap is a member of the Board of Directors of SRWSA. This will enable the provincial government to be informed of the plans and programs of SRWSA, resulting to smoother and better plan coordination between the two, especially as SRWSA is within the province's political jurisdiction. Considering that SRWSA is the second independent water authority established in Cambodia, and the first in Siem Reap, then it can also become a model for other water supply systems within Siem Reap province.

(9) Central Government

A representative of the Cabinet (Central Government) sits as a member of the Board of Directors of SRWSA, providing another viewpoint on how development projects being undertaken by the national government. Plan coordination is effected through this representation.

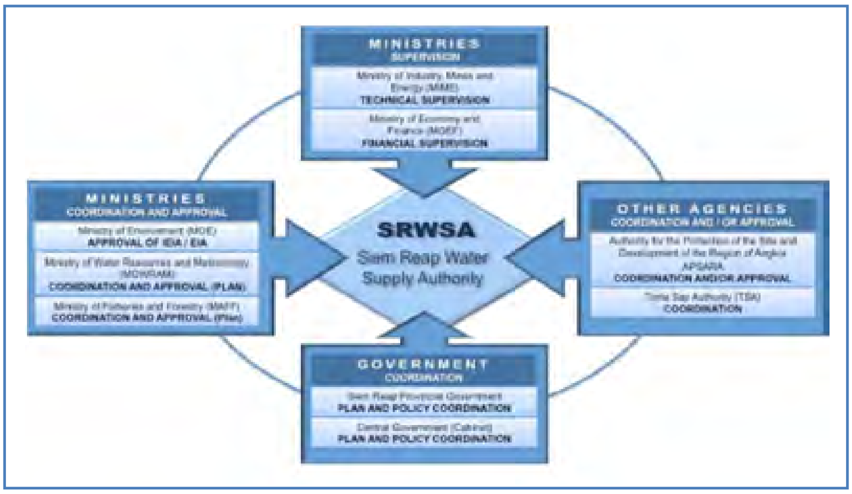


Figure 5.6 SRWSA's Linkages with Government Institutions

As shown in Figure 5.6, MIME and MOEF have direct supervision over SRWSA, which is contained in the *Law on General Statute of Public Enterprises*. SRWSA is under the "technical responsibility" of MIME, while MOEF provides financial control and inspection" over SRWSA. Three other ministries – MOE, MOWRAM, and MAFF – have limited authority over SRWSA, and this is only with regard to the implementation of specific laws and sub-decrees. These are the *Environmental Impact Assessment Sub-Decree* for the protection of the environment, which is being implemented by MOE; the *Law on Water Resources Management* for the sustainable use of water resources, which is being implemented by MOWRAM, and the *Law on Fisheries Management and Administration* for the conservation and management of fisheries, which is being implemented by MAFF. Coordinative linkage with SRWSA, based on their specific legal mandates, also lies with two government agencies, the APSARA and TSA. Plan and policy coordination is also made by SRWSA with the Provincial and Central Governments.

5-4-3 Key Stakeholder-Institutions in Project Implementation

There are several key stakeholder-institutions with complementary interests over the successful implementation of Priority Project and 2nd Project of the Siem Reap water supply expansion project. These are the following: (i) the Ministry of Economy and Finance, which will guarantee the loan to SRWSA, and will, therefore, want to ensure that the loan will be repaid; (ii) the Ministry of Industry, Mines and Energy, which has technical supervision over SRWSA, particularly over its future plans and projects involving government-guaranteed loans, and would, therefore monitor project implementation; and, (iii) the Ministry of Water Resources and Meteorology, which has a mandate over the sustainable utilization of Cambodia's water resources, (iv) the SRWSA which is the project beneficiary, the re-payer of the loan, and the project implementer; (v) the Provincial Government of Siem Reap, as the location of the Project is within its political jurisdiction; and (vi) the APSARA, because it has legal mandate over projects within its designated protected zones.

(1) Need for and Role of the Project Coordinating Committee (PCC)

There is need to organize a Project Coordinating Committee to coordinate and monitor the implementation of the Priority Project and 2nd Project of the expansion project. This will be similar to the "Steering Committee for the Study of the Siem Reap Water Supply Expansion Project" established on 22 September 2009 signed by the Minister of MIME, which has five members – MIME, MOEF, APSARA, SRWSA, the Provincial Government of Siem Reap, and JICA.

It is proposed that the Steering Committee earlier organized for the preparatory study be reconstituted to become the *Project Coordinating Committee for the Implementation of the Siem Reap Water Supply Expansion Project*, but with increased membership to include the representative of the ministers of MOEF and MOWRAM. JICA will no longer be part of the PCC, as it becomes the financing institution of the Project.

The Project Coordinating Committee (PCC) shall be the inter-agency coordinating committee charged with the *main role of providing policy guidelines for strategic coordination for Project implementation* for the Priority Project and the 2nd Project of the Siem Reap Water Supply Expansion Project. As such, it has no supervisory authority, but its existence is for over-all coordination of project implementation among the major stakeholders, as well as for resolving emerging concerns, major issues and conflicts such as regulation over the exploitation of groundwater sources that may arise during project implementation. The RGC should enact in cooperate with PCC enact regulatory measures with regard to the control of future groundwater development and imposition of sanctions to continued groundwater extraction in Siem Reap City one the Priority Project is implemented.

(2) The Need for and the Role of the Monitoring Agency: The Ministry of Industry, Mines and Energy

There is also a need to have an over-all monitoring agency for Project, in so far as the Project is implemented against the financial and technical plan. MIME is the most logical choice, as it is the Government agency that has technical supervision over SRWSA.

In the implementation of the project, it shall be the Department of Water Supply, one of the major departments within MIME that shall be given the *principal role of having over-all responsibility for monitoring Project implementation.*

(3) The Need for and the Role of a Project Executing and Management Unit: The SRWSA

The Siem Reap Water Supply Authority is an autonomous public economy. It is the project beneficiary, and ultimately the institution responsible for repaying the loan. As such, SRWSA will have the *primary roles of being (i) project executing agency, and (ii) of being the project implementer and manager, therefore, being directly responsible for undertaking actual field supervision and management of Project implementation*. For this purpose, it will establish a project management unit (PMU) within its Department of Planning and Technical *for the duration of project implementation*. It will also be in this department that the project consultants' team (PCT) will be lodged to provide consulting and advisory services for project implementation as specified in the Loan Agreement.

In summary, the principal roles of the project organizations are as shown below:

Project Organization	Level	Membership or Institution / Department	Role in Project Implementation	Responsibility
Project Coordination Committee	Inter-Agency Level	MIME, MOEF, MOWRAM, SRWSA, APSARA, Provincial Government	Over-all **strategic inter-agency coordination** and provision of policy guidelines of Project implementation	General Financial Implementation Legal
Project Monitoring	Ministry Level	MIME *Department of Water Supply*	Over-all responsibility for **monitoring Project implementation** against technical and financial	Monitoring Reporting
Project Management Unit	Institution Level	SRWSA *Department of Planning and Technical*	Directly responsible for **project execution and for undertaking actual field supervision and management** of Project implementation	General Project Implementation Project Closure

(4) Te General Implementing Framework of the Project

There is a need to situate the roles of the key stakeholder-institutions that have been identified for project implementation in a framework. This "implementing framework" shall define and govern the general and specific interactions among the project organizations, given their responsibilities for project implementation. The following Figure shows the *General Project Implementing Framework*.

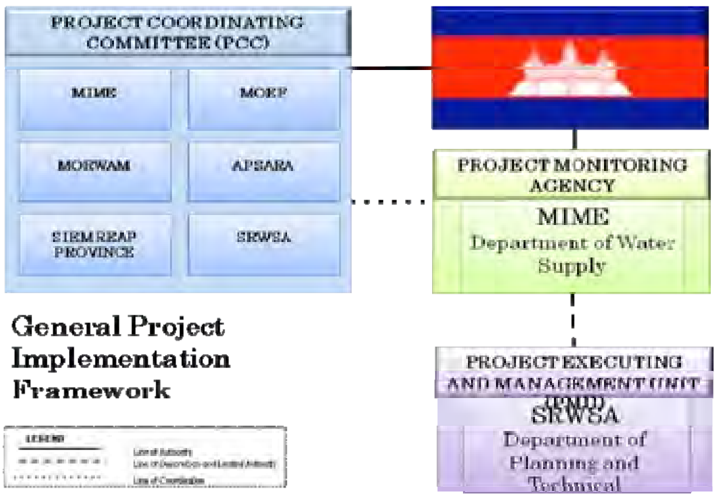


Figure 5.7 General Project Implementing Framework

As shown in the above figure, *a line of authority* (represented by a solid line) exists between the Royal Government of Cambodia and MIME, because the Ministry falls under the direct supervision and authority of RGC. A *line of authority* also exists between the RGC and PCC, because PCC is proposed to be established by virtue of an order emanating from the Council of Ministers.

A *line of coordination* (represented by a dotted line) describes the relationship of MIME and the PCC. Coordinative relationship will be established and sustained between MIME, as monitoring agency for the Project, and PCC, as over-all inter-agency monitoring and coordinating body, especially on oversight monitoring, matters of policy, and resolution of issues and conflicts among the Project's various stakeholders.

Finally, a *line of supervision and limited authority* (half-solid line) is the link that describes the relationship between MIME and SRWSA in project implementation. Strictly speaking, SRWSA is not under the management and operational control of MIME, because the former is an independent public economic establishment. However, MIME and MOEF still have technical and financial supervision over its affairs, respectively. In addition, MIME as the proposed monitoring agency will have over-all monitoring and supervision over project implementation for which SRWSA is the project implementing unit.

(5) General Project Implementing Guidelines

General project implementation and management shall be spelled out in, and governed by, the Loan Agreement between RGC and GOJ. It will include adherence to the Contract specifying the mutual rights and obligations of each party. It will emphasize respecting and abiding by all relevant laws in the RGC. It will also provide for setting up and supporting a project organization (project implementing unit) for the duration of implementation, and strengthening this unit as a primary consideration in the project implementation process.

(6) Role of the Project Consultants Team (PCT)

The Project Consultants Team (PCT) shall provide consulting services to SRWSA as prescribed in the Terms of Reference (TOR). Its services include, but shall not be limited to, project planning and management; project supervision; transfer of technology, and the development of appropriate implementation strategies, work processes and procedures consistent with the fundamental principles espoused by the preparatory study for the project. These may be in the areas of tendering, preparation of technical and feasibility studies, detailed design, and construction management and supervision, as well as financial studies for water tariff determination, start-up operation and maintenance, preparation of manuals, and capacity building.

As field-level consultant-advisor, the PCT shall report directly to the Department Director of the Department of Planning and Development where the "Project Management Unit" for the Project will be set up. The team members will work closely with their counterpart personnel from SRWSA, providing required assistance and advice on various aspects of project implementation as required in the Loan Agreement.

The PCT's position in the entire project scheme on the field level (PMU) for Priority Project and 2nd Project is shown in Figure 5.8.

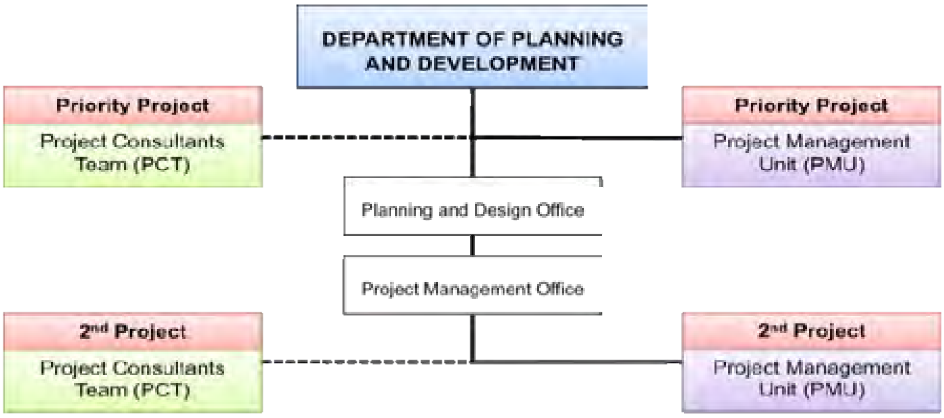


Figure 5.8 Project Consultants Team in Priority Project and 2nd Project

5-4-4 Responsibilities of the Project Organizations

This section will describe and delineate the specific responsibilities of the Project organizations. The end in view is to avoid duplication, and to cover gaps, to ensure the smooth implementation of Priority Project and 2nd Project. The summary of the project organizations' responsibilities are as shown:

Project Organization	Role	Responsibility
Project Coordinating Committee	Coordination and Oversight Monitoring	General
		Financial
		Implementation
		Legal
Monitoring Agency	Technical Supervision and Monitoring	Monitoring
		Reporting
Project Executing and Management Unit	• Executing Unit for the Project • Actual Field Supervision and Project Management	General
		Project Implementation
		Project Closure

(1) The Project Coordinating Committee (Inter-Agency Level)

The responsibilities of the PCC will fall under four categories – general, financial, implementation and legal responsibilities.

General Responsibilities of the PCC

- Formulate and/or recommend on policy issues referred to it because of legal or other conflicts that may arise;
- Identify and set-up mechanisms for systematic and coordinated delivery of services by providing assistance and information on possible resources from their own Ministries

and/or Agencies and its sub-offices or departments that can be tapped to augment and support the process of project implementation;

- To hold regular monthly meetings for the duration of the Project, and call for special meetings as the need arises;
- To regularly report to their respective Ministers on the progress of the Project;
- To report to the Government on the over-all progress of the Project, if required.

Financial Responsibilities

- To identify and ensure the inclusion in each Ministry's priority list of projects for the duration of the Project's implementation, all related facilities not covered under the loan proceeds, but may be part of the Royal Government of Cambodia responsibility under the Loan Agreement, that may fall under the concerned Ministry's jurisdiction;
- To include in the yearly budget call of the concerned Ministry, the priority list of projects that may be required for the Project;
- To ensure the timely release of counterpart (local) funds, if needed, for the Project to the appropriate Ministry;
- To make recommendations on investments related to the Project and include these in the priority investment program of the Government.

Implementation Responsibilities

- To facilitate timely release of construction and other licenses and permits needed for the Project;
- To follow-up solutions to project implementation bottlenecks, problems and issues; and/or course these to the concerned agencies for proper resolution;
- To ensure that the causes of delays in the implementation/construction of related facilities financed out of loan proceeds and/or local funds, if any, are identified and directed to the appropriate agency for resolution;
- To coordinate environmental requirements and/or considerations related to the Project.

Legal and Other Responsibilities

- To monitor land acquisition procedures on their compliance to law;
- To coordinate and find resolution to any legal issues that may arise during the course of the implementation of the Project, including passage of a law or decree that bans the absorption of groundwater.

(2) The Monitoring Agency (Ministry Level – MIME)

As earlier proposed, MIME will be the monitoring agency for the project. Its responsibilities would normally fall under monitoring and reporting.

Monitoring and Reporting

Over-all monitoring and technical supervision will be exercised by MIME, through its Department of Water Supply (DWS). While JICA has a built-in monitoring system of ODA projects, MIME/DWS must develop and set in place its own monitoring and evaluation system that would track the progress of the Project against the technical and financial plan.

Technical monitoring shall include scope, time or schedule, quality, and performance monitoring; while financial monitoring shall include cost (budget), procurement, and disbursements monitoring. The objective of monitoring and evaluation is to achieve efficient and effective project implementation as it keeps an eye on the progress of implementation and provides relevant and timely feedback to project managers and implementers. Feedback is necessary to provide project management the basis for improving operational plans, taking appropriate corrective actions or measures in case of shortfalls, and therefore, putting the implementation back on track.

Generally specified in the Loan Agreement would be the submission of *Quarterly Reports* to JICA until the completion of the project; as well as the *Project Completion Report* not later than six months after the completion of the project, using specified official forms and details of the report. All these reports will be prepared by SRWSA, with the assistance of the Consultants, to be reviewed by MIME (DWS) and when submitted to JICA, will bear the final approval and signature of the duly authorized MIME official.

On its own end, MIME/DWS may require SRWSA/PMU to submit regular monitoring reports on project implementation activities, and of the work of the Consultants. The content and regularity of monitoring may be designed jointly by SRWSA and MIME/DWS to be able to have a clearer understanding of monitoring activities. The monitoring system to be designed and implemented by MIME/DWS will facilitate project implementation and *expedite problem-solving* as one link, or is a part of the *multi-level performance-based expenditure management system*, or is within the *national framework for monitoring and evaluating public sector projects* of the RGC.

Therefore, the first level project monitoring will be performed by the implementing unit, SRWSA/PMU; then second-level by the monitoring agency, MIME/DWS; then the third level oversight coordinative level by the PCC. These levels of monitoring will surely facilitate project implementation because problems not sufficiently addressed on the first level, can be re-identified if it recurs on the second level and so forth, thereby integrating monitoring into a feedback loop that ends up into the next planning period. MIME/DWS shall require the SRWSA/PMU to submit regular (weekly, or every two weeks, or monthly, depending on the agreement) monitoring reports, specifying items that need to be reported. Monthly face-to-face meetings can be initiated to deal with those problems that may not have been adequately addressed.

Proposed Organization for Project Implementation at the Monitoring Agency Level

MIME's Department of Water Supply must be equipped to carry out the over-all monitoring responsibilities. It is proposed that a Siem Reap water supply expansion *project monitoring desk* be created for this project, in order to manage the tasks related to this area of responsibility. The desk will be manned by one engineer, on a concurrent basis, during the detailed design phase, and the prequalification of tender, tender evaluation and contract negotiation phases. This engineer, however, they should be given official appointment for this additional job.

Upon the start of construction, a full-time project monitoring officer (PMO) shall be appointed from among the engineers of the department, or shall be hired for the duration of Project. Also, a part-time accounting clerk (or accounting personnel) shall be made available, on a concurrent appointment, from the roster of existing DWS personnel during these project phases.

Proposed Job Functions

It is proposed that the project monitoring desk be handled by one professional engineer to develop and manage the multifarious responsibilities of MIME/DWS in relation to its monitoring role. The part-time accounting clerk will handle accounting work such as review of procurement and disbursements, and to ensure that these comply with JICA guidelines. Table 5.21 provides the recommended qualifications and job descriptions of these two positions.

Table 5.21 Job Qualifications and Job Function for Project Monitoring – MIME/DWS Level

POSITION	QUALIFICATIONS	FUNCTIONS
Project Monitoring Officer	Must be a licensed civil engineer and should possess at least seven years of relevant work experience.	Shall directly report to the Department Head of the Department of Water Supply, MIME
		Shall be responsible for carrying out the tasks of the project monitoring desk / office with MIME.
		Shall develop the monitoring and evaluation system for the technical and financial components of the Project. Monitoring and evaluating project compliance to the Loan Agreement Monitoring and evaluating the progress of the Project against approved work/financial plan
		Shall prepare and submit appropriate reports on the progress of and the status of the various activities of the Project to: (i) JICA; (ii) MIME; and (iii) PCC.
		Shall judiciously manage the operations and resources of the project monitoring desk / office.
		Shall exercise supervision over the Accountant.
Accountant	Must be a graduate of commerce and accountancy and should possess at least five years of relevant work experience.	Shall report directly to the Project Monitoring Officer.
		Shall be responsible for all administrative and financial functions delegated to it by the PMO.
		Shall assist in the review, monitoring and evaluation of the financial aspects of project implementation such as, but not limited to, procurement and disbursements.
		Shall maintain accurate financial records and proper files of administrative documents at all times.
		Shall assist in the preparation of appropriate reports on the progress and the status of the various activities of the Project to: (i) JICA; (ii) the MIME; and (iii) PCC.
		Shall perform additional tasks given to her/him from time to time.

(3) Project Executing and Project Management (Authority Level – SRWSA)

The Siem Reap Water Supply Authority, since its establishment as a public economy, may not have implemented a project of the scale, cost and magnitude of the Siem Reap water supply expansion project. However, its institutional capacity as an executing and implementing agency can be developed and strengthened especially on project execution, project coordination, project monitoring and supervision, and project management.

SRWSA in Project Execution

The employment of consultants and procurement of all goods and services, financed out of the proceeds of the Loan shall be in accordance with JICA's guidelines for procurement. Because of the size and nature of the Project, it is expected that the civil works contracts will be awarded on the basis of international competitive bidding. There is a domestic contracting industry in RGC, and sub-project surveys, investigations, and designs carried out with JICA funding can be undertaken by prequalified local contractors (private sector companies, institutes, and universities) selected by SRWSA on the basis of local competitive bidding using procedures acceptable to JICA. Procurement of materials and equipment is also expected through local bidding for the reason mentioned above.

Since disbursement of JICA funds follow the principle of payment against invoice and other evidences, together with the certification of completed work, RGC, through the MOEF, shall advance the funds to start the Project activities, and then claim reimbursement from JICA every time a certain portion of the work is completed. The responsibilities of RGC (represented by MOEF) in disbursement are specified in the Loan Agreement, and RGC will abide by the disbursement procedures such as *Commitment Procedures*, the *Reimbursement Procedure*, and *Transfer Procedures*.

For smooth disbursement of loan proceeds, the MOEF may delegate some of its authority to directly to SRWSA, as the project executor and implementer. As such SRWSA will carry out the final review and approval of all the documents submitted to it by the contractors and suppliers, and the General Director will affix his signature prior to its transmittal to JICA.

In project execution, SRWSA will have responsibilities borne out of the Loan Agreement which are: (i) The selection and employment of the Consultants for the Project under the *Guidelines for Selection and Procurement of Consultants for JICA Loans*; (ii) The selection and employment of the Contractors for the Project under the *Guidelines for Selection and Procurement of Contractors for JICA Loans* Performance of the prequalification of tender, tender calling, tender evaluation, and contract negotiation; (iii) Undertaking Project compliance to covenants stipulated in the Loan Agreement.

SRWSA in Project Implementation and Management

The SRWSA is tasked to provide day-to-day supervision over the project at the field level. While it shall be working very closely with the project Consultants, SRWSA's tasks relate to project management as a discipline, applying project management principles, concepts, tools and techniques to improve project performance and organizational effectiveness.

The general responsibilities of SRWSA/PMU are: (i) Reviews billing and expenditure statements; (ii) Prepares request for loan availment according to RGC and JICA disbursement procedures; (iii) Prepares and submits comprehensive work and financial plans (WFP) to MIME as monitoring agency (iv) Undertakes project implementation within the approved work plans and reports the progress of the project to MIME; (v) Assists and participates in coordinating with the PCC and JICA concerning project implementation; (vi) Prepares and submits appropriate supporting reports and jointly reports the progress of the Project to the Government through PCC; and (vii) Prepares and submits project completion reports, conducts closing workshop and prepares and recommends project acceptance certificate.

Project implementation and management must address the full range of activities from the beginning to the end of a project and the management of multiple sub-activities within the Project. SRWSA will become involved in the entire cycle of the Project as reflected in the whole range of services to be provided by the Consultant. Providing day-to-day supervision over the implementation of the Project means addressing technical skills like scheduling, cost estimating, and risk management; and also encompasses other disciplines such as scope definition, procurement management, financial management, asset management, human resource management, environmental and social considerations, and communications.

General Guidelines Governing SRWSA as the PMU

The SRWSA will set up the PMU within the Department of Planning and Technical Department (to be renamed Department of Planning and Development). Therefore, it is proposed that a full-time department director be recruited before the start of the design phase of the Project. Right now, the department director is holding the position of the chief of the Financial and Accounting Office, albeit on a concurrent basis; but his primary responsibility lies with the latter. The proper functioning of the department will benefit SRWSA as a whole, in addition to being a necessity for the design and construction phases of the Project. The department director to be recruited for should possess the required and approved qualifications for the position, and recruitment should follow the SRWSA's "Staff Rules and Regulations" policies. Other guidelines are as follows:

- The PMU staff to be hired will be for the duration of the Priority Project. However, current staff should be readily available for deployment also with the Project.
- The department staff will be utilization and maximization will be prioritized over hired / contract staff.
- Where feasible, department staff will be seconded to selected Consultant's positions.
- The staff shall obtain actual or on-the-job training, which will prove to be very invaluable for the future of SRWSA.
- The PMU staff for the 2nd Project will come from SRWSA's personnel.

Seconding or providing counterpart personnel from SRWSA to that of the Consultant's will mean reviewing the existing qualifications of all SRWSA personnel and matching them with the requirements of each position. This "exposure-assignment" method will ensure that the SRWSA personnel selected is the best counterpart for the Consultant, and is technically trainable to get the utmost benefits from the transfer of technology.

5-4-5 Proposed Organization Structure of PMU in SRWSA

The PMU shall serve as the technical arm in managing, supervising and controlling day-to-day project activities, including the work of the Consultants and contractors, in activities such as project planning and management, project construction supervision, procurement and disbursements, and preparation of reports.

(1) Priority Project Organization

For Priority Project, the PMU will be organized as a separate unit within the approved structure Department of Planning and Technical (to be renamed Department of Planning and Development). The department director will also be the project manager of the Project. He will be assisted by a full time staff hired for the duration of the Project – a project engineer, an assistant engineer and an administrative assistant.

The following figure shows the PMU organization for the Priority Project.

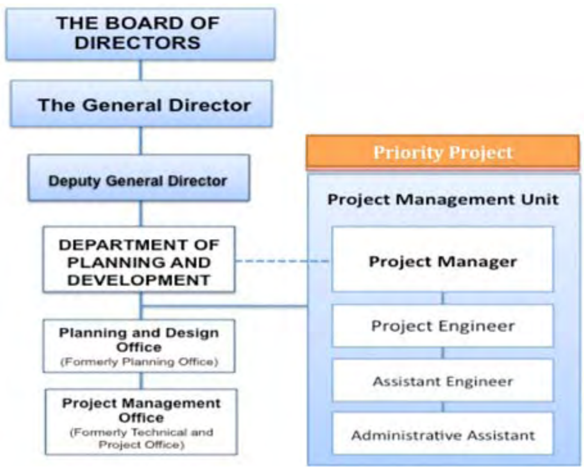


Figure 5.9 PMU Separate Unit in the Department of Planning and Development

(2) 2nd Project Organization

The PMU organization for the 2nd Project is similar to that of the Priority Project, in terms of the number of personnel needed. The difference is that it will no longer be a separate unit, but will be lodged in the Project Management Office (formerly Technical and Project Office). It is assumed that the personnel involved in the Priority Project would have received sufficient training, and will have the capacity and competence to undertake the tasks for the Project. Thus, the chief of office of the Project Management Office will perform the responsibilities as project manager for

2nd Project .

Table 5.10 shows the PMU organization for the 2nd Project.

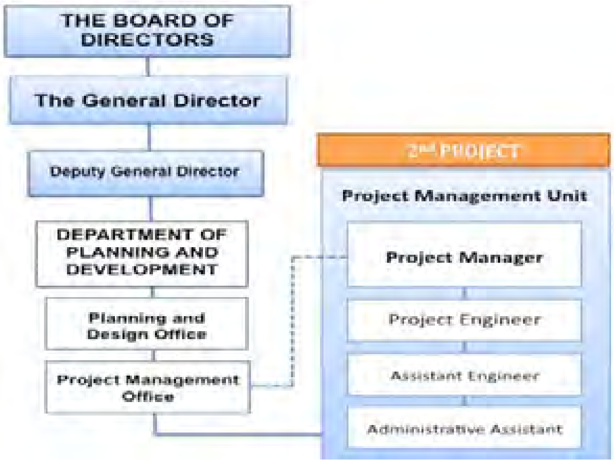


Figure 5.10 PMU as Part of the Department of Planning and Development

(3) Proposed Job Functions of the PMU Staff

As shown, the *Deputy General Director* will be the over-all in charge in project implementation and coordination activities. He shall ensure that the project is implemented in accordance with the schedules, plans and procedures agreed upon with JICA and the executing agency. In addition, as a member of the Evaluation Committee set up at in SRWSA, he shall establish the important linkage and coordination with MIME/DWS on procurement and other project-related activities.

The *Department Director* (Planning and Development Department) works under the supervision of the Deputy General Director. As department director, he shall be responsible for reviewing all documents and communications going to the SRWSA General Director, through the Deputy General Director, for approval or endorsement to external offices. He shall be responsible for management and supervision of technical tasks and studies, such as the review of detailed design, and detailed design of the new treatment plants; basic conceptual studies on local water distribution expansion. He shall bring to the attention of the Deputy General Director, and the General Director important issues and/or implementation conflicts that need immediate resolution on the level of legal, financial, investments, and policy formulation.

The *Department Director* will also perform the tasks and responsibilities of the *Project Manager*. It is expected that the position of a project manager requires ad hoc adjustments, based on moment-to-moment assessments of current conditions, within the context of a comprehensive plan created using sound and consistent methods from relevant past experience. This position also requires collaborative efforts among project stakeholders (JICA, RGC, PCC executing agency, local authorities, project beneficiaries, and other interested parties). The PM for the PMU is expected to perform the following tasks/responsibilities:

(a) Provides direction and guidance to the key personnel of the PMU.

- Reviews and confirm the scope of work of consultants for the approval of the Deputy General Director and General Director;
    - Defines the roles and responsibilities of each PMU team member and secure their respective commitments;
    - Defines the outputs, resource constraints, timelines and quality expectations for the submission of the outputs by each team member.
- Develops the work and financial plans of the project for approval of the Deputy General Director and determine the resource and logistic constraints to complete the objectives of the project.

(b) Develops systems, policies/rules and procedures to manage and monitor the implementation of the project components that should include:

- Monitoring benchmarks to evaluate the progress of the project;
- Monitoring the progress of the Consultant and Contractors in terms of scope, time and budget using the appropriate software;
- Database and monitoring system that will enable quick and accurate online downloading of information on the progress of the project;
- Development and implementation of standards, guidelines and regulations.

(c) Ensures the timeliness and quality of outputs of the Consultants, contractors and suppliers.

- Reviews all reports of the Consultant and recommends the appropriate action, where necessary;
- Recommends to the Deputy General Director the dispatch of people for field visits, coordination and inspection;
- Reviews post-field reports and identifies issues with the necessary recommendations for submission to the Deputy General Director;
- Reviews and recommends invoices, including certification of work completion/acceptance of Consultant and contractors/suppliers for billing purposes;

(d) Manages and monitors all pertinent activities, like work flow and records management; administrative coordination and financial transactions.

(e) Reviews and manages the monitoring plan for environmental and social considerations;

(f) Manages and monitors contractors to notify relevant organizations, like APSARA or EFEO, of any information whenever archaeological heritage is discovered in the course of construction; and

(g) Provides regular progress and performance evaluation reports and to the Deputy General Director, General Director, SRWSA Council of Administration, MIME, PCC and JICA.

The *project engineer* will report directly to the department director, and will be responsible for supervising the technical projects and activities of the PMU, developing various systems and procedures for the smooth implementation of the project, installing and/or developing project management processes for the PMU. The specific tasks of the project engineer are the following:

- Assists the project manager in his responsibility for the management and supervision of technical studies to be undertaken;
- Directly oversees and supervises the implementation of field-level activities, particularly in civil works construction;
- Certifies the completion of work and payments of suppliers;
- Develops and undertakes planning activities, such as but not limited to, the work (technical) and financial plans for submission to and approval of MIME and undertake the implementation of the approved work plan;
- Monitors project activities and accomplishments, using in part, the monitoring system designed by MIME for ODA projects;
- Prepares supporting reports on the progress of the project for MIME, the Government, and the JICA;
- Reviews monitoring report of consultants and contractor's work and submits this to MIME through the PMU's chain of command.

The *assistant engineer* will report directly to the project engineer and will have the following functions:

- Responsible for the field-level implementation and management by providing direction for the effective and efficient field implementation of the different components of the project, while also monitoring the performance of the contractor and the field experts of the Consultant;
- Validates the progress of implementation of each activity in the work plan;
- Assists in monitoring the activities and accomplishments of the project;
- Assists in preparing regular supporting reports for various users;
- Facilitates the preparation of the work (technical) and financial plan;
- Reports and/or find solutions to problems encountered in the field.

The *administrative officer* will report directly to the project manager, and will be responsible for the administrative and accounting functions such as records management, accounting and budgeting, general and support services, procurement, physical facilities and supplies. All delegated administrative and financial functions at the level of the project manager shall be the responsibility of administrative officer. The specific tasks are:

- With the project manager, prepare financial portion of the WFP;
- Coordinate and process procurement of goods and services for the PMU;
- Ensure timely preparation of report of disbursements of the Project;
- Develop maintain and manage records system, project office documents and communications system;
- Process request for payments from suppliers and review compliance with RGC and JICA procedures;
- Keep all project accounts up-to-date;

- Manage and maintain the book of accounts;
- Process vouchers and documents for disbursement of project funds;
- Prepare request for payment for suppliers, contractors and consultants based on the field-level disbursement procedures;
- Prepare periodic accounting reports.

Table 5.22 below provides the personnel requirement summary for project implementation (design and construction phases) for each of the project organizations.

Table 5.22 Personnel Requirement for Proposed Project Organizations

Project Organization	Phase	Year	Personnel Requirement
Project Coordinating Committee	1	2012	None
Monitoring Agency	1	2016	(1) Project Monitoring Officer on concurrent status
	2	2021-22	*Options – Hire or on Concurrent Status* (1) Project Monitoring Officer on full time basis
			(1) Accounting Clerk on part-time concurrent basis
Project Execution and Management Unit	Design	2012	*Hire* Department Director for Department of Planning and Development
	1	Starting 2014	*Hire* (1) Project Engineer (1) Assistant Engineer (1) Administrative Assistant
	2	2021-22	None All personnel for PMU will be regular employees of SRWSA

Chapter 6.
Implementation Plan

Chapter 6. Implementation Plan

6-1 Implementation Plan

The phases of the project are developed according to the following sizes of requirement in order to meet the water demand.

In order to avoid adversely affecting the financial burden over the SRWSA, one phase construction period assumed to be four years and the Priority Project should have another two years for the preparation of the Project. The preparation is a pre-construction stage and consists of several proceedings, detailed design and tendering.

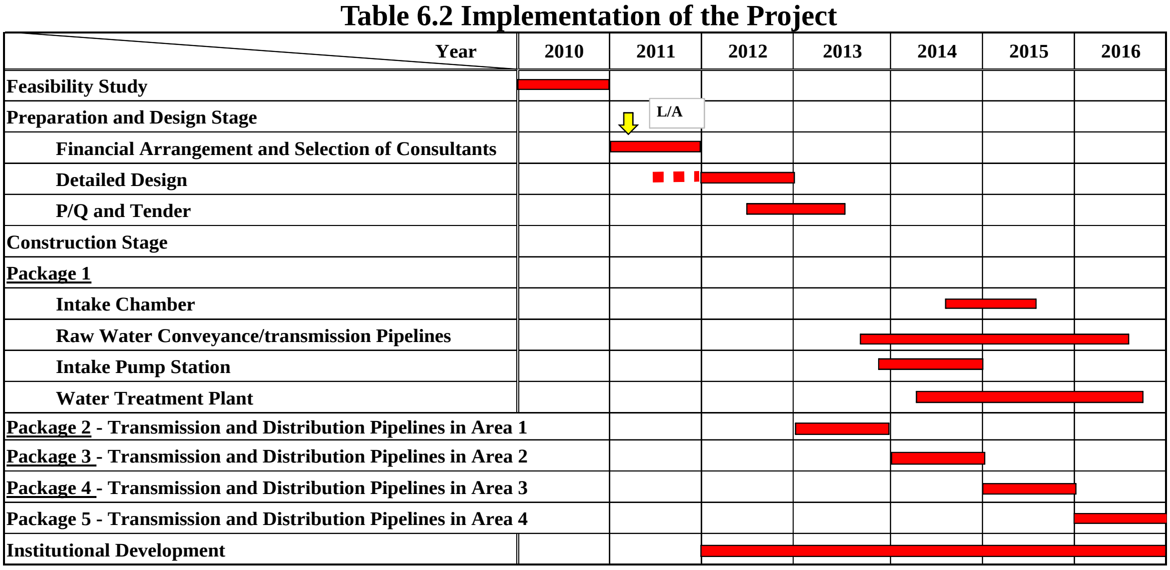
Table 6.1 Phasing of the Project (Nominal Design Capacity, m^3/d)

Items	Priority Project	2^{nd} Project	Total
Target Year	2022	2030	N/A
Intake chamber	60,000	-	60,000
Structure of intake pump station	60,000	-	60,000
Administration building in WTP	60,000	-	60,000
Mechanical and electrical works for raw water intake pump station	30,000	30,000	60,000
Raw water conveyance pressure main	30,000	30,000	60,000
Water treatment facilities	30,000	30,000	60,000
Clear water reservoir	30,000	30,000	60,000
Elevated water tank	30,000	30,000	60,000
Mechanical and electrical works for WTP	30,000	30,000	60,000
Mechanical works for chemical devices	30,000	30,000	60,000
Transmission/distribution pipelines	30,000	30,000	60,000
Elevated water tanks	30,000	30,000	60,000

6-1-1 Implementation Schedule

The implementation schedule is shown in Table 6.2 and detailed in **SR 6.1**.

Table 6.2 Implementation of the Project



In connection with the target years for this Study, the Priority Project is an urgent project and is expected to be completed by the end of 2016.

2010	Feasibility Study
2011	Financial Arrangement and Selection of Consultants
2011-2012	Detailed Design
2012-2013	Pre-qualification and Tender
2014-2016	Package 1 (Construction of WTP)
2013-2016	Package 2, 3, 4, and 5 (construction of pipelines)

6-1-2 Mode of Implementation

The construction works for the Priority Project will be carried out by selected contractor/s upon international/local competitive bidding (ICB/LCB) on the following tender package which has been decided taking into account the advantages in technical and economical aspects. The major consideration in packaging was put on the nature of works, the size of contract and to avoid less attractive to the international construction companies

- Package 1 : Construction of Intake Chamber, Raw Water Conveyance Pipeline, Intake Pump Station, and WTP (ICB)
- Package 2 : Construction of Transmission and Distribution Network Area 1 (Q4) (LCB)
- Package 3 : Construction of Transmission and Distribution Network Area 2 (Q3) (LCB)
- Package 4 : Construction of Transmission and Distribution Network Area 3 (Q2) (LCB)
- Package 5 : Construction of Transmission and Distribution Network Area 4 (Q1) (LCB)

The pre-qualification of tenders will be carried out for all the packages to select the qualified construction firms with sufficient capacity in terms of financial, technical and staffing.

6-1-3 Condition for Construction Execution

(1) Topography, Meteorology, Hydrology and Geology

The site for major works is located on a flat alluvial plain. The current ground elevation for the proposed WTP is 11 meters above the mean sea level at Ha Tiem (MSL). The ground elevation gently decreases toward Tonle Sap Lake within 11.5 kilo-meters of distance where the proposed water conveyance pipe line will be installed. The current ground elevation for the proposed distribution pipe line gently expanses from 12 meters to 20 meters above MSL.

The wet season occurs from May till November. The dry season occurs from December to April. The water level of Tonle Sap Lake in the wet season becomes high which reaches 11 meter above MSL. The construction works of Intake Chamber, Conveyance Pipe Line and Intake Pumping Station should be completed within the dry season, otherwise some auxiliary work will increase the construction cost and extend the construction period.

The ground water level is high in connection with the water level of Tonle Sap Lake. The intake chamber, a part of the proposed water conveyance pipe line and the proposed intake pumping station, will be installed completely under the ground water. Dewatering should be necessary for earth works.

Detailed soil investigations are summarized in **SR 4.6** and **4.14**.

(2) Infrastructure

The ports of Phnom Penh and Sihanoukville are the available ports to unload equipment from Japan and other countries. The materials and equipments which are imported and/or procured in Phnom Penh should be transported by an inland transport, because the construction site in Siem Reap locates 250 kilo-meter far from Phnom Penh.

(3) Labor Force

Skilled and semi-skilled laborers can be recruited in the Phnom Penh area. However, sufficient numbers of engineers for the construction will not be obtained in Cambodia. It will be necessary to employ additional engineers from other countries.

6-2 Permission and Legal Procedures

The proceedings to obtain permissions and authorizations for the project commencement are relatively straightforward, except the proceeding of environmental impact assessment (EIA). EIA examinations are executed in detail with important roles, because of not only the environmental protections and the ruins preservation but also a requirement satisfaction of international funding institutes. As **t**o land acquisition, with the approval of SRWSA Board Council, SRWSA is able to acquire necessary lands promptly using their own fund. However the measure of compulsory execution for land acquisition is avoided as much as possible in Cambodia. When the consent of landowner cannot be obtainable, SRWSA will immediately change the candidate land to other adjacent place.

Registration, inspection, surveying and mapping of the land is carried out by the General Department of Cadastre and Geography, Ministry of land Management, Urban Planning and Construction.

6-2-1 Authorization to Commence Water Supply Expansion

The authorization to commence the water supply expansion project is held jurisdiction over by both of Ministry of Industry, Mines and Energy (MIME) and Ministry of Economy and Finance (MOEF). MIME is in charge of technical matters, while MOEF deals financial matters. Loan agreements with financial institutes like new JICA are concluded by MOEF as financially controlling authority. The procedure to obtain authorizations from MIME and MOME is called as “Final Approval after Board Meeting”.

The authorization from the MIME and MOEF is stipulated in Article 13 of “Sub-decree 04 on

Establishment of Siem Reap Water Supply Authority as Public Enterprise with Financial management" The law was enforced on 10 January 2007.

In order to obtain the authorization to commence the water supply expansion, the procedure does not require long time, because the SRWSA Board Council consists of representatives of seven public organizations which include the representatives of MIME and MOEF. The seven representatives are as follows:

1) MIME
2) MOEF
3) APSARA
4) Siem Reap Governor
5) Council of Ministers
6) General Director of SRWSA
7) Employee Representative of SRWSA

These mean the representatives of MIME and MOEF are one of promoters and management regarding water supply in the city. The Board Council is held every three months.

In addition, this project is under supervision of the Steering Committee which consists of five members. The representatives of the five members are from almost same organizations of the Board Council. Namely:

1) MIME
2) APSARA
3) Siem Reap City
4) JICA
5) General Director of SRWSA

The existence of this Steering Committee is also one factor to enable smooth promotion of the Project.

6-2-2 Procedures before Project Commencement

Above mentioned proceedings are prerequisite of all other subsequent procedures. Based on the authorization of MIME and MOEF, the following procedures are taken.

1) EIA
2) Water Intake Activity
3) Occupation of Civil Structures in the Lake, Community Fisheries, Inundated Forest Area, Multiple Use Area, Biosphere Reserve
   Note: As to the designated areas above zones and areas, see maps in Chapter 11.
4) Land Acquisition
5) Loan Agreement
6) Permission of Construction

Out of many legal proceedings, EIA is the procedure which must pass the most rigorous examination. This procedure is based on Article 9 of Sub-Decree 72 on Environmental Impact Assessment Process. In addition, a salient feature of this project's proceedings is the numbers of kinds to request permissions with regards to the Tonle Sap Lake. On the shore of the lake, there are many kinds of designated environment-related zones such as Community Fisheries Area, Strictly Protected Inundated Forest Area, Multiple Use Area and Biosphere Reserve. The application for permission concerning Community Fisheries Area is based on Article 60 on Chapter 11 of "Law of Fisheries" and the application of Strictly Protected Inundated Forest Area is based on Article 28 on Chapter 6 of the same law. The large wetland system in the Tonle Sap Lake supports one of the world's most productive freshwater fisheries and the ecosystem is essential to the survival of many globally significant species. In recognition of the lake's importance, a Royal Decree designated the Tonle Sap as a Multi-Use Protected Area in 1993. In 1997 it was nominated as a biosphere reserve under UNESCO's Man and Biosphere Program.

As the big scale construction which includes two big diameter pipelines of 1,200 mm is planned to pass through the areas, the proceedings related to the Fisheries Administration of Ministry of Agriculture, Forestry and Fisheries (MOAFF) are anticipated to presuppose the compensations to farming and fishery.

Beside the said pipelines, as a water intake chamber is planned in the Tonle Sap Lake, the applications for water intaking act itself and occupation work pieces must be submitted to the Tonle Sap Authority (TSA). TSA is the organization which took the services related to the Tonle Sap Lake matters over from MOAFF in 2009. TSA is not in a position to give permissions to the water works directly. After receiving the application TSA will recommend to the Prime Minister about the water intake act and the construction. The Prime Minister will give the permission. It will be supposed to take one month to receive the permission. These procedures are also gathered in the Article 4 of the Royal Decree on Creation Authority of Tonle Sap (June 29, 2009). It says:

- be under the direct supervision and staffs of the Royal Government in all project in order to research study, control and suggest to the Royal Government,
- cooperate with ministries, institutions, relevant authorities, and other development partners to formulate the policy and strategy of any programs and projects,
- cooperate the present and future activities with the ministries institutions, local authority, national, international, non governmental organizations and any civil communities at the Tonle Sap Zone, for obtaining an effective support to implement the project,

Among the above applications, the areas of Community Fisheries zone, Inundated Forest Area zone, Multiple Use Area, Biosphere Reserve zone are mostly overlapped.

6-2-3 Land Acquisition

Necessary land acquisition arrangement is better be made before the project implementation.

The legislation regarding land acquisition is under the jurisdiction of the Ministry of Land Management, Urban Planning and Construction. The law for compulsory acquisition has not yet enacted. When the measure of compulsory acquisition is needed, the related authority has to obtain permission from the Assembly. But land acquisitions by compulsory acquisition are avoided as much as possible in Cambodia; especially water works makes it fundamental principles to acquire lands under mutual agreement.

On negotiations SRWSA, to begin with, talks with the chief of commune and then the chief of commune negotiates with the landowners. When the negotiation could not reach agreement, SRWSA needs to change the candidate lands to other places. Although it sometimes seems to require time, the time required to buy will be about three months, because the fund is of SRWSA and approvals is gotten only from SRWSA Board.

Public land is relatively easy to obtain and the payment will not be accrued.

According to the SRWSA, they are very prudent to acquire lands because it requires the big fund and their responsibility of acts. In the scheduling of respective proceedings, the timing relations among the permission of EIA, negotiation with landowners, securing of fund for land acquisitions and compensations, and negotiation with international funding institute are intricately-intertwined with each other. Therefore, the scheduling and its executions have to be done carefully.

6-2-4 Main Procedures during Detailed Design and Construction Stage

Building Permission

Building permission is done according to the Sub-Decree 86 named “Sub-decree on construction permit”. According to the Department of Land Management, Urban Planning and Construction (DLMUPC), they don’t have an upper decree of the Sub-Decree 86.

For the procedure of permission, the owner of the project submits three applications as follows:

1) Permission for construction,
2) Permission for opening site, and
3) Permission for closing site.

The permission for construction requires 45 working days from the application, but the permission in case of SRWSA presupposes to obtain the permissions from MIME beforehand.

For the application of permission for construction the owner prepares the organization of the construction and drawings. The drawings to submit consist both of architectural drawings and structural drawings but structural calculation is not necessary to submit. All drawings for submission must be written in Khmer language according to DLMUPC.

In Cambodia, there is no standard for architectural design yet, but the owner must get the examination of aesthetics aspect. Buildings are examined if they conform to the Khmer style or not.

As to the permission for opening site and permission for closing site, the owner must submit applications before one week respectively, and they have inspections of DLMUPC.

The Siem Reap City has no designated land use zone regulation. According to DLMUPC, they has prepared and sent the plan for approval to the Ministry Interior and National Security but not yet received the answer. So at the moment there are no limitations in the term of designated land use zone to build water treatment facilities.

In the private sector constructions like hotels, competent receiving offices for permission applications are classified by the building scale as follows:

- Less than 500 m^2 of floor area : Siem Reap District
- 500 to less than 3000 m^2 of floor area : Provincial Government
- More than 3000 m^2 of floor area : DLMUPC

DLMUPC does not involve in building water utility resources on the permission for construction

6-2-5 Application of Electricity Leading-In

As the Feasibility Study for the water supply project the receiving power is estimated as 2500kVA (including the demand of pumping station of 500KVA) and the receiving voltage will be 22 kV.

In order to receive the power, the procedure starts with submitting application of power lead-in to the Director of Electricité du Cambodge (EdC) at the stage of detailed design. The voltage is classified into low voltage of 400kVA and medium voltage of 600kVA. At the stage the site of the facility must be determined. Following to the application, EdC sends his engineer to survey to the site and when location of the facility is satisfactory, EdC gives the license to SRWSA for the promotion of the detailed design. It takes about one week from the submission of the application to the acceptance of the EdC. Then, in order to guide the detailed design stage of electric works, the copy of the regulation of EdC for the design will be handed to the Consultant.

All the flow of the procedure is as follows:

- Application is submitted to EdC.
- Site survey of EdC.
- In case the result of survey has no problem, license is given from EdC.
- Detailed design by the Consultant.
- Consultation with EdC on standards of electric design.
- Construction starts.
- EdC controls the construction from the start to the end.
- If the construction conforms to EdC’s standards, EdC approves the construction.
- SRWSA submits the application of connection.
- SRWSA concludes the contract with EdC.

The designation of an electrical chief engineer/licensed electrician in charge of operating and maintaining electric facilities in the plant, and the preparation of a “maintenance code/safety regulations are not required by EdC.

6-2-6 Procedures of Distribution Pipeline Works

For the pipe laying works in the City/down town area, in the Landscape Protection Area of MOE and in the Protect Zone of APSRA, special cautions will be required for aesthetic aspects and safety control. As to the said designated Zones and Areas.

As the procedure before the construction stage and during the detailed design stage, we have important two procedures. The one is occupying work pieces application to the Siem Reap Provincial Hall and the other is the negotiation on repair payments of road pavements with the Department of Public Works and Transport (DPWT).

Asphalt concrete-paved roads are managed and controlled by DPWT and the application of construction must be submitted and also the preparatory payment will be requested for the road repair after completion of constructions. As the amount is not necessarily small so that SRWSA must negotiate with DPWT in advance to avoid the problem.

DPWT explained that the payment doesn’t mean the fee for administrative services, but for road repair. The payment depends on kinds of road and the unit price for Double Bituminous Surface Treatment (DBST) is US$50 per square meter and the unit price for Asphalt Concrete (AC) road which is excavated across the road is US$100 per running meter. When the distance of pipe laying is long, negotiation will be conducted.

DPWT wants to avoid road excavation as possible as can and when determining the pipeline location near by the center of the road should be avoided. After the SRWSA side designs the plan, it must submit to DPWT for evaluation and approval. Then DPWT starts to estimate and decide the cost of road repair. The payment is to be done before the construction. If the plan is not detail the expert of DPWT will make suggestions and check at the site. The payment must be 100 percent in advance. But if there are many sites and long distance of pipelines a contract for some deposit have to be concluded and the documents to the Provincial Governor have to be submitted. The Provincial Hall will arrange a meeting to settle the issue. The Siem Reap Governor is controlling both organizations of SRWSA and RPWT.

DPWT explained that even if the construction will be executed under ODA, the procedure and payment are same as above-mentioned conditions. A construction along with soil pavement or side-walk SRWSA doesn’t need to pay. The soil roads and red laterite roads (gravel roads) in the city are under control of commune councils.

For the implementation of the construction, the following matter will be considered.

- Occupying work pieces documents must be submitted and permitted from the Provincial Hall. Exact plan is required and any kind of change must be updated.
- Construction site must be well organized, cleaned and arranged, especially for tourism.

- Safety control must be done by experts and be specialized. For safety construction in roads, DPWT doesn’t have exact technical standards. In the construction inside the downtown side, the police department has to involve for working process, but it is in the country side putting the sign boards is usual.
- In the construction stage buried structures such as telecommunication cable, electric cable and optical fiber cable must be paid attention and the contractor must request witnesses.
- In case detour is necessary, the contractor shall manage for that and put the signs.
- Before the construction commencement the contractor side should announce to the people around the sites by letter and the like regarding the site location, length of construction, construction influences and the project benefit. The notice of benefit is important to obtain their attention and cooperation. Public relations and explanation to commune chief is also important.

DPWT suggested that SRWSA organizes/employs team advisors from relevant organization which headed by SRWSA.

The procedures and an example of schedule which indicates the timing of procedure are summarized in the following tables.

Table 6.3 List of Proceedings

No.	Proceedings	Competent Authority	Required Time	Remarks
(1 stage): Authorization of Expansion				
1	Authorization of water supply expansion	MIME, MOEF	2-3 weeks (2months)	-When 2 months elapse, the application will be approved automatically.
(2 stage): After MIME permission before Land Acquisition				
2	Permission for taking water in and occupation work pieces	TSA	1 month	-Intake chamber/Tower and Raw water conveyance pipeline.
3	Permission for taking water	MWRAM		
4	Biosphere Reserve's permission	Tonle Sap Biosphere Reserve Office of UNESCO (MOE)	Included in the No. 2 procedure	-Construction of raw water conveyance pipeline in Buffer Zone.
5	EIA permission	Department of EIA (MOE)	2-3months	-Refer to Chapter 11.
6	Landscape Protection Area's permission for water main works	Department of Protected Area (MOE)	Included in EIA	-Refer to Chapter 11.
7	Multiple Use Area's permission	Department of National Park (MOE)	1 month	-Refer to Chapter 11.
8	Community Fisheries' permission	Fisheries Administration (MOAFF)	1 month	-Refer to Chapter 11. -Pump station and raw water conveyance pipeline. (Beforehand negotiations for compensation and land acquisition are necessary)
9	Strictly Protected Inundated Forest Area's permission	Fisheries Administration (MOAFF)		-Refer to Chapter 11
(3 stage): After Loan Agreement and during Detailed Design				
10	Permission for construction (of building)	Department of Land Management, Urban Planning and Construction (DLMUPC)	45days before construction	-If architectural design is conform to Cambodian style, other examinations can be smooth. Before construction, but before closing detailed design work.
11	Application of electricity leading-in	Electricité du Cambodge（EdC）	1 week	-The first application is to be done at the beginning of the detailed design stage and discussion is to be done on the standards.
12	Occupying work pieces permission for water mains	Siem Reap Provincial Hall	Short term	
13	Negotiation for repair payment of road pavements	Department of Public Works and Transport (DPWT)	1-2months	-Approval and negotiation of road repair payment.
(4 stage): During Construction				
14	Permission for opening site/closing site	DLMUPC	1 week	-Applications are sent at the beginning and the end of the construction.
15	Permission for connection of electricity	EdC	1 week	-EdC controls from start to end. -Finally the contract is concluded.

Note: ■marks denote activiteis of procedures.

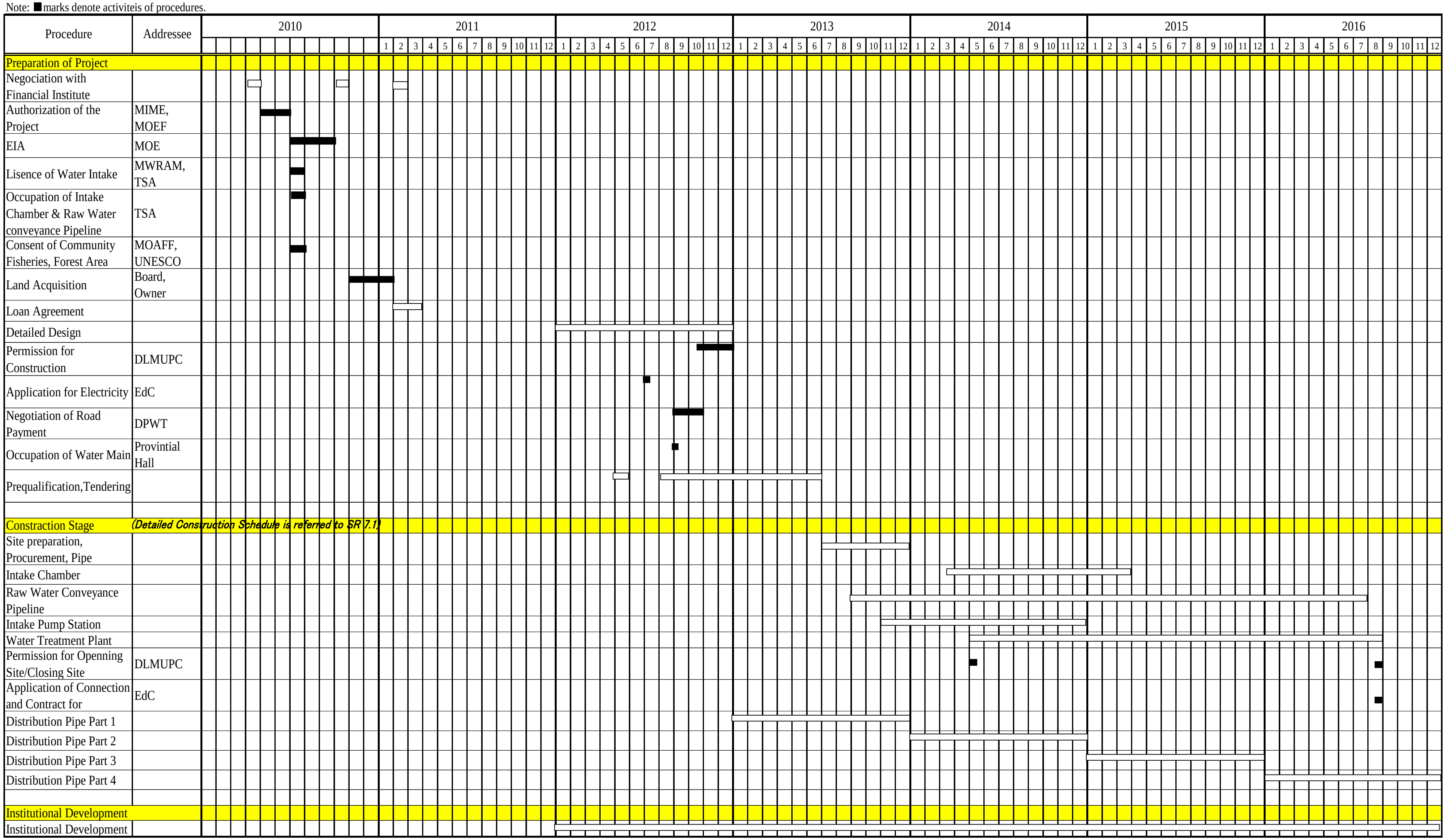


Figure 6.1 Proposed Legal Procedures for Obtaining Permissions

6-3 Procedures for Sound Management

Main issues of the captioned matter are restriction for groundwater collection and revision of water rate of commercial use. The followings are the current situations and regulations regarding these issues.

6-3-1 Restriction for Groundwater Collection and Switch to SRWSA Water

As to the regulations and policies to switch water usage after the completion of this Project from well water to SRWSA's water, surveys on regulations/laws, hearing from APSARA and DWRAM, and discussions with SRWSA were conducted. The certain switching will be vital for keeping public hygiene from water-related risk, protecting archaeological ruins and maintaining sound sustainable financial conditions of the Water Work. Especially hotels' water usages are focused on as commercial-scale utility customers.

There are four organizations which are thought to have relations with groundwater resources of hotels, namely:

- MWRAM/ DWRAM
- SR Provincial Governor
- APSARA
- SRWSA

Through the survey on the restriction of ground water collection, the findings given below;

There have not been any substantial/consistent regulations which restrict to collect groundwater in the Siem Reap City. To date no discernible problem is reported but the increasing hotels and commercial areas require much more water in the recent future. Considering the situation, SRWSA is planning to increase water production and the effective cost recovery at the same time. SRWSA has the intention to leverage "Water Resources Management Law" which MWRAM oversees, in order to control groundwater usage in collaboration with MWRAM and other organizations.

According to the Water Resources Management Law;

Water and water resource belong to the Government of Cambodia (Article3), practicing the water resource management law is under MWRAM jurisdiction (Article 6), MWRAM has a duty to keep the balance of water demand on economic development and regional environment in the present and future (Article 9), MWRAM has a duty to groundwater management (Article 10), using water resource over limited in domestic or small scale usage must be applied for license (Article 12), the government can amend the water license for public advantage (Article 16), MWRAM can cancel the water license in the cases that negative impact on public health or the environment (Article 17), and non-drilling zones for groundwater collection shall be defined in Sub-decree (Article 20).

Although MWRAM has all groundwater related rights and the restriction of groundwater collection is stipulated in the Article 20, as "non-drilling zones for groundwater collection shall be defined in Sub-decree", the decree has not determined/published yet. Regarding this matter DWRAM answered to the study team like following;

"MWRAM/Cambodia has no strict rules because we don't have enough supplied-water. Even if we have enough supplied-water, when the price is high, we can not prohibit people to use groundwater. MWRAM has no Sub-decree of Article 20 at the moment. Now MORAM is preparing the Sub-decree for water resource management. As to the policy/decree to make hotels switch their water source to SRWSA water in order to keep the groundwater level, there is no strict rule."

For these legal situations the General Director of SRWSA answered in the interview on 19 March, 2010, SRWSA and MWRAM will consider and enact the Sub-decree of Article 20 for prohibiting all the hotels and commercial entities from using groundwater and enforce to switch water from well to water works. In addition he mentioned that prior to this Project, the project of KTC will start its construction of water treatment facilities of 17,000 m^3/day and then will start the operation earlier than the Project of this JICA Feasibility Study, therefore the above mentioned Sub-decree will have been enacted when this JICA Project completes.

The General Director of SRWSA also mentioned in the discussion on 13 March 2010, SRWSA has the intention to invite the entire hotels representative to an explanatory meeting for the requesting cooperation to SRWSA and the intention to visit high school students and to explain the importance of clean water and ask them to request their families understanding and cooperation.

As to the Siem Reap Governor role, the role can issue a provincial ordinance to hotel representatives to encourage using SRWSA water. SRWSA also is expecting this effect.

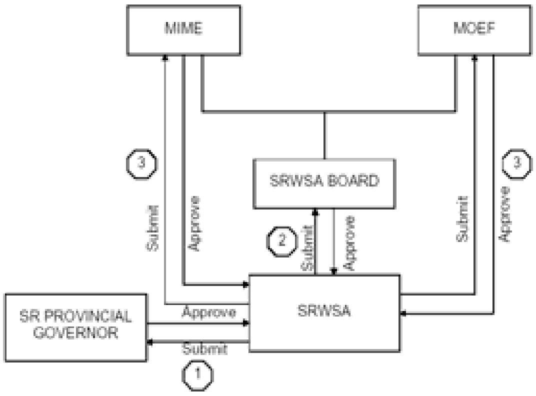
As to APSARA function, it is controlling the well water collection only in the ASPARA Zone 1 to 2. Therefore APSARA has no duties to control the well water collection in the feasibility study area. There is movement to organize the committee on ground water collection but it has not yet been materialized. However it has strong influence in tourism measure and takes part in both of the SRWSA Board Council and the Steering Committee of this JICA Project. SRWSA can expect APSARA's influence.

As above-mentioned, the promotion of enforceable measure which makes hotels switch their water source from well to SRWSA water depends on forthcoming legal approach and SRWSA's aggressive activities of public relations. Fortunately, most of hotels and populace recognize the present negative qualities of well water and are longing for clean and risk free water from SRWSA. Therefore it is considered that the switching over by legislative action will be able to be successful on condition that SRWSA will supply water in compliance with the Cambodia Drinking Water Standards at a reasonable water rate to the people through implementation of the Project.

6-3-2 Revision of Water Rate

Revision of water rate is determined by the approvals of MIME and MOEF.

First SRWSA requests the approval of the Provincial Governor, and then SRWSA submits the proposal of the revision to the SRWSA Board Council and finally request the final approval to MIME and MOEF. The flow of the revision is shown in Figure 6.2.



Note: Numbers of 1,2,3 denote the sequence of procedures

Figure 6.2 Flow of Water Rate Revision

6-4 Construction Plan and Schedule

Necessary permission and legal procedures shall be conducted before and/or during the construction works as detailed in the previous section 6-2.

The construction methods for the Works are analyzed based on the site investigation including topographic survey and soil investigation at the proposed sites and along the designated pipelines.

During the construction of the Works, the Contractors shall ensure that none of his activities shall cause undue hindrance to others/public in the performance of their duties. At least one lane of traffic shall be maintained over entire length of the main roads through the construction area and access shall be maintained at all times to properties adjacent to the construction areas.

All utility services shall be protected and maintained to consumers during the execution of the Works. The Contractors are responsible for maintaining temporary water supplies to consumers in the case of continuation of the Contractor's work beyond the allowed shut down period.

Each Contractor for packages is expected to provide temporary site offices for his own requirements and for the Engineer.

The proposed water treatment plant site office will be used as the main site office of the Engineer and ranked as a representative of project implementation for the Contractor, Consultants, and Engineer in addition to the supervision of the construction works for the water treatment plant. The other field offices will control the local construction works for the raw water conveyance pipelines, transmission pipelines, and distribution facilities, respectively.

6-4-1 Intake Facilities and Raw Water Conveyance Facilities

The field office will control the construction works for the intake chamber, raw water conveyance pipelines, raw water intake pump station, and raw water conveyance mains. A temporary and/or access roads will be required to maintain the daily activities of the Contractors around the site. The Contractor is recommended to provide a temporary filed office as mentioned in the previous section to supervise the following sophisticated construction works effectively in close collaboration with the construction works being proceeded at the proposed WTP site. A tentative construction schedule is referred to **SR 6.1.**

(1) General

- Construct access road to the site by cutting and/or filling with imported earth and/or gravels
- Provide temporary fencing
- Clear site and provide site office, stores, workshop, and parking area for vehicles, plant and equipment
- Establish water, electricity and telephone services
- Divert waterways as required
- Remove the trees from the route of access road

(2) Raw Water Intake Chamber, Raw Water Conveyance Pipelines, Raw Water Intake Pump Station, Raw Water Conveyance Main

- Place access road to the Tonle Sap Lake site and pump station site
- Place coffer dam at the construction area within the Tonle Sap Lake
- Provide dewatering and excavate soil to the required formation level
- Cast the concrete structure with openings left for pipe works, penstocks etc.
- Install pipes, gates, penstocks, ladders, pumps and other M & E works.
- Test for water tightness and repair if there are leakages.
- Remove coffer dam
- Remove surplus earth, debris etc. and dispose of at an approved location
- Commission the plant.
- Remove top soil and fill and compact site to the base level
- Set out the structure
- Drive bored/in-situ R.C piles socketed into the bed soil
- Build the structure leaving openings for pipeworks, valves, penstocks, gates,etc.

- Install pipeworks, valves, penstocks, instrumentation, electrical wiring and other mechanical/electrical works.
- Test the structure for water tightness and repair if there are leakages.
- Provide landscaping
- Disinfect and test run the structure
- Commission the structure.

6-4-2 Water Treatment Plant

The main site office will control the construction works in the plant site. A peculiar construction work is a large scale borrow fill at the proposed WTP site. Diversion of the existing stream flowing from southern area to the site is required to secure the proposed plant area. A good relation to the nearby residents and temple located near by the site is vital so much so that temporary roads should be provided to maintain the daily activities of residents around the site.

(1) General

- Provide temporary access road to the site by cutting and/or filling with imported earth
- Provide the residents with casual roads with imported earth or gravel
- Clear site where necessary
- Execute earthwork for the internal roads
- Divert waterways as required.
- Provide temporary fencing
- Establish site office, toilets, stock piling area, workshops, and parking area for vehicles, plant and equipment.
- Provide water, electricity and telephone services to the site

(2) Distribution Chamber/Flocculation Basin/Sedimentation Basin/Filtration Unit/Clear Water Reservoir/Transmission Pump Station/Administration Building/Chemical Building

The base for support the structures are located at least 3 to 5 m below of the planned base slabs level so that piling into the base soil is must.

- Remove top soil and fill approximately 3 to 5 m and compact site to the base level
- Set out the structure
- Drive bored/in-situ R.C piles socketed into the bed soil
- Build the structure leaving openings for pipeworks, valves, penstocks, gates,etc.
- Install pipeworks, valves, penstocks, instrumentation, electrical wiring and other mechanical/electrical works.
- Test the structure for water tightness and repair if there are leakages.
- Provide landscaping
- Disinfect and test run the structure
- Commission the structure.

(3) Clear Water Reservoir, Clear Water Pump Station, Backwash Recovery Facility, and Maintenance Building

The area for these structures is expected to be of sufficient bearing capacity. The designed foundation is there a raft foundation.

- Remove top soil and level site as required
- Sheet pile, if any, and excavate to the formation level of the structure
- Arrange for dewatering system, if any

- Build the concrete structure providing openings for pipe installations.
- Install pipeworks, valves, pumps, instrumentation, electrical wiring and other mechanical and electrical works.
- Test the structure for water tightness and repair if there are any leakages.
- Provide landscaping
- Disinfect and test run the structure
- Commission the structure

(4) Sludge Drying Beds

The foundation will be placed at a level of approximately +14 m.

- Remove top soil and level site as required
- Excavate to the foundation level
- Excavate the bottom 1 - 2 m below the foundation level
- Install dewatering
- Improve the ground by filling with moist compacted sand up to foundation level.
- Fill and compact the interspace in between the beds to the shape in stages up to the top level.
- Rubble pack the walls
- Tidy up the site and landscape
- Commission the beds

(5) Landscaping

- Relocate the existing stream, if any
- Construct access roads
- Complete all structures and pipe works
- Tidy up the site
- Landscape

6-4-3 Distribution Facilities

Distribution pipeline comprises the laying of ductile iron pipes of diameter varying from 250 mm to 800 mm for a length of approximately 34 km and PE/uPVC pipes ranging from 80 mm to 200 mm diameter for a length of about 326 km from the proposed WTP to the service areas. Approximately 84 km, 47 km, 98 km, and 131 km of distribution pipelines are shared by Q1 (northwestern area), Q2 (southwestern area), Q3 (northeastern area), Q4 (southeastern area), respectively as show in a distribution schematic. The pipeline would be laid mostly along the main roads under the jurisdiction of the road authority.

The road authority will carry out the permanent reinstatement of the roads and necessary payment shall be made for them from the project fund. However, the contractor will be required to effect temporary road reinstatement immediately after the completion of that part of work.

The detailed activities to be performed for the construction of the major distribution facilities are presented below in the sequential order.

(1) Distribution Pipes

- Obtain road authority approval for trenching and culvert/ bridge crossings
- Obtain police approval for the commencement of work and traffic control arrangements.

- Notify respective local authority, public and private transport companies etc.
- Inform public utility agencies (e.g. SRWSA, Telecom, EdC), and obtain their services to identify the locations of their underground utilities, and to assign their staff to stay with the contractor in critical areas of likely damage. Furthermore, these authorities should be kept informed to attend to any damage to the services promptly
- Notify residents/general public/traffic about the impending work and the likely inconveniences that may cause to them during the construction period by paper advertisements, electronic media, public address system and by hand bills.
- Study the road safety requirements and procure all necessary sign boards and other implements to comply with the requirements laid down by the Police.
- Investigate and decide locations where machine excavation, manual excavation, rock excavation, shoring, sheet piling, dewatering etc, will be required. The type of excavators, the suitability of excavated earth for backfilling or not etc., also could be ratified.
- Decide on the most appropriate dewatering system (e.g. well point system, sump method, direct dewatering)
- Study areas where any existing structures/properties are likely to be damaged and decide suitable methods to avoid such damages
- Study areas where any temporary relocation of people living around is needed and take necessary measures in this regard.
- Investigate on the need to divert/relocate existing services to facilitate the pipe laying and arrange for such diversions/relocations with the respective agencies.
- Arrange a suitable borrow pit in a nearby convenient area to procure imported earth if necessary.
- Arrange a stockpiling area for bulk storage of river sand, borrow earth, bedding materials, road reinstatement materials etc., These materials should be protected from rain by covering with polythene sheets/ tarpaulins or by other approved methods.
- Arrange a tipping area for disposing of surplus/unsuitable excavated earth, excavated road materials, and debris.
- Establish site offices (mobile or otherwise) complete with water, electricity, telephone and toilet facilities.
- Carry out trial holing to identify the configuration of the existing underground utilities and to decide on the most suitable route for the pipe laying causing minimum damage/disturbance to these services.
- Barricade the site and mobilize pipe laying crews and machinery
- Barricade the sites and mobilize chamber construction/manhole construction/bridge crossing/culvert crossing crews.
- Pipe laying to be followed by earth compaction tests.
- Carry out temporary reinstatement of the road along with the progress of pipe laying by the Contractor.
- Dispose of all surplus/unsuitable excavated earth and other debris.
- Install different types of valves.
- Flush and pressure test the main in sections and repair any leakages.
- Disinfect the main
- Carry out pressure test over the whole section in one operation
- Carry out permanent reinstatement of the road by the Contractor or respective road authorities
- Tidy up the site

(2) Water Pipe Bridge

- Inform the authorities about the commencement of this work

- Provide temporary access road and working area for the machines (cranes, pile driving rig, concrete truck mixers, pump cars, trucks) on either side of the riverbanks by filling with imported earth.
- Provide fencing
- Set out the bridge and provide coffer damming for the pier foundations
- Drive bored piles for the end pier foundations socketed into the bedrock.
- Excavate to the bedrock for the centre pier with dewatering arrangement
- Cast the foundation of the centre pier socketed into the bedrock and continue to the top
- Backfill the foundation excavation with rock fill.
- Cast the pile caps to the two end piers and continue to the top.
- Transport and install the prefabricated bridge on the piers, by the cranes.
- Provide backfilling where necessary
- Provide painting of the bridge against corrosion (if not done before)
- Install the water main.
- Remove the sheet piles/coffer damming and tidy up the site and remove site office
- Restore the original waterway of the river.

6-4-4 Elevated Water Tank

Elevated water tank are proposed in the premises of the proposed WTP site. The detailed major activities to be performed for the construction of the elevated water tank is presented below in the sequential order.

- Excavate for foundations
- Drive bored/in-situ R.C piles socketed into the bed sand (piles for filter units for future extension will be included), if any
- Construct the circular foundation and ring beam with reinforcement starter bars for ring wall
- Construct the ring wall
- Erect a temporary platform to support the formwork for the tank
- Form and place concrete for the tank base dome and conical section
- Form and place concrete for the tank base beam, tank wall and the beam at the top
- Construct the piping gallery within the tank area
- Form and concrete the top dome
- Construct platforms and stairs inside the tower
- Install tower piping and connect to yard piping
- Clean the tank
- Fill the tank with clean water and test for leakage
- Disinfect the reservoir
- Connect the old tank if appropriate
- Connect outlet to distribution system

6-5 Procurement Plan

The construction materials shall be procured in Cambodia to the greatest extent possible. However, construction materials that are not available in the country, cannot meet the quality or specifications of the design requirements, or cannot be reliably procured with regard to distribution volume or cost, shall be procured from other countries. The following summarizes a procurement plan for the project.

(1) Concrete, Pile, Sand, Gravel, Brick

These materials are easily procured in Siem Reap/Phnom Penh since they are manufactured in the city.

(2) Reinforcement Bar, Sheet Pile, Form

These materials are not produced in Cambodia. However, they can be obtained from local agencies in Siem Reap/Phnom Penh without difficulty. While a brand new sheet pile can be purchased from the agencies, it cannot be obtained as a leased material.

(3) Pipe

DCIP, HDPE and Steel pipe are not produced in Cambodia. These pipes should be imported from other countries. Concrete pipe is manufactured in Cambodia. They can be obtained from local agencies in Siem Reap/Phnom Penh without difficulty.

(4) Mechanical and Electrical Equipment

Major mechanical and electrical equipment such as pumps, chemical equipment, valves, control panels and power receiving/transforming equipment are not produced in Cambodia. These equipments must be imported from other countries.

(5) Construction Machinery

Construction machinery, such as backhoes, bulldozer, dump trucks and pile drivers, can be leased in Siem Reap/Phnom Penh.

Chapter 7.
Project Cost Estimates

Chapter 7. Project Cost Estimates

7-1 Composition of Project Costs

The project cost consists of following cost items.

1) Direct construction cost,
2) Engineering service cost,
3) Institutional Development Cost,
4) Land Acquisition cost,
5) Physical contingency; 10 % of 1) + 4), 5 % of 2)+ 3)
6) Compensation,
7) Administration Cost; 1.5% of the direct construction costs plus all the physical contingencies, and
8) Price contingency; (1.8% of FC portion and 7.9% of LC portion)

The project cost is estimated based on market prices of 2010.

7-2 Conditions and Assumptions for Cost Estimates

Construction conditions are considered availability of locally hiring heavy equipment and locally acquiring construction materials as well as suitability of the construction method. Some materials which are not available to be procured in Cambodia must be imported from other countries. Costs of those imported materials are included import/transport cost.

The price includes the entire Contractor’s financial and administrative costs including costs of liaison with external agencies, profits, and overheads.

Table 7.1 Component Division of Foreign and Local Portion

Item	Material	Foreign Portion	Local Portion
(1) Civil Works	Labor		O
	Sand, Gravel		O
	Concrete		O
	Form	O	O
	Reinforcement Bar	O	
	Pile		O
(2) Pipe and Fittings	DCIP	O	
	HDPE	O	
(3) Mechanical/Electrical Equipment	Pump	O	
	Sludge Collector	O	
	Valve	O	
	Control Panel	O	
	Transformer	O	
(4) Construction Machinery			O
(5) Building Works	Brick		O
	Indoor Materials	O	O

The project cost estimates are divided into the foreign currency portion (FC) and local currency portion (LC). The unit construction costs are divided into foreign and local currency portions according to certain ratios that take account of market conditions in Cambodia and other water supply projects currently being implemented. Local currency is denominated in US dollars, which are widely circulated and commonly used for daily transactions in Cambodia.

The division of foreign and local portions for each project component is shown in Table 7.1.

7-3 Estimate Approach

The project cost is estimated based on engineering designs and quantities as shown in Table 7.2. The engineering design indicates typical general drawings for facilities and the drawings indicates structural drawings for facilities. The engineering plans are established by a theoretical trial calculation such as hydraulic pipe network calculation.

Table 7.2 Base of Construction Quantities

Facilities	Base of Estimation
Intake Chamber	Engineering Design & Drawings
Raw Water Conveyance Pipe Line	Engineering Design
Intake Pumping Station	Engineering Design & Drawings
Raw Water Conveyance Pressure Main	Engineering Design
Water Treatment Plant	Engineering Design & Drawings
Water Distribution Complex	Engineering Plans
Water Transmission Pipe Line	Engineering Plans
Water Distribution Pipe Line	Engineering Plans

Unit prices and lump sum prices are collected from international constructors which have the real construction experience in Cambodia and took into consideration recent award contracts prices in Cambodia. Furthermore the unit cost was referred to the Project cost estimation for Water Supply Project in Phnom Penh. The costs are inclusive of 10 percent VAT (value added tax) of the LC portion.

7-4 Direct Construction Cost

The direct construction costs for the Priority Project are shown in the following tables. The direct cost consists of civil works and electro-mechanical works. The detailed cost estimation is referred to **SR 7.1.**

7-5 Engineering Service Cost

The engineering service covers Detailed Design, P/Q and Tendering and Construction Supervision. The costs are estimated at around US$5.25 million.

7-6 Institutional Development Cost

The management of water treatment facilities requires suitable number of staffs, an individual skill and an institutional system. The institutional development cost is estimated at US$920 thousand.

7-7 Land Acquisition and Compensation Costs

The required land area for the project is approximately 6 hectares as shown bellow.

1) Intake Pumping Station (80 m x 80m) = 0.64 ha
2) Water Treatment Plant (220 m x 180 m) =3.96 ha
3) Access Road from WTP to PS (width 3.5 m x 2 Lines x 3,000 m) = 2.1 ha
4) TOTAL AREA = 0.64 + 3.96 +2.10 = approx.6 ha

The land acquisition cost is estimated at US$300,000 based on the recent local land sales price which is provided by SRWSA.

7-8 Physical Contingency

The physical contingency is fundamental counter measure against increase of work amounts and material quantities caused by unpredictable matters through the project. 10 percent of the direct cost and land acquisition cost and 5 percent of engineering services and institutional development costs are employed in this study.

7-9 Compensation

The construction works will affect local resident's activities which are supposed to be an agriculture and fishery. The project includes compensations for concerned resident. The concept of compensations for them is shown bellow.

- Agriculture

  Occupation Area (Law Water Conveyance Pipeline); 9,600 m x 30 m
  =28.8 ha
  Occupation Period; 3 years (same as construction period)
  Farming Productivity; 4 t/ha, 1,000 Riel/kg (4,165 Riel = 1 USD)
  28.8 x 4 x 1,000 x 1,000 x 3 ÷ 4,165 = <u>83,000 USD</u>

- Fishery

  Occupation Width (Law Water Conveyance Pipeline);
  Construction width + Clearance = 150 m
  Existing Total Width of Fisheries = 1,500 m
  Occupation Period; 5 years (Forest Recovery Time)
  Fishing Productivity; 3t/year, 5 USD/kg
  150 ÷ 1,500 x 3,000 x 5 x 5 = <u>7,500 USD</u>

7-10 Administration Cost

Cambodia concerned authorities will pay extra administrative cost for dealing with the project. The administration cost is estimated 1.5 percent of the direct construction costs plus all the physical contingencies.

7-11 Price Contingencies

Price contingencies applied in this study are those escalation rates of 1.8 percent for FC portion and 7.9 percent for LC portion, respectively.

7-12 Priority Project Cost

The priority project costs are shown in the following tables.

Table 7.3 Priority Project Cost

Item	Cost(1,000US$)				
	FC	TAX(FC)	LC	TAX(LC)	Total
Civil Works	**16,932**	**0**	**23,399**	**2,340**	**42,672**
Intake Chamber	16	0	132	13	162
Water Conveyance Pipe	1,448	0	11,710	1,171	14,328
Intake Pump Station	555	0	739	74	1,368
Water Treatment Plant	2,507		5,627	563	8,697
Elevated Water Tank	228	0	553	55	836
Transmission/Distribution Pipelines	12,178	0	4,638	464	17,280
Mechanical/Electrical Works	**8,148**	**0**	**1,136**	**114**	**9,397**
Intake Pumping Station	2,086	0	259	26	2,371
Water Treatment Plant	6,062	0	877	88	7,027
Direct Construction Cost : (A)	**25,080**	**0**	**24,535**	**2,454**	**52,069**
Physical Contingency (10%) for (A) : (A)'	**2,508**	**0**	**2,454**	**245**	**5,207**
Price Contingency (FC:1.8%, LC;7.9%) for (A)+(A')	**2,215**	**0**	**11,423**	**1,142**	**14,780**
Engineering Services : (B)	**4,200**	**0**	**954**	**96**	**5,250**
Physical Contingency (5%) for (B) : (B')	**210**	**0**	**48**	**5**	**263**
Price Contingency (FC:1.8%, LC;7.9%) for (B)+(B')	**278**	**0**	**304**	**30**	**612**
Institutional Development : (C)	**860**	**0**	**55**	**5**	**920**
Physical Contingency (5%) for (C) : (C')	**43**	**0**	**3**	**0.3**	**46**
Price Contingency (FC:1.8%, LC;7.9%) for (C)+(C')	**68**	**0**	**22**	**2**	**91**
Land Acquisition : (D)	**0**	**0**	**273**	**27**	**300**
Physical Contingency (10%) for (D) : (D')	**0**	**0**	**27**	**3**	**30**
Price Contingency (FC:1.8%, LC;7.9%) for (D)+(D')	**0**	**0**	**24**	**2**	**26**
Social Compensation; (E)	**0**	**0**	**83**	**8**	**91**
Price Contingency (FC:1.8%, LC;7.9%) for (E)	**0**	**0**	**7**	**1**	**7**
Administration Cost (1.5% of the above total)	**0**	**0**	**864**	**86**	**951**
Total Project Cost	**35,461**	**0**	**41,074**	**4,108**	**80,642**

Notes: Project cost is rounded in 100 thousand US$. Price Contingency is based on compound interest.

7-13 Disbursement Schedule

The disbursement schedule for the project is shown in Table 7.4.

Table 7.4 Disbursement Schedule

	Total	2009	2010	2011	2012	2013	2014	2015	2016
Total Direct Construction Cost	52,069	-	-	-	-	11,108	15,119	16,226	9,615
- Foreign Component	25,080	-	-	-	-	7,287	6,570	7,177	4,046
- Local Component	24,535	-	-	-	-	3,474	7,772	8,227	5,063
- Tax on Local Comp	2,454	-	-	-	-	347	777	823	506
Physical Contingency	5,207	-	-	-	-	1,111	1,512	1,623	962
- Foreign Component	2,508	-	-	-	-	729	657	718	405
- Local Component	2,454	-	-	-	-	347	777	823	506
- Tax on Local Comp	245	-	-	-	-	35	78	82	51
Price Contingency	14,780		-	-	-	1,518	3,877	5,341	4,044
- Foreign Component	2,215		-	-	-	441	535	737	503
- Local Component	11,423		-	-	-	979	3,039	4,186	3,219
- Tax on Local Comp	1,142		-	-	-	98	304	419	322
Engineering Services	5,250	-	-	545	1,091	1,091	1,091	1,091	341
- Foreign Component	4,200	-	-	436	873	873	873	873	272
- Local Component	954	-	-	99	198	198	198	198	63
- Tax on Local Comp	96	-	-	10	20	20	20	20	6
Physical Contingency	263	-	-	27	55	55	55	55	17
- Foreign Component	210	-	-	22	44	44	44	44	14
- Local Component	48	-	-	5	10	10	10	10	3
- Tax on Local Comp	5	-	-	1	1	1	1	1	0
Price Contingency	612	-	-	17	71	109	149	191	74
- Foreign Component	278	-	-	8	33	50	68	86	32
- Local Component	304	-	-	8	34	53	74	96	38
- Tax on Local Comp	30	-	-	1	3	5	7	10	4
Instituional Capacity Developm	920	-	-	-	183	183	183	183	188
- Foreign Component	860	-	-	-	172	172	172	172	172
- Local Component	55	-	-	-	10	10	10	10	15
- Tax on Local Comp	5	-	-	-	1	1	1	1	1
Physical Contingency	46	-	-	-	9	9	9	9	9
- Foreign Component	43	-	-	-	9	9	9	9	9
- Local Component	3	-	-	-	1	1	1	1	1
- Tax on Local Comp	0	-	-	-	0.1	0.1	0.1	0.1	0.1
Price Contingency	91	-	-	-	9	13	17	22	30
- Foreign Component	68	-	-	-	7	10	13	17	20
- Local Component	22	-	-	-	2	3	4	5	9
- Tax on Local Comp	2	-	-	-	0.2	0.3	0.4	0.5	1.0
Land Acquisition	300	-	-	300	-	-	-	-	-
- Foreign Component	0	-	-	0	-	-	-	-	-
- Local Component	273	-	-	273	-	-	-	-	-
- Tax on Local Comp	27	-	-	27	-	-	-	-	-
Physical Contingency	30	-	-	30	-	-	-	-	-
- Foreign Component	0	-	-	0	-	-	-	-	-
- Local Component	27	-	-	27	-	-	-	-	-
- Tax on Local Comp	3	-	-	3	-	-	-	-	-
Price Contingency	26	-	-	26	-	-	-	-	-
- Foreign Component	0	-	-	0	-	-	-	-	-
- Local Component	24	-	-	24	-	-	-	-	-
- Tax on Local Comp	2	-	-	2	-	-	-	-	-
Social Compensation	91	-	-	91	-	-	-	-	-
- Foreign Component	0	-	-	0	-	-	-	-	-
- Local Component	83	-	-	83	-	-	-	-	-
- Tax on Local Comp	8	-	-	8	-	-	-	-	-
Price Contingency	7	-	-	7	-	-	-	-	-
- Foreign Component	0	-	-	0	-	-	-	-	-
- Local Component	7	-	-	7	-	-	-	-	-
- Tax on Local Comp	1	-	-	1	-	-	-	-	-
Project Administration	951	-	-	1	1	203	275	296	175
- Foreign Component	0	-	-	-	-	-	-	-	-
- Local Component	864	-	-	1	1	184	250	269	159
- Tax on Local Comp	86	-	-	0	0	18	25	27	16
Total project Cost	80,642	-	-	1,045	1,419	15,399	22,288	25,037	15,455
- Foreign Component	35,461	0	0	466	1,137	9,614	8,940	9,830	5,473
- Local Component	41,074	0	0	526	255	5,259	12,134	13,824	9,075
- Tax on Local Comp	4,108	0	0	53	26	526	1,214	1,383	907

7-14 Operation and Maintenance Cost

The water supply facilities should be kept such conditions through proper operation and maintenance as to show the given function at any time, namely so to supply enough good water demand with pressures and quality required.

The daily operation of the facilities requires chemicals for water treatment processes and electricity for mechanical plant operations. The maintenance of the facilities requires periodical check, cleaning, repair and replacement of parts/devices/functions.

The operation and maintenance are implemented by well trained technical staffs and the management of such operation and maintenance is conducted by administrative personnel.

The operation and maintenance cost for the water supply system consists of following items.

1) Salaries & Wages Cost,
2) Power (Electricity) Cost,
3) Chemical Cost,
4) Maintenance Expense Cost,
5) Administrative & General Expense Coast

The annual operation and maintenance cost is total of the above costs.

7-14-1 Salaries & Wages Cost

The real personnel cost of SRWSA in 2009 was 139,000 USD/year reported by SRWSA Data. It was based on a total of 40 staffs and 290 USD/Month/Person of average salary. The number of staffs for the operation and maintenance of Priority Project's facilities will be increased according to the raise of service connection number. The personnel cost in 2017 is estimated at 345,000 USD/year.

7-14-2 Power Cost

The current power cost for the existing WTP is 183,000 USD/year with 3,285,000 m^3 of annual water production reported by SRWSA Data. The power cost for Priority Project is estimated based on an electric consumption (kW/h) for the proposed mechanical/electrical plants. The water productivity of Priority Project gradually rises up to 30,000 m^3/d in accordance with the water demand and the service connection increase. The total power cost in 2017 is estimated at 220,000 USD/year.

7-14-3 Chemical Cost

The current chemical cost for the existing WTP is 37,000 USD/year with 3,285,000 m^3 of annual water production reported by SRWSA Data. The consumption of the chemicals for Priority Project as well as the power consumption is gradually increased. The total chemical cost in 2017 is estimated at 47,000 USD/year.

7-14-4 Maintenance Expense Cost

The water supply facilities require regular maintenances such as machinery repair, replacement of small scale devices, lubricants and fuels. SRWSA currently costs 6 percent of the gross value of utility plants for the maintenance reported by SRWSA Data. The total maintenance cost in 2017 is estimated at 252,000 USD/year.

7-14-5 Administrative & General Expense Cost

The management of the water supply system requires budgets for administrative activities and other miscellaneous expenses. The current administration cost for the existing WTP is 265,000 USD/year reported by SRWSA Data. The total administrative cost in 2017 is estimated at 207,000 USD/year.

Chapter 8
Financial and Economic Analysis on Priority Project

Chapter 8. Financial and Economic Analysis on Priority Project

8-1 Introduction

This report discusses the financial and economic considerations of the recommended Priority Project (The Project). In particular, the following aspects have been taken into consideration:

(1) The past and present financial performance and condition of SRWSA;

(2) Sources of Funds;

(3) Water tariff and Affordability Consideration;

(4) Financial Internal Rate of Return (FIRR) and debt service coverage ratio; and

(5) Economic Internal Rate of Return (EIRR).

8-2 Past and Present Financial Performance

The past and present financial performance and condition of SRWSA was undertaken to assessed it's financial capability to contribute counterpart funding, implement the Project; and provide adequate funds to operate and maintain the new infrastructure on a sustainable basis. The review covered the immediate past 3 years – 2007, 2008 and 2009 and utilized the audited financial statements for calendar year 2007 and the unaudited statements for calendar years 2008 and 2009. The historical profit and loss statements and balance sheets of SRWSA are presented in Table 8.1 and Table 8.2, respectively.

Table 8.1 Profit and Loss Statements, 2007 to 2009
(*Unaudited for 2008 and 2009)* (unit in KHR x 1000)

	2007	2008	2009
Operating Income			
Water Sales	2,264,818	3,465,661	3,839,815
Penalty Fees	5,603	5,697	7,003
Meter Maintenance Fee	345,583	26,985	37,415
New Connection Fee	391,765	311,008	1,220
Total Operating Income	**3,007,769**	**3,809,351**	**3,885,452**
Operating Expenses			
Salaries and Wages	191,544	657,857	580,447
Energy Cost for Pumping	629,723	754,722	763,189
Water Treatment Cost	61,706	109,427	153,300
Maintenance Cost	62,618	44,283	578,453
Other Operating Cost	890,340	785,610	1,102,262
Total Operating Expenses	**1,835,932**	**2,351,899**	**3,177,650**
Net Income before Depreciation	1,171,837	1,457,452	707,802
Depreciation Expense	612,418	496,501	538,934
Net Income before Interest	559,418	960,951	168,868
Add : Non-Operating Income		86,784	192,199
Less: Interest Expense		-	-
Net Income before Tax	559,418	1,047,736	361,066
Income Tax		209,547	177,707
Net Profit (Loss)	**559,418**	**838,189**	**183,360**
Source: SRWSA	**Audited**	**Unaudited**	**Unaudited**

The Profit and Loss Statements indicate an abnormally large increase in operating expenses during the year 2009.

- There is evidence of lack of training by staff in using and assigning the correct chart of account categories to correct expenditures, or asset designations. The chart of accounts should also have a written description in correct uses for the account titles. A future audit should also be able to detect errors in assigning accounts.
- Maintenance Costs have increased from an earlier average of approximately KHR50 million thousand per year up to the latest cost level of KHR578 million per year. Earlier costs in first two years were minimal during the organisation's earlier startup period with a new system, thus full costs of maintenance came into effect in year 2009.
- Other Operating Costs have also increased from an earlier level of KHR890 million per year up to KHR1,102 million per year. Other adjustments to system were only evident during the third operating year.

Table 8.2 Balance Sheet, 2007 to 2009

(Unaudited for 2008 and 2009) (unit in KHR x 1000)

	2007	2008	2009
Current Assets			
Cash	1,834,021	2,815,818	2,824,085
Customer Receivables	127,192	145,786	428,923
Other Receivables	-	102,678	176,462
Inventory: Materials/Supplies	270,032	289,475	920,433
Other Current Assets	-	39,517	-
Total Current Assets	2,231,244	3,393,275	4,349,903
Fixed Assets			
Utility Plant in Service	13,561,142	11,098,887	10,162,367
Land Holdings	8,191,841	8,191,841	7,783,680
Total Fixed Assets	21,752,983	19,290,727	17,946,047
Accumulated Depreciation	(612,418)	(968,476)	(1,507,410)
Works in Progress	-	-	666,177
Net Fixed Assets	21,140,564	18,322,251	17,104,814
Other Assets			
Utility Plant for future Use	-	433,840	-
Total Other Assets	-	433,840	-
Total Assets	**23,371,809**	**22,149,366**	**21,454,717**
Current Liabilities			
Accounts Payable	61,213	81,249	854,317
Guarantee Deposits	249,803	326,867	449,961
Taxes Payable	-	359,194	560,763
Other Current Liabilities	-	-	-
Total Current Liabilities	311,016	767,310	1,865,041
Long-Term Liabilities	-	-	-
Equity			
Capital	21,468,672	19,963,926	18,305,049
Reserves	-	-	-
Unallocated Profit	1,592,121	1,418,130	1,284,627
Total Equity	23,060,793	21,382,056	19,589,676
Total Liabilities & Equity	**23,371,809**	**22,149,366**	**21,454,717**
Source: SRWSA	**Audited**	**Unaudited**	**Unaudited**

The Balance Sheet also provides three extraordinary cost discrepancies. A further investigation with SRWSA found the following actions taking place:

- Customer Receivables increased from a 14 day turnover up to a 40 day turnover to nearly triple the previous levels. A further look revealed that government administration accounts were not being paid due to budget constraints of the customers. This has now resulted in firm action being taken to obtain these arrears. (See also 8-2-2 (2) – Operating Efficiency.)

- The fixed asset account for “Utility Plant in Service” account has erroneously been reducing in cost level from the 2007 level of KHR13 billion down to a revised level of only KHR10 billion. Nearly KHR3.5 billion has been removed from the asset account. SRWSA. Original transfer of assets often used incorrect overstated volumes and capacities thus overstating the valuations of account balances. These items have been corrected over the years 2008 and 2009. This also had an adverse effect upon the Capital Account.
- Current Liabilities have also increased by 950%. There appeared to be adequate cash to make the payments. SRWSA stated that there has been an intentional build up in some stocks in order to more promptly respond to breakdowns without delays caused by awaiting arrival of repair parts. This occurred toward the end of year 2009.

8-2-1 Methodology

The ratio indicators being utilised provide information on SRWSA’s

- operational performance, and
- financial health and condition,

which are important parameters for assessing potential loan repayment capacity.

The data becomes more informative when compared with additional related data in the form of ratios particularly when changes are compared over time.

The ratios utilized in the evaluation are grouped into 2 categories:

- financial status and condition
- operational efficiency.

(1) Financial Status and Condition

This category groups together various ratios that essentially provide a quick picture of the utility’s financial status and condition. As such, the ratios selected cover short- and long-term solvency, capacity to meet debt servicing obligations and capability to fund capital requirements. Five ratios are used under this category:

- *Cash Position* essentially measures the utility’s available cash in terms of number of days of operating and maintenance expenses.
- *Current Ratio* (also known as the Liquidity Ratio) is a common measure of short-run solvency, the ability of an enterprise to meet day-to-day operating and maintenance expenses.
- *Days Working Capital* reflects the capacity of the utility firm to provide capital for its day-to-day operating requirements. A low number of days could be indicative of some liquidity problem particularly its capacity to meet short-term debts like suppliers’ credit.
- *Debt to Equity ratio* (DER) is an indicator of the capacity of an entity to take on new debt/loan financing. A high percentage of debt (both short- and long-term) to total capitalization (retained earnings, reserves, and contributed capital) reflects that the firm or entity is heavily leveraged and implies diminished flexibility in servicing new debt.
- *Net Worth* is the most important indicator used to measure financial health. It is simply the amount by which assets exceed liabilities.

(2) Operational Efficiency Ratios

These ratios are indicators of management quality, particularly the ability of managers to control costs and collect receivables. F**ive** ratios are used to evaluate operational efficiency:

- *Operating Ratio* essentially expresses the comfort margin between annually recurring costs and revenues. A low number reflects excellent prospects for attaining profitability. In general, unleveraged utility firms should aim for a maximum operating ratio of 80% in order to attain profitability in operation.
- *Percentage of Non-Revenue Water* is the percentage of water for which revenues are not collected. It lumps together water billed but not collected, water used through fire hydrants and water losses through metering errors, leaks and unauthorized usage (pilferage).
- *Accounts Receivable Turnover* indicates the average number of days required to convert receivables to cash. As such, it reflects the efficiency of management in collecting receivables and in applying the utility’s credit policy.
- *Return on Revenue (ROR)* is a profitability indicator showing the ratio of net income before profit to total operating income. Simply put, it is that portion of total revenue that is transformed into profit.
- *Staff Productivity Index (SPI)* is a straightforward indicator of labor productivity as well as the quality of personnel management. A low number indicates increased efficiency or productivity of employees as it simply shows the number of staff employed per 1,000 connections. For SRWSA, the computation of the SPI is linked to the number of billed connections, which is lower than the reported number of connections.

8-2-2 Results of the Financial Analysis

The results of the performance review are illustrated in Table 8.3 below, the contents of which are discussed in the succeeding sections following the table.

(1) Financial Status and Condition

Table 8.3 Past and Present Financial Performance, 2007 to 2009

Performance Parameters	2007	2008	2009
Operating Results			
No. of of Billed Connections (SC)	3,146	3,720	3,926
Water Production, m3/year	2,265,545	3,169,208	3,281,897
Water Sold, m3/year	1,821,029	2,766,178	2,822,752
Average Water Tariff, KHR / m3	1,244	1,253	1,360
Number of Staff	44	43	43
Operating Revenue, KHR x million	3,008	3,809	3,885
Operating Expenses, KHR x million	1,836	2,352	3,178
Net Income, KHR x million	559	838	183
Operational Efficiency			
Operating Ratio	81%	75%	96%
Non-Revenue Water	20%	13%	14%
Customer Receivable Turn-over (Days)	15	14	40
Staff Productivity Index	14	12	11
Return on Revenue (ROR)	19%	28%	9%
Financial Status and Condition			
Days of Cash Position	315	386	273
Current Ratio	7.17	4.42	2.33
Days of Working Capital	382	408	285
Capitalization Ratio	1%	4%	10%
Net Worth, KHR x Million	23,061	21,382	19,590

On the overall, SRWSA's status and condition is financially sound. It is stable, very liquid and highly solvent. SRWSA is in a very good financial position in terms of meeting day-to-day operating needs and has the financial capacity to absorb long-term debt.

- *Cash Position is excellent*. Over the past 3 years, SRWSA has maintained a highly liquid position. However, a diminishing trend is noticeable.
  - 2008 cash position increased by 23% over that of 2007
  - Decrease in cash position in 2009 is higher at 29%
  - Net decrease in cash position equivalent to 6% less than that of 2007.
  - Available cash remains at excellent level of 273 days supply.
- SRWSA's *Days of Working Capital* has consistently been very good:
  - It averages at 358 days or 11.8 months of its annual operating needs during the past 3 years.
  - A declining trend is however observed.
  - Working capital increased to 408 days or 7% from 2007 – 2008
  - It decreased down to 285 days in 2009, which is lower by 96 days or a decrease of 25% compared to that of 2007
  - Currently SRWSA's working capital is still considered more than adequate.
- *Current Ratio* is generally considered adequate at a little over 2 at the end of 2009. A decreasing trend is however observed during the past 3 years.
- The *Capitalization Ratio* of SRWSA is excellent. Currently, the utility firm remains loan free. Its only liabilities are short-term payables in the form of suppliers' credits, income tax liabilities and guarantee deposits from its customers.
- SRWSA's *Net Worth* has consistently been excellent during the past 3 years. With no long-term debt, the utility firm has benefited tremendously from the JICA-grant financing of its existing physical assets.

(2) Operational Efficiency

In general, SRWSA's operational performance is quite good considering its relatively young age as an autonomous entity.

- *Operating ratio* of SRWSA is rather on the high side. During the past 3 years:
  - In 2007 - averages 81% of total revenue
  - In 2008 - averages 75% of total revenue.
  - In 2009 - averages 96% of total revenue.

  Given this performance in 2009, the water utility firm should revisit both its cost and revenue centers for the purpose of adapting measures to control or abate the increase in operating expenses while at the same time find ways to enhance revenue generation.
- SRWSA's volume of *non-revenue water* (NRW) is very good.
  - NRW averages 20% of annual water production in 2007.
  - NRW averages 13% of annual water production in 2008.
  - NRW averages 14% of annual water production in 2009.

  - SRWSA's recorded NRW may be considered exceptionally good as compared to the 27% average NRW of some 40 water utilities in Southeast Asia[1], its performance still needs to be improved when compared to the below 10% NRW record of Phnom Penh Water Supply Authority.

- SRWSA's collection performance shows a declining efficiency as can be discerned from the results of its operation last year. In 2009, the number of *days of customer accounts receivable* is equivalent to 40 days of operating income while the previous two years customer receivables is only 14-15 days. The following causes should be investigated:

  - Customer guarantee deposits should be reviewed for their effectiveness levels.
  - Some of the overdue bills are accounted for from unpaid bills of government administration connections. In most cases, payment of their water bills is delayed due to budgetary limitations. Payment of water bills cannot go beyond the approved budget without revising the approved budget for the year. Actual amount of accumulated overdue water bills from administration connections however is not available.
  - Aging of customer receivable bills have not been done, as it would require manual readings of each overdue customer account due to limitations in the computerized billing and collection system.

  Given the above findings, SRWSA should review the implementation of its customer credit policy and effectiveness of the guarantee deposit scheme. Unpaid bills beyond the payment deadline should automatically result to the disconnection of water service of the non-paying customers. The equivalent amount of unpaid bill of disconnected customers should then be deducted from their respective guarantee deposit.

  The existing guarantee deposit should be reviewed in terms of its effectiveness in covering prospective defaulting water bills. SRWSA should adjust the guarantee deposit from its customers based on the average water bill for say every 6 months. If average water bills exceed the amount of deposit, additional deposit should be required from its customers.

- *Return on Revenue* has declined during the past year. SRWSA's net income in 2009 dropped to only 9% of total revenue in 2009 as compared to the 28% ROR registered in 2008. Growth in revenues has been eclipsed by a much faster growth in operating expenses.

- SRWSA's *staff productivity index* (SPI) for the past 3 years show improving efficiency.

  - 14 staff per 1000 connections in 2007.
  - 12 staff per 1000 in 2008.
  - 11 staff per 1000 in 2009.
  - Further improvement in the SPI can be attained with the increase in customer base.

8-2-3 Prognosis

SRWSA's financial status and condition is sufficiently strong and stabl**e**. Its financial resources in terms of capitalization is more than adequate to fully support long-term debt for its capital expansion program.

[1] Average NRW of 40 participating utilities as reported in the 2005 Data Book of South East Asia Water Utilities Network published by the Asian Development Bank in 2007 is 27%.

8-3 Present and Future Sources of Funds

The SRWSA's sources of funds come primarily from internally generated funds as a consequence of its operation and donated or Official Development Assistance funds mainly from JICA. Internally generated funds come mainly from water revenues, which is primarily influenced by the water tariff. A small portion comes from other charges consisting of meter maintenance fees, new connection fee, guarantee deposit and surcharge on late payment of customer bills. Together with existing water tariff, these are discussed in the next sections of this report.

8-3-1 Existing Water Tariff

(1) Characteristics

The existing water tariff of SRWSA, which took effect in November 2009, is presented below. It includes the previous tariff for purposes of comparison.

Previous to November 2009, SRWSA has separate tariffs for each customer category: one for commercial/industrial connections and one for both domestic and administration connections. There were no consumption blocks then. On the other hand, the new tariff effective November 2009 has done away with the distinction among customer categories. However, the unified tariff schedule has 4 consumption blocks with increasing tariffs for each consumption block.

Table 8.4 Water Tariff (KHR/m^3)

Category	Consumption (m^3)	Effective 2006	Effective November 2009
Domestic/ Government	0 to 7	1,200	1,100
	8 to 15	1,200	1,500
	16 to 30	1,200	1,800
	30 <	1,200	2,000
Industrial and Commercial	0 to 7	1,400	1,100
	8 to 15	1,400	1,500
	16 to 30	1,400	1,800
	30 <	1,400	2,000

Source: SRWSA Commercial Office

(2) Tariff Level

Table 8.5 shows the average tariffs for the overall and each customer category with associated unit cost of operation during the past 3 years.

As shown below, the commercial/industrial consumers provide a cross-subsidy to both domestic and administration (government) consumers. The average tariffs for domestic and administration (government) consumers during the past 3 years were lower than the average costs to produce and deliver water supply service.

From the cost recovery viewpoint, SRWSA's water tariffs are considered full cost recovery tariffs as shown by its profitable operations.

Table 8.5 Average Tariff (KHR/m^3 Sold)

Descriptions	2007	2008	2009
Water Sales			
- Domestic	1,200	1,200	1,264
- Commercial	1,400	1,400	1,553
- Administration (Gov't)	1,200	1,200	1,200
- Overall Average	1,244	1,253	1,360
Operating Costs			
Overall Average	810	742	975

Source: SRWSA Commercial Office and Accounting Unit

Overall average tariff in 2009 was KHR1,360 or US$0.33 per m^3 using the exchange rate of KHR4,165 to a US$.

In terms of affordability, the water tariffs are considered affordable. The average monthly water bill of KHR12,804.00[2] is only 0.8 percent of the average monthly income (KH1,594,120) of households in Siem Reap. The generally accepted guideline on affordability is that the water supply charges should not exceed 4 percent of the monthly income of households.

8-3-2 Other Charges

Other charges provide SRWSA some supplemental revenue for its operating requirements. These consist of meter maintenance fee, connection fee, surcharge for late payments, and guarantee deposits.

(3) Meter Maintenance Fee.

This is a monthly charge applied to connections with no billable water consumption. Monthly charge is only KHR50.00, which is quite miniscule.

(4) New Connection Fee

SRWSA charges a uniform new connection fee of KHR517,500.00 (US$124.25) regardless of category. The fee covers materials from tapping point to owner's property line. In excess of the equivalent amount of the connection, additional cost is to the account of the new connection applicant.

SRWSA's connection fee which is equivalent to 32% of the average income of KHR1,594,120 per month of households in Siem Reap is relatively high and unaffordable to households earning below the average income. Affordability of the connection fee among low-income households is therefore foreseen as a major obstacle for accessing safe, potable and affordable water particularly

[2] The existing number of persons per household connection of 5.7 and the average domestic consumption of 60 lpcd for connected households were used. Total monthly consumption is 10.4 cubic meters per month = 5.7 persons x 60 liters per day per person x 1 cubic meter per 1000 liters x 365 days and divided by 12 months. KHR12,804 = 7 m3 x KHR1,100/m3 + 3.4 m3 x KHR1,500/m3.

that the proposed priority project shall be targeting the rural fringe areas of Siem Reap as the expansion area.

To enable the poor families to have access to the SRWSA's piped water system, the authority has two possible options for promoting individualized house connections among poor families in Siem Reap: (1) installment payment plan for service connection; or (2) special subsidy for financing the individual service connections of poor families.

(5) Guarantee Deposit

Each new connection applicant is required to shell out the amount of KHR77,000.00 (US$18.49) as a guarantee deposit for non-payment of monthly water bills.

(6) Surcharge or Penalty Fee

As a matter of good operational practice, SRWSA imposes a 1% surcharge (penalty fee) per day for water bills paid beyond the payment due date. Notice of disconnection including amount of surcharge is given to the customer after 10 days. At 1% per day penalty fee for 10 days, this results to a minimum of 10% surcharge for delayed payments. Actual amount collected during the past three years as reflected in SRWSA's income statements are however miniscule due to the excellent water bills collection record accomplished in 2007 and 2008 (unpaid and collectible customer receivables is only equivalent to 15 days of water sales). An increasing amount is however expected for the coming years as the SRWSA increases its customer base in line with its capital expansion program.

8-4 Financial Evaluation of the Priority Project

8-4-1 Analytical Approach and Methodology

The analytical approach employed in evaluating the financial desirability of the Project is described as follows:

(1) Revenue Analysis

In accordance with the law creating it, the SRWSA is operating under a full cost recovery principle, which simply means that all expenses related to providing the water service in Siem Reap plus a reasonable surplus shall be recovered through its water tariffs. In compliance, the following aspects were considered in the estimation of the water tariff per cubic meter:

- All cost - operating cost, depreciation expense, interest expense and taxes shall be recovered from the sale of water. The sum of these estimated costs divided by the total volume of water billed shall be the required average water tariff per m^3.
- No equity infusion by the government. This requires that all funding needs of SRWSA are provided for without any assistance from the royal government except for ODA loans. Cash generated from water sales and contracted loans/debts should be sufficient to fund all capital requirements including debt repayment.

- Debt service coverage ratio (DSCR) in any year is not less than one. Cash from operations shall be able to cover interest and principal repayment (debt service). A ratio of less than one means that cash from the year's operation cannot fully cover debt service. The objective therefore is to attain a DSCR of one or better for each year.

(2) Affordability of Water Tariffs

The affordability of water tariff is determined on the basis of the following 2 sets of parameters:

i) Affordability Parameter for Residential Connections

This is measured by computing the ratio of the average monthly water bill of families to their average monthly income. Per World Bank studies, a ratio not exceeding 4% of the average monthly income of families is deemed as the maximum amount affordable for water consumption.

Using raw data from the Social Survey Report for Siem Reap, the average income of families in the city was computed at KHR1,594,120 or about US$382.74 using the exchange rate of KHR4,165 to a US$.

ii) Affordability Indicators for Commercial Connections.

This is measured in two ways:

- By comparing the ratio of SRWSA's average unit cost of water for commercial connections to average own-unit production cost of commercial establishments. Using data gathered previously from the surveys conducted on hotels, guesthouses and restaurants in 2009, the Study Team estimated that the average cost incurred by commercial establishments with their own in-house water system ranges from US$0.70-1.00 per cubic meter. Water tariff is deemed affordable if the ratio is less than the maximum range of the own-unit cost of commercial establishments.
- By comparing the ratio of average cost of water per tourist to the average expenditure per tourist in Cambodia. The objective here is to show that the proposed water tariffs for commercial establishments have minimum financial impact to tourists. Per Ministry of Tourism data, average expenditure of tourists is US$425 for an average stay of 3.5 days. Employing the analogy of relating affordability of residential connections to average family income, the same approach can be applied for tourist expense on water, i.e. water expenditure as a ratio of average expenditure. Water tariff by the tourists is considered to be acceptable if total water bills during the 3.5 days stay is just small amount of the total expenditure of US$425.

  Likewise, acceptability can be likened to percentage of the water bill per tourist to the room rates of hotels and guesthouses. Since there is no actual data on the average room rate in Siem Reap, this study assumes US$15 is the average rate of guesthouses per day.

iii) Financial Internal Rate of Return

Financial internal rate of return shall be determined on the basis of the incremental revenue and costs arising from the operation of the new WTP of the priority project. The financial parameters considered in the tariff determination are limited to the debt service coverage ratio and the no equity infusion by the RGC.

(3) Financial Model

In carrying out the financial analysis as described above, the Study Team prepared a financial model that simulates the financial operation of the SRWSA on a year-to-year basis. The financial model generates the three basic financial statements of profit & loss statements, cash flow statements and balance sheets. In addition, it provides a summary table of key performance indicators for easy evaluation of the results of the financial forecast. The model basically starts with the identification and computation of all costs accruing to the operation of SRWSA – operating expenses, capital investments, and debt servicing; and the identification of key components of revenue i.e. water demand and average water tariff per cubic meter. The financial forecast covers thirty years 2011 to 2040.

For brevity considerations, the supporting schedules (**S.R. 8.3** – Opening Positions and **S.R. 8.6 to 8.8** – Supporting Schedules 1 to 3, respectively) used in the financial projections are not included in the main report but these are anyway presented in the supporting report for chapter 8.

(4) Constant 2010 Price Level

The financial forecast was accomplished based on constant 2010 price level. This is resorted to minimize the effects of many assumptions and conditions that cannot be ascertained as to their validity and appropriateness. By not considering the effects of inflation, the financial projections can be evaluated on the basis of real growth in terms of revenue and expenses.

(5) Assumptions Used in the Financial Forecast

The financial forecast was accomplished by using a number of assumptions that simulate the performance of SRWSA. The assumptions, which have been formulated on the basis of actual data provided by the SRWSA are as follows:

i) Other Operating Revenue

This is estimated on the basis of the following fees and charges currently imposed and recommended for adaption by the SRWSA:

- Meter maintenance fee of KHR50 per connection per month, the purpose of which is to cover the cost of operation related to inactive connections (connected to the water system but with no water consumption as per water meter reading).
- Surcharges for late payments of water bills. For simplicity, 10% of water bills are assumed to incur delayed payments and is therefore subject to a 10% surcharge, equivalent to 1%/day x 10 days. Although actual data indicate a high collection performance, it is assumed that collection performance will slightly dip as the SRWSA widens its market base that include a big portion will be coming from households with incomes that are considered low.

- New connection fees. SRWSA currently charges a fee of KHR517,500 per new water connection equivalent to US$124.25 regardless of connection category. It is however recommended that a higher connection fee be collected from commercial establishments since these require bigger pipelines and water meters. For this consideration, a new connection fee of US$500 is proposed as estimated by the Study Team for new commercial connections.

The above estimate is equivalent to the PPWSA connection fee for commercial connections.

-Basic Fee for 40mm	KHR1,841,200
-VAT (10%)	KHR 184,200
-Total New Connection Fee	KHR2,025,400 (US$486.00)

ii) Customer Guarantee Deposits

This represents monies advanced by customers for the mandatory guarantee deposit of KHR77,000 equivalent to US$18.49 per connection (KHR4,165=US$1.00). Like the connection fees, it is recommended that SRWSA collect a higher deposit of US$150 from new commercial connections beginning 2012. This is however not considered in the computation of other revenues. This is considered in the changes of working capital i.e. reflected as increase in customer deposits (see balance sheet).

iii) Inventory of Supplies and Materials

This represents the value of materials and supplies in SRWSA's inventory at the end of the accounting period. It is estimated at 1.5 months of the combined expenses for chemicals and other operating cost excluding salaries and power for pumping expense.

iv) Accrued Payables

This represents the combined value of all amounts owed to suppliers/service providers and is due to be paid within a period of one year or less. It is estimated at about one and a half months of operating expenses but excludes salaries and wages.

v) Ending Cash Balance

SRWSA is assumed to maintain a mandatory cash balance (in banks) equivalent to half a month of total operating expenses (Total Operating expenses x 1/12 x 0.5). Beginning cash position for the year is just a carry over from previous year's ending cash position. Cash in excess of ending cash balance is assumed invested in short-term investments that can be converted to cash any time of the year. This amount is reflected as short-term deposits in the Balance Sheet (shown in Table **S.R. 8.4**). This approach can be illustrated as follows:

Required ending cash balance for 2010	US$ million
O&M Expense (0.763) x 1/12 month x 0.5	= 0.031

vi) Customer Accounts Receivable

SRWSA is assumed to maintain its currently excellent collection performance thus the level of accounts receivable is forecasted at one month of annual revenues.

vii) On-time Collection of Water Bills

With the increase in number of connections particularly households, the collection performance will most likely suffer and is therefore presumed at 90% of water bills. Water bills in default would therefore be equivalent to 10% of total water sales.

viii) Interest Earned

In the forecast, funds deposited in the banks are assumed not to earn interest income for conservatism.

8-4-2 Capital and O&M Costs

Costs for operating and expanding the water services of SRWSA consist of capital investments from the Project and the KTC pipeline extension project, interest capitalized during construction, amortization of loans, replacement of electro-mechanical equipment during the forecast period, operating expenses, depreciation expense and income taxes. Estimates of these cost and expense items are provided for in the financial evaluation, as discussed below.

(1) Capital Investment Cost and Financing Plan

Capital investment needs of SRWSA consist of the Priority Project and the KTC pipeline extension.

i) Priority Project.

The total investment cost amounts to US$85.5 million. Using the cost estimates presented in Chapter 7, the project cost items are re-arranged and presented on the basis of eligible and ineligible expense items as summarized and discussed below:

Price contingency was estimated using the escalation rates of 1.8% for foreign cost components and 7.9% for local cost components. The annual breakdown is presented in the attached Financial Study 1 – Annual Project Cost. This table was created using table **S.R.8.2**, Project Cost Components.

The Project shall be financed through a combination of loan and counterpart funds of SRWSA. The loan shall come from an official development assistance loan from the Government of Japan through the JICA, which shall be on lent to SRWSA by the Royal Government of Cambodia (RGC) through the MOEF. Except for the interest rate, the terms and conditions of the loan to be on lent to SRWSA mirror that of JICA's on-lending terms to the RGC. The financing plan for the

Project was prepared on the basis of the estimated amounts of eligible and ineligible expense items for JICA funding assistance.

Eligible expense items consist of the direct cost items, engineering services and institutional capacity building component. Local taxes of these expense items are however not eligible for funding assistance and was therefore deducted from their total value. Also considered eligible expense items are the physical and price contingencies. Total eligible expense items amount to US$75.3 million, which is equivalent to 88.0 % of the total funding requirement of US$85.5 million.

Table 8.6 Priority Project Cost Components

Descriptions	Million US$	% Total
Eligible Project Cost Components		
Direct Cost Items, net of taxes	49.61	58.0%
Engineering Services, net of taxes	5.15	6.0%
Institutional Dev, net of taxes	0.91	1.1%
Subtotal, 2010 Price Level	**55.68**	65.1%
Physical Contingency	5.26	6.2%
Price Contingency	14.30	16.7%
Total Eligible Components, Current Prices	**75.25**	88.0%
Ineligible Project Cost Components		
Land Acquisition	0.30	0.4%
Social Compensation	0.09	0.1%
Project Administration	0.95	1.1%
Subtotal 2010 Price Level	**1.34**	1.6%
Physical Contingency	0.03	0.0%
Price Contingency	0.03	0.0%
Tax of Direct Cost Items	3.84	4.5%
Tax of Engineering Services	0.13	0.1%
Tax for Institutional Deve.	0.01	0.1%
Total Ineligible Components	**5.38**	6.3%
Total Project Cost, current prices	**80.64**	**94.3%**
Add: Capitalized Interest During Construction	4.85	5.7%
Total Investment Cost for the Project	**85.50**	**100%**

Notes: Figures are rounded based on S.R. 2 cost analysis.

Ineligible expense items for SRWSA counterpart funding consist of the local taxes of the eligible expense items, cost of land acquisition, social compensation and project administration expense. Total cost of ineligible expense items amount to US$5.38 million, which is equivalent to 6.3% of the total funding requirement of US$85.5 million.

Table 8.7 Priority Project Financing Resources

Descriptions	Million US$	%Share
Eligible Cost Items	75.25	88.0%
Capitalized Interest	4.85	5.7%
JICA Loan	**80.11**	**93.7%**
SRWSA Equity Contribution	5.38	6.3%
Total Financing Resources	**85.50**	**100%**

Notes: Figures are rounded.

ii) KTC Pipeline Extension Project

The authority is set to receive treated water from a privately owned bulk water supply system for redistribution to its customers particularly hotels that are currently not connected to the public water system. As per information from SRWSA, the KTC bulk water system is scheduled to be on-line not later than 2012 initially at 40% capacity. Total bulk supply capacity of 17,000 m^3/day shall be attained gradually to 60% in 2013 and 100% full capacity by 2014.

In order to utilize fully the treated water coming from the KTC bulk water system, the SRWSA needs to implement urgent works to expanding its distribution pipelines. Total project cost of the pipeline expansion is estimated at US$9.91million, the break down of which is shown in Table 8.8 below.

Table 8.8 KTC Pipeline Extension Cost

Descriptions	Million US$	%Total
Basic Construction Cost	7.31	65.0%
Physical Contingency	0.73	6.5%
Price Contingency	1.88	16.7%
Total Project Cost	**9.91**	**88.2%**
Add: Capitalized Interest	1.34	11.8%
Total Investment Cost - Pipelines	**11.26**	**100 %**

Notes: Figures are rounded based on F.S.4.

The above-mentioned cost estimates were computed assuming a 10% physical contingency and 7.9% annual inflation rate for the price contingency. In order to minimize the equity contribution requirement of SRWSA, interest charges are capitalized during construction. The annual KTC project cost is presented in Financial Study 4.

The KTC pipeline extension project shall be funded from a loan to be taken out from bilateral and multi-lateral financing agencies other than JICA. Pending actual negotiations with prospective financing institutions, the financial evaluation assumed that the KTC project shall be financed under terms and conditions adapted from the World Bank (Adaptive Program Loan) and the Asian Development Bank (Development Policy Loan). Maximum loan amount is 90% of total project cost plus capitalized interest during construction. The financing plan for the KTC pipeline project is shown in Table 8.9 below.

Table 8.9 KTC Pipeline Extension Financing Resources

	Million US$	%Share
KTC Pipeline Disbursement	8.92	79.0%
Capitalized Interest	1.34	12.0%
Total KTC Pipeline Extension Project Loan	**10.26**	**91.0%**
SRWSA Equity Contribution	1.0	9.0%
Total Financing Resources	**11.26**	**100.0%**

(2) Debt Servicing Needs

This is estimated on the basis of the financing plan for the capital investment program of SRWSA consisting of the priority and pipeline extension projects.

i) Priority Project Loan

The projected annual debt service schedule of the project loan from JICA shall be subject to an on-lending interest rate of 4.5%. However due to concerns on the impact of the loan to the water tariff, it was decided to adapt "step-ladder" interest rates that would achieve the same net present value of total debt service payments under a constant 4.5% interest rate. In order to determine the applicable "step-ladder" interest rates for the loan, a computational model was prepared as shown in the attached Financial Study 2.

Per Financial Study 2, total debt service under a constant 4.5% interest rate amounts to US$166.85 million with a net present value of US$57.91 million using a discount rate of 5.25%.

Using the model as presented in Financial Study 2, countless combinations of interest rates could however be possible. It was therefore arbitrarily decided that initial interest rate of 3% is a good compromise for MEF in accommodating SRWSA concerns regarding the impact of interest payments to its finances. From the initial 3%, a gradual rise in the interest is a preferred approach similar to a step-ladder. Succeeding interest rates are 3.75% for the period 11th to 20th year, 7.5% for the 21st to 30th year, and 10.40% for the 31st to 40th year of the loan. The total debt service payments under the assumed step-ladder interest rates sums up to US$185.41 million, with a net present value of US$57.91 million using the discount rate of 5.25%.

Notice that the second step interest rate was kept close to the initial rate. This is to give SRWSA sufficient lead-time to improve and expand its income generating capacity. Hopefully by the time that the higher interest rate takes effect, SRWSA's revenue base in terms of number of connections is fully optimized.

On top of the interest rate, the other terms and conditions of the loan are as follows:

- Loan maturity period is 40 years inclusive of 10 years grace on principal repayment;
- 100% of interest charges during construction are capitalized. This is recommended in order that available cash collections during the construction period shall be allocated primarily for satisfying the equity contribution requirements of the KTC pipeline project and the priority expansion project. Although capitalization of interest has a negative impact in that it increases the outstanding loans of the authority, the impact of interest being capitalized is mitigated by the lower rate of interest of 3% during the grace period.
- Principal repayment is for 30 years to start on the 11th year from initial loan drawdown.

The projected annual debt service schedule is presented in the attached Financial Study 3.

ii) KTC Pipeline Extension Project Loan

The KTC pipeline project loan is assumed to carry the following terms and conditions:

- Eight percent (8%) interest rate;

- Interest during construction shall be capitalized in order to allow the authority to muster sufficient cash for its equity contribution to the pipeline extension and to the Project;
- 30 years maturity period inclusive of 4 years grace on principal repayment; and
- 26 years repayment period.

The projected debt service schedule for this loan is presented in the attached Financial Study 5.

(3) Operating and Maintenance Costs

Financial Study 6 presents the projected annual operating and maintenance costs at constant 2010 price level. The operating and maintenance expenses consist of salaries and wages, cost of power and fuel, cost of water treatment, maintenance and miscellaneous overhead costs. These are projected yearly by applying actual cost data on cost parameters directly related to the recommended technical development scheme of the SRWSA.

The annual operating and maintenance cost of SRWSA were estimated on the basis of the operation of the existing and proposed additional source of supply that shall meet the projected water demand in Siem Reap City. Between the present and the operation of the water treatment plant under the recommended priority project, the proposed 17,000 m^3/day KTC bulk water supply system is expected to start operation beginning 2012 initially at 40% of capacity; increasing to 60% of capacity in 2013 and shall be operating at full capacity by 2014. Bulk water tariff is KHR850 per m^3 and increases by KHR50 every 5 years. It was therefore deemed appropriate to estimate the annual operating and maintenance needs of SRWSA on the basis of the sources of supply: existing WTP with a maximum capacity of 9,000; the proposed 17,000 m^3/day KTC Bulk Water Supply and the 30,000 m^3/day WTP of the Project, which is the subject of this evaluation.

(4) Replacement Costs

In consonance with the 30-year coverage for evaluating the project, replacement of sub-components of the Project is included among the capital investment needs of the SRWSA. These refer to the electro-mechanical equipment that has exceeded their average economic life of 15 years.

The total cost of electro-mechanical equipment at constant 2010 prices is US$10.338 million, as shown below.

Table 8.10 Replacement Cost

Million US$	**Total**	**2028**	**2029**	**2030**	**2031**
Electro-Mechanical Equipment	9.40	0.34	4.04	3.01	2.01
Physical Contingency (10%)	0.94	0.03	0.40	0.30	0.20
Total Cost, 2010 Prices	**10.34**	**0.37**	**4.44**	**3.31**	**2.21**

Notes: Figures are rounded based on S.R.8.2 cost analysis.

The above cost estimate was taken from **S.R.8.2** shown in the Supporting Report.

(5) Depreciation Cost

This represents the value of the normal wear and tear of SRWSA's utility plant in service. In the financial projection, existing assets are depreciated at 3% while that for new assets from the Project and the pipeline extension is estimated at 3.33% (1/30) of the average value of the fixed assets during the year. Said ratio assumes that the average economic life of the water system facilities is 30 years.

(6) Income Tax

In line with its autonomous character, the SRWSA is subject to income tax assessment. Income tax is computed at 20% of the net profit after deducting depreciation expense and interest charges. If it incurs a net operational loss, the SRWSA is exempted from paying income tax for the said taxable year.

8-4-3 Revenue and Tariff Analysis

The SRWSA derives its water revenue from the operation of the existing water treatment plant with a capacity of 9,000 m^3/day or 3,285,000 m^3/year, which is serving currently the needs of 4,129 connections (4,030 domestic/government[3] and 99 hotels). Per technical evaluation, the existing capacity is fully saturated with only the reduction of water losses affords the SRWSA to accommodate limited number of new connections, if ever. It is for this reason that SRWSA is seeking to develop new water resources and expand its water services in the city.

(1) Revenue Requirements

Per expansion program under the Project and the KTC bulk water supply project, the critical milestones to consider in determining the revenue needs of SRWSA are enumerated below.

Following on the program for the expansion of its facilities, it is clear that SRWSA needs to raise the needed funds either through equity infusion from the government or through its water revenues. The RGC however has discarded equity infusion as an option. Preferred option is to pursue full cost recovery through adjustment of water tariffs.

Table 8.11 Milestones of Activities

Year	Stage	Financial Study No.	Cash Req. US$ million	Milestone of Activities
2011	Engineering Design	1, 3, 4 & 5	0.086 0.467	Pipeline expansion project commences. Engineering Design Starts on Priority Project. Land purchase for Treatment Plant, pd compensation
2012	Start of KTC Project	1, 3, 4 & 5	0.027 0.336	KTC- SRWSA receives 40% of total plant capacity Engineering Design Works on Priority Project.
2013	Start up of	1, 3,	0.262	KTC continues to expand – additional 20%

[3] Total connections is 4,129 coming from actual January 2010 data of 4,030 domestic connections plus 30% of 321 hotels increasing by 3% thereafter.
[6] ADB Water for All website. Country water action: Philippines reaching out to peri-urban villages.

	Priority Proj	4 & 5	0.710	Actual Priority Project Starts.
2014	KTC complete	1 & 4	0.308 1.464	KTC pipeline completed – KTC 100% operational Works for priority project continues.
2015	KTC Loan pmt starts	1 & 4	1.651 0.950	Continue Project works. KTC fully operational. Pipeline loan payment on starts.
2016	Proj. finish	1 & 5	1.006 0.950	Project completion, startup, testing Pipeline loan payments continue.
2017	WTP Starts	3 & 5	2.400 0.950	Priority Project is operational. Payment of interest on JICA loan starts. Pipeline loan amortization continues.
2022	Pay on 2 Loans	3 & 5	4.490 0.950	Loan Amortization starts on JICA Loan. Pipeline Loan amortization continues.
2026	Full utilization of capacity is achieved.			
2031	Interest Rate up	3 & 5	6.120 0.950	Higher Debt Service Payments due to adjustment in interest rate. Pipeline Loan amortization continues.
2041	Interest Rate up	3 & 5	6.960	Higher Debt Service Payments due to adjustment in interest rate.

(2) Proposed Water Tariffs

The proposed adjustment in water tariffs has been formulated on the basis of the following principles:

Please note that the proposed water tariffs are computed based on real terms – allowance for price fluctuation due to inflation is not included in the derivation of the water tariffs.

- Water tariff must insure financial stability and growth of SRWSA without subsidy from the government.
- Water tariff must meet the debt service coverage ratio (DSCR) of not less than one.

Tariff Adjustment Cycle

Grouping years with similar financial cash requirements into tariff cycles, current situations appear to have five year cycles.

- In 2012, the operation of the KTC bulk water system results to water service for additional number of connections.
- In 2017, the operation of the Priority Project opens up water service to more people. Additionally, SRWSA starts paying interest charges for the JICA loan as shown in Financial Study 3.
- In 2022, introduction of principal repayment plus interest payment for the JICA loan.
- Beyond 2026, maximum production capacity requiring expansion plan.

The proposed tariff for each 5-year tariff period have been computed by adding all corresponding costs, expenses and some profit for said period, then dividing the net amount with the total volume of planned water sales for the 5-year period.

A series of financial runs were conducted and tested to meet cash flow and debt servicing parameters to arrive at the recommended average tariff per cubic meter. The results of each trial run are presented below and illustrated in attached Financial Studies 9 to 18.

- Trial Runs 1 & 2 were found to require Cash Infusions from the RGC.
- Trial Runs 3 & 4 eliminated the need for Capital Infusion in future years.

Table 8.12, which was created from **SR8.5** of the Supporting Report, indicates reason and results of four trial runs.

Table 8.12 Revenue Requirements – Tariff Planning Chart (US$ million)

Descriptions	**Trial Run 1** From Financial Study 7 to 9		**Trial Run 2** From Financial Study 10to 12		**Trial Run 3** From Financial Study 13 to 15		**Trial Run 4** From Financial Study 16 to18		
Years	2012-2016	From 2017	2012-2016	From 2017	2012-2016	From 2017	2012-2016	2017-2021	From 2022
Operating Expenses (5 yr)	8.594	14.170	8.594	14.170	8.594	14.170	8.594	14.170	18.146
Depreciation Expenses (5 yr)	1.421	15.397	1.421	15.397	1.421	15.397	1.421	15.397	15.397
Interest Charges (5 yr)	1.633	16.488	1.633	16.488	1.633	16.488	1.633	16.488	17.598
Income Taxes (5 yr)	0.986	0	1.047	0	1.108	0	1.108	0	0.658
Net Operating Profit (5 yr)	3.944	-9.986	4.188	-9.407	4.432	-8.249	4.432	-8.828	1.930
Total Revenue Requirement (5 yr)	16.578	36.069	16.883	36.648	17.188	37.806	17.188	37.227	53.729
LESS: Other Operating Revenue	2.690	2.253	2.693	2.259	2.696	2.270	2.696	2.265	1.767
Water Sales Required (5 years)	13.887	33.816	14.189	34.389	14.491	35.536	14.491	34.962	51.961
Total Billed Water Million m^3 (5yr)	30.190	57.316	30.190	57.316	30.190	57.316	30.190	57.316	82.478
Required Average Tariff US\$/m^3	0.46	0.59	0.47	0.60	0.48	0.62	0.48	0.61	0.63
Tariff in KHR (US$ x 4,165)	1,916	2,457	1,958	2,499	1,999	2,582	1,999	2,541	2,624
Indicators									
RGC Equity Infusion	Required in 2015, 2016 & 2017		Required in 2015, 2016 & 2017		**Not Required**				
Debt Service Coverage Ratio	**Less than 1.0 in 2021 & 2037**		**Greater than 1.0**		**Greater than 1.0**				

Notes: Tariff is computed based on real terms.

8-4-4 Financial Status and Condition for the Proposed Water Tariffs

(1) Liquidity of Operation

SRWSA is expected to experience some cash deficits during the 30-year projection period. However, the cash deficits during the projection period can be covered by the accumulated cash balances of previous years. In both Trial Runs 3 and 4, there is no need for government capital infusion as shown in Financial Studies 13 and 16.

(2) Debt Service Coverage Ratio

One important financial parameter for assessing the financial desirability of a project is the debt service coverage ratio. As defined, it is that portion of revenue after deducting operating expenses that can cover the debt servicing needs of outstanding loan obligations. Creditworthiness parameters warrant that net revenue after expenses is equivalent to no less than the amount of the annual debt service. Based on the results of the recommended Trial Runs, the annual debt service coverage ratio for the project is more than one in both Trial Runs 3 and 4, as shown in the attached Financial Studies 14 and 17.

(3) Profitability of Operation

The financial forecast shows that SRWSA shall continue to maintain its very good financial performance with the implementation of the minimum tariffs adjustments recommended in Trial Runs 3 and 4. The continuing profitability during the construction period is attained with the tariff adjustment in 2012 and 2017. As shown in Financial Studies 15 and 18 for recommended Trial Run 3 and Trial Run 4, the SRWSA shall still experience some losses even with the recommended tariffs adjustments in 2017.

Under Trial Run 3, SRWSA will incur losses in 2017 to 2023 and again in 2031 to 2037. The losses are however manageable as SRWSA would still be accumulating extra cash from its operations.

Under Trial Run 4, losses are likewise expected in 2017 to 2023 and again in 2031 to 2037. Despite the losses, SRWSA remains financially solvent. It has accumulated surplus funds that would carry it over during the years when losses are incurred.

Notice that for both recommended tariff options, losses are tolerated to occur mainly to avoid higher increase in tariffs.

(4) Recommended Trial Runs

On the basis of the financial results, both Trial Runs 3 and 4 satisfy the financial parameters established for this project. These are therefore adapted in this study for the purpose of formulating and evaluating the required water tariff schedules that would allow SRWSA to operate on a financially sustainable manner.

8-4-5 Proposed Water Tariff Schedules

SRWSA's financial health and condition is achieved not only due to the additional benefits derived from the increase in customer base but with the timely adjustment of tariffs as assumed in the financial forecast. It must therefore be emphasized that the financial soundness of the water authority is critically dependent on the adjustment of its water tariffs as proposed in the previous sections.

(1) Social Consideration

In establishing tier levels we are able to ease the payments of poor households by using higher tariff for high volume household and commercial users.

(2) Ratio Between Residential and Commercial Consumption

In formulating separate water tariffs for residential and commercial connections, the ratio of the projected water consumption between the two classifications of water connections were derived based on the water demand projection. These are as shown below.

Connection Classification	2012	2017	2022
Residential Connections	76.5%	77.9%	77.4%
Commercial Connections	23.5%	22.1%	22.6%

Note: Ratios shows five years' average water demand between residential and commercial connections.

(3) Consumption Ratio According to Tariff Blocks

The tariff schedules were computed using consumption ratios that are based on the actual metered billing data of SRWSA covering the period January to December of 2009, as tabulated below:

Per Table 8.13, higher consumption ratios are applied in the study for the 8-15 m^3 and 16-30 m^3 consumption blocks. This is to account for the increase in the number of connections to be served in the presently un-served areas of the SRWSA that shall be having water consumption within the range of the two consumption blocks. With the expansion of services to the fringe areas of Siem Reap, average consumption volumes shall be lower compared to the present, which currently services the core area of the city. The increase in consumption ratios for the 8-15 m^3 and 16-30 m^3 consumption blocks would result to a corresponding decrease of 10 percentage points for the consumption ratio for over 30 m^3 consumption block.

Table 8.13 Applied Consumption Ratio for Residential Water Tariff

Consumption Blocks	Actual Consumption Ratio	Applied in Study
1 – 7 m^3	10%	10%
8 – 15 m^3	15%	20%
16 – 30 m^3	25%	30%
Over 30 m^3	50%	
Proposed 30 – 60 m^3		30%
Proposed Over 60 m^3		10%

Also shown in Table 8.13 above, one more consumption block (30 to 60 m^3) is being proposed. The purpose here is to provide tariffs for all residential connections up to 60 m^3. Consumption beyond 60 m^3 should be considered as commercial volume.

Table 8.14 Hotel Consumption Ratio

Tourist Accommodations	No. of Units	Bed Cap.	Bed per Hotel	Per 60% Occupancy	Water Use (a)	Min. (a) / 1.25	Max. (a) x 1.25
Guesthouses	208	4,315	21	12	108m^3	86 m^3	135 m^3
Ordinary Hotels	95	9,341	98				
High-end Hotels	18	5,359	298	179	1,620m^3	1,200m^3	2,000m^3
Totals	**321**	**19,015**					

Note: Daily consumption rate for a tourist is assumed to be 300 lpcd.

For commercial connections, the ratio per consumption block is structured on the basis of actual hotel data of the Ministry of Tourism.

High-end Hotels. At average 60% occupancy rate, high-end hotels are serving 179 beds per hotel (298 x 60%). With an average per capita consumption of approximately 300 liters per day, total volume of water used up by tourists per high-end hotel is 1,620 m^3/month (179 x 300 lpcd x 30 days x m^3/1000 liters). Applying the peak factor of 1.25, consumption ranges from maximum 2,000 m^3/month to a minimum 1,200 m^3/month.

Guesthouses. At average 60% occupancy rate, guesthouses are serving 12 beds each (21 beds x 60%). With an average per capita consumption of 300 liters per day, total volume of water used by tourists staying in guesthouses is 108 m^3/month (12 x 300 lpcd x 30 days x m^3/1000 liters). Also, applying the peak factor of 1.25, consumption ranges from maximum 120 m^3/month to minimum less than 100 m^3/month. The maximum volume may be accounted during high season and the minimum would account for the low season of tourism activities in Siem Reap.

On the basis of the foregoing, the proposed tariff blocks for commercial connections were formulated as shown in Table 8.15. The first block represents consumption by guesthouses, the 2nd block represents consumption in between the guesthouses and the high-end hotels, and the last block is the high-end or 4 to 5-star hotels.

As to the distribution of consumption ratio, this is simply taken from the ratio of hotel beds in Siem Reap, wherein high-end hotels have 28% of total bed capacity (5,359 out of 19,015); ordinary hotels have 49% of total bed capacity (9,341 out of 19,015); and guesthouses 23% of total bed capacity (4,315 out of 19,015). Hence, the consumption ratio was assumed at 30% for high-end, 50% for ordinary and 20% for guesthouses.

(4) Water Tariff Schedules

The recommended average tariffs that would meet the cash requirements of SRWSA are:

i) Proposed Water Tariff Study 1

KHR1,999 (US$0.48 using KHR4,165/US$) per cubic meter effective 2012 and KHR2,582 (US$0.62 using KHR4,165/US$) starting in 2017. These recommended water tariffs for 2012 and 2017 can be achieved on the basis of the tariff schedules presented in Table 8.15.

2012 Water Tariff. Required tariff increase implements no increases in the first 2 consumption blocks of residential connections. A big increase is absorbed by commercial tariffs, resulting in 41% higher than the overall average tariff of KHR2,166 per cubic meter.

2017 Water Tariff. Two options are proposed:

- Option 1 tariff schedule carries a lower increase in residential tariffs as the required increase is borne by the commercial tariff. The tariff increase shall be achieved from high-volume residential connections and commercial connections. Under this option, commercial average tariff is 39% higher than the overall average of KHR2,582 per cubic meter.

- Option 2 implements a lower increase in commercial tariffs as increase is also shared by the residential tariffs. Commercial average tariff is 16% higher than the overall average tariff of KHR 2,582 per cubic meter. Also, a separate tariff schedule for commercial connections is not required under this option.

Table 8.15 Proposed Water Tariff 1 (KHR/m^3)

Trial Run 3				
Residential	**Consumption Ratio**	**2012**	**2017**	
			Option 1	**Option 2**
0 to 7 m^3	10%	1,100	1,300	1,550
8 to 15 m^3	20%	1,500	1,800	2,100
16 to 30 m^3	30%	1,800	2,300	2,500
31 to 60 m^3	30%	2,000	2,700	2,800
61 m^3 & up	10%	2,000	3,100	3,000
Average/m^3		**1,750**	**2,300**	**2,464**
Commercial				
0 to 100 m^3	20%	2,300	3,240	3,000
100 to 1,200 m^3	50%	2,770	3,600	3,000
>1,200 m^3	30%	3,220	3,765	3,000
Average/m^3		**2,811**	**3,578**	**3,000**
Overall Average		**1,999**	**2,582**	

Note: Proposed tariffs are in real terms. Tariffs do not include price escalation due to inflation.

ii)Proposed Water Tariff Study 2

KHR1,999 (US$0.48 using KHR4,165/US$) per m^3 effective 2012 and KHR2,541 (US$0.61 using KHR4,165/US$) starting in 2017 and KHR2,624 (US$0.63 using KHR4,165/US$) starting in 2022. These recommended water tariffs for 2012, 2017 and 2022 can be achieved on the basis of the tariff schedules, as illustrated in Table 8.16.

Table 8.16 Proposed Water Tariff 2 (KHR/m^3)

Trial Run 4					
Residential	**2012**	**2017**		**2022**	
		Option 1	**Option 2**	**Option 1**	**Option 2**
0 to 7 m^3	1,100	1,270	1,520	1,280	1,840
8 to 15 m^3	1,500	1,750	2,000	1,780	2,200
16 to 30 m^3	1,800	2,250	2,500	2,310	2,500
31 to 60 m^3	2,000	2,650	2,700	2,765	2,800
61 m3 & up	2,000	3,100	3,000	3,250	3,000
Average/m^3	**1,750**	**2,257**	**2,412**	**2,332**	**2,514**
Commercial					
0 to 100 m^3	2,300	3,100	3,000	3,300	3,000
100 to 1,200 m^3	2,770	3,500	3,000	3,600	3,000
>1,200 m^3	3,220	3,900	3,000	3,880	3,000
Average/m^3	**2,811**	**3,540**	**3,000**	**3,624**	**3,000**
Overall Average	**1,999**	**2,541**		**2,624**	

Note: Proposed tariffs are in real terms. Tariffs do not include price escalation due to inflation.

2012 Water Tariff. Required tariff increase implements no increases in the first 2 consumption blocks of residential connections. The big increase is absorbed by commercial tariffs, which results to 41% higher than the overall overage of KHR1,999 per cubic meter.

2017 Water Tariff. Two options are proposed:

- Option 1 tariff schedule carries a lower increase in residential tariffs as the required increase is borne by the commercial tariff. The tariff increase shall be achieved from high-volume residential connections and commercial connections. Under this option, commercial tariffs are 39% higher than the overall average tariff of KHR2,541 per cubic meter.
- Option 2 implements a lower increase in commercial tariffs as increase is also shared by the residential tariffs. The average commercial tariff is 18% higher than the overall average of KHR2,541 per cubic meter. Proposed tariff increases for commercial connections can be implemented under a unified tariff structure.

2022 Water Tariff. Two options are proposed:

- Option 1 tariff schedule carries a lower increase in residential tariffs as the required increase is borne by the commercial tariff. The tariff increase shall be achieved from high-volume residential connections and commercial connections. Under this option, commercial average tariff is 38% higher than the overall average tariff of KHR2,624 per cubic meter.
- Option 2 implements a lower increase in commercial tariffs as increase is also shared by the residential tariffs. Commercial average tariff is 14% higher than the overall average of KHR2,624 per cubic meter. Proposed tariff increases for commercial connections can be implemented under a unified tariff structure.

In setting up the tariff schedule for 2017 and 2022, it is possible to set residential tariffs at the highest allowable limit that complies with the affordability indicator of 4% of residential income. This however results to a lower commercial tariff, which defeats the purpose of this exercise – to find the most suitable combination of residential and commercial tariffs that would attain the required average tariff per cubic meter. Hence, the options for water tariff schedule for 2017 was limited to the 2 options.

8-4-6 Affordability Analysis

The above-mentioned water tariffs were subjected to separate affordability tests, the results of which are presented and discussed in the next sections.

(6) Proposed Water Tariff 1

The recommended tariff schedules were subjected to affordability test as will be discussed in the next sections.

Affordability of Water Tariffs for Residential Connections. The results of the affordability analysis as illustrated below show that the required tariff schedule for 2017 is affordable. The average monthly water bill of residential connections represents only 2.35% in 2012 to 3.6% in

2017 of average family income. The derived ratio of water bills to total income for the said tariff year is below the maximum 4% of average family income that can be allocated to water usage as per studies previously conducted by the World Bank and the Asian Development Bank.

Table 8.17 Affordability Test for the Proposed Water Tariff 1, Residential

Residential	2012	2017	
		Option 1	Option 2
Ave. Residential Tariff (KHR/m^3)	1,750	2,300	2,464
Unit Consumption Rate (lpcd)	114	124	124
Average Nos. of Household	5.7		
Ave. Monthly Consumption (m^3/family)	19.5	21.2	21.2
Ave. Monthly Bill (*KHR)	37,511	53,625	57,462
% of Ave. Income	**2.35%**	3.36%	**3.60%**
Ave. Monthly Family Income (KHR)	1,594,120		

Note: *10% VAT is included.

Affordability of Water Tariff for Commercial Connections. As described earlier in this report, this is determined on the basis of two distinct tests that provide some kind of measurement regarding the acceptability of the proposed water tariffs for commercial connections. The results of the two affordability tests are indicated below.

Table 8.18Affordability Test 1 for the Proposed Water Tariff 1, Commercial

Commercial	2012	2017	
		Option 1	Option 2
SRWSA Unit Cost (KHR/m^3)	3,093	3,936	3,299
Own System Unit Cost (KHR/m^3)			
Max. US$1.0	4,165		
% of SRWSA to Hotel Own Unit Cost*	74%	94%	79%

Note: *10% VAT is included.

- The test on ratio of average SRWSA unit cost to own-unit cost of commercial establishments show that the tariff schedules for both Options 1 and 2 are acceptable to commercial users.

Table 8.19 Affordability Test 2 for the Proposed Water Tariff 1, Commercial

Commercial	2012	2017	
		Option 1	Option 2
SRWSA Unit Cost (US$/m^3)	0.74 (KHR3,093)	0.94 (KHR3,936)	0.79 (KHR3,299)
Tourist Unit Consumption (lpcd)	304	314	
Ave. Days of Stay per Trip (days)	3.5		
Tourist Ave. Consumption (m^3/trip)	1.06	1.10	
A. Water Cost(*US$/trip/tourist)	0.79	1.04	0.87
Ave. Tourist Expenditure (US$/trip)	425		
% Cost of Water/Tourist Expenditure	0.19%	**0.24%**	0.20%
B. Water Cost per Day(*US$/d/tourist)	0.23	0.30	0.25
Water Cost/Room Rate			
- US$15	1.50%	**1.98%**	1.66%

Note: *10% VAT is included.

- The test on ratio of cost of water per tourist to total expenditure/tourist. Results of the test show that the proposed water tariffs of SRWSA have no effect or impact on tourists. Total expenditures for water per tourist is just a drop in the bucket so to say at maximum 0.24% for cost of water per tourist expenditure and approximately 2% for cost of water per room rate in

2017. The results show the water tariffs for commercial connections are acceptable for hotel and their guests.

(3) Proposed Water Tariff 2

The recommended tariff schedules were subjected to affordability test as will be discussed in the next sections.

Affordability of Water Tariffs for Residential Connections. The results of the affordability analysis as illustrated below show that the required tariff schedule for 2017 is affordable. The average monthly water bill of residential connections represents only 2.35% to 3.97% of the average family income in 2012 and 2022, respectively. The derived ratio of water bills to total income for the said tariff year is below the maximum 4% of average family income that can be allocated to water usage as per studies previously conducted by the World Bank and the Asian Development Bank.

Affordability of Water Tariff for Commercial Connections. As described earlier in this report, this is determined on the basis of two distinct tests that provide some kind of measurement regarding the acceptability of the proposed water tariffs for commercial connections. The results of the two affordability tests are discussed below.

Table 8.20 Affordability Test for the Proposed Water Tariff 2, Residential

Residential	**2012**	**2017**		**2022**	
		Option 1	**Option 2**	**Option 1**	**Option 2**
Ave. Residential Tariff (KHR/m^3)	1,750	2,257	2,412	2,332	2,514
Unit Consumption Rate (lpcd)	114	124		134	
Ave. Nos. of Household	5.7				
Ave. Mon. Consumption (m^3/family)	19.5	21.2	21.2	22.9	22.9
Ave. Monthly Bill(*KHR)	37,511	52,653	56,248	58,789	63,366
% of Average Income	**2.35%**	3.30%	3.53%	3.69%	**3.97%**
Ave. Mon. Family Income (KHR)	1,594,120				

Note: *10% VAT is included.

- The test on ratio of average SRWSA unit cost to own-unit cost of commercial establishments show that the tariff schedule for both 2017 and 2022 under Option 2 is more acceptable to commercial users than the tariffs under Option 1. Under the latter, tariffs for commercial connections are relatively higher.

Table 8.21 Affordability Test 1 for the Proposed Water Tariff 2, Commercial

Commercial	**2012**	**2017**		**2022**	
		Option 1	**Option 2**	**Option 1**	**Option 2**
SRWSA Unit Cost (KHR/m^3)	3,093	3,894	3,300	3,986	3,300
Own System Unit Cost (KHR/m^3)					
Max. US$1.0	4,165				
% of SRWSA to Hotel Own Unit Cost	74%	94%	79%	96%	79%

Note: *10% VAT is included.

- The test on ratio of cost of water per tourist to total expenditure/tourist. Results of the test show that the proposed water tariffs of SRWSA have no effect or impact on tourists. Total expenditures for water per tourist is just a drop in the bucket so to say at maximum 0.26% for cost of water per tourist and 2.1% for cost of water per room rate in 2022. The results show the water tariffs for commercial connections are not expensive to the tourists.

Table 8.22 Affordability Test 2 for the Proposed Water Tariff 2, Commercial

Commercial	2012	2017		2022	
		Option 1	Option 2	Option 1	Option 2
SRWSA Unit Cost (US$/m^3)	0.74	0.94	0.79	0.96	0.79
Tourist Unit Consumption (lpcd)	304	314		324	
Ave. Days of Stay per Trip (days)	3.5				
Tourist Ave. Consumption (m^3/trip)	1.06	1.10		1.13	
A. Water Cost (*US$/trip/tourist)	0.79	1.03	0.87	1.09	0.90
Ave. Tourist Expenditure (US$)	425				
% Cost of Water/Tourist Expenditure	0.19%	0.24%	0.20%	**0.26%**	0.21%
B. Water Cost per Day (*US$/d/tourist)	0.23	0.29	0.25	0.31	0.26
Water Cost/Room Rate					
- US$15	1.50%	1.96%	1.66%	2.07%	1.71%

Note: *10% VAT is added.

8-4-7 Prognosis

All of the proposed tariffs included in this section are affordable. The selection of the proposed water tariff study 2 over that of tariff study 1 would provide an easier transition with three tariff increments from 2012 up though 2026. The selection of option 2would provide simplicity of unified tariff for all commercial users. However, the selection of option 1 over option 2 is preferred since it would afford lower tariff for low volume residential users.

8-5 Financial Internal Rate of Return for the Priority Project

The financial internal rate of return for the Project (FIRR) is approximately 2.6% as shown in Financial Study 19 and 20 for Proposed Tariff Studies 1 and 2, respectively. The computation of the FIRR is however based on water tariffs that are constricted and regulated by the Royal Cambodian Government due to social and political considerations.

The FIRR could be higher under a tariff based on maximum capacity to pay of 4% of average monthly income of households in Siem Reap. Using optimum tariffs, the FIRR is 3.32% as shown in Financial Study 21. This FIRR was attained using the average water tariff of KHR2,807 (USD0.67) starting in 2017 and onwards. With this tariff, the average residential tariff is KHR2,529 that results to a maximum water bill of KHR63,744 (KHR2,529/m^3 x 22.9m^3 x 1.10 for VAT) equivalent to 4% of average income of KHR1,594,120 in 2027. In terms of the commercial water tariffs, the effective average water tariff is KHR 3,785 which would be equivalent to the maximum KHR4,165/m^3 own unit cost of commercial establishments with VAT included.

The FIRR is subjected to sensitivity tests to determine the effect of variances on some key assumptions. The selected sensitivity scenarios and the results of the tests are described and presented below.

- Scenario 1: Investment Cost increasing by 15 percent more than the base hypothesis results to a FIRR of 1.86% for Proposed Tariff Study 1 and 1.98% for Proposed Tariff Study 2;
- Scenario 2: Operating and Maintenance Costs increasing by 15 percent more than the base hypothesis results to an FIRR of 2.22% for Proposed Tariff Study 1 and 2.3% for Proposed Tariff Study 2; and,
- Scenario 3: Revenues decreasing by 15 percent less than the base hypothesis results to a FIRR of 1.34% for Proposed Tariff Study 1 and 1.47% for Proposed Tariff Study 2.

The results of the sensitivity test as described above show that the attainment of the required FIRR is highly sensitive to the attainment of the required revenues. This is closely followed by the influence of an increasing project cost. The FIRR is least affected by an increase in the operating expenses. The SRWSA is therefore advised to closely monitor its revenue center and be upbeat on factors affecting its revenue base as these have underlying effect on its ability to sustain the growth of much needed water sales.

8-6 Financial Conclusion and Recommendation

(1) The results of the financial evaluation show that the Project is financially feasible, as shown by the following indicators:

- SRWSA's financial condition shall not be adversely affected by the implementation of the project. In fact, it would enhance its long-term financial condition since the project expands its revenue base and thus provides better potential for attaining full cost recovery of operation as mandated by the government when it created SRWSA as an autonomous self-sufficient government entity.
- Debt service ratio of SRWSA or its ability to meet maturing loan obligations does not go below 1.0 throughout the study period.
- Cash position will not be affected during construction. SRWSA shall not require additional capital infusion from the government.
- The required water tariffs are affordable as these pass affordability parameters for residents and businesses.

(2) SRWSA as part of its promotional thrust of increasing its revenue base with more service connections should encourage the low-income households to have their own water connections by (1) offering an installment plan for its new service connection fee and (2) special subsidy for financing cost of new connection.

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(4) SRWSA is encouraged to create and maintain a sinking fund for future expansion of project based

on depreciation expense of the existing fixed assets.

(5) SRWSA is likewise encouraged to take the lead in working out the passage of a law or decree that bans the absorption of groundwater. The timing of the ban on groundwater absorption can take effect sometime in 2017 during which time full nominal design capacity of the completed WTP of the Project is available. The water authority should therefore take advantage of the available water supply by bringing the existing users of well water into the treated water system.

(6) Given the above findings, the Project is financially feasible. Its implementation is hereby recommended.

8-7 Economic Benefit-Cost Analysis

8-7-1 Introduction

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 implementation of the project aims to achieve the following direct and indirect benefits:

(1) Direct benefits

- Water is essential to the life and general well being of society as a whole.
- Water is an essential input to any production.

(2) Indirect Benefits

- The project helps boost employment and the economy because any program of expenditure has an “economic multiplier” effect on domestic activities.
- The project can help augment the government budget, as any development of productive activities generates new public revenues; and, therefore, the opportunity for the government to carry out new expansion programs.
- Sufficient water supply can reduce some social and economic costs, i.e., the morbidity and mortality rates of some diseases attributable to water shortage, damage caused by fires, etc.

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 depending on:

(3) The households who must pay the water tariffs, and

(4) The economy of the country; since large quantities of imports are required.

The economic benefit-cost analysis, therefore, 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.

8-7-2 Methodology for the Economic Analysis

The economic benefit-cost analysis utilized two methods of analysis: the benefit-cost ratio and the economic internal rate of return. These are discussed in more detail in the next sections.

(1) Benefit-Cost Ratio (BCR)

The BCR computes the present value of economic benefits generated by a project per unit of the present value of the economic costs associated with the project. This requires the prior discounting of benefits and costs. For infrastructure projects like water supply system, the applicable social discount rate is 12%.

A project is considered economically viable with a benefit-cost ratio equal to or greater than 1.

(2) Economic Internal Rate of Return (EIRR)

The EIRR is the discount rate at which the present value of economic benefits attributable to the project is equal to the present value of economic costs. It is differentiated from the BCR in that it avoids prior determination of the discount rate.

A project is considered economically feasible if the EIRR is greater than the social discount rate of 12%.

8-7-3 Economic Benefits

The implementation of the water supply project in Siem Reap is expected to provide significant benefits and desirable long-term effects. This includes both direct and indirect benefits.

The direct and immediate benefits are the following:

The delivery of water in greater quantity and closer to home on a more reliable basis;

- Better water quality;
- Improved environmental conditions; and
- Increase in consumer satisfaction.

On the other hand, the indirect benefits are the following:

- Increased productivity of the residents of the service area;
- Employment and livelihood opportunities for the residents of the municipality and outlying areas;
- Increase in land values;
- Increase in the marketability of housing and industrial park projects;
- Reduction in fire damages; and
- Tourism benefits.

Among the above, the quantification of benefits is concentrated to “increase” in consumer satisfaction. Said benefit was considered since the methodology for its quantification has long been established and accepted in the water supply industry. A discussion of some of the non-quantifiable benefits is however provided.

The economic benefit of the project is measured as the incremental increase in the value of certain socio-economic variables on a "with" and "without" project basis.

(1) Convenient and Reliable Service

The improvement of the water supply system will provide residents with a reliable water service. Additionally, a piped-water system arising from the availability of adequate supply of water will result to immeasurable convenience for the residents.

(2) Consumer Satisfaction

Consumer satisfaction benefit is computed as the economic value of the incremental water production directly arising from the project. In Siem Reap, the economic value of water is estimated to be 30% higher than the existing average tariff of SRWSA. This cost premium is based on past studies for water supply expansion projects that found households in areas without piped water pay a higher price per cubic meter for their supply of potable water. The higher price premium ranges from a low of 140% to as high as 400% higher than the corresponding cost of piped water[6]. Total benefit arising from an increase in consumer satisfaction is estimated with a net present value (using a 12% discount rate) of US$34.86 million, as shown in Economic Study 1.

(3) Health Benefits

Health benefits attributable to the project are measured on the basis of the following:

- Savings in household cost of medical health care due to water-borne diseases; and
- Savings in government health care expenditures due to water-borne diseases.

Based on the ADB-funded study on the development of the sewerage system in Siem Reap Province, the cost of individual health care is estimated at US$5.33 per year for private households and US$3.80 per person under the government’s health care program. Of this amount, only 10% is assumed for health care expenses due to water-borne diseases of both individuals and the local government. The economic benefit attributable to the water supply project is assumed at 33%.

The total health-related benefit that can be achieved in the province is estimated at US$27.1 million as presented in Economic Study 2.

(4) Tourism Benefits

A major benefit attributable to an improved water supply system in Siem Reap is related to the tourism industry which is centered on the Angkor Wat ruins. The impact of tourism in Siem Reap is tremendous that it affects not only the local economy but also the entire country. As such, the improvement and expansion of the water system has indirect effect on the tourism industry. The benefits attributable to the project are:

- Increased tourist spending due to an extended stay as a result of improved amenities and comfort for tourists staying in hotels with water service from SRWSA.
- Multiplier effect of the increased tourist spending to local employment.

Data of the Tourism Office in Siem Reap reports that on the average, tourist stay in Siem Reap for 3.5 days and spend a total of US$425. With the improved water supply, tourist stay as per their estimate is extended by one day or 4.5 days total stay. With the one-day extension, average spending is estimated at US$546.30 (US$425/3.5days x 4.5 days). Assumed net tourist spending ratio is 30% as per estimate of the tourism office.

The multiplier effect to local employment is measured through the net effect of the increased tourist spending to unskilled labor in Siem Reap. This is measured on the assumption that 20% of increased spending will benefit the local unskilled labor market. Due to under employment as well as unemployment situation in the province, said spending benefitting the unskilled labor market is adjusted to its competitive value by deducting the shadow price factor of 0.75% for unskilled labor. Net benefit attributable to the water supply project is assumed at 27%, which is 90% of 30%.

The benefit on tourist spending is estimated at US$304 million using a discount rate of 12 percent**.** Economic Study **3** presents the computation of this benefit.

8-7-4 Economic Costs

The direct costs of the project consist of the project, replacement, and operating and maintenance costs. These are converted into economic costs as will be discussed in the next sections.

(1) Project Cost

In the economic analysis, the project cost considered is at constant price level. Price contingencies are therefore excluded. Furthermore, the project cost estimates are adjusted to arrive at the true economic value of the project. Such adjustment is considered on account of the imperfections in the local market economy. The factors considered are given below:

- Taxes are netted out since they just constitute transfer payments;
- Foreign exchange premiums are a result of the interplay of the supply and demand for foreign currency (particularly the US$). In Cambodia, the US$ is valued at its going rate since it is publicly circulating being the “unofficial” form of currency in the country;
- Wages of unskilled labor like foreign exchange premium is normally set by government under a minimum wage law to protect the welfare of such workers. For this reason, wages of laborers are valued higher than when it is left free to the forces of demand and supply in the free market. To correct this over valuation, a social conversion factor of 0.75 is applied; and
- Salaries and wages of skilled labor are priced at the going market rate.

· By applying the foregoing factors, the project economic cost is estimated at US$56.521 million, as presented in Economic Study 4 – Chart 5.

(2) Replacement Costs

The economic life of water supply equipment ranges from 15 years (i.e., centrifugal pumps, valves, chlorinators, etc.), to 30 years (i.e. pump house structures, well structures, etc.) up to 50 years (i.e. ductile iron pipes, most civil work items like pumping stations, reservoirs, etc.).

Based on the estimated service life of the water supply facilities, the total replacement cost for facilities (both civil works and equipment) with an economic life of 15 years or less is estimated at US$10.182 million, as shown in Economic Study **4** – Chart 5.

(3) Operating and Maintenance Cost

In the economic analysis, only incremental operating and maintenance costs are considered. Unlike the financial project costs, these are subjected to shadow pricing to account for the imperfect pricing attributable to a market economy. The total incremental operating and maintenance cost is estimated at US$21.83 million, as presented in Economic Study 4 – Chart 5.

8-7-5 Benefit Cost Ratio and Economic Internal Rate of Return

(1) Benefit-Cost Analysis

The result of the benefit-cost analysis is shown in Economic Study **5** – Discounted Benefit-Cost Streams. A BCR of 4.50 is attained for the project using a discount rate of 12% based on a total net present value of benefits of US$156.71 million and total net present value of economic costs of US$34.82 million, also using a discount rate of 12%.

(2) Economic Internal Rate of Return (EIRR)

The EIRR of the project as presented in Economic Study 5 is 36.62%**.**

(3) Sensitivity Analysis

The EIRR is subjected to a sensitivity analysis to test the effects of variances to the assumptions in the base hypothesis. The factors considered in the sensitivity tests as well as the results of the tests are presented in tabular form below. The calculation of the EIRR for each of the above sensitivity scenarios is also presented in Economic Study 5.

Table 8.23 Economic Internal Rate of Return

Sensitivity Test Scenarios	**EIRR**
Scenario 1 - 15% Increase in Project Cost	33.73%
Scenario 2 - 15% Increase in O & M Costs	36.57%
Scenario 3 - 15% Reduction in Revenues	33.21%

8-7-6 Prognosis

Since the calculated BCR is more than one and the EIRR is higher than the 12% social discount rate for infrastructure projects[7], the recommended priority expansion project for the water supply system of Siem Reap City is economically feasible.

8-8 Recommendation

The recommended development program for the priority expansion of the water supply system of the SRWSA is viable financially and economically under the assumptions used in the evaluation.

- With the Project, SRWSA can achieve financial sustainability with the implementation of the recommended water tariff as per water tariff study 2: KHR1,999 per m^3 in 2012, KHR2,5841per m^3 in 2017 and KHR2,624 per m^3 in 2022 onwards.

- Implementation of the said required water tariffs is recommended under Option 1 since it affords lower tariffs for residential users.

- Tariff adjustment shall be carried out in accordance with the procedures shown in Figure 6.2 to keep sound financial background so that a consumption-based tariff structure is fair for all. The revenue from tariffs will cover O&M costs, capital development plus debt servicing properly to achieve operational and financial viability.

- With the Project, significant socio-economic benefits can be realized in terms of:

    - Reducing poverty rate by providing access to safe and potable water to the un-served areas of Siem Reap particularly the urban fringes and the rural outskirts of the city.

    - Reduction of health problems brought about by unsafe water thereby contributing to better productivity of the residents in the service area.

    - Stimulating the growth of the local economy with the development of the tourism-related businesses and light industries, all of which will rely mainly on safe and adequate water from SRWSA, especially when the extraction of groundwater will be discontinued to protect the Angkor Wat heritage area.

- The proposed Project Coordinating Committee (PCC) of SRWSA should enact regulatory measures with regard to the control of future groundwater development in reference to the procedure as mentioned in 6-3-1 “Restriction for groundwater Collection and Switch to SRWSA Water” in cooperation with appropriate RGC authorities.

- Contributing to the growth of the national economy by increased tourism arrivals, which will impact on job generation and higher levels of education.

[7] This is a widely accepted social discount rate as adapted by ADB in many of its infrastructure projects.

Financial Study 1
Annual Project Cost - J.I.C.A. and Matching Funds

Project Cost Components	%Total	Total	2011	2012	2013	2014	2015	2016
		US$ x 1,000						
Milestone Years		*Project Costs*	Design Stage	KTC Bulk 40% in	KTC Bulk 60% in	KTC Bulk 100%	Start Loan Paymnts	Project Cmplete Startup
Eligible Project Cost Components								
Direct Cost, net of taxes		49,615	-	-	10,761	14,342	15,404	9,109
Engineering Services, net of taxes		5,154	535	1,071	1,071	1,071	1,071	335
Institutional Dev, net of taxes		915	-	182	182	182	182	187
Subtotal - 2010 price level	65.1%	55,684	535	1,253	12,014	15,595	16,657	9,630
Physical Contingency	6.2%	5,265	27	63	1,139	1,497	1,603	937
Price Contingency	16.7%	14,308	16.45	75.73	1,536.08	3,732.15	5,125.76	3,821.87
Total Eligible Components	88.0%	75,257	578	1,391	14,689	20,824	23,385	14,389
Ineligible Project Cost Components								
Land Acquisition	0.4%	300	300	-	-	-	-	-
Social Compensation	0.1%	91	91	-	-	-	-	-
Project Administration	1.1%	951	1	1	203	275	296	175
Subtotal - 2010 price level	1.6%	1,342	392	1	203	275	296	175
Physical Contingency	0.0%	30	30	-	-	-	-	-
Price Contingency	0.0%	33	33	-	-	-	-	-
Tax Component of Eligible Items	4.7%	3,980	11	26	508	1,189	1,356	891
- basic tax	3.0%	2,555	10	21	368	798	844	514
- physical contingency	0.3%	250	1	1	36	79	83	51
- price contingency	1.4%	1,175	1	4	104	312	429	327
Total Ineligible Components	6.3%	5,385	467	27	710	1,464	1,651	1,066
Total Project Cost	94.3%	80,642	1,045	1,418	15,399	22,288	25,037	15,456
Add: Capitalized Interest During Constru	5.7%	4,856	9	39	285	835	1,533	2,155
Total Capital Investment	100.0%	85,498	1,054	1,457	15,684	23,123	26,570	17,611
Total Project Cost for FIRR Computation								
Total Project Cost Current Prices	100.0%	80,642	1,045	1,418	15,399	22,288	25,037	15,456
Less: Price Contingencies		15,516	51	79	1,640	4,044	5,554	4,148
Net Proj. Cost FIRR Computation	80.8%	65,126	994	1,339	13,759	18,244	19,482	11,307

Financial Study 2

Computation of Step-Ladder Interest Rates Achieving NPV=4.5%

Amounts are all in US$ million

Year	Project Draw-down	Interest Rate	Total Interest A	Loan Draw-down	% of Int Capital-ized	Capital-ized Interest	Interest Pay-ments	Principal Re-payment	Total Debt Service	Discount Factor	Present Value	Loan Out-standing	Interest Rate	Loan Draw-down	Capital-ized Interest	Total Interest B	Principal Re-payment	Total Debt Service	Discount Factor	Present Value	Loan Out-standing
	Interest Charges Computed As per Step-Ladder Increase in Rates to Achieve NPV=4.5%												Interest Charges Computed as per standard methodology								
2010												-									-
2011	0.58	3.00%	0.01	0.59	100%	0.01	-	-	-	1.00	-	0.59	4.50%	0.59	0.01	0.01	-	-	1.00	-	0.59
2012	1.39	3.00%	0.04	1.43	100%	0.04	-	-	-	0.95	-	2.02	4.50%	1.45	0.06	0.06	-	-	0.95	-	2.04
2013	14.69	3.00%	0.29	14.97	100%	0.29	-	-	-	0.90	-	16.99	4.50%	15.11	0.42	0.42	-	-	0.90	-	17.15
2014	20.82	3.00%	0.83	21.66	100%	0.83	-	-	-	0.86	-	38.65	4.50%	22.06	1.24	1.24	-	-	0.86	-	39.22
2015	23.39	3.00%	1.53	24.92	100%	1.53	-	-	-	0.81	-	63.57	4.50%	25.68	2.29	2.29	-	-	0.81	-	64.89
2016	14.39	3.00%	2.16	16.54	100%	2.16	-	-	-	0.77	-	80.11	4.50%	17.63	3.24	3.24	-	-	0.77	-	82.53
2017	-	3.00%	2.40	-	-	-	2.40	-	2.40	0.74	1.77	80.11	4.50%	-	-	3.71	-	3.71	0.74	2.73	82.53
2018	-	3.00%	2.40	-	-	-	2.40	-	2.40	0.70	1.68	80.11	4.50%	-	-	3.71	-	3.71	0.70	2.60	82.53
2019	-	3.00%	2.40	-	-	-	2.40	-	2.40	0.66	1.60	80.11	4.50%	-	-	3.71	-	3.71	0.66	2.47	82.53
2020	-	3.00%	2.40	-	-	-	2.40	-	2.40	0.63	1.52	80.11	4.50%	-	-	3.71	-	3.71	0.63	2.34	82.53
2021	-	3.75%	3.00	-	-	-	3.00	1.49	4.49	0.60	2.69	78.62	4.50%	-	-	3.71	1.35	5.07	0.60	3.04	81.17
2022	-	3.75%	2.95	-	-	-	2.95	1.54	4.49	0.57	2.56	77.08	4.50%	-	-	3.65	1.41	5.07	0.57	2.89	79.76
2023	-	3.75%	2.89	-	-	-	2.89	1.60	4.49	0.54	2.43	75.48	4.50%	-	-	3.59	1.48	5.07	0.54	2.74	78.28
2024	-	3.75%	2.83	-	-	-	2.83	1.66	4.49	0.51	2.31	73.81	4.50%	-	-	3.52	1.54	5.07	0.51	2.61	76.74
2025	-	3.75%	2.77	-	-	-	2.77	1.73	4.49	0.49	2.20	72.09	4.50%	-	-	3.45	1.61	5.07	0.49	2.48	75.13
2026	-	3.75%	2.70	-	-	-	2.70	1.79	4.49	0.46	2.09	70.30	4.50%	-	-	3.38	1.69	5.07	0.46	2.35	73.44
2027	-	3.75%	2.64	-	-	-	2.64	1.86	4.49	0.44	1.98	68.44	4.50%	-	-	3.30	1.76	5.07	0.44	2.23	71.68
2028	-	3.75%	2.57	-	-	-	2.57	1.93	4.49	0.42	1.88	66.51	4.50%	-	-	3.23	1.84	5.07	0.42	2.12	69.84
2029	-	3.75%	2.49	-	-	-	2.49	2.00	4.49	0.40	1.79	64.51	4.50%	-	-	3.14	1.92	5.07	0.40	2.02	67.91
2030	-	3.75%	2.42	-	-	-	2.42	2.07	4.49	0.38	1.70	62.44	4.50%	-	-	3.06	2.01	5.07	0.38	1.92	65.90
2031	-	7.50%	4.68	-	-	-	4.68	1.44	6.12	0.36	2.20	61.00	4.50%	-	-	2.97	2.10	5.07	0.36	1.82	63.80
2032	-	7.50%	4.57	-	-	-	4.57	1.55	6.12	0.34	2.09	59.45	4.50%	-	-	2.87	2.20	5.07	0.34	1.73	61.61
2033	-	7.50%	4.46	-	-	-	4.46	1.67	6.12	0.32	1.99	57.78	4.50%	-	-	2.77	2.29	5.07	0.32	1.64	59.31
2034	-	7.50%	4.33	-	-	-	4.33	1.79	6.12	0.31	1.89	55.99	4.50%	-	-	2.67	2.40	5.07	0.31	1.56	56.92
2035	-	7.50%	4.20	-	-	-	4.20	1.93	6.12	0.29	1.79	54.07	4.50%	-	-	2.56	2.51	5.07	0.29	1.48	54.41
2036	-	7.50%	4.05	-	-	-	4.05	2.07	6.12	0.28	1.70	52.00	4.50%	-	-	2.45	2.62	5.07	0.28	1.41	51.79
2037	-	7.50%	3.90	-	-	-	3.90	2.23	6.12	0.26	1.62	49.77	4.50%	-	-	2.33	2.74	5.07	0.26	1.34	49.06
2038	-	7.50%	3.73	-	-	-	3.73	2.39	6.12	0.25	1.54	47.38	4.50%	-	-	2.21	2.86	5.07	0.25	1.27	46.20
2039	-	7.50%	3.55	-	-	-	3.55	2.57	6.12	0.24	1.46	44.81	4.50%	-	-	2.08	2.99	5.07	0.24	1.21	43.21
2040	-	7.50%	3.36	-	-	-	3.36	2.76	6.12	0.23	1.39	42.04	4.50%	-	-	1.94	3.12	5.07	0.23	1.15	40.09
2041	-	10.41%	4.37	-	-	-	4.37	2.59	6.96	0.22	1.50	39.45	4.50%	-	-	1.80	3.26	5.07	0.22	1.09	36.83
2042	-	10.41%	4.11	-	-	-	4.11	2.86	6.96	0.20	1.43	36.60	4.50%	-	-	1.66	3.41	5.07	0.20	1.04	33.42
2043	-	10.41%	3.81	-	-	-	3.81	3.15	6.96	0.19	1.35	33.44	4.50%	-	-	1.50	3.56	5.07	0.19	0.99	29.85
2044	-	10.41%	3.48	-	-	-	3.48	3.48	6.96	0.18	1.29	29.96	4.50%	-	-	1.34	3.72	5.07	0.18	0.94	26.13
2045	-	10.41%	3.12	-	-	-	3.12	3.84	6.96	0.18	1.22	26.12	4.50%	-	-	1.18	3.89	5.07	0.18	0.89	22.24
2046	-	10.41%	2.72	-	-	-	2.72	4.24	6.96	0.17	1.16	21.88	4.50%	-	-	1.00	4.07	5.07	0.17	0.85	18.18
2047	-	10.41%	2.28	-	-	-	2.28	4.69	6.96	0.16	1.10	17.19	4.50%	-	-	0.82	4.25	5.07	0.16	0.80	13.93
2048	-	10.41%	1.79	-	-	-	1.79	5.17	6.96	0.15	1.05	12.02	4.50%	-	-	0.63	4.44	5.07	0.15	0.76	9.49
2049	-	10.41%	1.25	-	-	-	1.25	5.71	6.96	0.14	1.00	6.31	4.50%	-	-	0.43	4.64	5.07	0.14	0.72	4.85
2050	-	10.41%	0.66	-	-	-	0.66	6.31	6.96	0.14	0.95	(0.00)	4.50%	-	-	0.22	4.85	5.07	0.14	0.69	(0.00)
Totals	75.26		110.16	80.11		4.856	105.30	80.11	185.41		57.91		Totals			91.59	82.53	166.85		57.91	

Debt Service
Total per Step-ladder Rates 185.41 US$ million
NPV @Discount Rate= 5.25% 57.91 US$ million

NPV @Discount Rate= 5.25%

Step Ladder Interest Rates

0 to 10 years	3.000%
11 to 20	3.750%
21 to 30	7.500%
31 to 40	10.405%

Debt Service
Total per constant 4.5% Interest Rate 166.85 US$ million
NPV @Discount Rate= 5.25% 57.91 US$ million

Notes

1/ Project drawdown figures are the eligible components for JICA loan financing taken from table 8.6
2/ Total interest A represents the annual interest charges based on the step-ladder interest rates and loan drawdown. It is computed as:
(loan drawdown x interest rate x 0.5 + loan outstanding x interest rate).
3/ Loan drawdown is project drawdown + capitalized interest
4/ % interest capitalized represents the ratio of total interest capitalized while capitalize interest represents the amount in USD.
5/ Interest payments represents the amount of total interest that is due for payment by the authority.
6/ Principal repayment represents capital portion of debt service per year, which is computed based on a uniform series or equal periodic payments.
7/ Loan outstanding is the amount of loan borrowed and unpaid at the end of each year.
8/ Discount rate of 5.25% is the dsc. rate of National Bank of Cambodia as of Dec. 2008, per World Fact Book of CIA of USA as published on internet.
9/ Total interest B represents the annual interest charges based on a constant 4.5% interest rate.

Financial Study 3
Projected Debt Service Schedule for JICA Loan

US$ x 1,000,000.

Case Scenario: **Interest NPV=4.5%: Grace period @3%, IDC 100% capitalized and Repayment 1st 10 years @3.75%, next 10 years @7.50% and last 10 years @10.40%**

Assumed Loan Terms: NPV=4.5%		0 - 10 years	1 - 20 years	1 - 30 years	1 - 40 years
Interest Rate		3.000%	3.750%	7.500%	10.405%
Maturity in Years		40	30	20	10
Grace Period (Principal)		10	0	0	0
First Drawdown	2011				
First Principla Payment	2021				
First Interest Payment	2011				
Total Loan, USD million	-	80.11	80.11	62.44	42.04
Annual Ammotization, USD million	-	-	4.49	6.12	6.96

	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**
Opening Balance	-	-	0.59	2.02	16.99	38.65	63.57	80.11	80.11	80.11	80.11	80.11	78.62	77.08
Additions (Loan Drawdown in Table 8	-	0.59	1.43	14.97	21.66	24.92	16.54	-	-	-	-	-	-	-
Interest Expense/Payments	-	-	-	-	-	-	-	2.40	2.40	2.40	2.40	3.00	2.95	2.89
Capitalized Interest	-	0.01	0.04	0.29	0.83	1.53	2.16	-	-	-	-	-	-	-
Total Interest	-	0.01	0.04	0.29	0.83	1.53	2.16	2.40	2.40	2.40	2.40	3.00	2.95	2.89
Principal Repayment	-	-	-	-	-	-	-	-	-	-	-	1.49	1.54	1.60
Amortization (Debt Service)	-	-	-	-	-	-	-	2.40	2.40	2.40	2.40	4.49	4.49	4.49
Closing Balance	-	0.59	2.02	16.99	38.65	63.57	80.11	80.11	80.11	80.11	80.11	78.62	77.08	75.48

	2024	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**
Opening Balance	75.48	73.81	72.09	70.30	68.44	66.51	64.51	62.44	61.00	59.45	57.78	55.99	54.07	52.00
Additions (Loan Drawdown in Table 8	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Interest Expense/Payments	2.83	2.77	2.70	2.64	2.57	2.49	2.42	4.68	4.57	4.46	4.33	4.20	4.05	3.90
Capitalized Interest	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Interest	2.83	2.77	2.70	2.64	2.57	2.49	2.42	4.68	4.57	4.46	4.33	4.20	4.05	3.90
Principal Repayment	1.66	1.73	1.79	1.86	1.93	2.00	2.07	1.44	1.55	1.67	1.79	1.93	2.07	2.23
Amortization (Debt Service)	4.49	4.49	4.49	4.49	4.49	4.49	4.49	6.12	6.12	6.12	6.12	6.12	6.12	6.12
Closing Balance	73.81	72.09	70.30	68.44	66.51	64.51	62.44	61.00	59.45	57.78	55.99	54.07	52.00	49.77

	2038	**2039**	**2040**	**2041**	**2042**	**2043**	**2044**	**2045**	**2046**	**2047**	**2048**	**2049**	**2050**
Opening Balance	49.77	47.38	44.81	42.04	39.45	36.60	33.44	29.96	26.12	21.88	17.19	12.02	6.31
Additions (Loan Drawdown in Table 8	-	-	-	-	-	-	-	-	-	-	-	-	-
Interest Expense/Payments	3.73	3.55	3.36	4.37	4.11	3.81	3.48	3.12	2.72	2.28	1.79	1.25	0.66
Capitalized Interest	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Interest	3.73	3.55	3.36	4.37	4.11	3.81	3.48	3.12	2.72	2.28	1.79	1.25	0.66
Principal Repayment	2.39	2.57	2.76	2.59	2.86	3.15	3.48	3.84	4.24	4.69	5.17	5.71	6.31
Amortization (Debt Service)	6.12	6.12	6.12	6.96	6.96	6.96	6.96	6.96	6.96	6.96	6.96	6.96	6.96
Closing Balance	47.38	44.81	42.04	39.45	36.60	33.44	29.96	26.12	21.88	17.19	12.02	6.31	-

Financial Study 4

KTC Pipeline Extension Project Cost and Financing Plan

	% Total	US$ x 1,000,000.				
		Total	2011	2012	2013	2014
Pipeline Extension Construction Cost	64.9%	7.308	0.723	2.621	1.899	2.065
Physical Contingency	6.5%	0.731	0.072	0.262	0.190	0.207
Price Contingency	16.7%	1.879	0.063	0.474	0.535	0.807
Total Project Cost	88.1%	9.918	0.858	3.357	2.624	3.079
Capitalized Interest	11.9%	1.342	0.032	0.193	0.433	0.683
Total Investment Cost	**100.0%**	**11.259**	**0.890**	**3.550**	**3.057**	**3.762**
Financed by:						
Project Cost Disbursement	79%	8.926	0.772	3.021	2.362	2.771
Capitalized Interest	12%	1.342	0.032	0.193	0.433	0.683
Total Loan Drawdown (Additions)	91%	10.268	0.804	3.214	2.795	3.454
Counterpart Contribution	9%	0.992	0.086	0.336	0.262	0.308
Total Financed	100%	11.259	0.890	3.550	3.057	3.762
Physical Contingency		10%				
Inflation Rate - Local Component		7.90%				
Annual Price Escalation Factors			1.08	1.16	1.26	1.36
Baseline Construction Costs		*7,308,000*	*723,000*	*2,621,000*	*1,899,000*	*2,065,000*

Financial Study 5

Projected Debt Service Schedule for KTC Pipeline Financing

US$ Million

Assumed Loan Terms

Interest Rate	8%	
Maturity in Years	30	
Grace Period (Principal)	4	
First Drawdown	2011	
First Principla Payment	2015	
First Interest Payment	2011	
Total Loan, USD millior	10.12	88.7% of project cost + 100% capitalized interest
Annual Ammot. US$ mi	0.94	

Interest during construction is capitalized.

	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**
Opening Balance	-	-	0.80	4.02	6.81	10.27	10.14	10.00	9.85	9.69	9.51	9.33	9.12	8.90	8.66	8.41
Additions	-	0.80	3.21	2.79	3.45	-	-	-	-	-	-	-	-	-	-	-
Interest Expense	-	-	-	-	-	0.82	0.81	0.80	0.79	0.78	0.76	0.75	0.73	0.71	0.69	0.67
Principal Repayment	-	-	-	-	-	0.13	0.14	0.15	0.16	0.17	0.19	0.20	0.22	0.24	0.26	0.28
Amortization	-	-	-	-	-	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Closing Balance	-	0.80	4.02	6.81	10.27	10.14	10.00	9.85	9.69	9.51	9.33	9.12	8.90	8.66	8.41	8.13

Interest during construction is capitalized.

	2026	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**	**2040**
Opening Balance	8.13	7.83	7.51	7.16	6.78	6.37	5.93	5.46	4.95	4.39	3.79	3.15	2.45	1.69	0.88
Additions	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Interest Expense	0.65	0.63	0.60	0.57	0.54	0.51	0.47	0.44	0.40	0.35	0.30	0.25	0.20	0.14	0.07
Principal Repayment	0.30	0.32	0.35	0.38	0.41	0.44	0.48	0.51	0.55	0.60	0.65	0.70	0.75	0.81	0.88
Amortization	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Closing Balance	7.83	7.51	7.16	6.78	6.37	5.93	5.46	4.95	4.39	3.79	3.15	2.45	1.69	0.88	-

Financial Study 6

Projected Operation & Maintenance Expenses *(Staffing Levels determined in Chapter 5 - Table 5.19)*

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
KTC Bulk Water Supply (KHR850/KHR4165 =USD0.20)											
Purchased Price, USD/m3			0.20	0.20	0.20	0.20	0.20	0.22	0.22	0.22	0.22
Bulk Water Purchased, 1000 x m3/year	-	-	2,482	3,723	6,205	6,205	6,205	6,205	6,205	6,205	6,205
Total Cost of Bulk Water, USD x 1000	-	-	507	760	1,266	1,266	1,266	1,341	1,341	1,341	1,341
Salaries & Wages											
Existing No. of Staff	40	40	40	40	40	40	40	40	40	40	40
- Average Salary & Benefit, USD/year	3,484	3,484	3,484	3,484	3,484	3,484	3,484	3,484	3,484	3,484	3,484
- Subtotal Personal Services, USD x 1000	139	139	139	139	139	139	139	139	139	139	139
Staff Increase from KTC Bulk Supply	-	-	16	38	38	38	38	38	38	38	38
- Average Salary & Benefit, USD/year	3,484	3,484	3,484	3,484	3,484	3,484	3,484	3,484	3,484	3,484	3,484
- Subtotal Personal Services, USD x 1000	-	-	56	132	132	132	132	132	132	132	132
Staff Increase from JICA Project	-	-	-	-	-	-	-	21	35	52	57
- Average Salary & Benefit, USD/year	3,484	3,484	3,484	3,484	3,484	3,484	3,484	3,484	3,484	3,484	3,484
- Subtotal Personal Services, USD x 1000	-	-	-	-	-	-	-	73	123	181	199
Total Personal Services, USD x 1000	139	139	195	272	272	272	272	345	395	453	470
Power Cost											
Existing WTP											
Unit Cost, USD/m3	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
Water Production, 1000 x m3/year	3,285	3,285	2,559	2,196	651	1,650	2,712	3,285	3,285	3,285	3,285
Sub-total Power Cost, USD x 1000	183	183	143	123	36	92	151	183	183	183	183
Priority Project WTP											
Unit Cost, USD/m3	-	-	-	-	-	-	-	0.067	0.067	0.067	0.067
Water Production, 1000 x m3/year	-	-	-	-	-	-	-	554	1,871	3,282	4,792
Subtotal Power Cost, USD x 1000	-	-	-	-	-	-	-	37	125	219	319
Total Power Cost, USD x 1000	183	183	143	123	36	92	151	220	308	402	503
Chemical Cost	ALL US$ FIGURES x 1,000.										
Existing WTP											
Unit Cost, USD/m3	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011
Water Production, 1000 x m3/year	3,285	3,285	2,559	2,196	651	1,650	2,712	3,285	3,285	3,285	3,285
Subtotal Chemical Cost, USD x 1000	37	37	29	25	7	19	30	37	37	37	37
Priority Project WTP											
Unit Cost, USD/m3	-	-	-	-	-	-	-	0.019	0.019	0.019	0.019
Water Production, 1000 x m3/year	-	-	-	-	-	-	-	554	1,871	3,282	4,792
Subtotal Chemical Cost, USD x 1000	-	-	-	-	-	-	-	10	35	62	91
Total Chemical Cost, USD x 1000	37	37	29	25	7	19	30	47	72	99	128
Maintenance Expense											
Existing WTP											
As % of Utility Plant in Service	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%
Gross Value of Fixed Assets, USD x 1000	2,440	2,440	2,440	2,440	2,440	2,440	2,440	2,440	2,440	2,440	2,440
Subtotal Maintenance Expense, USD x 1000	139	139	139	139	139	139	139	139	139	139	139
Priority Project WTP											
As % of Utility Plant	0%	0%	0%	0%	0%	0%	0%	1.0%	1.3%	1.5%	1.8%
Gross Value Mech/Elec Equip, USD x 1000	-	-	-	-	-	-	-	11,354	11,354	11,354	11,354
Subtotal Maintenance Expense, USD x 1000	-	-	-	-	-	-	-	114	142	170	199
Total Maintenance Expense, USD x 1000	139	139	139	139	139	139	139	252	280.811	309.196	337.581
Administrative & General Expenses											
Due Existing WTP											
- As a percentage of Salaries	190%	190%	70%	70%	70%	70%	70%	60%	60%	60%	60%
- Subtotal Admin/Gen Expense, USD x 1000	265	265	98	98	98	98	98	84	84	84	84
Due KTC Bulk	-	-	-	-	-	-	-	-	-	-	-
- As a percentage of Salaries	-	-	70%	70%	70%	70%	70%	60%	60%	60%	60%
- Subtotal Admin/Gen Expense, USD x 1000	-	-	39	93	93	93	93	79	79	79	79
Due Priority Project WTP											
- As a percentage of Salaries	-	-	-	-	-	-	-	60%	60%	60%	60%
- Subtotal Admin/Gen Expense, USD x 1000	-	-	-	-	-	-	-	44	74	109	119
Total Admin/General Expenses, USD x 1000	265	265	137	190	190	190	190	207	237	272	282
Summary of O & M Expenses, USD x 1000											
Existing System	763	763	547	523	419	486	558	582	582	582	582
KTC Bulk Supply	-	-	601	985	1,491	1,491	1,491	1,553	1,553	1,553	1,553
JICA Project	-	-	-	-	-	-	-	278	499	741	927
Total O&M Expenses, 2010 prices	763	763	1,149	1,508	1,911	1,978	2,049	2,413	2,633	2,876	3,061

Allocation of Demand/Production											
Billed Water, 1000 x m3/year											
- 9,000 cumd - Existing WTP	2,727	2,727	2,176	1,888	567	1,452	2,414	2,957	2,957	2,957	2,957
- 17,000 cumd - KTC Bulk Supply	-	-	2,110	3,202	5,398	5,460	5,522	5,585	5,585	5,585	5,585
- 30,000 cumd - Proposed WTP	-	-	-	-	-	-	-	498	1,684	2,954	4,313
Total Billed Volume, 1000 x m3/year	2,727	2,727	4,285	5,090	5,965	6,913	7,937	9,039	10,225	11,495	12,854
Production, 1000 x m3/year											
- 9,000 cumd - Existing WTP	3,285	3,285	2,559	2,196	651	1,650	2,712	3,285	3,285	3,285	3,285
- 17,000 cumd - KTC Bulk Supply	-	-	2,482	3,723	6,205	6,205	6,205	6,205	6,205	6,205	6,205
- 30,000 cumd - Proposed WTP	-	-	-	-	-	-	-	554	1,871	3,282	4,792
Total Volume Produced, 1000 x m3/year	3,285	3,285	5,041	5,919	6,856	7,855	8,917	10,044	11,361	12,772	14,282

Financial Study 6

Projected Operation & Maintenance Expenses

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
KTC Bulk Water Supply (KHR850/KHR4165 =USD0.20)										
Purchased Price, USD/m3	0.22	0.23	0.23	0.23	0.23	0.23	0.24	0.24	0.24	0.24
Bulk Water Purchased, 1000 x m3/year	6,205	6,205	6,205	6,205	6,205	6,205	6,205	6,205	6,205	6,205
Total Cost of Bulk Water, USD x 1000	1,341	1,415	1,415	1,415	1,415	1,415	1,490	1,490	1,490	1,490
Salaries & Wages										
Existing No. of Staff	40	40	40	40	40	40	40	40	40	40
- Average Salary & Benefit, USD/year	3,484	3,484	3,484	3,484	3,484	3,484	3,484	3,484	3,484	3,484
- Subtotal Personal Services, USD x 1000	139	139	139	139	139	139	139	139	139	139
Staff Increase from KTC Bulk Supply	38	38	38	38	38	38	38	38	38	38
- Average Salary & Benefit, USD/year	3,484	3,484	3,484	3,484	3,484	3,484	3,484	3,484	3,484	3,484
- Subtotal Personal Services, USD x 1000	132	132	132	132	132	132	132	132	132	132
Staff Increase from JICA Project	60	63	63	63	63	63	63	63	63	63
- Average Salary & Benefit, USD/year	3,484	3,484	3,484	3,484	3,484	3,484	3,484	3,484	3,484	3,484
- Subtotal Personal Services, USD x 1000	209	219	219	219	219	219	219	219	219	219
Total Personal Services, USD x 1000	481	491	491	491	491	491	491	491	491	491
Power Cost										
Existing WTP										
Unit Cost, USD/m3	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
Water Production, 1000 x m3/year	3,285	3,285	3,285	3,285	3,285	3,285	3,285	3,285	3,285	3,285
Sub-total Power Cost, USD x 1000	183	183	183	183	183	183	183	183	183	183
Priority Project WTP										
Unit Cost, USD/m3	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067
Water Production, 1000 x m3/year	5,736	6,722	7,752	8,825	9,943	10,950	10,950	10,950	10,950	10,950
Subtotal Power Cost, USD x 1000	382	448	517	588	663	730	730	730	730	730
Total Power Cost, USD x 1000	566	632	700	772	846	913	913	913	913	913
Chemical Cost							ALL US$ FIGURES x 1,000.			
Existing WTP										
Unit Cost, USD/m3	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011
Water Production, 1000 x m3/year	3,285	3,285	3,285	3,285	3,285	3,285	3,285	3,285	3,285	3,285
Subtotal Chemical Cost, USD x 1000	37	37	37	37	37	37	37	37	37	37
Priority Project WTP										
Unit Cost, USD/m3	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019
Water Production, 1000 x m3/year	5,736	6,722	7,752	8,825	9,943	10,950	10,950	10,950	10,950	10,950
Subtotal Chemical Cost, USD x 1000	109	127	147	167	188	207	207	207	207	207
Total Chemical Cost, USD x 1000	145	164	184	204	225	244	244	244	244	244
Maintenance Expense										
Existing WTP										
As % of Utility Plant in Service	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%
Gross Value of Fixed Assets, USD x 1000	2,440	2,440	2,440	2,440	2,440	2,440	2,440	2,440	2,440	2,440
Subtotal Maintenance Expense, USD x 1000	139	139	139	139	139	139	139	139	139	139
Priority Project WTP										
As % of Utility Plant	2.0%	2.3%	2.5%	2.8%	3.0%	3.3%	3.3%	3.3%	3.3%	3.3%
Gross Value Mech/Elec Equip, USD x 1000	11,354	11,354	11,354	11,354	11,354	11,354	11,354	11,354	11,354	11,354
Subtotal Maintenance Expense, USD x 1000	227	255	284	312	341	369	369	369	369	369
Total Maintenance Expense, USD x 1000	365.967	394.352	422.737	451	480	508	508	508	508	508
Administrative & General Expenses										
Due Existing WTP										
- As a percentage of Salaries	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%
- Subtotal Admin/Gen Expense, USD x 1000	84	84	84	84	84	84	84	84	84	84
Due KTC Bulk	-	-	-	-	-	-	-	-	-	-
- As a percentage of Salaries	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%
- Subtotal Admin/Gen Expense, USD x 1000	79	79	79	79	79	79	79	79	79	79
Due Priority Project WTP										
- As a percentage of Salaries	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%
- Subtotal Admin/Gen Expense, USD x 1000	125	132	132	132	132	132	132	132	132	132
Total Admin/General Expenses, USD x 1000	288	295	295	295	295	295	295	295	295	295
Summary of O & M Expenses, USD x 1000										
Existing System	582	582	582	582	582	582	582	582	582	582
KTC Bulk Supply	1,553	1,627	1,627	1,627	1,627	1,627	1,702	1,702	1,702	1,702
JICA Project	1,052	1,182	1,298	1,419	1,543	1,657	1,657	1,657	1,657	1,657
Total O&M Expenses, 2010 prices	3,187	3,391	3,508	3,628	3,752	3,867	3,941	3,941	3,941	3,941

Allocation of Demand/Production										
Billed Water, 1000 x m3/year										
- 9,000 cumd - Existing WTP	2,957	2,957	2,957	2,957	2,957	2,957	2,957	2,957	2,957	2,957
- 17,000 cumd - KTC Bulk Supply	5,585	5,585	5,585	5,585	5,585	5,585	5,585	5,585	5,585	5,585
- 30,000 cumd - Proposed WTP	5,163	6,050	6,977	7,943	8,949	9,855	9,855	9,855	9,855	9,855
Total Billed Volume, 1000 x m3/year	13,704	14,591	15,518	16,484	17,490	18,396	18,396	18,396	18,396	18,396
Production, 1000 x m3/year										
- 9,000 cumd - Existing WTP	3,285	3,285	3,285	3,285	3,285	3,285	3,285	3,285	3,285	3,285
- 17,000 cumd - KTC Bulk Supply	6,205	6,205	6,205	6,205	6,205	6,205	6,205	6,205	6,205	6,205
- 30,000 cumd - Proposed WTP	5,736	6,722	7,752	8,825	9,943	10,950	10,950	10,950	10,950	10,950
Total Volume Produced, 1000 x m3/year	15,226	16,212	17,242	18,315	19,433	20,440	20,440	20,440	20,440	20,440

Financial Study 6

Projected Operation & Maintenance Expenses

	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
KTC Bulk Water Supply (KHR850/KHR4165 =USD0.20)										
Purchased Price, USD/m3	0.24	0.25	0.25	0.25	0.25	0.25	0.26	0.26	0.26	0.26
Bulk Water Purchased, 1000 x m3/year	6,205	6,205	6,205	6,205	6,205	6,205	6,205	6,205	6,205	6,205
Total Cost of Bulk Water, USD x 1000	1,490	1,564	1,564	1,564	1,564	1,564	1,639	1,639	1,639	1,639
Salaries & Wages										
Existing No. of Staff	40	40	40	40	40	40	40	40	40	40
- Average Salary & Benefit, USD/year	3,484	3,484	3,484	3,484	3,484	3,484	3,484	3,484	3,484	3,484
- Subtotal Personal Services, USD x 1000	139	139	139	139	139	139	139	139	139	139
Staff Increase from KTC Bulk Supply	38	38	38	38	38	38	38	38	38	38
- Average Salary & Benefit, USD/year	3,484	3,484	3,484	3,484	3,484	3,484	3,484	3,484	3,484	3,484
- Subtotal Personal Services, USD x 1000	132	132	132	132	132	132	132	132	132	132
Staff Increase from JICA Project	63	63	63	63	63	63	63	63	63	63
- Average Salary & Benefit, USD/year	3,484	3,484	3,484	3,484	3,484	3,484	3,484	3,484	3,484	3,484
- Subtotal Personal Services, USD x 1000	219	219	219	219	219	219	219	219	219	219
Total Personal Services, USD x 1000	491	491	491	491	491	491	491	491	491	491
Power Cost										
Existing WTP										
Unit Cost, USD/m3	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
Water Production, 1000 x m3/year	3,285	3,285	3,285	3,285	3,285	3,285	3,285	3,285	3,285	3,285
Sub-total Power Cost, USD x 1000	183	183	183	183	183	183	183	183	183	183
Priority Project WTP										
Unit Cost, USD/m3	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067
Water Production, 1000 x m3/year	10,950	10,950	10,950	10,950	10,950	10,950	10,950	10,950	10,950	10,950
Subtotal Power Cost, USD x 1000	730	730	730	730	730	730	730	730	730	730
Total Power Cost, USD x 1000	913	913	913	913	913	913	913	913	913	913
Chemical Cost										
Existing WTP										
Unit Cost, USD/m3	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011
Water Production, 1000 x m3/year	3,285	3,285	3,285	3,285	3,285	3,285	3,285	3,285	3,285	3,285
Subtotal Chemical Cost, USD x 1000	37	37	37	37	37	37	37	37	37	37
Priority Project WTP										
Unit Cost, USD/m3	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019
Water Production, 1000 x m3/year	10,950	10,950	10,950	10,950	10,950	10,950	10,950	10,950	10,950	10,950
Subtotal Chemical Cost, USD x 1000	207	207	207	207	207	207	207	207	207	207
Total Chemical Cost, USD x 1000	244	244	244	244	244	244	244	244	244	244
Maintenance Expense										
Existing WTP										
As % of Utility Plant in Service	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%
Gross Value of Fixed Assets, USD x 1000	2,440	2,440	2,440	2,440	2,440	2,440	2,440	2,440	2,440	2,440
Subtotal Maintenance Expense, USD x 1000	139	139	139	139	139	139	139	139	139	139
Priority Project WTP										
As % of Utility Plant	3.3%	3.3%	3.3%	3.3%	3.3%	3.3%	3.3%	3.3%	3.3%	3.3%
Gross Value Mech/Elec Equip, USD x 1000	11,354	11,354	11,354	11,354	11,354	11,354	11,354	11,354	11,354	11,354
Subtotal Maintenance Expense, USD x 1000	369	369	369	369	369	369	369	369	369	369
Total Maintenance Expense, USD x 1000	508	508	508	508	508	508	508	508	508	508
Administrative & General Expenses										
Due Existing WTP										
- As a percentage of Salaries	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%
- Subtotal Admin/Gen Expense, USD x 1000	84	84	84	84	84	84	84	84	84	84
Due KTC Bulk	-	-	-	-	-	-	-	-	-	-
- As a percentage of Salaries	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%
- Subtotal Admin/Gen Expense, USD x 1000	79	79	79	79	79	79	79	79	79	79
Due Priority Project WTP										
- As a percentage of Salaries	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%
- Subtotal Admin/Gen Expense, USD x 1000	132	132	132	132	132	132	132	132	132	132
Total Admin/General Expenses, USD x 1000	295	295	295	295	295	295	295	295	295	295
Summary of O & M Expenses, USD x 1000										
Existing System	582	582	582	582	582	582	582	582	582	582
KTC Bulk Supply	1,702	1,776	1,776	1,776	1,776	1,776	1,851	1,851	1,851	1,851
JICA Project	1,657	1,657	1,657	1,657	1,657	1,657	1,657	1,657	1,657	1,657
Total O&M Expenses, 2010 prices	3,941	4,016	4,016	4,016	4,016	4,016	4,090	4,090	4,090	4,090

	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Allocation of Demand/Production										
Billed Water, 1000 x m3/year										
- 9,000 cumd - Existing WTP	2,957	2,957	2,957	2,957	2,957	2,957	2,957	2,957	2,957	2,957
- 17,000 cumd - KTC Bulk Supply	5,585	5,585	5,585	5,585	5,585	5,585	5,585	5,585	5,585	5,585
- 30,000 cumd - Proposed WTP	9,855	9,855	9,855	9,855	9,855	9,855	9,855	9,855	9,855	9,855
Total Billed Volume, 1000 x m3/year	18,396	18,396	18,396	18,396	18,396	18,396	18,396	18,396	18,396	18,396
Production, 1000 x m3/year										
- 9,000 cumd - Existing WTP	3,285	3,285	3,285	3,285	3,285	3,285	3,285	3,285	3,285	3,285
- 17,000 cumd - KTC Bulk Supply	6,205	6,205	6,205	6,205	6,205	6,205	6,205	6,205	6,205	6,205
- 30,000 cumd - Proposed WTP	10,950	10,950	10,950	10,950	10,950	10,950	10,950	10,950	10,950	10,950
Total Volume Produced, 1000 x m3/year	20,440	20,440	20,440	20,440	20,440	20,440	20,440	20,440	20,440	20,440

Financial Study 7 - Trial Run 1

FLOW OF FUNDS STATEMENTS

USD Million

Interest NPV=4.5%: Grace period @3%, IDC 100% capitalized and Repayment 1st 10 years @3.75%, next 10 years @7.50% and last 10 years @10.405%

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
INTERNAL CASH GENERATION											
Net Income Before Interest	0.06	0.07	1.94	0.95	0.89	1.18	1.60	0.28	0.79	1.33	1.97
Add: Depreciation Expense	0.07	0.07	0.10	0.21	0.30	0.40	0.40	3.08	3.08	3.08	3.08
Operating Cash Flow	0.14	0.14	2.05	1.16	1.19	1.58	2.01	3.36	3.87	4.41	5.05
Add: Beg Cash Position	0.67	0.03	0.03	0.05	0.06	0.08	0.08	0.09	0.10	0.11	0.12
Working Cap Inc/(Dec)	0.06	(0.00)	0.02	(0.08)	(0.01)	(0.01)	(0.01)	0.09	0.00	0.00	0.00
CASH BEFORE DEBT SERVICE	0.74	0.17	2.06	1.30	1.26	1.67	2.10	3.36	3.97	4.51	5.17
DEBT SERVICE											
Interest Charges - Priority Project	-	-	-	-	-	-	-	2.40	2.40	2.40	2.40
Interest Charges - KTC Pipeline	-	-	-	-	-	0.82	0.81	0.80	0.79	0.78	0.76
Total Interest Charges	-	-	-	-	-	0.82	0.81	3.20	3.19	3.18	3.16
Principal Repayment - Priority Project	-	-	-	-	-	-	-	-	-	-	-
Principal Repayment - KTC Project	-	-	-	-	-	0.13	0.14	0.15	0.16	0.17	0.19
Principal Repayments	-	-	-	-	-	0.13	0.14	0.15	0.16	0.17	0.19
Total Debt Service	-	-	-	-	-	0.95	0.95	3.35	3.35	3.35	3.35
CASH BEFORE INCOME TAX	0.74	0.17	2.06	1.30	1.26	0.72	1.15	0.00	0.62	1.16	1.81
TAXES (20%)											
Income Tax	0.01	0.01	0.39	0.19	0.18	0.07	0.16	-	-	-	-
CASH AVAILABLE FOR INVESTMENT	0.73	0.16	1.67	1.11	1.08	0.65	0.99	0.00	0.62	1.16	1.81
CAPITAL INVESTMENT REQUIREMENTS											
Priority Project	-	1.04	1.42	15.40	22.29	25.04	15.46	-	-	-	-
Capitalized Interest - Priority Project	-	0.01	0.04	0.29	0.83	1.53	2.16	-	-	-	-
Total Investment - Priority Project	-	1.05	1.46	15.68	23.12	26.57	17.61	-	-	-	-
KTC Pipeline Extension	-	0.86	3.36	2.62	3.08	-	-	-	-	-	-
Capitalized Interest - KTC Pipeline	-	0.03	0.19	0.43	0.68	-	-	-	-	-	-
Total Investment - KTC Pipeline	-	0.89	3.55	3.06	3.76	-	-	-	-	-	-
Annual Capital Investment	-	1.94	5.01	18.74	26.88	26.57	17.61	-	-	-	-
Add: Cash Ending Balance	0.03	0.03	0.05	0.06	0.08	0.08	0.09	0.10	0.11	0.12	0.13
FINANCING REQUIREMENTS	0.70	(1.82)	(3.39)	(17.70)	(25.89)	(26.00)	(16.70)	(0.10)	0.51	1.04	1.69
FUNDS FROM LOANS & GRANTS											
Grants	-	-	-	-	-	-	-	-	-	-	-
Loan 1 - Priority Project	-	0.59	1.43	14.97	21.66	24.92	16.54	-	-	-	-
Loan 2 - KTC Project	-	0.80	3.21	2.79	3.45	-	-	-	-	-	-
Loan3	-	-	-	-	-	-	-	-	-	-	-
Outstanding Loans	-	-	-	-	-	-	-	-	-	-	-
Funds From Loans	-	1.39	4.64	17.77	25.11	24.92	16.54	-	-	-	-
CASH SURPLUS/(DEFICIT)	0.70	(0.43)	1.26	0.07	(0.77)	(1.08)	(0.16)	(0.10)	0.51	1.04	1.69
If Cash Surplus:											
(Purchase)/Sell Deposits	0.70	-	1.26	0.07	-	-	-	-	0.51	1.04	1.69
If Cash Deficit:											
Sale of Deposits	-	0.43	-	-	0.77	0.83	-	-	-	-	-
Additional Equity Needed	-	-	-	-	-	0.25	0.16	0.10	-	-	-
Total Cash Raised	-	0.43	-	-	0.77	1.08	0.16	0.10	-	-	-

Financial Study 7 - Trial Run 1

FLOW OF FUNDS STATEMENTS

USD Million

Interest NPV=4.5%: Grace period @3%, IDC 100% capitalized and Repayment 1st 10 years @3.75%, next 10 years @7.50% and last 10 years @10.405%

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
INTERNAL CASH GENERATION										
Net Income Before Interest	2.13	2.46	2.90	3.36	3.84	4.28	3.94	3.93	3.78	3.67
Add: Depreciation Expense	3.08	3.08	3.08	3.08	3.08	3.08	3.08	3.09	3.24	3.35
Operating Cash Flow	5.21	5.54	5.98	6.44	6.92	7.36	7.02	7.02	7.02	7.02
Add: Beg Cash Position	0.13	0.13	0.14	0.15	0.15	0.16	0.16	0.16	0.16	0.16
Working Cap Inc/(Dec)	(0.01)	0.01	0.01	0.01	0.01	0.01	(0.02)	-	-	-
CASH BEFORE DEBT SERVICE	5.35	5.66	6.11	6.58	7.06	7.51	7.20	7.19	7.19	7.19
DEBT SERVICE										
Interest Charges - Priority Project	3.00	2.95	2.89	2.83	2.77	2.70	2.64	2.57	2.49	2.42
Interest Charges - KTC Pipeline	0.75	0.73	0.71	0.69	0.67	0.65	0.63	0.60	0.57	0.54
Total Interest Charges	3.75	3.68	3.60	3.52	3.44	3.35	3.26	3.17	3.07	2.96
Principal Repayment - Priority Project	1.49	1.54	1.60	1.66	1.73	1.79	1.86	1.93	2.00	2.07
Principal Repayment - KTC Project	0.20	0.22	0.24	0.26	0.28	0.30	0.32	0.35	0.38	0.41
Principal Repayments	1.69	1.77	1.84	1.92	2.00	2.09	2.18	2.28	2.38	2.48
Total Debt Service	5.44	5.44	5.44	5.44	5.44	5.44	5.44	5.44	5.44	5.44
CASH BEFORE INCOME TAX	(0.10)	0.22	0.67	1.13	1.62	2.07	1.76	1.74	1.74	1.74
TAXES (20%)										
Income Tax	-	-	-	-	0.08	0.19	0.14	0.15	0.14	0.14
CASH AVAILABLE FOR INVESTMENT	(0.10)	0.22	0.67	1.13	1.54	1.88	1.62	1.59	1.60	1.60
CAPITAL INVESTMENT REQUIREMENTS										
Priority Project	-	-	-	-	-	-	-	0.37	4.44	3.31
Capitalized Interest - Priority Project	-	-	-	-	-	-	-	-	-	-
Total Investment - Priority Project	-	-	-	-	-	-	-	0.37	4.44	3.31
KTC Pipeline Extension	-	-	-	-	-	-	-	-	-	-
Capitalized Interest - KTC Pipeline	-	-	-	-	-	-	-	-	-	-
Total Investment - KTC Pipeline	-	-	-	-	-	-	-	-	-	-
Annual Capital Investment	-	-	-	-	-	-	-	0.37	4.44	3.31
Add: Cash Ending Balance	0.13	0.14	0.15	0.15	0.16	0.16	0.16	0.16	0.16	0.16
FINANCING REQUIREMENTS	(0.23)	0.08	0.52	0.98	1.38	1.72	1.46	1.05	(3.01)	(1.88)
FUNDS FROM LOANS & GRANTS										
Grants	-	-	-	-	-	-	-	-	-	-
Loan 1 - Priority Project	-	-	-	-	-	-	-	-	-	-
Loan 2 - KTC Project	-	-	-	-	-	-	-	-	-	-
Loan3	-	-	-	-	-	-	-	-	-	-
Outstanding Loans	-	-	-	-	-	-	-	-	-	-
Funds From Loans	-	-	-	-	-	-	-	-	-	-
CASH SURPLUS/(DEFICIT)	(0.23)	0.08	0.52	0.98	1.38	1.72	1.46	1.05	(3.01)	(1.88)
If Cash Surplus:										
(Purchase)/Sell Deposits	-	0.08	0.52	0.98	1.38	1.72	1.46	1.05	-	-
If Cash Deficit:										
Sale of Deposits	0.23	-	-	-	-	-	-	-	3.01	1.88
Additional Equity Needed	-	-	-	-	-	-	-	-	-	-
Total Cash Raised	0.23	-	-	-	-	-	-	-	3.01	1.88

Financial Study 7 - Trial Run 1
FLOW OF FUNDS STATEMENTS
USD Million

Interest NPV=4.5%: Grace period @3%, IDC 100% capitalized and Repayment 1st 10 years @3.75%, next 10 years @7.50% and last 10 years @10.405%

	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
INTERNAL CASH GENERATION										
Net Income Before Interest	3.60	3.52	3.52	3.52	3.52	3.52	3.45	3.45	3.45	3.45
Add: Depreciation Expense	3.42	3.42	3.42	3.42	3.42	3.42	3.42	3.42	3.42	3.42
Operating Cash Flow	7.02	6.95	6.95	6.95	6.95	6.95	6.87	6.87	6.87	6.87
Add: Beg Cash Position	0.16	0.16	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17
Working Cap Inc/(Dec)	-	0.00	-	-	-	-	0.00	-	-	-
CASH BEFORE DEBT SERVICE	7.19	7.11	7.11	7.11	7.11	7.11	7.04	7.04	7.04	7.04
DEBT SERVICE										
Interest Charges - Priority Project	4.68	4.57	4.46	4.33	4.20	4.05	3.90	3.73	3.55	3.36
Interest Charges - KTC Pipeline	0.51	0.47	0.44	0.40	0.35	0.30	0.25	0.20	0.14	0.07
Total Interest Charges	5.19	5.05	4.90	4.73	4.55	4.36	4.15	3.93	3.69	3.43
Principal Repayment - Priority Project	1.44	1.55	1.67	1.79	1.93	2.07	2.23	2.39	2.57	2.76
Principal Repayment - KTC Project	0.44	0.48	0.51	0.55	0.60	0.65	0.70	0.75	0.81	0.88
Principal Repayments	1.88	2.03	2.18	2.35	2.52	2.72	2.92	3.15	3.39	3.64
Total Debt Service	7.07	7.07	7.07	7.07	7.07	7.07	7.07	7.07	7.07	7.07
CASH BEFORE INCOME TAX	0.11	0.03	0.04	0.04	0.04	0.04	(0.04)	(0.03)	(0.03)	(0.03)
TAXES (20%)										
Income Tax	-	-	-	-	-	-	-	-	-	0.00
CASH AVAILABLE FOR INVESTMENT	0.11	0.03	0.04	0.04	0.04	0.04	(0.04)	(0.03)	(0.03)	(0.04)
CAPITAL INVESTMENT REQUIREMENTS										
Priority Project	2.21	-	-	-	-	-	-	-	-	-
Capitalized Interest - Priority Project	-	-	-	-	-	-	-	-	-	-
Total Investment - Priority Project	2.21	-	-	-	-	-	-	-	-	-
KTC Pipeline Extension	-	-	-	-	-	-	-	-	-	-
Capitalized Interest - KTC Pipeline	-	-	-	-	-	-	-	-	-	-
Total Investment - KTC Pipeline	-	-	-	-	-	-	-	-	-	-
Annual Capital Investment	2.21	-	-	-	-	-	-	-	-	-
Add: Cash Ending Balance	0.16	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17
FINANCING REQUIREMENTS	(2.26)	(0.13)	(0.13)	(0.13)	(0.13)	(0.13)	(0.21)	(0.20)	(0.20)	(0.21)
FUNDS FROM LOANS & GRANTS										
Grants	-	-	-	-	-	-	-	-	-	-
Loan 1 - Priority Project	-	-	-	-	-	-	-	-	-	-
Loan 2 - KTC Project	-	-	-	-	-	-	-	-	-	-
Loan3	-	-	-	-	-	-	-	-	-	-
Outstanding Loans	-	-	-	-	-	-	-	-	-	-
Funds From Loans	-	-	-	-	-	-	-	-	-	-
CASH SURPLUS/(DEFICIT)	(2.26)	(0.13)	(0.13)	(0.13)	(0.13)	(0.13)	(0.21)	(0.20)	(0.20)	(0.21)
If Cash Surplus:										
(Purchase)/Sell Deposits	-	-	-	-	-	-	-	-	-	-
If Cash Deficit:										
Sale of Deposits	2.26	0.13	0.13	0.13	0.13	0.13	0.21	0.20	0.20	0.21
Additional Equity Needed	-	-	-	-	-	-	-	-	-	-
Total Cash Raised	2.26	0.13	0.13	0.13	0.13	0.13	0.21	0.20	0.20	0.21

Financial Study 8 - Trial Run 1

KEY FINANCIAL INDICATORS

USD Million

Interest NPV=4.5%: Grace period @3%, IDC 100% capitalized and Repayment 1st 10 years @3.75%, next 10 years @7.50% and last 10 years @10.405%

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
PROJECTION PARAMETERS											
Currency:	USD Million										
Prices/Costs:	Current										
Exchange Rate:	4,165	KHR to USD									
Domestic Infaltion Rate	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Foreign Inflation Rate	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Exchange Rate (KHR to 1US$)	4,165	4,165	4,165	4,165	4,165	4,165	4,165	4,165	4,165	4,165	4,165
OPERATING RESULTS											
Operating Revenues	0.90	0.90	3.19	2.67	3.10	3.56	4.06	5.78	6.50	7.28	8.11
Operating Expenses	0.76	0.76	1.15	1.51	1.91	1.98	2.05	2.41	2.63	2.88	3.06
Net Income	0.05	0.05	1.56	0.76	0.71	0.29	0.63	(2.92)	(2.40)	(1.85)	(1.19)
Cash from Operations	0.14	0.14	2.05	1.16	1.19	1.58	2.01	3.36	3.87	4.41	5.05
Operating Ratio	85%	85%	36%	56%	62%	56%	51%	42%	40%	39%	38%
Total Assets	4.92	6.36	12.79	31.41	57.33	82.72	99.98	97.12	94.64	92.71	91.42
Working Capital	0.72	0.29	1.58	1.58	0.69	(0.16)	(0.18)	(0.08)	0.42	1.46	1.65
Working Capital (Days)	337	136	496	378	130	(28)	(31)	(13)	57	182	194
OPERATING EFFICIENCY											
Active Service Connections	4,129	4,248	13,786	16,186	18,744	21,464	24,346	27,392	30,607	33,987	37,537
Average Tariff (USD)	0.33	0.33	0.46	0.46	0.46	0.46	0.46	0.59	0.59	0.59	0.59
Average Water Monthly Bill (USD)	18.15	17.69	19.31	13.76	13.77	13.82	13.88	17.57	17.71	17.85	18.01
Percent Growth in Connections	0%	3%	225%	17%	16%	15%	13%	13%	12%	11%	10%
Water Production (m3 x 1000)	3,285	3,285	5,041	5,919	6,856	7,855	8,917	10,044	11,361	12,772	14,282
Water Sold (in 000 of m3)	2,727	2,727	4,285	5,090	5,965	6,913	7,937	9,039	10,225	11,495	12,854
Water Losses	17%	16%	15%	14%	13%	12%	11%	10%	10%	10%	10%
FINANCIAL PERFORMANCE RATIOS											
Acc. Receivable (Days)	30	30	30	30	30	30	30	30	30	30	30
Current Ratio	4.53	2.42	4.70	4.04	1.92	0.81	0.80	0.92	1.37	2.18	1.58
Debt/Equity Ratio	0.00	0.29	0.95	3.36	6.26	8.83	9.86	14.26	23.00	43.74	103.05
Debt Service Coverage						1.76	2.21	1.00	1.18	1.35	1.54
Self Financing Ratio		28.4%	7.2%	5.2%	6.6%	6.2%	6.1%				
Return on Revenues	5.7%	5.9%	48.7%	28.5%	22.9%	8.0%	15.6%	-50.6%	-36.9%	-25.4%	-14.7%
Return on Assets	1.3%	0.9%	14.4%	2.6%	1.3%	0.3%	0.6%	-3.0%	-2.6%	-2.1%	-1.4%
Return on Equity	1.1%	1.1%	24.6%	10.7%	9.1%	3.4%	6.9%	-46.4%	-61.6%	-90.6%	-140.1%
INVESTMENT PROGRAM	-	1.9	5.0	18.7	26.9	26.6	17.6	-	-	-	-
Investment Project	-	1.9	4.8	18.0	25.4	25.0	15.5	-	-	-	-
Capitalized Interest	-	0.0	0.2	0.7	1.5	1.5	2.2	-	-	-	-
FINANCING PLAN	-	1.9	5.0	18.7	26.9	26.6	17.6	-	-	-	-
Grants	-	-	-	-	-	-	-	-	-	-	-
Loan 1 - Priority Project	-	0.6	1.4	15.0	21.7	24.9	16.5	-	-	-	-
Loan 2 - KTC Project	-	0.8	3.2	2.8	3.5	-	-	-	-	-	-
Loan3	-	-	-	-	-	-	-	-	-	-	-
Outstanding Loans	-	-	-	-	-	-	-	-	-	-	-
Internally Generated Financing	-	0.6	0.4	1.0	1.8	1.7	1.1	-	-	-	-

Financial Study 8 - Trial Run 1
KEY FINANCIAL INDICATORS
USD Million

Interest NPV=4.5%: Grace period @3%, IDC 100% capitalized and Repayment 1st 10 years @3.75%, next 10 years @7.50% and last 10 years @10.405%

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
PROJECTION PARAMETERS										
Currency:										
Prices/Costs:										
Exchange Rate:										
Domestic Infaltion Rate	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Foreign Inflation Rate	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Exchange Rate (KHR to 1US$)	4,165	4,165	4,165	4,165	4,165	4,165	4,165	4,165	4,165	4,165
OPERATING RESULTS										
Operating Revenues	8.40	8.93	9.49	10.07	10.68	11.23	10.96	10.96	10.96	10.96
Operating Expenses	3.19	3.39	3.51	3.63	3.75	3.87	3.94	3.94	3.94	3.94
Net Income	(1.62)	(1.22)	(0.70)	(0.16)	0.32	0.74	0.54	0.61	0.57	0.57
Cash from Operations	5.21	5.54	5.98	6.44	6.92	7.36	7.02	7.02	7.02	7.02
Operating Ratio	38%	38%	37%	36%	35%	34%	36%	36%	36%	36%
Total Assets	88.16	85.25	82.76	80.73	79.11	77.82	76.19	74.52	72.72	70.80
Working Capital	1.35	1.37	1.83	2.74	4.06	5.70	7.05	8.00	4.88	3.61
Working Capital (Days)	152	145	188	272	389	531	644	731	446	330
OPERATING EFFICIENCY										
Active Service Connections	39,327	41,159	43,032	44,948	46,903	48,913	48,913	48,913	48,913	48,913
Average Tariff (USD)	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59
Average Water Monthly Bill (USD)	17.79	18.08	18.38	18.67	18.97	19.13	18.68	18.68	18.68	18.68
Percent Growth in Connections	5%	5%	5%	4%	4%	4%	0%	0%	0%	0%
Water Production (m3 x 1000)	15,226	16,212	17,242	18,315	19,433	20,440	20,440	20,440	20,440	20,440
Water Sold (in 000 of m3)	13,704	14,591	15,518	16,484	17,490	18,396	18,396	18,396	18,396	18,396
Water Losses	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
FINANCIAL PERFORMANCE RATIOS										
Acc. Receivable (Days)	30	30	30	30	30	30	30	30	30	30
Current Ratio	1.46	1.44	1.57	1.82	2.16	2.56	2.88	3.08	2.23	2.07
Debt/Equity Ratio	-112.00	-42.40	-30.63	-28.20	-30.99	-42.70	-59.64	-113.97	-1271.05	130.46
Debt Service Coverage	0.98	1.04	1.12	1.21	1.30	1.38	1.32	1.32	1.32	1.32
Self Financing Ratio								100.0%	100.0%	100.0%
Return on Revenues	-19.3%	-13.6%	-7.4%	-1.6%	3.0%	6.6%	5.0%	5.6%	5.2%	5.2%
Return on Assets	-1.9%	-1.5%	-0.9%	-0.2%	0.5%	1.1%	0.8%	1.0%	0.9%	0.9%
Return on Equity	210.9%	61.3%	26.1%	5.6%	-12.8%	-41.7%	-44.0%	-97.5%	-1055.4%	110.6%
INVESTMENT PROGRAM	-	-	-	-	-	-	-	0.4	4.4	3.3
Investment Project	-	-	-	-	-	-	-	0.4	4.4	3.3
Capitalized Interest	-	-	-	-	-	-	-	-	-	-
FINANCING PLAN	-	-	-	-	-	-	-	0.4	4.4	3.3
Grants	-	-	-	-	-	-	-	-	-	-
Loan 1 - Priority Project	-	-	-	-	-	-	-	-	-	-
Loan 2 - KTC Project	-	-	-	-	-	-	-	-	-	-
Loan3	-	-	-	-	-	-	-	-	-	-
Outstanding Loans	-	-	-	-	-	-	-	-	-	-
Internally Generated Financing	-	-	-	-	-	-	-	0.4	4.4	3.3

Financial Study 8 - Trial Run 1
KEY FINANCIAL INDICATORS
USD Million

Interest NPV=4.5%: Grace period @3%, IDC 100% capitalized and Repayment 1st 10 years @3.75%, next 10 years @7.50% and last 10 years @10.405%

	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
PROJECTION PARAMETERS										
Currency:										
Prices/Costs:										
Exchange Rate:										
Domestic Infaltion Rate	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Foreign Inflation Rate	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Exchange Rate (KHR to 1US$)	4,165	4,165	4,165	4,165	4,165	4,165	4,165	4,165	4,165	4,165
OPERATING RESULTS										
Operating Revenues	10.96	10.96	10.96	10.96	10.96	10.96	10.96	10.96	10.96	10.96
Operating Expenses	3.94	4.02	4.02	4.02	4.02	4.02	4.09	4.09	4.09	4.09
Net Income	(1.60)	(1.53)	(1.37)	(1.21)	(1.03)	(0.84)	(0.70)	(0.48)	(0.24)	0.01
Cash from Operations	7.02	6.95	6.95	6.95	6.95	6.95	6.87	6.87	6.87	6.87
Operating Ratio	36%	37%	37%	37%	37%	37%	37%	37%	37%	37%
Total Assets	67.33	63.78	60.23	56.68	53.13	49.58	45.96	42.33	38.71	35.08
Working Capital	1.20	0.92	0.63	0.32	(0.00)	(0.34)	(0.76)	(1.20)	(1.67)	(0.81)
Working Capital (Days)	110	82	56	29	(0)	(30)	(67)	(106)	(147)	(72)
OPERATING EFFICIENCY										
Active Service Connections	48,913	48,913	48,913	48,913	48,913	48,913	48,913	48,913	48,913	48,913
Average Tariff (USD)	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59
Average Water Monthly Bill (USD)	18.68	18.68	18.68	18.68	18.68	18.68	18.68	18.68	18.68	18.68
Percent Growth in Connections	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Water Production (m3 x 1000)	20,440	20,440	20,440	20,440	20,440	20,440	20,440	20,440	20,440	20,440
Water Sold (in 000 of m3)	18,396	18,396	18,396	18,396	18,396	18,396	18,396	18,396	18,396	18,396
Water Losses	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
FINANCIAL PERFORMANCE RATIOS										
Acc. Receivable (Days)	30	30	30	30	30	30	30	30	30	30
Current Ratio	1.34	1.25	1.16	1.08	1.00	0.92	0.84	0.75	0.68	0.80
Debt/Equity Ratio	-59.95	-24.04	-15.16	-11.15	-8.87	-7.40	-6.33	-5.55	-4.96	-4.66
Debt Service Coverage	1.02	1.00	1.01	1.01	1.01	1.01	0.99	1.00	1.00	1.00
Self Financing Ratio	100.0%									
Return on Revenues	-14.6%	-13.9%	-12.5%	-11.0%	-9.4%	-7.6%	-6.4%	-4.4%	-2.2%	0.1%
Return on Assets	-2.5%	-2.6%	-2.5%	-2.3%	-2.1%	-1.8%	-1.7%	-1.2%	-0.7%	0.0%
Return on Equity	147.4%	58.5%	34.5%	23.3%	16.5%	11.8%	9.1%	5.8%	2.8%	-0.2%
INVESTMENT PROGRAM	2.2	-	-	-	-	-	-	-	-	-
Investment Project	2.2	-	-	-	-	-	-	-	-	-
Capitalized Interest	-	-	-	-	-	-	-	-	-	-
FINANCING PLAN	2.2	-	-	-	-	-	-	-	-	-
Grants	-	-	-	-	-	-	-	-	-	-
Loan 1 - Priority Project	-	-	-	-	-	-	-	-	-	-
Loan 2 - KTC Project	-	-	-	-	-	-	-	-	-	-
Loan3	-	-	-	-	-	-	-	-	-	-
Outstanding Loans	-	-	-	-	-	-	-	-	-	-
Internally Generated Financing	2.2	-	-	-	-	-	-	-	-	-

Financial Study 9 - Trial Run 1

PROFIT & LOSS STATEMENTS

US$ Million

Interest NPV=4.5%: Grace period @3%, IDC 100% capitalized and Repayment 1st 10 years @3.75%, next 10 years @7.50% and last 10 years @10.405%

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Number of Connections											
- Existing WTP	4,129	4,129	4,129	4,129	4,129	4,129	4,129	4,129	4,129	4,129	4,129
- Increment form KTC Bulk Water	99	119	9,657	12,057	14,615	17,335	20,217	20,217	20,217	20,217	20,217
- Increment from Priority Project	-	-	-	-	-	-	-	3,046	6,261	9,641	13,191
Total	4,228	4,248	13,786	16,186	18,744	21,464	24,346	27,392	30,607	33,987	37,537
Billed Water, 1000 x m3/year											
- Per existing WTP	2,727	2,727	2,176	1,888	567	1,452	2,414	2,957	2,957	2,957	2,957
- Increment due KTC project	-	-	2,110	3,202	5,398	5,460	5,522	5,585	5,585	5,585	5,585
- Increment due priority project	-	-	-	-	-	-	-	498	1,684	2,954	4,313
Total Billed Water, 1000 x m3/year	2,727	2,727	4,285	5,090	5,965	6,913	7,937	9,039	10,225	11,495	12,854
Average Tariff, USD/m3	0.33	0.33	0.46	0.46	0.46	0.46	0.46	0.59	0.59	0.59	0.59
Water Losses	17%	16%	15%	14%	13%	12%	11%	10%	10%	10%	10%
Production Capacity, 1000 x m3/year											
- Existing WTP	3,285	3,285	3,285	3,285	3,285	3,285	3,285	3,285	3,285	3,285	3,285
- KTC Bulk Water	-	-	2,482	3,723	6,205	6,205	6,205	6,205	6,205	6,205	6,205
- Priority Project WTP	-	-	-	-	-	-	-	10,950	10,950	10,950	10,950
Total Production Capacity, 1000 x m3/year	3,285	3,285	5,767	7,008	9,490	9,490	9,490	20,440	20,440	20,440	20,440

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Operating Revenue											
Water Sales											
- Existing WTP	0.89	0.89	1.00	0.87	0.26	0.67	1.11	1.74	1.74	1.74	1.74
- Increment Due KTC	-	-	0.97	1.47	2.48	2.51	2.54	3.29	3.29	3.29	3.29
- Without Priority Project	0.89	0.89	1.97	2.34	2.74	3.18	3.65	5.04	5.04	5.04	5.04
- Increment Due Priority Project	-	-	-	-	-	-	-	0.29	0.99	1.74	2.54
Total Water Sales	0.89	0.89	1.97	2.34	2.74	3.18	3.65	5.33	6.03	6.78	7.58
Less: Value Added Tax	-	-	-	-	-	-	-	-	-	-	-
Net Water Sales	0.89	0.89	1.97	2.34	2.74	3.18	3.65	5.33	6.03	6.78	7.58
Penalties and Fines											
- Without Priority Project	0.01	0.01	0.02	0.02	0.03	0.03	0.04	-	-	-	-
- Increment Due Priority Project	-	-	-	-	-	-	-	0.05	0.06	0.07	0.08
Total Penalties and Fines	0.01	0.01	0.02	0.02	0.03	0.03	0.04	0.05	0.06	0.07	0.08
Connection Fees & Other Charges											
- Without Priority Project	-	0.00	1.20	0.31	0.33	0.35	0.37	-	-	-	-
- Increment Due Priority Project	-	-	-	-	-	-	-	0.39	0.41	0.43	0.45
Total Conn. Fees & Other Charges	-	0.00	1.20	0.31	0.33	0.35	0.37	0.39	0.41	0.43	0.45
Total Operating Revenue	0.90	0.90	3.19	2.67	3.10	3.56	4.06	5.78	6.50	7.28	8.11
Operating Expenses											
Bulk Water Purchases	-	-	0.51	0.76	1.27	1.27	1.27	1.34	1.341	1.341	1.341
Salaries & Wages	0.14	0.14	0.20	0.27	0.27	0.27	0.27	0.34	0.395	0.453	0.470
Power Costs	0.18	0.18	0.14	0.12	0.04	0.09	0.15	0.22	0.308	0.402	0.503
Chemical Costs	0.04	0.04	0.03	0.02	0.01	0.02	0.03	0.05	0.072	0.099	0.128
Maintenance Expense	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.25	0.281	0.309	0.338
Administrative & General Expenses	0.26	0.26	0.14	0.19	0.19	0.19	0.19	0.21	0.237	0.272	0.282
Total Operating Expenses	0.76	0.76	1.15	1.51	1.91	1.98	2.05	2.41	2.63	2.88	3.06
Income before Depreciation	0.14	0.14	2.05	1.16	1.19	1.58	2.01	3.36	3.87	4.41	5.05
Depreciation Expense	0.07	0.073	0.101	0.213	0.301	0.403	0.40	3.08	3.08	3.08	3.08
Income before Interest Charges	0.06	0.07	1.94	0.95	0.89	1.18	1.60	0.28	0.79	1.33	1.97
Interest Charges'- Priority Project	-	-	-	-	-	-	-	2.40	2.40	2.40	2.40
Interest Charges'- KTC Pipeline Project	-	-	-	-	-	0.82	0.81	0.80	0.79	0.78	0.76
Total Interest Charges	-	-	-	-	-	0.82	0.81	3.20	3.19	3.18	3.16
Income Before Taxes	0.06	0.07	1.94	0.95	0.89	0.36	0.79	(2.92)	(2.40)	(1.85)	(1.19)
Income Taxes	0.01	0.01	0.39	0.19	0.18	0.07	0.16	-	-	-	-
NET PROFIT/(LOSS)	0.05	0.05	1.56	0.76	0.71	0.29	0.63	(2.92)	(2.40)	(1.85)	(1.19)

Financial Study 9 - Trial Run 1
PROFIT & LOSS STATEMENTS
US$ Million

Interest NPV=4.5%: Grace period @3%, IDC 100% capitalized and Repayment 1st 10 years @3.75%, next 10 years @7.50% and last 10 years @10.405%

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Number of Connections										
- Existing WTP	4,129	4,129	4,129	4,129	4,129	4,129	4,129	4,129	4,129	4,129
- Increment form KTC Bulk Water	20,217	20,217	20,217	20,217	20,217	20,217	20,217	20,217	20,217	20,217
- Increment from Priority Project	14,981	16,813	18,686	20,602	22,557	24,567	24,567	24,567	24,567	24,567
Total	39,327	41,159	43,032	44,948	46,903	48,913	48,913	48,913	48,913	48,913
Billed Water, 1000 x m3/year										
- Per existing WTP	2,957	2,957	2,957	2,957	2,957	2,957	2,957	2,957	2,957	2,957
- Increment due KTC project	5,585	5,585	5,585	5,585	5,585	5,585	5,585	5,585	5,585	5,585
- Increment due priority project	5,163	6,050	6,977	7,943	8,949	9,855	9,855	9,855	9,855	9,855
Total Billed Water, 1000 x m3/year	13,704	14,591	15,518	16,484	17,490	18,396	18,396	18,396	18,396	18,396
Average Tariff, USD/m3	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59
Water Losses	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
Production Capacity, 1000 x m3/year										
- Existing WTP	3,285	3,285	3,285	3,285	3,285	3,285	3,285	3,285	3,285	3,285
- KTC Bulk Water	6,205	6,205	6,205	6,205	6,205	6,205	6,205	6,205	6,205	6,205
- Priority Project WTP	10,950	10,950	10,950	10,950	10,950	10,950	10,950	10,950	10,950	10,950
Total Production Capacity, 1000 x m3/year	20,440	20,440	20,440	20,440	20,440	20,440	20,440	20,440	20,440	20,440

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Operating Revenue										
Water Sales										
- Existing WTP	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74
- Increment Due KTC	3.29	3.29	3.29	3.29	3.29	3.29	3.29	3.29	3.29	3.29
- Without Priority Project	5.04	5.04	5.04	5.04	5.04	5.04	5.04	5.04	5.04	5.04
- Increment Due Priority Project	3.05	3.57	4.12	4.69	5.28	5.81	5.81	5.81	5.81	5.81
Total Water Sales	8.09	8.61	9.16	9.73	10.32	10.85	10.85	10.85	10.85	10.85
Less: Value Added Tax	-	-	-	-	-	-	-	-	-	-
Net Water Sales	8.09	8.61	9.16	9.73	10.32	10.85	10.85	10.85	10.85	10.85
Penalties and Fines										
- Without Priority Project	-	-	-	-	-	-	-	-	-	-
- Increment Due Priority Project	0.08	0.09	0.09	0.10	0.10	0.11	0.11	0.11	0.11	0.11
Total Penalties and Fines	0.08	0.09	0.09	0.10	0.10	0.11	0.11	0.11	0.11	0.11
Connection Fees & Other Charges										
- Without Priority Project	-	-	-	-	-	-	-	-	-	-
- Increment Due Priority Project	0.23	0.24	0.24	0.25	0.25	0.27	-	-	-	-
Total Conn. Fees & Other Charges	0.23	0.24	0.24	0.25	0.25	0.27	-	-	-	-
Total Operating Revenue	8.40	8.93	9.49	10.07	10.68	11.23	10.96	10.96	10.96	10.96
Operating Expenses										
Bulk Water Purchases	1.341	1.415	1.415	1.415	1.415	1.415	1.490	1.490	1.490	1.490
Salaries & Wages	0.481	0.491	0.491	0.491	0.491	0.491	0.491	0.491	0.491	0.491
Power Costs	0.566	0.632	0.700	0.772	0.846	0.913	0.913	0.913	0.913	0.913
Chemical Costs	0.145	0.164	0.184	0.204	0.225	0.244	0.244	0.244	0.244	0.244
Maintenance Expense	0.366	0.394	0.423	0.451	0.480	0.508	0.508	0.508	0.508	0.508
Administrative & General Expenses	0.288	0.295	0.295	0.295	0.295	0.295	0.295	0.295	0.295	0.295
Total Operating Expenses	3.19	3.39	3.51	3.63	3.75	3.867	3.94	3.94	3.94	3.94
Income before Depreciation	5.21	5.54	5.98	6.44	6.92	7.36	7.02	7.02	7.02	7.02
Depreciation Expense	3.08	3.08	3.08	3.08	3.08	3.08	3.08	3.09	3.24	3.35
Income before Interest Charges	2.13	2.46	2.90	3.36	3.84	4.28	3.94	3.93	3.78	3.67
Interest Charges'- Priority Project	3.00	2.95	2.89	2.83	2.77	2.70	2.64	2.57	2.49	2.42
Interest Charges'- KTC Pipeline Project	0.75	0.73	0.71	0.69	0.67	0.65	0.63	0.60	0.57	0.54
Total Interest Charges	3.75	3.68	3.60	3.52	3.44	3.35	3.26	3.17	3.07	2.96
Income Before Taxes	(1.62)	(1.22)	(0.70)	(0.16)	0.40	0.93	0.68	0.76	0.71	0.71
Income Taxes	-	-	-	-	0.08	0.19	0.14	0.15	0.14	0.14
NET PROFIT/(LOSS)	(1.62)	(1.22)	(0.70)	(0.16)	0.32	0.74	0.54	0.61	0.57	0.57

Financial Study 9 - Trial Run 1

PROFIT & LOSS STATEMENTS

US$ Million

Interest NPV=4.5%: Grace period @3%, IDC 100% capitalized and Repayment 1st 10 years @3.75%, next 10 years @7.50% and last 10 years @10.405%

	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Number of Connections										
- Existing WTP	4,129	4,129	4,129	4,129	4,129	4,129	4,129	4,129	4,129	4,129
- Increment form KTC Bulk Water	20,217	20,217	20,217	20,217	20,217	20,217	20,217	20,217	20,217	20,217
- Increment from Priority Project	24,567	24,567	24,567	24,567	24,567	24,567	24,567	24,567	24,567	24,567
Total	48,913	48,913	48,913	48,913	48,913	48,913	48,913	48,913	48,913	48,913
Billed Water, 1000 x m3/year										
- Per existing WTP	2,957	2,957	2,957	2,957	2,957	2,957	2,957	2,957	2,957	2,957
- Increment due KTC project	5,585	5,585	5,585	5,585	5,585	5,585	5,585	5,585	5,585	5,585
- Increment due priority project	9,855	9,855	9,855	9,855	9,855	9,855	9,855	9,855	9,855	9,855
Total Billed Water, 1000 x m3/year	18,396	18,396	18,396	18,396	18,396	18,396	18,396	18,396	18,396	18,396
Average Tariff, USD/m3	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59
Water Losses	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
Production Capacity, 1000 x m3/year										
- Existing WTP	3,285	3,285	3,285	3,285	3,285	3,285	3,285	3,285	3,285	3,285
- KTC Bulk Water	6,205	6,205	6,205	6,205	6,205	6,205	6,205	6,205	6,205	6,205
- Priority Project WTP	10,950	10,950	10,950	10,950	10,950	10,950	10,950	10,950	10,950	10,950
Total Production Capacity, 1000 x m3/year	20,440	20,440	20,440	20,440	20,440	20,440	20,440	20,440	20,440	20,440

Operating Revenue

	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Water Sales										
- Existing WTP	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74
- Increment Due KTC	3.29	3.29	3.29	3.29	3.29	3.29	3.29	3.29	3.29	3.29
- Without Priority Project	5.04	5.04	5.04	5.04	5.04	5.04	5.04	5.04	5.04	5.04
- Increment Due Priority Project	5.81	5.81	5.81	5.81	5.81	5.81	5.81	5.81	5.81	5.81
Total Water Sales	10.85	10.85	10.85	10.85	10.85	10.85	10.85	10.85	10.85	10.85
Less: Value Added Tax	-	-	-	-	-	-	-	-	-	-
Net Water Sales	10.85	10.85	10.85	10.85	10.85	10.85	10.85	10.85	10.85	10.85
Penalties and Fines										
- Without Priority Project	-	-	-	-	-	-	-	-	-	-
- Increment Due Priority Project	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11
Total Penalties and Fines	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11
Connection Fees & Other Charges										
- Without Priority Project	-	-	-	-	-	-	-	-	-	-
- Increment Due Priority Project	-	-	-	-	-	-	-	-	-	-
Total Conn. Fees & Other Charges	-	-	-	-	-	-	-	-	-	-
Total Operating Revenue	10.96	10.96	10.96	10.96	10.96	10.96	10.96	10.96	10.96	10.96

Operating Expenses

	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Bulk Water Purchases	1.490	1.564	1.564	1.564	1.564	1.564	1.639	1.639	1.639	1.639
Salaries & Wages	0.491	0.491	0.491	0.491	0.491	0.491	0.491	0.491	0.491	0.491
Power Costs	0.913	0.913	0.913	0.913	0.913	0.913	0.913	0.913	0.913	0.913
Chemical Costs	0.244	0.244	0.244	0.244	0.244	0.244	0.244	0.244	0.244	0.244
Maintenance Expense	0.508	0.508	0.508	0.508	0.508	0.508	0.508	0.508	0.508	0.508
Administrative & General Expenses	0.295	0.295	0.295	0.295	0.295	0.295	0.295	0.295	0.295	0.295
Total Operating Expenses	3.94	4.02	4.02	4.02	4.02	4.02	4.09	4.09	4.09	4.09
Income before Depreciation	7.02	6.95	6.95	6.95	6.95	6.95	6.87	6.87	6.87	6.87
Depreciation Expense	3.42	3.42	3.42	3.42	3.42	3.42	3.42	3.42	3.42	3.42
Income before Interest Charges	3.60	3.52	3.52	3.52	3.52	3.52	3.45	3.45	3.45	3.45
Interest Charges'- Priority Project	4.68	4.57	4.46	4.33	4.20	4.05	3.90	3.73	3.55	3.36
Interest Charges'- KTC Pipeline Project	0.51	0.47	0.44	0.40	0.35	0.30	0.25	0.20	0.14	0.07
Total Interest Charges	5.19	5.05	4.90	4.73	4.55	4.36	4.15	3.93	3.69	3.43
Income Before Taxes	(1.60)	(1.53)	(1.37)	(1.21)	(1.03)	(0.84)	(0.70)	(0.48)	(0.24)	0.02
Income Taxes	-	-	-	-	-	-	-	-	-	0.00
NET PROFIT/(LOSS)	(1.60)	(1.53)	(1.37)	(1.21)	(1.03)	(0.84)	(0.70)	(0.48)	(0.24)	0.01

Financial Study 10 - Trial Run 2
FLOW OF FUNDS STATEMENTS
USD Million

Interest NPV=4.5%: Grace period @3%, IDC 100% capitalized and Repayment 1st 10 years @3.75%, next 10 years @7.50% and last 10 years @10.405%

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
INTERNAL CASH GENERATION											
Net Income Before Interest	0.06	0.07	1.99	1.00	0.95	1.25	1.68	0.37	0.89	1.44	2.10
Add: Depreciation Expense	0.07	0.07	0.10	0.21	0.30	0.40	0.40	3.08	3.08	3.08	3.08
Operating Cash Flow	0.14	0.14	2.09	1.22	1.25	1.65	2.09	3.45	3.97	4.52	5.18
Add: Beg Cash Position	0.67	0.03	0.03	0.05	0.06	0.08	0.08	0.09	0.10	0.11	0.12
Working Cap Inc/(Dec)	0.06	(0.00)	0.03	(0.08)	(0.01)	(0.01)	(0.01)	0.09	0.00	0.00	0.00
CASH BEFORE DEBT SERVICE	0.74	0.17	2.09	1.35	1.32	1.74	2.18	3.45	4.07	4.63	5.30
DEBT SERVICE											
Interest Charges - Priority Project	-	-	-	-	-	-	-	2.40	2.40	2.40	2.40
Interest Charges - KTC Pipeline	-	-	-	-	-	0.82	0.81	0.80	0.79	0.78	0.76
Total Interest Charges	-	-	-	-	-	0.82	0.81	3.20	3.19	3.18	3.16
Principal Repayment - Priority Project	-	-	-	-	-	-	-	-	-	-	-
Principal Repayment - KTC Project	-	-	-	-	-	0.13	0.14	0.15	0.16	0.17	0.19
Principal Repayments	-	-	-	-	-	0.13	0.14	0.15	0.16	0.17	0.19
Total Debt Service	-	-	-	-	-	0.95	0.95	3.35	3.35	3.35	3.35
CASH BEFORE INCOME TAX	0.74	0.17	2.09	1.35	1.32	0.79	1.23	0.09	0.72	1.27	1.94
TAXES (20%)											
Income Tax	0.01	0.01	0.40	0.20	0.19	0.09	0.17	-	-	-	-
CASH AVAILABLE FOR INVESTMENT	0.73	0.16	1.70	1.15	1.13	0.71	1.06	0.09	0.72	1.27	1.94
CAPITAL INVESTMENT REQUIREMENTS											
Priority Project	-	1.04	1.42	15.40	22.29	25.04	15.46	-	-	-	-
Capitalized Interest - Priority Project	-	0.01	0.04	0.29	0.83	1.53	2.16	-	-	-	-
Total Investment - Priority Project	-	1.05	1.46	15.68	23.12	26.57	17.61	-	-	-	-
KTC Pipeline Extension	-	0.86	3.36	2.62	3.08	-	-	-	-	-	-
Capitalized Interest - KTC Pipeline	-	0.03	0.19	0.43	0.68	-	-	-	-	-	-
Total Investment - KTC Pipeline	-	0.89	3.55	3.06	3.76	-	-	-	-	-	-
Annual Capital Investment	-	1.94	5.01	18.74	26.88	26.57	17.61	-	-	-	-
Add: Cash Ending Balance	0.03	0.03	0.05	0.06	0.08	0.08	0.09	0.10	0.11	0.12	0.13
FINANCING REQUIREMENTS	0.70	(1.82)	(3.36)	(17.66)	(25.84)	(25.94)	(16.64)	(0.01)	0.61	1.15	1.82
FUNDS FROM LOANS & GRANTS											
Grants	-	-	-	-	-	-	-	-	-	-	-
Loan 1 - Priority Project	-	0.59	1.43	14.97	21.66	24.92	16.54	-	-	-	-
Loan 2 - KTC Project	-	0.80	3.21	2.79	3.45	-	-	-	-	-	-
Loan3	-	-	-	-	-	-	-	-	-	-	-
Outstanding Loans	-	-	-	-	-	-	-	-	-	-	-
Funds From Loans	-	1.39	4.64	17.77	25.11	24.92	16.54	-	-	-	-
CASH SURPLUS/(DEFICIT)	0.70	(0.43)	1.29	0.11	(0.72)	(1.03)	(0.09)	(0.01)	0.61	1.15	1.82
If Cash Surplus:											
(Purchase)/Sell Deposits	0.70	-	1.29	0.11	-	-	-	-	0.61	1.15	1.82
If Cash Deficit:											
Sale of Deposits	-	0.43	-	-	0.72	0.95	-	-	-	-	-
Additional Equity Needed	-	-	-	-	-	0.08	0.09	0.01	-	-	-
Total Cash Raised	-	0.43	-	-	0.72	1.03	0.09	0.01	-	-	-

Financial Study 10 - Trial Run 2
FLOW OF FUNDS STATEMENTS
USD Million

Interest NPV=4.5%: Grace period @3%, IDC 100% capitalized and Repayment 1st 10 years @3.75%, next 10 years @7.50% and last 10 years @10.405%

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
INTERNAL CASH GENERATION										
Net Income Before Interest	2.27	2.61	3.06	3.53	4.02	4.47	4.13	4.12	3.97	3.86
Add: Depreciation Expense	3.08	3.08	3.08	3.08	3.08	3.08	3.08	3.09	3.24	3.35
Operating Cash Flow	5.35	5.69	6.14	6.61	7.10	7.55	7.21	7.21	7.21	7.21
Add: Beg Cash Position	0.13	0.13	0.14	0.15	0.15	0.16	0.16	0.16	0.16	0.16
Working Cap Inc/(Dec)	(0.01)	0.01	0.01	0.01	0.01	0.01	(0.02)	-	-	-
CASH BEFORE DEBT SERVICE	5.49	5.81	6.27	6.74	7.24	7.70	7.39	7.37	7.37	7.37
DEBT SERVICE										
Interest Charges - Priority Project	3.00	2.95	2.89	2.83	2.77	2.70	2.64	2.57	2.49	2.42
Interest Charges - KTC Pipeline	0.75	0.73	0.71	0.69	0.67	0.65	0.63	0.60	0.57	0.54
Total Interest Charges	3.75	3.68	3.60	3.52	3.44	3.35	3.26	3.17	3.07	2.96
Principal Repayment - Priority Project	1.49	1.54	1.60	1.66	1.73	1.79	1.86	1.93	2.00	2.07
Principal Repayment - KTC Project	0.20	0.22	0.24	0.26	0.28	0.30	0.32	0.35	0.38	0.41
Principal Repayments	1.69	1.77	1.84	1.92	2.00	2.09	2.18	2.28	2.38	2.48
Total Debt Service	5.44	5.44	5.44	5.44	5.44	5.44	5.44	5.44	5.44	5.44
CASH BEFORE INCOME TAX	0.04	0.37	0.83	1.30	1.79	2.25	1.95	1.93	1.93	1.93
TAXES (20%)										
Income Tax	-	-	-	0.00	0.12	0.22	0.17	0.19	0.18	0.18
CASH AVAILABLE FOR INVESTMENT	0.04	0.37	0.83	1.30	1.68	2.03	1.77	1.74	1.75	1.75
CAPITAL INVESTMENT REQUIREMENTS										
Priority Project	-	-	-	-	-	-	-	0.37	4.44	3.31
Capitalized Interest - Priority Project	-	-	-	-	-	-	-	-	-	-
Total Investment - Priority Project	-	-	-	-	-	-	-	0.37	4.44	3.31
KTC Pipeline Extension	-	-	-	-	-	-	-	-	-	-
Capitalized Interest - KTC Pipeline	-	-	-	-	-	-	-	-	-	-
Total Investment - KTC Pipeline	-	-	-	-	-	-	-	-	-	-
Annual Capital Investment	-	-	-	-	-	-	-	0.37	4.44	3.31
Add: Cash Ending Balance	0.13	0.14	0.15	0.15	0.16	0.16	0.16	0.16	0.16	0.16
FINANCING REQUIREMENTS	(0.09)	0.22	0.68	1.15	1.52	1.87	1.61	1.20	(2.86)	(1.73)
FUNDS FROM LOANS & GRANTS										
Grants	-	-	-	-	-	-	-	-	-	-
Loan 1 - Priority Project	-	-	-	-	-	-	-	-	-	-
Loan 2 - KTC Project	-	-	-	-	-	-	-	-	-	-
Loan3	-	-	-	-	-	-	-	-	-	-
Outstanding Loans	-	-	-	-	-	-	-	-	-	-
Funds From Loans	-	-	-	-	-	-	-	-	-	-
CASH SURPLUS/(DEFICIT)	(0.09)	0.22	0.68	1.15	1.52	1.87	1.61	1.20	(2.86)	(1.73)
If Cash Surplus:										
(Purchase)/Sell Deposits	-	0.22	0.68	1.15	1.52	1.87	1.61	1.20	-	-
If Cash Deficit:										
Sale of Deposits	0.09	-	-	-	-	-	-	-	2.86	1.73
Additional Equity Needed	-	-	-	-	-	-	-	-	-	-
Total Cash Raised	0.09	-	-	-	-	-	-	-	2.86	1.73

Financial Study 10 - Trial Run 2
FLOW OF FUNDS STATEMENTS
USD Million

Interest NPV=4.5%: Grace period @3%, IDC 100% capitalized and Repayment 1st 10 years @3.75%, next 10 years @7.50% and last 10 years @10.405%

	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
INTERNAL CASH GENERATION										
Net Income Before Interest	3.78	3.71	3.71	3.71	3.71	3.71	3.63	3.63	3.63	3.63
Add: Depreciation Expense	3.42	3.42	3.42	3.42	3.42	3.42	3.42	3.42	3.42	3.42
Operating Cash Flow	7.21	7.13	7.13	7.13	7.13	7.13	7.06	7.06	7.06	7.06
Add: Beg Cash Position	0.16	0.16	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17
Working Cap Inc/(Dec)	-	0.00	-	-	-	-	0.00	-	-	-
CASH BEFORE DEBT SERVICE	7.37	7.30	7.30	7.30	7.30	7.30	7.22	7.23	7.23	7.23
DEBT SERVICE										
Interest Charges - Priority Project	4.68	4.57	4.46	4.33	4.20	4.05	3.90	3.73	3.55	3.36
Interest Charges - KTC Pipeline	0.51	0.47	0.44	0.40	0.35	0.30	0.25	0.20	0.14	0.07
Total Interest Charges	5.19	5.05	4.90	4.73	4.55	4.36	4.15	3.93	3.69	3.43
Principal Repayment - Priority Project	1.44	1.55	1.67	1.79	1.93	2.07	2.23	2.39	2.57	2.76
Principal Repayment - KTC Project	0.44	0.48	0.51	0.55	0.60	0.65	0.70	0.75	0.81	0.88
Principal Repayments	1.88	2.03	2.18	2.35	2.52	2.72	2.92	3.15	3.39	3.64
Total Debt Service	7.07	7.07	7.07	7.07	7.07	7.07	7.07	7.07	7.07	7.07
CASH BEFORE INCOME TAX	0.30	0.22	0.22	0.22	0.22	0.22	0.15	0.15	0.15	0.15
TAXES (20%)										
Income Tax	-	-	-	-	-	-	-	-	-	0.04
CASH AVAILABLE FOR INVESTMENT	0.30	0.22	0.22	0.22	0.22	0.22	0.15	0.15	0.15	0.11
CAPITAL INVESTMENT REQUIREMENTS										
Priority Project	2.21	-	-	-	-	-	-	-	-	-
Capitalized Interest - Priority Project	-	-	-	-	-	-	-	-	-	-
Total Investment - Priority Project	2.21	-	-	-	-	-	-	-	-	-
KTC Pipeline Extension	-	-	-	-	-	-	-	-	-	-
Capitalized Interest - KTC Pipeline	-	-	-	-	-	-	-	-	-	-
Total Investment - KTC Pipeline	-	-	-	-	-	-	-	-	-	-
Annual Capital Investment	2.21	-	-	-	-	-	-	-	-	-
Add: Cash Ending Balance	0.16	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17
FINANCING REQUIREMENTS	(2.08)	0.05	0.06	0.06	0.06	0.06	(0.02)	(0.02)	(0.02)	(0.06)
FUNDS FROM LOANS & GRANTS										
Grants	-	-	-	-	-	-	-	-	-	-
Loan 1 - Priority Project	-	-	-	-	-	-	-	-	-	-
Loan 2 - KTC Project	-	-	-	-	-	-	-	-	-	-
Loan3	-	-	-	-	-	-	-	-	-	-
Outstanding Loans	-	-	-	-	-	-	-	-	-	-
Funds From Loans	-	-	-	-	-	-	-	-	-	-
CASH SURPLUS/(DEFICIT)	(2.08)	0.05	0.06	0.06	0.06	0.06	(0.02)	(0.02)	(0.02)	(0.06)
If Cash Surplus:										
(Purchase)/Sell Deposits	-	0.05	0.06	0.06	0.06	0.06	-	-	-	-
If Cash Deficit:										
Sale of Deposits	2.08	-	-	-	-	-	0.02	0.02	0.02	0.06
Additional Equity Needed	-	-	-	-	-	-	-	-	-	-
Total Cash Raised	2.08	-	-	-	-	-	0.02	0.02	0.02	0.06

Financial Study 11 - Trial Run 2

KEY FINANCIAL INDICATORS

US$ Million

Interest NPV=4.5%: Grace period @3%, IDC 100% capitalized and Repayment 1st 10 years @3.75%, next 10 years @7.50% and last 10 years @10.405%

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
PROJECTION PARAMETERS											
Currency:	US$ Million										
Prices/Costs:	Current										
Exchange Rate:	4,165	KHR to US$									
Domestic Infaltion Rate	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Foreign Inflation Rate	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Exchange Rate (KHR to 1US$)	4,165	4,165	4,165	4,165	4,165	4,165	4,165	4,165	4,165	4,165	4,165
OPERATING RESULTS											
Operating Revenues	0.90	0.90	3.24	2.72	3.16	3.63	4.14	5.87	6.61	7.40	8.24
Operating Expenses	0.76	0.76	1.15	1.51	1.91	1.98	2.05	2.41	2.63	2.88	3.06
Net Income	0.05	0.05	1.59	0.80	0.76	0.34	0.70	(2.83)	(2.30)	(1.74)	(1.06)
Cash from Operations	0.14	0.14	2.09	1.22	1.25	1.65	2.09	3.45	3.97	4.52	5.18
Operating Ratio	85%	85%	35%	55%	61%	55%	50%	41%	40%	39%	37%
Total Assets	4.92	6.36	12.82	31.48	57.46	82.73	99.99	97.12	94.75	92.94	91.78
Working Capital	0.72	0.29	1.62	1.66	0.82	(0.15)	(0.17)	(0.08)	0.53	1.68	2.01
Working Capital (Days)	337	136	507	396	154	(27)	(30)	(11)	72	211	236
OPERATING EFFICIENCY											
Active Service Connections	4,129	4,248	13,786	16,186	18,744	21,464	24,346	27,392	30,607	33,987	37,537
Average Tariff (USD)	0.33	0.33	0.47	0.47	0.47	0.47	0.47	0.60	0.60	0.60	0.60
Average Water Monthly Bill (USD)	18.15	17.69	19.57	14.02	14.04	14.09	14.15	17.85	17.99	18.14	18.30
Percent Growth in Connections	0%	3%	225%	17%	16%	15%	13%	13%	12%	11%	10%
Water Production (m3 x 1000)	3,285	3,285	5,041	5,919	6,856	7,855	8,917	10,044	11,361	12,772	14,282
Water Sold (in 000 of m3)	2,727	2,727	4,285	5,090	5,965	6,913	7,937	9,039	10,225	11,495	12,854
Water Losses	17%	16%	15%	14%	13%	12%	11%	10%	10%	10%	10%
FINANCIAL PERFORMANCE RATIOS											
Acc. Receivable (Days)	30	30	30	30	30	30	30	30	30	30	30
Current Ratio	4.53	2.42	4.78	4.19	2.09	0.82	0.81	0.92	1.47	2.37	1.71
Debt/Equity Ratio	0.00	0.29	0.95	3.32	6.16	8.82	9.86	14.24	22.36	39.37	72.62
Debt Service Coverage						1.84	2.30	1.03	1.21	1.38	1.58
Self Financing Ratio		8.8%	41.8%	7.2%	4.9%	3.0%	7.0%				
Return on Revenues	5.7%	5.9%	49.1%	29.4%	24.0%	9.4%	16.9%	-48.2%	-34.8%	-23.5%	-12.9%
Return on Assets	1.3%	0.9%	14.8%	2.7%	1.4%	0.4%	0.7%	-2.9%	-2.5%	-1.9%	-1.2%
Return on Equity	1.1%	1.1%	25.0%	11.2%	9.6%	4.1%	7.6%	-44.9%	-57.3%	-76.4%	-88.0%
INVESTMENT PROGRAM	-	1.94	5.01	18.74	26.88	26.57	17.61	-	-	-	-
Investment Project	-	1.90	4.77	18.02	25.37	25.04	15.46	-	-	-	-
Capitalized Interest	-	0.04	0.23	0.72	1.52	1.53	2.16	-	-	-	-
FINANCING PLAN	-	1.94	5.01	18.74	26.88	26.57	17.61	-	-	-	-
Grants	-	-	-	-	-	-	-	-	-	-	-
Loan 1 - Priority Project	-	0.59	1.43	14.97	21.66	24.92	16.54	-	-	-	-
Loan 2 - KTC Project	-	0.80	3.21	2.79	3.45	-	-	-	-	-	-
Loan3	-	-	-	-	-	-	-	-	-	-	-
Outstanding Loans	-	-	-	-	-	-	-	-	-	-	-
Internally Generated Financing	-	0.55	0.36	0.97	1.77	1.65	1.07	-	-	-	-

Financial Study 11 - Trial Run 2

KEY FINANCIAL INDICATORS

Interest NPV=4.5%: Grace period @3%, IDC 100% capitalized and Repayment 1st 10 years @3.75%, next 10 years @7.50% and last 10 years @10.405%

US$ Million

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
PROJECTION PARAMETERS										
Currency:										
Prices/Costs:										
Exchange Rate:										
Domestic Infaltion Rate	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Foreign Inflation Rate	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Exchange Rate (KHR to 1US$)	4,165	4,165	4,165	4,165	4,165	4,165	4,165	4,165	4,165	4,165
OPERATING RESULTS										
Operating Revenues	8.54	9.08	9.65	10.24	10.85	11.41	11.15	11.15	11.15	11.15
Operating Expenses	3.19	3.39	3.51	3.63	3.75	3.87	3.94	3.94	3.94	3.94
Net Income	(1.48)	(1.07)	(0.54)	0.01	0.46	0.89	0.69	0.76	0.72	0.72
Cash from Operations	5.35	5.69	6.14	6.61	7.10	7.55	7.21	7.21	7.21	7.21
Operating Ratio	37%	37%	36%	35%	35%	34%	35%	35%	35%	35%
Total Assets	88.66	85.89	83.56	81.70	80.21	79.07	77.59	76.08	74.42	72.65
Working Capital	1.84	2.01	2.63	3.71	5.16	6.95	8.45	9.55	6.59	5.46
Working Capital (Days)	208	213	270	368	495	647	772	872	602	498
OPERATING EFFICIENCY										
Active Service Connections	39,327	41,159	43,032	44,948	46,903	48,913	48,913	48,913	48,913	48,913
Average Tariff (USD)	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60
Average Water Monthly Bill (USD)	18.09	18.38	18.68	18.98	19.28	19.45	18.99	18.99	18.99	18.99
Percent Growth in Connections	5%	5%	5%	4%	4%	4%	0%	0%	0%	0%
Water Production (m3 x 1000)	15,226	16,212	17,242	18,315	19,433	20,440	20,440	20,440	20,440	20,440
Water Sold (in 000 of m3)	13,704	14,591	15,518	16,484	17,490	18,396	18,396	18,396	18,396	18,396
Water Losses	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
FINANCIAL PERFORMANCE RATIOS										
Acc. Receivable (Days)	30	30	30	30	30	30	30	30	30	30
Current Ratio	1.62	1.65	1.82	2.10	2.47	2.91	3.25	3.48	2.66	2.62
Debt/Equity Ratio	-315.56	-62.70	-43.61	-42.68	-55.20	-144.89	439.25	76.98	41.80	28.34
Debt Service Coverage	1.01	1.07	1.15	1.24	1.33	1.41	1.36	1.35	1.35	1.35
Self Financing Ratio								517.5%	43.4%	58.2%
Return on Revenues	-17.3%	-11.8%	-5.6%	0.1%	4.3%	7.8%	6.2%	6.8%	6.5%	6.4%
Return on Assets	-1.8%	-1.3%	-0.7%	0.0%	0.6%	1.3%	1.1%	1.2%	1.1%	1.1%
Return on Equity	543.4%	79.7%	28.8%	-0.3%	-32.8%	-170.0%	412.5%	81.9%	43.7%	30.3%
INVESTMENT PROGRAM	-	-	-	-	-	-	-	0.4	4.4	3.3
Investment Project	-	-	-	-	-	-	-	0.4	4.4	3.3
Capitalized Interest	-	-	-	-	-	-	-	-	-	-
FINANCING PLAN	-	-	-	-	-	-	-	0.4	4.4	3.3
Grants	-	-	-	-	-	-	-	-	-	-
Loan 1 - Priority Project	-	-	-	-	-	-	-	-	-	-
Loan 2 - KTC Project	-	-	-	-	-	-	-	-	-	-
Loan3	-	-	-	-	-	-	-	-	-	-
Outstanding Loans	-	-	-	-	-	-	-	-	-	-
Internally Generated Financing	-	-	-	-	-	-	-	0.4	4.4	3.3

Financial Study 11 - Trial Run 2

KEY FINANCIAL INDICATORS

Interest NPV=4.5%: Grace period @3%, IDC 100% capitalized and Repayment 1st 10 years @3.75%, next 10 years @7.50% and last 10 years @10.405%

US$ Million

	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
PROJECTION PARAMETERS										
Currency:										
Prices/Costs:										
Exchange Rate:										
Domestic Infaltion Rate	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Foreign Inflation Rate	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Exchange Rate (KHR to 1US$)	4,165	4,165	4,165	4,165	4,165	4,165	4,165	4,165	4,165	4,165
OPERATING RESULTS										
Operating Revenues	11.15	11.15	11.15	11.15	11.15	11.15	11.15	11.15	11.15	11.15
Operating Expenses	3.94	4.02	4.02	4.02	4.02	4.02	4.09	4.09	4.09	4.09
Net Income	(1.41)	(1.34)	(1.19)	(1.02)	(0.84)	(0.65)	(0.52)	(0.29)	(0.05)	0.16
Cash from Operations	7.21	7.13	7.13	7.13	7.13	7.13	7.06	7.06	7.06	7.06
Operating Ratio	35%	36%	36%	36%	36%	36%	37%	37%	37%	37%
Total Assets	69.36	66.00	62.64	59.27	55.91	52.54	49.11	45.67	42.23	38.74
Working Capital	3.24	3.14	3.03	2.91	2.78	2.63	2.39	2.13	1.86	2.86
Working Capital (Days)	296	282	272	261	249	236	210	188	163	251
OPERATING EFFICIENCY										
Active Service Connections	48,913	48,913	48,913	48,913	48,913	48,913	48,913	48,913	48,913	48,913
Average Tariff (USD)	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60
Average Water Monthly Bill (USD)	18.99	18.99	18.99	18.99	18.99	18.99	18.99	18.99	18.99	18.99
Percent Growth in Connections	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Water Production (m3 x 1000)	20,440	20,440	20,440	20,440	20,440	20,440	20,440	20,440	20,440	20,440
Water Sold (in 000 of m3)	18,396	18,396	18,396	18,396	18,396	18,396	18,396	18,396	18,396	18,396
Water Losses	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
FINANCIAL PERFORMANCE RATIOS										
Acc. Receivable (Days)	30	30	30	30	30	30	30	30	30	30
Current Ratio	1.92	1.86	1.79	1.73	1.66	1.60	1.51	1.44	1.36	1.70
Debt/Equity Ratio	68.18	-161.19	-38.31	-22.28	-16.03	-12.77	-10.65	-9.32	-8.48	-8.23
Debt Service Coverage	1.04	1.03	1.03	1.03	1.03	1.03	1.02	1.02	1.02	1.02
Self Financing Ratio	13.4%									
Return on Revenues	-12.6%	-12.0%	-10.6%	-9.2%	-7.6%	-5.8%	-4.6%	-2.6%	-0.5%	1.5%
Return on Assets	-2.3%	-2.3%	-2.1%	-2.0%	-1.7%	-1.4%	-1.2%	-0.8%	-0.2%	0.5%
Return on Equity	-148.1%	344.6%	75.3%	39.3%	24.5%	15.9%	11.2%	6.0%	1.1%	-3.4%
INVESTMENT PROGRAM	2.2	-	-	-	-	-	-	-	-	-
Investment Project	2.2	-	-	-	-	-	-	-	-	-
Capitalized Interest	-	-	-	-	-	-	-	-	-	-
FINANCING PLAN	2.2	-	-	-	-	-	-	-	-	-
Grants	-	-	-	-	-	-	-	-	-	-
Loan 1 - Priority Project	-	-	-	-	-	-	-	-	-	-
Loan 2 - KTC Project	-	-	-	-	-	-	-	-	-	-
Loan3	-	-	-	-	-	-	-	-	-	-
Outstanding Loans	-	-	-	-	-	-	-	-	-	-
Internally Generated Financing	2.2	-	-	-	-	-	-	-	-	-

Financial Study 12 - Trial Run 2

PROFIT & LOSS STATEMENTS

US$ Million

Interest NPV=4.5%: Grace period @3%, IDC 100% capitalized and Repayment 1st 10 years @3.75%, next 10 years @7.50% and last 10 years @10.405%

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Number of Connections											
- Existing WTP	4,129	4,129	4,129	4,129	4,129	4,129	4,129	4,129	4,129	4,129	4,129
- Increment form KTC Bulk Water	99	119	9,657	12,057	14,615	17,335	20,217	20,217	20,217	20,217	20,217
- Increment from Priority Project	-	-	-	-	-	-	-	3,046	6,261	9,641	13,191
Total	4,228	4,248	13,786	16,186	18,744	21,464	24,346	27,392	30,607	33,987	37,537
Billed Water, 1000 x m3/year											
- Per existing WTP	2,727	2,727	2,176	1,888	567	1,452	2,414	2,957	2,957	2,957	2,957
- Increment due KTC project	-	-	2,110	3,202	5,398	5,460	5,522	5,585	5,585	5,585	5,585
- Increment due priority project	-	-	-	-	-	-	-	498	1,684	2,954	4,313
Total Billed Water, 1000 x m3/year	2,727	2,727	4,285	5,090	5,965	6,913	7,937	9,039	10,225	11,495	12,854
Average Tariff, USD/m3	0.33	0.33	0.47	0.47	0.47	0.47	0.47	0.60	0.60	0.60	0.60
Water Losses	17%	16%	15%	14%	13%	12%	11%	10%	10%	10%	10%
Production Capacity, 1000 x m3/year											
- Existing WTP	3,285	3,285	3,285	3,285	3,285	3,285	3,285	3,285	3,285	3,285	3,285
- KTC Bulk Water	-	-	2,482	3,723	6,205	6,205	6,205	6,205	6,205	6,205	6,205
- Priority Project WTP	-	-	-	-	-	-	-	10,950	10,950	10,950	10,950
Total Production Capacity, 1000 x m3/year	3,285	3,285	5,767	7,008	9,490	9,490	9,490	20,440	20,440	20,440	20,440
Operating Revenue											
Water Sales											
- Existing WTP	0.89	0.89	1.02	0.89	0.27	0.68	1.13	1.77	1.77	1.77	1.77
- Increment Due KTC	-	-	0.99	1.50	2.54	2.57	2.60	3.35	3.35	3.35	3.35
- Without Priority Project	0.89	0.89	2.01	2.39	2.80	3.25	3.73	5.12	5.12	5.12	5.12
- Increment Due Priority Project	-	-	-	-	-	-	-	0.30	1.01	1.77	2.59
Total Water Sales	0.89	0.89	2.01	2.39	2.80	3.25	3.73	5.42	6.13	6.90	7.71
Less: Value Added Tax	-	-	-	-	-	-	-	-	-	-	-
Net Water Sales	0.89	0.89	2.01	2.39	2.80	3.25	3.73	5.42	6.13	6.90	7.71
Penalties and Fines											
- Without Priority Project	0.01	0.01	0.02	0.02	0.03	0.03	0.04	-	-	-	-
- Increment Due Priority Project	-	-	-	-	-	-	-	0.05	0.06	0.07	0.08
Total Penalties and Fines	0.01	0.01	0.02	0.02	0.03	0.03	0.04	0.05	0.06	0.07	0.08
Connection Fees & Other Charges											
- Without Priority Project	-	0.00	1.20	0.31	0.33	0.35	0.37	-	-	-	-
- Increment Due Priority Project	-	-	-	-	-	-	-	0.39	0.41	0.43	0.45
Total Conn. Fees & Other Charges	-	0.00	1.20	0.31	0.33	0.35	0.37	0.39	0.41	0.43	0.45
Total Operating Revenue	0.90	0.90	3.24	2.72	3.16	3.63	4.14	5.87	6.61	7.40	8.24
Operating Expenses											
Bulk Water Purchases	-	-	0.51	0.76	1.27	1.27	1.27	1.34	1.341	1.341	1.341
Salaries & Wages	0.14	0.14	0.20	0.27	0.27	0.27	0.27	0.34	0.395	0.453	0.470
Power Costs	0.18	0.18	0.14	0.12	0.04	0.09	0.15	0.22	0.308	0.402	0.503
Chemical Costs	0.04	0.04	0.03	0.02	0.01	0.02	0.03	0.05	0.072	0.099	0.128
Maintenance Expense	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.25	0.281	0.309	0.338
Administrative & General Expenses	0.26	0.26	0.14	0.19	0.19	0.19	0.19	0.21	0.237	0.272	0.282
Total Operating Expenses	0.76	0.76	1.15	1.51	1.91	1.98	2.05	2.41	2.63	2.88	3.06
Income before Depreciation	0.14	0.14	2.09	1.22	1.25	1.65	2.09	3.45	3.97	4.52	5.18
Depreciation Expense	0.07	0.073	0.101	0.213	0.301	0.403	0.40	3.08	3.08	3.08	3.08
Income before Interest Charges	0.06	0.07	1.99	1.00	0.95	1.25	1.68	0.37	0.89	1.44	2.10
Interest Charges'- Priority Project	-	-	-	-	-	-	-	2.40	2.40	2.40	2.40
Interest Charges'- KTC Pipeline Project	-	-	-	-	-	0.82	0.81	0.80	0.79	0.78	0.76
Total Interest Charges	-	-	-	-	-	0.82	0.81	3.20	3.19	3.18	3.16
Income Before Taxes	0.06	0.07	1.99	1.00	0.95	0.43	0.87	(2.83)	(2.30)	(1.74)	(1.06)
Income Taxes	0.01	0.01	0.40	0.20	0.19	0.09	0.17	-	-	-	-
NET PROFIT/(LOSS)	0.05	0.05	1.59	0.80	0.76	0.34	0.70	(2.83)	(2.30)	(1.74)	(1.06)

Financial Study 12 - Trial Run 2

PROFIT & LOSS STATEMENTS

US$ Million

Interest NPV=4.5%: Grace period @3%, IDC 100% capitalized and Repayment 1st 10 years @3.75%, next 10 years @7.50% and last 10 years @10.405%

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Number of Connections										
- Existing WTP	4,129	4,129	4,129	4,129	4,129	4,129	4,129	4,129	4,129	4,129
- Increment form KTC Bulk Water	20,217	20,217	20,217	20,217	20,217	20,217	20,217	20,217	20,217	20,217
- Increment from Priority Project	14,981	16,813	18,686	20,602	22,557	24,567	24,567	24,567	24,567	24,567
Total	39,327	41,159	43,032	44,948	46,903	48,913	48,913	48,913	48,913	48,913
Billed Water, 1000 x m3/year										
- Per existing WTP	2,957	2,957	2,957	2,957	2,957	2,957	2,957	2,957	2,957	2,957
- Increment due KTC project	5,585	5,585	5,585	5,585	5,585	5,585	5,585	5,585	5,585	5,585
- Increment due priority project	5,163	6,050	6,977	7,943	8,949	9,855	9,855	9,855	9,855	9,855
Total Billed Water, 1000 x m3/year	13,704	14,591	15,518	16,484	17,490	18,396	18,396	18,396	18,396	18,396
Average Tariff, USD/m3	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60
Water Losses	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
Production Capacity, 1000 x m3/year										
- Existing WTP	3,285	3,285	3,285	3,285	3,285	3,285	3,285	3,285	3,285	3,285
- KTC Bulk Water	6,205	6,205	6,205	6,205	6,205	6,205	6,205	6,205	6,205	6,205
- Priority Project WTP	10,950	10,950	10,950	10,950	10,950	10,950	10,950	10,950	10,950	10,950
Total Production Capacity, 1000 x m3/year	20,440	20,440	20,440	20,440	20,440	20,440	20,440	20,440	20,440	20,440
Operating Revenue										
Water Sales										
- Existing WTP	1.77	1.77	1.77	1.77	1.77	1.77	1.77	1.77	1.77	1.77
- Increment Due KTC	3.35	3.35	3.35	3.35	3.35	3.35	3.35	3.35	3.35	3.35
- Without Priority Project	5.12	5.12	5.12	5.12	5.12	5.12	5.12	5.12	5.12	5.12
- Increment Due Priority Project	3.10	3.63	4.19	4.77	5.37	5.91	5.91	5.91	5.91	5.91
Total Water Sales	8.22	8.75	9.31	9.89	10.49	11.04	11.04	11.04	11.04	11.04
Less: Value Added Tax	-	-	-	-	-	-	-	-	-	-
Net Water Sales	8.22	8.75	9.31	9.89	10.49	11.04	11.04	11.04	11.04	11.04
Penalties and Fines										
- Without Priority Project	-	-	-	-	-	-	-	-	-	-
- Increment Due Priority Project	0.08	0.09	0.09	0.10	0.10	0.11	0.11	0.11	0.11	0.11
Total Penalties and Fines	0.08	0.09	0.09	0.10	0.10	0.11	0.11	0.11	0.11	0.11
Connection Fees & Other Charges										
- Without Priority Project	-	-	-	-	-	-	-	-	-	-
- Increment Due Priority Project	0.23	0.24	0.24	0.25	0.25	0.27	-	-	-	-
Total Conn. Fees & Other Charges	0.23	0.24	0.24	0.25	0.25	0.27	-	-	-	-
Total Operating Revenue	8.54	9.08	9.65	10.24	10.85	11.41	11.15	11.15	11.15	11.15
Operating Expenses										
Bulk Water Purchases	1.341	1.415	1.415	1.415	1.415	1.415	1.490	1.490	1.490	1.490
Salaries & Wages	0.481	0.491	0.491	0.491	0.491	0.491	0.491	0.491	0.491	0.491
Power Costs	0.566	0.632	0.700	0.772	0.846	0.913	0.913	0.913	0.913	0.913
Chemical Costs	0.145	0.164	0.184	0.204	0.225	0.244	0.244	0.244	0.244	0.244
Maintenance Expense	0.366	0.394	0.423	0.451	0.480	0.508	0.508	0.508	0.508	0.508
Administrative & General Expenses	0.288	0.295	0.295	0.295	0.295	0.295	0.295	0.295	0.295	0.295
Total Operating Expenses	3.19	3.39	3.51	3.63	3.75	3.867	3.94	3.94	3.94	3.94
Income before Depreciation	5.35	5.69	6.14	6.61	7.10	7.55	7.21	7.21	7.21	7.21
Depreciation Expense	3.08	3.08	3.08	3.08	3.08	3.08	3.08	3.09	3.24	3.35
Income before Interest Charges	2.27	2.61	3.06	3.53	4.02	4.47	4.13	4.12	3.97	3.86
Interest Charges'- Priority Project	3.00	2.95	2.89	2.83	2.77	2.70	2.64	2.57	2.49	2.42
Interest Charges'- KTC Pipeline Project	0.75	0.73	0.71	0.69	0.67	0.65	0.63	0.60	0.57	0.54
Total Interest Charges	3.75	3.68	3.60	3.52	3.44	3.35	3.26	3.17	3.07	2.96
Income Before Taxes	(1.48)	(1.07)	(0.54)	0.01	0.58	1.11	0.86	0.95	0.90	0.89
Income Taxes	-	-	-	0.00	0.12	0.22	0.17	0.19	0.18	0.18
NET PROFIT/(LOSS)	(1.48)	(1.07)	(0.54)	0.01	0.46	0.89	0.69	0.76	0.72	0.72

Financial Study 12 - Trial Run 2

PROFIT & LOSS STATEMENTS

US$ Million

Interest NPV=4.5%: Grace period @3%, IDC 100% capitalized and Repayment 1st 10 years @3.75%, next 10 years @7.50% and last 10 years @10.405%

	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Number of Connections										
- Existing WTP	4,129	4,129	4,129	4,129	4,129	4,129	4,129	4,129	4,129	4,129
- Increment form KTC Bulk Water	20,217	20,217	20,217	20,217	20,217	20,217	20,217	20,217	20,217	20,217
- Increment from Priority Project	24,567	24,567	24,567	24,567	24,567	24,567	24,567	24,567	24,567	24,567
Total	48,913	48,913	48,913	48,913	48,913	48,913	48,913	48,913	48,913	48,913
Billed Water, 1000 x m3/year										
- Per existing WTP	2,957	2,957	2,957	2,957	2,957	2,957	2,957	2,957	2,957	2,957
- Increment due KTC project	5,585	5,585	5,585	5,585	5,585	5,585	5,585	5,585	5,585	5,585
- Increment due priority project	9,855	9,855	9,855	9,855	9,855	9,855	9,855	9,855	9,855	9,855
Total Billed Water, 1000 x m3/year	18,396	18,396	18,396	18,396	18,396	18,396	18,396	18,396	18,396	18,396
Average Tariff, USD/m3	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60
Water Losses	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
Production Capacity, 1000 x m3/year										
- Existing WTP	3,285	3,285	3,285	3,285	3,285	3,285	3,285	3,285	3,285	3,285
- KTC Bulk Water	6,205	6,205	6,205	6,205	6,205	6,205	6,205	6,205	6,205	6,205
- Priority Project WTP	10,950	10,950	10,950	10,950	10,950	10,950	10,950	10,950	10,950	10,950
Total Production Capacity, 1000 x m3/year	20,440	20,440	20,440	20,440	20,440	20,440	20,440	20,440	20,440	20,440

	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Operating Revenue										
Water Sales										
- Existing WTP	1.77	1.77	1.77	1.77	1.77	1.77	1.77	1.77	1.77	1.77
- Increment Due KTC	3.35	3.35	3.35	3.35	3.35	3.35	3.35	3.35	3.35	3.35
- Without Priority Project	5.12	5.12	5.12	5.12	5.12	5.12	5.12	5.12	5.12	5.12
- Increment Due Priority Project	5.91	5.91	5.91	5.91	5.91	5.91	5.91	5.91	5.91	5.91
Total Water Sales	11.04	11.04	11.04	11.04	11.04	11.04	11.04	11.04	11.04	11.04
Less: Value Added Tax	-	-	-	-	-	-	-	-	-	-
Net Water Sales	11.04	11.04	11.04	11.04	11.04	11.04	11.04	11.04	11.04	11.04
Penalties and Fines										
- Without Priority Project	-	-	-	-	-	-	-	-	-	-
- Increment Due Priority Project	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11
Total Penalties and Fines	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11
Connection Fees & Other Charges										
- Without Priority Project	-	-	-	-	-	-	-	-	-	-
- Increment Due Priority Project	-	-	-	-	-	-	-	-	-	-
Total Conn. Fees & Other Charges	-	-	-	-	-	-	-	-	-	-
Total Operating Revenue	11.15	11.15	11.15	11.15	11.15	11.15	11.15	11.15	11.15	11.15
Operating Expenses										
Bulk Water Purchases	1.490	1.564	1.564	1.564	1.564	1.564	1.639	1.639	1.639	1.639
Salaries & Wages	0.491	0.491	0.491	0.491	0.491	0.491	0.491	0.491	0.491	0.491
Power Costs	0.913	0.913	0.913	0.913	0.913	0.913	0.913	0.913	0.913	0.913
Chemical Costs	0.244	0.244	0.244	0.244	0.244	0.244	0.244	0.244	0.244	0.244
Maintenance Expense	0.508	0.508	0.508	0.508	0.508	0.508	0.508	0.508	0.508	0.508
Administrative & General Expenses	0.295	0.295	0.295	0.295	0.295	0.295	0.295	0.295	0.295	0.295
Total Operating Expenses	3.94	4.02	4.02	4.02	4.02	4.02	4.09	4.09	4.09	4.09
Income before Depreciation	7.21	7.13	7.13	7.13	7.13	7.13	7.06	7.06	7.06	7.06
Depreciation Expense	3.42	3.42	3.42	3.42	3.42	3.42	3.42	3.42	3.42	3.42
Income before Interest Charges	3.78	3.71	3.71	3.71	3.71	3.71	3.63	3.63	3.63	3.63
Interest Charges'- Priority Project	4.68	4.57	4.46	4.33	4.20	4.05	3.90	3.73	3.55	3.36
Interest Charges'- KTC Pipeline Project	0.51	0.47	0.44	0.40	0.35	0.30	0.25	0.20	0.14	0.07
Total Interest Charges	5.19	5.05	4.90	4.73	4.55	4.36	4.15	3.93	3.69	3.43
Income Before Taxes	(1.41)	(1.34)	(1.19)	(1.02)	(0.84)	(0.65)	(0.52)	(0.29)	(0.05)	0.20
Income Taxes	-	-	-	-	-	-	-	-	-	0.04
NET PROFIT/(LOSS)	(1.41)	(1.34)	(1.19)	(1.02)	(0.84)	(0.65)	(0.52)	(0.29)	(0.05)	0.16

Financial Study 13 - Trial Run 3
Proposed Tariff Study 1
FLOW OF FUNDS STATEMENTS
USD Million

Interest NPV=4.5%: Grace period @3%, IDC 100% capitalized and Repayment 1st 10 years @3.75%, next 10 years @7.50% and last 10 years @10.405%

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
INTERNAL CASH GENERATION											
Net Income Before Interest	0.06	0.07	2.03	1.05	1.01	1.32	1.76	0.56	1.10	1.67	2.36
Add: Depreciation Expense	0.07	0.07	0.10	0.21	0.30	0.40	0.40	3.08	3.08	3.08	3.08
Operating Cash Flow	0.14	0.14	2.13	1.27	1.31	1.72	2.17	3.64	4.18	4.75	5.44
Add: Beg Cash Position	0.67	0.03	0.03	0.05	0.06	0.08	0.08	0.09	0.10	0.11	0.12
Working Cap Inc/(Dec)	0.06	(0.00)	0.03	(0.08)	(0.01)	(0.01)	(0.01)	0.10	0.00	0.01	0.01
CASH BEFORE DEBT SERVICE	0.74	0.17	2.13	1.40	1.38	1.81	2.26	3.62	4.28	4.86	5.55
DEBT SERVICE											
Interest Charges - Priority Project	-	-	-	-	-	-	-	2.40	2.40	2.40	2.40
Interest Charges - KTC Pipeline	-	-	-	-	-	0.82	0.81	0.80	0.79	0.78	0.76
Total Interest Charges	-	-	-	-	-	0.82	0.81	3.20	3.19	3.18	3.16
Principal Repayment - Priority Project	-	-	-	-	-	-	-	-	-	-	-
Principal Repayment - KTC Project	-	-	-	-	-	0.13	0.14	0.15	0.16	0.17	0.19
Principal Repayments	-	-	-	-	-	0.13	0.14	0.15	0.16	0.17	0.19
Total Debt Service	-	-	-	-	-	0.95	0.95	3.35	3.35	3.35	3.35
CASH BEFORE INCOME TAX	0.74	0.17	2.13	1.40	1.38	0.86	1.31	0.27	0.92	1.50	2.20
TAXES (20%)											
Income Tax	0.01	0.01	0.41	0.21	0.20	0.10	0.19	-	-	-	-
CASH AVAILABLE FOR INVESTMENT	0.73	0.16	1.73	1.19	1.17	0.76	1.12	0.27	0.92	1.50	2.20
CAPITAL INVESTMENT REQUIREMENTS											
Priority Project	-	1.04	1.42	15.40	22.29	25.04	15.46	-	-	-	-
Capitalized Interest - Priority Project	-	0.01	0.04	0.29	0.83	1.53	2.16	-	-	-	-
Total Investment - Priority Project	-	1.05	1.46	15.68	23.12	26.57	17.61	-	-	-	-
KTC Pipeline Extension	-	0.86	3.36	2.62	3.08	-	-	-	-	-	-
Capitalized Interest - KTC Pipeline	-	0.03	0.19	0.43	0.68	-	-	-	-	-	-
Total Investment - KTC Pipeline	-	0.89	3.55	3.06	3.76	-	-	-	-	-	-
Annual Capital Investment	-	1.94	5.01	18.74	26.88	26.57	17.61	-	-	-	-
Add: Cash Ending Balance	0.03	0.03	0.05	0.06	0.08	0.08	0.09	0.10	0.11	0.12	0.13
FINANCING REQUIREMENTS	0.70	(1.82)	(3.33)	(17.62)	(25.79)	(25.89)	(16.58)	0.17	0.81	1.38	2.07
FUNDS FROM LOANS & GRANTS											
Grants	-	-	-	-	-	-	-	-	-	-	-
Loan 1 - Priority Project	-	0.59	1.43	14.97	21.66	24.92	16.54	-	-	-	-
Loan 2 - KTC Project	-	0.80	3.21	2.79	3.45	-	-	-	-	-	-
Loan3	-	-	-	-	-	-	-	-	-	-	-
Outstanding Loans	-	-	-	-	-	-	-	-	-	-	-
Funds From Loans	-	1.39	4.64	17.77	25.11	24.92	16.54	-	-	-	-
CASH SURPLUS/(DEFICIT)	0.70	(0.43)	1.32	0.15	(0.68)	(0.97)	(0.03)	0.17	0.81	1.38	2.07
If Cash Surplus:											
(Purchase)/Sell Deposits	0.70	-	1.32	0.15	-	-	-	0.17	0.81	1.38	2.07
If Cash Deficit:											
Sale of Deposits	-	0.43	-	-	0.68	0.97	0.03	-	-	-	-
Additional Equity Needed	-	-	-	-	-	-	-	-	-	-	-
Total Cash Raised	-	0.43	-	-	0.68	0.97	0.03	-	-	-	-

Financial Study 13 - Trial Run 3
Proposed Tariff Study 1
FLOW OF FUNDS STATEMENTS
USD Million

Interest NPV=4.5%: Grace period @3%, IDC 100% capitalized and Repayment 1st 10 years @3.75%, next 10 years @7.50% and last 10 years @10.405%

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
INTERNAL CASH GENERATION										
Net Income Before Interest	2.55	2.90	3.37	3.86	4.37	4.84	4.50	4.49	4.34	4.23
Add: Depreciation Expense	3.08	3.08	3.08	3.08	3.08	3.08	3.08	3.09	3.24	3.35
Operating Cash Flow	5.63	5.98	6.45	6.94	7.45	7.92	7.58	7.58	7.58	7.58
Add: Beg Cash Position	0.13	0.13	0.14	0.15	0.15	0.16	0.16	0.16	0.16	0.16
Working Cap Inc/(Dec)	(0.01)	0.01	0.01	0.01	0.02	0.01	(0.02)	-	-	-
CASH BEFORE DEBT SERVICE	5.76	6.10	6.58	7.07	7.59	8.07	7.76	7.74	7.74	7.74
DEBT SERVICE										
Interest Charges - Priority Project	3.00	2.95	2.89	2.83	2.77	2.70	2.64	2.57	2.49	2.42
Interest Charges - KTC Pipeline	0.75	0.73	0.71	0.69	0.67	0.65	0.63	0.60	0.57	0.54
Total Interest Charges	3.75	3.68	3.60	3.52	3.44	3.35	3.26	3.17	3.07	2.96
Principal Repayment - Priority Project	1.49	1.54	1.60	1.66	1.73	1.79	1.86	1.93	2.00	2.07
Principal Repayment - KTC Project	0.20	0.22	0.24	0.26	0.28	0.30	0.32	0.35	0.38	0.41
Principal Repayments	1.69	1.77	1.84	1.92	2.00	2.09	2.18	2.28	2.38	2.48
Total Debt Service	5.44	5.44	5.44	5.44	5.44	5.44	5.44	5.44	5.44	5.44
CASH BEFORE INCOME TAX	0.32	0.66	1.14	1.63	2.15	2.62	2.32	2.30	2.30	2.30
TAXES (20%)										
Income Tax	-	-	-	0.07	0.19	0.30	0.25	0.26	0.25	0.25
CASH AVAILABLE FOR INVESTMENT	0.32	0.66	1.14	1.56	1.96	2.33	2.07	2.04	2.05	2.05
CAPITAL INVESTMENT REQUIREMENTS										
Priority Project	-	-	-	-	-	-	-	0.37	4.44	3.31
Capitalized Interest - Priority Project	-	-	-	-	-	-	-	-	-	-
Total Investment - Priority Project	-	-	-	-	-	-	-	0.37	4.44	3.31
KTC Pipeline Extension	-	-	-	-	-	-	-	-	-	-
Capitalized Interest - KTC Pipeline	-	-	-	-	-	-	-	-	-	-
Total Investment - KTC Pipeline	-	-	-	-	-	-	-	-	-	-
Annual Capital Investment	-	-	-	-	-	-	-	0.37	4.44	3.31
Add: Cash Ending Balance	0.13	0.14	0.15	0.15	0.16	0.16	0.16	0.16	0.16	0.16
FINANCING REQUIREMENTS	0.19	0.52	0.99	1.41	1.80	2.17	1.91	1.50	(2.56)	(1.43)
FUNDS FROM LOANS & GRANTS										
Grants	-	-	-	-	-	-	-	-	-	-
Loan 1 - Priority Project	-	-	-	-	-	-	-	-	-	-
Loan 2 - KTC Project	-	-	-	-	-	-	-	-	-	-
Loan3	-	-	-	-	-	-	-	-	-	-
Outstanding Loans	-	-	-	-	-	-	-	-	-	-
Funds From Loans	-	-	-	-	-	-	-	-	-	-
CASH SURPLUS/(DEFICIT)	0.19	0.52	0.99	1.41	1.80	2.17	1.91	1.50	(2.56)	(1.43)
If Cash Surplus:										
(Purchase)/Sell Deposits	0.19	0.52	0.99	1.41	1.80	2.17	1.91	1.50	-	-
If Cash Deficit:										
Sale of Deposits	-	-	-	-	-	-	-	-	2.56	1.43
Additional Equity Needed	-	-	-	-	-	-	-	-	-	-
Total Cash Raised	-	-	-	-	-	-	-	-	2.56	1.43

Financial Study 13 - Trial Run 3
Proposed Tariff Study 1
FLOW OF FUNDS STATEMENTS
USD Million

Interest NPV=4.5%: Grace period @3%, IDC 100% capitalized and Repayment 1st 10 years @3.75%, next 10 years @7.50% and last 10 years @10.405%

	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
INTERNAL CASH GENERATION										
Net Income Before Interest	4.15	4.08	4.08	4.08	4.08	4.08	4.01	4.01	4.01	4.01
Add: Depreciation Expense	3.42	3.42	3.42	3.42	3.42	3.42	3.42	3.42	3.42	3.42
Operating Cash Flow	7.58	7.50	7.50	7.50	7.50	7.50	7.43	7.43	7.43	7.43
Add: Beg Cash Position	0.16	0.16	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17
Working Cap Inc/(Dec)	-	0.00	-	-	-	-	0.00	-	-	-
CASH BEFORE DEBT SERVICE	7.74	7.67	7.67	7.67	7.67	7.67	7.60	7.60	7.60	7.60
DEBT SERVICE										
Interest Charges - Priority Project	4.68	4.57	4.46	4.33	4.20	4.05	3.90	3.73	3.55	3.36
Interest Charges - KTC Pipeline	0.51	0.47	0.44	0.40	0.35	0.30	0.25	0.20	0.14	0.07
Total Interest Charges	5.19	5.05	4.90	4.73	4.55	4.36	4.15	3.93	3.69	3.43
Principal Repayment - Priority Project	1.44	1.55	1.67	1.79	1.93	2.07	2.23	2.39	2.57	2.76
Principal Repayment - KTC Project	0.44	0.48	0.51	0.55	0.60	0.65	0.70	0.75	0.81	0.88
Principal Repayments	1.88	2.03	2.18	2.35	2.52	2.72	2.92	3.15	3.39	3.64
Total Debt Service	7.07	7.07	7.07	7.07	7.07	7.07	7.07	7.07	7.07	7.07
CASH BEFORE INCOME TAX	0.67	0.59	0.60	0.60	0.60	0.60	0.52	0.53	0.53	0.53
TAXES (20%)										
Income Tax	-	-	-	-	-	-	-	0.02	0.06	0.11
CASH AVAILABLE FOR INVESTMENT	0.67	0.59	0.60	0.60	0.60	0.60	0.52	0.51	0.46	0.41
CAPITAL INVESTMENT REQUIREMENTS										
Priority Project	2.21	-	-	-	-	-	-	-	-	-
Capitalized Interest - Priority Project	-	-	-	-	-	-	-	-	-	-
Total Investment - Priority Project	2.21	-	-	-	-	-	-	-	-	-
KTC Pipeline Extension	-	-	-	-	-	-	-	-	-	-
Capitalized Interest - KTC Pipeline	-	-	-	-	-	-	-	-	-	-
Total Investment - KTC Pipeline	-	-	-	-	-	-	-	-	-	-
Annual Capital Investment	2.21	-	-	-	-	-	-	-	-	-
Add: Cash Ending Balance	0.16	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17
FINANCING REQUIREMENTS	(1.70)	0.42	0.43	0.43	0.43	0.43	0.35	0.34	0.29	0.24
FUNDS FROM LOANS & GRANTS										
Grants	-	-	-	-	-	-	-	-	-	-
Loan 1 - Priority Project	-	-	-	-	-	-	-	-	-	-
Loan 2 - KTC Project	-	-	-	-	-	-	-	-	-	-
Loan3	-	-	-	-	-	-	-	-	-	-
Outstanding Loans	-	-	-	-	-	-	-	-	-	-
Funds From Loans	-	-	-	-	-	-	-	-	-	-
CASH SURPLUS/(DEFICIT)	(1.70)	0.42	0.43	0.43	0.43	0.43	0.35	0.34	0.29	0.24
If Cash Surplus:										
(Purchase)/Sell Deposits	-	0.42	0.43	0.43	0.43	0.43	0.35	0.34	0.29	0.24
If Cash Deficit:										
Sale of Deposits	1.70	-	-	-	-	-	-	-	-	-
Additional Equity Needed	-	-	-	-	-	-	-	-	-	-
Total Cash Raised	1.70	-	-	-	-	-	-	-	-	-

Financial Study 14 -Trial Run 3
Proposed Tariff Study 1
KEY FINANCIAL INDICATORS

Interest NPV=4.5%: Grace period @3%, IDC 100% capitalized and Repayment 1st 10 years @3.75%, next 10 years @7.50% and last 10 years @10.405%

USD Million

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
PROJECTION PARAMETERS											
Currency:	USD Million										
Prices/Costs:	Current										
Exchange Rate:	4,165	KHR to USD									
Domestic Infaltion Rate	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Foreign Inflation Rate	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Exchange Rate (KHR to 1US$)	4,165	4,165	4,165	4,165	4,165	4,165	4,165	4,165	4,165	4,165	4,165
OPERATING RESULTS											
Operating Revenues	0.90	0.90	3.28	2.77	3.22	3.70	4.22	6.05	6.81	7.63	8.50
Operating Expenses	0.76	0.76	1.15	1.51	1.91	1.98	2.05	2.41	2.63	2.88	3.06
Net Income	0.05	0.05	1.62	0.84	0.81	0.40	0.76	(2.65)	(2.09)	(1.50)	(0.80)
Cash from Operations	0.14	0.14	2.13	1.27	1.31	1.72	2.17	3.64	4.18	4.75	5.44
Operating Ratio	85%	85%	35%	54%	59%	53%	49%	40%	39%	38%	36%
Total Assets	4.92	6.36	12.86	31.56	57.58	82.83	100.06	97.37	95.21	93.63	92.73
Working Capital	0.72	0.29	1.65	1.73	0.94	(0.05)	(0.10)	0.17	0.98	2.37	2.95
Working Capital (Days)	337	136	518	414	177	(9)	(18)	25	135	297	347
OPERATING EFFICIENCY											
Active Service Connections	4,129	4,248	13,786	16,186	18,744	21,464	24,346	27,392	30,607	33,987	37,537
Average Tariff (USD)	0.33	0.33	0.48	0.48	0.48	0.48	0.48	0.62	0.62	0.62	0.62
Average Water Monthly Bill (USD)	18.15	17.69	19.83	14.28	14.31	14.36	14.43	18.40	18.55	18.71	18.87
Percent Growth in Connections	0%	3%	225%	17%	16%	15%	13%	13%	12%	11%	10%
Water Production (m3 x 1000)	3,285	3,285	5,041	5,919	6,856	7,855	8,917	10,044	11,361	12,772	14,282
Water Sold (in 000 of m3)	2,727	2,727	4,285	5,090	5,965	6,913	7,937	9,039	10,225	11,495	12,854
Water Losses	17%	16%	15%	14%	13%	12%	11%	10%	10%	10%	10%
FINANCIAL PERFORMANCE RATIOS											
Acc. Receivable (Days)	30	30.0	30	30	30	30	30	30	30	30	30
Current Ratio	4.53	2.42	4.86	4.34	2.25	0.94	0.89	1.17	1.88	2.93	2.04
Debt/Equity Ratio	0.00	0.29	0.94	3.29	6.07	8.72	9.78	13.70	20.09	30.24	40.74
Debt Service Coverage						1.91	2.38	1.08	1.28	1.45	1.66
Self Financing Ratio		28.4%	7.2%	5.2%	6.6%	6.2%	6.1%				
Return on Revenues	5.7%	5.9%	49.5%	30.4%	25.0%	10.7%	18.1%	-43.8%	-30.7%	-19.7%	-9.5%
Return on Assets	1.3%	0.9%	15.1%	2.9%	1.4%	0.5%	0.8%	-2.8%	-2.2%	-1.7%	-0.9%
Return on Equity	1.1%	1.1%	25.4%	11.6%	10.0%	4.7%	8.3%	-40.4%	-46.9%	-50.9%	-37.3%
INVESTMENT PROGRAM	-	1.9	5.0	18.7	26.9	26.6	17.6	-	-	-	-
Investment Project	-	1.9	4.8	18.0	25.4	25.0	15.5	-	-	-	-
Capitalized Interest	-	0.0	0.2	0.7	1.5	1.5	2.2	-	-	-	-
FINANCING PLAN	-	1.9	5.0	18.7	26.9	26.6	17.6	-	-	-	-
Grants	-	-	-	-	-	-	-	-	-	-	-
Loan 1 - Priority Project	-	0.6	1.4	15.0	21.7	24.9	16.5	-	-	-	-
Loan 2 - KTC Project	-	0.8	3.2	2.8	3.5	-	-	-	-	-	-
Loan3	-	-	-	-	-	-	-	-	-	-	-
Outstanding Loans	-	-	-	-	-	-	-	-	-	-	-
Internally Generated Financing	-	0.6	0.4	1.0	1.8	1.7	1.1	-	-	-	-

Financial Study 14 -Trial Run 3
Proposed Tariff Study 1
KEY FINANCIAL INDICATORS

Interest NPV=4.5%: Grace period @3%, IDC 100% capitalized and Repayment 1st 10 years @3.75%, next 10 years @7.50% and last 10 years @10.405%

USD Million

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
PROJECTION PARAMETERS										
Currency:										
Prices/Costs:										
Exchange Rate:										
Domestic Infaltion Rate	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Foreign Inflation Rate	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Exchange Rate (KHR to 1US$)	4,165	4,165	4,165	4,165	4,165	4,165	4,165	4,165	4,165	4,165
OPERATING RESULTS										
Operating Revenues	8.81	9.37	9.96	10.57	11.21	11.79	11.52	11.52	11.52	11.52
Operating Expenses	3.19	3.39	3.51	3.63	3.75	3.87	3.94	3.94	3.94	3.94
Net Income	(1.20)	(0.77)	(0.23)	0.27	0.75	1.19	0.99	1.06	1.02	1.01
Cash from Operations	5.63	5.98	6.45	6.94	7.45	7.92	7.58	7.58	7.58	7.58
Operating Ratio	36%	36%	35%	34%	33%	33%	34%	34%	34%	34%
Total Assets	89.88	87.40	85.39	83.79	82.59	81.75	80.57	79.35	77.99	76.52
Working Capital	3.06	3.53	4.46	5.81	7.54	9.63	11.42	12.82	10.15	9.32
Working Capital (Days)	346	374	457	576	724	897	1,043	1,171	927	852
OPERATING EFFICIENCY										
Active Service Connections	39,327	41,159	43,032	44,948	46,903	48,913	48,913	48,913	48,913	48,913
Average Tariff (USD)	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62
Average Water Monthly Bill (USD)	18.67	18.98	19.29	19.60	19.91	20.08	19.63	19.63	19.63	19.63
Percent Growth in Connections	5%	5%	5%	4%	4%	4%	0%	0%	0%	0%
Water Production (m3 x 1000)	15,226	16,212	17,242	18,315	19,433	20,440	20,440	20,440	20,440	20,440
Water Sold (in 000 of m3)	13,704	14,591	15,518	16,484	17,490	18,396	18,396	18,396	18,396	18,396
Water Losses	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
FINANCIAL PERFORMANCE RATIOS										
Acc. Receivable (Days)	30	30	30	30	30	30	30	30	30	30
Current Ratio	2.04	2.14	2.38	2.73	3.15	3.64	4.04	4.33	3.56	3.78
Debt/Equity Ratio	90.51	480.16	-1507.57	369.21	81.01	35.28	23.45	16.98	13.20	10.75
Debt Service Coverage	1.06	1.12	1.21	1.30	1.39	1.48	1.43	1.42	1.42	1.42
Self Financing Ratio								100.0%	100.0%	100.0%
Return on Revenues	-13.7%	-8.3%	-2.3%	2.6%	6.7%	10.1%	8.6%	9.2%	8.8%	8.8%
Return on Assets	-1.4%	-1.0%	-0.3%	0.4%	1.0%	1.7%	1.5%	1.7%	1.6%	1.6%
Return on Equity	-126.7%	-442.1%	421.3%	125.1%	77.5%	55.2%	31.5%	25.1%	19.5%	16.3%
INVESTMENT PROGRAM	-	-	-	-	-	-	-	0.4	4.4	3.3
Investment Project	-	-	-	-	-	-	-	0.4	4.4	3.3
Capitalized Interest	-	-	-	-	-	-	-	-	-	-
FINANCING PLAN	-	-	-	-	-	-	-	0.4	4.4	3.3
Grants	-	-	-	-	-	-	-	-	-	-
Loan 1 - Priority Project	-	-	-	-	-	-	-	-	-	-
Loan 2 - KTC Project	-	-	-	-	-	-	-	-	-	-
Loan3	-	-	-	-	-	-	-	-	-	-
Outstanding Loans	-	-	-	-	-	-	-	-	-	-
Internally Generated Financing	-	-	-	-	-	-	-	0.4	4.4	3.3

Financial Study 14 -Trial Run 3
Proposed Tariff Study 1

Interest NPV=4.5%: Grace period @3%, IDC 100% capitalized and Repayment 1st 10 years @3.75%, next 10 years @7.50% and last 10 years @10.405%

KEY FINANCIAL INDICATORS

USD Million

	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
PROJECTION PARAMETERS										
Currency:										
Prices/Costs:										
Exchange Rate:										
Domestic Infaltion Rate	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Foreign Inflation Rate	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Exchange Rate (KHR to 1US$)	4,165	4,165	4,165	4,165	4,165	4,165	4,165	4,165	4,165	4,165
OPERATING RESULTS										
Operating Revenues	11.52	11.52	11.52	11.52	11.52	11.52	11.52	11.52	11.52	11.52
Operating Expenses	3.94	4.02	4.02	4.02	4.02	4.02	4.09	4.09	4.09	4.09
Net Income	(1.04)	(0.97)	(0.82)	(0.65)	(0.47)	(0.28)	(0.15)	0.06	0.25	0.46
Cash from Operations	7.58	7.50	7.50	7.50	7.50	7.50	7.43	7.43	7.43	7.43
Operating Ratio	34%	35%	35%	35%	35%	35%	36%	36%	36%	36%
Total Assets	73.60	70.61	67.62	64.62	61.63	58.64	55.58	52.49	49.36	46.17
Working Capital	7.47	7.75	8.01	8.26	8.50	8.72	8.85	8.95	8.99	10.28
Working Capital (Days)	683	695	718	741	762	782	779	788	791	905
OPERATING EFFICIENCY										
Active Service Connections	48,913	48,913	48,913	48,913	48,913	48,913	48,913	48,913	48,913	48,913
Average Tariff (USD)	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62
Average Water Monthly Bill (USD)	19.63	19.63	19.63	19.63	19.63	19.63	19.63	19.63	19.63	19.63
Percent Growth in Connections	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Water Production (m3 x 1000)	20,440	20,440	20,440	20,440	20,440	20,440	20,440	20,440	20,440	20,440
Water Sold (in 000 of m3)	18,396	18,396	18,396	18,396	18,396	18,396	18,396	18,396	18,396	18,396
Water Losses	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
FINANCIAL PERFORMANCE RATIOS										
Acc. Receivable (Days)	30	30	30	30	30	30	30	30	30	30
Current Ratio	3.13	3.11	3.09	3.06	3.02	2.98	2.91	2.83	2.75	3.52
Debt/Equity Ratio	12.51	14.86	17.73	21.00	24.13	26.02	26.37	23.76	19.32	14.97
Debt Service Coverage	1.09	1.08	1.08	1.08	1.08	1.08	1.07	1.07	1.07	1.07
Self Financing Ratio	100.0%									
Return on Revenues	-9.0%	-8.4%	-7.1%	-5.6%	-4.1%	-2.4%	-1.3%	0.5%	2.2%	4.0%
Return on Assets	-1.7%	-1.6%	-1.5%	-1.2%	-1.0%	-0.6%	-0.3%	0.2%	0.7%	1.4%
Return on Equity	-20.0%	-23.0%	-23.9%	-23.6%	-20.6%	-13.9%	-7.8%	3.2%	11.6%	17.4%
INVESTMENT PROGRAM	2.2	-	-	-	-	-	-	-	-	-
Investment Project	2.2	-	-	-	-	-	-	-	-	-
Capitalized Interest	-	-	-	-	-	-	-	-	-	-
FINANCING PLAN	2.2	-	-	-	-	-	-	-	-	-
Grants	-	-	-	-	-	-	-	-	-	-
Loan 1 - Priority Project	-	-	-	-	-	-	-	-	-	-
Loan 2 - KTC Project	-	-	-	-	-	-	-	-	-	-
Loan3	-	-	-	-	-	-	-	-	-	-
Outstanding Loans	-	-	-	-	-	-	-	-	-	-
Internally Generated Financing	2.2	-	-	-	-	-	-	-	-	-

Financial Study 15 - Trial Run 3

Proposed Tariff Study 1

PROFIT & LOSS STATEMENTS

US$ Million

Interest NPV=4.5%: Grace period @3%, IDC 100% capitalized and Repayment 1st 10 years @3.75%, next 10 years @7.50% and last 10 years @10.405%

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Number of Connections											
- Existing WTP	4,129	4,129	4,129	4,129	4,129	4,129	4,129	4,129	4,129	4,129	4,129
- Increment form KTC Bulk Water	99	119	9,657	12,057	14,615	17,335	20,217	20,217	20,217	20,217	20,217
- Increment from Priority Project	-	-	-	-	-	-	-	3,046	6,261	9,641	13,191
Total	4,228	4,248	13,786	16,186	18,744	21,464	24,346	27,392	30,607	33,987	37,537
Billed Water, 1000 x m3/year											
- Per existing WTP	2,727	2,727	2,176	1,888	567	1,452	2,414	2,957	2,957	2,957	2,957
- Increment due KTC project	-	-	2,110	3,202	5,398	5,460	5,522	5,585	5,585	5,585	5,585
- Increment due priority project	-	-	-	-	-	-	-	498	1,684	2,954	4,313
Total Billed Water, 1000 x m3/year	2,727	2,727	4,285	5,090	5,965	6,913	7,937	9,039	10,225	11,495	12,854
Average Tariff, USD/m3	0.33	0.33	0.48	0.48	0.48	0.48	0.48	0.62	0.62	0.62	0.62
Water Losses	17%	16%	15%	14%	13%	12%	11%	10%	10%	10%	10%
Production Capacity, 1000 x m3/year											
- Existing WTP	3,285	3,285	3,285	3,285	3,285	3,285	3,285	3,285	3,285	3,285	3,285
- KTC Bulk Water	-	-	2,482	3,723	6,205	6,205	6,205	6,205	6,205	6,205	6,205
- Priority Project WTP	-	-	-	-	-	-	-	10,950	10,950	10,950	10,950
Total Production Capacity, 1000 x m3/year	3,285	3,285	5,767	7,008	9,490	9,490	9,490	20,440	20,440	20,440	20,440
Operating Revenue											
Water Sales											
- Existing WTP	0.89	0.89	1.04	0.91	0.27	0.70	1.16	1.83	1.83	1.83	1.83
- Increment Due KTC	-	-	1.01	1.54	2.59	2.62	2.65	3.46	3.46	3.46	3.46
- Without Priority Project	0.89	0.89	2.06	2.44	2.86	3.32	3.81	5.30	5.30	5.30	5.30
- Increment Due Priority Project	-	-	-	-	-	-	-	0.31	1.04	1.83	2.67
Total Water Sales	0.89	0.89	2.06	2.44	2.86	3.32	3.81	5.60	6.34	7.13	7.97
Less: Value Added Tax	-	-	-	-	-	-	-	-	-	-	-
Net Water Sales	0.89	0.89	2.06	2.44	2.86	3.32	3.81	5.60	6.34	7.13	7.97
Penalties and Fines											
- Without Priority Project	0.01	0.01	0.02	0.02	0.03	0.03	0.04	-	-	-	-
- Increment Due Priority Project	-	-	-	-	-	-	-	0.06	0.06	0.07	0.08
Total Penalties and Fines	0.01	0.01	0.02	0.02	0.03	0.03	0.04	0.06	0.06	0.07	0.08
Connection Fees & Other Charges											
- Without Priority Project	-	0.00	1.20	0.31	0.33	0.35	0.37	-	-	-	-
- Increment Due Priority Project	-	-	-	-	-	-	-	0.39	0.41	0.43	0.45
Total Conn. Fees & Other Charges	-	0.00	1.20	0.31	0.33	0.35	0.37	0.39	0.41	0.43	0.45
Total Operating Revenue	0.90	0.90	3.28	2.77	3.22	3.70	4.22	6.05	6.81	7.63	8.50
Operating Expenses											
Bulk Water Purchases	-	-	0.51	0.76	1.27	1.27	1.27	1.34	1.341	1.341	1.341
Salaries & Wages	0.14	0.14	0.20	0.27	0.27	0.27	0.27	0.34	0.395	0.453	0.470
Power Costs	0.18	0.18	0.14	0.12	0.04	0.09	0.15	0.22	0.308	0.402	0.503
Chemical Costs	0.04	0.04	0.03	0.02	0.01	0.02	0.03	0.05	0.072	0.099	0.128
Maintenance Expense	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.25	0.281	0.309	0.338
Administrative & General Expenses	0.26	0.26	0.14	0.19	0.19	0.19	0.19	0.21	0.237	0.272	0.282
Total Operating Expenses	0.76	0.76	1.15	1.51	1.91	1.98	2.05	2.41	2.63	2.88	3.06
Income before Depreciation	0.14	0.14	2.13	1.27	1.31	1.72	2.17	3.64	4.18	4.75	5.44
Depreciation Expense	0.07	0.073	0.101	0.213	0.301	0.403	0.40	3.08	3.08	3.08	3.08
Income before Interest Charges	0.06	0.07	2.03	1.05	1.01	1.32	1.76	0.56	1.10	1.67	2.36
Interest Charges'- Priority Project	-	-	-	-	-	-	-	2.40	2.40	2.40	2.40
Interest Charges'- KTC Pipeline Project	-	-	-	-	-	0.82	0.81	0.80	0.79	0.78	0.76
Total Interest Charges	-	-	-	-	-	0.82	0.81	3.20	3.19	3.18	3.16
Income Before Taxes	0.06	0.07	2.03	1.05	1.01	0.50	0.95	(2.65)	(2.09)	(1.50)	(0.80)
Income Taxes	0.01	0.01	0.41	0.21	0.20	0.10	0.19	-	-	-	-
NET PROFIT/(LOSS)	0.05	0.05	1.62	0.84	0.81	0.40	0.76	(2.65)	(2.09)	(1.50)	(0.80)

Financial Study 15 - Trial Run 3

Proposed Tariff Study 1

PROFIT & LOSS STATEMENTS

US$ Million

Interest NPV=4.5%: Grace period @3%, IDC 100% capitalized and Repayment 1st 10 years @3.75%, next 10 years @7.50% and last 10 years @10.405%

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Number of Connections										
- Existing WTP	4,129	4,129	4,129	4,129	4,129	4,129	4,129	4,129	4,129	4,129
- Increment form KTC Bulk Water	20,217	20,217	20,217	20,217	20,217	20,217	20,217	20,217	20,217	20,217
- Increment from Priority Project	14,981	16,813	18,686	20,602	22,557	24,567	24,567	24,567	24,567	24,567
Total	39,327	41,159	43,032	44,948	46,903	48,913	48,913	48,913	48,913	48,913
Billed Water, 1000 x m3/year										
- Per existing WTP	2,957	2,957	2,957	2,957	2,957	2,957	2,957	2,957	2,957	2,957
- Increment due KTC project	5,585	5,585	5,585	5,585	5,585	5,585	5,585	5,585	5,585	5,585
- Increment due priority project	5,163	6,050	6,977	7,943	8,949	9,855	9,855	9,855	9,855	9,855
Total Billed Water, 1000 x m3/year	13,704	14,591	15,518	16,484	17,490	18,396	18,396	18,396	18,396	18,396
Average Tariff, USD/m3	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62
Water Losses	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
Production Capacity, 1000 x m3/year										
- Existing WTP	3,285	3,285	3,285	3,285	3,285	3,285	3,285	3,285	3,285	3,285
- KTC Bulk Water	6,205	6,205	6,205	6,205	6,205	6,205	6,205	6,205	6,205	6,205
- Priority Project WTP	10,950	10,950	10,950	10,950	10,950	10,950	10,950	10,950	10,950	10,950
Total Production Capacity, 1000 x m3/year	20,440	20,440	20,440	20,440	20,440	20,440	20,440	20,440	20,440	20,440
Operating Revenue										
Water Sales										
- Existing WTP	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83
- Increment Due KTC	3.46	3.46	3.46	3.46	3.46	3.46	3.46	3.46	3.46	3.46
- Without Priority Project	5.30	5.30	5.30	5.30	5.30	5.30	5.30	5.30	5.30	5.30
- Increment Due Priority Project	3.20	3.75	4.33	4.92	5.55	6.11	6.11	6.11	6.11	6.11
Total Water Sales	8.50	9.05	9.62	10.22	10.84	11.41	11.41	11.41	11.41	11.41
Less: Value Added Tax	-	-	-	-	-	-	-	-	-	-
Net Water Sales	8.50	9.05	9.62	10.22	10.84	11.41	11.41	11.41	11.41	11.41
Penalties and Fines										
- Without Priority Project	-	-	-	-	-	-	-	-	-	-
- Increment Due Priority Project	0.08	0.09	0.10	0.10	0.11	0.11	0.11	0.11	0.11	0.11
Total Penalties and Fines	0.08	0.09	0.10	0.10	0.11	0.11	0.11	0.11	0.11	0.11
Connection Fees & Other Charges										
- Without Priority Project	-	-	-	-	-	-	-	-	-	-
- Increment Due Priority Project	0.23	0.24	0.24	0.25	0.25	0.27	-	-	-	-
Total Conn. Fees & Other Charges	0.23	0.24	0.24	0.25	0.25	0.27	-	-	-	-
Total Operating Revenue	8.81	9.37	9.96	10.57	11.21	11.79	11.52	11.52	11.52	11.52
Operating Expenses										
Bulk Water Purchases	1.341	1.415	1.415	1.415	1.415	1.415	1.490	1.490	1.490	1.490
Salaries & Wages	0.481	0.491	0.491	0.491	0.491	0.491	0.491	0.491	0.491	0.491
Power Costs	0.566	0.632	0.700	0.772	0.846	0.913	0.913	0.913	0.913	0.913
Chemical Costs	0.145	0.164	0.184	0.204	0.225	0.244	0.244	0.244	0.244	0.244
Maintenance Expense	0.366	0.394	0.423	0.451	0.480	0.508	0.508	0.508	0.508	0.508
Administrative & General Expenses	0.288	0.295	0.295	0.295	0.295	0.295	0.295	0.295	0.295	0.295
Total Operating Expenses	3.19	3.39	3.51	3.63	3.75	3.867	3.94	3.94	3.94	3.94
Income before Depreciation	5.63	5.98	6.45	6.94	7.45	7.92	7.58	7.58	7.58	7.58
Depreciation Expense	3.08	3.08	3.08	3.08	3.08	3.08	3.08	3.09	3.24	3.35
Income before Interest Charges	2.55	2.90	3.37	3.86	4.37	4.84	4.50	4.49	4.34	4.23
Interest Charges'- Priority Project	3.00	2.95	2.89	2.83	2.77	2.70	2.64	2.57	2.49	2.42
Interest Charges'- KTC Pipeline Project	0.75	0.73	0.71	0.69	0.67	0.65	0.63	0.60	0.57	0.54
Total Interest Charges	3.75	3.68	3.60	3.52	3.44	3.35	3.26	3.17	3.07	2.96
Income Before Taxes	(1.20)	(0.77)	(0.23)	0.34	0.93	1.49	1.24	1.32	1.27	1.27
Income Taxes	-	-	-	0.07	0.19	0.30	0.25	0.26	0.25	0.25
NET PROFIT/(LOSS)	(1.20)	(0.77)	(0.23)	0.27	0.75	1.19	0.99	1.06	1.02	1.01

Financial Study 15 - Trial Run 3
Proposed Tariff Study 1

Interest NPV=4.5%: Grace period @3%, IDC 100% capitalized and Repayment 1st 10 years @3.75%, next 10 years @7.50% and last 10 years @10.405%

PROFIT & LOSS STATEMENTS

US$ Million

	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Number of Connections										
- Existing WTP	4,129	4,129	4,129	4,129	4,129	4,129	4,129	4,129	4,129	4,129
- Increment form KTC Bulk Water	20,217	20,217	20,217	20,217	20,217	20,217	20,217	20,217	20,217	20,217
- Increment from Priority Project	24,567	24,567	24,567	24,567	24,567	24,567	24,567	24,567	24,567	24,567
Total	48,913	48,913	48,913	48,913	48,913	48,913	48,913	48,913	48,913	48,913
Billed Water, 1000 x m3/year										
- Per existing WTP	2,957	2,957	2,957	2,957	2,957	2,957	2,957	2,957	2,957	2,957
- Increment due KTC project	5,585	5,585	5,585	5,585	5,585	5,585	5,585	5,585	5,585	5,585
- Increment due priority project	9,855	9,855	9,855	9,855	9,855	9,855	9,855	9,855	9,855	9,855
Total Billed Water, 1000 x m3/year	18,396	18,396	18,396	18,396	18,396	18,396	18,396	18,396	18,396	18,396
Average Tariff, USD/m3	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62
Water Losses	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
Production Capacity, 1000 x m3/year										
- Existing WTP	3,285	3,285	3,285	3,285	3,285	3,285	3,285	3,285	3,285	3,285
- KTC Bulk Water	6,205	6,205	6,205	6,205	6,205	6,205	6,205	6,205	6,205	6,205
- Priority Project WTP	10,950	10,950	10,950	10,950	10,950	10,950	10,950	10,950	10,950	10,950
Total Production Capacity, 1000 x m3/year	20,440	20,440	20,440	20,440	20,440	20,440	20,440	20,440	20,440	20,440
Operating Revenue										
Water Sales										
- Existing WTP	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83
- Increment Due KTC	3.46	3.46	3.46	3.46	3.46	3.46	3.46	3.46	3.46	3.46
- Without Priority Project	5.30	5.30	5.30	5.30	5.30	5.30	5.30	5.30	5.30	5.30
- Increment Due Priority Project	6.11	6.11	6.11	6.11	6.11	6.11	6.11	6.11	6.11	6.11
Total Water Sales	11.41	11.41	11.41	11.41	11.41	11.41	11.41	11.41	11.41	11.41
Less: Value Added Tax	-	-	-	-	-	-	-	-	-	-
Net Water Sales	11.41	11.41	11.41	11.41	11.41	11.41	11.41	11.41	11.41	11.41
Penalties and Fines										
- Without Priority Project	-	-	-	-	-	-	-	-	-	-
- Increment Due Priority Project	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11
Total Penalties and Fines	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11
Connection Fees & Other Charges										
- Without Priority Project	-	-	-	-	-	-	-	-	-	-
- Increment Due Priority Project	-	-	-	-	-	-	-	-	-	-
Total Conn. Fees & Other Charges	-	-	-	-	-	-	-	-	-	-
Total Operating Revenue	11.52	11.52	11.52	11.52	11.52	11.52	11.52	11.52	11.52	11.52
Operating Expenses										
Bulk Water Purchases	1.490	1.564	1.564	1.564	1.564	1.564	1.639	1.639	1.639	1.639
Salaries & Wages	0.491	0.491	0.491	0.491	0.491	0.491	0.491	0.491	0.491	0.491
Power Costs	0.913	0.913	0.913	0.913	0.913	0.913	0.913	0.913	0.913	0.913
Chemical Costs	0.244	0.244	0.244	0.244	0.244	0.244	0.244	0.244	0.244	0.244
Maintenance Expense	0.508	0.508	0.508	0.508	0.508	0.508	0.508	0.508	0.508	0.508
Administrative & General Expenses	0.295	0.295	0.295	0.295	0.295	0.295	0.295	0.295	0.295	0.295
Total Operating Expenses	3.94	4.02	4.02	4.02	4.02	4.02	4.09	4.09	4.09	4.09
Income before Depreciation	7.58	7.50	7.50	7.50	7.50	7.50	7.43	7.43	7.43	7.43
Depreciation Expense	3.42	3.42	3.42	3.42	3.42	3.42	3.42	3.42	3.42	3.42
Income before Interest Charges	4.15	4.08	4.08	4.08	4.08	4.08	4.01	4.01	4.01	4.01
Interest Charges'- Priority Project	4.68	4.57	4.46	4.33	4.20	4.05	3.90	3.73	3.55	3.36
Interest Charges'- KTC Pipeline Project	0.51	0.47	0.44	0.40	0.35	0.30	0.25	0.20	0.14	0.07
Total Interest Charges	5.19	5.05	4.90	4.73	4.55	4.36	4.15	3.93	3.69	3.43
Income Before Taxes	(1.04)	(0.97)	(0.82)	(0.65)	(0.47)	(0.28)	(0.15)	0.08	0.32	0.57
Income Taxes	-	-	-	-	-	-	-	0.02	0.06	0.11
NET PROFIT/(LOSS)	(1.04)	(0.97)	(0.82)	(0.65)	(0.47)	(0.28)	(0.15)	0.06	0.25	0.46

Financial Study 16 - Trial Run 4
Proposed Tariff Study 2
FLOW OF FUNDS STATEMENTS
US$ Million

Interest NPV=4.5%: Grace period @3%, IDC 100% capitalized and Repayment 1st 10 years @3.75%, next 10 years @7.50% and last 10 years @10.405%

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
INTERNAL CASH GENERATION											
Net Income Before Interest	0.06	0.07	2.03	1.05	1.01	1.32	1.76	0.47	1.00	1.56	2.23
Add: Depreciation Expense	0.07	0.07	0.10	0.21	0.30	0.40	0.40	3.08	3.08	3.08	3.08
Operating Cash Flow	0.14	0.14	2.13	1.27	1.31	1.72	2.17	3.54	4.08	4.64	5.31
Add: Beg Cash Position	0.67	0.03	0.03	0.05	0.06	0.08	0.08	0.09	0.10	0.11	0.12
Working Cap Inc/(Dec)	0.06	(0.00)	0.03	(0.08)	(0.01)	(0.01)	(0.01)	0.09	0.00	0.01	0.01
CASH BEFORE DEBT SERVICE	0.74	0.17	2.13	1.40	1.38	1.81	2.26	3.54	4.17	4.74	5.42
DEBT SERVICE											
Interest Charges - Priority Project	-	-	-	-	-	-	-	2.40	2.40	2.40	2.40
Interest Charges - KTC Pipeline	-	-	-	-	-	0.82	0.81	0.80	0.79	0.78	0.76
Total Interest Charges	-	-	-	-	-	0.82	0.81	3.20	3.19	3.18	3.16
Principal Repayment - Priority Project	-	-	-	-	-	-	-	-	-	-	-
Principal Repayment - KTC Project	-	-	-	-	-	0.13	0.14	0.15	0.16	0.17	0.19
Principal Repayments	-	-	-	-	-	0.13	0.14	0.15	0.16	0.17	0.19
Total Debt Service	-	-	-	-	-	0.95	0.95	3.35	3.35	3.35	3.35
CASH BEFORE INCOME TAX	0.74	0.17	2.13	1.40	1.38	0.86	1.31	0.18	0.82	1.39	2.07
TAXES (20%)											
Income Tax	0.01	0.01	0.41	0.21	0.20	0.10	0.19	-	-	-	-
CASH AVAILABLE FOR INVESTMENT	0.73	0.16	1.73	1.19	1.17	0.76	1.12	0.18	0.82	1.39	2.07
CAPITAL INVESTMENT REQUIREMENTS											
Priority Project	-	1.04	1.42	15.40	22.29	25.04	15.46	-	-	-	-
Capitalized Interest - Priority Project	-	0.01	0.04	0.29	0.83	1.53	2.16	-	-	-	-
Total Investment - Priority Project	-	1.05	1.46	15.68	23.12	26.57	17.61	-	-	-	-
KTC Pipeline Extension	-	0.86	3.36	2.62	3.08	-	-	-	-	-	-
Capitalized Interest - KTC Pipeline	-	0.03	0.19	0.43	0.68	-	-	-	-	-	-
Total Investment - KTC Pipeline	-	0.89	3.55	3.06	3.76	-	-	-	-	-	-
Annual Capital Investment	-	1.94	5.01	18.74	26.88	26.57	17.61	-	-	-	-
Add: Cash Ending Balance	0.03	0.03	0.05	0.06	0.08	0.08	0.09	0.10	0.11	0.12	0.13
FINANCING REQUIREMENTS	0.70	(1.82)	(3.33)	(17.62)	(25.79)	(25.89)	(16.58)	0.08	0.71	1.27	1.94
FUNDS FROM LOANS & GRANTS											
Grants	-	-	-	-	-	-	-	-	-	-	-
Loan 1 - Priority Project	-	0.59	1.43	14.97	21.66	24.92	16.54	-	-	-	-
Loan 2 - KTC Project	-	0.80	3.21	2.79	3.45	-	-	-	-	-	-
Loan3	-	-	-	-	-	-	-	-	-	-	-
Outstanding Loans	-	-	-	-	-	-	-	-	-	-	-
Funds From Loans	-	1.39	4.64	17.77	25.11	24.92	16.54	-	-	-	-
CASH SURPLUS/(DEFICIT)	0.70	(0.43)	1.32	0.15	(0.68)	(0.97)	(0.03)	0.08	0.71	1.27	1.94
If Cash Surplus:											
(Purchase)/Sell Deposits	0.70	-	1.32	0.15	-	-	-	0.08	0.71	1.27	1.94
If Cash Deficit:											
Sale of Deposits	-	0.43	-	-	0.68	0.97	0.03	-	-	-	-
Additional Equity Needed	-	-	-	-	-	-	-	-	-	-	-
Total Cash Raised	-	0.43	-	-	0.68	0.97	0.03	-	-	-	-

Financial Study 16 - Trial Run 4

Interest NPV=4.5%: Grace period @3%, IDC 100% capitalized and Repayment 1st 10 years @3.75%, next 10 years @7.50% and last 10 years @10.405%

Proposed Tariff Study 2

FLOW OF FUNDS STATEMENTS

US$ Million

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
INTERNAL CASH GENERATION										
Net Income Before Interest	2.41	3.05	3.53	4.03	4.55	5.02	4.68	4.67	4.52	4.41
Add: Depreciation Expense	3.08	3.08	3.08	3.08	3.08	3.08	3.08	3.09	3.24	3.35
Operating Cash Flow	5.49	6.13	6.61	7.11	7.63	8.10	7.76	7.76	7.76	7.76
Add: Beg Cash Position	0.13	0.13	0.14	0.15	0.15	0.16	0.16	0.16	0.16	0.16
Working Cap Inc/(Dec)	(0.01)	0.04	0.01	0.01	0.02	0.01	(0.02)	-	-	-
CASH BEFORE DEBT SERVICE	5.62	6.23	6.74	7.24	7.77	8.25	7.95	7.93	7.93	7.93
DEBT SERVICE										
Interest Charges - Priority Project	3.00	2.95	2.89	2.83	2.77	2.70	2.64	2.57	2.49	2.42
Interest Charges - KTC Pipeline	0.75	0.73	0.71	0.69	0.67	0.65	0.63	0.60	0.57	0.54
Total Interest Charges	3.75	3.68	3.60	3.52	3.44	3.35	3.26	3.17	3.07	2.96
Principal Repayment - Priority Project	1.49	1.54	1.60	1.66	1.73	1.79	1.86	1.93	2.00	2.07
Principal Repayment - KTC Project	0.20	0.22	0.24	0.26	0.28	0.30	0.32	0.35	0.38	0.41
Principal Repayments	1.69	1.77	1.84	1.92	2.00	2.09	2.18	2.28	2.38	2.48
Total Debt Service	5.44	5.44	5.44	5.44	5.44	5.44	5.44	5.44	5.44	5.44
CASH BEFORE INCOME TAX	0.18	0.78	1.29	1.80	2.32	2.81	2.50	2.49	2.49	2.49
TAXES (20%)										
Income Tax	-	-	-	0.10	0.22	0.33	0.28	0.30	0.29	0.29
CASH AVAILABLE FOR INVESTMENT	0.18	0.78	1.29	1.70	2.10	2.47	2.22	2.18	2.19	2.19
CAPITAL INVESTMENT REQUIREMENTS										
Priority Project	-	-	-	-	-	-	-	0.37	4.44	3.31
Capitalized Interest - Priority Project	-	-	-	-	-	-	-	-	-	-
Total Investment - Priority Project	-	-	-	-	-	-	-	0.37	4.44	3.31
KTC Pipeline Extension	-	-	-	-	-	-	-	-	-	-
Capitalized Interest - KTC Pipeline	-	-	-	-	-	-	-	-	-	-
Total Investment - KTC Pipeline	-	-	-	-	-	-	-	-	-	-
Annual Capital Investment	-	-	-	-	-	-	-	0.37	4.44	3.31
Add: Cash Ending Balance	0.13	0.14	0.15	0.15	0.16	0.16	0.16	0.16	0.16	0.16
FINANCING REQUIREMENTS	0.05	0.64	1.15	1.54	1.94	2.31	2.05	1.65	(2.41)	(1.28)
FUNDS FROM LOANS & GRANTS										
Grants	-	-	-	-	-	-	-	-	-	-
Loan 1 - Priority Project	-	-	-	-	-	-	-	-	-	-
Loan 2 - KTC Project	-	-	-	-	-	-	-	-	-	-
Loan3	-	-	-	-	-	-	-	-	-	-
Outstanding Loans	-	-	-	-	-	-	-	-	-	-
Funds From Loans	-	-	-	-	-	-	-	-	-	-
CASH SURPLUS/(DEFICIT)	0.05	0.64	1.15	1.54	1.94	2.31	2.05	1.65	(2.41)	(1.28)
If Cash Surplus:										
(Purchase)/Sell Deposits	0.05	0.64	1.15	1.54	1.94	2.31	2.05	1.65	-	-
If Cash Deficit:										
Sale of Deposits	-	-	-	-	-	-	-	-	2.41	1.28
Additional Equity Needed	-	-	-	-	-	-	-	-	-	-
Total Cash Raised	-	-	-	-	-	-	-	-	2.41	1.28

Financial Study 16 - Trial Run 4

Proposed Tariff Study 2

FLOW OF FUNDS STATEMENTS

US$ Million

Interest NPV=4.5%: Grace period @3%, IDC 100% capitalized and Repayment 1st 10 years @3.75%, next 10 years @7.50% and last 10 years @10.405%

	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
INTERNAL CASH GENERATION										
Net Income Before Interest	4.34	4.27	4.27	4.27	4.27	4.27	4.19	4.19	4.19	4.19
Add: Depreciation Expense	3.42	3.42	3.42	3.42	3.42	3.42	3.42	3.42	3.42	3.42
Operating Cash Flow	7.76	7.69	7.69	7.69	7.69	7.69	7.62	7.62	7.62	7.62
Add: Beg Cash Position	0.16	0.16	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17
Working Cap Inc/(Dec)	-	0.00	-	-	-	-	0.00	-	-	-
CASH BEFORE DEBT SERVICE	7.93	7.85	7.86	7.86	7.86	7.86	7.78	7.79	7.79	7.79
DEBT SERVICE										
Interest Charges - Priority Project	4.68	4.57	4.46	4.33	4.20	4.05	3.90	3.73	3.55	3.36
Interest Charges - KTC Pipeline	0.51	0.47	0.44	0.40	0.35	0.30	0.25	0.20	0.14	0.07
Total Interest Charges	5.19	5.05	4.90	4.73	4.55	4.36	4.15	3.93	3.69	3.43
Principal Repayment - Priority Project	1.44	1.55	1.67	1.79	1.93	2.07	2.23	2.39	2.57	2.76
Principal Repayment - KTC Project	0.44	0.48	0.51	0.55	0.60	0.65	0.70	0.75	0.81	0.88
Principal Repayments	1.88	2.03	2.18	2.35	2.52	2.72	2.92	3.15	3.39	3.64
Total Debt Service	7.07	7.07	7.07	7.07	7.07	7.07	7.07	7.07	7.07	7.07
CASH BEFORE INCOME TAX	0.85	0.78	0.78	0.78	0.78	0.78	0.71	0.71	0.71	0.71
TAXES (20%)										
Income Tax	-	-	-	-	-	-	0.01	0.05	0.10	0.15
CASH AVAILABLE FOR INVESTMENT	0.85	0.78	0.78	0.78	0.78	0.78	0.70	0.66	0.61	0.56
CAPITAL INVESTMENT REQUIREMENTS										
Priority Project	2.21	-	-	-	-	-	-	-	-	-
Capitalized Interest - Priority Project	-	-	-	-	-	-	-	-	-	-
Total Investment - Priority Project	2.21	-	-	-	-	-	-	-	-	-
KTC Pipeline Extension	-	-	-	-	-	-	-	-	-	-
Capitalized Interest - KTC Pipeline	-	-	-	-	-	-	-	-	-	-
Total Investment - KTC Pipeline	-	-	-	-	-	-	-	-	-	-
Annual Capital Investment	2.21	-	-	-	-	-	-	-	-	-
Add: Cash Ending Balance	0.16	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17
FINANCING REQUIREMENTS	(1.52)	0.61	0.62	0.62	0.62	0.62	0.53	0.49	0.44	0.39
FUNDS FROM LOANS & GRANTS										
Grants	-	-	-	-	-	-	-	-	-	-
Loan 1 - Priority Project	-	-	-	-	-	-	-	-	-	-
Loan 2 - KTC Project	-	-	-	-	-	-	-	-	-	-
Loan3	-	-	-	-	-	-	-	-	-	-
Outstanding Loans	-	-	-	-	-	-	-	-	-	-
Funds From Loans	-	-	-	-	-	-	-	-	-	-
CASH SURPLUS/(DEFICIT)	(1.52)	0.61	0.62	0.62	0.62	0.62	0.53	0.49	0.44	0.39
If Cash Surplus:										
(Purchase)/Sell Deposits	-	0.61	0.62	0.62	0.62	0.62	0.53	0.49	0.44	0.39
If Cash Deficit:										
Sale of Deposits	1.52	-	-	-	-	-	-	-	-	-
Additional Equity Needed	-	-	-	-	-	-	-	-	-	-
Total Cash Raised	1.52	-	-	-	-	-	-	-	-	-

Financial Study 17 - Trial Run 4
Proposed Tariff Study 2
KEY FINANCIAL INDICATORS

Interest NPV=4.5%: Grace period @3%, IDC 100% capitalized and Repayment 1st 10 years @3.75%, next 10 years @7.50% and last 10 years @10.405%

US$ Million

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
PROJECTION PARAMETERS											
Currency:	US$ Million										
Prices/Costs:	Current										
Exchange Rate:	4,165	KHR to USD									
Domestic Infaltion Rate	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Foreign Inflation Rate	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Exchange Rate (KHR to 1US$)	4,165	4,165	4,165	4,165	4,165	4,165	4,165	4,165	4,165	4,165	4,165
OPERATING RESULTS											
Operating Revenues	0.90	0.90	3.28	2.77	3.22	3.70	4.22	5.96	6.71	7.51	8.37
Operating Expenses	0.76	0.76	1.15	1.51	1.91	1.98	2.05	2.41	2.63	2.88	3.06
Net Income	0.05	0.05	1.62	0.84	0.81	0.40	0.76	(2.74)	(2.19)	(1.62)	(0.93)
Cash from Operations	0.14	0.14	2.13	1.27	1.31	1.72	2.17	3.54	4.08	4.64	5.31
Operating Ratio	85%	85%	35%	54%	59%	53%	49%	40%	39%	38%	37%
Total Assets	4.92	6.36	12.86	31.56	57.58	82.83	100.06	97.28	95.01	93.32	92.29
Working Capital	0.72	0.29	1.65	1.73	0.94	(0.05)	(0.10)	0.08	0.79	2.06	2.51
Working Capital (Days)	337	136	518	414	177	(9)	(18)	12	108	258	295
OPERATING EFFICIENCY											
Active Service Connections	4,129	4,248	13,786	16,186	18,744	21,464	24,346	27,392	30,607	33,987	37,537
Average Tariff (USD)	0.33	0.33	0.48	0.48	0.48	0.48	0.48	0.61	0.61	0.61	0.61
Average Water Monthly Bill (USD)	18.15	17.69	19.83	14.28	14.31	14.36	14.43	18.12	18.27	18.42	18.59
Percent Growth in Connections	0%	3%	225%	17%	16%	15%	13%	13%	12%	11%	10%
Water Production (m3 x 1000)	3,285	3,285	5,041	5,919	6,856	7,855	8,917	10,044	11,361	12,772	14,282
Water Sold (in 000 of m3)	2,727	2,727	4,285	5,090	5,965	6,913	7,937	9,039	10,225	11,495	12,854
Water Losses	17%	16%	15%	14%	13%	12%	11%	10%	10%	10%	10%
FINANCIAL PERFORMANCE RATIOS											
Acc. Receivable (Days)	30	30	30	30	30	30	30	30	30	30	30
Current Ratio	4.53	2.42	4.86	4.34	2.25	0.94	0.89	1.08	1.71	2.67	1.89
Debt/Equity Ratio	0.00	0.29	0.94	3.29	6.07	8.72	9.78	13.90	21.00	33.79	51.21
Debt Service Coverage						1.91	2.38	1.06	1.24	1.41	1.62
Self Financing Ratio		28.4%	7.2%	5.2%	6.6%	6.2%	6.1%				
Return on Revenues	5.7%	5.9%	49.5%	30.4%	25.0%	10.7%	18.1%	-46.0%	-32.7%	-21.6%	-11.1%
Return on Assets	1.3%	0.9%	15.1%	2.9%	1.4%	0.5%	0.8%	-2.8%	-2.4%	-1.8%	-1.1%
Return on Equity	1.1%	1.1%	25.4%	11.6%	10.0%	4.7%	8.3%	-42.4%	-51.4%	-61.2%	-54.5%
INVESTMENT PROGRAM	-	1.9	5.0	18.7	26.9	26.6	17.6	-	-	-	-
Investment Project	-	1.9	4.8	18.0	25.4	25.0	15.5	-	-	-	-
Capitalized Interest	-	0.0	0.2	0.7	1.5	1.5	2.2	-	-	-	-
FINANCING PLAN	-	1.9	5.0	18.7	26.9	26.6	17.6	-	-	-	-
Grants	-	-	-	-	-	-	-	-	-	-	-
Loan 1 - Priority Project	-	0.6	1.4	15.0	21.7	24.9	16.5	-	-	-	-
Loan 2 - KTC Project	-	0.8	3.2	2.8	3.5	-	-	-	-	-	-
Loan3	-	-	-	-	-	-	-	-	-	-	-
Outstanding Loans	-	-	-	-	-	-	-	-	-	-	-
Internally Generated Financing	-	0.6	0.4	1.0	1.8	1.7	1.1	-	-	-	-

Financial Study 17 - Trial Run 4
Proposed Tariff Study 2
KEY FINANCIAL INDICATORS
US$ Million

Interest NPV=4.5%: Grace period @3%, IDC 100% capitalized and Repayment 1st 10 years @3.75%, next 10 years @7.50% and last 10 years @10.405%

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
PROJECTION PARAMETERS										
Currency:										
Prices/Costs:										
Exchange Rate:										
Domestic Infaltion Rate	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Foreign Inflation Rate	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Exchange Rate (KHR to 1US$)	4,165	4,165	4,165	4,165	4,165	4,165	4,165	4,165	4,165	4,165
OPERATING RESULTS										
Operating Revenues	8.67	9.52	10.12	10.74	11.38	11.97	11.71	11.71	11.71	11.71
Operating Expenses	3.19	3.39	3.51	3.63	3.75	3.87	3.94	3.94	3.94	3.94
Net Income	(1.34)	(0.63)	(0.07)	0.40	0.89	1.34	1.14	1.20	1.17	1.16
Cash from Operations	5.49	6.13	6.61	7.11	7.63	8.10	7.76	7.76	7.76	7.76
Operating Ratio	37%	36%	35%	34%	33%	32%	34%	34%	34%	34%
Total Assets	89.30	86.97	85.11	83.65	82.59	81.90	80.86	79.79	78.58	77.26
Working Capital	2.48	3.10	4.18	5.66	7.54	9.78	11.72	13.27	10.75	10.07
Working Capital (Days)	281	329	429	562	724	910	1,071	1,212	982	919
OPERATING EFFICIENCY										
Active Service Connections	39,327	41,159	43,032	44,948	46,903	48,913	48,913	48,913	48,913	48,913
Average Tariff (USD)	0.61	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63
Average Water Monthly Bill (USD)	18.38	19.28	19.59	19.91	20.22	20.39	19.94	19.94	19.94	19.94
Percent Growth in Connections	5%	5%	5%	4%	4%	4%	0%	0%	0%	0%
Water Production (m3 x 1000)	15,226	16,212	17,242	18,315	19,433	20,440	20,440	20,440	20,440	20,440
Water Sold (in 000 of m3)	13,704	14,591	15,518	16,484	17,490	18,396	18,396	18,396	18,396	18,396
Water Losses	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
FINANCIAL PERFORMANCE RATIOS										
Acc. Receivable (Days)	30	30	30	30	30	30	30	30	30	30
Current Ratio	1.84	2.00	2.30	2.69	3.15	3.68	4.12	4.44	3.71	4.00
Debt/Equity Ratio	231.71	-328.31	-249.66	1060.10	81.04	33.01	21.42	15.35	11.85	9.60
Debt Service Coverage	1.03	1.14	1.24	1.33	1.43	1.52	1.46	1.46	1.46	1.46
Self Financing Ratio								667.1%	100.0%	100.0%
Return on Revenues	-15.5%	-6.6%	-0.7%	3.8%	7.8%	11.2%	9.7%	10.3%	10.0%	9.9%
Return on Assets	-1.6%	-0.8%	-0.1%	0.5%	1.2%	2.0%	1.7%	1.9%	1.8%	1.8%
Return on Equity	-361.8%	244.8%	22.2%	535.2%	92.2%	58.1%	33.1%	25.9%	20.1%	16.7%
INVESTMENT PROGRAM	-	-	-	-	-	-	-	0.4	4.4	3.3
Investment Project	-	-	-	-	-	-	-	0.4	4.4	3.3
Capitalized Interest	-	-	-	-	-	-	-	-	-	-
FINANCING PLAN	-	-	-	-	-	-	-	0.4	4.4	3.3
Grants	-	-	-	-	-	-	-	-	-	-
Loan 1 - Priority Project	-	-	-	-	-	-	-	-	-	-
Loan 2 - KTC Project	-	-	-	-	-	-	-	-	-	-
Loan3	-	-	-	-	-	-	-	-	-	-
Outstanding Loans	-	-	-	-	-	-	-	-	-	-
Internally Generated Financing	-	-	-	-	-	-	-	0.4	4.4	3.3

Financial Study 17 - Trial Run 4

Proposed Tariff Study 2

Interest NPV=4.5%: Grace period @3%, IDC 100% capitalized and Repayment 1st 10 years @3.75%, next 10 years @7.50% and last 10 years @10.405%

KEY FINANCIAL INDICATORS

US$ Million

	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
PROJECTION PARAMETERS										
Currency:										
Prices/Costs:										
Exchange Rate:										
Domestic Infaltion Rate	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Foreign Inflation Rate	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Exchange Rate (KHR to 1US$)	4,165	4,165	4,165	4,165	4,165	4,165	4,165	4,165	4,165	4,165
OPERATING RESULTS										
Operating Revenues	11.71	11.71	11.71	11.71	11.71	11.71	11.71	11.71	11.71	11.71
Operating Expenses	3.94	4.02	4.02	4.02	4.02	4.02	4.09	4.09	4.09	4.09
Net Income	(0.85)	(0.78)	(0.63)	(0.46)	(0.28)	(0.09)	0.03	0.21	0.40	0.61
Cash from Operations	7.76	7.69	7.69	7.69	7.69	7.69	7.62	7.62	7.62	7.62
Operating Ratio	34%	34%	34%	34%	34%	34%	35%	35%	35%	35%
Total Assets	74.53	71.73	68.92	66.11	63.30	60.49	57.61	54.67	51.69	48.66
Working Capital	8.40	8.86	9.31	9.75	10.17	10.58	10.89	11.14	11.32	12.77
Working Capital (Days)	768	795	835	874	912	949	959	980	996	1,124
OPERATING EFFICIENCY										
Active Service Connections	48,913	48,913	48,913	48,913	48,913	48,913	48,913	48,913	48,913	48,913
Average Tariff (USD)	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63
Average Water Monthly Bill (USD)	19.94	19.94	19.94	19.94	19.94	19.94	19.94	19.94	19.94	19.94
Percent Growth in Connections	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Water Production (m3 x 1000)	20,440	20,440	20,440	20,440	20,440	20,440	20,440	20,440	20,440	20,440
Water Sold (in 000 of m3)	18,396	18,396	18,396	18,396	18,396	18,396	18,396	18,396	18,396	18,396
Water Losses	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
FINANCIAL PERFORMANCE RATIOS										
Acc. Receivable (Days)	30	30	30	30	30	30	30	30	30	30
Current Ratio	3.40	3.42	3.43	3.43	3.42	3.40	3.35	3.28	3.20	4.13
Debt/Equity Ratio	10.61	11.76	12.83	13.64	13.94	13.51	12.59	11.12	9.32	7.71
Debt Service Coverage	1.12	1.11	1.11	1.11	1.11	1.11	1.10	1.10	1.10	1.10
Self Financing Ratio	100.0%									
Return on Revenues	-7.3%	-6.7%	-5.4%	-4.0%	-2.4%	-0.8%	0.3%	1.8%	3.4%	5.2%
Return on Assets	-1.4%	-1.3%	-1.1%	-0.9%	-0.6%	-0.2%	0.1%	0.5%	1.1%	1.9%
Return on Equity	-13.9%	-14.7%	-13.4%	-10.9%	-7.2%	-2.4%	0.8%	5.1%	8.9%	11.9%
INVESTMENT PROGRAM	2.2	-	-	-	-	-	-	-	-	-
Investment Project	2.2	-	-	-	-	-	-	-	-	-
Capitalized Interest	-	-	-	-	-	-	-	-	-	-
FINANCING PLAN	2.2	-	-	-	-	-	-	-	-	-
Grants	-	-	-	-	-	-	-	-	-	-
Loan 1 - Priority Project	-	-	-	-	-	-	-	-	-	-
Loan 2 - KTC Project	-	-	-	-	-	-	-	-	-	-
Loan3	-	-	-	-	-	-	-	-	-	-
Outstanding Loans	-	-	-	-	-	-	-	-	-	-
Internally Generated Financing	2.2	-	-	-	-	-	-	-	-	-

Financial Study 18 - Trial Run 4
Proposed Tariff Study 2
PROFIT & LOSS STATEMENTS
US$ Million

Interest NPV=4.5%: Grace period @3%, IDC 100% capitalized and Repayment 1st 10 years @3.75%, next 10 years @7.50% and last 10 years @10.405%

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Number of Connections											
- Existing WTP	4,129	4,129	4,129	4,129	4,129	4,129	4,129	4,129	4,129	4,129	4,129
- Increment form KTC Bulk Water	99	119	9,657	12,057	14,615	17,335	20,217	20,217	20,217	20,217	20,217
- Increment from Priority Project	-	-	-	-	-	-	-	3,046	6,261	9,641	13,191
Total	4,228	4,248	13,786	16,186	18,744	21,464	24,346	27,392	30,607	33,987	37,537
Billed Water, 1000 x m3/year											
- Per existing WTP	2,727	2,727	2,176	1,888	567	1,452	2,414	2,957	2,957	2,957	2,957
- Increment due KTC project	-	-	2,110	3,202	5,398	5,460	5,522	5,585	5,585	5,585	5,585
- Increment due priority project	-	-	-	-	-	-	-	498	1,684	2,954	4,313
Total Billed Water, 1000 x m3/year	2,727	2,727	4,285	5,090	5,965	6,913	7,937	9,039	10,225	11,495	12,854
Average Tariff, USD/m3	0.33	0.33	0.48	0.48	0.48	0.48	0.48	0.61	0.61	0.61	0.61
Water Losses	17%	16%	15%	14%	13%	12%	11%	10%	10%	10%	10%
Production Capacity, 1000 x m3/year											
- Existing WTP	3,285	3,285	3,285	3,285	3,285	3,285	3,285	3,285	3,285	3,285	3,285
- KTC Bulk Water	-	-	2,482	3,723	6,205	6,205	6,205	6,205	6,205	6,205	6,205
- Priority Project WTP	-	-	-	-	-	-	-	10,950	10,950	10,950	10,950
Total Production Capacity, 1000 x m3/year	3,285	3,285	5,767	7,008	9,490	9,490	9,490	20,440	20,440	20,440	20,440

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Operating Revenue											
Water Sales											
- Existing WTP	0.89	0.89	1.04	0.91	0.27	0.70	1.16	1.80	1.80	1.80	1.80
- Increment Due KTC	-	-	1.01	1.54	2.59	2.62	2.65	3.41	3.41	3.41	3.41
- Without Priority Project	0.89	0.89	2.06	2.44	2.86	3.32	3.81	5.21	5.21	5.21	5.21
- Increment Due Priority Project	-	-	-	-	-	-	-	0.30	1.03	1.80	2.63
Total Water Sales	0.89	0.89	2.06	2.44	2.86	3.32	3.81	5.51	6.24	7.01	7.84
Less: Value Added Tax	-	-	-	-	-	-	-	-	-	-	-
Net Water Sales	0.89	0.89	2.06	2.44	2.86	3.32	3.81	5.51	6.24	7.01	7.84
Penalties and Fines											
- Without Priority Project	0.01	0.01	0.02	0.02	0.03	0.03	0.04	-	-	-	-
- Increment Due Priority Project	-	-	-	-	-	-	-	0.06	0.06	0.07	0.08
Total Penalties and Fines	0.01	0.01	0.02	0.02	0.03	0.03	0.04	0.06	0.06	0.07	0.08
Connection Fees & Other Charges											
- Without Priority Project	-	0.00	1.20	0.31	0.33	0.35	0.37	-	-	-	-
- Increment Due Priority Project	-	-	-	-	-	-	-	0.39	0.41	0.43	0.45
Total Conn. Fees & Other Charges	-	0.00	1.20	0.31	0.33	0.35	0.37	0.39	0.41	0.43	0.45
Total Operating Revenue	0.90	0.90	3.28	2.77	3.22	3.70	4.22	5.96	6.71	7.51	8.37
Operating Expenses											
Bulk Water Purchases	-	-	0.51	0.76	1.27	1.27	1.27	1.34	1.341	1.341	1.341
Salaries & Wages	0.14	0.14	0.20	0.27	0.27	0.27	0.27	0.34	0.395	0.453	0.470
Power Costs	0.18	0.18	0.14	0.12	0.04	0.09	0.15	0.22	0.308	0.402	0.503
Chemical Costs	0.04	0.04	0.03	0.02	0.01	0.02	0.03	0.05	0.072	0.099	0.128
Maintenance Expense	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.25	0.281	0.309	0.338
Administrative & General Expenses	0.26	0.26	0.14	0.19	0.19	0.19	0.19	0.21	0.237	0.272	0.282
Total Operating Expenses	0.76	0.76	1.15	1.51	1.91	1.98	2.05	2.41	2.63	2.88	3.06
Income before Depreciation	0.14	0.14	2.13	1.27	1.31	1.72	2.17	3.54	4.08	4.64	5.31
Depreciation Expense	0.07	0.07	0.10	0.21	0.30	0.40	0.40	3.08	3.08	3.08	3.08
Income before Interest Charges	0.06	0.07	2.03	1.05	1.01	1.32	1.76	0.47	1.00	1.56	2.23
Interest Charges'- Priority Project	-	-	-	-	-	-	-	2.40	2.40	2.40	2.40
Interest Charges'- KTC Pipeline Project	-	-	-	-	-	0.82	0.81	0.80	0.79	0.78	0.76
Total Interest Charges	-	-	-	-	-	0.82	0.81	3.20	3.19	3.18	3.16
Income Before Taxes	0.06	0.07	2.03	1.05	1.01	0.50	0.95	(2.74)	(2.19)	(1.62)	(0.93)
Income Taxes	0.01	0.01	0.41	0.21	0.20	0.10	0.19	-	-	-	-
NET PROFIT/(LOSS)	0.05	0.05	1.62	0.84	0.81	0.40	0.76	(2.74)	(2.19)	(1.62)	(0.93)

Financial Study 18 - Trial Run 4
Proposed Tariff Study 2
PROFIT & LOSS STATEMENTS

Interest NPV=4.5%: Grace period @3%, IDC 100% capitalized and Repayment 1st 10 years @3.75%, next 10 years @7.50% and last 10 years @10.405%

US$ Million

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Number of Connections										
- Existing WTP	4,129	4,129	4,129	4,129	4,129	4,129	4,129	4,129	4,129	4,129
- Increment form KTC Bulk Water	20,217	20,217	20,217	20,217	20,217	20,217	20,217	20,217	20,217	20,217
- Increment from Priority Project	14,981	16,813	18,686	20,602	22,557	24,567	24,567	24,567	24,567	24,567
Total	39,327	41,159	43,032	44,948	46,903	48,913	48,913	48,913	48,913	48,913
Billed Water, 1000 x m3/year										
- Per existing WTP	2,957	2,957	2,957	2,957	2,957	2,957	2,957	2,957	2,957	2,957
- Increment due KTC project	5,585	5,585	5,585	5,585	5,585	5,585	5,585	5,585	5,585	5,585
- Increment due priority project	5,163	6,050	6,977	7,943	8,949	9,855	9,855	9,855	9,855	9,855
Total Billed Water, 1000 x m3/year	13,704	14,591	15,518	16,484	17,490	18,396	18,396	18,396	18,396	18,396
Average Tariff, USD/m3	0.61	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63
Water Losses	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
Production Capacity, 1000 x m3/year										
- Existing WTP	3,285	3,285	3,285	3,285	3,285	3,285	3,285	3,285	3,285	3,285
- KTC Bulk Water	6,205	6,205	6,205	6,205	6,205	6,205	6,205	6,205	6,205	6,205
- Priority Project WTP	10,950	10,950	10,950	10,950	10,950	10,950	10,950	10,950	10,950	10,950
Total Production Capacity, 1000 x m3/year	20,440	20,440	20,440	20,440	20,440	20,440	20,440	20,440	20,440	20,440

Operating Revenue										
Water Sales										
- Existing WTP	1.80	1.86	1.86	1.86	1.86	1.86	1.86	1.86	1.86	1.86
- Increment Due KTC	3.41	3.52	3.52	3.52	3.52	3.52	3.52	3.52	3.52	3.52
- Without Priority Project	5.21	5.38	5.38	5.38	5.38	5.38	5.38	5.38	5.38	5.38
- Increment Due Priority Project	3.15	3.81	4.40	5.00	5.64	6.21	6.21	6.21	6.21	6.21
Total Water Sales	8.36	9.19	9.78	10.38	11.02	11.59	11.59	11.59	11.59	11.59
Less: Value Added Tax	-	-	-	-	-	-	-	-	-	-
Net Water Sales	8.36	9.19	9.78	10.38	11.02	11.59	11.59	11.59	11.59	11.59
Penalties and Fines										
- Without Priority Project	-	-	-	-	-	-	-	-	-	-
- Increment Due Priority Project	0.08	0.09	0.10	0.10	0.11	0.12	0.12	0.12	0.12	0.12
Total Penalties and Fines	0.08	0.09	0.10	0.10	0.11	0.12	0.12	0.12	0.12	0.12
Connection Fees & Other Charges										
- Without Priority Project	-	-	-	-	-	-	-	-	-	-
- Increment Due Priority Project	0.23	0.24	0.24	0.25	0.25	0.27	-	-	-	-
Total Conn. Fees & Other Charges	0.23	0.24	0.24	0.25	0.25	0.27	-	-	-	-
Total Operating Revenue	8.67	9.52	10.12	10.74	11.38	11.97	11.71	11.71	11.71	11.71
Operating Expenses										
Bulk Water Purchases	1.341	1.415	1.415	1.415	1.415	1.415	1.490	1.490	1.490	1.490
Salaries & Wages	0.481	0.491	0.491	0.491	0.491	0.491	0.491	0.491	0.491	0.491
Power Costs	0.566	0.632	0.700	0.772	0.846	0.913	0.913	0.913	0.913	0.913
Chemical Costs	0.145	0.164	0.184	0.204	0.225	0.244	0.244	0.244	0.244	0.244
Maintenance Expense	0.366	0.394	0.423	0.451	0.480	0.508	0.508	0.508	0.508	0.508
Administrative & General Expenses	0.288	0.295	0.295	0.295	0.295	0.295	0.295	0.295	0.295	0.295
Total Operating Expenses	3.19	3.39	3.51	3.63	3.75	3.867	3.94	3.94	3.94	3.94
Income before Depreciation	5.49	6.13	6.61	7.11	7.63	8.10	7.76	7.76	7.76	7.76
Depreciation Expense	3.08	3.08	3.08	3.08	3.08	3.08	3.08	3.09	3.24	3.35
Income before Interest Charges	2.41	3.05	3.53	4.03	4.55	5.02	4.68	4.67	4.52	4.41
Interest Charges'- Priority Project	3.00	2.95	2.89	2.83	2.77	2.70	2.64	2.57	2.49	2.42
Interest Charges'- KTC Pipeline Project	0.75	0.73	0.71	0.69	0.67	0.65	0.63	0.60	0.57	0.54
Total Interest Charges	3.75	3.68	3.60	3.52	3.44	3.35	3.26	3.17	3.07	2.96
Income Before Taxes	(1.34)	(0.63)	(0.07)	0.51	1.11	1.67	1.42	1.51	1.46	1.45
Income Taxes	-	-	-	0.10	0.22	0.33	0.28	0.30	0.29	0.29
NET PROFIT/(LOSS)	(1.34)	(0.63)	(0.07)	0.40	0.89	1.34	1.14	1.20	1.17	1.16

Financial Study 18 - Trial Run 4
Proposed Tariff Study 2
PROFIT & LOSS STATEMENTS
US$ Million

Interest NPV=4.5%: Grace period @3%, IDC 100% capitalized and Repayment 1st 10 years @3.75%, next 10 years @7.50% and last 10 years @10.405%

	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Number of Connections										
- Existing WTP	4,129	4,129	4,129	4,129	4,129	4,129	4,129	4,129	4,129	4,129
- Increment form KTC Bulk Water	20,217	20,217	20,217	20,217	20,217	20,217	20,217	20,217	20,217	20,217
- Increment from Priority Project	24,567	24,567	24,567	24,567	24,567	24,567	24,567	24,567	24,567	24,567
Total	48,913	48,913	48,913	48,913	48,913	48,913	48,913	48,913	48,913	48,913
Billed Water, 1000 x m3/year										
- Per existing WTP	2,957	2,957	2,957	2,957	2,957	2,957	2,957	2,957	2,957	2,957
- Increment due KTC project	5,585	5,585	5,585	5,585	5,585	5,585	5,585	5,585	5,585	5,585
- Increment due priority project	9,855	9,855	9,855	9,855	9,855	9,855	9,855	9,855	9,855	9,855
Total Billed Water, 1000 x m3/year	18,396	18,396	18,396	18,396	18,396	18,396	18,396	18,396	18,396	18,396
Average Tariff, USD/m3	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63
Water Losses	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
Production Capacity, 1000 x m3/year										
- Existing WTP	3,285	3,285	3,285	3,285	3,285	3,285	3,285	3,285	3,285	3,285
- KTC Bulk Water	6,205	6,205	6,205	6,205	6,205	6,205	6,205	6,205	6,205	6,205
- Priority Project WTP	10,950	10,950	10,950	10,950	10,950	10,950	10,950	10,950	10,950	10,950
Total Production Capacity, 1000 x m3/year	20,440	20,440	20,440	20,440	20,440	20,440	20,440	20,440	20,440	20,440
Operating Revenue										
Water Sales										
- Existing WTP	1.86	1.86	1.86	1.86	1.86	1.86	1.86	1.86	1.86	1.86
- Increment Due KTC	3.52	3.52	3.52	3.52	3.52	3.52	3.52	3.52	3.52	3.52
- Without Priority Project	5.38	5.38	5.38	5.38	5.38	5.38	5.38	5.38	5.38	5.38
- Increment Due Priority Project	6.21	6.21	6.21	6.21	6.21	6.21	6.21	6.21	6.21	6.21
Total Water Sales	11.59	11.59	11.59	11.59	11.59	11.59	11.59	11.59	11.59	11.59
Less: Value Added Tax	-	-	-	-	-	-	-	-	-	-
Net Water Sales	11.59	11.59	11.59	11.59	11.59	11.59	11.59	11.59	11.59	11.59
Penalties and Fines										
- Without Priority Project	-	-	-	-	-	-	-	-	-	-
- Increment Due Priority Project	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12
Total Penalties and Fines	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12
Connection Fees & Other Charges										
- Without Priority Project	-	-	-	-	-	-	-	-	-	-
- Increment Due Priority Project	-	-	-	-	-	-	-	-	-	-
Total Conn. Fees & Other Charges	-	-	-	-	-	-	-	-	-	-
Total Operating Revenue	11.71	11.71	11.71	11.71	11.71	11.71	11.71	11.71	11.71	11.71
Operating Expenses										
Bulk Water Purchases	1.490	1.564	1.564	1.564	1.564	1.564	1.639	1.639	1.639	1.639
Salaries & Wages	0.491	0.491	0.491	0.491	0.491	0.491	0.491	0.491	0.491	0.491
Power Costs	0.913	0.913	0.913	0.913	0.913	0.913	0.913	0.913	0.913	0.913
Chemical Costs	0.244	0.244	0.244	0.244	0.244	0.244	0.244	0.244	0.244	0.244
Maintenance Expense	0.508	0.508	0.508	0.508	0.508	0.508	0.508	0.508	0.508	0.508
Administrative & General Expenses	0.295	0.295	0.295	0.295	0.295	0.295	0.295	0.295	0.295	0.295
Total Operating Expenses	3.94	4.02	4.02	4.02	4.02	4.02	4.09	4.09	4.09	4.09
Income before Depreciation	7.76	7.69	7.69	7.69	7.69	7.69	7.62	7.62	7.62	7.62
Depreciation Expense	3.42	3.42	3.42	3.42	3.42	3.42	3.42	3.42	3.42	3.42
Income before Interest Charges	4.34	4.27	4.27	4.27	4.27	4.27	4.19	4.19	4.19	4.19
Interest Charges'- Priority Project	4.68	4.57	4.46	4.33	4.20	4.05	3.90	3.73	3.55	3.36
Interest Charges'- KTC Pipeline Project	0.51	0.47	0.44	0.40	0.35	0.30	0.25	0.20	0.14	0.07
Total Interest Charges	5.19	5.05	4.90	4.73	4.55	4.36	4.15	3.93	3.69	3.43
Income Before Taxes	(0.85)	(0.78)	(0.63)	(0.46)	(0.28)	(0.09)	0.04	0.26	0.50	0.76
Income Taxes	-	-	-	-	-	-	0.01	0.05	0.10	0.15
NET PROFIT/(LOSS)	(0.85)	(0.78)	(0.63)	(0.46)	(0.28)	(0.09)	0.03	0.21	0.40	0.61

Financial Study 19

Discounted Cash Flow Statement - Proposed Tariff Study 1

In US$ Million

Year		Billed Water, m3 x 1,000 Total	Billed Water, m3 x 1,000 Existing WTP	Billed Water, m3 x 1,000 KTC Bulk Water	Billed Water, m3 x 1,000 This Project	Average Tariff US$/m3	Base Case: Potential Water Sales	Base Case: Life Cycle Costs, US$ million Project Cost	Base Case: Life Cycle Costs, US$ million O&M Cost	Base Case: Life Cycle Costs, US$ million Replace-ment cost	Base Case: Life Cycle Costs, US$ million Total	Base Case: Net Cash Inflow	Sensitivity Analysis: 15% Increase in Proj. Cost	Sensitivity Analysis: 15% Increase in O&M Cost	Sensitivity Analysis: 15% Reduction in Revenue
Year 0	2010	2,727	2,727	-	-		-	-	-	-	-	-			
Year 1	2011	2,727	2,727	-			-	0.99	-	-	0.99	(0.99)	(1.14)	(0.99)	(0.99)
Year 2	2012	4,285	2,176	2,110			-	1.34	-	-	1.34	(1.34)	(1.54)	(1.34)	(1.34)
Year 3	2013	5,090	1,888	3,202			-	13.76	-	-	13.76	(13.76)	(15.82)	(13.76)	(13.76)
Year 4	2014	5,965	567	5,398			-	18.24	-	-	18.24	(18.24)	(20.98)	(18.24)	(18.24)
Year 5	2015	6,913	1,452	5,460			-	19.48	-	-	19.48	(19.48)	(22.40)	(19.48)	(19.48)
Year 6	2016	7,937	2,414	5,522			-	11.31	-	-	11.31	(11.31)	(13.00)	(11.31)	(11.31)
Year 7	2017	9,039	2,957	5,585	498	0.620	0.309	-	0.28	-	0.28	0.03	0.03	(0.01)	(0.01)
Year 8	2018	10,225	2,957	5,585	1,684	0.620	1.044	-	0.50	-	0.50	0.55	0.55	0.47	0.41
Year 9	2019	11,495	2,957	5,585	2,954	0.620	1.831	-	0.74	-	0.74	1.09	1.09	0.98	0.85
Year 10	2020	12,854	2,957	5,585	4,313	0.620	2.674	-	0.93	-	0.93	1.75	1.75	1.61	1.40
Year 11	2021	13,704	2,957	5,585	5,163	0.620	3.201	-	1.05	-	1.05	2.15	2.15	1.99	1.73
Year 12	2022	14,591	2,957	5,585	6,050	0.620	3.751	-	1.18	-	1.18	2.57	2.57	2.39	2.08
Year 13	2023	15,518	2,957	5,585	6,977	0.620	4.325	-	1.30	-	1.30	3.03	3.03	2.83	2.46
Year 14	2024	16,484	2,957	5,585	7,943	0.620	4.924	-	1.42	-	1.42	3.51	3.51	3.29	2.86
Year 15	2025	17,490	2,957	5,585	8,949	0.620	5.548	-	1.54	-	1.54	4.01	4.01	3.77	3.28
Year 16	2026	18,625	2,957	5,585	9,855	0.620	6.110	-	1.66	-	1.66	4.45	4.45	4.20	3.66
Year 17	2027	18,625	2,957	5,585	9,855	0.620	6.110	-	1.66	-	1.66	4.45	4.45	4.20	3.66
Year 18	2028	18,625	2,957	5,585	9,855	0.620	6.110	-	1.66	0.37	2.03	4.08	4.08	3.83	3.28
Year 19	2029	18,625	2,957	5,585	9,855	0.620	6.110	-	1.66	4.44	6.10	0.01	0.01	(0.24)	(0.79)
Year 20	2030	18,625	2,957	5,585	9,855	0.620	6.110	-	1.66	3.31	4.97	1.14	1.14	0.89	0.34
Year 21	2031	18,625	2,957	5,585	9,855	0.620	6.110	-	1.66	2.21	3.87	2.24	2.24	2.00	1.45
Year 22	2032	18,625	2,957	5,585	9,855	0.620	6.110	-	1.66	-	1.66	4.45	4.45	4.20	3.66
Year 23	2033	18,625	2,957	5,585	9,855	0.620	6.110	-	1.66	-	1.66	4.45	4.45	4.20	3.66
Year 24	2034	18,625	2,957	5,585	9,855	0.620	6.110	-	1.66	-	1.66	4.45	4.45	4.20	3.66
Year 25	2035	18,625	2,957	5,585	9,855	0.620	6.110	-	1.66	-	1.66	4.45	4.45	4.20	3.66
Year 26	2036	18,625	2,957	5,585	9,855	0.620	6.110	-	1.66	-	1.66	4.45	4.45	4.20	3.66
Year 27	2037	18,625	2,957	5,585	9,855	0.620	6.110	-	1.66	-	1.66	4.45	4.45	4.20	3.66
Year 28	2038	18,625	2,957	5,585	9,855	0.620	6.110	-	1.66	-	1.66	4.45	4.45	4.20	3.66
Year 29	2039	18,625	2,957	5,585	9,855	0.620	6.110	-	1.66	-	1.66	4.45	4.45	4.20	3.66
Year 30	2040	18,625	2,957	5,585	9,855	0.620	6.110	-	1.66	-	1.66	4.45	4.45	4.20	3.66
Year 31	2041	18,625	2,957	5,585	9,855	0.620	6.110	-	1.66	-	1.66	4.45	4.45	4.20	3.66
Year 32	2042	18,625	2,957	5,585	9,855	0.620	6.110	-	1.66	-	1.66	4.45	4.45	4.20	3.66
Year 33	2043	18,625	2,957	5,585	9,855	0.620	6.110	-	1.66	0.37	2.03	4.08	4.08	3.83	3.28
Year 34	2044	18,625	2,957	5,585	9,855	0.620	6.110	-	1.66	4.44	6.10	0.01	0.01	(0.24)	(0.79)
Year 35	2045	18,625	2,957	5,585	9,855	0.620	6.110	-	1.66	3.31	4.97	1.14	1.14	0.89	0.34
Year 36	2046	18,625	2,957	5,585	9,855	0.620	6.110	-	1.66	2.21	3.87	2.24	2.24	2.00	1.45
Year 37	2047	18,625	2,957	5,585	9,855	0.620	6.110	-	1.66	-	1.66	4.45	4.45	4.20	3.66
Year 38	2048	18,625	2,957	5,585	9,855	0.620	6.110	-	1.66	-	1.66	4.45	4.45	4.20	3.66
Year 39	2049	18,625	2,957	5,585	9,855	0.620	6.110	-	1.66	-	1.66	4.45	4.45	4.20	3.66
Year 40	2050	18,625	2,957	5,585	9,855	0.620	6.110	-	1.66	-	1.66	4.45	4.45	4.20	3.66
								Financial Internal Rate of Return				**2.60%**	**1.86%**	**2.22%**	**1.34%**

Financial Study 20

Discounted Cash Flow Statement - Proposed Tariff Study 2

In US$ Million

Year		Billed Water, m3 x 1,000				Average	Base Case						Sensitivity Analysis		
						Tariff	Potential	Life Cycle Costs, US$ million					15%	15%	15%
		Total	Existing WTP	KTC Bulk Water	This Project	US$/m3	Water Sales	Project Cost	O&M Cost	Replace-ment cost	Total	Net Cash Inflow	Increase in Proj. Cost	Increase in O&M Cost	Reduction in Revenue
Year 0	2010	2,727	2,727	-	-		-	-	-	-	-	-			
Year 1	2011	2,727	2,727	-			-	0.99	-	-	0.99	(0.99)	(1.14)	(0.99)	(0.99)
Year 2	2012	4,285	2,176	2,110			-	1.34	-	-	1.34	(1.34)	(1.54)	(1.34)	(1.34)
Year 3	2013	5,090	1,888	3,202			-	13.76	-	-	13.76	(13.76)	(15.82)	(13.76)	(13.76)
Year 4	2014	5,965	567	5,398			-	18.24	-	-	18.24	(18.24)	(20.98)	(18.24)	(18.24)
Year 5	2015	6,913	1,452	5,460			-	19.48	-	-	19.48	(19.48)	(22.40)	(19.48)	(19.48)
Year 6	2016	7,937	2,414	5,522			-	11.31	-	-	11.31	(11.31)	(13.00)	(11.31)	(11.31)
Year 7	2017	9,039	2,957	5,585	498	0.61	0.304	-	0.28	-	0.28	0.03	0.03	(0.02)	(0.01)
Year 8	2018	10,225	2,957	5,585	1,684	0.61	1.027	-	0.50	-	0.50	0.53	0.53	0.45	0.39
Year 9	2019	11,495	2,957	5,585	2,954	0.61	1.802	-	0.74	-	0.74	1.06	1.06	0.95	0.83
Year 10	2020	12,854	2,957	5,585	4,313	0.61	2.631	-	0.93	-	0.93	1.70	1.70	1.57	1.36
Year 11	2021	13,704	2,957	5,585	5,163	0.61	3.149	-	1.05	-	1.05	2.10	2.10	1.94	1.69
Year 12	2022	14,591	2,957	5,585	6,050	0.63	3.812	-	1.18	-	1.18	2.63	2.63	2.45	2.13
Year 13	2023	15,518	2,957	5,585	6,977	0.63	4.395	-	1.30	-	1.30	3.10	3.10	2.90	2.52
Year 14	2024	16,484	2,957	5,585	7,943	0.63	5.004	-	1.42	-	1.42	3.59	3.59	3.37	2.93
Year 15	2025	17,490	2,957	5,585	8,949	0.63	5.638	-	1.54	-	1.54	4.09	4.09	3.86	3.36
Year 16	2026	18,625	2,957	5,585	9,855	0.63	6.209	-	1.66	-	1.66	4.55	4.55	4.30	3.74
Year 17	2027	18,625	2,957	5,585	9,855	0.63	6.209	-	1.66	-	1.66	4.55	4.55	4.30	3.74
Year 18	2028	18,625	2,957	5,585	9,855	0.63	6.209	-	1.66	0.37	2.03	4.18	4.18	3.93	3.37
Year 19	2029	18,625	2,957	5,585	9,855	0.63	6.209	-	1.66	4.44	6.10	0.11	0.11	(0.14)	(0.70)
Year 20	2030	18,625	2,957	5,585	9,855	0.63	6.209	-	1.66	3.31	4.97	1.24	1.24	0.99	0.43
Year 21	2031	18,625	2,957	5,585	9,855	0.63	6.209	-	1.66	2.21	3.87	2.34	2.34	2.09	1.53
Year 22	2032	18,625	2,957	5,585	9,855	0.63	6.209	-	1.66	-	1.66	4.55	4.55	4.30	3.74
Year 23	2033	18,625	2,957	5,585	9,855	0.63	6.209	-	1.66	-	1.66	4.55	4.55	4.30	3.74
Year 24	2034	18,625	2,957	5,585	9,855	0.63	6.209	-	1.66	-	1.66	4.55	4.55	4.30	3.74
Year 25	2035	18,625	2,957	5,585	9,855	0.63	6.209	-	1.66	-	1.66	4.55	4.55	4.30	3.74
Year 26	2036	18,625	2,957	5,585	9,855	0.63	6.209	-	1.66	-	1.66	4.55	4.55	4.30	3.74
Year 27	2037	18,625	2,957	5,585	9,855	0.63	6.209	-	1.66	-	1.66	4.55	4.55	4.30	3.74
Year 28	2038	18,625	2,957	5,585	9,855	0.63	6.209	-	1.66	-	1.66	4.55	4.55	4.30	3.74
Year 29	2039	18,625	2,957	5,585	9,855	0.63	6.209	-	1.66	-	1.66	4.55	4.55	4.30	3.74
Year 30	2040	18,625	2,957	5,585	9,855	0.63	6.209	-	1.66	-	1.66	4.55	4.55	4.30	3.74
Year 31	2041	18,625	2,957	5,585	9,855	0.63	6.209	-	1.66	-	1.66	4.55	4.55	4.30	3.74
Year 32	2042	18,625	2,957	5,585	9,855	0.63	6.209	-	1.66	-	1.66	4.55	4.55	4.30	3.74
Year 33	2043	18,625	2,957	5,585	9,855	0.63	6.209	-	1.66	0.37	2.03	4.18	4.18	3.93	3.37
Year 34	2044	18,625	2,957	5,585	9,855	0.63	6.209	-	1.66	4.44	6.10	0.11	0.11	(0.14)	(0.70)
Year 35	2045	18,625	2,957	5,585	9,855	0.63	6.209	-	1.66	3.31	4.97	1.24	1.24	0.99	0.43
Year 36	2046	18,625	2,957	5,585	9,855	0.63	6.209	-	1.66	2.21	3.87	2.34	2.34	2.09	1.53
Year 37	2047	18,625	2,957	5,585	9,855	0.63	6.209	-	1.66	-	1.66	4.55	4.55	4.30	3.74
Year 38	2048	18,625	2,957	5,585	9,855	0.63	6.209	-	1.66	-	1.66	4.55	4.55	4.30	3.74
Year 39	2049	18,625	2,957	5,585	9,855	0.63	6.209	-	1.66	-	1.66	4.55	4.55	4.30	3.74
Year 40	2050	18,625	2,957	5,585	9,855	0.63	6.209	-	1.66	-	1.66	4.55	4.55	4.30	3.74
								Financial Internal Rate of Return				**2.72%**	**1.98%**	**2.34%**	**1.47%**

Financial Study 21

Discounted Cash Flow Statement - Maximum Affordability of SRWSA Consumers

In US$ Million

Year		Billed Water, m3 x 1,000				Average	Base Case						Sensitivity Analysis		
						Tariff	Potential	Life Cycle Costs, US$ million					15%	15%	15%
		Total	Existing WTP	KTC Bulk Water	This Project	US$/m3	Water Sales	Project Cost	O&M Cost	Replace-ment cost	Total	Net Cash Inflow	Increase in Proj. Cost	Increase in O&M Cost	Reduction in Revenue
Year 0	2010	2,727	2,727	-	-		-	-	-	-	-	-			
Year 1	2011	2,727	2,727	-			-	0.99	-	-	0.99	(0.99)	(1.14)	(0.99)	(0.99)
Year 2	2012	4,285	2,176	2,110			-	1.34	-	-	1.34	(1.34)	(1.54)	(1.34)	(1.34)
Year 3	2013	5,090	1,888	3,202			-	13.76	-	-	13.76	(13.76)	(15.82)	(13.76)	(13.76)
Year 4	2014	5,965	567	5,398			-	18.24	-	-	18.24	(18.24)	(20.98)	(18.24)	(18.24)
Year 5	2015	6,913	1,452	5,460			-	19.48	-	-	19.48	(19.48)	(22.40)	(19.48)	(19.48)
Year 6	2016	7,937	2,414	5,522			-	11.31	-	-	11.31	(11.31)	(13.00)	(11.31)	(11.31)
Year 7	2017	9,039	2,957	5,585	498	0.67	0.336	-	0.28	-	0.28	0.06	0.06	0.02	0.01
Year 8	2018	10,225	2,957	5,585	1,684	0.67	1.135	-	0.50	-	0.50	0.64	0.64	0.56	0.49
Year 9	2019	11,495	2,957	5,585	2,954	0.67	1.991	-	0.74	-	0.74	1.25	1.25	1.14	0.99
Year 10	2020	12,854	2,957	5,585	4,313	0.67	2.907	-	0.93	-	0.93	1.98	1.98	1.84	1.60
Year 11	2021	13,704	2,957	5,585	5,163	0.67	3.480	-	1.05	-	1.05	2.43	2.43	2.27	1.97
Year 12	2022	14,591	2,957	5,585	6,050	0.67	4.078	-	1.18	-	1.18	2.90	2.90	2.72	2.36
Year 13	2023	15,518	2,957	5,585	6,977	0.67	4.702	-	1.30	-	1.30	3.40	3.40	3.21	2.79
Year 14	2024	16,484	2,957	5,585	7,943	0.67	5.353	-	1.42	-	1.42	3.93	3.93	3.72	3.24
Year 15	2025	17,490	2,957	5,585	8,949	0.67	6.031	-	1.54	-	1.54	4.49	4.49	4.26	3.70
Year 16	2026	18,625	2,957	5,585	9,855	0.67	6.642	-	1.66	-	1.66	4.98	4.98	4.74	4.12
Year 17	2027	18,625	2,957	5,585	9,855	0.67	6.642	-	1.66	-	1.66	4.98	4.98	4.74	4.12
Year 18	2028	18,625	2,957	5,585	9,855	0.67	6.642	-	1.66	0.37	2.03	4.61	4.61	4.36	3.75
Year 19	2029	18,625	2,957	5,585	9,855	0.67	6.642	-	1.66	4.44	6.10	0.54	0.54	0.29	(0.33)
Year 20	2030	18,625	2,957	5,585	9,855	0.67	6.642	-	1.66	3.31	4.97	1.67	1.67	1.42	0.81
Year 21	2031	18,625	2,957	5,585	9,855	0.67	6.642	-	1.66	2.21	3.87	2.78	2.78	2.53	1.91
Year 22	2032	18,625	2,957	5,585	9,855	0.67	6.642	-	1.66	-	1.66	4.98	4.98	4.74	4.12
Year 23	2033	18,625	2,957	5,585	9,855	0.67	6.642	-	1.66	-	1.66	4.98	4.98	4.74	4.12
Year 24	2034	18,625	2,957	5,585	9,855	0.67	6.642	-	1.66	-	1.66	4.98	4.98	4.74	4.12
Year 25	2035	18,625	2,957	5,585	9,855	0.67	6.642	-	1.66	-	1.66	4.98	4.98	4.74	4.12
Year 26	2036	18,625	2,957	5,585	9,855	0.67	6.642	-	1.66	-	1.66	4.98	4.98	4.74	4.12
Year 27	2037	18,625	2,957	5,585	9,855	0.67	6.642	-	1.66	-	1.66	4.98	4.98	4.74	4.12
Year 28	2038	18,625	2,957	5,585	9,855	0.67	6.642	-	1.66	-	1.66	4.98	4.98	4.74	4.12
Year 29	2039	18,625	2,957	5,585	9,855	0.67	6.642	-	1.66	-	1.66	4.98	4.98	4.74	4.12
Year 30	2040	18,625	2,957	5,585	9,855	0.67	6.642	-	1.66	-	1.66	4.98	4.98	4.74	4.12
Year 31	2041	18,625	2,957	5,585	9,855	0.67	6.642	-	1.66	-	1.66	4.98	4.98	4.74	4.12
Year 32	2042	18,625	2,957	5,585	9,855	0.67	6.642	-	1.66	-	1.66	4.98	4.98	4.74	4.12
Year 33	2043	18,625	2,957	5,585	9,855	0.67	6.642	-	1.66	0.37	2.03	4.61	4.61	4.36	3.75
Year 34	2044	18,625	2,957	5,585	9,855	0.67	6.642	-	1.66	4.44	6.10	0.54	0.54	0.29	(0.33)
Year 35	2045	18,625	2,957	5,585	9,855	0.67	6.642	-	1.66	3.31	4.97	1.67	1.67	1.42	0.81
Year 36	2046	18,625	2,957	5,585	9,855	0.67	6.642	-	1.66	2.21	3.87	2.78	2.78	2.53	1.91
Year 37	2047	18,625	2,957	5,585	9,855	0.67	6.642	-	1.66	-	1.66	4.98	4.98	4.74	4.12
Year 38	2048	18,625	2,957	5,585	9,855	0.67	6.642	-	1.66	-	1.66	4.98	4.98	4.74	4.12
Year 39	2049	18,625	2,957	5,585	9,855	0.67	6.642	-	1.66	-	1.66	4.98	4.98	4.74	4.12
Year 40	2050	18,625	2,957	5,585	9,855	0.67	6.642	-	1.66	-	1.66	4.98	4.98	4.74	4.12
								Financial Internal Rate of Return				**3.32%**	**2.57%**	**2.98%**	**2.10%**

Economic Study 1
Consumer Surplus

Year	Water Demand Projection m3	Billed Water From Existing Water System m3	Billed Water From KTC Bulk Water m3	Billed Water From New JICA Proj m3	FIRR Water Tariff USD/m3	Benefit Due	Total Consumer Surplus USD million
2010	2,726,550	2,726,550	-	-	-	-	-
2011	2,759,400	2,759,400	-	-	-	-	-
2012	4,285,209	2,175,509	2,109,700	-	-	-	-
2013	5,090,185	1,888,405	3,201,780	-	-	-	-
2014	5,965,062	566,712	5,398,350	-	-	-	-
2015	6,912,829	1,452,429	5,460,400	-	-	-	-
2016	7,936,530	2,414,080	5,522,450	-	-	-	-
2017	9,039,263	2,956,500	5,584,500	498,263	0.61	0.20	0.36
2018	10,224,648	2,956,500	5,584,500	1,683,648	0.61	0.20	1.23
2019	11,494,520	2,956,500	5,584,500	2,953,520	0.61	0.20	2.16
2020	12,853,536	2,956,500	5,584,500	4,312,536	0.61	0.20	3.16
2021	13,703,567	2,956,500	5,584,500	5,162,567	0.61	0.20	3.78
2022	14,591,240	2,956,500	5,584,500	6,050,240	0.63	0.20	4.57
2023	15,517,515	2,956,500	5,584,500	6,976,515	0.63	0.20	5.27
2024	16,483,564	2,956,500	5,584,500	7,942,564	0.63	0.20	6.00
2025	17,489,775	2,956,500	5,584,500	8,948,775	0.63	0.20	6.77
2026	18,396,000	2,956,500	5,584,500	9,855,000	0.63	0.20	7.45
2027	18,396,000	2,956,500	5,584,500	9,855,000	0.63	0.20	7.45
2028	18,396,000	2,956,500	5,584,500	9,855,000	0.63	0.20	7.45
2029	18,396,000	2,956,500	5,584,500	9,855,000	0.63	0.20	7.45
2030	18,396,000	2,956,500	5,584,500	9,855,000	0.63	0.20	7.45
2031	18,396,000	2,956,500	5,584,500	9,855,000	0.63	0.20	7.45
2032	18,396,000	2,956,500	5,584,500	9,855,000	0.63	0.20	7.45
2033	18,396,000	2,956,500	5,584,500	9,855,000	0.63	0.20	7.45
2034	18,396,000	2,956,500	5,584,500	9,855,000	0.63	0.20	7.45
2035	18,396,000	2,956,500	5,584,500	9,855,000	0.63	0.20	7.45
2036	18,396,000	2,956,500	5,584,500	9,855,000	0.63	0.20	7.45
2037	18,396,000	2,956,500	5,584,500	9,855,000	0.63	0.20	7.45
2038	18,396,000	2,956,500	5,584,500	9,855,000	0.63	0.20	7.45
2039	18,396,000	2,956,500	5,584,500	9,855,000	0.63	0.20	7.45
2040	18,396,000	2,956,500	5,584,500	9,855,000	0.63	0.20	7.45
						NPV (12%)	34.86

Economic Study 2

Health Benefits

Year	Projected Served Population	Incremental Served Population	Average Personal Medical Expenditure		33% Reduction Due Project	SubTotal Benefit Due	AVERAGE Government Exp.		33% Reduction Due Project	SubTotal Benefit Due	Total Health Benefit
			Healthcare USD	Water-Borne USD	USD	USD x 1000	Healthcare USD	Water-borne USD	USD	USD x 1000	USD x 1000
2010	53,350	-	5.33	0.53	-	-	3.80	-	-	-	-
2011	65,130	-	5.44	0.54	-	-	3.88	-	-	-	-
2012	77,780	-	5.55	0.55	-	-	3.96	-	-	-	-
2013	91,330	-	5.66	0.57	-	-	4.04	-	-	-	-
2014	105,780	-	5.77	0.58	-	-	4.12	-	-	-	-
2015	121,140	-	5.89	0.59	-	-	4.20	-	-	-	-
2016	137,420	-	6.01	0.60	-	-	4.28	-	-	-	-
2017	154,630	154,630	6.13	0.61	2.22	343.81	4.37	0.44	1.59	245.20	589.01
2018	172,790	172,790	6.25	0.62	2.27	391.87	4.46	0.45	1.62	279.48	671.35
2019	191,880	191,880	6.37	0.64	2.31	443.87	4.54	0.45	1.65	316.56	760.43
2020	211,940	211,940	6.50	0.65	2.36	500.08	4.64	0.46	1.68	356.65	856.73
2021	222,000	222,000	6.63	0.66	2.41	534.30	4.73	0.47	1.72	381.05	915.35
2022	232,300	232,300	6.76	0.68	2.45	570.27	4.82	0.48	1.75	406.70	976.97
2023	242,820	242,820	6.90	0.69	2.50	608.01	4.92	0.49	1.79	433.62	1,041.64
2024	242,820	242,820	7.04	0.70	2.55	620.17	5.02	0.50	1.82	442.30	1,062.47
2025	242,820	242,820	7.18	0.72	2.61	632.58	5.12	0.51	1.86	451.14	1,083.72
2026	242,820	242,820	7.32	0.73	2.66	645.23	5.22	0.52	1.90	460.17	1,105.39
2027	242,820	242,820	7.47	0.75	2.71	658.13	5.33	0.53	1.93	469.37	1,127.50
2028	242,820	242,820	7.62	0.76	2.76	671.30	5.43	0.54	1.97	478.76	1,150.05
2029	242,820	242,820	7.77	0.78	2.82	684.72	5.54	0.55	2.01	488.33	1,173.05
2030	242,820	242,820	7.92	0.79	2.88	698.42	5.65	0.57	2.05	498.10	1,196.51
2031	242,820	242,820	8.08	0.81	2.93	712.38	5.76	0.58	2.09	508.06	1,220.45
2032	242,820	242,820	8.24	0.82	2.99	726.63	5.88	0.59	2.13	518.22	1,244.85
2033	242,820	242,820	8.41	0.84	3.05	741.17	6.00	0.60	2.18	528.59	1,269.75
2034	242,820	242,820	8.58	0.86	3.11	755.99	6.12	0.61	2.22	539.16	1,295.15
2035	242,820	242,820	8.75	0.87	3.18	771.11	6.24	0.62	2.26	549.94	1,321.05
2036	242,820	242,820	8.92	0.89	3.24	786.53	6.36	0.64	2.31	560.94	1,347.47
2037	242,820	242,820	9.10	0.91	3.30	802.26	6.49	0.65	2.36	572.16	1,374.42
2038	242,820	242,820	9.28	0.93	3.37	818.31	6.62	0.66	2.40	583.60	1,401.91
2039	242,820	242,820	9.47	0.95	3.44	834.67	6.75	0.68	2.45	595.27	1,429.95
2040	242,820	242,820	9.66	0.97	3.51	851.37	6.89	0.69	2.50	607.18	1,458.55
		Totals				**15,803**				**11,271**	**27,074**

Economic Study 3

TOURISM BENEFITS

Year	Projected Visitor Arrivals	Water Demand Coverage	Days staying in Siem Reap: Without Proj 3.50	Days staying in Siem Reap: With Proj 4.50	Incremental Tourist Stay	Daily Gross Spending by Foreign Tourists: Without Project USD	Daily Gross Spending by Foreign Tourists: With Project USD	Foreign Tourists: net spending ratio 0.30	Foreign Tourists: Per capita daily net spending	Economic Benefit USD x 1000	Unskilled labour comp. 20% of gross spending USD x 1000 20%	SWRF 0.75 20% of labor component econ. Benefit USD x 1000 0.75	TOTAL Economic Benefit USD x 1000 27%
2010	2,322,788	-	-	-	-	-	-	-	-	-	-	-	-
2011	2,392,472	-	-	-	-	-	-	-	-	-	-	-	-
2012	2,464,246	-	-	-	-	-	-	-	-	-	-	-	-
2013	2,538,173	-	-	-	-	-	-	-	-	-	-	-	-
2014	2,614,318	-	-	-	-	-	-	-	-	-	-	-	-
2015	2,692,748	-	-	-	-	-	-	-	-	-	-	-	-
2016	2,773,530	-	-	-	-	-	-	-	-	-	-	-	-
2017	2,856,736	1,856,879	6,499,075	8,355,954	1,856,879	121.43	121.43	30.00%	36	67,643	45,096	33,822	27,396
2018	2,942,438	2,059,707	7,208,974	9,268,681	2,059,707	121.43	121.43	30.00%	36	75,032	50,021	37,516	30,388
2019	3,030,712	2,273,034	7,955,618	10,228,651	2,273,034	121.43	121.43	30.00%	36	82,803	55,202	41,402	33,535
2020	3,121,633	2,497,306	8,740,572	11,237,878	2,497,306	121.43	121.43	30.00%	36	90,973	60,649	45,487	36,844
2021	3,215,282	2,668,684	9,340,394	12,009,078	2,668,684	121.43	121.43	30.00%	36	97,216	64,811	48,608	39,373
2022	3,311,740	2,848,097	9,968,338	12,816,435	2,848,097	121.43	121.43	30.00%	36	103,752	69,168	51,876	42,020
2023	3,411,093	3,035,872	10,625,553	13,661,426	3,035,872	121.43	121.43	30.00%	36	110,592	73,728	55,296	44,790
2024	3,411,093	3,035,872	10,625,553	13,661,426	3,035,872	121.43	121.43	30.00%	36	110,592	73,728	55,296	44,790
2025	3,411,093	3,035,872	10,625,553	13,661,426	3,035,872	121.43	121.43	30.00%	36	110,592	73,728	55,296	44,790
2026	3,411,093	3,035,872	10,625,553	13,661,426	3,035,872	121.43	121.43	30.00%	36	110,592	73,728	55,296	44,790
2027	3,411,093	3,035,872	10,625,553	13,661,426	3,035,872	121.43	121.43	30.00%	36	110,592	73,728	55,296	44,790
2028	3,411,093	3,035,872	10,625,553	13,661,426	3,035,872	121.43	121.43	30.00%	36	110,592	73,728	55,296	44,790
2029	3,411,093	3,035,872	10,625,553	13,661,426	3,035,872	121.43	121.43	30.00%	36	110,592	73,728	55,296	44,790
2030	3,411,093	3,035,872	10,625,553	13,661,426	3,035,872	121.43	121.43	30.00%	36	110,592	73,728	55,296	44,790
2031	3,411,093	3,035,872	10,625,553	13,661,426	3,035,872	121.43	121.43	30.00%	36	110,592	73,728	55,296	44,790
2032	3,411,093	3,035,872	10,625,553	13,661,426	3,035,872	121.43	121.43	30.00%	36	110,592	73,728	55,296	44,790
2033	3,411,093	3,035,872	10,625,553	13,661,426	3,035,872	121.43	121.43	30.00%	36	110,592	73,728	55,296	44,790
2034	3,411,093	3,035,872	10,625,553	13,661,426	3,035,872	121.43	121.43	30.00%	36	110,592	73,728	55,296	44,790
2035	3,411,093	3,035,872	10,625,553	13,661,426	3,035,872	121.43	121.43	30.00%	36	110,592	73,728	55,296	44,790
2036	3,411,093	3,035,872	10,625,553	13,661,426	3,035,872	121.43	121.43	30.00%	36	110,592	73,728	55,296	44,790
2037	3,411,093	3,035,872	10,625,553	13,661,426	3,035,872	121.43	121.43	30.00%	36	110,592	73,728	55,296	44,790
2038	3,411,093	3,035,872	10,625,553	13,661,426	3,035,872	121.43	121.43	30.00%	36	110,592	73,728	55,296	44,790
2039	3,411,093	3,035,872	10,625,553	13,661,426	3,035,872	121.43	121.43	30.00%	36	110,592	73,728	55,296	44,790
2040	3,411,093	3,035,872	10,625,553	13,661,426	3,035,872	121.43	121.43	30.00%	36	110,592	73,728	55,296	44,790
								Totals		**2,508,086**		**1,254,043**	**1,015,775**
								NPV at	**12%**	**750,887**		**375,444**	**304,109**

Economic Study 4 - Chart 1

Conversion of Financial Costs to Economic Costs

Worksheet A: Financial Cost, US$ x 1000

Year	Land	Civil Works	Equipment	Eng'g Svcs	Insti Dev	Social Comp	Admin	Total PC	Replace	O&M	Total
2010											
2011	330	-	-	572	-	91	1	994	-	-	994
2012	-	-	-	1,146	192	-	1	1,339	-	-	1,339
2013	-	11,847	373	1,146	192	-	203	13,759	-	-	13,759
2014	-	12,188	4,444	1,146	192	-	275	18,244	-	-	18,244
2015	-	14,536	3,313	1,146	192	-	296	19,482	-	-	19,482
2016	-	8,368	2,208	358	197	-	175	11,307	-	-	11,307
2017	-	-	-	-	-	-	-	-	-	278	278
2018	-	-	-	-	-	-	-	-	-	499	499
2019	-	-	-	-	-	-	-	-	-	741	741
2020	-	-	-	-	-	-	-	-	-	927	927
2021	-	-	-	-	-	-	-	-	-	1,052	1,052
2022	-	-	-	-	-	-	-	-	-	1,182	1,182
2023	-	-	-	-	-	-	-	-	-	1,298	1,298
2024	-	-	-	-	-	-	-	-	-	1,419	1,419
2025	-	-	-	-	-	-	-	-	-	1,543	1,543
2026	-	-	-	-	-	-	-	-	-	1,657	1,657
2027	-	-	-	-	-	-	-	-	-	1,657	1,657
2028	-	-	-	-	-	-	-	-	372.53	1,657	2,030
2029	-	-	-	-	-	-	-	-	4,444	1,657	6,101
2030	-	-	-	-	-	-	-	-	3,313	1,657	4,970
2031	-	-	-	-	-	-	-	-	2,208	1,657	3,866
2032	-	-	-	-	-	-	-	-	-	1,657	1,657
2033	-	-	-	-	-	-	-	-	-	1,657	1,657
2034	-	-	-	-	-	-	-	-	-	1,657	1,657
2035	-	-	-	-	-	-	-	-	-	1,657	1,657
2036	-	-	-	-	-	-	-	-	-	1,657	1,657
2037	-	-	-	-	-	-	-	-	-	1,657	1,657
2038	-	-	-	-	-	-	-	-	-	1,657	1,657
2039	-	-	-	-	-	-	-	-	-	1,657	1,657
2040	-	-	-	-	-	-	-	-	-	1,657	1,657
Totals	330	46,939	10,337	5,513	966	91	951	65,126	10,337	33,799	109,262

Economic Study 4 - Chart 2

Conversion of Financial Costs to Economic Costs

Worksheet B: Financial Cost (Net of taxes), USD x 1000

Year	Land	Civil Works	Equipment	Eng'g Svcs	Insti Dev	Social Comp	Admin	Total PC	Replace	O&M	Total
2010											
2011	300	-	-	447	-	83	1	831	-	-	831
2012	-	-	-	896	180	-	1	1,076	-	-	1,076
2013	-	11,468	339	896	180	-	184	13,067	-	-	13,067
2014	-	11,385	4,392	896	180	-	250	17,102	-	-	17,102
2015	-	13,673	3,271	896	180	-	269	18,288	-	-	18,288
2016	-	7,839	2,181	279	179	-	159	10,637	-	-	10,637
2017	-	-	-	-	-	-	-	-	-	253	253
2018	-	-	-	-	-	-	-	-	-	453	453
2019	-	-	-	-	-	-	-	-	-	674	674
2020	-	-	-	-	-	-	-	-	-	842	842
2021	-	-	-	-	-	-	-	-	-	957	957
2022	-	-	-	-	-	-	-	-	-	1,075	1,075
2023	-	-	-	-	-	-	-	-	-	1,075	1,075
2024	-	-	-	-	-	-	-	-	-	1,075	1,075
2025	-	-	-	-	-	-	-	-	-	1,075	1,075
2026	-	-	-	-	-	-	-	-	-	1,075	1,075
2027	-	-	-	-	-	-	-	-	-	1,075	1,075
2028	-	-	-	-	-	-	-	-	339	1,075	1,413
2029	-	-	-	-	-	-	-	-	4,392	1,075	5,466
2030	-	-	-	-	-	-	-	-	3,271	1,075	4,346
2031	-	-	-	-	-	-	-	-	2,181	1,075	3,255
2032	-	-	-	-	-	-	-	-	-	1,075	1,075
2033	-	-	-	-	-	-	-	-	-	1,075	1,075
2034	-	-	-	-	-	-	-	-	-	1,075	1,075
2035	-	-	-	-	-	-	-	-	-	1,075	1,075
2036	-	-	-	-	-	-	-	-	-	1,075	1,075
2037	-	-	-	-	-	-	-	-	-	1,075	1,075
2038	-	-	-	-	-	-	-	-	-	1,075	1,075
2039	-	-	-	-	-	-	-	-	-	1,075	1,075
2040	-	-	-	-	-	-	-	-	-	1,075	1,075
Totals	**300**	**44,365**	**10,182**	**4,309**	**897**	**83**	**864**	**61,001**	**10,182**	**23,595**	**94,778**

Economic Study 4 - Chart 3
Conversion of Financial Costs to Economic Costs

Worksheet C: Unskilled Labor Component, USD x 1000

Year	Land	Civil Works	Equipment	Eng'g Svcs	Insti Dev	Social Comp	Admin	Total PC	Replace	O&M	Total	Social Conv Factor	Total With Shadow Pricing
2010	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	-	-	-	-	-	-	0	0	-	-	0	0.75	0
2012	-	-	-	-	-	-	0	0	-	-	0	0.75	0
2013	-	4,587	-	-	-	-	37	4,624	-	-	4,624	0.75	3,468
2014	-	4,554	-	-	-	-	50	4,604	-	-	4,604	0.75	3,453
2015	-	5,469	-	-	-	-	54	5,523	-	-	5,523	0.75	4,142
2016	-	3,136	-	-	-	-	32	3,167	-	-	3,167	0.75	2,376
2017	-	-	-	-	-	-	-	-	-	76	76	0.75	57
2018	-	-	-	-	-	-	-	-	-	136	136	0.75	102
2019	-	-	-	-	-	-	-	-	-	202	202	0.75	152
2020	-	-	-	-	-	-	-	-	-	253	253	0.75	190
2021	-	-	-	-	-	-	-	-	-	287	287	0.75	215
2022	-	-	-	-	-	-	-	-	-	322	322	0.75	242
2023	-	-	-	-	-	-	-	-	-	322	322	0.75	242
2024	-	-	-	-	-	-	-	-	-	322	322	0.75	242
2025	-	-	-	-	-	-	-	-	-	322	322	0.75	242
2026	-	-	-	-	-	-	-	-	-	322	322	0.75	242
2027	-	-	-	-	-	-	-	-	-	322	322	0.75	242
2028	-	-	-	-	-	-	-	-	-	322	322	0.75	242
2029	-	-	-	-	-	-	-	-	-	322	322	0.75	242
2030	-	-	-	-	-	-	-	-	-	322	322	0.75	242
2031	-	-	-	-	-	-	-	-	-	322	322	0.75	242
2032	-	-	-	-	-	-	-	-	-	322	322	0.75	242
2033	-	-	-	-	-	-	-	-	-	322	322	0.75	242
2034	-	-	-	-	-	-	-	-	-	322	322	0.75	242
2035	-	-	-	-	-	-	-	-	-	322	322	0.75	242
2036	-	-	-	-	-	-	-	-	-	322	322	0.75	242
2037	-	-	-	-	-	-	-	-	-	322	322	0.75	242
2038	-	-	-	-	-	-	-	-	-	322	322	0.75	242
2039	-	-	-	-	-	-	-	-	-	322	322	0.75	242
2040	-	-	-	-	-	-	-	-	-	322	322	0.75	242
Totals	-	17,746	-	-	-	-	173	17,919	-	7,079	24,997	0.75	18,748

Economic Study 4 - Chart 4
Conversion of Financial Costs to Economic Costs

Worksheet D: Financial Cost (net of taxes and unskilled labor), USD x 1000

Year	Land	Civil Works	Equipment	Eng'g Svcs	Insti Dev	Social Comp	Admin	Total PC	Replace	O&M	Total	Social Conv Factor	Total With Shadow Pricing
2010													
2011	300	-	-	447	-	83	1	831	-	-	831	1.00	831
2012	-	-	-	896	180	-	1	1,076	-	-	1,076	1.00	1,076
2013	-	6,881	339	896	180	-	147	8,442	-	-	8,442	1.00	8,442
2014	-	6,831	4,392	896	180	-	200	12,498	-	-	12,498	1.00	12,498
2015	-	8,204	3,271	896	180	-	215	12,765	-	-	12,765	1.00	12,765
2016	-	4,703	2,181	279	179	-	127	7,470	-	-	7,470	1.00	7,470
2017	-	-	-	-	-	-	-	-	-	177	177	1.00	177
2018	-	-	-	-	-	-	-	-	-	317	317	1.00	317
2019	-	-	-	-	-	-	-	-	-	472	472	1.00	472
2020	-	-	-	-	-	-	-	-	-	590	590	1.00	590
2021	-	-	-	-	-	-	-	-	-	670	670	1.00	670
2022	-	-	-	-	-	-	-	-	-	752	752	1.00	752
2023	-	-	-	-	-	-	-	-	-	752	752	1.00	752
2024	-	-	-	-	-	-	-	-	-	752	752	1.00	752
2025	-	-	-	-	-	-	-	-	-	752	752	1.00	752
2026	-	-	-	-	-	-	-	-	-	752	752	1.00	752
2027	-	-	-	-	-	-	-	-	-	752	752	1.00	752
2028	-	-	-	-	-	-	-	-	339	752	1,091	1.00	1,091
2029	-	-	-	-	-	-	-	-	4,392	752	5,144	1.00	5,144
2030	-	-	-	-	-	-	-	-	3,271	752	4,023	1.00	4,023
2031	-	-	-	-	-	-	-	-	2,181	752	2,933	1.00	2,933
2032	-	-	-	-	-	-	-	-	-	752	752	1.00	752
2033	-	-	-	-	-	-	-	-	-	752	752	1.00	752
2034	-	-	-	-	-	-	-	-	-	752	752	1.00	752
2035	-	-	-	-	-	-	-	-	-	752	752	1.00	752
2036	-	-	-	-	-	-	-	-	-	752	752	1.00	752
2037	-	-	-	-	-	-	-	-	-	752	752	1.00	752
2038	-	-	-	-	-	-	-	-	-	752	752	1.00	752
2039	-	-	-	-	-	-	-	-	-	752	752	1.00	752
2040	-	-	-	-	-	-	-	-	-	752	752	1.00	752
Totals	300	26,619	10,182	4,309	897	83	691	43,082	10,182	16,517	69,781		69,781

Economic Study 4 - Chart 5
Conversion of Financial Costs to Economic Costs

Worksheet E: Total Economic Cost, USD x 1000

Year	Land	Civil Works	Equipment	Eng'g Svcs	Insti Dev	Social Comp	Admin	Total PC	Replace	O&M	Total
2010											
2011	300	-	-	447	-	83	1	831	-	-	831
2012	-	-	-	896	180	-	1	1,076	-	-	1,076
2013	-	10,322	339	896	180	-	175	11,911	-	-	11,911
2014	-	10,246	4,392	896	180	-	238	15,951	-	-	15,951
2015	-	12,305	3,271	896	180	-	255	16,907	-	-	16,907
2016	-	7,055	2,181	279	179	-	151	9,845	-	-	9,845
2017	-	-	-	-	-	-	-	-	-	234	234
2018	-	-	-	-	-	-	-	-	-	419	419
2019	-	-	-	-	-	-	-	-	-	623	623
2020	-	-	-	-	-	-	-	-	-	779	779
2021	-	-	-	-	-	-	-	-	-	885	885
2022	-	-	-	-	-	-	-	-	-	994	994
2023	-	-	-	-	-	-	-	-	-	994	994
2024	-	-	-	-	-	-	-	-	-	994	994
2025	-	-	-	-	-	-	-	-	-	994	994
2026	-	-	-	-	-	-	-	-	-	994	994
2027	-	-	-	-	-	-	-	-	-	994	994
2028	-	-	-	-	-	-	-	-	339	994	1,333
2029	-	-	-	-	-	-	-	-	4,392	994	5,386
2030	-	-	-	-	-	-	-	-	3,271	994	4,265
2031	-	-	-	-	-	-	-	-	2,181	994	3,175
2032	-	-	-	-	-	-	-	-	-	994	994
2033	-	-	-	-	-	-	-	-	-	994	994
2034	-	-	-	-	-	-	-	-	-	994	994
2035	-	-	-	-	-	-	-	-	-	994	994
2036	-	-	-	-	-	-	-	-	-	994	994
2037	-	-	-	-	-	-	-	-	-	994	994
2038	-	-	-	-	-	-	-	-	-	994	994
2039	-	-	-	-	-	-	-	-	-	994	994
2040	-	-	-	-	-	-	-	-	-	994	994
Totals	**300**	**39,928**	**10,182**	**4,309**	**897**	**83**	**821**	**56,521**	**10,182**	**21,825**	**88,529**

Economic Study 5
Discounted Economic Cash Flow Statement

USD x 1,000,000

	Base Case Scenario									Sensitivity Scenarios		
Year	Consumer Surplus	Health Benefits	Tourism Benefits	Economic Benefits	Project Cost	Replace Cost	O&M Cost	Economic Costs	Net Benefit	15% Increase in Proj Cost	15% Increase in O&M	15% Reduction in Benefits
2010	-	-	-	-	-	-	-	-	-	-	-	-
2011	-	-	-	-	0.83	-	-	0.83	(0.83)	(0.96)	(0.83)	(0.83)
2012	-	-	-	-	1.08	-	-	1.08	(1.08)	(1.24)	(1.08)	(1.08)
2013	-	-	-	-	11.91	-	-	11.91	(11.91)	(13.70)	(11.91)	(11.91)
2014	-	-	-	-	15.95	-	-	15.95	(15.95)	(18.34)	(15.95)	(15.95)
2015	-	-	-	-	16.91	-	-	16.91	(16.91)	(19.44)	(16.91)	(16.91)
2016	-	-	-	-	9.85	-	-	9.85	(9.85)	(11.32)	(9.85)	(9.85)
2017	0.36	0.59	27.40	28.35	-	-	0.23	0.23	28.12	28.12	28.08	23.86
2018	1.23	0.67	30.39	32.29	-	-	0.42	0.42	31.87	31.87	31.81	27.03
2019	2.16	0.76	33.54	36.46	-	-	0.62	0.62	35.83	35.83	35.74	30.37
2020	3.16	0.86	36.84	40.86	-	-	0.78	0.78	40.08	40.08	39.96	33.95
2021	3.78	0.92	39.37	44.07	-	-	0.89	0.89	43.18	43.18	43.05	36.57
2022	4.57	0.98	42.02	47.57	-	-	0.99	0.99	46.58	46.58	46.43	39.44
2023	5.27	1.04	44.79	51.11	-	-	0.99	0.99	50.11	50.11	49.96	42.45
2024	6.00	1.06	44.79	51.86	-	-	0.99	0.99	50.86	50.86	50.71	43.08
2025	6.77	1.08	44.79	52.64	-	-	0.99	0.99	51.64	51.64	51.50	43.75
2026	7.45	1.11	44.79	53.35	-	-	0.99	0.99	52.35	52.35	52.20	44.35
2027	7.45	1.13	44.79	53.37	-	-	0.99	0.99	52.37	52.37	52.22	44.37
2028	7.45	1.15	44.79	53.39	-	0.34	0.99	1.33	52.06	52.06	51.91	44.05
2029	7.45	1.17	44.79	53.41	-	4.39	0.99	5.39	48.03	48.03	47.88	40.02
2030	7.45	1.20	44.79	53.44	-	3.27	0.99	4.27	49.17	49.17	49.02	41.16
2031	7.45	1.22	44.79	53.46	-	2.18	0.99	3.17	50.29	50.29	50.14	42.27
2032	7.45	1.24	44.79	53.49	-	-	0.99	0.99	52.49	52.49	52.34	44.47
2033	7.45	1.27	44.79	53.51	-	-	0.99	0.99	52.52	52.52	52.37	44.49
2034	7.45	1.30	44.79	53.54	-	-	0.99	0.99	52.54	52.54	52.39	44.51
2035	7.45	1.32	44.79	53.56	-	-	0.99	0.99	52.57	52.57	52.42	44.53
2036	7.45	1.35	44.79	53.59	-	-	0.99	0.99	52.59	52.59	52.44	44.56
2037	7.45	1.37	44.79	53.61	-	-	0.99	0.99	52.62	52.62	52.47	44.58
2038	7.45	1.40	44.79	53.64	-	-	0.99	0.99	52.65	52.65	52.50	44.60
2039	7.45	1.43	44.79	53.67	-	-	0.99	0.99	52.68	52.68	52.53	44.63
2040	7.45	1.46	44.79	53.70	-	-	0.99	0.99	52.70	52.70	52.56	44.65
								EIRR	**36.62%**	**33.73%**	**36.57%**	**33.21%**

NPV of Benefits @12% Social Discount Rate	**156.71**
NPV of Costs @12% Social Discount Rate	**34.82**
Benefit/Cost Ratio (BCR)	**4.50**

Chapter 9.
Drainage, Sewerage, and Sanitation Systems In The Study Area

Chapter 9. Drainage, Sewerage, and Sanitation Systems in The Study Area

9-1 Current Status of Drainage & Wastewater Master Plan for Siem Reap

Currently, the following three major wastewater management plans are available in Siem Reap City:

1. Mekong Tourism Development Project Part A1 : Siem Reap Wastewater Management Final Design Report (**MTDP SRWM**: ADB Loan No. 1969-CAM (SF), April 2006): Refer to 9-2 for detail

2. Feasibility Study Report on the Siem Reap Sewerage System and Improvement of Siem Reap River in the Kingdom of Cambodia (**KOICA**, July 2008): Refer to 9-3 for detail

3. Siem Reap Urban Development Project Drainage & Sewerage Master Plan for the District of Siem Reap Priority Works Draft Master Plan (**SRDSMP**: AFD, December 2009): Refer to 9-4 for detail

9-2 MTDP SRWM: ADB Loan No. 1969-CAM (SF), April 2006

As to **MTDP SRWM**, the proposed sewerage facilities were completed on 31 December 2009 with additional works and now being operated and maintained by Siem Reap Sewerage and Wastewater Treatment Plant Unit under the Ministry of Public Works and Transport.

This project was proposed to mitigate the following problems which Siem Reap District has been suffered for long time:

- Frequent flooding in the central commercial and tourist accommodation area
- Inundation of properties by the combined stormwater runoff and wastewater
- The existing Town Center Drain (TCD) receives raw sewage, septic tank effluent, sullage wastewater, and municipal solid waste resulting in its gross contamination and reduced capacity for the conveyance of stormwater and wastewater flow
- Consequent negative impacts on public safety, access, public health and the aesthetic quality of the urban environment significantly diminish the amenity of the area for support of tourism

The proposed sewerage facilities are as follows:

- Rehabilitation of Town Center Drain L = 2.1 km
- Interceptor Sewer System includes interception chambers, interceptor connection sewers and interceptor sewer. Interceptor main sewer with diameter of 600 to 700 mm and total length of 3,658 m.
- Sanitary sewer with diameter of 200 to 400 mm and total length of 2,820 m.

- 77 service connections
- Improvement of water course of exiting irrigation canal from TDC junction to Town-Ring-Road, L = 900 m
- Wastewater Pumping Station with capacity of 160 L/sec
- Sewer force main with diameter of 450 mm, total length of 2,812 m
- Wastewater Treatment Plant (3 stage Wastewater Stabilization Pond) with capacity of 2,776 m3/day (Stage-1) to be expanded to 5,552 m3/day in Stage-2 scheduled to be completed in 2015
- Additional Works (Variation Order No. 5)
  - Additional interceptor connecting sewer and sanitary sewer of 2,994 m with 116 service connections
  - Road/Access improvement of 786 m long in Stoeng Thmey Village
  - 4 debris traps connects to TCD
  - 2 new storm drain, L = 679 m
  - Rehabilitation/repair/replace of 60 stormwater collection chambers within storm drain collection area to TCD
- Extra Additional Works (Variation Order No. 6)
  - Repair/replace of additional 40 stormwater collection chambers and inlet structures along Sam Dech Tep Vong Street
  - Improvement of irrigation canal from TCD end to Ring-Road
  - Improvement of water course of exiting irrigation canal from TCD end to Psar Kraom Market

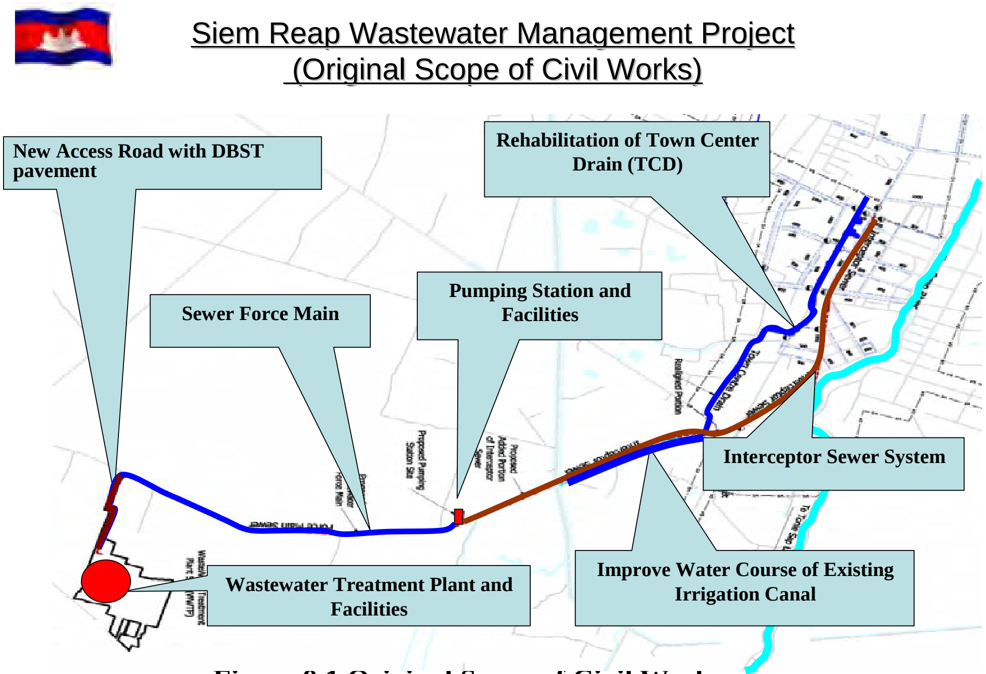


Figure 9.1 Original Scope of Civil Works

Total service area is 265 ha.　Design data for WWTP is as follows:

Table 9.1 Design Data of Wastewater Treatment Plant

Influent	
- Service Population	40,059 persons equivalent
- Unit Sewage Flow	126 L/c.day
- BOD load	364 mg/L
- Ambient Temperature	24 ℃
Wastewater Stabilization Pond	
- WWTP Area	20.3 ha
- Plant Design Capacity	2,776 m^3/day (Stage-1)
	5,552 m^3/day (Stage-2)
- Dimension of Facilities	
Anaerobic Pond	W 29.86 m×L 58.86 m×H 4.5 m×2 units (existing)
Facultative Pond	W 44.50 m×L 119.00 m×H 2.25 m×2 units (existing)
Maturation Pond	W 81.00 m×L 221.00 m×H 2.0 m×2 units (existing)
Sludge Drying Bed	W 24.28 m×L 58.86 m×1 unit (existing)
- BOD Removal Rate	95 %
- Coliform Removal Rate	99 %
Effluent	
- BOD load	18.2 mg/L
- Allowable Limit of BOD	80 mg/L [*)]

[*)] Source : Cambodian Water Pollution Control Sub-decree No. 27 on April 1999

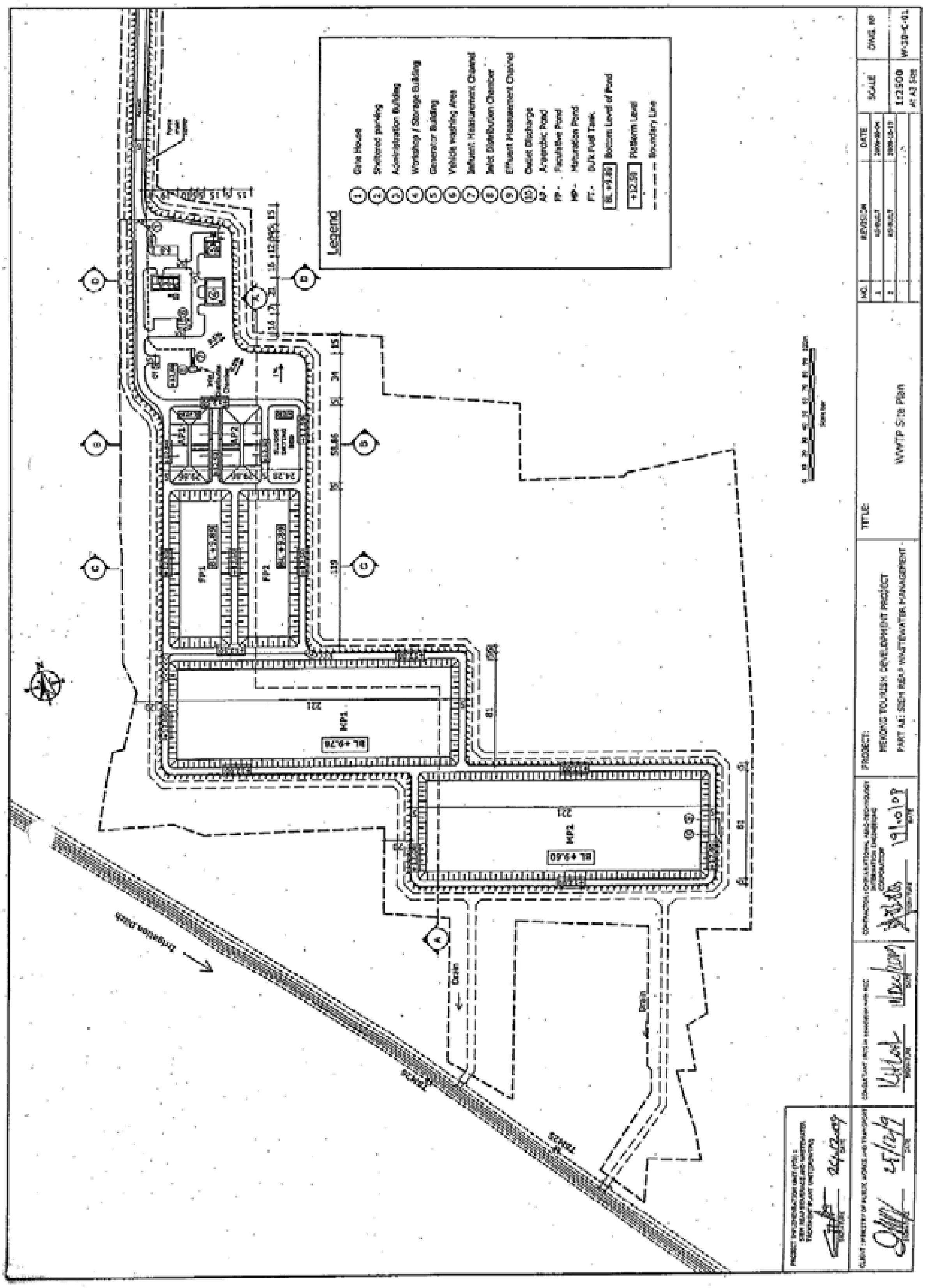


Figure 9.2 Detailed drawings of WWTP Facilities

The followings are the completed sewerage facilities:

	
Mechanical Coarse Screen in Wastewater Pumping Station (WWPS)	Activated Carbon Deodorizing Tower at WWPS
	
Pumps 4.8 m^3/min × 2 units (1 unit Stand-by)	Monitor Panel of WWPS and Wastewater Treatment Plant (WWTP)
	
Inlet Measurement Channel and Inlet Distribution Chamber	Ultrasonic Water Level Sensor installed in Partial Flume

	
Anaerobic Pond	Polyethylene Waterproof Sheet covering the dike and bottom of Ponds
	
Septage Disposal Facility installed next to Anaerobic Pond	Facultative Pond
	
Maturation Pond	Effluent of Maturation Pond

This project also provided sewer cleaning equipment and septage collection vaccum truck with tank capacity of 6 m^3.

Table 9.2 Provided Sewer Maintenance Equipment

Sewer Cleaning Equipment: 1 set of Sewer Jetting Machine on Trailer ➢ High pressure jetting hose on reel with about 60 m long ➢ 10 m long suction hose and strainer ➢ Pumping system can supply water of 45 l/min in 150 bar ➢ Minimum 400 L water tank ➢ Variety set of nozzles and accessories for effective sewer cleaning up to 250 mm pipes Preferable: The same type was adopted in Sihanoukville Sewerage and Wastewater Treatment Unit	
Septage Collection Vacuum Truck: 1 set of Sewage Vacuum Truck ➢ Truck with 210 hp diesel engine and manual gear system, 9 speed synchromesh, powered steering ➢ Fixed cylindrical steel tank with capacity of 6,000 L (Tank Dia. 1,700 mm, Length 4,000 mm) ➢ Rotary vane type vacuum pump powered hydraulically by PTO with maximum capacity of 10,000 L/min, 1,200 rpm, 0.95 bar vacuum and 1.5 bar pressure	
Spare Parts	Spare parts for minimum of 3 years for above items

SRWM WWTP has a septage reception facility.

This project also involved Institutional Development Program and the results are as follows:

- Siem Reap Sewerage and Wastewater Treatment Plant Unit was officially established by MPWT-PRAKAS No. 074 dated 11 February 2008
- PRAKAS on the establishment and operation of Siem Reap Sewerage and Wastewater Treatment Plant Unit approved by MPWT-PRAKAS No. 092 dated 20 March 2008
- Organization chart and staffing for Siem Reap Sewerage and Wastewater Treatment Plant Unit approved with MPWT-PRAKAS No. 092 dated 20 March 2008
- Inter-ministerial PRAKAS on service charge for connection and monthly user fee for the sewer collection and treatment of Siem Reap Sewerage and Wastewater Treatment Plant Unit approved by the Minister of Ministry of Economics and Finance inter-ministerial PRAKAS No. 132 dated 02 March 2008
- Developed documents and forms for administrative operation of the Unit dealing with service users such as Application Form, Agreement and Technical Form, etc
- Established/furnished office and recruited 24 staff for Siem Reap Sewerage and Wastewater Treatment Plant Unit and currently received trainings from the project under capacity building program comprised of the following activities:
  - 22 July – 23 August 2009 : Training session on computerized accounting/billing and financial management system of SRSWTPU
  - 14 – 16 September 2009 : Training session on administrative management of newly established SRSWTPU
  - 16 – 17 September 2009 : Technical training session on basic design and construction concept of sewers/drains and plumbing works of SRSWTPU
  - 30 September – 3 October 2009 : Four days study tour to Sihanoukville Sewerage and Wastewater Treatment Plant as well as visit production process plant and wastewater management of Angkor Beer Brewery
  - 17 December 2009 : Training session on benefit monitoring and evaluation (BME) of the project for SRSWTPU

Organization chart of the Ministry of Public Works and Transport and Siem Reap Sewerage and Wastewater Treatment Plant Unit (SRSWTPU) are shown below:

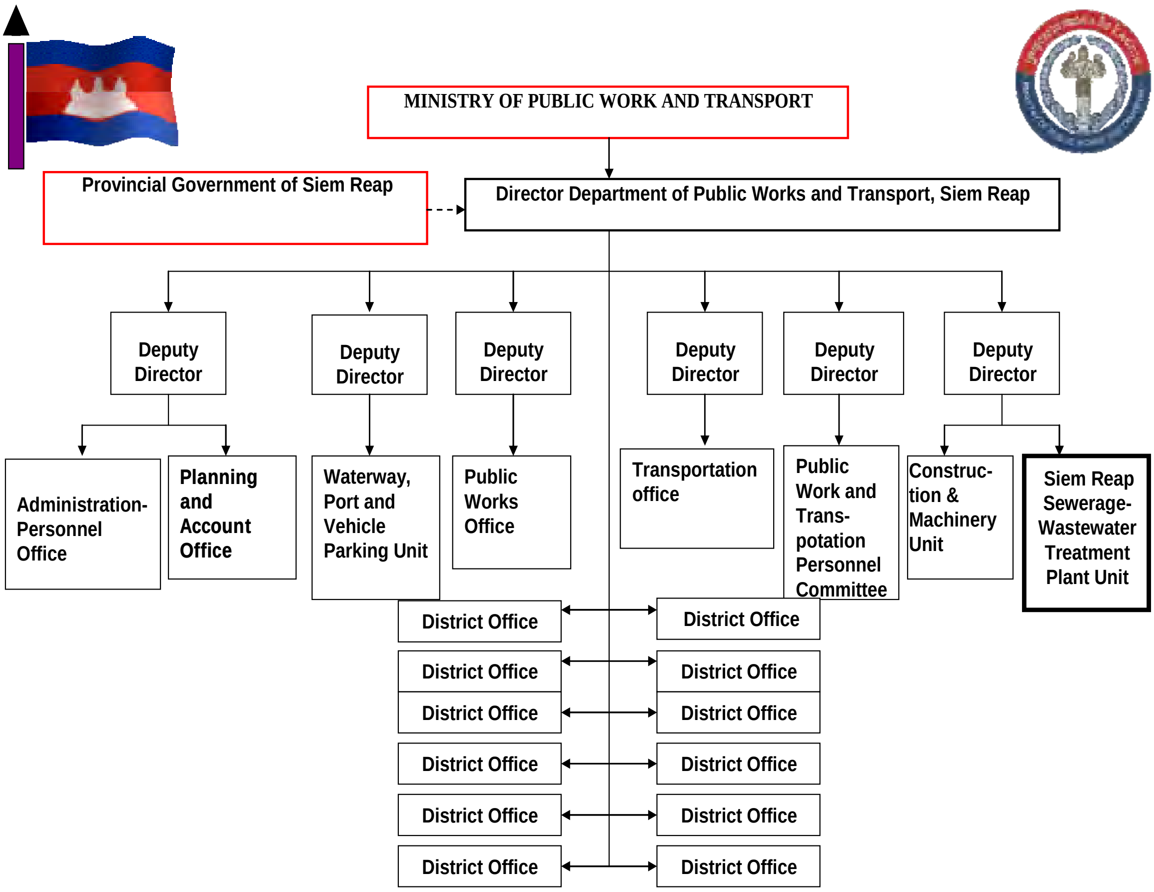


Figure 9.3 Organization chart of the Ministry of Public Works and Transport

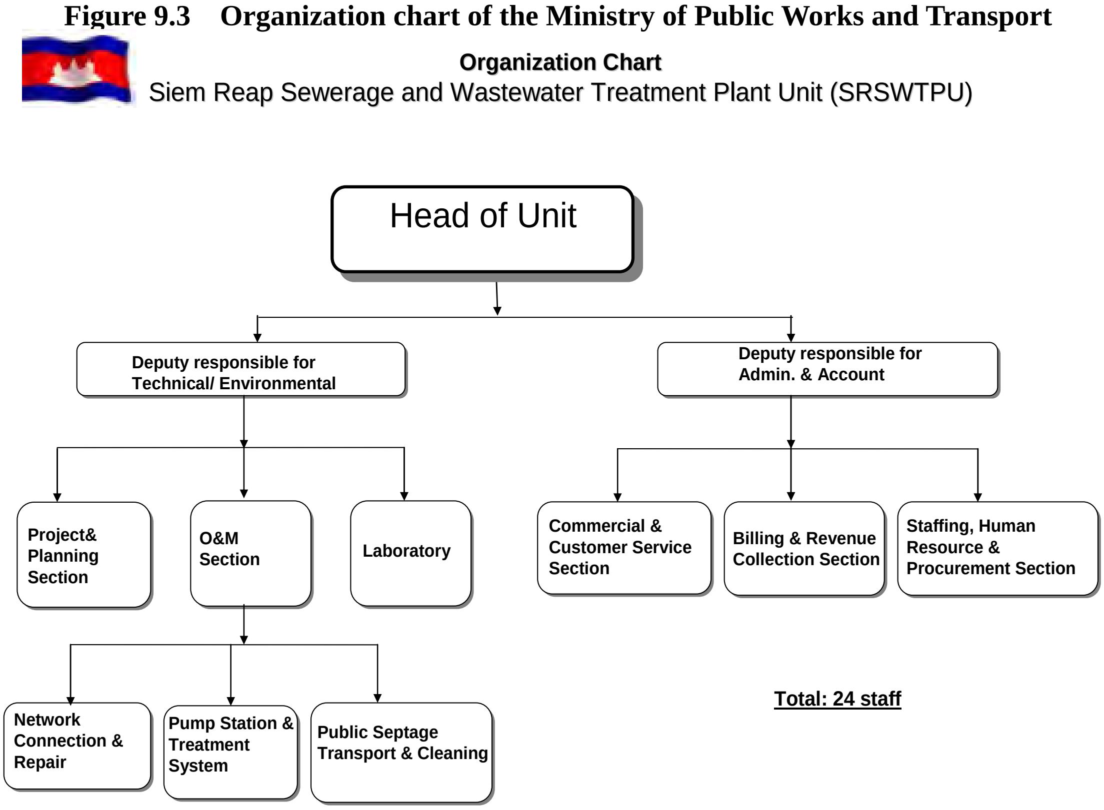


Figure 9.4 Organization chart of Siem Reap Sewerage and Wastewater Treatment Plant Unit (SRSWTPU)

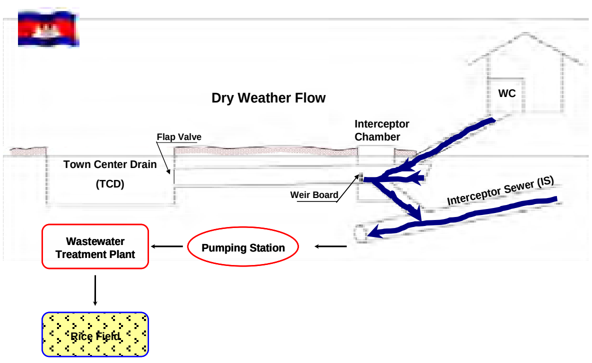
The total project cost (Contract Amount) was 14.37 million US Dollar.

This project aimed the reconstruction and modification of TCD and incoming combined sewers

- Construct "Interception Chamber" in course of existing combined sewer
- As interception chamber has diversion weir, all incoming wastewater during dry weather is diverted to Interceptor Sewer
- In case of wet weather, 4 times of Dry Weather Flow is diverted to Interceptor Sewer and remaining flow is discharged to TCD

Refer to the following schematic diagrams showing how Interceptor Sewer and Interceptor Chamber work during Dry Weather and Wet Weather:

Table 9.3 Functions of Interceptor Chamber during Dry and Wet Weather

<table>
<tr>
<td>
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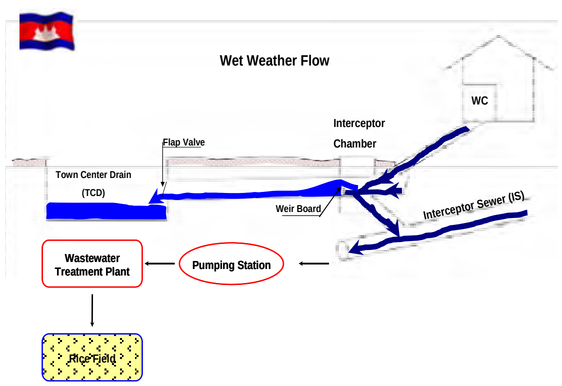
<td>
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</tr>
<tr>
<td>In case of Dry Weather</td>
<td>In case of Wet Weather</td>
</tr>
</table>

Therefore, until separate sewers are provided throughout the service area, interceptor sewer will also carry stormwater up to 4 times of Dry Weather Flow. The following photos are showing reconstructed Town Center Drain (TCD):

Table 9.4 Views of reconstructed Town Center Drain

	
View of Town Center Drain	Existing incoming Combined Sewer with Flap Gate

Project Benefits

Before the project completion, some parts of Town Center Drain were non-sealed earth drain and all generated wastewater and stormwater has been connected to TDC through the existing combined sewerage network. As major potable water source is tube wells, some wells located near by TCD was heavily contaminated by wastewater infiltration and also by flooding during rainy season. This was proven by the morbidity rate of water-borne diseases. But after the completion of this project, morbidity rate was drastically decreased and this apparently shows the benefit of the Project. The transition of morbidity rate is shown in Table 9.5.

Table 9.5 Transition in Water-borne Disease Morbidity Ratio in Siem Reap City

Name of Diseases	2006	2007	2008
Normal Diarrhea	4,201	3,011	2,490
	(1.000)	(0.717)	(0.593)
Strong Diarrhea	319	192	197
	(1.000)	(0.602)	(0.618)
Decentria	8,457	8,317	7,342
	(1.000)	(0.983)	(0.868)
Skin Disease	3,483	3,391	3,192
	(1.000)	(0.974)	(0.916)

Source) Siem Reap Provincial Hospital

Morbidity of typical water-borne disease Diarrhea was decreased to almost 60%. Flooding was also mitigated by the reconstruction of Town Center Drain. The following graph visually shows the transition in disease morbidity:

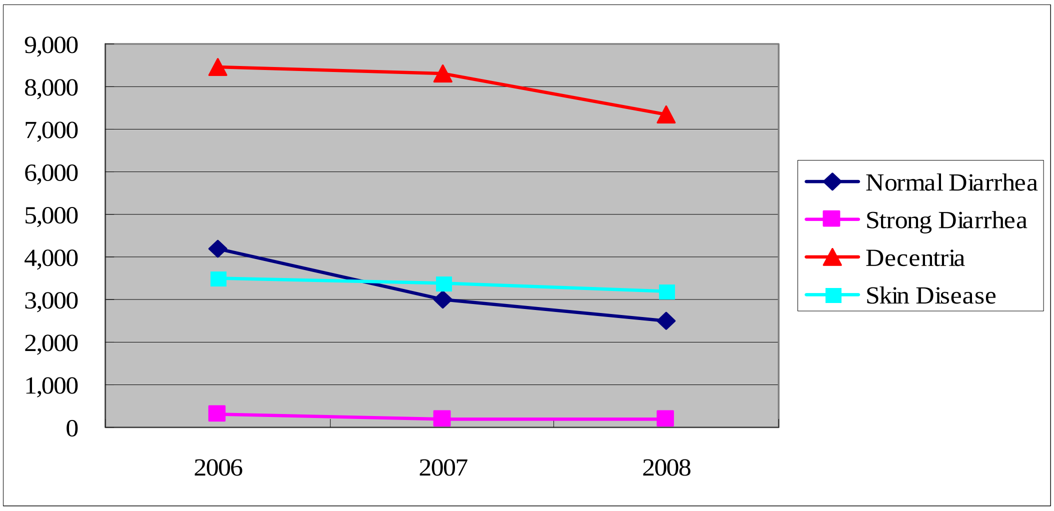


Figure 9.5 Transition in Water-borne Disease Morbidity Ratio

Sewerage tariff has not been collected in Siem Reap City but the Unit has a plan to charge the tariff together with public service tariff such as water supply and garbage collection. Proposed sewerage tariff table is shown in Table 9.6.

Table 9.6 Sewerage Tariff Table

Type of Consumers	Connect Service	Monthly Service Charge
Private House		Unit: Cambodian Riel
House Size less than 70 m^2 (Type-1)	42,000	4,000
House Size from 70 m^2 to 300 m^2 (Type-2)	123,000	13,000
House Size larger than 300 m^2 (Type-3)	205,000	35,000
Hotel		
With room number of 1 to 20 (Type-1)	164,000	110,000
With room number of 21 to 40 (Type-2)	246,000	123,000
With room number of 41 to 60 (Type-3)	287,000	186,000
With room number of 61 to 100 (Type-4)	410,000	522,000
With room number larger than 101 (Type-5)	902,000	1,260,000
Guest House		
With room number of 1 to 7 (Type-1)	82,000	30,000
With room number of 8 to 15 (Type-2)	164,000	58,000
With room number larger than 16 (Type-3)	287,000	145,000
Restaurant		
With chair number of 1 to 40 (Type-1)	164,000	37,000
With chair number of 41 to 100 (Type-2)	205,000	46,000
With chair number larger than 101 (Type-3)	246,000	187,000
Others		
Store House/Car Parking	205,000	41,000
Gas Station/Work Shop/Machinery Repair Factory	164,000	73,000
Massage Club/Karaoke Club/Night Club	205,000	42,000
Governmental (Public) Building	164,000	44,000
Pagoda	82,000	22,000
School (Private/Public)	41,000	41,000
Hospital/Clinic (Private/Public)	205,000	62,000
Small Factory	287,000	68,000
Car Washing Station	205,000	57,000
Bank	205,000	90,000
Company Office/Governmental Office	164,000	69,000
Souvenir Shop/Super Market	144,000	25,000
Game Center	144,000	25,000
Other Business Center	164,000	208,000
Small Business House	123,000	11,000
Central Mart	287,000	473,000
Old Mart	746,000	174,000
nge Mart	213,000	50,000
Public Toilet	41,000	9,000
Septic Tank Clean Service - Public Wastewater (Contract)		
Septic Tank Type I (Private House)		120,000/Truck
Septic Tank Type II (Hotel Type-1 and 2, Guest House, Restaurant, Public Bldg)		200,000/Truck
Septic Tank Type III (Guest House Type-3, 4, 5 and Restaurant)		400,000/Truck
Septic Tank outside of Service Area		250,000/Truck

9-3 KOICA Feasibility Study, July 2008

Feasibility Study of **KOICA**, they proposed additional service area surrounding that of MTDP SRWM under ADB Loan. Total service area is 934 ha including 265 ha of ADB project service area. They planned sewerage facilities for East District and West District, respectively. East/West District is urban area divided by Siem Reap River.

KOICA planned their WWTP next to MTDP SRWM WWTP. They also employed 3 stage wastewater stabilization pond and its total site area is 40 ha. Figure 9.6 shows the layout of the proposed wastewater facilities:

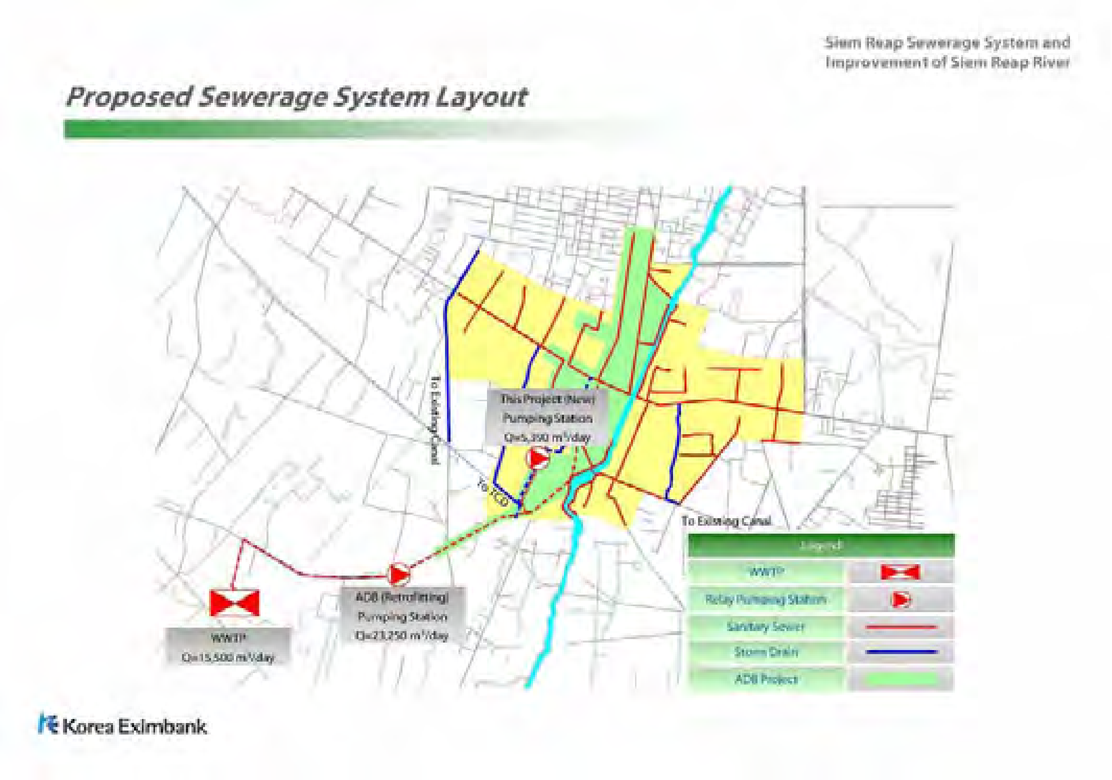


Figure 9.6 Proposed Sewerage System Layout

The followings are the proposed sewerage facilities:

✧ Sanitary Sewers :

Diameter (mm)	East District (m)	West District (m)
200	23,240	14,335
250	1,615	640
300	175	1,565
350	-	1,430
400	725	715
500	2,160	665
Total	27,915	19,350

✧ Stormwater Drainage :

Dimension	East District (m)	West District (m)
Box 3.0 m × 2.0 m	1,380	4,690

✧ Pumping Stations :

New Relay Pumping Station

Item	Specifications	Remarks
Service Area	299 ha	
Total Capacity	5,390 m^3/day	Hourly Maximum
Pump House Dimension	B4.0 m×W4.0 m×H2.5 m	
Pump Specifications	1.9 m^3/min×20 mH×3 (1) units	( ) for stand-by

Modification of ADB existing Relay Pumping Station

Item	Specifications	Remarks
Service Area	934 ha (365 ha in East, 569 ha in West)	
Total Capacity	23,250 m^3/day	Hourly Maximum
Pump House Dimension	B4.7 m×W7.0 m×H1.0 m×2	
Pump Specifications	4.8 m^3/min×25 mH×2 units (Existing) 6.55 m^3/min×25 mH×2 (1) units (New)	( ) for stand-by

Design data for WWTP is as follows:

- Service Population	52,758 persons in 2020
- Tourism Population	54,150 persons (Overnight) 27,113 persons (Returning)
- Unit Wastewater Flow	160 L/c.day (Domestic WW) 80 L/c.day (Overnight Tourists WW) 24 L/c.day (Returning Tourists WW)
- Incoming Wastewater Flow	14,767 m^3/day in 2020
- BOD load	182 mg/L
- Ambient Temperature	24 ℃
- WWTP Area	40 ha
- Plant Design Capacity	10,000 m^3/day (Adding ADB Plant = 15,500 m^3/day)
- Dimension of Facilities	
Pershall Flume	Throat width 12 inch×2 (Inflow, Outflow)
Anaerobic Pond	W 29.86 m×L 58.86 m×H 4 m×4 units
Facultative Pond	W 47.0 m×L 119.0 m×H 1.75 m×4 units
Maturation Pond	W 81.0 m×L 208.0 m×H 1.5 m×4 units
Sludge Drying Bed	
Administration Building	W 22.4 m×L 12.4 m
- BOD Removal Rate	95 %
- Coloform Removal Rate	99 %
Effluent	
- BOD load	9.1 mg/L
- Allowable Limit of BOD	80 mg/L [*)]

[*)] Source : Cambodian Water Pollution Control Sub-decree No. 27 on April 1999

Source of these Tables is “Feasibility Study Report on the Siem Reap Sewerage System and Improvement of Siem Reap River in the Kingdom of Cambodia, July 2008, Korea Exim Bank”.

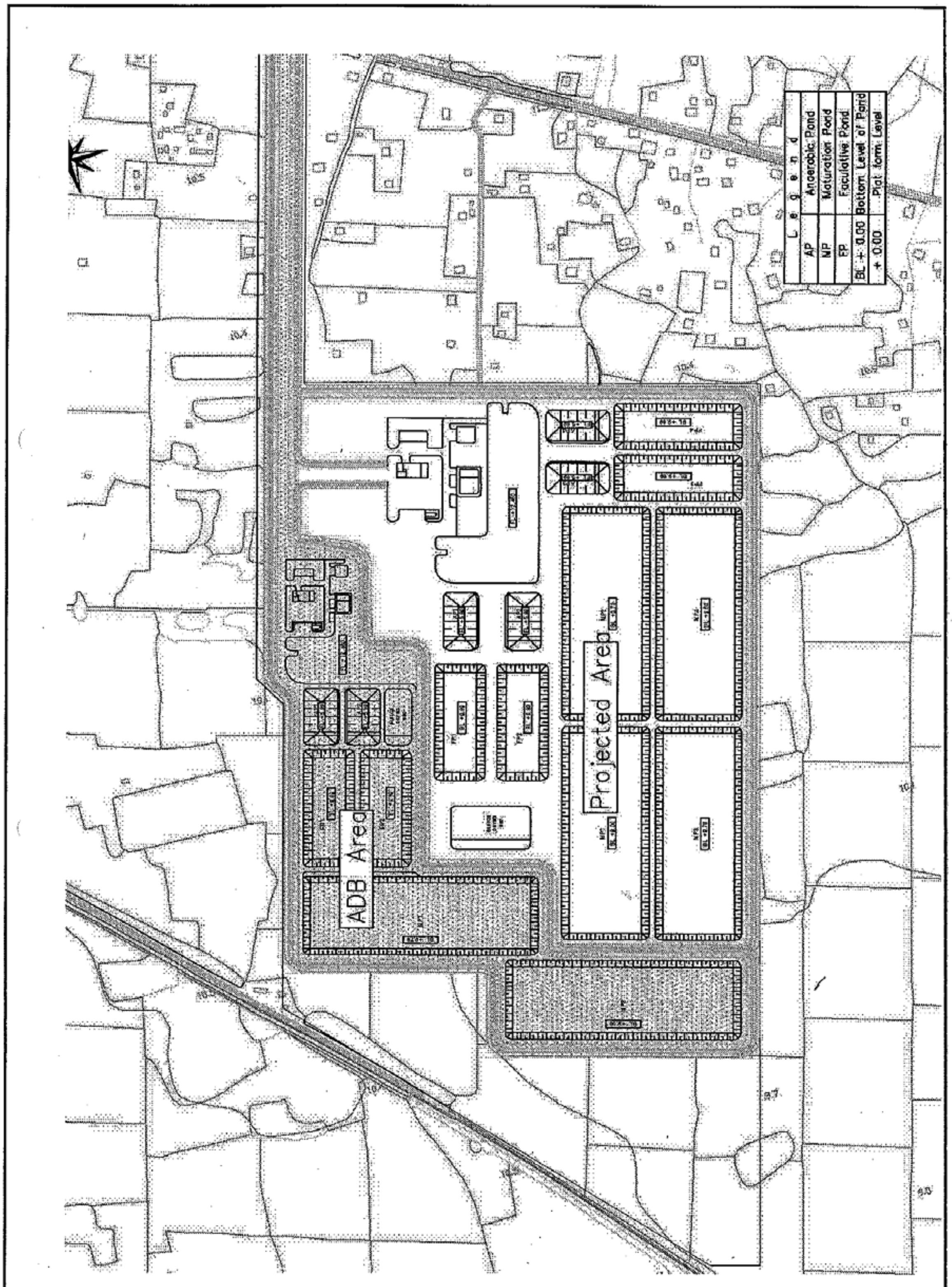


Figure 9.7 KOICA WWTP General Plan

Estimated project cost is US$ 44,546,000 of which US$ 29,908,000 is funded from Korean EDCF Loan and remaining US$ 14,638,000 is funded by the Cambodian Government. Detailed project cost breakdown in shown in the Table below:

Table 9.7 Estimated Project Cost

Item	EDCF				Recipient Country	Total
	Foreign Currency	Local Currency	The 3rd Country	Subtotal		
1. Direct Construction Cost	7,956	12,512	1,000	21,468	-	21,468
a. Sanitary Sewer	1,519	3,086	815	5,420	-	5,420
b. Storm Drain	2,161	3,086	-	4,577	-	4,577
c. Relay Pumping Station	538	326	85	949	-	949
・Civil Works	181	182	-	363	-	363
・Architectural Works	-	34	-	34	-	34
・Mechanical Works	298	21	-	319	-	319
・Electrical Works	-	82	85	167	-	167
・Instrumentation Works	59	7	-	66	-	66
d. Wastewater Treatment Plant	3,111	5,521	96	8,728	-	8,728
・Civil Works	2,870	3,864	-	6,734	-	6,734
・Architectural Works	-	1,588	-	1,588	-	1,588
・Mechanical Works	73	9	-	82	-	82
・Electrical Works	-	52	96	148	-	148
・Instrumentation Works	168	8	-	176	-	176
e. Floodgates	236	59	4	299	-	299
・Civil Works	-	27	-	27	-	27
・Mechanical Works	90	21	-	111	-	111
・Electrical Works	-	1	4	5	-	5
・Instrumentation Works	146	10	-	156	-	156
f. Revetment Improvement	391	1,104	-	1,495	-	1,495
2. Consulting Services	1,799	502	-	2,301	-	2,301
3. Direct Project Cost (1+2)	9,755	13,014	1,000	23,769	-	23,769
4. Taxes and Duties	-	-	-	-	3,273	3,273
VAT (10% of 1+2)	-	-	-	-	2,377	2,377
Custom Duties (10% of Foreign Materials)	-	-	-	-	896	896
5. Physical Contingencies (5% of 3)	488	651	50	1,189	-	1,189
6. Price Contingencies	1,024	3,739	158	4,921	-	4,921
7. Project Management Cost (2% of 3)	-	-	-	-	475	475
8. Service Charge (0.1% of 3+5+6)	29	-	-	29	-	29
9. Land Compensation and Resettlement Cost	-	-	-	-	10,890	10,890
10. Total Project Cost (3+4+5+6+7+8+9)	11,296 (38%)	17,404 (58%)	1,208 (4%)	29,908 (100%)	14,638	44,546

Note) All monetary units is thousand US Dollars
Source) "Feasibility Study Report on the Siem Reap Sewerage System and Improvement of Siem Reap River in the Kingdom of Cambodia, July 2008, Korea Exim Bank"

The project implementation will start after the Korean EDCF Loan Agreement becomes effective and implementation period is estimated as 4 years including detailed design and selection of contractor. (* L/A was signed on 4th June 2009)

Appropriate sewerage tariff shall be proposed through the consultation with MPWT at detailed design stage.

Further, the project includes the following Capacity Building Program:

- Community sanitation and health awareness program
- Preparation of Initial Environment Examination (IEE)
- Preparation of Environment Management Plan (EMP)
- Recommendation on organizational structure and functions for an entity to operate and maintain the sewerage system
- Preparation of legal documents to create the entity
- Establishment of fee structure for the purpose of cost recovery by the entity

9-4 SRDSMP: AFD, December 2009

Siem Reap Urban Development Project Drainage & Sewerage Master Plan for the District of Siem Reap Priority Works, Draft Master Plan (**SRDSMP**: AFD, December 2009) is the newest Master Plan still under preparation.

As aforementioned, one sewerage system with WWTP is completed under ADB Loan and another sewerage system is scheduled to be completed within 4 years after the loan agreement. Therefore SRDSMP is targeting to serve the urban area which is not yet covered by these two projects.

As well as the said two sewerage master plans, this master plan is based on Integrated Mater Plan for Sustainable Development (IMPSD) of Siem Reap and Angkor Town in the Kingdom of Cambodia (2006, JICA) for major design parameters such as population projection, water consumption, wastewater generation rate and wastewater quality.

Needless to mention, as to wastewater generation rates and wastewater quality estimation, the design results of this Study, the newest study is reflected.

9-4-1 Current Status of AFD Sewerage Master Plan

(1) Target Study Areas for Centralized Wastewater Management System

Siem Reap development area consists of two distinct service areas: the Urban Area and the Peri-urban/Rural Area. The urban area can be defined by the following features:

- Central business district
- Area having gross population density exceeding about 20 persons/ha
- Hotel, tourism and commercial areas
- Major water service area: within the urban service area it is intended to provide wastewater collection service wherever an off-site wastewater stream is generated

Figure 2.1 in Chapter 2 shows the present and future water service development area of Siem Reap Water Supply Authority (SRWSA) and rough delineation of Urban Area, Peri-urban Area and Rural Area.

Urban area is target service area for centralized wastewater management system.

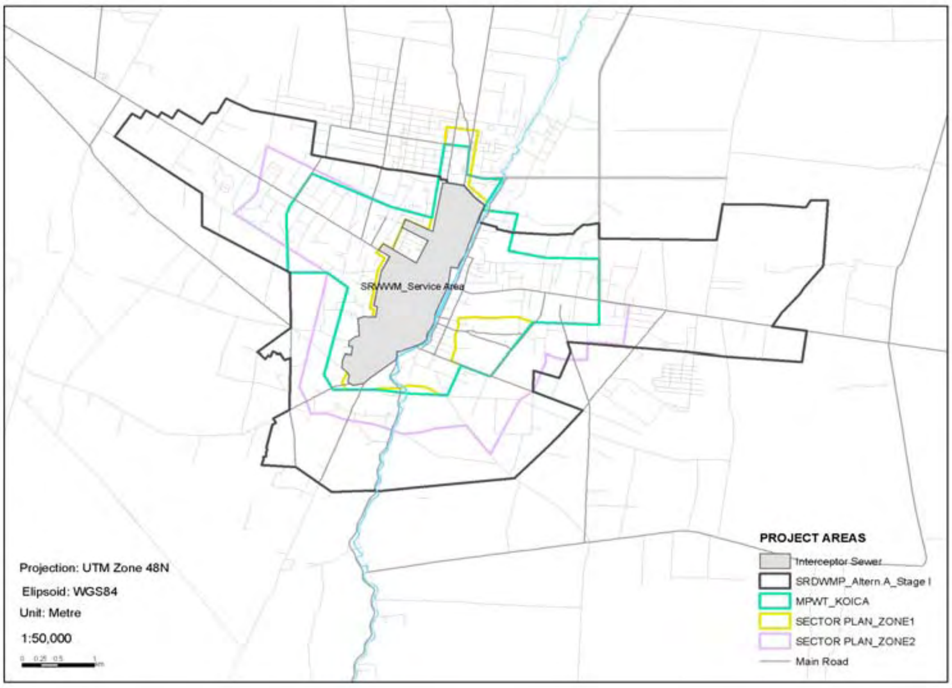


Figure 9.8 Related Project Areas

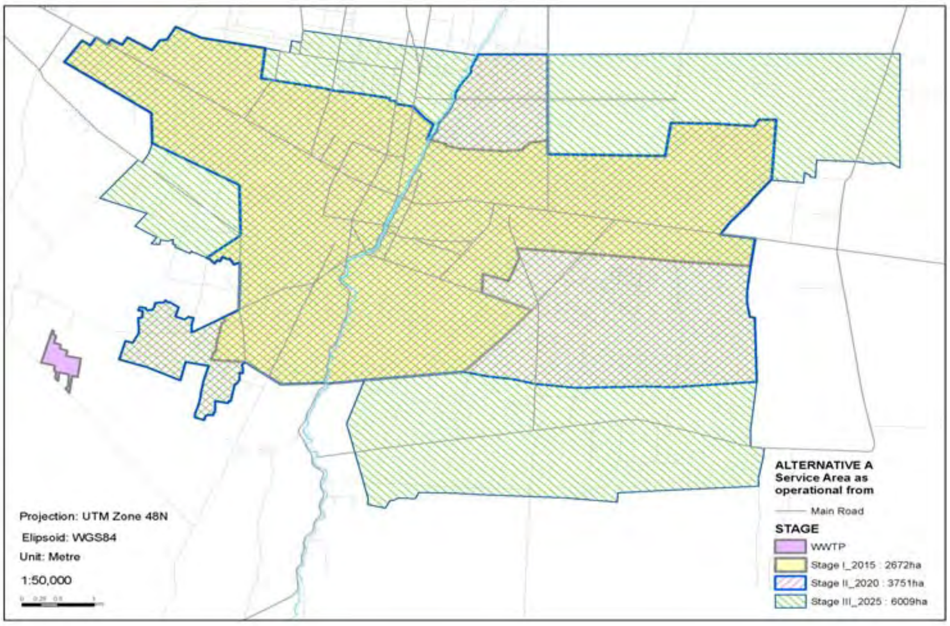


Figure 9.9 Alternative A: Implementation Staging

Figure 9.8 shows the project areas of three other related projects all having 2020 as target planning year.

- Integrated Mater Plan for Sustainable Development (IMPSD) Sector Plan Zone 1 and 2 (598 ha and 1,322 ha, respectively)
- MTDP SRWM Service Area (ADB: 265 ha)

- Feasibility Study KOICA (934 ha included ADB's 265 ha)

While Stage-1 of SRDSMP proposed for completion in 2015 with target planning year of 2035 has an area about 2,672 ha:

Figure 9.9 and Figure 9.10 show two alternative implementation programs, Alternative A and B. Alternative A is a three stage program:

- Stage 1: to be completed in year 2015, targets the urban development area plus the tourism accommodation and commercial areas.
- Stage 2: to be completed in 2020, extends the service area to include the indicated area to the north (developing cultural-tourism-hotel zone), southwest (contiguous settlement area) and southeast (developing extended settlement area)
- Stage 3: to be completed in 2025, complete the provision of service to entire 6,009 ha urban service area

Note) The total Urban Service Area of 6,009 ha includes the service area of KOICA, 934 ha.

Alternative B is a two stage program:

- Stage 1: to be completed in 2015, incorporates Alternative A Stage 1 and 2
- Stage 2: to be completed in 2025, is identical to Alternative A Stage 3

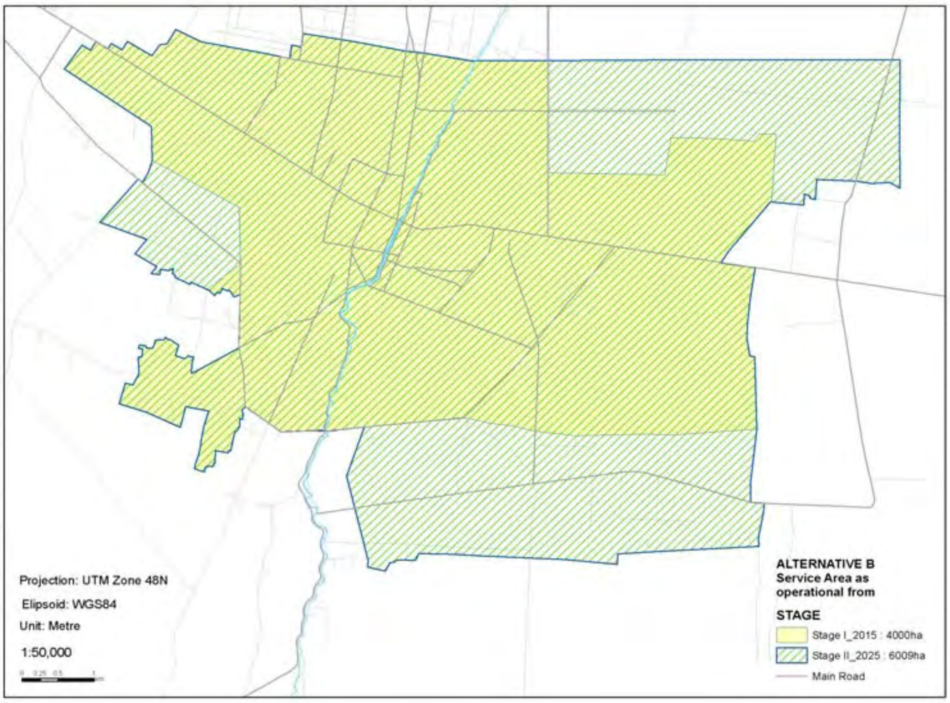


Figure 9.10 Alternative B: Implementation Staging

Figure 9.11 and Figure 9.12 respectively show the impacts of Alternative A and B addressing the reduction of the service backlog through project implementation period. Both alternatives assume that the service provided by the second phase of MTDP SRWM increasing capacity to 5,552 m^3/day and the KOICA project at 10,000 m^3/day will be completed in 2015.

Wastewater generation rate is reckoned by multiplying unit water consumption rate set by water use categories, category-wise service population and sewerage conversion rate. Service backlog means the gap between wastewater generation rate and total WWTP capacity. If total WWTP capacity is less than wastewater generation rate, service backlog becomes minus. At present, only existing WWTP is ADB WWTP but total WWTP capacity will be increased by ADB Second Stage construction, KOICA project and proposed ADF project.

With either Alternative A and B, service backlog will be maintained at a relatively low level (less than 5,000 m^3/day). In the absence of significant differences in the effectiveness of these two alternatives, intuitively Alternative would be expected to be the least costly because of the lower cost in initial program. Thus, the further examination on other options will be conducted using Alternative A as the base plan.

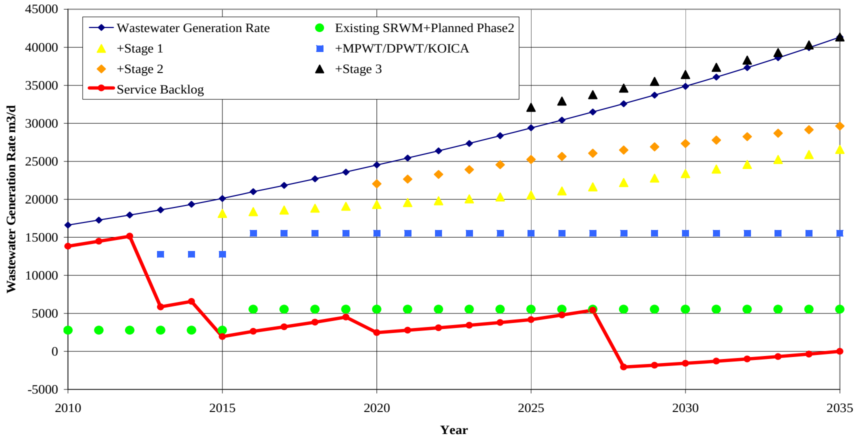


Figure 9.11 Alternative A: Collection Service Provided and Backlog

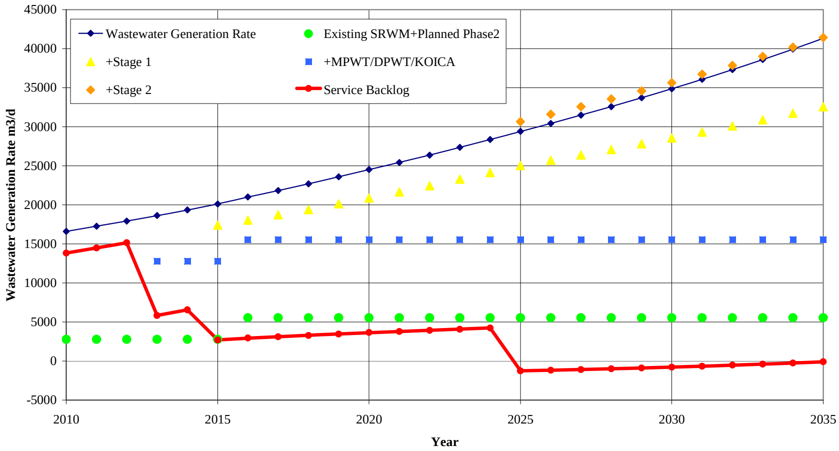


Figure 9.12 Alternative B: Collection Service Provided and Backlog

Source) "Drainage & Sewerage Master Plan for the District of Siem Reap Priority Works Draft Master Plan, AFD, December 2009"

If service backlog decreases, pollution loads have been burdened by public water bodies will be lessened and eventually loads to Tole Sap Lake, the valuable water source will be mitigated as well. Preservation of water quality in Tole Sap Lake will contribute to aqua-environmental conservation and public hygiene upgrading.

The urban service area has been divided into two groups of service sub-areas, SA_W1 to SA_W7 in the west of Siem Reap River and SA_E1 to SA_E12 in the east as shown in Figure 9.13.

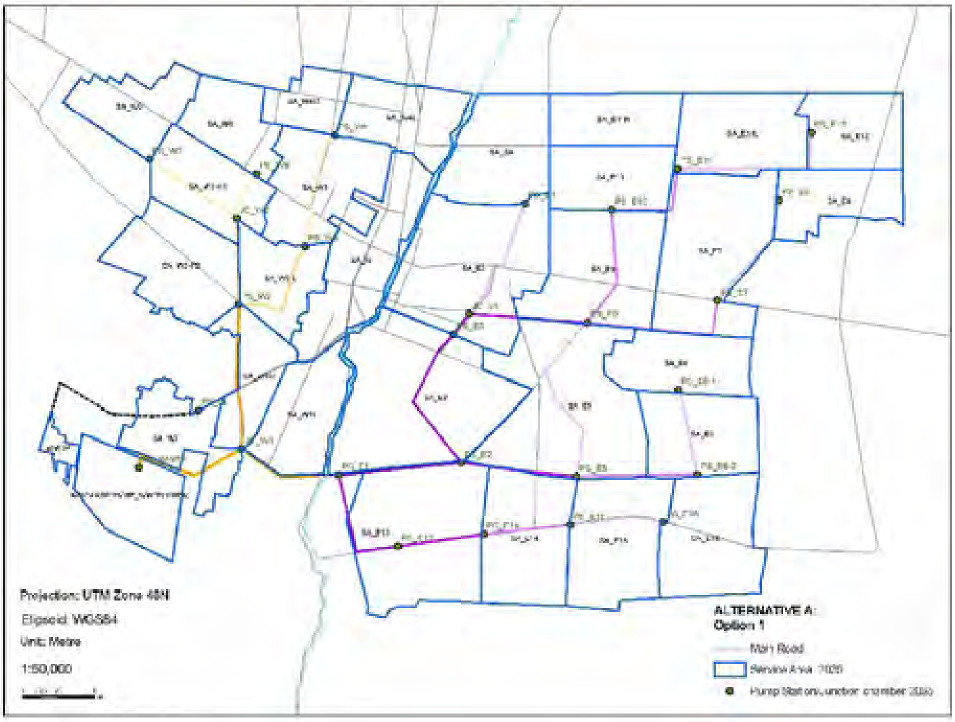


Figure 9.13 Service Sub Areas

(2) Trunk Sewers, Reticulation Sewers and other related sewerage facilities

Reticulation sewers and related facilities were designed by abovementioned service sub-area wise. The elements of the system include:

- Service connections: 100 mm and 150 mm diameter, totaling 634 km located at about 10 m intervals along with the reticulation sewers
- Inspection chambers: to be provided on each service connection
- Reticulation sewers: 150 mm, 200 mm, 250 mm and 300 mm diameter, totaling 653 km
- Manholes: totaling about 9,400 pieces spaced at 70 m intervals along with the reticulation sewers

Table 9.8 is a schedule of trunk sewers having total length of about 40.7 km with 490 manholes with intervals of 100 m approximately.

(3) Pumping Stations

Table 9.9 is a schedule of pumping stations required. There are a total of 23 pump stations ranging in peak flow capacity from 1,128 m^3/day to 71,619 m^3/day.

Table 9.8 Trunk Sewers

Service Sub Area	Trunk Sewer Length, m									Av. Depth (m)
	300 mm	350 mm	400 mm	500 mm	600 mm	700 mm	800 mm	1000 mm	1200 mm	
SA_E2							2211	1708		3.1
SA_E3					1880					3.8
						362				4.0
SA_E4										
SA_E5			2122							3.6
				1602						4.2
SA_E6			1916							3.0
			1685							4.7
SA_E7		1720								3.3
SA_E8										
SA_E9				1737	1648					3.4
SA_E10										
SA_E11-R										
SA_E11-L	1432									4.1
SA_E11-L	2333									6.5
SA_E13				1204						3.2
(FM)				1704						5.2
SA_E14			1213							3.2
SA_E15			1296							3.4
SA_W1-R						2019				2.5
SA_W1-L								1157		2.9
SA_W2-R			1472							3.0
			1213							5.9
SA_W2-R	703									2.1
SA_W2-L				1601						2.8
SA_W3				1685						5.6
SA_W7									3063	4.4

Table 9.9 Schedule of Pumping Stations

Pump Station	2035 Peak Flow Rate	TDH	Station Type	Total Pumps (1 pump standby)	Initial Year	Initial Duty Pump Sets	2035 Duty Pump Sets	Pump Set Power Rating
	m^3/d	m ww		nr		nr	nr	kW
W4	2334	4.0	Submersible	2	2020	1	1	1.5
W3	9554	4.4	Submersible	2	2015	1	1	6.7
W5	1559	3.9	Submersible	2	2015	1	1	1.0
W6	3097	3.8	Submersible	2	2015	1	1	1.9
W2	20122	6.2	Submersible	2	2015	1	1	19.8
E12	1166	3.8	Submersible	2	2025	1	1	0.7
E11	4916	6.2	Submersible	2	2025	1	1	4.9
E10	3588	5.3	Submersible	2	2025	1	1	3.1
E9	5697	3.2	Submersible	2	2015	1	1	2.9
E8	1128	3.9	Submersible	2	2015	1	1	0.7
E7	5178	6.3	Submersible	2	2015	1	1	5.2
E6-1	3750	6.0	Submersible	2	2020	1	1	3.6
E6-2	7036	3.1	Submersible	2	2020	1	1	3.5
E5	12774	4.8	Submersible	2	2020	1	1	9.8
E4	5176	4.1	Submersible	3	2020	1	2	1.7
E3	38227	3.9	WW/ DW	4	2015	2	3	7.8
E2	47601	4.2	WW/ DW	4	2015	2	3	10.7
E16	5000	6.0	Submersible	2	2025	1	1	4.8
E15	2855	4.0	Submersible	2	2025	1	1	1.8
E14	5108	3.2	Submersible	2	2025	1	1	2.6
E13	6872	3.2	Submersible	2	2025	1	1	3.5
E1	51459	3.4	WW/ DW	4	2015	2	3	9.3
WWTP	71619	6.9	WW/ DW	4	2015	2	3	26.2

Source) "Drainage & Sewerage Master Plan for the District of Siem Reap Priority Works Draft Master Plan, AFD, December 2009"

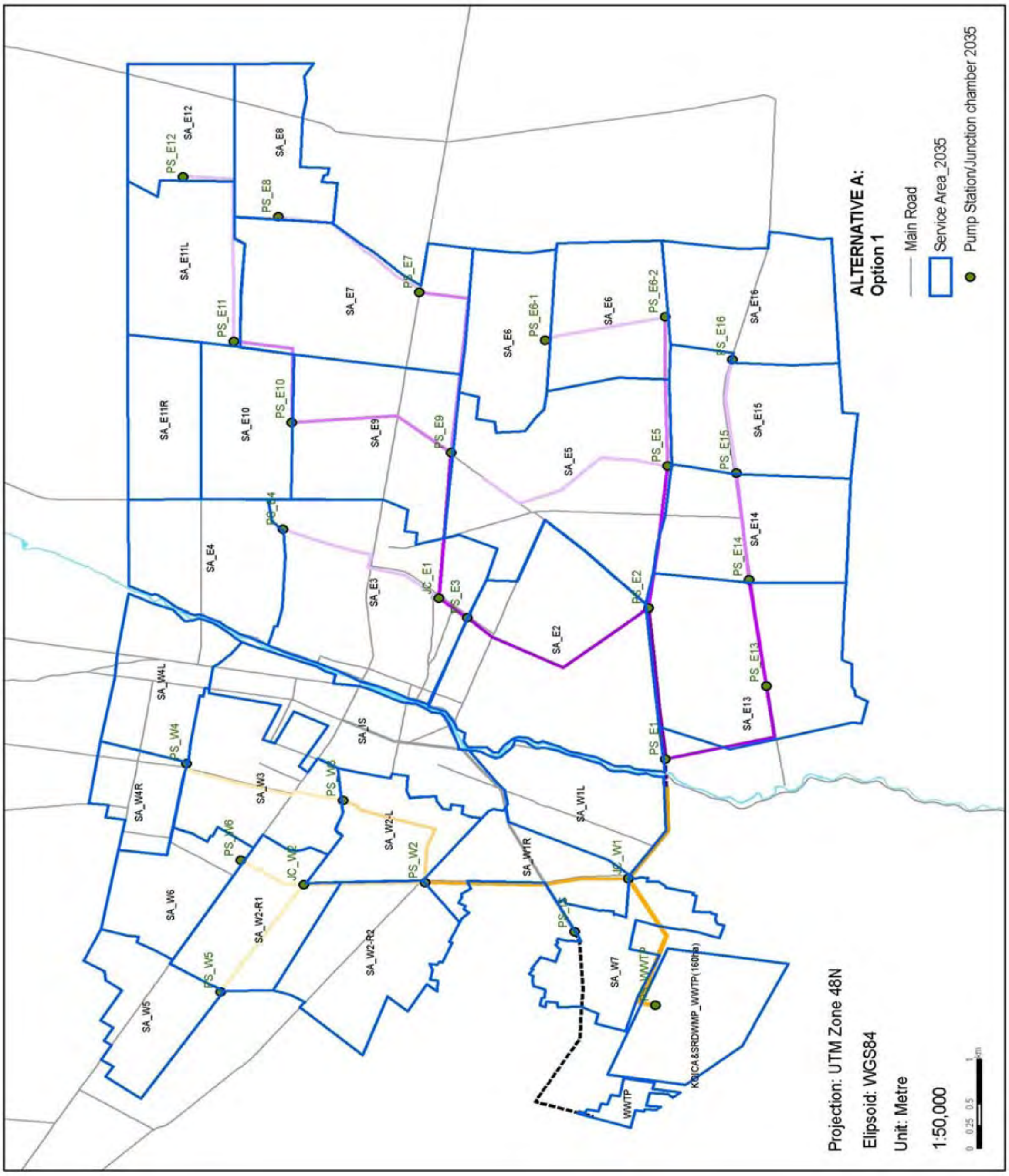


Figure 9.14 Alternative A: Option 1

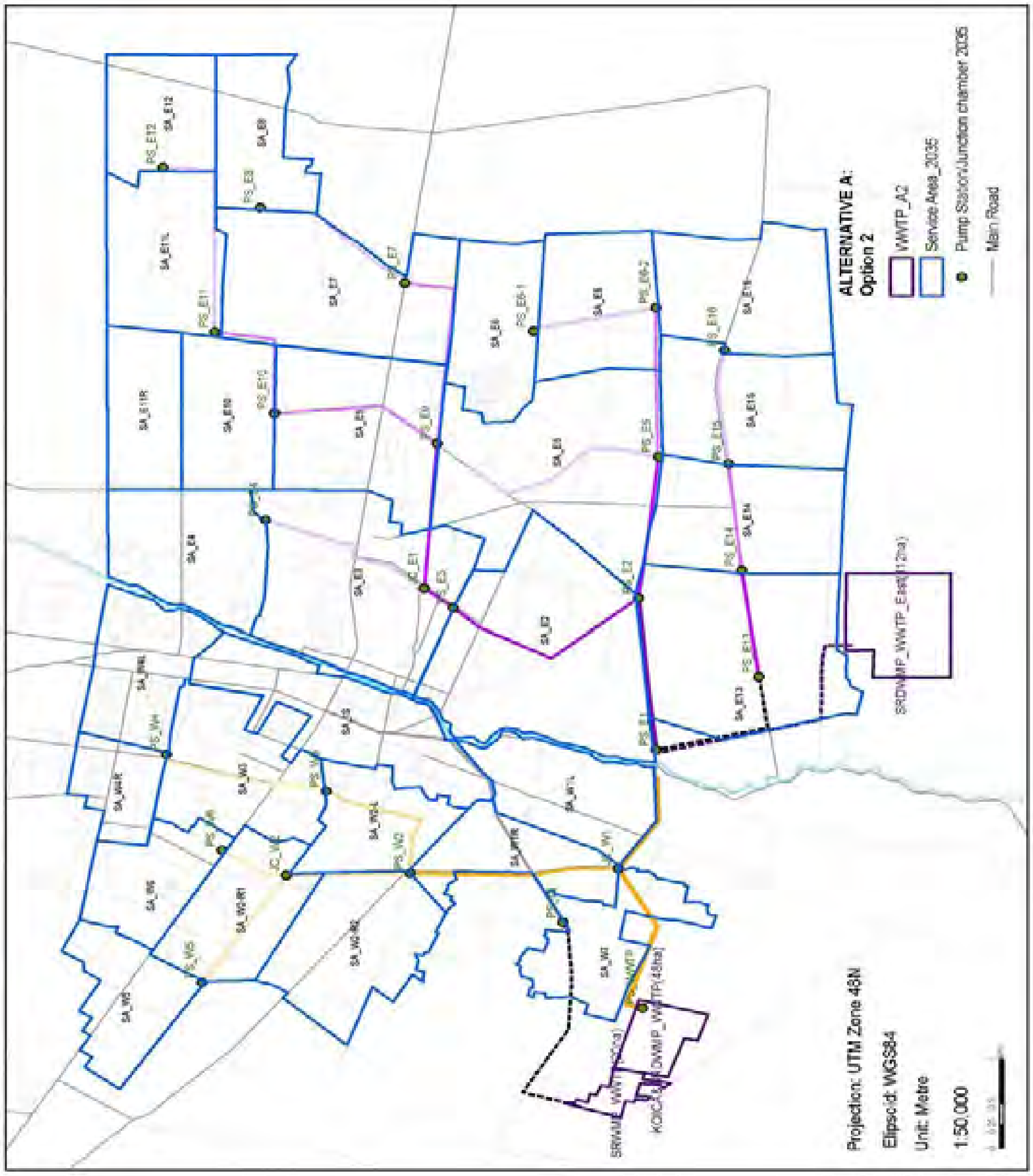


Figure 9.15 Alternative A: Option 2

Figure 9.14 and Figure 9.15 describe two further alternatives on Alternative A with different Wastewater Treatment Plant allocation:

- Option 1 : Provides treatment of all wastewater at a location to the east of the existing 20 ha WWTP site constructed under MTDP SRWM. The total site area required is 160 ha, including 40 ha for the KOICA site.
- Option 2 : Provides independent treatment facilities for the East and West service areas. West WWTP needs additional 8 ha excluding 40 ha for the KOICA site. East WWTP requires 112 ha in total.

Their staged construction schedule for the treatment facilities are shown as follows:

Table 9.10 Staged Construction Schedule for WWTP

Options	Stage 1 : 2015	Stage 2 : 2018	Stage 3 : 2028	Total Additional Capacity (m^3/day)
Option1 All West	10,000	10,000	10,000	30,000
	Stage 1 : 2015	Stage 2 : 2025		
Option 2 East	14,000	14,000		28,000
Option 2 West		2,000		2,000

(4) Estimated Construction Cost of Alternative A1

Table 9.11 summarized the estimated cost of Option 1 of Alternative A.

Table 9.11 Estimated Investment Cost Wastewater Master Plan Alternative A1

System Components	Alternative A1				
	2015	2018	2020	2025	2035
Wastewater Treatment Plant Costs	7,650,000	7,650,000		7,650,000	
Trunk Sewer Costs	5,370,341		2,241,348	3,464,607	
Trunk Sewer Manholes	687,616		286,981	443,606	
Pump Station Costs	8,748,036		3,651,051	5,643,683	
Reticulation and Property Connection Costs	75,302,901		31,428,164	48,580,703	
Total	97,758,894	7,650,000	37,607,543	65,782,599	
Cumulative Total	97,758,894	105,408,894	143,016,437	208,799,037	208,799,037

Note 1) Abovementioned project cost was estimated to cover un-served urban service area just excluding MTDP SRWM project, since the progress of KOICA project is still not obvious.

Note 2) Source of these Tables is “Drainage & Sewerage Master Plan for the District of Siem Reap Priority Works Draft Master Plan, AFD, December 2009”

The overall cost of Alternative B will not be significantly different and the selection of the optimum alternative is likely to be determined by the site availability and the cost of site acquisition. The west site location is in a locally low lying area of limited suitability for agriculture and development. The east site is typically of high agricultural and development potential.

These site characteristics may be determining factors for land purchase. The cost of site acquisition is not included in the cost estimates.

9-4-2 Current Status of AFD Storm Water Drainage Master Plan

(1) General

Siem Reap is located in a very flat and low-laying area close to Tonle Sap Lake. The Siem Reap River flows through the city dividing it into East and West drainage areas and main river system further to east and west are the Roulous River and the Puok River, respectively. These are shown in Figure 9.16. The rivers and ultimately all stormwater drainage flow into Tonle Sap Lake.

The Siem Reap River has natural gradient of about 1/1,000 from North to South towards Tonle Sap Lake. During rainy season, the river carries significant flows. In September 2009, the river flows was estimated to be 133 m^3/sec and many areas adjacent to the river were flooded for a period.

The level of the river through the town is controlled by the downstream Crocodile Dam, from where irrigation canals deliver river water to both the east and west banks.

However, the current stormwater drainage infrastructure cannot deal with heavy storm. Heavy storms can cause widespread flooding and water levels in drain and in Siem Reap River rise considerably. In poorly drained areas, urban runoff mixes with sewage from overflowing latrines and sewers, causing pollution. Doe to the flat topography, the existing drainage system does not have sufficient gradient and this makes it vulnerable to blockage from settled solids and dumped wastes.

National Road 6 (NR6) acts as a hydraulic bottleneck causing flooding, due to insufficient and clogged culverts and drains installed beneath the road over most of its entire length from east to west in the city area. This was reported by the previous study including Integrated Mater Plan for Sustainable Development (IMPSD) of Siem Reap and Angkor Town in the Kingdom of Cambodia (2006, JICA) but up to now the situation is the same and the city area has expanded.

Figure 9.17 shows the existing combined drainage system together with major stormwater drains.

The existing drains in the older developed part of Siem Reap town center were constructed in the 1950s and are in poor state of repair due to lack of maintenance and deterioration of the infrastructure. As states in the previous section, the KOICA proposed the construction of stormwater drainage with the following dimension and length in East and West District. Their location is also shown in Figure 9.17.

Dimension	East District (m)	West District (m)
Box 3.0 m × 2.0 m	1,380	4,690

(2) Irrigation Canal

A number of existing agricultural irrigation canals, some of them date back to ancient Angkor civilizations, cross the project area. Though many of theses are in a state of disuse, others are still functioning and carry water to agricultural areas located in southwest and southeast of the city. This canal network has a base flow even during dry season and consequently reduces the capacity for stormwater drainage.

There are major irrigation canals named C1 to C6 and their location is also shown in Figure 9.16.

(3) Current Status of Western Siem Reap District

There are two major drainage called Town Center Drain (TCD) and the Western Drain. Neither has sufficient capacity for the flows generated in their catchment area but TCD was reconstructed through KTDP SRWM (ADB) project to have sufficient hydraulic capacity.

The northern part of the Western Drain currently connects into inadequate system located in the south of NR 6 and as the road acts like dike, large areas have been suffered by chronic flooding.

(4) Current Status of Eastern Siem Reap District

On the eastern bank of the river, there are three major existing drains, namely D7, D2 and D10. However, since these drains are connected to inadequate systems crossing or located in the south of NR 6, road acts like dike and large areas have been suffered by chronic flooding.

To mitigate such flooding damages, the Priority Works was proposed.

(5) Stormwater System Concepts

Stormwater in urban area is generated from building roofs, paved areas and roads during rainfall events. The amount of stormwater is related to the amount of rainfall precipitation as well as the nature of ground surface. Vegetated surfaces decrease the rate of stormwater runoff and also allow rainfall to penetrate into soil. While, impervious surfaces do not act like this and produce more runoff.

The volume of stormwater generated in urban area shall be reduced, or at least controlled. This can be achieved by using more pervious materials for streets, sidewalks and parking areas. Designing of urban landscape that provides parks, grass turf for local infiltration is also effective. Land developments might increase runoff amount, shall be required to provide stormwater detention ponds to reduce peak flows and impacts to water conveyance facilities located downstream.

As rainfall intensity is relatively high in Siem Reap, the volume of generated stormwater is also huge. However, the hydraulic capacity for the proposed drainage is limited owing to the flat topography and high water levels at Tonle Sap Lake, the ultimate outlet.

The only practical way to prevent flooding is to provide large capacity stormwater drains (inline storage) or to provide stormwater detention (storage) facilities. To minimize the size of downstream drains, previous studies have recommended stormewater detention in various catchment areas.

However, owing to high rainfall intensity, the calculated storage volume is huge and seemed to be inapplicable. The area required for stormwater detention basins, where these may be feasible are limited and are shown in Figure 9.18.

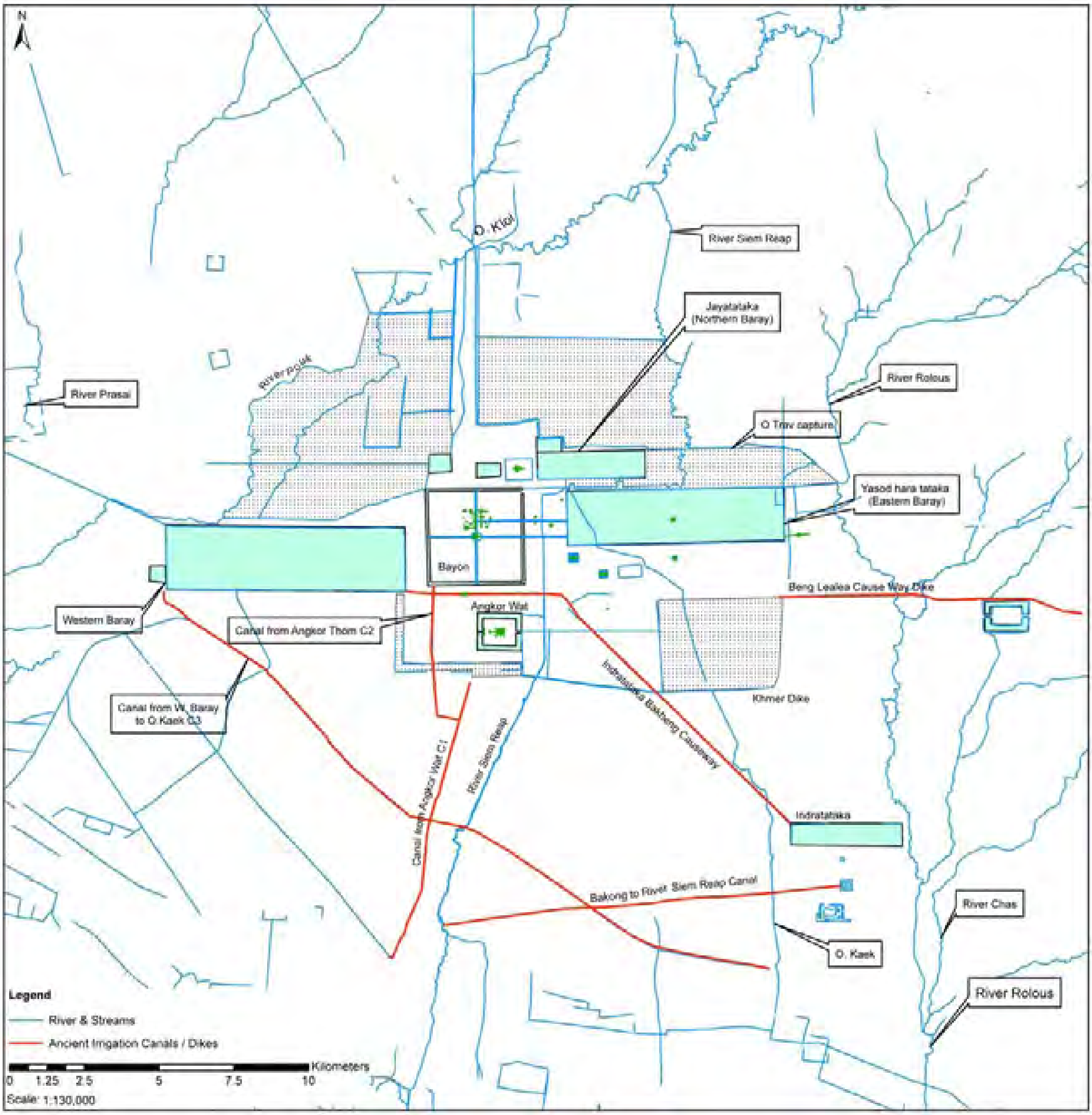


Figure 9.16 Rivers and Ancient Irrigation Systems

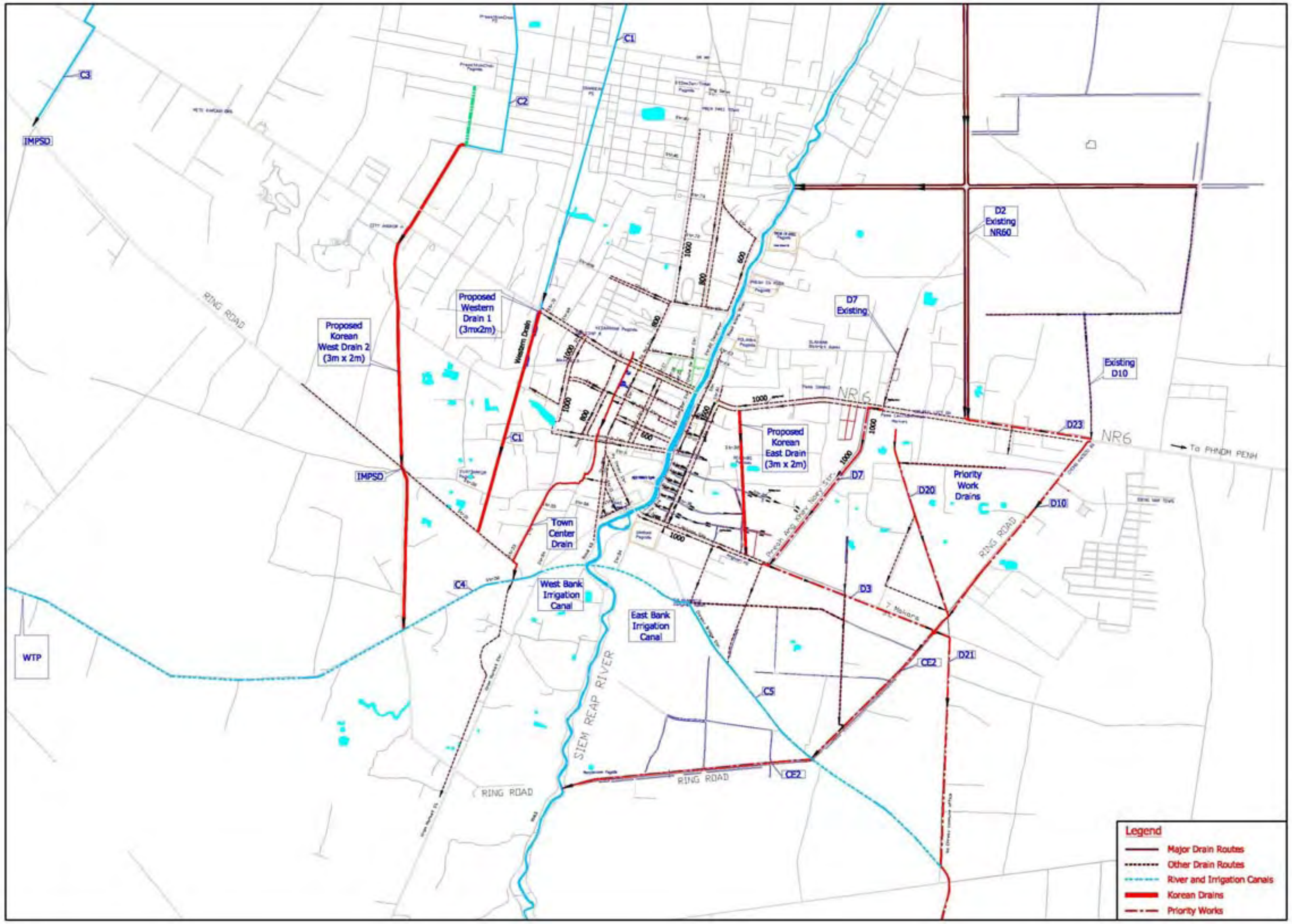


Figure 9.17 Stormwater Drainage System

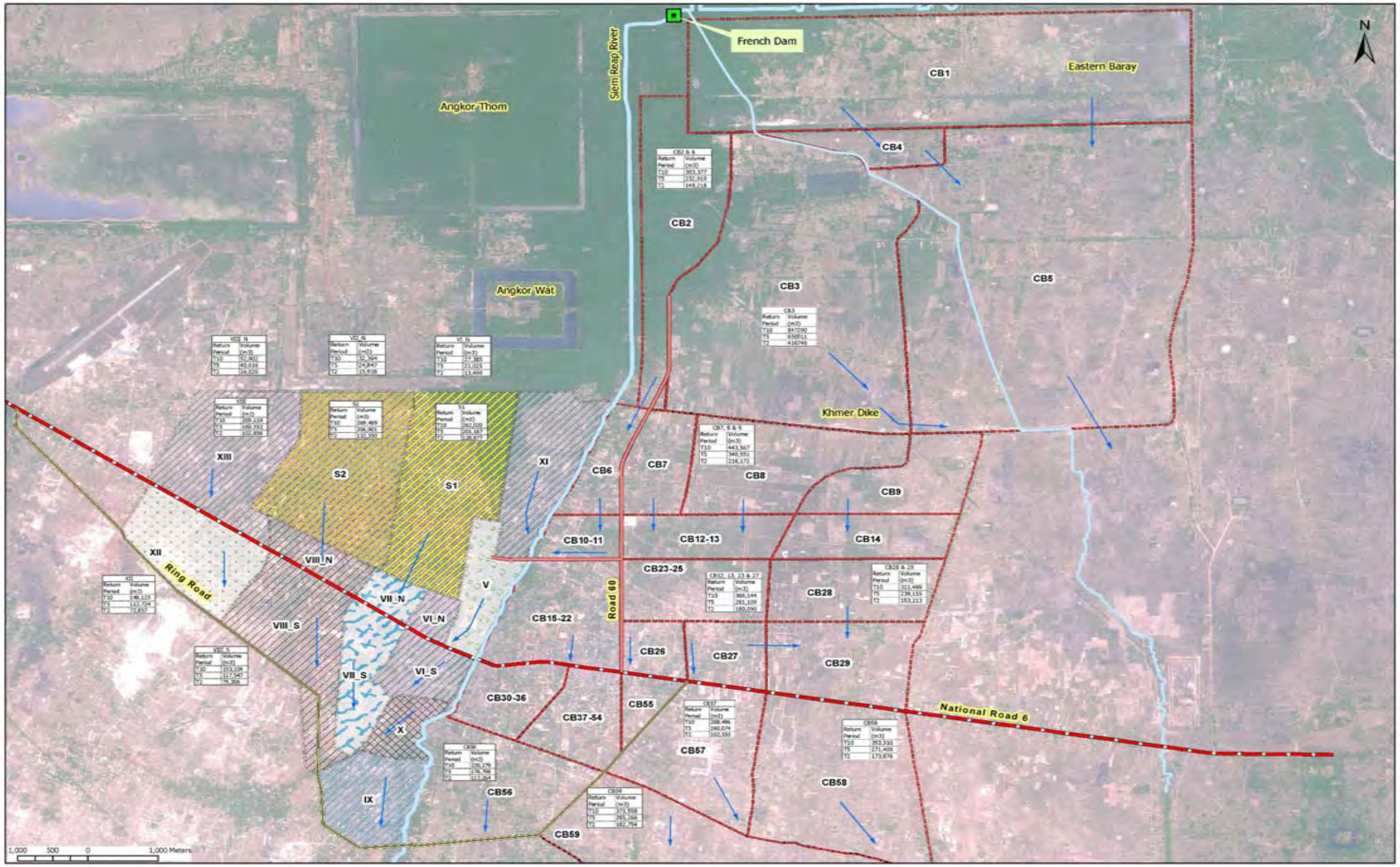


Figure 9.18 Stormwater Detention Basins

(6) Priority Works

The Priority Works drainage project is currently under way in Eastern Siem Reap consisted of main drains shown in Figure 9.19.

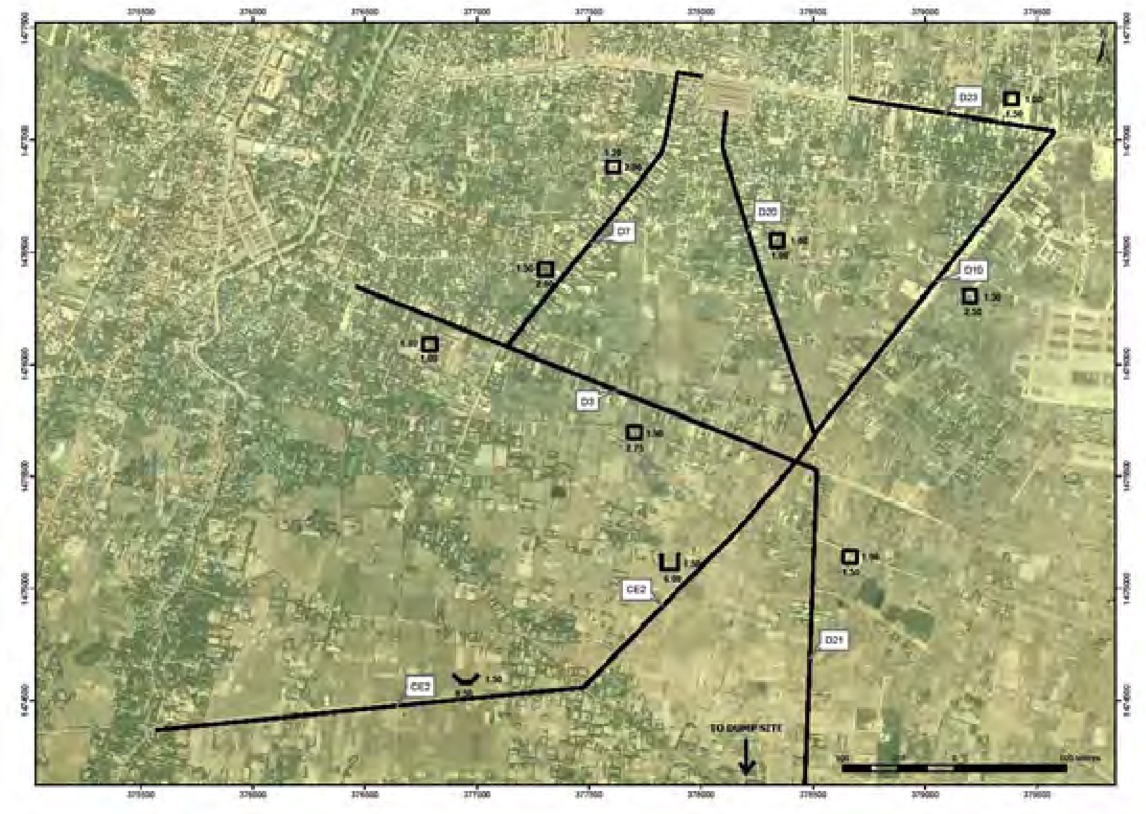


Figure 9.19 Overall Priority Works Drain Routes

The project will be implemented in phases. The first phase comprises drain D23, D10, part of D3, D21, additional D3A (cleaning), D3B and overflowing structures shown in Figure 4.3.2.

Now construction contract of these drainage facilities are under tendering and scheduled to be awarded on the end of March 2010 and planned to be completed in 810 days (2 years and 3 months) after the issuance of Letter of Acceptance.

The remaining drains are to be constructed when funding is obtained.

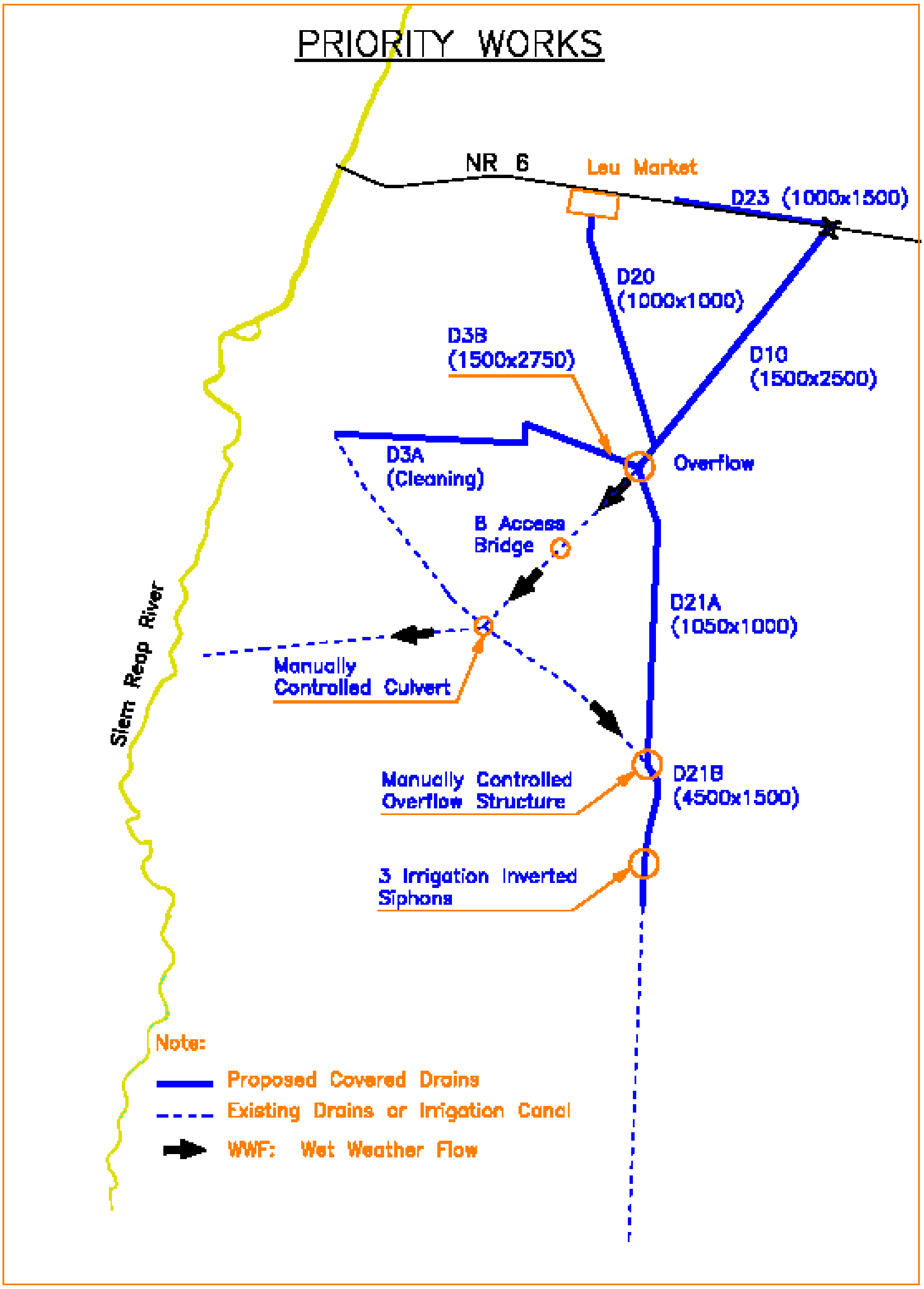


Figure 9.20 Priority Works – Phase 1

(7) Stormwater Retention Basins

As discussed in the previous section, retention basins can reduce the peak flows poured into drainage system. Storage capacity can be:

- "Off-line" in detention basins, however finding suitable locations where this will be feasible might be difficult
- "In-line" as that provided in wide canals constructed along with the roads having large road reserve in the hotel area
- "On-site" storage

The only possible areas suitable for "off-line" storage are undeveloped areas or those not to be developed within the Archaeological Park Area.

"In-line" detention will be possible along roads with sufficient reserve width for construction of canal or basin and this only possible on the roads extension to Hotels and Tourist Zones.

"On-site" storage is possible in large land development zones such as hotels and cultural zones. They should be designed with individual on-site storage can store all stormwater runoff to minimize the impact to downstream areas and to promote rainwater harvesting. Hotels in those zones shall minimize the use of impervious areas to limit runoff and shall recycle stormwater for gardening and landscaping. All commercial developments should also store rainwater for this purpose.

(8) Stormwater Drainage System Alternatives

1) Western Siem Reap

Table 9.12 shows the dimension of necessary drain in Western Siem Reap:

Table 9.12 Western Drain Dimensions (m) (All drains with 1.5 m flow depth)

Nodes		Without Detention Basins				With Detention Basins	
		2 Year Frequency Storm		5 Year Frequency Storm			
		Earth Drain Bottom Width	Concrete Drain Width	Earth Drain Bottom Width	Concrete Drain Width	Earth Drain Bottom Width	Concrete Drain Width
Western Drain - TCD Extension (1)							
TCD1a	TCD1b	Concrete	5.0	Concrete	5.0	Concrete	5.0
TCD1b	TCD1c	20.0	12.0	23.0	12.0	22	12.0
TCD1c	TCD2f	20.0	12.0	23.0	12.0	22	12.0
Western Drain 1 - WD1							
WD1a	WD1b	11.5	6.0	14.5	7.1	1.3	1.8
WD1b	WD1c	12.3	7.0	15.5	7.1	1.5	2.0
WD1c	WD1d	19.0	9.5	23.0	11.5	2.8	2.8
WD1d	WD1e	19.0	10.0	23.0	11.5	3.0	2.9
WD1e	WD2e	19.0	10.0	23.0	11.5	3.2	3.0
Western Drain 2 - WD2							
WD2a	WD2b	12.0	7.0	15.8	8.5	1.8	1.8
WD2b	WD2c	14.0	8.0	18.0	10.2	2.1	2.1
WD2c	WD2d	15.0	9.0	20.5	11.5	2.4	2.4
WD2d	WD2e	18.0	11.0	23.5	13.7	2.8	2.8
WD2e	WD2f	55.0	28.0	71.0	35.0	11.5	7
Western Drain 3 – WD3							
WD3a	WD3b	15.0	8.5	20.0	9.5	1.8	1.8
WD3b	WD3c	19.0	11.5	25.5	13.0	2.5	2.5

Note (1) Limited flow into upper reaches of TCD Extension from existing TCD
Because of land constraints 1a to 1b must be a concrete drain

2) Eastern Siem Reap

Table 9.13 shown the dimension of necessary drain in Eastern Siem Reap:

Table 9.13 Eastern Drain Dimensions (m)   (All drains with 1.5 m flow depth)

Nodes		Without Detention Basins				With Detention Basins	
		2 Year Frequency Storm		5 Year Frequency Storm			
		Earth Drain Bottom Width	Concrete Drain Width	Earth Drain Bottom Width	Concrete Drain Width	Earth Drain Bottom Width	Concrete Drain Width
Eastern Drain ED1(1)							
ED1a	ED1b	-	-	-	-	Concrete	6
ED1b	ED1c	-	-	-	-	Concrete	7
ED1c	ED1d	-	-	-	-	11	7
Eastern Drain ED2							
ED2a	ED2b	44	23	58	29	3	3
ED2b	ED2c	44	28	58	37	5	5
ED2c	ED2d	44	30	58	66	6	6
ED2d	ED2e	26	21	35	27	5	5
ED2e	ED2f	34	27	46	35	6	6
ED2f	ED2g	40	31	53	65	7	7
ED2g	ED2h	43	34	53	77	9	9
Eastern Drain ED3							
ED3a	ED3b	130	63	167	68	21	11
ED3b	ED3c	110	68	144	77	30	16
ED3c	ED3d	65	42	85	48	30	16

Note (1)   Limited flow into upper reaches of ED1 from existing Priority Works drainage programme

3) Estimated Construction Cost of Western and Eastern Drains

The following Table indicates the project cost needed for Western and Eastern Drains, with and without detention basins.

Table 9.14 Costs - Western Drain Systems Without Detention Basins (US$ 1000)

System	Without Detention Basins			
	2 Year Frequency Storm		5 Year Frequency Storm	
	Earth Drain	Concrete Drain	Earth Drain	Concrete Drain
Eastern Drain System TCD Extension				
Drains - concrete	686.8	686.8	834.2	834.2
Drains - downstream	289.4	1 855.5	305.3	2 248.8
Land costs	143.6	74.2	157.6	75.0
Sub total	**1 119.8**	**2 616.5**	**1 297.1**	**3 158.0**
Western Drain System WD 1				
Drains - concrete	5 221.8	5 221.8	6 596.7	6 596.7
Land costs	125.5	125.5	139.0	139.0
Sub total	**5 349.4**	**5 349.4**	**6 735.7**	**6 735.7**
Western Drain System WD 2				
Drains	3 352.7	23 769.7	3 705.8	27 242.9
Land costs	1 661.0	801.6	2 085.1	347.2
Sub total	**5 013.7**	**24 571.3**	**5 790.9**	**22 590.1**
Western Drain System WD 3				
Drains	1 476.8	16 643.3	6 270.0	55 714.0
Land costs	732.6	375.2	889.0	410.7
Sub total	**2 209.4**	**17 018.5**	**7 159.0**	**56 124.7**
Grand Total	**13 692.3**	**49 555.7**	**20 982.7**	**88 608.5**

Table 9.15 Costs - Western Systems With Detention Basins (US$ 1000)

System	With Detention Basins	
	Earth Drain	Concrete Drain
Western Drain – TCD Extension		
Detention Basins	209.5	209.5
Drains	596.8	1 086.4
Land costs - basins	547.6	547.6
Land costs - drains	153.0	89.8
Sub total	**1 506.9**	**1 933.3**
Western Drain System WD 1		
Detention Basins (none)	0	0
Drains	285.2	1 412.4
Land costs - basins	0	0
Land costs - drains	137.6	66.8
Sub total	**422.8**	**1 479.2**
Western Drain System WD 2		
Detention Basins	2 033.4	2 033.4
Drains	1 654.0	8 450.3
Land costs - basins	547.6	547.6
Land costs - drains	818.7	100.8
Sub total	**5 053.7**	**11 132.1**
Western Drain System WD 3		
Detention Basins	2 419.4	2 419.4
Drains	690.9	7 284.0
Land costs - basins	411.4	411.4
Land costs - drains	333.6	159.3
Sub total	**3 855.3**	**10 274.1**
Grand Total	**10 838.7**	**24 818.7**

Table 9.16 Costs - Eastern Drain Systems Without Detention Basins (US$ 1000)

System	Without Detention Basins			
	2 Year Frequency Storm		5 Year Frequency Storm	
	Earth Drain	Concrete Drain	Earth Drain	Concrete Drain
Eastern Drain System ED 1 (Priority Works Extension)				
No detention basins in Priority Works system – costs from Table below				
Sub total	**1 521.1**	**2 482.1**	**1 521.1**	**2 482.1**
Eastern Drain System ED 2				
Drains	4 252.5	26 301.0	4 845.4	33 984.2
Land costs	2 336.7	1 500.8	2 852.2	2 563.4
Sub total	**6 589.2**	**27 801.8**	**7 697.6**	**36 547.6**
Eastern Drain System ED 3				
Drains	9 552.8	40 790.9	11 024.7	45 440.0
Land costs	5 066.3	2 909.3	6 346.2	3 621.8
Sub total	**14 619.1**	**43 693.8**	**17 370.9**	**49 061.8**
Grand Total	**36 419.4**	**73 977.7**	**40 279.6**	**88 091.5**

Table 9.17 Costs - Eastern Drain Systems With Detention Basins (US$ 1000)

System	With Detention Basins	
	Earth Drain	Concrete Drain
Eastern Drain System ED 1 (Priority Works Extension)		
Drains	1 521.1	2 482.1
Land costs - drains	Not applicable – in roads	
Sub total	**1 521.1**	**2 482.1**
Eastern Drain System ED 2		
Detention Basins	2 331.2	2 331.2
Drains	1 435.4	6 286.2
Land costs - basins	141.9	141.9
Land costs - drains	659.1	411.6
Sub total	**4 567.6**	**9 170.9**
Eastern Drain System ED 3		
Detention Basins	4 864.5	4 864.5
Drains	5 721.3	23 223.3
Land costs - basins	1 325.1	1 325.1
Land costs - drains	2 115.1	951.6
Sub total	**14 026.0**	**30 364.5**
Grand Total	**20 114.7**	**42 017.5**

4) Recommended Drain Scheme

From the technical aspect, the recommended drain scheme was tabulated in Table 9.18 with the following premises:

- Detention basin design was based on 5-year storm frequency storage
- Drains with no detention basins were designed for 2-year frequency storm

As to the location of drains tabulated in Table, refer to Figure 9.21 and Figure 9.22.

Table 9.18 Recommended Drain Scheme

Drainage System	Component	Costs (US$)	
		Sub Total	Total
Western Siem Reap			
TCD Ext.	No detention basins		
	TCD Extension to 1b - concrete	686 800	
	Extension from 1b – earth drain	289 400	
	Cost of TCD Extension		976 200
WD1	No detention basins all concrete channels	5 221 800	
	Land costs	125 500	
	Cost of WD1		5 349 400
WD2	All detention basins, all earth drains		
	Detention basins	2 033 400	
	Drains	1 654 000	
	Land costs	1 366 300	
	Cost of WD2		5 053 700
WD3	All detention basins, all earth drains		
	Detention basins	2 419 400	
	Drains	690 900	
	Land costs	745 000	
	Cost of WD3		3 855 300
	Total Cost for Western Drains		**15 234 600**
Eastern Siem Reap			
ED1	No detention basins		
	Priority Works Extension	1 521 100	
	Cost of ED1		1 521 100
ED2	All detention basins, all earth drains		
	Detention basins	2 331 200	
	Drains	1 435 004	
	Land costs	801 000	
	Cost of ED2		4 567 600
ED3	All detention basins, all earth drains		
	Detention basins	4 864 500	
	Drains	5 721 300	
	Land costs	3 440 200	
	Cost of ED3		14 026 000
	Total Cost for Eastern Drains		**20 114 700**
	Total Cost for all Drains		**35 349 300**

Note) Source of these Tables is “Drainage & Sewerage Master Plan for the District of Siem Reap Priority Works Draft Master Plan, AFD, December 2009”

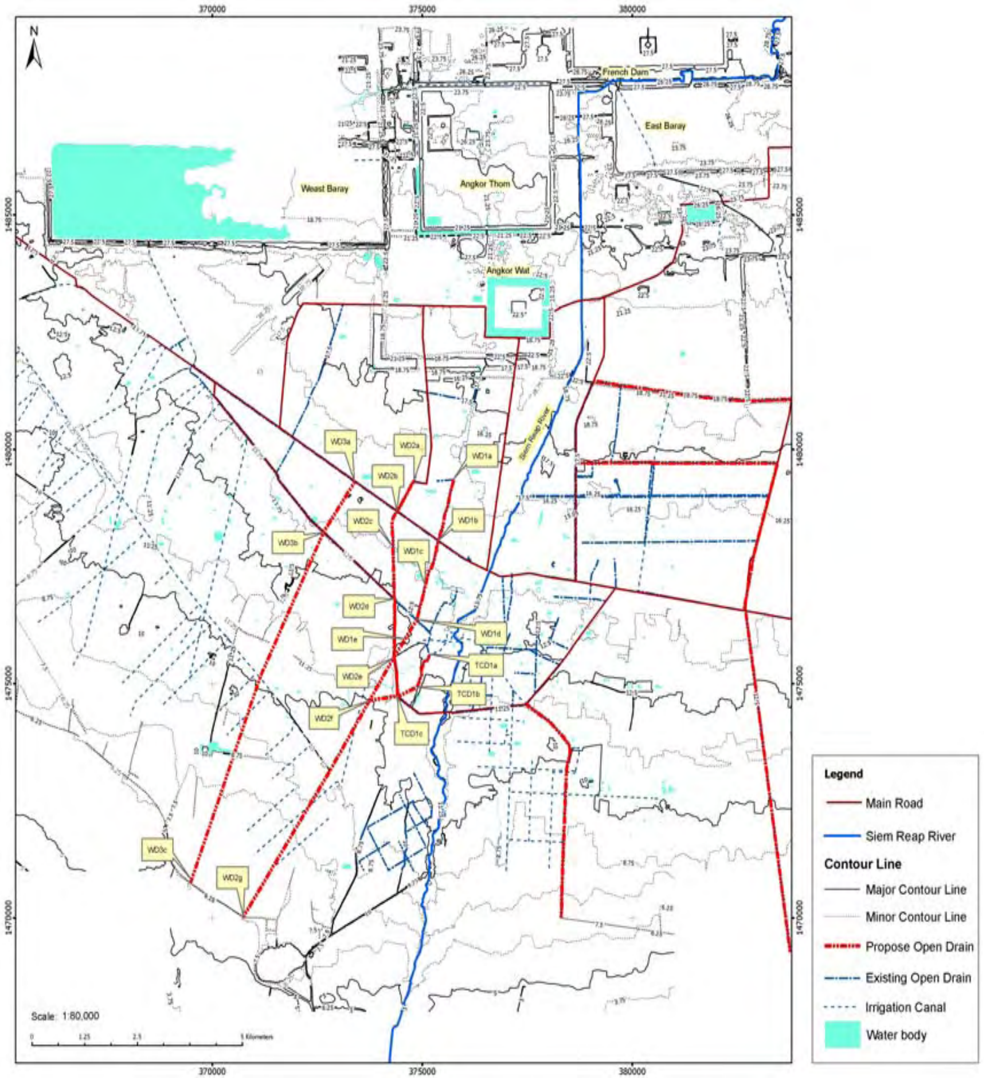


Figure 9.21 Western Drainage Routes

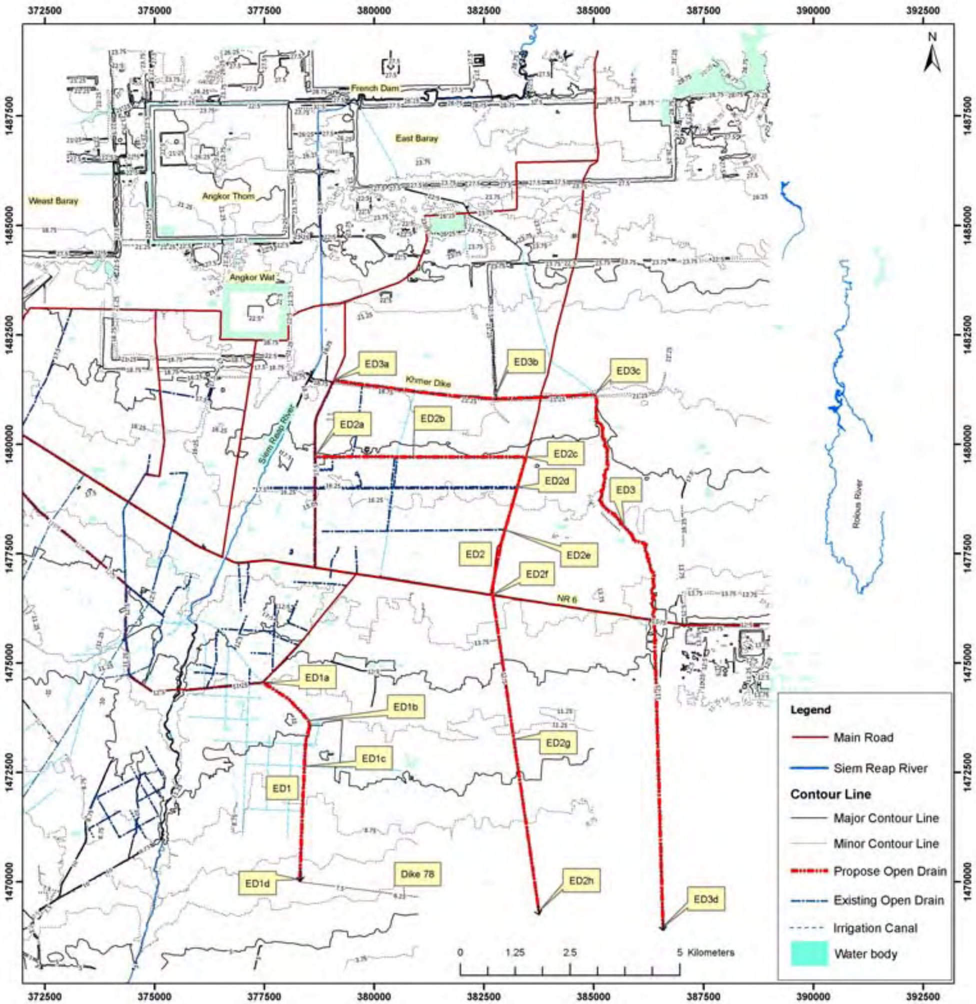


Figure 9.22 Eastern Drainage Routes

9-5 Japanese Grant Aid Assistance Needs in Sewerage and Drainage Sector

Past investment in sewerage and drainage sector in Siem Reap has been at a level well below that needed for sustainability. As a consequence, the current infrastructure cannot meet the standards needed to achieve compliance with the environmental requirement and in particular:

- Increasing pollution of Siem Reap River due to discharge of untreated wastewater into the river
- Open drains have insufficient capacity for stormwater
- Open drains are abused with the discharged garbage
- Some of the drains have been filled for construction and/or insufficient pipes have been installed diminishing the capacity of network
- Flooding by stormwater combined with wastewater causes sanitary and health problems
- Streets are flooded by heavy rain
- Effluent from septic tanks are discharged directly into drains
- Eventually, the Tonle Sap Lake the proposed water source has been heavily polluted

However, the following criteria are employed to identify the relevancy as Japanese Grant Aid Project:

- Restriction in project implementation period, basically single fiscal year
- Limitation in project budget
- Project sustainability
- Financial feasibility
- Environmental viability
- Stable and early display of project benefits

Based on the abovementioned Grant Aid Assistance introduction criteria, the Study Team recommends the feasible assistance by Japanese Grant Aid.

9-5-1 Sewerage Sector

As mentioned in previous section, even if the KOICA project is completed, still there will be un-served urban area. Installation cost of sanitary sewer and WWTP covering the said un-served urban area was estimated to be **208,799,037 US$**, without WWTP site acquisition cost.

It is noteworthy that above estimated project cost is to cover the urban service area of 6,008 ha only excluding the existing service area of ADB Project. In other words, this project cost includes the target service area of KOICA study. KOICA just started the detailed design of the proposed facilities on last April 2010 and the whole system is scheduled to be completed in the year of 2015.

Figure 9.23 shows the relationship between the target areas of available Sewerage Master Plans:

- MTDP SRWM: A = 265 ha, completed on December 2009
- KOICA: A = 934 ha, including that of MTDP SRWM, Now on-going
- SRDSMP: A = 6,009 ha, including that of KOICA, Draft Master Plan was prepared on December 2009

Characteristics of service areas proposed by each project, study are as follows:

- MTDP SRWM target area covers the City Center located along with the west side of Siem Reap River
- Proposed KOICA target area covers the eastern and western areas surrounding MTDP SRWM target area
- SRDSMP covers further wide area surrounding KOICA target area

As shown in Figure 9.23, most of core urban area is to be served by KOICA project and the most of the remaining un-served area can be regarded as Peri-Urban Area where centralized sewerage system might not be always feasible. As Siem Reap City has extremely flat topography, 23 pumping stations including one in WWTP are needed to collect the generated sewage and this also attributed to the huge project cost.

Since the Sewerage Master Plan was prepared by the assistance of AFD, possible assistance by Japanese Grant Aid in facility construction is "Cooperative Assistance" sharing service area with other Donor Agencies.

Figure 9.24 shows the relationship between service areas of:

- MTDP SRWM: A = 265 ha
- KOICA: A = 934 ha and
- JICA Siem Reap Water Supply Expansion Project: A = 3,360 ha

Whole JICA F/S Area was divided into four areas and their respective area, estimated water consumption and unit area water consumption is shown in Table 9.19:

Table 9.19 Unit Area Water Consumption

F/S Area	Water Consumption* (m^3/day)	Area (ha)	Unit Area Water Consumption (m^3/day/ha)
Area 1	13,600	860	15.67
Area 2	13,100	620	20.94
Area 3	14,500	880	16.32
Area 4	14,800	1,000	14.72
Total	56,000	3,360	

*) Water consumption amount was rounded up

Based on the estimated area-wise unit area water consumption, total water consumption within KOICA project sewerage service area was estimated:

Table 9.20 Water Consumption within KOICA Service Area

KOICA Area	Unit Area Water Consumption (m^3/day/ha)	Area (ha)	Water Consumption (m^3/day)
Area 1	15.67	318	4,983
Area 2	20.94	293	6,135
Area 3	16.32	114	1,860
Area 4	14.72	209	3,076
Total		934	16,054
			(1.032)
WWTP Capacity (ADB + KOICA)			15,552
			(1.000)

The estimated total water consumption is slightly exceeding the total WWTP capacity. However, whole amount of consumed water will not turn to sewage. According to the available sewerage studies, the conversion ratios are as follows:

Table 9.21 Sewage Conversion Ratio

Name of Study	Conversion Ratio
KOICA Feasibility Study	0.85
Drainage & Sewerage Master Plan for the District of Siem Reap (AFD)	0.80

In both study, groundwater infiltration was counted and the rate was 10% of generated sewage.

Therefore, total incoming sewage amount can be calculated as:

16,054 (water consumption within KOICA sewerage service area)×0.85×1.10

= $\underline{15,010\ m^3/day}$ < 15,552 m^3/day (WWTP Capacity)

Therefore, even if water consumption is increased by water supply system expansion in the future, generated sewage within KOICA sewerage service area can be properly treated by the expanded WWTP.

As to further future, the relationship between projected water consumption, generated sewage amount and WWTP capacity was summarized in Table 9.22:

Table 9.22 Future Water Consumption, generated Sewage Amount and WWTP Capacity

Items Year	2015	2020	2025	Remarks
Water Supply Amount (m^3/d)	18,939	35,215	47,917	Daily Average Amount (Qw)
Sewage Amount (m^3/d)	17,708	32,926	44,802	Qw×0.85×1.10 (Qs)
WWTP Capacity				
ADB Project (m^3/d)	5,552			
KOICA Project (m^3/d)	10,000			
AFD Project (m^3/d)	10,000	10,000	10,000	
Total WWTP Capacity (m^3/d)	25,552	35,552	45,552	
Ratio	0.693	0,926	0.984	Qs/WWTP Capacity

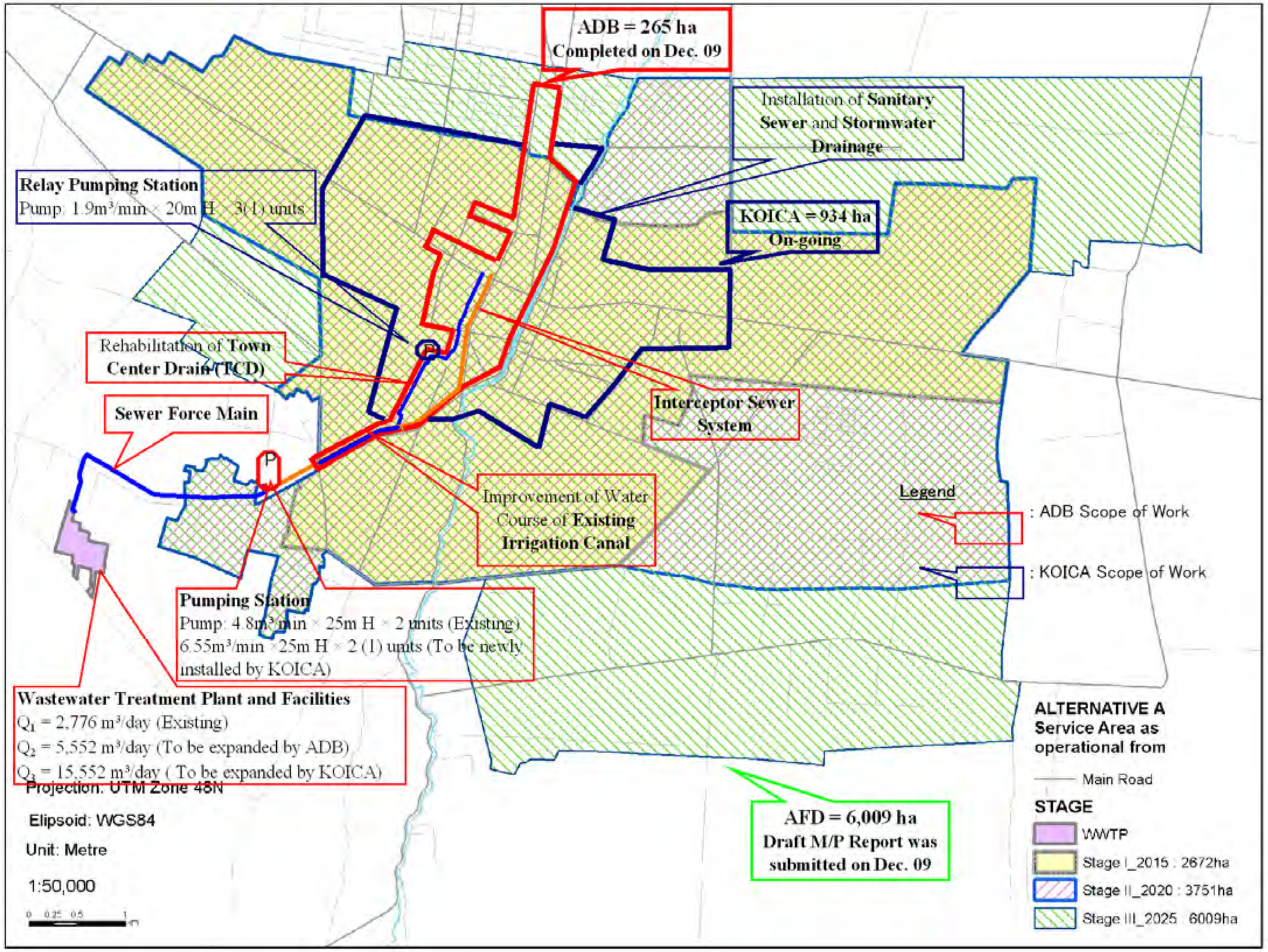


Figure 9.23 Target Sewerage Service Area

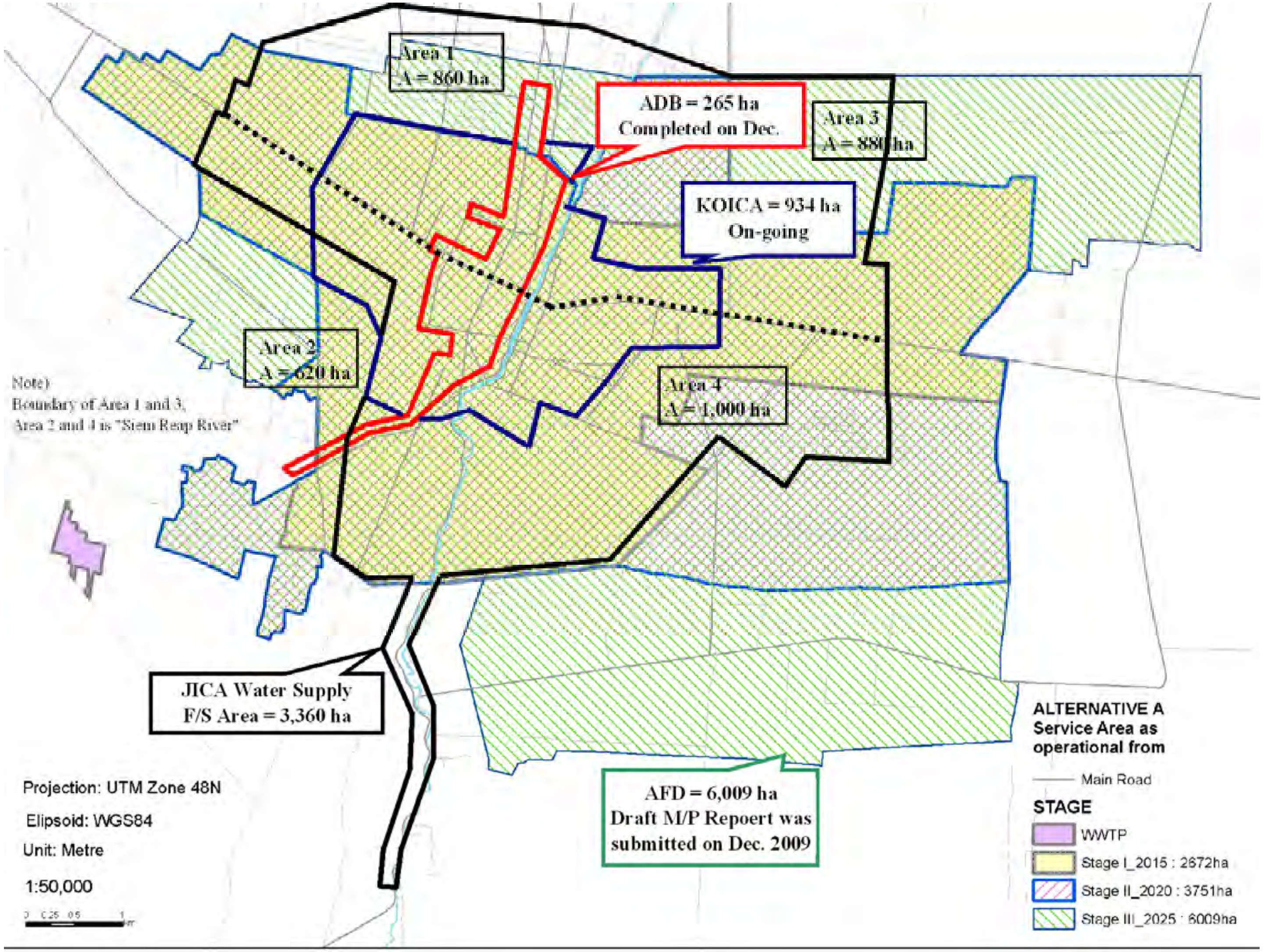


Figure 9.24 Relationship Between Sewerage and Water Supply Service Area

9-5-2 For Drainage Sector

As aforementioned in previous section, proposed first phase of Priority Works programmed to drain the east urban extension area are now under tendering and supposed to be completed in 2 years and 3 month (810 days) after the issuance of Letter of Acceptance. The remaining second phase will be implemented when appropriate fund is found.

However, even if second phase of Priority Works are completed, total drainage system capacity is still insufficient and project cost of additional drainage facility was estimated as **35,349,300 US$**.

Likewise in case of Sewerage Master Plan, Drainage Master Plan was also prepared by the assistance of AFD, possible assistance by Japanese Grant Aid in facility construction is "Cooperative Assistance" sharing service area with other Donor Agencies.

9-5-3 Proposed Japanese Grant Aid Assistance

Since the remaining un-served area in AFD study is huge (in case of sewerage area, A = 6,009 ha – 934 ha = 5,075 ha), total project cost became huge. Also, as electricity in Cambodia is expensive, operation cost of pumping station will also be huge. For reference, electricity is 19 yen/kWH in Cambodia and 12 yen/kWH in Japan.

Further, as the most of remaining un-served area can be regarded as "Peri-urban area", the optimim sewage management system shall be properly employed for sustainable and stable system operation. In peri-urban area with less population density, centralized sewerage system might not be always feasible. Therefore, zone-wise priority study is needed at minimum to screen the target area because specific "Priority Project" was not proposed in AFD Master Plan.

Accordingly, the introduction of Japanese Grant Aid in sewerage and drainage system development is not deemed as realistic, because potential project benefit is estimated to be less.

Peri-urban area shall be served by the existing "On-site System" and then, the possible assistance direction of Japanese Grant Aid shall be supporting project maintaining these existing system including said On-site System and sewer network. They must be appropriately maintained through the future because effluent of the existing On-site System flows into the drains nearby and eventually flows into Tonle Sap Lake until the areas are served by separate sewers.

Further, provision of sewer cleaning equipment is needed as well since the length of sewer will increase through the future.

Capacity building for the counterpart agency through Japanese Technical Assistance Project is also effective to keep sustainable function of the completed facilities.

1. Provision of Sewer Cleaning Equipment

If KOICA project is completed, diameter-wise breakdown of sewer length will be approximately as follows:

Table 9.23 Overall Sewer Length by Diameter

Diameter	200	250	300	350	400	500	600	700
Length	40,370	2,767	1,754	1,430	1,667	2,840	632	3,931
Note) Length unit is Meter							Total	55,390

ADB SRWM project also provided one set of sewer cleaning equipment and one unit of septage collection vaccum truck with tank capacity of 6 m^3 and now they are operated and maintained by Siem Reap Sewerage and Wastewater Treatment Plant Unit (SRSWTPU) newly established under the Ministry of Public Works and Transport. Their photos and specifications are shown in Table 9.2.

To maintain sound functions of completed sewers, systematic and periodical sewer cleaning is essential. Although SRSWTPU owns one set of sewer cleaning equipment, it's not sufficient. <u>Provision of plural sets of sewer cleaning equipment with accessories</u> and preparation of sewer cleaning plan is needed for stable sewer function.

2. Provision of Septage Collection Vacuum Tanker Truck

Even if the remaining urban areas are to be served by separate sewerage system, construction works will take long time period and until the time of system completion, service areas are to be served by the existing on-site system represented by Septic Tanks. Further, in peri-urban/rural areas where the centralized sewerage system is not feasible, service by on-site system will be continued. As such on-site system shall be properly maintained through the future to preserve sound hygiene and living environment, appropriate maintenance activities shall be practiced.

Typical septic tank has three compartments and the last one is soak pit for ground infiltration. To maintain sound tank function, periodical septage removal is essential. Septage is sludge accumulated in septic tanks. Typical removal frequency is once in every two or three years.

Therefore, provision of septage collection equipment is indispensable. Currently SRSWTPU owns one septage collection vaccum truck but it not enough. According to the AFD wastewater master plan, daily septage generation amount was estimated in Table 9.24.

Providing that the existing SRWM 6 m^3 capacity septage collection tanker collects septage by three round trip per day, collected septage amount will be 18 m^3/day. Based on the daily septage generation amount, <u>three additional 6 m^3 capacity septage collection tankers are required.</u>

As ADB SRWM WWTP has septage receiving facility but allowable septage amount is 10 m^3/day. For stable and appropriate septage treatment, WWTP to be designed and constructed in future shall have such septage receiving facility.

Table 9.24 Septage Service Population and Quantities Projection

Year	Septage service population (1)	Projected septage quantities, m^3 /day
2010	61,762	62
2015	66,583	67
2020	71,685	72
2025	77,064	77
2030	73,307	73
2035	66,742	67

(1) The septage service area population includes the rural and peri-urban area, and the unserved population in the urban service area.
Source) Drainage & Sewerage Master Plan for the District of Siem Reap Priority Works Draft Master Plan (December 2009)

3. Construction of Septage Treatment Facility

As aforementioned, the allowable septage amount in the existing WWTP is 10 m^3/day and it's apparently insufficient compared with daily septage generation amount estimated in Table 9.24.

Therefore, this capacity shortage shall be covered by the construction of septage treatment facility. This facility shall be designed to treat septage exclusively.

4. Technical Assistance Project for Capacity Building towards counterpart Agency

Further, Japanese Technical Assistant Project for capacity building in the following fields is needed to maintain the sound functions of completed facilities:

Table 9.25 Proposed Capacity Building through Technical Assistance Project

Task	Counterpart Agencies	Specific Fields
Capacity Development	Siem Reap Sewerage and Wastewater Treatment Plant Unit (SRSWTPU) under the Ministry of Public Works and Transport	➢ Training on computerized accounting/billing and financial management system ➢ Training session on administrative management ➢ Training on basic design and construction concept of sewers/drains and plumbing works ➢ Formulation of "Annual Sewer Cleaning Plan" ➢ Collect and maintain documents and drawings of the completed facilities in digital files ➢ Prepare daily record on incoming and outgoing sewage flow and quality in WWTP ➢ Prepare repair record on sewerage facilities ➢ Establish Inventory System for stored materials and equipment ➢ Enlightenment campaign on benefits generated by sewerage and drainage system and on elimination of garbage dumping into sewers and open drains ➢ Encourage Sanitary/Hygiene education in Schools ➢ Official registration of private contractors currently undertaking septage collection. Reportedly, some of them are dumping collected septage into open drain or open land without any treatment. To eliminate such illegal environmental contamination, they shall be registered by Governmental offices and they must follow the legal instructions and regulations. Further, their work shall be periodically monitored. In case of infringement, penalties are enforceable. As Department of Public Works and Transport in Siem Reap owns their Septage Disposal Site located 6 km west of the City, collected septage shall be disposed here.

9-5-4 Conclusion and Recommendations

The Study Team proposes the following should be done as the Japan's Grant Aid Project:

1. **Provision of Sewer Cleaning Equipment**
2. **Provision of Septage Collection Vacuum Tanker Truck**
3. **Construction of Septage Treatment Facility**
4. **Technical Assistance Project for Capacity Building towards counterpart Agency**

Sewerage system development project needs long time period. For instance, in case of KOICA project, 4 years are needed after the L/A signing including the selection of Consultants, Contractor, Construction Supervision and Plant Commissioning Test.

While, execution of the proposed on-site/sewerage system maintenance project needs much less period and therefore, project benefit will also be displayed in very early stage.

The proposed project can be "Model Project" applicable to other Provinces with modifications owing to their locality.

Further, the Study Team would like to strongly recommend the **Dispatch of JICA Expert in Sewerage Sector**. As described in former sections, three donor agencies are implementing sewerage system construction project and are preparing sewerage feasibility study and sewerage master plan. Some of them are overwrapping.

Such issues attribute that no one was assigned to collect the relevant report, study and information to make mutual adjustment between plural donor agencies.

To mitigate such inefficient project and study progress, JICA Expert in sewerage sector shall be dispatched.

Chapter 10.
Environmental and Social Considerations

Chapter 10. Environmental and Social Considerations

10-1 Project Summary

10-1-1 Project Title

The Siem Reap Water Supply Expansion Project in The Kingdom of Cambodia.

10-1-2 The Type of the Study

In Cambodia Initial Environmental Impact Assessment (IEIA) / Environmental Impact Assessment (EIA) should be conducted for the project whose purpose is to supply drinking water to more than 10,000 people (Sub-Decree on EIA Process NO.72, 1999). At the same time EIA should be conducted for the project whose site is located in Zone 5 of protected area designated by APSARA. Zone 5 comprises whole area of Siem Reap Province. The region is to be managed as a multiple-use area with an emphasis on economic and social development of cultural tourism. Development activities which could potentially damage the archaeological, the natural, or the social heritage harbored in the province are regulated by comprehensive coordination policies. Environmental impact assessments are to be carried out in advance of any project proposed in the region.

10-1-3 Methodology and Result of Screening

Department of EIA Review and Monitoring, Ministry of Environment (MOE) in Cambodia is preparing "Guideline for conducting EIA Report" and the draft Guideline proposes the composition of EIA Report shown in Table 10.1.

Table 10.1 Composition of EIA Report in Draft Guideline in Cambodia

1. Project Summary 2. Introduction 3. Purpose of the Project 4. Project Description 5. Description of Environmental Resources 5.1 Physical resources (Air, Water, Land/Soil/Geology) 5.2 Ecological resources (Biodiversity, Fauna, Flora, Forest) 5.3 Socio-economical resources (Population, Infrastructure, Land use, Public health and welfare, Economic condition, Custom, Tradition, Ethnic group 6. Public Participation 7. Environmental Impact Analysis (Construction, Operation, Closure) 8. Environmental Impact Mitigation Measures 9. Economical Analysis and the Environmental value 10. Environmental Management Plan (Monitoring Program) 11. Institutional capacity 12. Conclusion and Suggestion 13. Reference

Since the following environmental items should be considered additionally in EIA report for this project compared with JICA/JBIC Guideline, EIA for this project should be prepared to fit the requirement of JICA/JBIC Guideline, based on the draft Guideline of Cambodia as shown in Figure 10.1.

- Wastes
- Noise & Vibration
- Subsidence
- Protected Areas
- Resettlement
- Living & Livelihood
- Heritage
- Landscape
- Working Conditions

According to the advice from the Department of EIA, MOE, screening system for EIA is now under consideration in Cambodia and it may be a similar type of JICA/JBIC Guideline. Therefore, for this project screening was carried out based on mainly JBIC Guidelines because the project is intended for a Japanese Yen loan.

The criteria of JBIC are as follows;

Category A: likely to have significant adverse impacts

Category B: potential adverse impacts are less than those of Category A projects

Category C: likely to have minimal or little adverse impacts

The project is classified as ‘Category B’ because the mitigation measures can be considered although the project may give some impact on environmental and social situation.

The result of screening is as shown in Table 10.2.

There may be possibility of twelve (12) impacts on environmental and social situation as follows:

i) Air Quality
ii) Water Quality
iii) Wastes
iv) Noise & Vibration
v) Hydrology
vi) Protected Areas
vii) Ecosystem and Biota
viii) Living & Livelihood
ix) Heritage
x) Landscape
xi) Impacts during Construction
xii) Monitoring

Draft Guideline of Cambodia	
NO	Items
Physical resources	
1.	Air
2.	Water
3.	Land/Soil/Geology
Ecological resources	
4.	Biodiversity
5.	Fauna
6.	Flora
7.	Forest
Socio-economical resources	
8.	Population
9.	Infrastructure
10.	Land use
11.	Public health & welfare
12.	Economic condition
13.	Custom
14.	Tradition
15.	Ethnic group
16.	Public participation
17.	Economic analysis
18.	Monitoring program
19.	Institutional capacity

+

Guideline of JBIC	
NO	Items
Mitigation measures	
1.	Air quality
2.	Water quality
3.	Wastes
4.	Noise & Vibration
5.	Subsidence
6.	Hydrology
Natural environment	
7.	Protected area
8.	Ecosystem & biota
Social Environment	
9.	Resettlement
10.	Living & livelihood
11.	Heritage
12.	Landscape
13.	Ethnic minorities & Indigenous peoples
Others	
14.	Impacts during construction
15.	Monitoring

=

Items for this Project	
NO	Items
Physical resources	
1.	Air quality
2.	Water quality
3.	Wastes
4.	Noise & Vibration
5.	Subsidence
6.	Hydrology
7.	Land
Ecological resources	
8.	Protected area
9.	Flora & Forest
10.	Fauna
Socio-economical resources	
11.	Resettlement
12.	Population
13.	Infrastructure
14.	Land use
15.	Public health & welfare
16.	Economic condition (Living & livelihood)
17.	Heritage
18.	Land acquisition
19.	Public participation
Others	
20.	Impacts during construction
21.	Monitoring
22.	Economic analysis
23.	Institutional capacity

Figure 10.1 Items to be Studied for Environmental and Social Considerations in The Study

Table 10.2 The Result of Screening

NO	Environmental Item	Impact	Description
Mitigation Measures			
(1)	Air Quality	x	Although the project owner has an experience with treatment of chlorine, the management plan of chlorine during operation of water treatment facility shall be checked.
(2)	Water Quality	x	Preliminary design of effluent discharged from water treatment facility shall be checked.
(3)	Wastes	x	Sludge disposal plan shall be checked based on the preliminary design.
(4)	Noise & Vibration	x	Design element for noise and vibration shall be checked as well as land use around the pumping station and water treatment facility.
(5)	Subsidence		Extraction of a large volume of groundwater is not planned for this project because surface water from Tonle Sap Lake is utilized for water source.
(6)	Hydrology	x	Wastewater volume will increase due to expansion of water supply system and it might be source of water pollution.
Natural Environment			
(1)	Protected Areas	x	Although there are many kind of protected areas designated by Cambodian laws in the study area, the project site can be located outside of the protected areas. The preliminary design shall be checked and mitigation measures shall be introduced to reduce environmental impact on the protected areas.
(2)	Ecosystem and biota	x	Since the project site will encompass inundated forests where fish produces eggs, the area to be altered should be minimized by proper design, and flora and fauna shall be examined by field survey to assess impact on ecosystem.
Social Environment			
(1)	Resettlement		Involuntary resettlement will not be caused by project implementation.
(2)	Living and Livelihood	x	Efforts should be made to minimize the impacts caused by land acquisition. There might be a possibility that the project adversely affects the water area uses if water intake disturbs the current navigation and fishing. The preliminary design of water intake shall be checked.
(3)	Heritage	x	There will be little possibility that the project damages the local archeological, historical, cultural and religious heritage sites. However, construction of the facility for the project should be conducted with caution not to give impact on the heritage site after it is uncovered.
(4)	Landscape	x	The appearance of water intake tower may give some impact on the landscape.
(5)	Ethnic Minorities and Indigenous Peoples		The Khmer is dominant race in the study area. The Vietnamese and the Cham are living in and around Tonle Sap Lake. The Kuy is ethnic minority living in northern part of Siem Reap Province. There is little impact on ethnic minorities and indigenous peoples.
(6)	Working Conditions		There is little adverse impact on working condition of SRWSA.
Others			
(1)	Imapcts during Construction	x	Noise, vibrations, turbid water, dust, exhaust gases and wastes, impact on ecosystem and social environment, health and safety education for traffic safety, accident, public health, infectious diseases shall be checked based on preliminary design and basic plan.
(2)	Monitoring	x	SRWSA must develop and implement monitoring program for the environmental items that are considered to have potential impacts, including accident.

x means that some impact may be expected.

10-1-4 Responsible agencies which implement the project

Siem Reap Water Supply Authority.

10-1-5 Background of the Project

(1) Background

The town of Siem Reap, the object area of this Study, with a population of 173,000 (in 2008) is located approximately 5 km south to the Angkor World Heritage Site and about 2,000,000 tourists visit the city yearly. The existing water treatment facility which was constructed under Japanese grant aid in 2006 has a capacity of 8,000m^3/day. This water supply capacity is too small compared with 43,200m^3/day which is the water demand in 2015 projected by SRWSA. In addition, Siem Reap is under threat of land subsidence which is a social problem, caused largely by the many hotels operating around the heritage site coupled with a sharp increase in tourism related industries which has resulted in uncontrolled abstraction of groundwater sources in the area. As a result of the circumstances mentioned above, JICA decided to conduct this Study for the expansion of the water supply system in Siem Reap Town.

(2) Study Area

The study area covers all the communes of the newly established Siem Reap City and one adjacent commune, Kandaek, of the City, a total of 14 communes.

(3) Target Year

The target year for Feasibility Study is 2022.

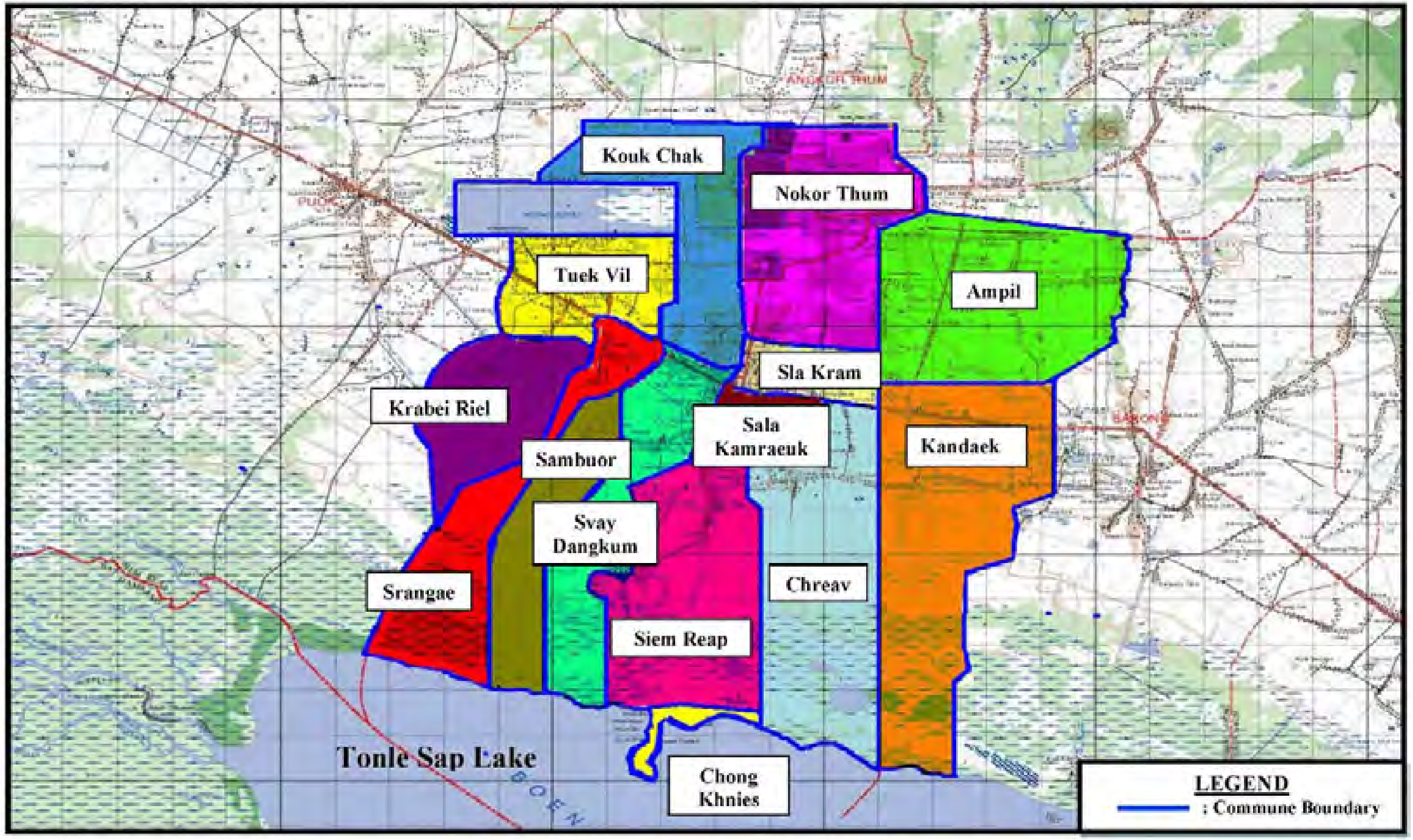


Figure 10.2 Study Area (13 Communes in Siem Reap City + Kandaek Commune) *Source; JICA Study Team*

10-2 Project Description

Feasibility Study (F/S = Phase1) shall provide a new intake facility, a treatment plant, a transmission/distribution systems to supply additional water required for the existing Siem Reap service area, elevated water tank with clear water lifting pump facilities, distribution pipelines from the proposed elevated water tank to the existing distribution system, and expansion of distribution network to un-served areas. Facilities provided in this project are as shown in Table 10.3 and Figure 10.3.

Although the nominal design capacity for Phase 1 is 30,000m^3/day which will meet the water demand in 2022, main part of raw water conveyance pipelines, water intake structure, and administrative common facilities will be sized for Phase 2 (target year 2030) capacity, which nominal design capacity would be 60,000m^3/day. Ten percent allowances will be added to design the works for loss through the works. Distribution of water to Siem Reap service areas under Phase 1 will be for those communes as Sla Kram, Svay Dangkum, Sala Kamraeuk, Kouk Chak, Siem Reap, Chreav, and Nokor Thum.

The population served by the project will be 232 thousand of residents and 27 thousand of tourists, respectively. (For details refer to Chapter 2)

Tonle Sap Lake water was selected as the most appropriate raw water for the proposed water supply development scheme among three alternatives, Tonle Sap Lake water, the water from the West Baray and Groundwater.

Table 10.3 Facilities provided in the F/S Project

NO	Facility	Description
a)	Raw water conveyance pipelines	Capacity of raw water conveyance pipelines; 66,000 m^3/day including 10% allowances for the nominal design capacity for Phase 2
b)	Raw water intake pump station	Space of the pump station is sized for Phase 2. Phase 1 facilities includes only for capacity of 33,000m^3/day (additional pumps will be expanded in Phase 2)
c)	Raw water intake pipe	Pipes used for raw water transmission main from raw water transmission pump station to WTP should be of 800 mm dia. DI pipes of 3,400m length to satisfy a capacity of 33,000 m^3/day
d)	WTP	Production capacity of 30,000 m^3/day
e)	Clear water pumps	Deliver 30,000 m^3/day to the elevated water tank
f)	Clear water pump station, chemical building, administration building, etc.	
g)	Elevated water tank	2,000 m^3 will be allocated in WTP
h)	Distribution main from treatment plant to service areas	Approximately 62 km. of distribution main system. DI pipes with diameters from 250mm to 1,000mm, and PE/uPVC pipes with diameters from 50mm to 200mm
i)	Distribution pipelines	In the distribution system 421 km of PE and uPVC pipes will be used, dependent on pipe sizes
j)	Communication and power supply to intake, pumping station and WTP	
k)	Plant and equipment necessary for operation and maintenance	

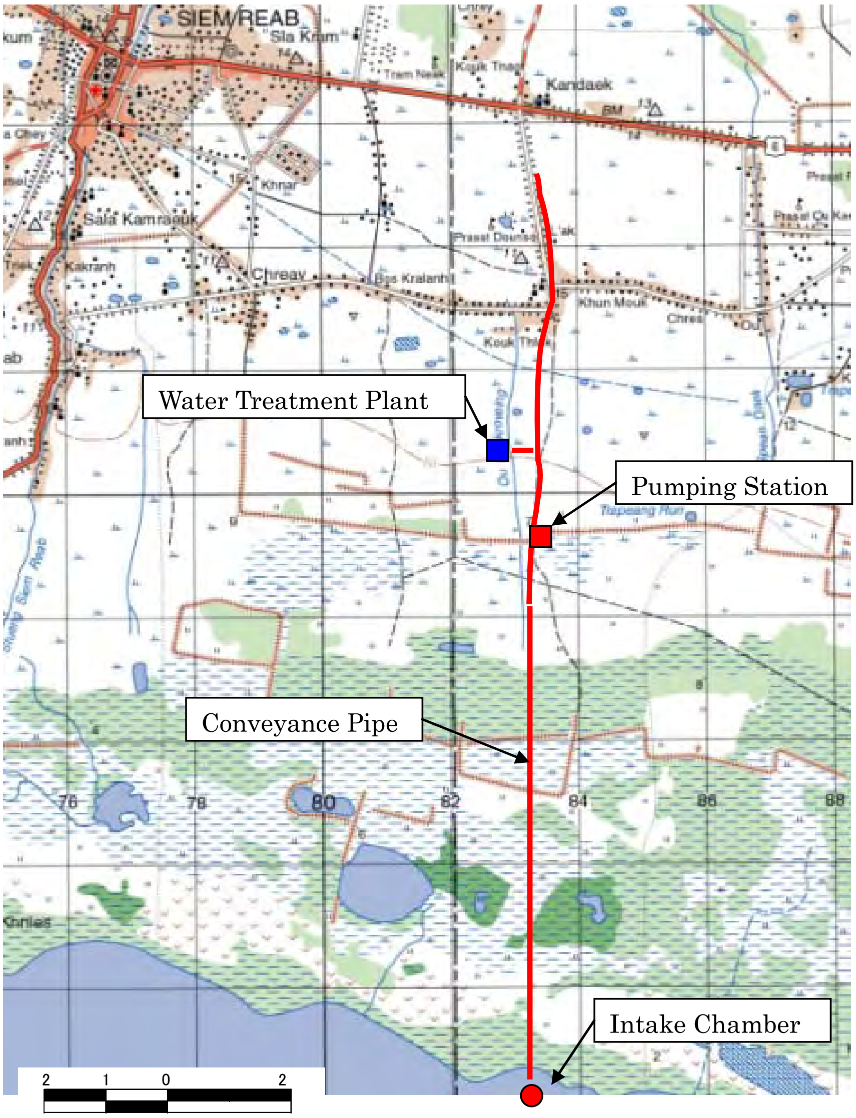


Figure 10.3 Location of Facilities for F/S Project

10-3 Description of Environmental Resources

10-3-1 Physical resources

(1) Air Quality

It is presumed that emissions from small-scale power generators and traffic mainly contribute to air pollution in Siem Reap City because no other pollution sources, such as large-scale factories, exist in the area. Ambient concentrations of some air pollutants in the City are shown in Table 10.4. The concentration of NO_2 is much lower than the standard of Cambodia both in dry and rainy seasons. It is estimated that the concentrations of SO_2 and CO are also below the standard though the comparison between the standards and the detected cannot be done because the exposing time of detectors were not consistent with the standard time. No data is available on particulate matters (PM) or total suspended particulate (TSP), but the City is dusty because traffic lifts dusts mainly derived from unpaved roads. (*Source*: *The Study on Integrated Master Plan For Sustainable Development of Siem Reap / Angkor Town, JICA, 2006)*

Also because Siem Reap is part of the alluvial plains, sandstone deposits from the escarpment make the surface ground sandy. However, during rainy season, TSP in the air is washed down by daily heavy rain.

Table 10.4 Air Quality in Siem Reap City (2004)

Parameter	February 2004				July 2004				Standard
	Angkor Heritage Area		South of Heritage Area		Angkor Heritage Area		South of Heritage Area		
	1 week average	max	1week average	max	1 week average	max	1week average	max	
NO2 (mg/m3) 24hrs average	0.026	0.043	0.021	0.043	0.028	0.043	0.009	0.009	0.1
SO2 (mg/m3) 10hrs average	<0.06	–	<0.06	–	<0.06	–	<0.06	–	0.3 (24 hrs average)
CO (mg/m3) (24hrs average)	1.20	1.60	0.86	1.00	1.00	1.60	0.68	1.00	20 (8 hrs average)

(*Source*: *The Study on Integrated Master Plan For Sustainable Development of Siem Reap / Angkor Town, JICA, 2006)*

(2) Water Quality

It is necessary to grasp the situation of three kinds of water like surface water of river and lake and groundwater.

<u>Siem Reap River</u>

Domestic sewage, commercial waste, agricultural run-off, and untreated solid waste pollute surface water in the country. Increasing concentrations of coliform bacteria, a presence in water that indicates fecal contamination, represent a serious health risk, especially during April and July. Sedimentation from land clearing, from both commercial and subsistence farming, also contribute to overall decrease in water quality (World Bank 2003). Siem Reap River and Tonle Sap Lake are contaminated with effluents as both are the final discharge points for the drainage system. The volume loads of these water bodies dilute pollutants that become less harmful to human and animal life. Water quality of water bodies also vary by season and by flood level. However, high volumes of feces, urine and gray water are released daily in inland water bodies in the country. There are regional differences in BOD. Although Siem Reap River contains chemical and biological pollutants due to domestic waste discharged into it, water can be flushed out with upstream water during the rainy season.

<u>Tonle Sap Lake</u>

i) Result of Water Quality Analysis by JICA Study Team

A water quality analysis was undertaken by JICA Study Team to examine the safety and appropriateness of the water for potable use and also to give reference data for the design of water treatment facilities. The results of water quality examination which has been carried out two times in 2009 are shown in Table 10.5 and Table 10.6.

Table 10.5 Water Quality Data by The Team (June 29, 2009)

No.	Description of Item	Unit	MIME-DWQS	S1
A	**Microbiological Test**			
1	Total coliform	Count/100ml	0	9.3×10^2
2	E.coli	MPN/100ml	0	56
B	**Physical and Chemical Test**			
3	pH		6.5-8.5	7.7
4	DO	mg/l	>6	5.4
5	Total Suspended Solid (TSS)	mg/l		498
6	Odour	-		Slight muddy
7	Taste (Threshold taste)	-		Acceptable
8	Color	Pt-4		100
9	Turbidity	NTU	5	200
10	Transparency	Dept (cm)		2.5
11	Nitrite (NO_2)	mg/l	3	ND<0.1
12	Nitrate (NO_3)	mg/l	50	2.53
13	Ammonium-N	mg/l	1.5	0.05
14	Chloride	mg/l	250	6.81
15	Total nitrogen	mg/l		3.50
16	Total phosphate	mg/l		1.04
17	Iron	mg/l	0.3	3.333
18	Manganese	mg/l	0.1	0.05604
19	Hardness	mg/l	300*	107
20	Total Dissolve solid (TDS)	mg/l	800	55.50
21	Alkalinity	mg/l		190.00
22	Cyanide	mg/l	0.07	ND<0.04
23	Mercury	mg/l	1	0.0018
24	Copper	mg/l	1	ND<0.0003
25	Zinc	mg/l	3	0.00648
26	Lead	μg/l	10	2.57
27	Hexavalent chromium	μg/l	50	10
28	Cadmium	μg/l	3	ND<0.2
29	Arsenic	μg/l	50	0.94
30	Fluoride	mg/l	1.5	0.23
31	Phenols	mg/l		ND<0.025
32	Chlorophyll a	μg/l		5.80

MIME DWQS: Ministry of Industry Mines and Energy, Drinking Water Quality Standard, Jan. 2004
* Hardness is expressed as mg/L $CaCO_3$

Table 10.6 Water Quality Data by The Team (October 6, 2009)

No.	Description of Items	Unit	MIME-DWQS	S1
A	**Microbiological Test**			
1	Total coliform	Count/100ml	0	<30
2	E.coli	MPN/100ml	0	0
B	**Physical and Chemical Test**			
3	Temperature	^{0}C	-	29.40
4	pH	-	6.5-8.5	7.80
5	Odor	-	-	Normal
6	Taste	-	-	Normal
7	Transparency	Dept (cm)	-	74.50
8	Dissolved Oxygen (DO)	mg/l	>6	7.30
9	Turbidity	NTU	5	3.5
10	Color	Pt-4	-	30
11	Total Suspended Solid (TSS)	mg/l	-	44.00
12	Total Dissolved Solid (TDS)	mg/l	800	51.30
13	Hardness	mg/l	300	83.30
14	Alkalinity	mg/l	-	4.20
15	Nitrite (NO2)	mg/l	3	<0.10
16	Nitrate (NO3)	mg/l	50	<0.10
17	Ammonium (NH4)	mg/l	1.5	0.24
18	Chloride (Cl)	mg/l	250	4.02
19	Total Nitrogen (T-N)	mg/l	-	0.58
20	Total Phosphorus (T-P)	mg/l	-	0.26
21	Iron (Fe)	μg/l	0.3 (mg/l)	0.51
22	Manganese (Mn)	μg/l	0.1 (mg/l)	ND<0.3

ii) Existing Water Quality Data

The team for Project on Capacity Building for Water Supply System in Cambodia Phase 2 carried out the water quality sampling and analysis from March to June (late of dry season to early of rainy season) in 2009 weekly at 2 points, which are both located almost in the same area of tentatively proposed intake site (Sampling Point NO.1) and the water sampling site by this JICA Study Team (Sampling Point NO.2) as shown in Figure 10.4. The sampling point of NO.1 is located approximately 200m north and 50 m east from NO.2. The sampling was carried out 13 times in total and the analysis was made for 9 parameters every time. Iron, turbidity and color exceed the standard compared with water quality standard for drinking water in Table 10.7.

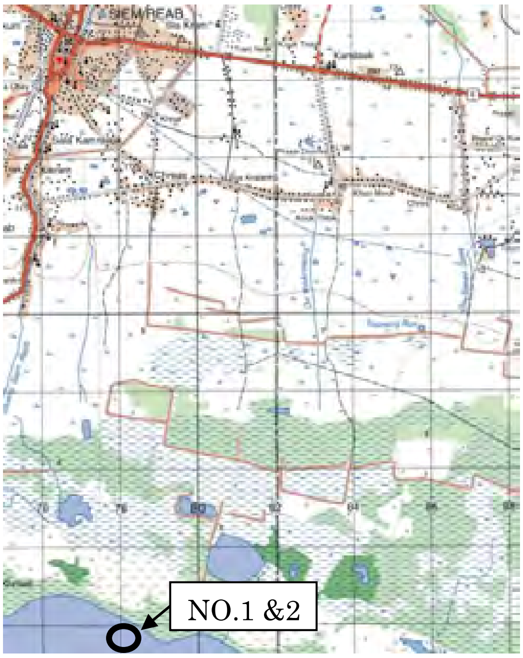


Figure 10.4 Water Sampling Points

Table 10.7 Comparison with the Water Quality Standards of Drinking water

Item	Parameter	Unit	Sample 1	Sample 2	MIME, DWQS
1	Iron, Fe	mg/L	**4.48**	**5.55**	0.3
2	Manganese, Mn	mg/L	0.59	0.54	0.1
3	Ammonia, NH3	mg/L	0.32	0.30	1.5
4	Sulfate, SO4	mg/L	3.69	3.00	250
5	Turbidity	FTU	**661.97**	**477.77**	5
6	Alkalinity	mg/L	36.69	36.43	-
7	Color	TCU	**207.38**	**252.02**	5
8	pH	-	7.17	7.40	6.5-8.5
9	Conductivity	μS/cm	110.25	109.92	1600

The JICA Study on Integrated Master Plan for Sustainable Development of Siem Reap (2006) carried out the water quality survey in the Tonle Sap Lake and the concentrations of SS, COD and Total Coliform exceed the standard in Cambodia.

(3) Wastes

The amount of municipal solid waste discharged from the central district including 5 communes of Siem Reap City is approximately 150 tons/day and the solid waste management company, Gaea, collects 110 tons every day based on the contract for 50 years since 2007. Municipal solid waste is collected from hotels, restaurants, guest houses, markets and private houses in central area mainly at night and in outskirt at day time. They have collection vehicles shown in Table 10.8 and transport the waste to the final disposal site located 25km distant east from the center of the City.

Collection fees of municipal waste are 1～2.5 US$/month for Cambodian people and 5～25 US$/month for foreigners. On the other hand the company does not pay disposal fee because the finial disposal site is owned and operated by the waste management company itself.

The staff of the company consists of 160 members including 57 street sweepers and the streets in Siem Reap City are cleaned regularly. The local government responsible for municipal solid waste management is not Department of Public Works and Transport, but both of Siem Reap Municipality and Provincial Department of Environment. The former rules operation and maintenance of the solid waste management, and the latter does technical aspects.

Table 10.8 Collection Vehicle owned by Waste Management Company

NO	Vehicle	Capacity (ton)	Unit
1.	Compacter Truck	11	5
2.	Open Container Truck	4.5	6
3.	Large Container Truck	16	2

Source: Hearing from the municipal solid waste management company

(4) Noise and Vibration

The JICA Study Team conducted noise and vibration surveys both in dry and rainy seasons in 2005, at the intersection of National Road No.6 and the bridge, and at the entrance of Angkor Heritage as shown in Figure 10.5. The noise and vibration levels were monitored for 14 hours from 6:00 a.m. to 8 p.m. based on the Japanese Industrial Standard (JIS). Figure 10.6 shows the results of surveys.

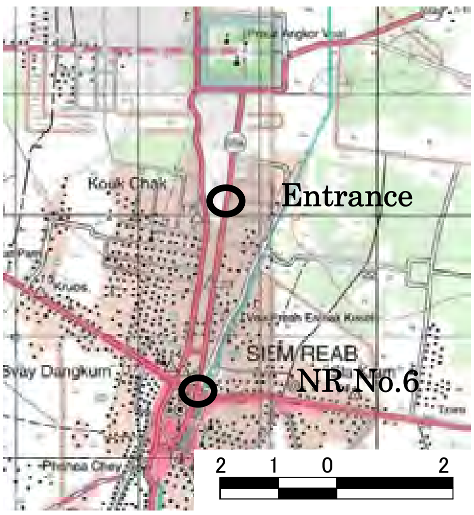
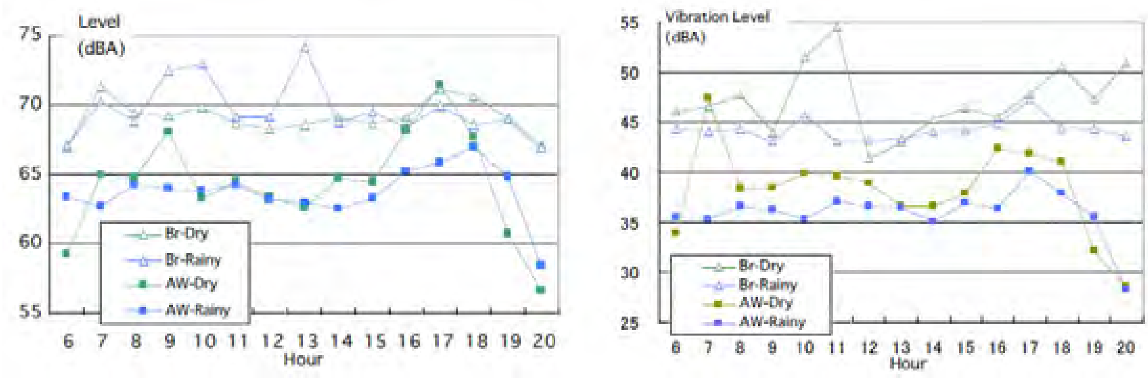


Figure 10.5 Survey Points of Noise and Vibration



Br: Intersection of NR 6 and Bridge
AW: the Entrance of Angkor Wat

Figure 10.6 Noise and Vibration in Siem Reap City
(*Source*: *The Study on Integrated Master Plan For Sustainable Development of Siem Reap / Angkor Town, JICA, 2006)*

The result of noise survey shows that the noise levels in the dry and the rainy seasons are almost same. The noise level stabilizes at 65dBA in the daytime and goes below 60dBA at night in the Angkor Heritage Area. The range of vibration level is 40dBA to 50dBA along Route 6. The vibration level reaches at 55dBA in a moment when the traffic passes and the level is predicted to be higher inevitably when the heavy traffic passes.

(5) Hydrology

Siem Reap City is located in a very flat and low-laying area close to Tonle Sap Lake. The Siem Reap River flows through the city dividing it into East and West drainage areas and main river system further to east and west are the Roulous River and the Puok River, respectively. The rivers and all stormwater drainage flow into Tonle Sap Lake. The Siem Reap River has natural gradient of about 1/1,000 from North to South towards Tonle Sap Lake. During rainy season, the river carries significant flows. In September 2009, the river flow was estimated to be 133 m_3/sec and many areas adjacent to the river were flooded for a period.

The current stormwater drainage infrastructure cannot deal with heavy storm. Heavy storms can cause widespread flooding and water levels in drain and in Siem Reap River rise considerably. In poorly drained areas, urban runoff mixes with sewage from overflowing latrines and sewers, causing pollution. Due to the flat topography, the existing drainage system does not have sufficient gradient and this makes it vulnerable to blockage from settled solids and dumped wastes.

National road N0.6 acts as a hydraulic bottleneck causing flooding, due to insufficient and clogged culverts and drains installed beneath the road over most of its entire length from east to west in the city area.

(6) Land

The Study area is generally covered by alluvial fan deposits on the surface and the layers below the surface is composed of diluvial deposits, Pleistocene sediments, Plicene clay stones, Mesozoic sedimentary rocks, and Paleogene volcanic rocks in order from the surface to the deeper part. Top soils are generally classified by their potential use. The acid lithosols are found in the northern area of Kulen mountains and suitable for forest. Alluvial lithosols and cultural hydromorphics exist mainly along the rivers and good for agricultural use. Plinthicite and red-yellow podzols are seen widely in the flat lowland and suitable for plantation of agro-forestry. Coarse sandy alluvial deposits are found generally in the northern part of the study area, and fine sand to silt deposits is found in the area near Tonle Sap Lake. Top soil of cultivated upland, paddy field and the bottom of the barays is generally composed of organic clay and silty clay. Total thickness of alluvial deposits is 10-20m in the northern area and 20-30m in the southern area. Diluvial deposits layer underling the alluvial deposits is composed of coaser particle than that of alluvial deposits in general and the thickness is 20m in most part.

10-3-2 Ecological resources

(1) Protected Area

i) The Protected Area stipulated by MOE

MOE stipulates five kinds of natural protected areas, National Park, Wildlife Sanctuary, Landscape Protected Area, Multiple Use Area and Heritage Protected Area. Within the study area there are two kinds of protected areas, Angkor Landscape Protected Area and Tonle Sap Multiple Use Area. The location is shown in Figure 10.7 and the definitions are as follows;

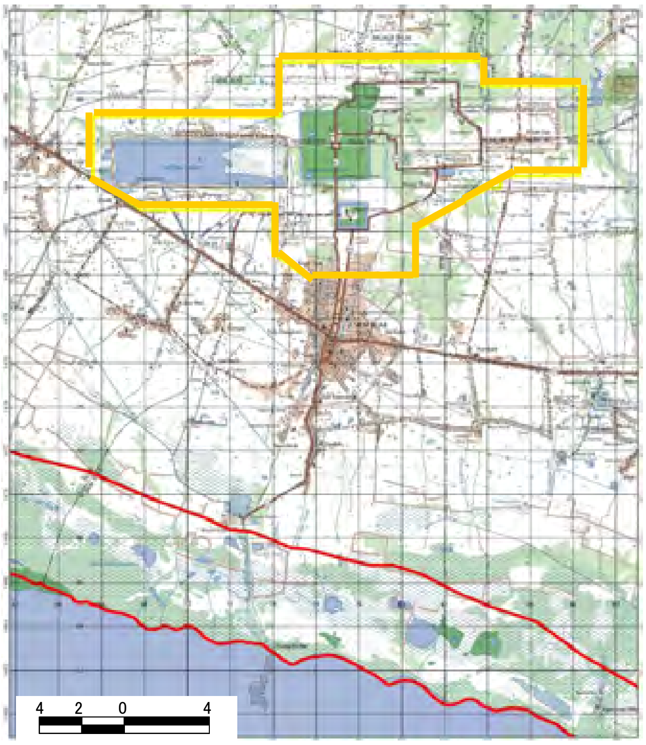
Landscape Protected Area

A land or water area where the nature, ecosystem and cultural heritage should be protected from destruction by human beings and there is a special beautiful area, and normally there is rich biodiversity. To prevent this traditional area from destruction or to conserve this area is more important than to develop it for human beings' lives.

Multiple Use Area

The land or the water area, which has much natural system and needs to be managed for protection of biodiversity and sustainable ecosystem. More over, it can give natural products and services for community's use demand.

The facility for the project like water treatment facility should not be constructed in these areas.



	Landscape Protected Area
	Multiple Use Area

Figure 10.7 Natural Protected Area by MOE

(Source: Natural Resource Assessment and Environmental Data Management Department, MOE)

ii)The Protected Area stipulated by MOAFF

The Department of Fisheries, Ministry of Agriculture, Forestry and Fisheries (MOAFF) stipulates Fish Sanctuary, Community Fisheries, Fishing Lot and Strictly Protected Inundated Forest Area. Within the study area there are three kinds of areas, Community Fisheries, Fishing Lot and Strictly Protected Inundated Forest Area. The location is shown in Figure 10.8.

The targets of the Community Fisheries are as follows;

- To manage fisheries resources in a sustainable manner and ensure equitable sharing of benefits from fisheries resources,
- To increase understanding and recognition of the benefits and importance of fisheries resources through direct participation in managing, using and protecting fisheries resources, and
- To improve the standard of living in order to contribute to poverty reduction.

The fishery domain is the state property. It can cover public or private land in the flooding season (management of these fisheries does not affect the ownership of the lands). (Article 9, Law on Fisheries)

There are about 37 Fishing Lots in Tonle Sap Lake at present although there were more than 50 lots before. In 2001, the government embarked on an extensive reform of the fisheries sector by improving access by the poor to the Fishing Lots. The government repealed 495,000 ha of officially auctioned Fishing Lots, a reduction of 53% in the size of the official Fishing Lots to allow the poor to access common fisheries resources. Industrial fishing is based on the Fishing Lots or concessions which were allocated through an auction system for exclusive exploitation over a two-year period. The Fishing Lot, NO.4, only one belonging to the Siem Reap Provincial area, can be leased for as much as 80 million Riels (US$200,000) a year (source: Provincial Department of Fisheries). The artisanal and family fishermen are not permitted to enter the Lot and fish outside it during an open season of fishing from October to May.

Strictly Protected Inundated Forest Area is set for sustainability of fishery resources and for important aquatic habitats to feed, spawn and breed since 1962.

The facility for the project like water treatment facility should not be constructed in these areas and pipeline should not be set through the heavily wooded areas

Department of Forest stipulates Community Forests which can fulfill same function as Community Fisheries. They prepare Community Forest Management Plan and Community Forest Agreement for implementing the sustainable use and development of forest resources. There is no Community Forest in the study area, although there are some Community Forests in northern mountainous area.

There is no protected area designated by Department of Agriculture in the study area.

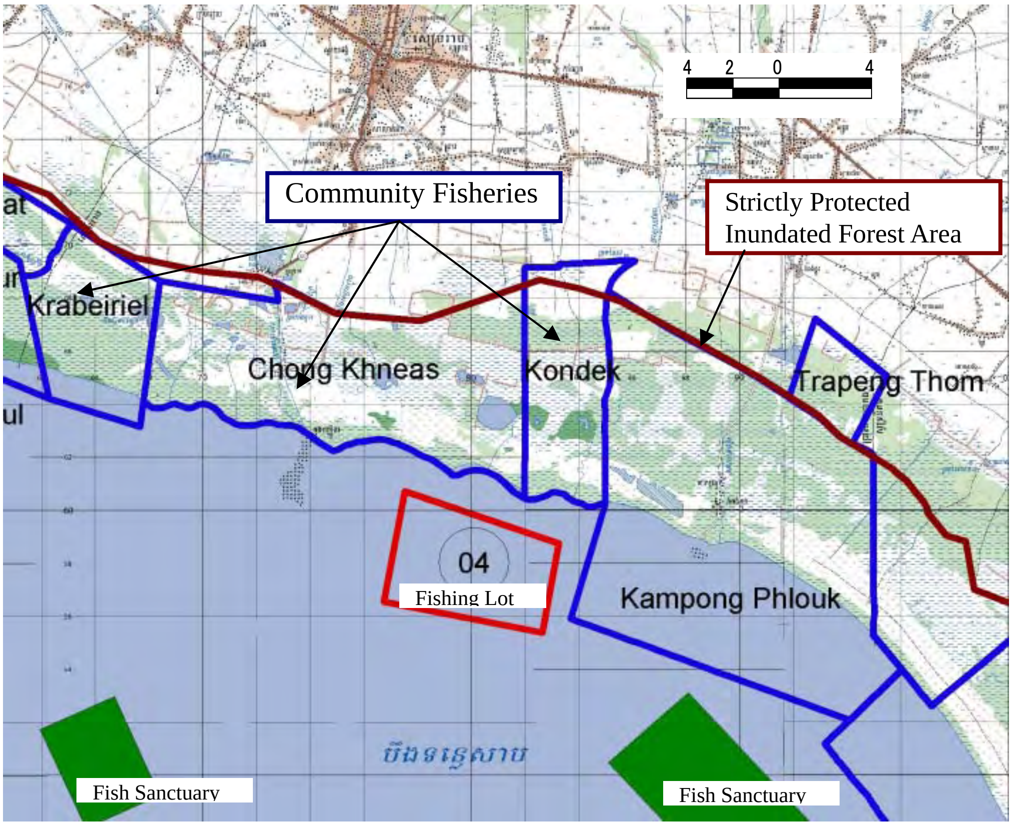


Figure 10.8 The Protected Area by Department of Fisheries

(Source: Fisheries Administration, MOAFF)

iii) The World Cultural Heritage Area inscribed by UNESCO

On 14th December 1992, Angkor was inscribed in the World Heritage List and the World Heritage in Danger covering the area of 401km2 with 90 temples.

Angkor was inscribed on the basis of the following criteria:

a) it represents a unique artistic achievement, a master piece of creative genius;
b) it has exerted great influence over a span of time, within a cultural area of the world, on developments in architecture, monumental arts, and landscaping;
c) it bears a unique exceptional testimony to a civilization which has disappeared; and
d) it is an outstanding example of an architectural ensemble which illustrates a significant stage in history.

Also the Angkor Park was inscribed under five conditions as below:

(a) Enact adequate protective legislation

(b) Establish an adequately staffed national protection agency

(c) Establish permanent boundaries based on the UNDP project

(d) Define meaningful buffer zones

(e) Establish monitoring and coordination of the internationally conservation effort.

These conditions were successively fulfilled. A Royal decree of 19th February 1995 providing a legal basis for the creation of the Autorité pour la Protection du Site et l'Aménagement de la Région d'Angkor (the National Authority for the Protection of the Site and Development of Angkor called APSARA Authority– conditions (a) and (b)). This acronym is a Khmer common word and signifies "celestial dancer".

iv) The Protected Area designated by APSARA
Angkor Archaeological Area is protected by APSARA shown in Figure 10.9, in accordance with the recommendation of UNESCO.

The definition of four kinds of zones is as follows; (source; APSARA homepage)

Zone1: Monumental Sites

Areas which contain the most significant archaeological site in the country and therefore deserve the highest level of protection.

Zone 2: Protected Archaeological Reserves

Areas rich in archaeological remains which need to be protected from damaging land use practices and inappropriate development. They will most frequently surround monumental Sites, providing protection to adjacent areas of known or likely archaeological importance. Zone 1 and 2 require intensive management aimed at integrating archaeological and visitor interests with local interests and needs.

Three main Monumental Sites identified in the region are those of Angkor, Rolous and Banteay Srei. Each lies within a Protected Archaeological Reserve which, in the case of the Angkor site, acts as a buffer zone. Additional sites could be added at a later date to protect and manage areas such as Beng Mealea, Koh Ker, or Preah Khan in Kompong Svay.

The three sites, including their Archaeological Reserves zones, cover the areas with the highest density of archaeological remains, including the original sites of the ancient Angkorian capital, with most of the well-known temples and many ancient hydrological structures such as the barays, canals and dikes. The Protected Archaeological Reserve around the Angkor site also contains a large local population whose interests are to be protected.

The Angkor Monument Site and its Archaeological Reserve comprises an area of more than 350 square kilometers. It contains:

/the original Angkor Park as designated in 1925 and reconfirmed with minor modifications during the subsequent decades;
/additional areas which together constitute the core of the Angkor Monumental Site;

/a protection zone to safeguard archaeological sites in the surrounding landscape (zone2); and buffer areas, particularly between Siem Reap and Angkor Vat, which are necessary to conserve the integrity of the Monumental Sites, Preserve the area as a tourist attraction and prevent all development not essential to the protection of the cultural heritage.

Zone 3: Protected Cultural Landscapes

Areas with distinctive landscape characteristics which should be protected on a account of their traditional features, land use practices, varied habitats, historic building, or man-made features from the past or of recent origin that contribute to the cultural value or reflect traditional lifestyles and patterns of land use. Cultural Landscapes may also serve to safeguard visual perspectives and relationships between significant features which contribute to their historic or aesthetic value. Protected Cultural Landscapes are subject to regulations aimed at controlling damaging and disruptive activities.

The ancient canalized river valleys of the Stung Siem Reap and Stung Roluos from where they flow off the Phnom Kulen to their mouths at the Tonle Sap have been designated Protected Cultural Landscapes. The ancient causeways running from the Angkor site northwest to Banteay Srei are Cultural Landscapes extending the protected areas of the Angkorian heritage and further into the surrounding environment. These areas may be expanded and other areas zoned for protection at a later date.

Zone 4: Sites of Archaeological, Anthropological or Historic Interest

Including all other important archaeological sites, but of less significance than Monumental Sites, that require protection for research, education or tourist interest. The sites and areas are subject to regulations aimed at controlling damaging activities similar to those applying to Protected Archaeological Reserves.

A number of the more important below and above-ground archaeological sites identified within the Siem Reap region, such as Phnom Krom, Wat Athvea and Chau Srei Vibol are indicative of the areas included in Zone 4. Other sites may be included in the future.

Zone 5: The Socio-economic and Cultural Development Zone of the Siem Reap region, comprising the whole of Siem Reap Province, is the largest zone to which protective policies apply.

This comprehensive zone covers an area of 10,000 square kilometers including the Phnom Kulen, the shores of the Tonle Sap and the Angkor plain. It conforms largely to the catchment area of greater metropolitan Angkor during the ancient period and is rich in remains of both prehistoric and historic civilization. The region also contains important natural areas which are to be protected and others to be developed in a sustainable manner.

The region is to be managed as a multiple-use area with an emphasis on economic and social development of cultural tourism. Development activities which could potentially damage the archaeological, the natural, or the social heritage harbored in the province are regulated by comprehensive coordination policies. Archaeological and environmental impact assessments are to be carried out in advance of any project proposed in the region. The intention is not to hold back development but to ensure that it be appropriately located and directed, at all times taking into consideration the requirements of heritage conservation.

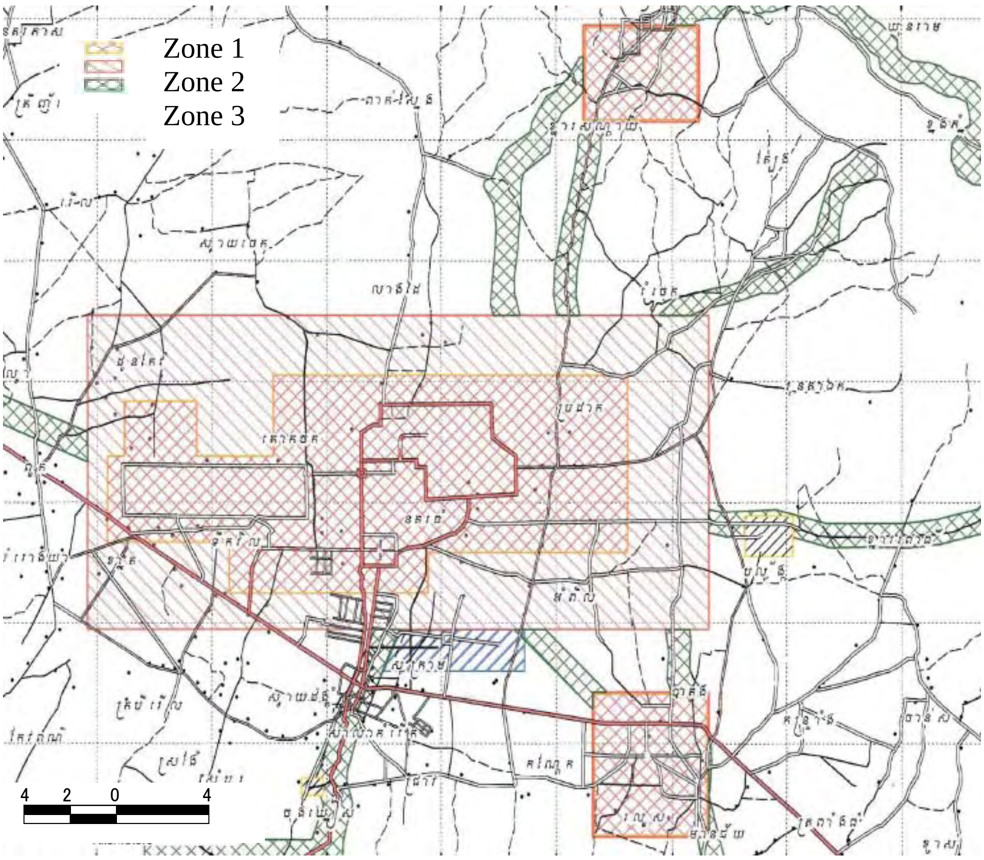


Figure 10.9 APSARA Protected Area

(Source: APSARA)

v) Tonle Sap Biosphere Reserve Area by UNESCO

Tonle Sap Biosphere Reserve is divided into core areas, a buffer zone and a flexible transition zone. Within the study area there are transition area and buffer zone as shown in Figure 10.10. There is no core zone which is defined likewise national park or wildlife sanctuary.

The transition area is limited between the outer boundary of the buffer zone and National Road NO.5 and NO.6. It is the integrated economic zone, which is managed for sustainable agriculture, human settlement and land use, without having adverse effects on the flooded forest, water quality and soils of the region around the Tonle Sap Lake.

The buffer zone covers the area of 541,482ha. Its boundary corresponds to the outer boundary of the Tonle Sap Multiple Use Area.

The buffer zone surrounding such core areas which are covered by flooded forest of a variety of species. Activities are managed to be consistent to the protection and conservation plan of the core areas. Fishery activities and other development plans will be managed based on existing law and regulations in a coordinated and cooperative manner. The buffer zone is also subject to experimental research and discovery of method for the management of flooded forest, fishery, agriculture, housing settlement, land use, water resources, navigation and tourism to ensure their sustainability, increased production, while preserving the environmental quality and fish.

The facility for the project like water treatment facility should not be constructed in the buffer zone area.

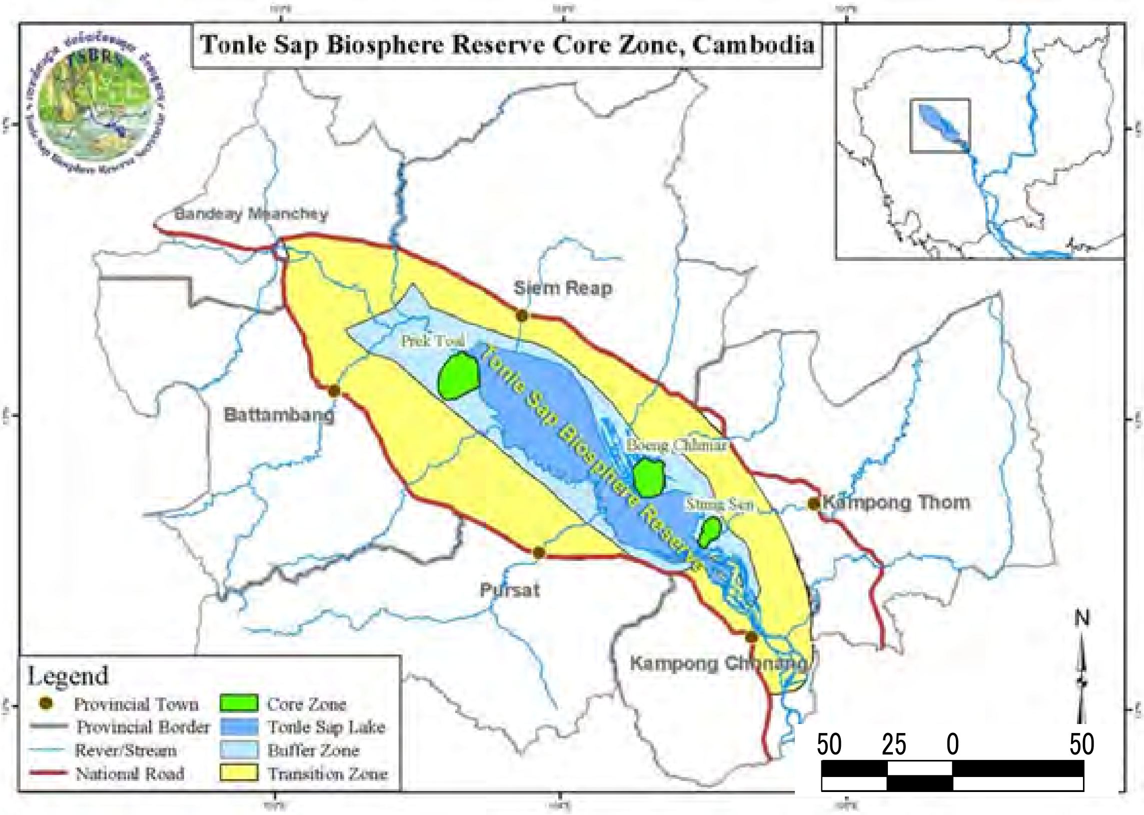


Figure 10.10 Tonle Sap Biosphere Reserve

(Source: Website)

vi) Provincial Conservation Area protected by Community

The Boeng Peareang Lake had been protected by the community. In 2006 the biodiversity of the area was studied by experts involving Department of Environment in Province (DOE). There are big trees in inundated forest and many kinds of bird build their nest on the trees. DOE prepared a document to submit to MOE and got approval of Boeng Peareang Natural

Conservation Area including the lake with signatures of Minister of Environment and Provincial Governor in 2008. Total area is 3,098ha as shown in Figure 10.11. The pipelines of water supply expansion project should not be laid down through Boeng Peareang Lake itself in the conservation area, while it can be set through the conservation area, according to the opinion of relevant persons.

The Polav Lake had been protected by Kandeak Community Fisheries. In 2008 the lake of 4 ha was decided as Fish Conservation Area (Sanctuary) signed by Minister of Agriculture, Forest and Fisheries as shown in Figure 10.11.

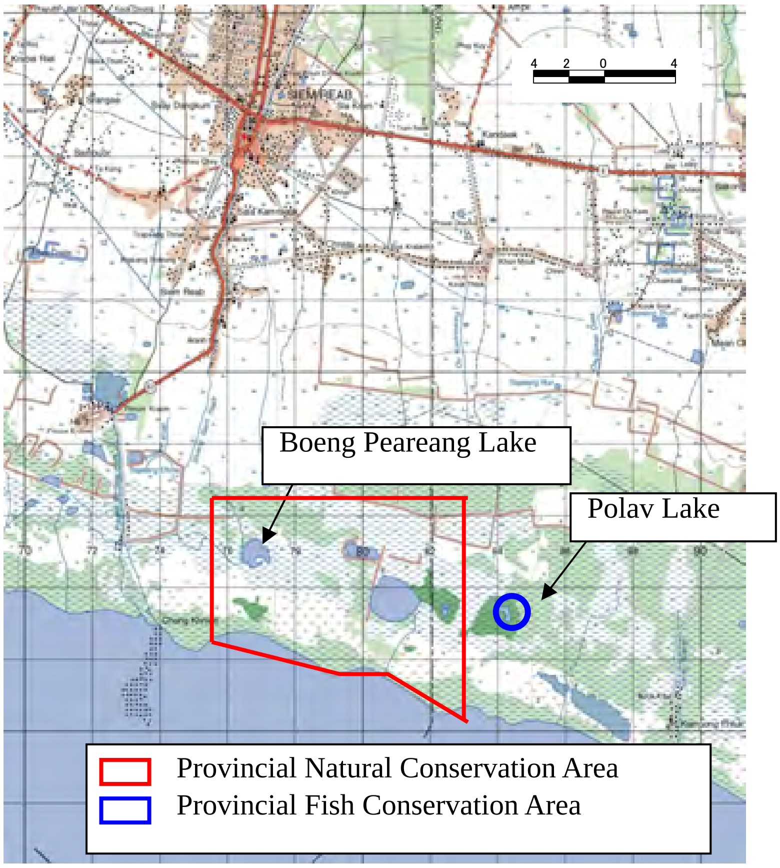


Figure 10.11 Provincial Conservation Area

(Source: Siem Reap Provincial Department of Environment and Kandeak Community Fisheries)

(2) Ecological resources

The survey on Flora and Fauna for this project was conducted with the aim to get a better understanding on the current status of flora and fauna species and assess potential impacts of future expansion of water supply on their survival and regeneration. The field study was conducted 5 days in December 2009 and January 2010.

Study Method

The study is based on the review of existing reports and literatures, and field survey in the proposed location. The visual observation with guiding manuals is carried out along the predetermined route and interview is undertaken with more than forty key informants, mainly the fishermen and the rice farmers to supplement the observation. Due to different schedule and specific requirements of flora and fauna specialists, three teams were set up, forest and mammal team, fishery and amphibian, and waterbird and reptile team. Acting as the team leader, Ph.D. Bonheur Neou, former Deputy Secretary General of Tonle Sap Basin Authority, provided an overall guidance on methodology being used and ensured accuracy of the survey across all the flora and fauna features. The survey methodology for each flora and fauna is summarized below.

Flora

The flooded forest in the study area is a typical secondary forest which is much disturbed by the communities living in Chong Kneas, Chreaov and Kandek communes. Recession rice farming is the main encroachment causing large clearing of flooded forest. Other forest use is firewood collection and cutting for fishing gears.

Based on observed forest composition and density, the present flooded forest pattern in this study area can be divided into four zones of forest type: i) a mixture of gallery forest with bush/shrubs extending from the lake shore until the location (approx 1.7 km); ii) degraded area with scattering stands of trees, recession rice and large floating water hyacinth extending up to the point (approx 3.8 km); iii) a reservoir O Smoan where a good mixture of bush/shrubs present (approx 2.0 km) and iv) a recession rice up to Dam 78 (approx 1.3 km). North of dam 78 is again wet season rice fields. Plot 1 and plot 2 represent zone (i), plot 3 corresponds to zone (ii), plot 5 represents reservoir forest of zone (iii), and plot 7 and 8 represent zone (iv).(Figure 10.12)

Observation and plot measurements indicate that zones (i) and (iii) are of special interest as there remains good forest cover in both diversity and density. Of particular interest is O Smoan reservoir which extends between recession rice fields with approximate length of 2.0 km along the route B. The reservoir is built for the purpose of recession rice, but somehow the flooded forest is also protected. It was reported that O Smoan and the canal were built before Khmer Rouge regime in around 1950s. Building pipeline across this reservoir must be considered carefully as it would destroy large forest area and make the area exposed to more encroachment.

At least 35 forest species were identified from the 8 plots selected.

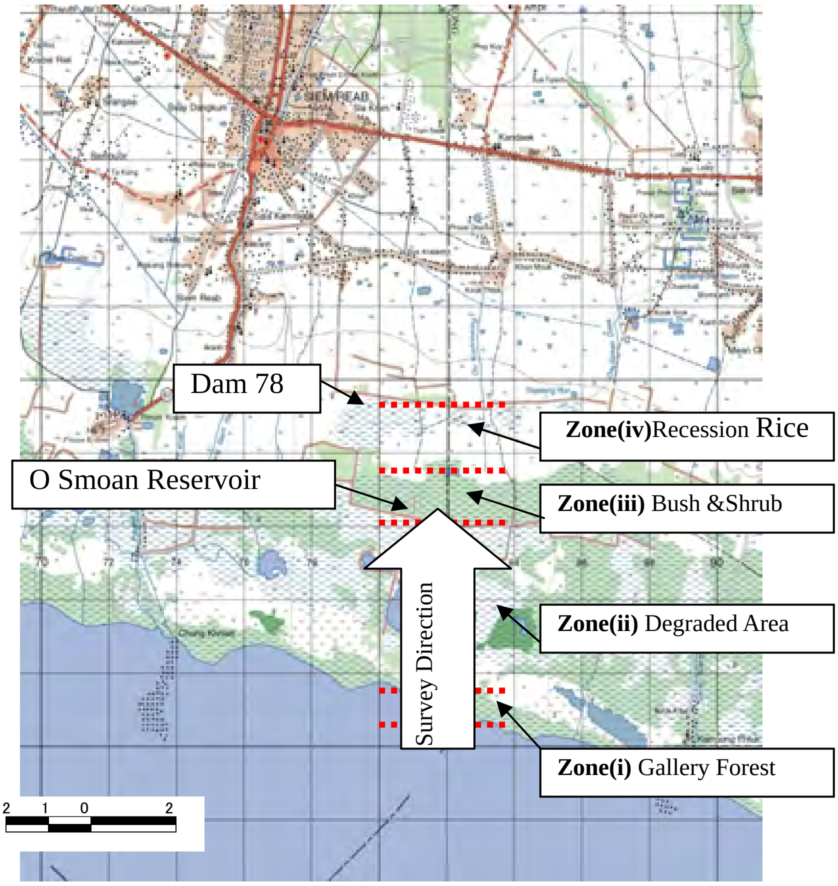


Figure 10.12 Location of Forest Type

Fauna

1) Mammal

Mammal faunal diversity of the survey area by both track-sign survey along transects and interview is not particularly high due to high human disturbance as areas are easily accessible from Chong Kneas and Kandek communes for fishing, resources foraging, hunting and rice farming. Only one species of primate (O. Primates) has been recorded during interview using mammal field guide of Cambodia (Men et al., 2000). Long-tailed Macaque *Macaca fascicularis* is reported by fishermen but not seen by our survey, meaning its number is significantly declining due to hunting for commercial purpose (for Chinese Macaque farming). Silvered Langur is rarely seen by local fishermen. Hairy-nosed Otter *Lutra Sumatran* has been spotted on a rare case and was informed to migrate across the Lake in the direction to Prek Toal. It is reported their skin is used for traditional medicine. Other species include Mainland Slender-tailed Treeshrew *Dendrogale murina*, Squirrel *Callosciurus finlaysonii*, Berdmore's Squirrel *Menetes berdmorei*, small Asian Mongoose *Herpestes javanicus*, Common Palm Civet *Paradoxurus hermaphroditus*, and Leopard Cat *Prionailurus bengalensis* have been reported by hunters with declining population. Only mainland Slender-tailed Treeshrew was sighted during the survey at the first plot. In the past the study area served as feeding habitats for Asian

Elephant *Elephas maximus* which seasonally descended here from upland Tonle Sap watershed for food. Irrawaddy Dolphins *Orcaella brevirostris* were also common in the area but now fully extinct due to especially widespread killing by Khmer Rouge officers for making oil for diesel engine in 1976-78. Villagers informed that dolphin flesh is not commonly used as food, only their fat is useful.

2) Fish

A total of 104 indigenous fish species belonging to 56 genus, 27 families and 10 orders were identified. Species composition was determined based on number of species counted from all collected samples. Fish species of Cyprinidae family were found most abundant comprising of 39 species or 38%, followed by species of Siluridae (9%), Clupeidae (5%), Channidae (4%), Clariidae (4%), Osphronemidae (4%) and Cobitidae (4%). The remaining percentage is constituted by species of other families.

Endangered species were identified through interviews with fishermen in the communities in the study area. The interview was conducted directly with individual fisherman in each village by using fish poster (published by FiA 2009, WWW.fia.maff.gov.kh). 47 fish species in total were identified from the interview, and 57 species were caught in Bor and gill net from fisherman in December. At least 5 species were classified as threatened species as shown in Table 10.9, while the habitats are not identified.

Table 10.9 Endangered fish species

Order	Family	Species	Local name
Cypriniformes	Cyprinidae	*Probarbus jullieni*	Trey trawsak
Cypriniformes	Cyprinidae	*Probarbus labeamajor*	Trey trawsak
Cypriniformes	Cyprinidae	*Puntius partipentazona*	Trey kla
Siluriformes	Siluridae	*Wallago micropogon*	Trey stuak
Clupeiformes	Engraulidae	*Lycothrissa crocodilus*	Trey chhmar kror poeu

3) Amphibians

As the areas were flooded at the time of survey, poster was used to interview fishermen. It was reported only 3 species of amphibians have been recorded in this site, namely *Bufo macrotis, Kaloula pulchra* and *Rana erythraea.* A short field study can be supplemented in Feb-March when the areas fully dry up. Farmers of dry rice reported abundance of frogs during dry season when water recedes and dry rice is cultivated. In fact all these species are abundant in the Tonle Sap Lake and are not really significant species of concern.

4) Waterbird

Direct field observation and interview were conducted with the assistance of Mr. Hong Chamnan, an ornithologist from General Directorate of Forestry and Wildlife. He identified 67 bird species. A photograph of comb ducks was taken during field visit. Bird nests were not found, indicating that the study area is not a particular important site for breeding like in Perk Toil. Nevertheless flock of bird colonies visit the areas for food during dry season from February. Birds are often caught for food as their meats are of particular delicacy.

5) Reptile

Due to pressure caused by human activities such as forest destruction, rice farming, and hunting, no turtle species were observed or found during the survey. However, interview with fishermen indicated existence of some turtle species though their number is on the dramatic decline. Three species reported to be found are *Malayemys subtrijuga*, *Hieremys annandalii, Cuara amboinensis*, which are classified as near threatened species.

Crocodile was not expected to be found here either as this species is very sensitive to any human disturbance.

Water snakes are reported found in the areas as the species can still reproduce well in the mix of mosaic vegetation and rice fields. They are often caught by gillnet and used for household consumption and crocodile feeding. Five species confirmed by fishermen include *Enhydris enhydris, Cerberus rynchops, enhidris bocourti, Homalopsis buccata and Erpeton tentaculatum*, of which two species were collected by survey team.

Lizard species were reported to exist in the areas and one skink species was also seen by the team.

10-3-3 Socio-economical resources:

(1) Population

The recorded data from 2003 through 2009 of 13 communes of Siem Reap City plus one adjacent commune Kandaek commune in Prasat Bakong District in the Study Area shows that the population increase trend of the City is quite different from that of the province. The population growth rate varies from 2.9 % to 9.2 % dependent on status of each commune, which is much higher than 2.4 to 2.5 % of the Provincial growth rate. For example, the populations in Sla Kram commune and Svay Dangkum commune have increased over 14,000 and 10,000 or 9.2 % and 7.1 % of annual average growth rate, in the last six years. A total of 53,000 populations and an average of 5.9 % in the study area have increased from 2003 through 2009. This trend shows a typical population increase in urban areas in Cambodia. The population increase is caused by migration into Siem Reap City due to that sharp increase of economic activities through tourism industries would be taken place in the Study Area.

The population by village in the study area is as shown in Table 10.10. It is made up in order to descending prevalence of population except both of Kanndeak Commune situated outside of Siem Reap City and Chong Kheas where many people are living in the floating village. The commune with the largest population is Sla Kram, 40,473 and next one is Svay Dangkum, 34,878, and Siem Reap Commune ranks fifth, 17,564 among twelve communes.

Based on the hearing from the representative of each commune, population in the local area consists of farmers, fishermen, workers for building construction, local government staff and the rest. Around the project candidate site from raw water intake to water treatment plant through the pumping station there is no residential area. The site has a higher portion of rice field and abandoned bare land.

Table 10.10 Population by village in Study Area (2009)

Commune / Village		Population	Commune / Village		Population	Commune / Village		Population
1	**Sla Kram**	**40,473**	5- 4	Korkragn	2,426	9- 7	Bang Koung	1,133
1- 1	Slor Kram	2,740	5- 5	Kra Sangroleung	856	9- 8	Kiri manon	1,162
1- 2	Boeng dunpa	5,951	5- 6	Spean Chreav	2,647	9- 9	Bos tom	283
1- 3	Chong Kavsu	12,679	5- 7	Arragn	3,406	9- 10	Trach chrom	403
1- 4	Dork pou	3,518	5- 8	Treak	1,412	**10**	**Norkor Thum**	**6,644**
1- 5	Bantay chas	6,334	**6**	**Teuk Vil**	**9,890**	10- 1	Rohal	1,143
1- 6	Trang	3,473	6- 1	Kouk doung	1,648	10- 2	Sras srang	1,004
1- 7	Mondol 3	5,778	6- 2	Sandan	1,731	10- 3	Sras srang	735
2	**Svay Dangkum**	**34,878**	6- 3	Chrei	1,174	10- 4	Kravan	938
2- 1	Pngea Chei	941	6- 4	Prayut	564	10- 5	Arak svay	548
2- 2	Kantrork	2,098	6- 5	Bantay Cheu	955	10- 6	Ang Chang	2,276
2- 3	Kouk Krasang	891	6- 6	Teuk Vil	517	**11**	**Srangae**	**6,430**
2- 4	Svay Chrei	882	6- 7	Pri Chas	761	11- 1	Kasikam	1,698
2- 5	Pou Bos	680	6- 8	Tuek Tla	520	11- 2	Tnal	1,468
2- 6	Tmei	1,357	6- 9	Pri Tmei	988	11- 3	Roka Thom	534
2- 7	Svay Dangkum	1,758	6- 10	Chei	1,032	11- 4	Prei Thom	672
2- 8	Salakanseng	10,977	**7**	**Chreav**	**9,492**	11- 5	Srangie	828
2- 9	Krous	3,072	7- 1	Chreav	770	11- 6	Chanlong	765
2- 10	Vihear Chin	4,874	7- 2	Knar	3,617	11- 7	Ta Chouk	465
2- 11	Steng Tmei	2,272	7- 3	Bos Kralang	1,214	**12**	**Sambour**	**3,553**
2- 12	Mondol 1	2,197	7- 4	Ta Chek	634	12- 1	Pnouv	760
2- 13	Mondol 2	338	7- 5	Veal	1,262	12- 2	Sambour	884
2- 14	Ta phoul	2,541	7- 6	Kra sang	1,183	12- 3	Veal	649
3	**Sala Kamraeuk**	**21,600**	7- 7	Boeng	812	12- 4	Chrei	574
3- 1	Vat Bo	5,886	**8**	**Krabei Riel**	**7,604**	12- 5	Ta kong	686
3- 2	Vat Svay	4,659	8- 1	Ta Ros	610	**13**	**Kanndeak**	**12,334**
3- 3	Vat Damnak	3,939	8- 2	RoKa	899	13- 1	Kouk Tlouk	1,468
3- 4	Sala Kam reak	1,790	8- 3	Prei Pou	398	13- 2	Trapang Tem	1,209
3- 5	Chun long	1,025	8- 4	To tear	507	13- 3	Khun Mouk	981
3- 6	Ta Vean	3,585	8- 5	Krasang	556	13- 4	Chras	1,004
3- 7	Trapang Treng	716	8- 6	Popil	423	13- 5	Ou	1,351
4	**Kouk Chak**	**19,367**	8- 7	Trapang veng	499	13- 6	Spean Ka ek	1,508
4- 1	Trapang Ses	3,561	8- 8	Kouk doung	677	13- 7	Trang	930
4- 2	Veal	2,937	8- 9	Boeng	961	13- 8	Chrei	1,859
4- 3	Kasin tabong	3,228	8- 10	Prorma	826	13- 9	Kouk Tanot	1,261
4- 4	Kouk Chan	1,331	8- 11	Khnar	562	13- 10	Lo ork	763
4- 5	Khatean	1,723	8- 12	Prei kroch	686	**14**	**Chong Khneas**	**6,866**
4- 6	Kouk Beng	1,281	**9**	**Ampil**	**6,788**	14- 1	Phum Pir	812
4- 7	Kouk Tanot	2,125	9- 1	Kouk Chan	780	14- 2	Phum Muoy	971
4- 8	Nokor krav	3,181	9- 2	Thnal Chak	375	14- 3	Phum Bei	845
5	**Siem Reap**	**17,564**	9- 3	Tanot	469	14- 4	Phum Buon	737
5- 1	Pou	2,774	9- 4	Trapang Run	751	14- 5	Phum Pram	571
5- 2	Phnom krom	3,204	9- 5	Ta pang	532	14- 6	Phum Prammuoy	826
5- 3	Pror Lay	839	9- 6	Prei kuy	900	14- 7	Phum Prampir	2,104
						Total (14Commune-118Villages)		203,483

(2) Infrastructure

Road

Over $800 million has been invested in rehabilitating the country's roadways since the mid-1990s since the royal government identified rehabilitation as a stimulus to sustainable economic recovery. The road network is the principal mode through which people and goods move and covers approximately 39,000km throughout the country. There are seven national roads that make up the primary highways or 4,800km (NR 1 to 7) of roadways. Of this, 2,700km have been rehabilitated. Primary highways split off into secondary highways, also considered provincial roads of which 2% are paved. The conditions on lesser roads can be quite poor with some areas in effect isolated during the rainy season. Many unpaved roads in the peri-urban area of Siem Reap are made of laterite, a reddish clay-like material that is hard when dry and slippery when wet, or macadam, broken stone used in compact layers for road surfacing. Poor road conditions are related to drainage problems that afflict the city. *(Source: Chapter V. Urban Infrastructure and Environmental Management, Siem Reap: Urban Development in the Shadow of Angkor, 2008)*

Major road network in Siem Reap District consists of Route 6, Route 63 and Route 66. Route 6 connecting Phnom Penh and Siem Reap and running east-west direction is a main corridor in the city. Route 63 runs north-south direction linking from the center of the city to the Tonle Sap Lake, and Route 66 also runs north-south direction linking from the Angkor heritage area to the city center. Branch roads are stemmed from these trunk roads towards residential and tourist area. Road construction and rehabilitation have been implemented in the city, but rapid traffic increase outpaces and traffic congestion arises at some bottleneck points in peak hours. *(Source: The Study on Integrated Master Plan For Sustainable Development of Siem Reap / Angkor Town, JICA, 2006)*

When the study team visited every Commune Center to conduct public hearing from the representative of Commune, it was found that community roads had not been developed enough to transport goods easily by motorcycle and car, and sometimes a usual passenger car could not pass the road after heavy rain. Some representatives of Commune say they have been requesting budget for road improvement to Provincial Governor.

Wastewater Treatment System

Waste water Treatment Plant with capacity 2,776m3/day was constructed in December 2009 by Mekong Tourism Development Project Part A1, Siem Reap Wastewater Management（ADB）, and ADB is now promoting construction of another plant with the same capacity 2,776m3/day of target year 2015, resulting 5,552m3/day of capacity in total.

On the other hand, for the project of Siem Reap Sewerage System and Improvement of Siem Reap River in the Kingdom of Cambodia funded by KOICA, detail design of the WWTP with capacity 10,000m3/day started targeting completion in 2015.

Therefore, WWTP with capacity 15,552m3/day will come into existence in 2015. Moreover, Draft Report is already completed for Drainage & Sewerage Master Plan for the District of Siem Reap Priority Works funded by AFD.

Electricity

Two Communes in the study area have been waiting for supply of electricity.

(3) Land use

The soils in the floodplain of the Tonle Sap are generally poor in fertility. The three major soil types found in this area are a) young lacustrine alluvial soils, b) alluvial soils, c) acid sulphate soils. The young lacustrine soils were formed from colluvial and alluvial outwash from acidic and basic rocks from the upland areas bordering the Tonle Sap Lake, and from silt and clay deposits carried by the floods of the Mekong River. (*Source:3.Fisheries and Floodplain Agriculture in the Tonle Sap Region, National Environmental Action Plan 1998-2002*)

Current land spread from southern part of Siem Reap City to Tonle Sap Lake is occupied with wet season rice[1] field for the most part, and partly with flooded rise[2] field and abandoned field covered by grass. According to the information from Provincial Department of Agriculture, the productivity of the land is 3～3.5 ton/ha and it is fertile compared with that of poor land, 1.5～2.0 ton/ha. The chief of Kanndeak Commune says that it is 4.0 ton/ha in the recession rice area in the Commune.

In addition here is little floating rice[3] (deep-water rice) area in Siem Reap Province, while there are floating rice areas in Kompong Thom Province.

There is inundated forest along the Tonle Sap Lake shore and a majority of this forest has been logged over at least once.

(4) Public health and welfare

In majority of communes in study area drinking water is provided from well and water quality is not good enough to drink directly. They use water from well after boiling.

[1] Wet season rice: the rice is grown in the rainy season during May and October/November
[2] Flooded rice: the rice is grown in dry season during December/January and May/June. It is also called as recession rice since it grows in recession water.
[3] Floating rice: the rice with stem more than 3m long grows in deep water.

No information of public health and welfare could be obtained from Commune representative except Chong Kneas where floating village is located. Most of all people in floating village drink water from Tonle Sap Lake after boiling. There is concern of water-borne diseases and chief of the commune requests improvement of Community Health Center.

High percentage of latrine indicates better living standards and knowledge about health care in the community. However, based on the result of social survey conducted by JICA Study Team in August 2009, 31% of interviewed households, all of which consists of 34 poor income households, 33 medium income households and 33 better-off households in the area without water supply service, have no sanitary latrine and defecate around their house compounds by digging and burying human waste.

Traffic accidents are the second biggest public health concern after HIV/AIDS according to the secretary of state of MPWT (*Phnom Penh Post* 28 August 2008). Road improvement and motorization have led to a greater number of accidents and causalities. Most accidents in Siem Reap involve motorbikes, which are also the most popular form of transport. *(Source:Chapter V. Urban Infrastructure and Environmental Management, Siem Reap: Urban Development in the Shadow of Angkor, 2008)*

(5) Economic condition

There are many Communes which have a higher proportion of farmers in the study area. They are also affected by worldwide economic depression, and construction workers in some Communes have lost their job because of hanging up of new building construction.

According to the result of social survey conducted by JICA Study Team in August 2009, the average monthly income of low income households is 91US$/m as shown in Table 10.11. If the family consists of four members, they are living along under poverty line. (91/30/4=0.7US$/day/capita < 1 US$/day/capita).

Table 10.11 Average Income of Household in the Study Area (2009)

	Water Supply Service (Amount of Consumed Water)			No Water Supply Service (Income)		
Category	Low (27)	Medium (38)	High (35)	Low (34)	Medium (33)	Better-off (33)
(1,000 Riel)	1,577	2,729	2,641	363	824	1,229
(US$)	394	682	660	91	206	307

( ) shows number of interviewed households

(6) Heritage

Mr. Christophe Pottier at Centre of l'EFEO in Siem Reap had been contributing for conservation of cultural heritages for a long time and recently went back to Sydney University in Australia. At present Mr. Damian Evans is working for it as a subsequent researcher. Based on the GIS data from Australian Research Centre, distribution of cultural heritages was studied in the related area, where facilities like water intake, conveyance pipeline, pumping station, water treatment plant and main distribution pipeline to the existing road are constructed and closed between lines of latitude 1,460,000 and 1,476,000 and longitude 378,000 and 386,000 shown in Figure 10.13. Forty-five (45) cultural heritages are found in the area, while there are more than 3,000 cultural heritages registered in GIS Database in the Study Area. There are four kinds of types in the area, i.e. “Linear (Canal)”, “Reservoir”, “Temple” and “Significant Mound”. However, there is no Linear (Road) and no Linear (Dyke/Dam) in the area.

The project owner should keep the pipeline and the relevant facilities away from these cultural heritages as much as possible.

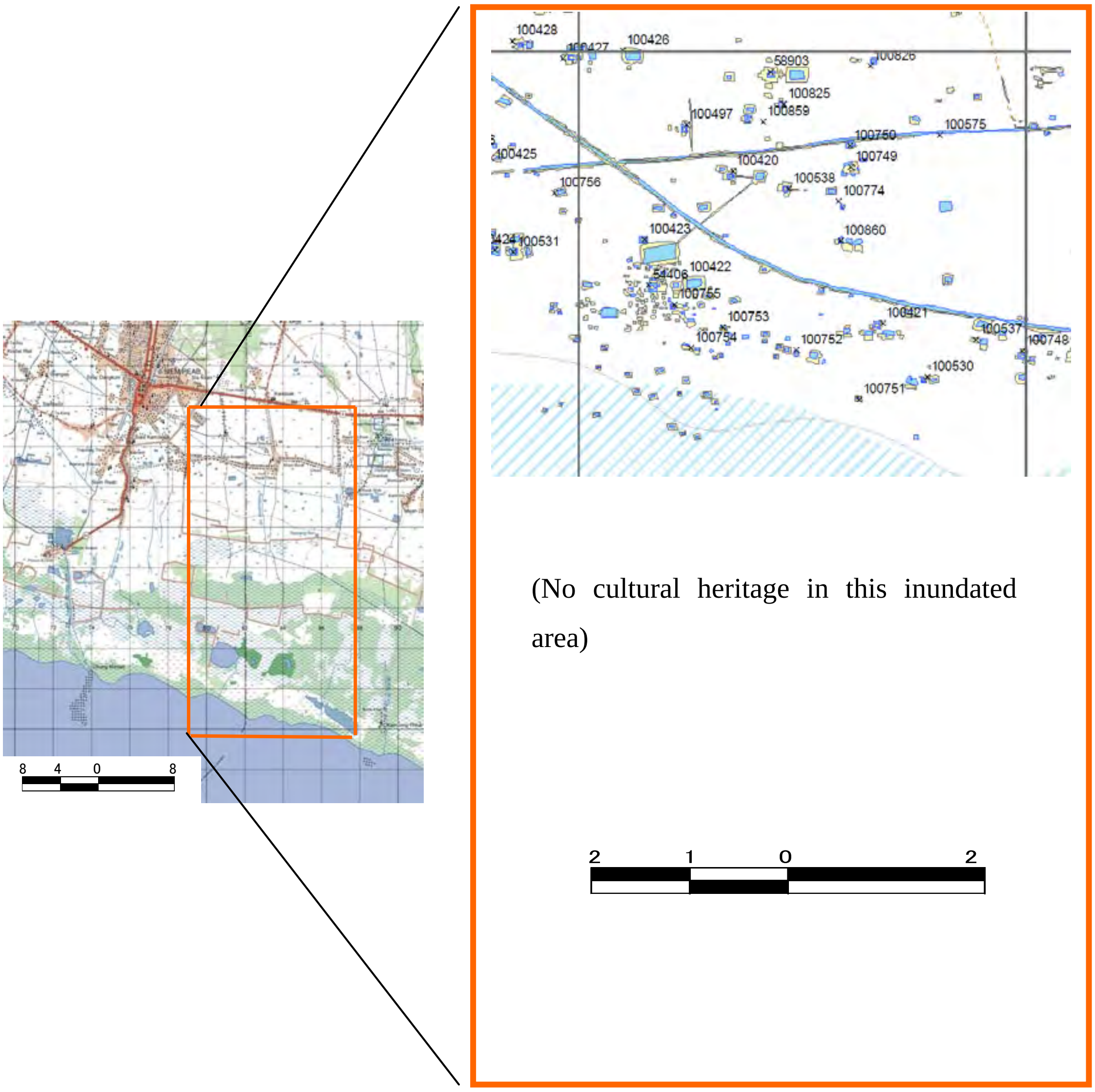


Figure 10.13 Location Map of Cultural Heritage in the Examination Area
(latitude 1,460,000 and 1,476,000 / longitude 378,000 and 386,000)
(Source: Mr. Damian Evans, Australian Research Centre)

(7) Land Acquisition

Although the system of land acquisition seems to be generally complicated and difficult in Cambodia, buying and selling of land is easy according to the opinion of Department of Agriculture and Department of Land Management in Siem Reap Province. Change of land use from agricultural land to another kind of land is not strictly limited and implemented based on a contract agreement between a seller and a buyer. Local governmental organization has no power to control private dealing. It is said that a coordination committee, consisting of the representative from relevant organization, would be set up by Provincial Governor if some conflict rises up between a seller and a buyer, and that forced transfer of local people is difficult even for development of infrastructure in case they are living legally on their own land.

The candidate site for conveyance pipeline from raw water intake to the pumping station is owned by government because it belongs almost to the Strictly Protected Inundated Area and the site for transmission pipeline from the pumping station to the water treatment plant consists of privately-owned areas. The project owner should buy the lands for PS and WTP because they are private properties.

10-4 Public Participation

10-4-1 First Phase of Public Participation

(1) Public Hearing from Local People

According to advice from MOE, the study team conducted public hearing from representative of community level, like Chief, Deputy Chief and/or Secretary of 14 Communes. After explanation of the project summary, interview was carried out. The main questions are as follows:

a. Population of the commune
b. How to get drinking water at present
c. Quality of drinking water
d. Opinion of water supply system expansion
e. Willingness to pay
f. Environmental issue
g. Opinion on water source

There are some Communes without electricity, and some chiefs say it would be so hard for local people to pay water charge although they have been waiting for safe and clean drinking water provided by a new system.

In addition to this, Stakeholder Hearing from the representative of three Community Fisheries was carried out in the study area. They have been managing their Community Fisheries in accordance with Community Fishing Area Management Plan. They hope the project facility would not be an obstacle against navigation of fishing boat and not give a significant impact on fishing area.

Most of all people the study team conducted stakeholder hearing from expressed that they have been waiting for introduction of water supply system. Particularly chiefs from Commune are expecting water supply by pipe because they have not got out of trouble for supply of safe water from wells to local people.

(2) Public Hearing from Other Stakeholders like Provincial and Central Government

The public hearing from other stakeholders than local people was conducted. Each opinion was collected after study team member explained the outline of the project and showed three kinds of alternatives of water source, a) surface water from Tonle Sap Lake, b) surface water from the canal of West Baray, and c) groundwater from the area near Tonle Sap Lake.

Most of officials recommend that the water supply expansion project should be implemented in Siem Reap City and that surface water form Tonle Sap Lake should be used for source of water supply system. Tonle Sap Authority says water sources from West Baray and groundwater are not enough for future demand and UNESCO advises the project owner should conduct archaeological excavation at the bottom of West Baray prior to construction of relevant facilities. It takes a long time to get approval for planning and designing of the project. MOE and MOAFF consider it is difficult to construct a big open canal through the protected area of Multiple Use Area and Strictly Protected Inundated Forest because the open canal may give a significant impact on the protected area due to extensive alteration of the land and they recommend use of pipeline laid down under the ground to mitigate impact on the natural condition in the protected area.

(3) First Stakeholder Meeting

The first stakeholder meeting was organized by the project owner, SRWSA, at Pacific Hotel Siem Reap on 21st October 2009. The report on the meeting is as follows.

- Date & Time: 8:30-12:40 21st October 2009
- Place for Meeting: Pacific Hotel Siem Reap
- Method of Public Information: Invitation Letter, E-mail & Mobile phone
- Manner of Presentation: Power point, Microphone, Distribution of Handout
- Number of participant: 44 persons (Governor's Office, Dpt. of Agriculture, Forestry, Fisheries, Land Management, Public Works and Transportation, Water Resources and Meteorology, Environment, AFD, ADB, GTZ, APSARA, Communes, JICA Headquarter and Cambodia, others)
- Facilitator: Mr. Kong SOKVAN, Director of Production & Commercial
- Interpreter: Mr. Cheav CHANNY, Deputy General Director, SRWSA / Ms. Reath Kanha, Assistant of JICA Study Team
- Program of the Meeting

NO	Time	Theme	Presenter
	8:30- 9:00	Registration	Staff of SRWSA
	9:00- 9:10	Opening Address	Mr. Som KUNTHEA General Director, SRWSA
	9:10- 9:40	Outline of Project	Mr. Yoshihiko SATO Leader, JICA Study Team
	9:40-10:20	Process of Water Source Selection	Mr. Hiroshi OKADA JICA Study Team
	10:20-10:30	Coffee Break	Staff of SRWSA
	10:30-11:10	Initial Environmental Impact Assessment & Scoping for EIA	Mr. Shinya KAWADA JICA Study Team
	11:10-11:30	Question and Answer	Mr. Cheav CHANNY Deputy General Director, SRWSA
	11:30-11:40	Closing Address	Mr. Bun THARITH Vice Governor of Siem Reap Province
	11:50-12:40	Lunch Time	

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Question and Answer
1. Cost of construction for tap water Question: How much cost should be burdened by each house for connecting newly to water pipe? Answer: 520,000 riels (approximately 130 US$) 2. Disposal of Sludge Question: Where do you thaw the sludge discharged from water treatment facility? Answer: At present water treatment facility the sludge is dried up in the pit and then stored in the premises.

10-4-2 Second Phase of Public Participation

(1) Public Hearing from Local People

- Agriculture in the Strictly Protected Inundated Forest

Public hearing from the chief of Kandaek Commune, where conveyance pipeline may be laid, was conducted regarding agricultural activities in the Strictly Protected Inundated Forest Area according to the questionnaire in Table 10.12. As a result, the followings came out.

- Recession rice starts in December every year.
- Recession rice area is dried up in March, April and May.
- Local people in the Commune should understand the necessity of water supply project and the chief of the Commune can persuade local people not to raise a claim against public works.
- Since local people had been growing rice for a long time before MOAFF designated Strictly Protected Inundated Forest Area in 1968, they have continued their activities at present as same as before. Therefore, they do not think it is illegal.
- Project owner should offer compensation to the farmers during construction, although they have to understand the importance of the project.

- The price of rice is 800～1,000 riel/kg (approx 0.2～0.25 US$/kg) and the yield of rice is 2.5～4.0 tons/ha.

▪ Impact on Community Fisheries

Public hearing from the chief of Kandaek Community Fisheries, where conveyance pipeline may be laid, was conducted regarding impact on Community Fisheries according to the questionnaire in Table 10.13. As a result, the followings came out.

- The peak time of fisheries is form July to August.
- Family fishermen act during rainy season from June to December, while fishing companies are prohibited to catch fish during rainy season when fish produces eggs.
- The members of Kandaek Community Fisheries are 5,550 and the committee consists of 11 members.
- The members own 30～40 boats only and yield of fish is only three (3) tons / Community Fisheries/season.
- The chief of the Community Fisheries insists that project owner should give compensation to them because there are impacts on fish and fishing area due to cutting protected inundated forest.

Table 10.12 Questionnaire of Farming in the Strictly Protected Inundated Forest Area

1. When do you start to grow recession rice, January or February?
2. Is it depending on the distance from Tonle Sap Lake?
3. Which month does the recession rice area dry up, i.e. no water, April, May or June?
4. What do you think construction of drinking water pipeline passing through the recession rice area?
5. According to explanation of Provincial Department of Fisheries, it is prohibited for local people to cultivate the land in strictly protected flooded forest area. Do you know it?
6. Is it illegal to grow rice there?
7. If it is illegal, we are afraid that you may not be able to complain about public works in the recession rice area.
8. What should the project owner do for local people who grow rice in recession rice area when the water supply project is implemented and some part of farm land is used for construction of pipeline?
9. The project owner should give some compensation to the farmers whose rice land is disturbed and harvest is not given. What do you think about illegal cultivation?
10. One or two years later after construction you can grow rice again same as at present because the pipeline is laid 2 or 3 m deep under the ground. Is there any problem about it?
11. Do you want anything regarding construction of the pipeline?
12. Do you want anything regarding the water supply system expansion project?
13. How much is price of rice?
14. How many kilograms of rice can you get from the area of one ha?

Table 10.13 Questionnaire of impact on Community Fisheries

1. When is the peak of fishing?
2. When is the fishing season, from_________to__________?
3. How many members are acting for fishery in Kandaek Community Fisheries?
4. How many tonnes can your Community Fisheries catch fish for one season?
5. Could you explain how to catch fish?
6. Do you have any trouble due to construction of intake?
7. Do you have any trouble due to construction of pipeline?
8. Do you think the project owner should pay compensation to your Community Fisheries?

(2) Second Stakeholder Meeting

- Date & Time: 8:30-13:30 24th March 2010
- Place for Meeting: Prince D' Angkor Hotel

- Method of Public Information: Invitation Letter, E-mail & Mobile phone
- Manner of Presentation: Power point, Microphone, Distribution of Handout
- Number of participant: 46 persons (Provincial Governor, Vice Governor, Governor's Office, Dpt. of Agriculture, Land Management, Public Works and Transportation, Water Resources and Meteorology, Environment, Health, Tourism, Human Resources and Industry, Mines and Energy, Tonle Sap Authority, MOAFF (Fisheries Directorate), APSARA, UNESCO, Communes, Community Fisheries and others)
- Facilitator: Mr. Kong SOKVAN, Director of Production & Commercial
- Interpreter: Mr. Cheav CHANNY, Deputy General Director, SRWSA / Ms. Reath Kanha, Assistant of JICA Study Team
- Program of the Meeting

NO	Time	Theme	Presenter
	8:30- 9:00	Registration	Staff of SRWSA
	9:00- 9:10	Opening Address	Mr. Som KUNTHEA General Director, SRWSA
	9:10- 9:35	Summary of Feasibility Study for Siem Reap Water Supply Expansion Project	Mr. Yoshihiko SATO, Leader of JICA Study Team
	9:35-10:35	Preliminary Design of Facilities and Construction Scheme for Siem Reap Water Supply Expansion Project	Mr. Kentaro SATO & Mr. Atsushi KANAYA
	10:35-10:45	Coffee Break	Staff of SRWSA
	10:45-11:25	Environmental Impact Assessment of Siem Reap Water Supply Expansion Project	Mr. Shinya KAWADA, JICA Study Team
	11:25-12:00	Question and Answer	Mr. Cheav CHANNY Deputy General Director, SRWSA
	12:00-12:10	Closing Address	Mr. Bun THARITH Governor of Siem Reap Province
	12:10-13:30	Lunch Time	

- Minutes of Meeting

Question and Answer
H.E. Srun Limsong, Deputy Secretary General of ESCAP / The Council of Ministry of Fisheries Directorate I would like to suggest two things concerned with inundated forest and wastewater discharge. As you know we have exported fish to other countries and it means that Tonle Sap Lake has saved life of human beings for many years. Therefore, the inundated forest should be cut at minimum because it is very important for fisheries and the quality of wastewater discharged from water treatment plant should be careful. We know the development is necessary, but don't forget sustainability of natural resources. Sustainable development should be taken into consideration. **JICA Study Team Member** **Q:** Can the project owner get approval from MOE regarding EIA based on the content which JICA Study Team explained today by power point and how many days does it take to get approval for EIA from MOE after submission of EIA Report? **A: Mr. Siem Piseth, Dep. Provincial Department of Environment** We cannot but wait for direction from MOE. I did not know detail about this project including the situation of the project site. I just now know it after receiving an explanation from JICA Study Team. I think this project has no problem, but I don't know whether MOE give approval for EIA of this project or not. I know that development always gives impact on surrounding area. We have to check impact due to noise and vibration. There is no impact on people because there is no house around project site, but vibration could give

impact on the nature. So we should find the way to reduce vibration.
Also we should protect environment from solid waste and wastewater that flows into Tonle Sap Lake and should find a good solution.
We are happy to get JICA's help. I hope the project could be realized as soon as possible. Conservation and development must go together harmonized. If we are insistent too much strictly on conservation of environment, it would make the development late.

Sou Platong, Deputy Governor

Changing from district to city is natural trend for human life. It means that water to be supplied and sewage to be treated increase. Number of tourists, local people and immigrants need to be well organized according to water supply system. Supply of safe drinking water is very important, but 20% of people in Siem Reap city can share in bounty of water supply system. Therefore, expansion of the system is necessary. I support this project 100% in order to get safe drinking water.
In master plan water supply to the eastern area of Siem Reap River is considered and the eastern area needs water supply more than other area. Even Zone 1 and Zone2 of APSARA might need some water supply if there is no impact without using groundwater. I think development gives more benefit than effect. As you know, Siem Reap is covered with the protected sites from north to south. Development and Conservation must go together well. Local authority should tell their people to understand how important water supply system is. We must co-operate for this project.

Mr. Channy, Deputy General Director, SRWSA

A: JICA also thinks about supplying water in Zone II as well.

Mr. Siem Piseth, Department of Environment

Q: As you know, expansion of water supply would increase wastewater volume. What do you think about control system of wastewater? Do you have any plan for this problem?

Mr. Channy

A1: It is under the control of Provincial Department of Public Work and Transportation. SRWSA is responsible for only clean water or fresh water supply. Ministry of Public Work and Transportation controls whole country about this matter. So I would like to transfer this question to DPWT.

Mr. Ang Kimsoun, Deputy Chief of Public Works Office, DPWT

A2: ADB have conducted the project for the west site of Siem Reap River, but for the east site the project for wastewater is not conducted. We don't have any project for wastewater in eastern area.

Mr. Siem Piseth

Discussion at stakeholder meeting should be made after preparing the agenda for discussion about the impact on wastewater. We should help each other to find a good solution.

Mr. Channy

A: The JICA study has been conducted very careful and detail about any impact is examined. There is not much impact on environment. Trees would grow again 2 or 3 years later. As you saw on their presentation, they are very careful for impact and avoid for both conservation areas for the pipe line.
(Since the content of this question and answer became clear unfortunately after the stakeholder meeting, Study Team visited Office of DPWT the next day to explain wastewater treatment projects in detail to be implemented and discuss it with Mr. Kimsoun. He had no information of the waste treatment project because he is an engineer of road, and he understood the project proceeding in eastern area of Siem Reap River and apologized for his careless remarks at the second stakeholder meeting.)

Facilitator, Mr. Kong SOKVAN, Director of Production & Commercial

Most of people at the meeting would like to get water supply, especially representative of Governor Mr. Buntharith. He wants to get water as soon as possible, one or two years later or as soon as tomorrow. He thinks completion of the project in 2017 is late because he has to wait for a long time. However, he thanks Japanese government for helping Cambodia. He wishes JICA Study Team succeeds in this project. All participants should bring all the theme of meeting today to their people in authorities and organizations.

10-5 Environmental Impact Analysis and Mitigation Measures

10-5-1 Methodology

According to an advice from Department of EIA in MOE, Environmental Impact Assessment was conducted based on JBIC Guideline for Environmental and Social Considerations. In reference to current environmental situation obtained from existing reports, impact due to implementation of the project was assessed and evaluated. Since the project owner, Siem Reap Water Supply Authority, has been operating a water supply system, similar environmental impacts given by the existing facility, like air pollution of chlorine, water pollution of wastewater and noise emitted from facility, were studied. The environmental items are as follows:

i) Air Quality
ii) Water Quality
iii) Wastes
iv) Noise & Vibration
v) Hydrology
vi) Protected Areas
vii) Ecosystem and Biota
viii) Living & Livelihood
ix) Heritage
x) Landscape
xi) Monitoring
(Impacts during Construction)

10-5-2 Air Quality

(1) Construction phase (Air Quality)

Construction during dry season may give impact on air quality. From water intake to water treatment plant through pumping station, little impact is expected due to dust on living condition of local people because there is no residential area along the pipeline. However, construction of distribution pipe along the existing road in the town area might give some impact with dust because there are many houses along the road. Consideration should be made to lay down the pipe and fill in the trench in a short while after excavation and not to leave it open for a long time.

Air pollution gas is emitted from heavy machines like a bulldozer and a damp truck in construction site. Although the number of heavy machines operating at the same place is not large in case of construction of distribution pipe and little impact is expected on surrounding area. Regular maintenance of heavy machine is necessary because much pollutant is emitted from an engine in poor condition.

(2) Operation phase (Air Quality)

There is possibility of impact on air quality due to chlorine in operation and emission gas from power generator. However, the latter gas is emitted at the emergency of blackout and the case is very rare and lasts only a short time. In order to avoid risk by accident of chlorine treatment a trench is planned next to gas container and the container can be thrown into the water in the trench in case of emergency to dis-acidify chlorine with $CaCO_3$.

There is little air pollution while chlorine gas is used normally in operation. The staffs of project owner, SRWSA, have been operating the water treatment plant with capacity 8,000m3/day since 2006 and they have already accumulated know-how. Much chlorine has never leaked accidentally at the existing water treatment plant and it has been managed appropriately every day. Little impact is expected on air quality by operation of this new water treatment plant.

Manual for countermeasures in an emergency is shown in Table 10.14 and the training has been carried out once every two months in SRWSA.

Table 10.14 Manual for Countermeasures in an Emergency

Step 1

Move to non-contaminated area of chlorine promptly.

- Try not to inhale chlorine.
- Move to windward area to escape from leaked chlorine gas.
- Warn to persons if they are around the chlorination plant and take them to windward area

Step 2

Inform to the administration department that chlorine is leaking at chlorination plant.

Step 3

Wear a gas mask.

- Operators should know where the gas masks are kept.
- As a usual training, operators must periodically practice the training of how to use the gas mask in an emergency case

Step 4

Close the valve that is just upstream side of the leaking point on the pipeline.

- If leak has occurred on a chlorine gas piping or chlorinator, close all the container main valves.
- If leak has occurred at screwed part of a container main valve, leakage should be stopped with emergency kit B

Then immediately inform to the chlorine supplier to ask for a suitable treatment. In case the leaking point is liquid side, rotate the container so that the leaking valve comes to upper side.

Step 5

Start the chlorine injection with maximum flow rate so that chlorinator extracts chlorine remaining inside the pipe.

Step 6

The leaking chlorine in chlorination plant area must finally be diffused to the atmosphere. Operate the ventilation fan for emergency use.

10-5-3 Water Quality

(1) Construction phase (Water Quality)

It is possible to minimize impact on water quality by implementing construction on the land during dry season in a concentrated manner. However, turbid water might be discharged from the construction site of water intake and conveyance pipeline in the water.

Prior to construction of water intake, a sheet pile coffer dam is constructed and water is pumped out of the coffer dam. Since the water discharged into Tonle Sap Lake from the coffer dam is the same as that of Tonle Sap Lake, little impact is given on the lake water. The upwelling water is pumped out of the coffer dam continuously into Tonle Sap Lake during construction of the intake. Although the water discharged from the coffer dam might be turbid, the amount is not much and little impact is expected on the surrounding water area in the lake.

As regards construction of conveyance pipe in the water, at first the dyke approximately 30m wide is constructed and water inside the dyke is discharged into Tonle Sap Lake. If much turbid water is discharged, the water will be discharged once into a lagoon prepared on the land and flown away to the lake to prevent turbid water from spreading out directly in the lake and to promote particle settling down.

(2) Operation phase (Water Quality)

There is usually no significant impact on river water except a critical incident because pollutants, such as SS, BOD and COD contained in effluents discharged from water treatment facility can comply with the effluent standards in Cambodia and originally the quantity of raw water is very small and the quality not so polluted because it is taken from Tonle Sap Lake. Moreover, environmental management (monitoring) plan will be developed by SRWSA to prevent water pollution due to unusual discharge of polluted water. The effluent standards of SS, BOD and COD in Cambodia are 50mg/l, 30mg/l and 50mg/l respectively as shown in Table 10.15.

Table 10.15 Standard of Wastewater

NO	Para meters	Unit	Allowable limits for pollutant substance discharging to Protected public water area
1	SS	mg/l	<50
2	BOD	mg/l	<30
3	COD	mg/l	<50

Total volume of water consumption will drastically increase according to expansion of water supply system in Siem Reap City. It means that wastewater discharged from households would increase also according to the amount of water consumption and that water quality in the rivers and the lakes would be polluted unless the wastewater treatment system is improved. Impact on water body in Tonle Sap Basin and on the Lake itself due to increase of wastewater will be minimized because wastewater treatment system is improved around the same time. (Refer to 11-5-6 Hydrology)

10-5-4 Wastes

(1) Construction phase (Wastes)

Prior to construction of facilities some forest trees are cut and the roots taken up, and the site for the facilities are excavated. The trees can be sold as material for buildings or firewood, while the roots and surplus soil will be disposed on the proper disposal site. If waste generated during construction of relevant facilities for this project is treated and disposed properly in accordance with the regulation, Sub-Decree on Solid Waste Management No. 36, little impact is expected on surrounding area.

(2) Operation phase (Wastes)

The sludge, which is not hazardous and not toxic, is discharged from water treatment plant. The staffs of project owner, SRWSA, take away the sludge from lagoon to the storage pit, dry it up and dispose of it on a premise at present. In the future the sludge will increase according to water volume to be supplied and it will be difficult to dispose it on a premise and it should be transported to a proper disposal site. In Siem Reap City a municipal solid waste management company collects solid waste daily from central district at a charge of 1～2.5 US$/kg. The project owner can prepare budgets and order the company to collect and transport the sludge to the final disposal site when necessary.

10-5-5 Noise & Vibration

(1) Construction phase (Noise & Vibration)

Little impact is expected on local people’s daily life due to noise and vibration emitted from construction of intake, conveyance pipeline, pumping station, transmission pipe and water treatment plant, because there is no residential area along the construction site. However, since construction sites of distribution pipe are mainly located in urban area, construction near private houses in urban area should be stopped at night and on holiday to reduce impact due to noise and vibration on the surrounding area. Particularly consideration should be made not to give significant impact on tourists. In some cases it might be necessary to adopt low-noise-machines near main archaeological temples.

(2) Operation phase (Noise & Vibration)

Noise emitted from pumping station and water treatment plant gives little impact on surrounding area because it is usually not so big. Even if power supply is cut off and power generators start running and emit noise, little impact is expected on local people’s living because they will be stored in the closed room to prevent strong noise from getting out directly and there is no residential area around them. The standard of noise in Cambodia is shown in Table 10.16.

Table 10.16 Standard of Noise

Unit; dB(A)

NO	Area	Period of time		
		6:00-18:00	18:00-22:00	22:00-6:00
1	Quiet area Hospitals Libraries School Kindergarden	45	40	35
2	Residential area Hotels Administration Offices House	60	50	45
3	Commercial and service area and mix	70	65	50
4	Small industrial factories intermingling in residential areas	75	70	55

10-5-6 Hydrology

Waste water Treatment Plant with capacity 2,776m^3/day was constructed in December 2009 by the project funded by ADB and construction of another plant with the same capacity 2,776m^3/day is to be planned in target year 2015, resulting 5,552m^3/day of capacity in total. And the detail design of the Wastewater Treatment Plant with capacity 10,000m3/day started targeting completion in 2015, funded by KOICA. Therefore, Wastewater Treatment Plant with capacity 15,552m^3/day will come into existence in 2015. On the other hand, a draft report is already completed for Drainage & Sewerage Master Plan for the District of Siem Reap Priority Works funded by AFD. The wastewater discharged from central district of the area covered by Siem Reap Water Supply Expansion Project is collected and treated by the wastewater treatment system improved by ADB and KOICA projects and the rest of the area will be covered by the project of AFD. Although the wastewater after going through the treatment system will flow finally into Tonle Sap Lake, there may be little impact on the lake if the wastewater is discharged meeting the standards for effluent in Cambodia, because the surface water from the lake is utilized as the water source for this project and it means that the water from the lake is circulated and the amount of water is basically balanced.

10-5-7 Protected Areas

There are many protected areas in study area. Plans and designs were reviewed to prevent the element of the project disturbing the protected areas. The conveyance pipeline route from raw water intake to pumping station is planned bypassing provincial conservation areas of Boeng Peareang Natural Conservation Area and Polav Fish Conservation Area after review of alternatives. However, the project cannot keep from the protected areas as shown in Figure 10.14, Figure 10.15 & Table 10.17. Regards as getting approval from relevant organizations, the procedures are shown in Table 6.3.

(1) Strictly Protected Inundated Forest Area (MOAFF)

Pipeline is laid down 8km long in the protected area, 1.7km in gallery forest and 2km in the area mixed with bush and shrub of O Smoan Reservoir. At first an open canal was planned from Tonle Sap Lake to the pumping station from the viewpoint of technology, economy and maintenance. The width of the open canal would be up to 50m because water level in Tonle Sap Lake is very low in the dry season and a deep canal should be excavated. It means that forest area more than 70m wide is lost including the site for disposal of waste soil and that 1.7km gallery forest and 2km bush and shrub area would be lost and not reforested permanently. The impact on natural resources around Tonle Sap Lake might be too significant. Therefore, in the second place pipeline system was taken into consideration although maintenance of conveyance pipe under the ground is not easy. The forest area would be disturbed only 30m wide including whole construction site and the forest area would be reforested some years later after the trench is filled with soil as same as before.

As trees are cut down approx 30m wide, some tall trees in the inundated forest area are lost. However, it is impossible to lay down the conveyance pipe without cutting the trees because the forest area continues along the lakeside. Therefore the project owner should minimize the alteration of the forest for the project site, and for a few years after construction, set up a barrier which prevents people from passing through the water area over the pipeline for fishing and prevents them from cutting trees for firewood, in order to keep the area not disturbed by people and promote the reforestation. At the same time the gallery forest area will be refforested by young trees and the regrowth of the forest will be monitored by the project owner.

The project owner has to submit the application to Fisheries Administration, MOAFF, to get an approval for development in this area.

(2) Multiple Use Area (MOE)

Pipeline is laid down 4km long in the Multiple Use Area. Since it is laid down 2-3m deep under ground, little impact on land use is expected after construction. The project owner has to submit the application to Department of National Park, MOE, to get an approval for development in this area. A relevant official from MOE says it is not difficult to use the area for improvement of local people’s living condition around Tonle Sap Lake like this project because the area should be used for multipurpose considering environmental condition.

(3) Community Fisheries (MOAFF)

Trees in the inundated protected forest are cut down. Some impact may be expected on fishery domain. Although the project owner, SRWSA, explained the project to the chief of Kandeak Community Fisheries and it is ready to offer compensation to the Community Fisheries, the project owner has to submit the agreement with members of the Fisheries, to Fisheries

Administration, MOAFF, to get an approval for development in this area from MOAFF.

(4) Buffer Zone of Tonle Sap Biosphere Reserve (UNESCO)

Pipeline is laid down 4km long in the buffer zone. Since it is laid down 2-3m deep under ground, little impact on core zones is expected. The project owner has to submit the application to Tonle Sap Biosphere Reserve Office in MOE, to get an approval for development in this area.

(5) APSARA Protected Area (APSARA)

Distribution pipes are laid down mainly along the existing road. Little impact on protected area is expected. When the pipes are laid down outside of the existing road in APSARA Zone 2 and Zone 3, the project owner should inform APSARA of the construction schedule and location prior to construction, to get some advice.

(6) Landscape Protected Area (MOE)

Distribution pipes are laid down mainly along the existing road. Little impact on landscape protected area is expected. When the pipes are laid down outside of the existing road in this area, the project owner should inform the Department of Protected Area, MOE, of the construction schedule and location prior to construction, to get an approval.

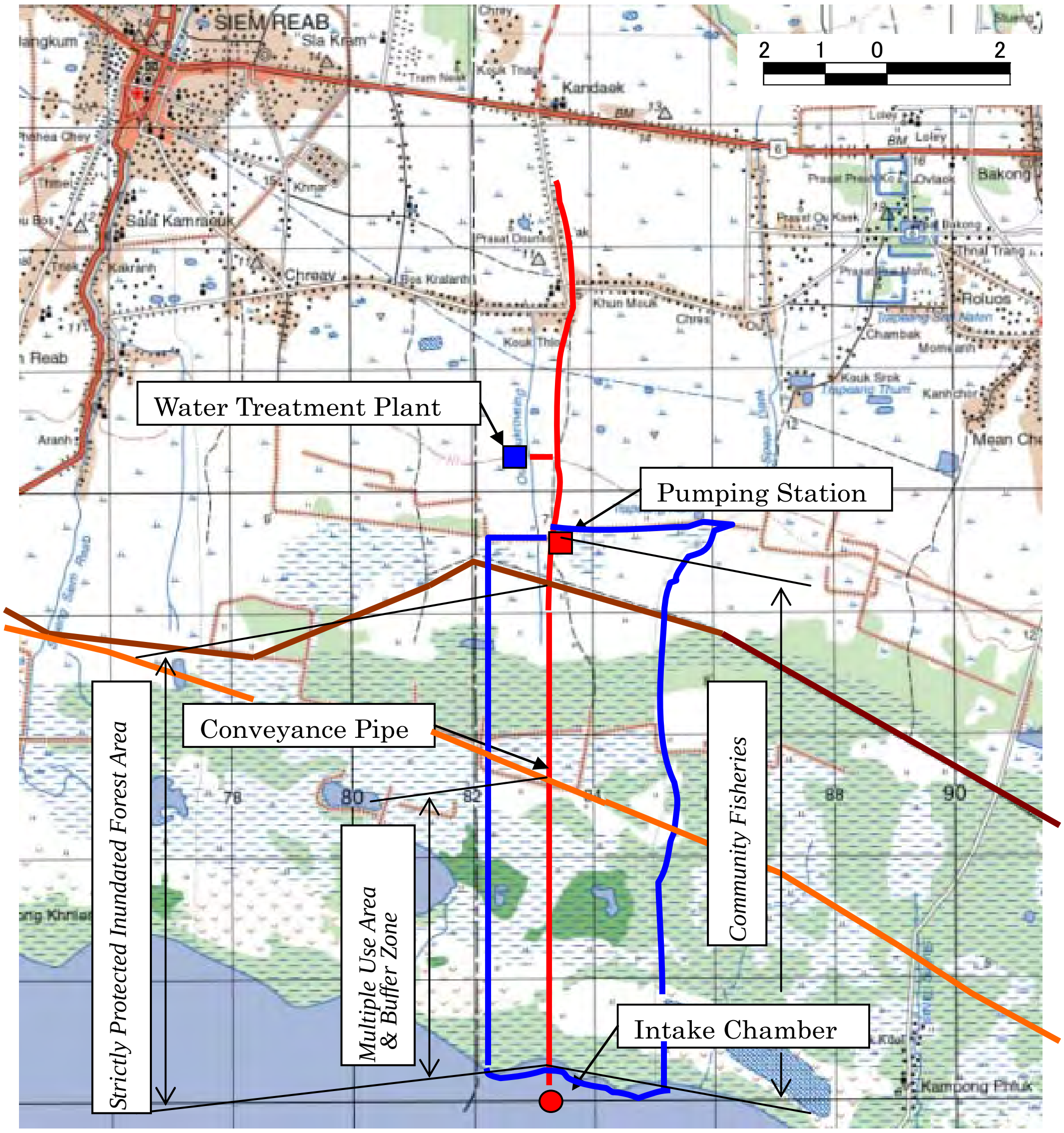

Figure 10.14 Location Map of Protected Areas and Facilities (*from Intake to WTP*)
(*MOE, MOAFF & UNESCO*)

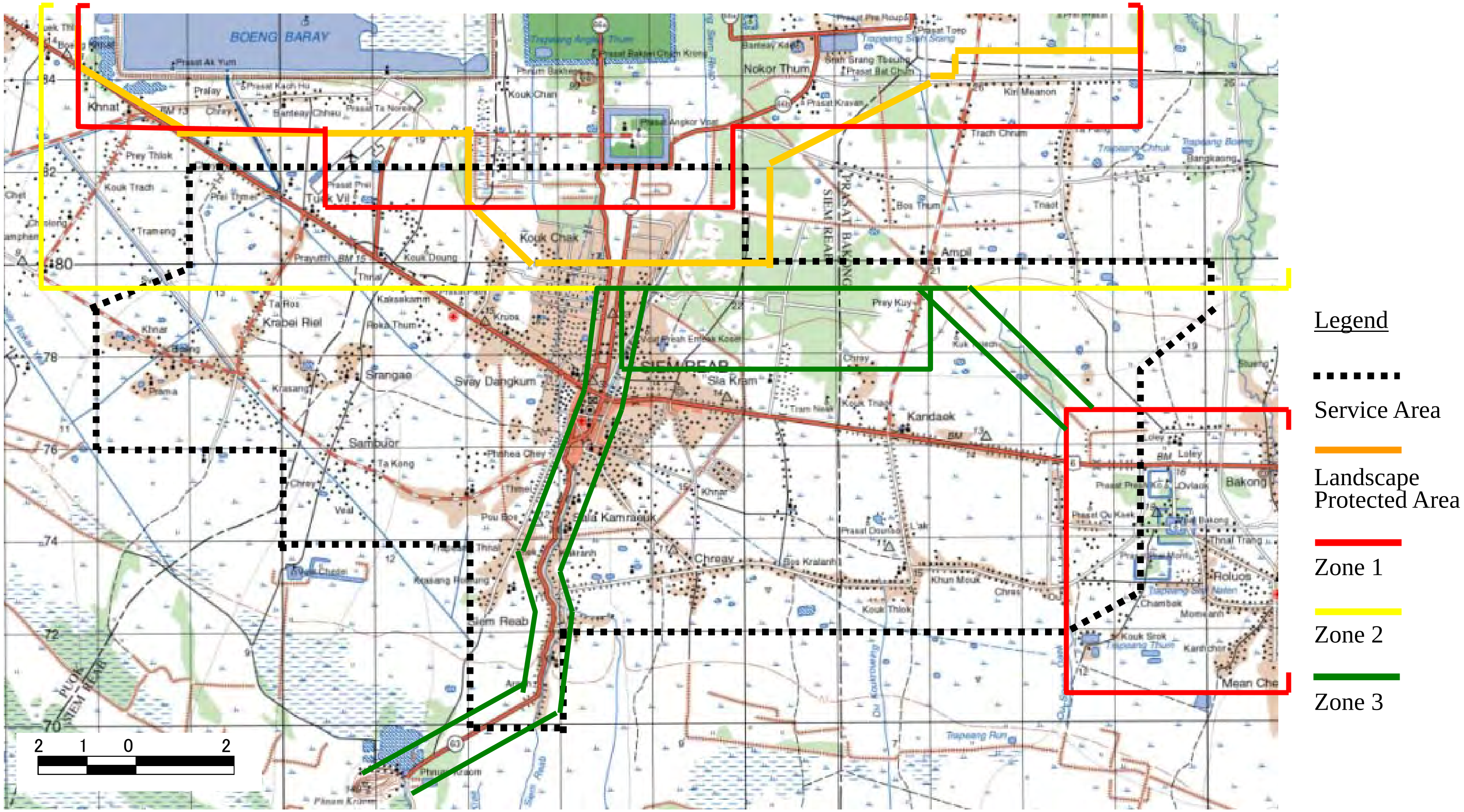

Figure 10.15 Location Map of Protected Areas for Distribution Area (***MOE & APSARA*****)**

Table 10.17 Protected Area influenced by the project

NO	Name of Protected Area	Authority	Definition	Impact	Mitigation Measures	Time required for Permissions
1.	Strictly Protected Inundated Forest Area	MOAFF	Conservation of Inundated Forest Area for fishery	Pipeline is laid down 8km long in the protected area, and 1.7km in gallery forest and 2km in the area mixed with bush and shrub of O Smoan Reservoir Trees are cut down approx 30m wide.	Since it is impossible for water pipeline to avoid gallery forest along lake coast and bush/shrub area in O Smoan Reservoir, construction site shall be minimized to reduce impact on the flora and fauna. Although the project owner is not obligated to plant trees and the forest will be restored back in a few years after construction, the owner will carry out forestation in gallery forest	1 month
2.	Multiple Use Area	MOE	Conservation of biodiversity and ecosystem. Multiple use for local people in the community	Pipeline is laid down 4km long in the Multiple Use Area. Since it is 2-3m deep under ground, little impact on land use is expected.	The area is used for improvement of local people's living condition. Construction site shall be minimized since the project owner is not obligated to plant trees. At least gallery forest area will be afforested. After construction the project site will go back to the prior land use.	3 months
3.	Community Fisheries	DOFi	Zone where fishing is managed sustainably according to management plan in community	Trees in the Inundated protected forest are cut down. Some impact may be expected on fishery.	Compensation to Community Fisheries should be considered. Construction site shall be minimized since the project owner is not obligated to plant trees. The reforestation of gallery forest area is effective for the project site to go back to the prior situation.	1 month
4.	Buffer Zone of Tonle Sap Biosphere Reserve	UNESCO	Buffer zone to protect core zone.	Pipeline is laid down 4km long in the buffer zone. Since it is 2-3m deep under ground, little impact on core zones is expected.	Construction site shall be minimized since the project owner is not obligated to plant trees. The reforestation of gallery forest area is effective for the project site to go back to the prior condition.	2 months
5.	APSARA Protected Area	APSARA	Conservation of archaeological site Zone 1～4	Mainly along the roads, distribution pipes are laid down. Little impact on protected area is expected.	Prior consultation should be conducted in case of construction outside right-of-way.	1 month
6.	Landscape Protected Area	MOE	Conservation of landscape	Mainly along the roads, distribution pipes are laid down. Little impact on landscape protected area is expected.	Prior consultation should be conducted in case of construction outside right-of-way.	3 months

10-5-8 Ecosystem and Biota

(1) Flooded Forest

Construction of water pipeline may give impact on forest ecosystem in zone (i) and zone (iii) as it needs removal of some forest trees. At the same time it may have impact on dams and canal associated with the O Smoan reservoir. The dykes and dams of the reservoir should be restored after completion of construction. At the same time, the pipeline will cross recession rice area also and discussion with farmers for appropriate compensation is needed to avoid social conflicts. Small funding can be provided for reforestation of degraded areas on the pipeline route in the vicinity of Boeng Peareang Conservation Area and in the O Smoan reservoir.

(2) Fish

There is no major concern over the possible impact of the project on the fishery ecology or species loss as pipeline will not cause any change in terms of obstruction of migratory route or disturbance to fish reproduction. Funding can be provided to Community Fisheries for conservation of forest and conservation areas.

(3) Amphibian

No major impact of the project is foreseen as many amphibians reproduce quickly even in this much disturbed areas.

(4) Mammal

The study areas are not significant habitats for mammal species, including species of global conservation as the areas are highly disturbed by human activities such as dry season rice, forest encroachment, firewood collection, wildlife hunting and fishing. However, there are some portions of good forest habitats, especially in the area near the shore line (near fishing lot 4) and in O Smoan Reservoir located between small dyke and dam 78 where diversity of forest species is observed. In addition Boeng Peareang Conservation Area is a potential corridor for species migration connecting one area with another. Possible major impact is associated with the laying of the water pipes across these two habitats, especially the portion of O Smoan reservoir and the Lake shore gallery forest.

Less frequent maintenance along the pipeline is better. The pipeline has to go across the lake shore gallery forest as there is no other way, but the effects are only temporary during construction, and the flooded forest will come back to its original form after completion of laying the pipes.

(5) Bird

Like other fauna species, the study area is not the breeding area for water birds of global significance. Many birds, including those of international significance such as spot-bill pelicans

Philippoussis, comb ducks *Sarkidiornis melanotos*, open-billed storks *Anastomus oscitans*, migrate here during the dry season for food and are mainly concentrated in Boeng Peareang where water is permanently available year round. Boeng Peareang is also under management of Community Fisheries and may become attractive for tourism visit if road is easily accessible during dry season.

Small funding support can be provided for conservation and reforestation of degraded areas in Boeng Peareang.

(6) Reptile

The study area is much disturbed and can not be a major habitat for reptile species; therefore no major impact is expected to happen from the construction of water pipes. There is, however, a number of turtle species of conservation value in the study area although their number is in dramatic decline. Although a small portion of forest will be cut for laying pipeline, the forest will be restored back in a few years after construction.

(7) Conclusion

The study areas are under heavy disturbance and therefore cannot be a significant area for conservation. However, a number of issues need careful consideration as the following:

- The pipeline can cross some good forest areas, especially gallery forest zone and bush/shrub zone which may be affected,
- Pipeline may cross the recession rice fields and disturb rice farmers, causing conflicts,
- Disturbance to some faunal species such as birds and reptiles.

The above mentioned issues can be addressed based on the following recommendation:

- Reforestation of the Boeng Peareang Conservation Area will help to restore habitats for many fauna species, especially waterbirds and reptile,
- Small funding can be allocated to Community Fisheries to promote forest planting and conservation of Community Fisheries areas.

The study area is not rich in species of global significance due to high pressure caused by recession rice framing, forest clearing for firewood and fishing, and wildlife hunting. However, project owner should not use this as a pretext to go ahead without due consideration, and rather use this project as an opportunity for both water supply and improved management of natural resources and environment in the areas. The survey reveals presence of relatively large portion of flooded forest which should be carefully removed. Additional study should be conducted to get additional information for defining the optimal route for laying the pipeline at the stage of detail design. Principally, the project owner can be supported as it does not have major impact on flora and fauna ecosystem, and natural forest will come back after completion of construction.

10-5-9 Living & Livelihood

(1) Construction phase (Living & Livelihood)

Construction of water intake is implemented in the water of Tonle Sap Lake even if it is during dry season. On the other hand members of Community Fisheries fish during rainy season although fishing in the wet season is illegal. Therefore, construction in the water of Tonle Sap Lake gives little impact on fishing activities. Despite this, project owner has to show information of the construction and what fishermen should be careful about on a sign board to prevent accident of fishing boats. The intake is constructed at the point approx 1km offshore from gallery forest and the construction site of pipeline 1km long blocks out transportation of fishing boats. Although fishing boats have to take a detour, little impact might be given on fishermen.

Construction during dry season gives some impact on recession rice area between intake and pumping station because recession rice is grown from December to April/May, in dry season. The project owner, SRWSA, is ready to offer compensation to the farmers influenced by construction. No compensation is necessary after pipe is laid down, the trench is filled with soil and cultivation is possible same as usual.

Since farmers growing wet season rice do no farming during dry season, project owner, SRWSA, needs not to pay compensation to them, if the pipe construction finishes by the beginning of wet season, June, and it gives no damage on cultivation of farm.

Since the transmission pipe from pumping station to water treatment plant and the distribution pipe from water treatment plant to existing road are planned to be laid down under the existing dyke and bank as much as possible and the case that pipeline cuts through agricultural land is minimized, it might give little impact on farmers' living condition. However, project owner, SRWSA, should take the compensation into consideration for them whenever pipeline route is changed and they are influenced.

Candidate site for pumping station is located on recession rice area, and the site for water treatment plant on abandoned land at present. The area necessary for two sites are 0.5 ha and 4ha only respectively and little impact might be on the land owner if he can sell the land at a reasonable price.

(2) Operation phase (Living & Livelihood)

In the dry season the water level of Tonle Sap Lake goes down and intake facility may come out in the way of fishing boats. In order to prevent accident by boats, a tower will be built on the intake and even in rainy season local people can identify the location of the intake and prevent accident from occurring. Therefore, little impact may be given on fishing and transportation by water.

10-5-10 Heritage

From the raw water intake to Water Treatment Plant through the Pumping Station there is no cultural heritage. However, there are two cultural heritages with ID No. 100752 and old canal on the way from the Water Treatment Plant to existing road as shown in Figure 10.16. If the distribution pipeline is laid down straight forward north from the Water Treatment Plant, the pipeline would come across both of them and give impact on them. Therefore, the straight pipeline should be avoided and it is possible to get around ID No. 100752. As regards the old canal, project owner should inform construction schedule to relevant authorities like APSARA and obtain approval from them prior to excavating the old canal. Archaeological expert will have a good opportunity for knowing the situation of the heritage, collecting artifacts and making a report by drawing a cross-section of the old canal.

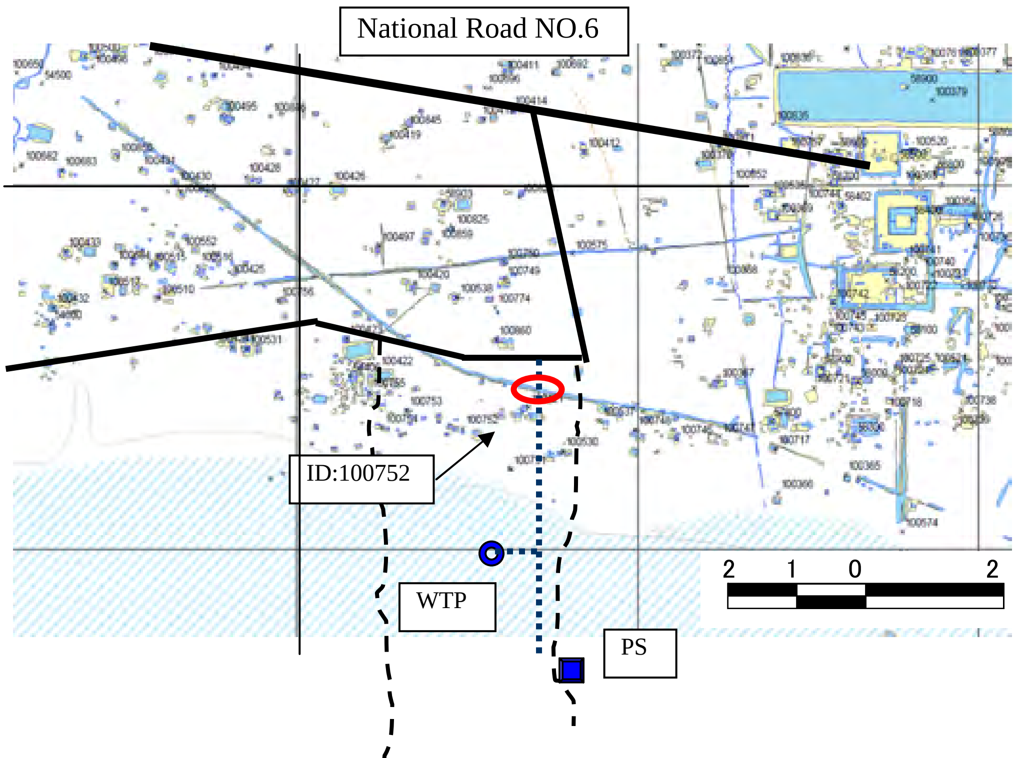

Figure 10.16 Location of Cultural Heritage

10-5-11 Landscape

New facilities appear after completion of the project and may give some impacts to the existing landscape. The appearance should be harmonized with the surrounding area. Tonle Sap Lake is one of resources of tourism owing to beautiful inundated forest. The design which might give significant impact on the landscape viewed from offshore should be avoided. Although an intake tower will appear outside of inundated forest area, there would be little impact of the landscape because at present there is a large building outside of the area as shown in Figure 10.17. A small tower in the figure shows relatively a scale of intake tower image.

A new pumping station and a new water treatment plant will give little impact on the surrounding landscape because two sites are located in the recession rice area and degraded area on plain land respectively, far from residential area.

Figure 10.17 Existing Towers located outside of Inundated Forest Area
(A small tower in the figure shows relatively a scale of intake tower image)

10-5-12 Monitoring

Environmental monitoring plan for construction and operation of this project is as shown in Table 10.18.At the phase of operation, impact on water quality and wastes should be monitored. Once per 4 months the quality of wastewater discharged from the Water Treatment Plant should be analyzed by SS, BOD and COD, while the quantity is small because the wastewater is reused in principle in the water treatment system. The analysis has not been conducted for wastewater discharged from the existing Water Treatment Plant owned by SRWSA because raw water is pumped up from underground and the quality of groundwater is stable relatively. However, for the new water supply system surface water from Tonle Sap Lake is used as raw water and the quality may vary according to natural condition. The budget for the analysis should be prepared every year. Proper disposal of the sludge should be monitored at the same time.

The ecosystem around the raw water intake facility should be monitored regularly. Since fishermen belonging to Kandaek Community Fisheries always come by the area near the intake by boat and are ware of the natural condition, the project owner should conduct hearing from the representatives of Kandaek Community Fisheries regarding significant impact on the surrounding area two times in dry season and wet season respectively.

After reforestation in the gallery forest area surrounded by a barrier, the number of young trees should be counted and the height be measured by visual observation per year for five years.

(1) Construction phase (Monitoring)

At the phase of construction, impacts on water quality, noise & vibration, ecosystem & biota, living & livelihood and heritage should be monitored. The quantity and quality of turbid water discharged from construction site of intake and conveyance pipe into Tonle Sap Lake should be monitored by visual observation once a week by project manager and some mitigation measures should be introduced in case that there is significant impact on the lake.

Noise emitted from heavy machine may give an impact on tourist sightseeing in a quiet cultural heritage. Noise should be checked by ears and mitigation measures should be introduced if necessary when construction is implemented near a main cultural heritage.

Since tall trees to be cut down should be minimized, the number of felled tall trees should be recorded. The data will be of help to reforestation in the future.

The area of recession rice field where rice cannot be grown during construction, and also the area of community fisheries disturbed by construction, should be identified accurately to ensure consistency with compensation.

Prior to excavation of old canal, project manager should request APSARA to inspect the situation of archaeological site and to propose how to proceed excavation of trench for pipeline. All information should be transferred to APSARA whenever a cultural heritage is found during construction.

(2) Operation phase (Monitoring)

At the phase of operation, impact on water quality and wastes should be monitored. Once per 4 months the quality of wastewater discharged from the Water Treatment Plant should be analyzed by SS, BOD and COD, while the quantity is small because the wastewater is reused in principle in the water treatment system. The analysis has not been conducted for wastewater discharged from the existing Water Treatment Plant owned by SRWSA because raw water is pumped up from underground and the quality of groundwater is stable relatively. However, for the new water supply system surface water from Tonle Sap Lake is used as raw water and the quality may vary according to natural condition. The budget for the analysis should be prepared every year. Proper disposal of the sludge should be monitored at the same time.

The ecosystem around the raw water intake facility should be monitored regularly. Since fishermen belonging to Kandaek Community Fisheries always come by the area near the intake by boat and are ware of the natural condition, the project owner should conduct hearing from the representatives of Kandaek Community Fisheries regarding significant impact on the surrounding area two times in dry season and wet season respectively.

After reforestation in the gallery forest area surrounded by a barrier, the number of young trees should be counted and the height be measured by visual observation per year for five years.

Table 10.18 Environmental Monitoring Plan for Construction and Operation

<Construction Phase>

- Water Quality（Effluent/Wastewater）

Item	Unit	Measured Value （Mean）	Measured Value （Max.）	Country's Standards	Standards for Contract	Referred International Standards	Remarks (Measurement Point, Frequency, Method, etc.)
Turbidity	-	-	-	-	-	-	**Measurement point**; One (1) point at the water area where turbid water is discharged from pipeline construction site **Frequency**; One (1) time per week **Method**; Visual observation/ Hearing from the representatives of Kandaek Community Fisheries one time per month

- Noise/Vibration

Item	Monitoring Results during Report Period	Remarks (Measurement Point, Frequency, Method, etc.)
Noise/Vibration	(Ex. Are there any complaints from tourists?)	Noise and vibration check by ears whenever construction site is located in the neighborhood of the resource for tourism.

- Ecosystem

Monitoring Item	Monitoring Results during Report Period	Remarks (Measurement Point, Frequency, Method, etc.)
Number of the tall trees felled down		**Point**; The area of construction site for pipeline in the gallery forest (30m wide x 1.5km long) **Frequency**; During construction of the pipeline in the gallery forest **Method**; Recording the number of the tall trees cut down (The number will be criteria of reforestation)

- Living / Livelihood

Monitoring Item	Monitoring Results during Report Period	Remarks (Measurement Point, Frequency, Method, etc.)
Area of construction site		**Point**; Recession rice area and Community Fisheries area **Frequency**; One (1) time after completion of pipeline construction in those areas **Method**; checking the discrepancy between plan and construction / Hearing from the representatives of Commune and Community Fisheries

- Heritage

Monitoring Item	Monitoring Results during Report Period	Remarks (Measurement Point, Frequency, Method, etc.)
Evaluation of the value (Old Canal)		**Point**; Point where the pipeline closes an old canal **Frequency**; One (1) time **Method**; Notifying APSARA prior to construction and getting the instruction
Evaluation of the value (unknown cultural heritage)		**Point**; Anywhere in construction area of pipeline **Frequency**; During construction **Method**; Notifying APSARA whenever cultural heritage is found.

<Operation Phase>

= Water Quality（Effluent/Wastewater）

Item	Unit	Measured Value (Mean)	Measured Value (Max.)	Country's Standards	Standards for Contract	Referred International Standards	Remarks (Measurement Point, Frequency, Method, etc.)
SS (Suspended Solid）	mg/l			<50	-	-	**Measurement point**; One (1) point at outlet of Water Treatment Plant **Frequency**; One (1) time per four (4) months **Method**; Filtration and Dried 105℃
BOD	mg/l			<30	-	-	**Measurement point**; One (1) point at outlet of Water Treatment Plant **Frequency**; One (1) time per four (4) months **Method**; Winkler Method (5210B)
COD	mg/l			<50	-	-	**Measurement point**; One (1) point at outlet of Water Treatment Plant **Frequency**; One (1) time per four (4) months **Method**; Reflux Method (5220B)

- Waste

Monitoring Item	Monitoring Results during Report Period	Remarks (Measurement Point, Frequency, Method, etc.)
Sludge		**Point**; Drying bed **Frequency**; One (1) time per four (4) months **Method**; Taking photographs/ Document for disposal of sludge at proper final disposal site

- Ecosystem

Monitoring Item	Monitoring Results during Report Period	Remarks (Measurement Point, Frequency, Method, etc.)
Negative effects to natural environment around the intake facility		**Point**; Surrounding area of the intake facility **Frequency**; Two times per year (dry & wet season) **Method**; Hearing from the representatives of Kandaek Community Fisheries
Number and height of trees in the gallery forest area reforested		**Point**; The area over the pipeline (30m wide x 1.5km long) **Frequency**; One time per year (for five years) **Method**; Counting the number and measuring height of the trees growing by visual observation

No.	Environmental Items	Item to be measured	Construction Phase		Operation Phase		Cost
			Times	Point	Times	Point	
1.	Air Quality	Chlorine	—	—	• Check system for leaked chlorine will be equipped.		Project cost
2.	Water Quality	SS, BOD, COD	• 1 time/week by visual observation (Turbidity)		1 time /4months	1 point at outlet	3x3x20 =180US$
3.	Wastes	Sludge	—		1 time /4months	Drying bed	Project cost
4.	Noise & Vibration	Noise	• Noise check by ears at main temple near construction site		—	—	—
5.	Ecosystem & Biota	Forest	• Count the number of tall trees felled in gallery forest		—	—	Project cost
6.	Living & Livelihood	Area to be disturbed	• Area of Recession rice • Area of Community Fisheries		—	—	Project cost (Compensation)
7.	Heritage	Evaluation	• 1 time at the old Canal • Anytime at heritage site		—	—	Project cost

10-5-13 Confirmation of Environmental and Social Considerations based on Environmental Checklist of JBIC Guideline (2002.4)

Confirmation of Environmental and Social Considerations were conducted based on Environmental Checklist of JBIC Guidelines. The result is as shown in Table 10.19. Significant impact will not be expected due to implementation of the project.

Table 10.19 Confirmation of Environmental Considerations by JBIC Checklist

1. Permits and Explanation	(1) EIA and Environmental Permits	① Have EIA reports been officially completed? ② Have EIA reports been approved by authorities of the host country's government? ③ Have EIA reports been unconditionally approved? If conditions are imposed on the approval of EIA reports, are the conditions satisfied? ④ In addition to the above approvals, have other required environmental permits been obtained from the appropriate regulatory authorities of the host country's government?	① No, but it will be completed by the end of July in 2010. ② No, but it will be approved by the end of August in 2010. ③ Conditions will not be imposed on the approval of EIA report. ④ Other environmental permits will not be necessary.
	(2) Explanation to the Public	① Are contents of the project and the potential impacts adequately explained to the public based on appropriate procedures, including information disclosure? Is understanding obtained from the public? ② Are proper responses made to comments from the public and regulatory authorities?	① Before completion of EIA report stakeholder meetings were held two times. At first meeting the information of water source selection process was disclosed adequately to the public and at second stakeholer meeting design of relevant facilities and environmental impacts incuding mitigation measures were disclosed before completion of draft EIA report. On the other hand, stakeholder hearings from local people of each commune in the study area, local gevernment and central government were conducted respectively. The understanding of the project and environmental impact was obtained from the public. ② There were only two questions at the first stakeholder meeting regarding the individual cost of connection to the water supply pipeline and how to treat sludge discharged from water treatment facility. At the second stakeholder meeting, participants expressed concern about felling of protected inundated forest and increase of wastewater according to expansion of water supply system. Proper responses and explanation were made to the question.
2 Mitigation Measures	(1)Air Quality	① Is there a possibility that chlorine from chlorine storage facilities and chlorine injection facilities will cause air pollution? Do chlorine concentrations within the working environments comply with the country's occupational health and safety standards?	① There is little air pollution while chlorine gas is used normally in operation. The staffs of project owner, SRWSA, have been operating the water treatment plant with capacity 8,000m3/day since 2006 and they have already accumulated know-how. Much chlorine has never leaked accidentally at the existing water treatment plant and it has been managed appropriately every day. Little impact is expected on air quality by operation of this new water treatment plant. Manual for countermeasures in an emergency is prepared and the training has been carried out once every two months in SRWSA.

<table>
<tr>
<td rowspan="2">2 Mitigation Measures</td>
<td>(2)Water Quality</td>
<td>① Do pollutants, such as SS, BOD, COD contained in effluents discharged by the facility operations comply with the country's effluent standards?</td>
<td>①There is usually no significant impact on river water except a critical incident because pollutants, such as SS, BOD and COD contained in effluents discharged from water treatment plant can comply with the effluent standards in Cambodia and originally raw water quality is not so polluted because it is taken from Tonle Sap Lake. Moreover, environmental monitoring plan will be developed by SRWSA to prevent water pollution due to unusual discharge of polluted water. The effluent standards of SS, BOD and COD in Cambodia are 50mg/l, 30mg/l and 50mg/l respectively as shown in the table.
<table>
<tr><td rowspan="2">NO</td><td rowspan="2">Para meters</td><td rowspan="2">Unit</td><td colspan="2">Allowable limits for pollutant substance discharging to</td></tr>
<tr><td>Protected public water area</td><td>public water area and sewer</td></tr>
<tr><td>1</td><td>SS</td><td>mg/l</td><td><50</td><td><80</td></tr>
<tr><td>2</td><td>BOD</td><td>mg/l</td><td><30</td><td><80</td></tr>
<tr><td>3</td><td>COD</td><td>mg/l</td><td><50</td><td><100</td></tr>
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<tr>
<td>(3)Wastes</td>
<td>① Are wastes, such as sludges generated by the facility operations properly treated and disposed of in accordance with the country's standards?</td>
<td>① The sludge, which is not hazardous and not toxic, is discharged from water treatment plant. The staffs of project owner, SRWSA, take away the sludge from lagoon to the storage pit, dry it up and dispose of it on a premise at present. In the future the sludge will increase according to water volume to be supplied and it will be difficult to dispose it on a premise and it should be transported to a proper disposal site. In Siem Reap City a municipal solid waste management company collects solid waste daily from central district at a charge of 1～2.5 US$/kg. The project owner can prepare budgets and order the company to collect and transport the sludge to the final disposal site when necessary.</td>
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</table>

<table>
<tr><td rowspan="3">2 Mitigation Measures</td><td>(4)Noise & Vibration</td><td>① Do noise and vibrations generated from the facilities, such as pumping stations comply with the country's standards?</td><td>①Noise emitted from pumping station and water treatment plant gives little impact on surrounding area because it is usually not so big. Even if power supply is cut off and power generators start running and emit noise, little impact is expected on local people’s living because they will be stored in the closed room to prevent strong noise from getting out directly and there is no residential area around them.
Unit; dB(A)
<table>
<tr><th rowspan="2">NO</th><th rowspan="2">Area</th><th colspan="3">Period of time</th></tr>
<tr><th>6:00-18:00</th><th>18:00-22:00</th><th>22:00-6:00</th></tr>
<tr><td>1</td><td>Quiet area
Hospitals
Libraries
School
Kindergarden</td><td>45</td><td>40</td><td>35</td></tr>
<tr><td>2</td><td>Residential area
Hotels
Administration Offices
House</td><td>60</td><td>50</td><td>45</td></tr>
<tr><td>3</td><td>Commercial and service area and mix</td><td>70</td><td>65</td><td>50</td></tr>
<tr><td>4</td><td>Small industrial factories intermingling in residential areas</td><td>75</td><td>70</td><td>55</td></tr>
</table></td></tr>
<tr><td>(5)Subsidence</td><td>① In the case of extraction of a large volume of groundwater, is there a possibility that the extraction of groundwater will cause subsidence?</td><td>①Extraction of a large volume of groundwater is not planned for this project because surface water from Tonle Sap Lake is utilized for water source.</td></tr>
<tr><td>(6)Hydrology</td><td>①Is there any impact on water body like a river and a lake due to increase of wastewater subsequent to the introduction of new water supply system?</td><td>①Wastewater Treatment Plant with capacity 2,776m3/day was constructed already by ADB and another plant with the same capacity is to be planned in target year 2015. And the detail design of the Wastewater Treatment Plant with capacity 10,000m3/day started targeting completion in 2015, funded by KOICA. Therefore,the wastewater discharged from central district of the area covered by Siem Reap Water Supply Expansion Project is collected and treated by the new wastewater treatment system.</td></tr>
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<tr>
<td rowspan="2">3. Natural Environment</td>
<td>(1)Protected Areas</td>
<td>① Is the project site located in protected areas designated by the country's laws or international treaties and conventions? Is there a possibility that the project will affect the protected areas?</td>
<td>①There are many protected areas in study area. Plans and designs were reviewed to prevent the element of the project disturbing the protected areas. Significant impact will not be expected although the project cannot keep from the protected areas as shown in the table.
<table>
<tr><th>NO</th><th>Name of Protected Area</th><th>Authority</th><th>Definition</th><th>Impact</th><th>Mitigation Measures</th></tr>
<tr><td>1.</td><td>Strictly Protected Inundated Forest Area</td><td>MOAFF</td><td>Conservation of Inundated Forest Area for fishery</td><td>Pipeline is laid down 8km long in the protected area, and 1.7km in gallery forest and 2km in the area mixed with bush and shrub of O Smoan Reservoir Trees are cut down approx 30m wide.</td><td>Since it is impossible for water pipeline to avoid gallery forest along lake coast and bush/shrub area in O Smoan Reservoir, construction site shall be minimized to reduce impact on the flora and fauna. The forest will be restored back in a few years after construction.</td></tr>
<tr><td>2.</td><td>Multiple Use Area</td><td>MOE</td><td>Conservation of biodiversity and ecosystem.
Multiple use for local people in the community</td><td>Pipeline is laid down 4km long in the Multiple Use Area. Since it is 2-3m deep under ground, little impact on land use is expected.</td><td>The area is used for improvement of local people's living condition.
Construction site shall be minimized.</td></tr>
<tr><td>3.</td><td>Community Fisheries</td><td>DOFi</td><td>Zone where fishing is managed sustainably according to management plan in community</td><td>Trees in the Inundated protected forest are cut down.
Some impact may be expected on fishery.</td><td>Compensation to Community Fisheries should be considered.
Construction site shall be minimized.</td></tr>
<tr><td>4.</td><td>Buffer Zone of Tonle Sap Biosphere Reserve</td><td>UNESCO</td><td>Buffer zone to protect core zone.</td><td>Pipeline is laid down 4km long in the buffer zone. Since it is 2-3m deep under ground, little impact on core zones is expected.</td><td>Construction site shall be minimized.</td></tr>
<tr><td>5.</td><td>APSARA Protected Area</td><td>APSARA</td><td>Conservation of archaeological site Zone 1 ～4</td><td>Mainly along the roads, distribution pipes are laid down. Little impact on protected area is expected.</td><td>Prior consultation should be conducted in case of construction outside right-of-way.</td></tr>
<tr><td>6.</td><td>Landscape Protected Area</td><td>MOE</td><td>Conservation of landscape</td><td>Mainly along the roads, distribution pipes are laid down. Little impact on landscape protected area is expected.</td><td>Prior consultation should be conducted in case of construction outside right-of-way.</td></tr>
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<tr>
<td>(2)Ecosystem and biota</td>
<td>① Does the project site encompass primeval forests, tropical rain forests, ecologically valuable habitats (e.g., coral reefs, mangroves, or tidal flats)?

② Does the project site encompass the protected habitats of endangered species designated by the country's laws or international treaties and conventions?

③ If significant ecological impacts are anticipated, are adequate protection measures taken to reduce the impacts on the ecosystem?

④ Is there a possibility that the amount of water (e.g., surface water, groundwater) used by the project will adversely affect aquatic environments, such as rivers? Are adequate measures taken to reduce the impacts on aquatic environments, such as aquatic organisms?</td>
<td>① Since the project site does not encompass primeval forests, tropical rain forests and ecologically valuable habitats, but gallery forest and the area mixed with bush and shrub, where fish produces eggs and grow up small fish, the area to be altered should be minimized.
② Although the project site does not encompass the protected habitats (Core zones of Tonle Sap Biosphere Reserve) of endangered species designated by Cambodian laws or international treaties and conventions, there is a possibility of inhabitation of endangered species in the site. Therefore, cutting down of inundated forest will be minimized and afforested.
③ Significant ecological impacts will not be anticipated because the construction site of pipeline is minimized and filled with soil after laying down pipe.
④ Although there is little possibility that the amount of surface water used by the project will adversely affect aquatic environments because water body of Tonle Sap Lake is huge and garting is set on the intake.</td>
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4. Social Environment	(1)Resettlement	① Is involuntary resettlement caused by project implementation? If involuntary resettlement is caused, are efforts made to minimize the impacts caused by the resettlement? ② Is adequate explanation on relocation and compensation given to affected persons prior to resettlement? ③ Is the resettlement plan, including proper compensation, estoration of livelihoods and living standards developed based on socioeconomic studies on resettlement? ④ Does the resettlement plan pay particular attention to vulnerable groups or persons, including women, children, the elderly, people below the poverty line, ethnic minorities, and indigenous peoples? ⑤ Are agreements with the affected persons obtained prior to resettlement? ⑥ Is the organizational framework established to properly implement resettlement? Are the capacity and budget secured to implement the plan? ⑦ Is a plan developed to monitor the impacts of resettlement?	① ②③④⑤⑥⑦Involuntary resettlement is not be caused by project implementation. Compensation will be prepared by project owner, SRWSA, for recession rice area and Community Fisheries influenced by construction of pipeline.
	(2)Living and Livelihood	① Is there a possibility that the project will adversely affect the living conditions of inhabitants? Are adequate measures considered to reduce the impacts, if necessary? ② Is there a possibility that the amount of water used (e.g., surface water, groundwater) by the project will adversely affect the existing water uses and water area uses?	① There will be a possibility that the project affects not adversely but positively the living conditions of inhabitants because safe drinking water is supplied. ② In the dry season the water level of Tonle Sap Lake goes down and intake facility may come out in the way of fishing boats. In order to prevent accident by boats, a tower will be built on the intake and even in rainy season local people can identify the location of the intake and prevent accident from occurring. Therefore, little impact may be given on fishing and transportation by water.
	(3)Heritage	① Is there a possibility that the project will damage the local archeological, historical, cultural, and religious heritage sites? Are adequate measures considered to protect these sites in accordance with the country's laws?	① There are two cultural heritages of an old temple and old canal on the way from the Water Treatment Plant to existing road. As regards the old canal, project owner should inform construction schedule to relevant authorities like APSARA and obtain approval from them prior to excavating the old canal. Archaeological expert says he can have a good opportunity for knowing the situation of the heritage, collecting artifacts and making a report by drawing a cross-section of the old canal.
	(4)Landscape	① Is there a possibility that the project will adversely affect the local landscape? Are necessary measures taken?	① Although an intake tower will appear outside of inundated forest area, there would be little impact of the landscape because at present there is a large building outside of the area.

4. Social Environment	(5) Ethnic Minorities and Indigenous Peoples	① Does the project comply with the country's laws for rights of ethnic minorities and indigenous peoples? ② Are considerations given to reduce the impacts on culture and lifestyle of ethnic minorities and indigenous peoples?	①② There is little impact on ethnic minorities and indigenous peoples.
	(6) Working Conditions	① Is the project proponent not violating any laws and ordinances associated with the working conditions of the country which the project proponent should observe in the project? ② Are tangible safety considerations in place for individuals involved in the project, such as the installation of safety equipment which prevents industrial accidents, and management of hazardous materials? ③ Are intangible measures being planned and implemented for individuals involved in the project, such as the establishment of a safety and health program,and safety training (including traffic safety and public sanitation) for workers etc.? ④ Are appropriate measures being taken to ensure that security guards involved in the project do not violate safety of other individuals involved, or local residents?	①The project owner has experiences for operation of water supply system since 1996. they have never been violating any laws and ordinances associated with the working conditions of Cambodia. ②Check system for leaked chlorine is designed and regular training will be conducted according to the manual for countermeasures in an emergency. ③ The operators of WTP in SRWSA have been operating the current water treatment plant on three shifts and commuting to/from work by motorcycle, and safety education of commuting and training for operation have been conducted regularly. ④The project owner has experiences of water supply system since 1996 and there has been no affair that security guards violated safety of other individuals or local residents

5. Other	(1) Imapcts during Construction	① Are adequate measures considered to reduce impacts during construction (e.g.,noise, vibrations, turbid water, dust, exhaust gases, and wastes)?	①**Air quailty**; Construction of distribution pipe along the existing road in the town area might give some impact with dust because there are many houses along the road. Consideration should be made to lay down the pipe and fill in the trench in a short while after excavation and not to leave it open for a long time. Regular maintenance of heavy machine is necessary. **Water quality**; If much turbid water is discharged, the water will be disharged into a pond excavated on the land and flown away to the lake to prevent turbid water from spreading out and to promote particle settling down. **Waste**; If waste generated during construction of relevant facilities for this project is treated and disposed properly in accordance with the regulation, little impact is expected on surrounding area. **Noise & Vibration**; Construction near private houses in urban area should be stopped at night and on holiday to reduce impact due to noise and vibration on the surrounding area. Particularly consideration should be made not to give significant impact on tourists. In some cases it might be necessary to adopt low-noise-machines near main archaeological temples.
		② If construction activities adversely affect the natural environment (ecosystem),are adequate measures considered to reduce impacts?	② Construction site in gallery forest and the area mixed with bush & shrub should be minimized and the former is afforested.
		③ If construction activities adversely affect the social environment, are adequate measures considered to reduce impacts?	③ Compensation for reccesion rice area and Community Fisheries will be prepered by project owner, SRWSA.
		④ If necessary, is health and safety education (e.g., traffic safety, public health) provided for project personnel, including workers?	④ Health and safety education for project personnel including workers will be planned and included in contract conditions.
	(2)Monitoring	① Does the proponent develop and implement monitoring program for the environmental items that are considered to have potential impacts?	① SRWSA will implement monitoring program for the environmental items that are considered to have potential impacts.
		② Are the items, methods and frequencies included in the monitoring program judged to be appropriate?	②The items, methods and frequencies are appropriate.
		③ Does the proponent establish an adequate monitoring framework (organization, personnel, equipment, and adequate budget to sustain the monitoring framework)?	③The project owner will establish Project Management Unit for this project and the manager of the Unit will control the monitoring plan.
		④ Are any regulatory requirements pertaining to the monitoring report system identified, such as the format and frequency of reports from the proponent	④Although any regulatory requirements pertaining to the monitoring report are not identified, the project owner should submit monitoring reports to DOE of Siem Reap Province.

5. Other	(2)Monitoring	

<Construction Phase>

- Water Quality（Effluent/Wastewater）

Item	Unit	Measured Value (Mean)	Measured Value (Max.)	Country's Standards	Standards for Contract	Referred International Standards	Remarks (Measurement Point, Frequency, Method, etc.)
Turbidity	-	-	-	-	-	-	**Measurement point**; One (1) point at the water area where turbid water is discharged from pipeline construction site **Frequency**; One (1) time per week **Method**; Visual observation/ Hearing from the representatives of Kandaek Community Fisheries one time per month

- Noise/Vibration

Item	Monitoring Results during Report Period	Remarks (Measurement Point, Frequency, Method, etc.)
Noise/Vibration	(Ex. Are there any complaints from tourists?)	Noise and vibration check by ears whenever construction site is located in the neighborhood of the resource for tourism.

- Ecosystem

Monitoring Item	Monitoring Results during Report Period	Remarks (Measurement Point, Frequency, Method, etc.)
Number of the tall trees felled down		**Point**; The area of construction site for pipeline in the gallery forest (30m wide x 1.5km long) **Frequency**; During construction of the pipeline in the gallery forest **Method**; Recording the number of the tall trees cut down (The number will be criteria of reforestation)

- Living / Livelihood

Monitoring Item	Monitoring Results during Report Period	Remarks (Measurement Point, Frequency, Method, etc.)
Area of construction site		**Point**; Recession rice area and Community Fisheries area **Frequency**; One (1) time after completion of pipeline construction in those areas **Method**; checking the discrepancy between plan and construction / Hearing from the representatives of Commune and Community Fisheries

- Heritage

Monitoring Item	Monitoring Results during Report Period	Remarks (Measurement Point, Frequency, Method, etc.)
Evaluation of the value (Old Canal)		**Point**; Point where the pipeline closes an old canal **Frequency**; One (1) time **Method**; Notifying APSARA prior to construction and getting the instruction
Evaluation of the value (unknown cultural heritage)		**Point**; Anywhere in construction area of pipeline **Frequency**; During construction **Method**; Notifying APSARA whenever cultural heritage is found.

5. Other	(2)Monitoring		<Operation Phase> (see tables below)

<Operation Phase>

- Water Quality（Effluent/Wastewater）

Item	Unit	Measured Value (Mean)	Measured Value (Max.)	Country's Standards	Standards for Contract	Referred International Standards	Remarks (Measurement Point, Frequency, Method, etc.)
SS (Suspended Solid)	mg/l			<50	-	-	**Measurement point**; One (1) point at outlet of Water Treatment Plant **Frequency**; One (1) time per four (4) months **Method**; Filtration and Dried 105℃
BOD	mg/l			<30	-	-	**Measurement point**; One (1) point at outlet of Water Treatment Plant **Frequency**; One (1) time per four (4) months **Method**; Winkler Method (5210B)
COD	mg/l			<50	-	-	**Measurement point**; One (1) point at outlet of Water Treatment Plant **Frequency**; One (1) time per four (4) months **Method**; Reflux Method (5220B)

- Waste

Monitoring Item	Monitoring Results during Report Period	Remarks (Measurement Point, Frequency, Method, etc.)
Sludge		**Point**; Drying bed **Frequency**; One (1) time per four (4) months **Method**; Taking photographs/ Document for disposal of sludge at proper final disposal site

- Ecosystem

Monitoring Item	Monitoring Results during Report Period	Remarks (Measurement Point, Frequency, Method, etc.)
Negative effects to natural environment around the intake facility		**Point**; Surrounding area of the intake facility **Frequency**; Two times per year (dry & wet season) **Method**; Hearing from the representatives of Kandaek Community Fisheries
Number and height of trees in the gallery forest area reforested		**Point**; The area over the pipeline (30m wide x 1.5km long) **Frequency**; One time per year (for five years) **Method**; Counting the number and measuring height of the trees growing by visual observation

5. Other	Note on Using Environmental Checklist	① If necessary, the impacts to transboundary or global issues should be confirmed (e.g., the project includes factors that may cause problems, such as transboundary waste treatment, acid rain, destruction of the ozone layer, or global warming).	① The impacts to transboundary or global issues will be little.

1) Regarding the term "Country's Standards" mentioned in the above table, in the event that environmental standards in the country where the project is located diverge significantly from international standards, appropriate environmental considerations are made, if necessary. In cases where local environmental regulations are yet to be established in some areas, considerations should be made based on comparisons with appropriate standards of other countries (including Japan' experience).
2) Environmental checklist provides general environmental items to be checked. It may be necessary to add or delete an item taking into account the characteristics of the project and the particular circumstances of the country and locality in which it is located.

Chapter 11.
Evaluation of Priority Project

Chapter 11.Evaluation of Priority Project

11-1 Socio-Economic Evaluation

The *Cambodia Millennium Development Goals* (CMDGs) establishes the key underlying coverage targets for the development of water supply sector and, therefore, becomes one of the viable guides in evaluating the project. There are two main quantitative evaluation indicators utilized – water supply coverage[1], and served population[2]. The long-term water supply development plan envisages exceeding the CMDG with respect to urban coverage ratio in the Siem Reap City and its surroundings by a five-year delay in 2020, which will continue to be supplied as at present with SRWSA safe water at a level of 90 percent in 2030. As for water supply to tourists, 80 percent coverage will be achieved in the same year as domestic water supply in 2020 and 100 percent in 2030. In this sense, the long-term water supply development 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 Priority Project, 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 overall health of the project beneficiaries, measured by evaluation indicators as the reduction of water diseases' outbreaks and the reduction of infant and maternal mortality associated with water-borne diseases. Improved water supply in the areas also reduces the burden of fetching water that typically falls on women and children, contributing indirectly to greater rural labor force productivity and improved school attendance and educational achievement of children.

Improved water supply from the Central Distribution System (CDS) aids the development of the tourism industry in Siem Reap City, particularly in the tourism-related service businesses such as hotels and restaurants. In this connection, there are over 300 number of guesthouses and hotels in the service area, all of which are waiting to be connected to the system. Water supply is also among the critical infrastructure requirements for labor-intensive, light manufacturing industries that the RGC has targeted for promotion in its industrial policy.

[1] Water supply coverage (%) = [population served] x 100 / [total population in the present service area] is an important evaluation indicator because any water utility is mandated to serve a given and defined service area.

[2] Served population is the production/population (m3/d/c) = [annual production volume (m3) /365] / [number of people served]. It shows the capacity of the present system to supply water to all types of customers in its service area.

Expansion of water supply inevitably results in greater production of wastewater. Preparation and implementation of the priority project for drainage and sewerage in the Study Area is urgently necessary, to ensure that the health benefits from improved water supply are not lost on account of deterioration in sanitary and environmental conditions. 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 Tonle Sap Lake, 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.

11-2 Environmental Evaluation

JICA categorized this Plan project as Category B. The proposed long-term water supply development 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 the previous section, Environment Mitigation Measures will be adequately conducted, the related agencies should monitor those activities as recommended in Environmental Monitoring Measures.

11-3 Technical Evaluation

By the Priority Project augmentation project, which includes construction of raw intake facilities, water treatment plant, and clear water transmission/distribution pipelines, a daily total water supply capacity of 56,000 m^3 will be achieved in early 2017. The project will secure the supply capacity to meet the water demand up to the year 2022. The jurisdiction of SRWSA water supply is expanded to 33.6 km^2 by the Priority Project in the long-term water supply development plan, approximately five times the area compared to 6.9 km^2 of the current water supply covering areas.

Served population will reach 233 thousand or 82 percent as well as 7.8 thousand or 86 percent of tourists of the projected population in 2017 in the long-term water supply development plan in cooperate with the existing water supply systems. Water tank and distribution pipes will be extended and enforced to secure 24-hour/day water supply. The number of service connections will reach approximately 41,000 connections in 2022, from approximately 4,500 at present.

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

It is noteworthy that the coverage will be achieved with continued efforts to control non-revenue water[3] at the level of 10 percent through 100 percent metering of all service connections[4], well organized operation and maintenance efforts on the transmission/distribution pipelines, including optimization of supplied pressure and making use of the proposed supplied water monitoring system to reduce annual operation and maintenance costs[5].

Preservation of raw water quality is another important issue for both drinking water quality control and minimization of production cost.

The criteria for the technical, financial and institutional evaluation for the priority project are anchored on the DAC Framework for evaluating development assistance – relevance, efficiency, effectiveness, impact and sustainability.

11-4 Financial Evaluation

Financial soundness is a key element for pursuing and attaining the CMDGs for the water supply sector. With the implementation of the project and the financial support of the MOEF by way of the JICA loan, SRWSA can attain full financial autonomy as envisioned in the National Water Sector Policy and incorporated in the sub-decree creating SRWSA as an autonomous public enterprise. This can be achieved by having a water tariff[6] that is pro- poor, but balances the need for SRWSA to be financially viable as an institution. Periodic adjustment of water tariffs is, however, a necessary consequence due to increasing cost as well as supporting the repayment of the loan. The required tariffs proposed in this study are found to be affordable to both residential and commercial customers. With the water tariffs adjusted on a regular basis, the financial effectiveness of SRWSA may be sustained.

The implementation of the project widens the customer base, which can boost the revenue potential of SRWSA, thus cost per service connection[7] should be affordable to all types of customers. In addition, collection efficiency[8] of water fees must be sustained at the highest levels

[3] Non revenue water (%) = [total annual production (m3) - total billed consumption (m3)] x 100/[total annual production (m3)]
[4] No. of metered connections (%) = metered connection / unmetered connections
[5] Unit production cost (US$/m3) = [annual O&M cost (US$)] / [total annual production (m3)]
[6] Average tariff (US$/m3) = [total annual billing (US$)] / [total annual consumption (m3)]
[7] Capital expenditure/connection (US$) = [total capital expenditure over the last 5 years (US$) / 5] / [number of utility connections]
[8] Collection efficiency (%) = [total annual collections (US$) / total annual billings (US$)] x 100

possible. The result would be a low operating ratio[9] that will indicate the efficiency of SRWSA as an institution.

11-5 Institutional Evaluation

Institutional development is inherently difficult as this is only achieved over the long-term. One project, therefore, may not immediately achieve the capacity building objectives. However, this priority project provides clear avenues to jumpstart building organizational capacity of the SRWSA, as well as the capacities of its staff. Training undertaken by SRWSA personnel can be measured by the actual number of training hours, or cost of training per employee; however, the "return on training" has always been difficult to quantify and measure. Translating the training investment into impacts will have to go beyond traditional measures.

The staff productivity index[10] is, therefore utilized as one indicator of organizational efficiency. It not only was used in planning the number of SRWSA personnel in each important development phases, where accompanying organization structures are recommended, but also in targeting organizational efficiency when comparing SRWSA with other Asian water utilities of the same size.

11-6 Evaluation by DAC 5 Indices

The criteria for the technical, financial and institutional evaluation for the Priority Project are anchored on the DAC Framework for evaluating development assistance – relevance, efficiency, effectiveness, impact and sustainability. Towards this end, questions to be ascertained are shown below:

EVALUATION MATRIX (Technical, Financial and Institutional)			
EVALUATION CRITERIA	**FOCUS AREA**	**QUESTIONS**	**INFORMATION REQUIRED**
RELEVANCE (Technical and Financial)	Project Formulation / Design	Was the economic rationale for the Project based on sound analysis?	Economic / Household surveys
		Did the project formulation and design incorporate lessons from related projects?	• Content analysis of past projects and key informant interviews
		Did the project avoid duplication of efforts in other projects?	• Results from key informant interviews with local offices and organizations such as SRWSA. Content analysis of meetings and consultations with national-level organizations
		Did the project formulation (design) adopt correct solution to identified problem?	
		Is the project design sound in terms of a series of necessary conditions being met?	
	Stakeholder Consultation and	Were the stakeholders consulted and do they "own" the project design?	• Consultation process used and local stakeholder representation in project formulation

9 Operating ratio = [annual O&M cost (US$)] / [annual revenue (US$)]
10 Staff/1,000 connections ratio = [number of utility staff] / [number of utility connections/1,000]

	Coordination		• Establishment and meeting minutes of the Project Steering Committee
		How well does project formulation / design address local needs and priorities and formulated with appropriate strategies?	• Role of stakeholder agencies and organizations in needs assessment and project implementation • Consistency with stakeholders' objectives and government structures
		Did the project provide for coordination with and/or complementarities with development partners?	
	Risks Mitigation	Did the project identify relevant risks and provide mitigation measures?	Types of risks identified and safeguard / mitigation measures envisaged in project design
RELEVANCE (Institutional)	Organization Structure	Is the proposed organization structure relevant to SRWSA as a water utility so that its mission and objectives can be realized?	Organization structure, mission and objectives
		Is the organization set-up reflective of the type and the design of water system?	Unit functions
	Human Resources	Is the SRWSA human resources plan relevant to the number and quality required to manage, operate and maintain the utility?	HR Inventory
	Implementation Arrangements	Are the implementation arrangements appropriate for the various stakeholders and their levels of interest in SRWSA?	Government structures and mandates
	Capacity Building	Are the training approaches and methodologies relevant to the actual and emerging needs of the organizational units?	Needs assessments
		Do the training programs and courses address the training needs of the staff?	Personnel training history
EFFICIENCY (Technical and Financial)	Assumptions	Were these assumptions valid: (i) Projected number of connections; (ii) Service coverage; (iii) number of beneficiaries; (iv) procurement and management costs; (v) input costs, risks, and others	• EIRR, FIRR calculation and documents • List of key assumptions, economic and financial parameters
	Project management	Have all the project partners and organizations been identified together with their mandated roles?	• Clarification of the roles and responsibilities of project partners • Composition and frequency of project steering committee meetings
	Project implementation	How effective was the intra and inter-agency coordination mechanisms in the project?	
EFFICIENCY (Institutional)	Assumptions	Were these assumptions valid: (i) Projected number of connections; (ii) Service coverage	Technical and financial projections
	Staff and organizational efficiency	What is the projected staff productivity index (SPI)?	Projections on the number of service connections
	Project implementation and management	How effective was the intra and inter-agency coordination mechanisms in the project?	Clarification of roles and responsibilities of project organizations
EFFECTIVENESS Technical and Financial)	Project achievements	Will the project achieve what it intended to do?	• List of project outputs • Baseline data on key performance indicators compared to initial data • Beneficiaries' perception about project benefits
		What factors will contribute to the success (or weakness) of the project?	Incentives or Constraints, if any
EFFECTIVENESS (Institutional)	Capacity Building	Were capacity building objectives achieved?	Capacity building outputs

		What factors contributed to the success (or weakness) of capacity building?	Constraints, if any
IMPACT (Technical and Financial)	Socio-economic impact	What are the impacts of the project on beneficiaries' health?	Perceptions about project benefits and negative impacts expressed by beneficiaries
		How much impact will the project have on industries and businesses, such as tourism-related service and light manufacturing?	Tourism arrivals, increased number of businesses serviced by SRWSA, jobs created
	Environmental impact	How much over-all impact is seen in Siem Reap through the water supply project?	• List of environmental safeguards • Protection of heritage sites through conservation of groundwater
IMPACT	Organizational Effectiveness	What are the impacts of the training program/courses on organizational effectiveness?	Key performance indicators of SRWSA
	Customer Perception of SRWSA	How much improvement is recognized in terms of public's awareness towards SRWSA service?	Perceptions about the project benefits and negative impacts expressed by beneficiaries
SUSTAINABILITY (Technical and Financial)	Viability of SRWSA	Is there availability of adequate and effective demand for the project's water supply services?	• Growth in service coverage area • Mechanism to reflect consumers' wants and complaints in the service delivery
	Water tariff	Are there appropriate policies and procedures, particularly on tariff-setting, to ensure self-reliance of SRWSA?	• Affordability of water tariff as against financial sustainability of SRWSA • Frequency and amounts collected as water service fee from consumers
	Other policies	Are there other policies – financial, human resources, technical operations and management – to ensure continued operations of SRWSA?	• Policies and Procedures issued by SRWSA Board of Directors and Management • Water resource management-related laws, regulations and procedures
	Adequacy of policies and regulatory conditions	Are there appropriate policies to ensure continued funding of SRWSA?	
	Political will	Is there political will to ensure national and local governments' ownership and commitment to the project?	• Results of meetings of the project steering (coordinating) committee, executing agency and project management unit
	Environmental, social and technological, and natural resource risks	Are all risks identified and mitigation measures recommended?	
SUSTAINABILITY	Institutional life cycle	Is there availability of adequate and effective demand for the project's water supply services?	• Service coverage area • Mechanism to reflect consumers' wants and complaints in the service delivery
	Institutional policy on management systems	Are there appropriate policies and procedures present to ensure continued management, operation and maintenance of SRWSA?	Revisions of human resources, financial and technical manuals
	Institutional policy on human resources	Is there application of appropriate policies to ensure the maintenance of required human resources?	

11-6-1 Relevance

The mission of SRWSA is to produce, supply and distribute safe and potable water supply and reliable water service to Siem Reap and other areas within the political jurisdiction of Siem Reap province.

The Priority Project aims to develop a daily water supply capacity of 30,000 m^3 fulfilling the 2022 water demand proposed in the long-term water supply development plan targeting year 2030. The Project will achieve 80 percent of water supply coverage of the proposed service areas in 2020 in Siem Reap city, contributing to the goal set by the Cambodia Millennium Development Goals (CMDGs).

The Project will benefit the population in the service areas in Siem Reap city to meet the fundamental development challenges of reducing poverty and the stabilization of the people's livelihood. The Project will benefit an improvement in the health status and quality of life of the people of Siem Reap city through providing a safe water supply.

Judging from that the Project should be implemented as an urgent project to cope with the increasing water demand in the area. The Project is eventually expected to mitigate a social problem on thread of land subsidence caused by the many hotels operating around the heritage site couples with a sharp increase in tourism related industries which has resulted in uncontrolled abstraction of groundwater source in the area.

11-6-2 Effectiveness

The proposed water supply systems with a design capacity of 30,000 m^3/d includes construction of new raw water intake facilities, raw water conveyance pipelines, raw water transmission pump station, water treatment plant, transmission/distribution pipelines.

The additional water supply capacity will be able to cover the water demand of residents and tourists by the year 2022 projected in the long-term water supply development plan in cooperate with the existing and planned water supply systems.

By augmenting the water supply capacity, service coverage will reach 80 percent in 2020 to fulfill the target set by the CMDGs. The proposed water supply system will contribute to improvement of level of service such as distribution of 24/7 potable water and reliable water service to all households, businesses and institutional consumers within its jurisdiction.

Likewise, the Project will reinforce management systems of SRWSA to ensure the backbone of water utility operations and human resources as the brain of the organization. The reinforced management systems should reflect the country's water sector policies and the downstream policies and procedures. The reinforced work force will aim for a professional highly trained and motivated work force to ensure highest productivity and customer satisfaction.

11-6-3 Efficiency

The implementation of the Siem Reap Water Supply Expansion Project will be funded out of a loan from the Government of Japan, through the Japan International Cooperation Agency, to the Royal Government of Cambodia (RGC).

Ensuring the successful implementation of the Project necessitates setting up a rational project implementation system that would take into consideration the requirements of, and the agreements between, both the lender (GOJ) and borrower (RGC).

SRWSA should be tasked to provide day-to-day supervision over the project at the field level. While it shall be working very closely with the project Consultants, SRWSA's tasks relate to project management as a discipline, applying project management principles, concepts, tools and techniques to improve project performance and organizational effectiveness. SRWSA will become involved in the entire cycle of the Project as reflected in the whole range of services to be provided by the Consultant. Providing day-to-day supervision over the implementation of the Project includes addressing technical skills like scheduling, cost estimating, and risk management; and also encompasses other disciplines such as scope definition, procurement management, financial management, asset management, human resource management, environmental and social considerations, and communications.

11-6-4 Impact

The expected impacts from the Project are to achieve the CMDG clean water coverage targets include improved public health overall and reduction of infant and maternal mortality associated with water-borne disease. Improved water supply in the 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.

Improved water supply from the Project is an aid to tourism industry development in Siem Reap city. Development of tourism industry will eventually support financial soundness of SRWSA by using up the projected water demand. 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.

Providing new water supply systems taking water from the Tonle Sap Lake, a switching over from groundwater sources will be promoted to eliminate the threat of land subsidence which possibly causes a positive impact to the Angkor Heritages' preservations. Eventually, tourism industry will be enhanced in the region and comprehensive growth in economy can be expected.

On the negative side, it must be mentioned that expanded water supply inevitably results in greater production of wastewater. Preparation and implementation of projects 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. 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 Tonle Sap Lake, 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.

11-6-5 Sustainability

A major key of successful implementation of the Project are in several stakeholder-institutions with complementary interests. These are the following: i) MOEF, which will guarantee the loan to SRWSA, and will, therefore, want to ensure that the loan will be repaid; ii) MIME, which has technical supervision over SRWSA, particularly over its future plans and projects involving government-guaranteed loans, and would, therefore monitor project implementation; and, iii) MWRAM, which has a mandate over the sustainable utilization of Cambodia's water resources, iv) SRWSA which is the project beneficiary, the re-payer of the loan, and the project implementer; v) the Provincial Government of Siem Reap, as the location of the Project is within its political jurisdiction; and vi) APSARA, because it has legal mandate over projects within its designated protected zones. They should play important roles as summarized below:

Project Organization	Level	Membership or Institution / Department	Role in Project Implementation
Project Coordination Committee	Inter-Agency Level	MIME, MOEF, MOWRAM, SRWSA, APSARA, Provincial Government	Over-all coordination and oversight monitoring of work accomplishments
	Ministry Level	MIME *Department of Water Supply*	Over-all responsibility for monitoring and supervision of Project
Project Implementation Agency/ Management Unit	Institution Level	SRWSA *Department of Planning and Technical*	Directly responsible for undertaking actual field supervision and management of Project implementation

As an operator of the proposed water supply systems, which is new facilities and entail the development of new and/or revised policies, SRWSA should build up or develop their capacity to prepare for the requirements, results and impacts to be brought about by the upcoming improvement and expansion of its water supply system. Current SRWSA staff must be ready for this eventuality. However, the resultant rapid growth in the number of customers will necessitate a proportionate increase in the number of staff and a change in SRWSA's organization structure. It is very inevitable, therefore, to provide training to identified key personnel to equip them with skills required to operate the expanded system, as well as to the staff of the new and/or reconstituted departments and offices. SRWSA must be able to transform organizational and individual potentials into actuality.

In addition, SRWSA should keep sound financial background so that a consumption-based tariff structure that is fair for all –residential, commercial/business and industrial consumers should be retained. The revenue from tariffs will cover O&M costs, capital development plus debt servicing properly to achieve operational and financial viability.

11-7 Proposed Objectively Verifiable Indicators for Measurement of Project Operations and Effects

The following summarizes base line indicators for year 2010, 2017, and 2022.

Descriptions/Year	2010	2017	2022
Estimated numbers of connections	4,525	27,392	41,159
Projected population served (residents)	53,350	154,630	232,300
Turbidity of treated water quality* (NTU)	5	5	5
Color of treated water quality *(TCU)	5	5	5
Proposed water production capacity (m^3/d)	9,000	56,000	56,000 to 86,000

Table 11.1 summarizes proposed performance indicators for monitor of project operations and effects.

Table 11.1 Performance Indicators for Measurement of Project Operations and Effects

	Performance Indicator (Evaluation Index)	Formula	Relevance
1.	Water Supply Coverage	Water supply coverage (%) = [population served] x 100 / [total population in the present service area]	Any water utility must be able to supply the entire population in its mandated service area or jurisdiction. For SRWSA, it must be able to improve supply coverage for all types of customer (domestic, business/commercial, institutional) as well as the growing population in its service area. In addition to safe water, service supply service must 24-hours per day.
2.	Per capita consumption	Per capita consumption (l/c/d) = [total annual domestic consumption (m3) x 1,000/365] / [number of people served]	
3.	Served Population	Production/population (m^3/d/c) = [annual production volume (m3) /365] / [number of people served]	
4.	Non-revenue water	Non revenue water (%) = [total annual production (m3) - total billed consumption (m^3)] x 100/[total annual production (m^3)]	Non-revenue water is unbilled, therefore is lost revenue. The lower NRW, the better for SRWSA.
5.	Average Tariff	Average tariff (US$/$m^3$) = [total annual billing (US$)] / [total annual consumption (m^3)]	Tariff is dependent on many factors, however, average tariff should be pro-poor, and should be adequate to cover all expenses, including debt servicing.
6.	Unit Cost of Production	Unit production cost (US$/$m^3$) = [annual O&M cost (US$)] / [total annual production (m^3)]	The lower the cost of production, the better, as it means that the utility is more efficient.
7.	Operating ratio	Operating ratio = [annual O&M cost (US$)] / [annual revenue (US$)]	The lower the operating ratio, the more efficient the water utility.
8.	Collection efficiency	Collection efficiency (%) = [total annual collections (US$) / total annual billings (US$)] x 100	The higher collection efficiency, the better. Actually, collection efficiency should be 100% to ensure that there is revenue to run the utility.
9.	Accounts Receivable	Accounts receivable (months equivalent) = [accounts receivable at end of the fiscal year] / [total annual billings/12]	Accounts receivable is also used as a measure since it means that services are billed. This is also connected to collection efficiency.
10.	Staff Productivity Index	Staff/1,000 connections ratio = [number of utility staff] / [number of utility connections/1,000]	SPI is a measure of organizational efficiency, since less staff is needed to operate and manage the water utility, meaning staff is efficient.
11.	Cost per service connection	Capital expenditure/connection (US$) = [total capital expenditure over the last 5 years (US$) / 5] / [number of utility connections]	Cost per service connection should be affordable to all customers so that every customer can be motivated to connect to the system
12.	Metering	No. of metered connections (%) = metered connection / unmetered connections	To ensure that production is billed properly and there is low NRW, all connections should be metered.
13.	Management Salaries		This reflects whether the utility can hire and retain the required qualified staff to operate and manage the system.
14.	Others: Leaks repaired Complaints received No. of new connections Annual Operation and Maintenance Costs O&M Cost Components Water diseases Outbreaks O&M Cost Components		

Chapter 12.
Conclusion and Recommendations

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12-1 Conclusion

The Project aims to meet the existing and projected shortfall in water supply with the immediate construction of the Project facilities. Thus, the Project offers not only tangible impacts, but also intangible benefits, such as:

- Improving the quality of life of the people of Siem Reap, particularly those in the service area, by (i) supplying potable water, therefore reducing health problems brought about by unsafe water, and (ii) providing reliable 24 hr water service, thereby contributing to better productivity of the residents in the service area.
- Stimulating the growth of the local economy with the enhancement / development of the present and future tourism-related businesses and light industries, all of which will rely mainly on safe and adequate water from SRWSA, especially when the extraction of groundwater will be discontinued to protect the Angkor Wat heritage area.
- Contributing to the growth of the national economy by increased tourism arrivals, which will impact on job generation and higher levels of education.
- Supporting the policies set out in the CMDG, particularly in reducing “poverty rates in urban and more accessible rural areas” and improving “urban access to safe water and rural access to improved sanitation”.

Consequently, it would be imperative and urgent for the Project to be implemented with loan assistance from the Government of Japan.

However, there are certain realities that must be recognized to guarantee a better success ratio in implementing the Project. Foremost is that the capabilities of the existing staff of the Siem Reap Water Supply System are presently lacking both in terms of numbers and experience to enable the new water supply scheme to be operated and maintained effectively, which necessitates a capacity building program. Next is the provision by SRWSA of sufficient budget to increase the required manpower to enable the skills base to be strengthened through the training and development activities under the proposed project components. Last is the necessity of increasing water rates in the medium term to ensure SRWSA’s continued sustainability and financial autonomy.

12-2 Recommendations

In the course of executing the long-term water supply development plan, the following important activities should be prioritized:

12-2-1 Before the project implementation

1) Project organizations

The project organizations, such as *Project Coordinating Committee* (PCC) and the *Project Management Unit* should be set up to be ready to discharge their roles and functions according to the requirements of the Project.

In addition, the office of the *Project Consultant Team* should be organized to mark the start of the tendering phase upon completion of detailed design review stage.

2) Land acquisition

Necessary land acquisition for the project sites is better be carried out by SRWSA before the project implementation.

3) Clearance of the relevant laws and regulations

SRWSA/MIME should facilitate the required clearances needed for the Project implementation in accordance with the relevant laws and regulations in Cambodia.

4) Protection of water sources

Tonle Sap Lake 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.

5) Project monitoring and reporting system

The development of a tri-level project monitoring and evaluation system is essential to maintain efficient work relationships among the project organizations, and to minimize conflicts among project partners.

12-2-2 During the project implementation

6) Manpower hiring schedule and staff review and assessment

The SRWSA institutional development plan follows the timeline of the three physical improvements plans being proposed in this Study and recommends the most optimum organization structure and number of human resources for each phase, as follows: (i) the availability of KTC Bulk Water in 2012-13, (ii) the completion of the facilities under Phase 1 in 2017, and (iii) the completion of the facilities under Phase 2 in 2022.

The need is translating this into a manpower-hiring schedule based on actual requirements after a thorough staff review and assessment to ensure proper matching of qualifications with job functions of the present personnel.

7) Orientation and/or Training

Aside from the trainings recommended under the capacity building program, there is a need to provide the following: (i) orientation training to all employees to prepare them for Project implementation; (ii) training on the monitoring and evaluation system, and (iii) training on the disbursement procedures.

8) Proper maintenance and periodic replacement/rehabilitation

New construction or expansion projects can be done using Japan's ODA loan and/or assistance of international donor, 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 including the groundwater level and land subsidence monitoring systems .

9) 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 Cambodia Drinking Water Standards.

10) Regulation over the exploitation of groundwater sources

RGC in cooperate with the Project Coordinating Committee (PCC) should enact regulatory measures with regard to the control of future groundwater development and imposition of sanctions to continued groundwater extraction in Siem Reap City once the Project is implemented.

11) Water tariff

SRWSA should keep sound financial background so that a consumption-based tariff structure that is fair for all – residential, commercial/business and industrial consumers should be retained. The revenue from tariffs will cover O&M costs, capital development plus debt servicing properly to achieve operational and financial viability.

12-2-3 After the project implementation

12) 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.

13) Improvement of drainage, sewerage, and sanitation in the study area

The proposed “Drainage, Sewerage, and Sanitization Project” should be implemented as scheduled to preserve the public water bodies clean and eventually to connect to prevent the Tonle Sap Lake be in good condition as raw water source of the public water supply systems.