Supporting Report – 6

Present Conditions of Drainage and Sewerage Systems

Supporting Report 6.1 Present Conditions of Study Area in Drainage and Sewerage Aspects

Table SR6.1.1 Major Drainage Facilities in Study Area

No.	Area	Description	Major Facilities/Features
	City Center Area	**(37.1 km^2)**	
1	Trabek Area (12.5 km^2)	Most of water is discharged into Boeng Cheung Aek by Trabek pumping station, which has been rehabilitated with ADB Loan by 2003. A part of local runoff flow into the Tonle Sap and Bassac by gravity flow.	Trabek Pumping Station Trabek Channel Toul Sen East Channel Toul Sen West Channel St.288 Branch Channel Sewer Network
2	Tumpun Area (17.5 km^2)	Water is discharged into Boeng Cheung Aek by Tumpun pumping station, which has been constructed under Japan's grant aid program by 2004.	Tumpun Pumping Station Tumpun Toek Pumping Station Boeng Salang Pumping Station Tumpun Inlet Channel Mean Chey Channel Toek Leak Pumping Station Salang Channel Sewer Network
3	Tuol Kouk Area (3.8 km^2)	Water is discharged into Northeast Area by pumping stations and sewer pipe.	Tuol Kouk I Pumping Station Tuol Kouk II Pumping Station
4	Boeng Kak Area (2.1 km^2)	Water flow into Boeng Poung Peay with gravity flow.	Boeng Kak
5	Wat Phnom Area (1.2 km^2)	Water flow into Tonle Sap via sewer pipes with gravity flow.	-
	Outskirts Area	**(450.9 km^2)**	
1	Pochentong Area (16 km^2)	Water flow into Southwest Area and Tumpun Area with gravity flow.	Small channels (No name given)
2	Northeast Area (41 km^2)	Water flow into Tonle Sap through Svay Pak drainage sluiceway with gravity flow.	Svay Pak Drainage Sluiceway Boeng Poung Peay Boeng Reacheaksei Boeng Kbal Damrei Boeng Veaeng
3	Northwest Area (87 km^2)	Water flow into Northeast Area with gravity flow.	Small ditches (No name given)
4	Southeast Area (56 km^2)	Water flow into Tonle Basak through Preaek Thnaot River with gravity flow.	Boeng Cheung Aek Boeng Andaer Preaek Thnaot River
5	Southwest Area (136 km^2)	Water flow into Preaek Thnaot River with gravity flow.	Preaek Thnaot River
6	East Area (83 km^2)	Water flow into Tonle Sap, Mekong River and Tonle Basak with gravity flow.	Chakto Mukh Pumping Station Preah Kumlung Pumping Station
7	Preak Pnov Area (31.9 km^2)	Water flow into Tonle Sap with gravity flow.	Preaek Pnov River Preaek Ou Ksach

Table SR6.1.2 Present Land Use and Land Development Condition in Study Area

No.	Area	Land Use / Land Development
City Center Area		**(37.1 km^2)**
1	Trabek Area (12.5 km^2)	- Hotels, offices, embassies, factories, etc. are located and a lot of squatters spread in the Bassac riverfront. - Upstream reach of this area is Urban center and downstream reach is dense residential area. - A major watershed in the City Center area. - There is a marsh called Boeng Trabek, which is utilized as hydroponic fields. Note: Boeng Trabek must not be reclaimed and must be preserved with present condition as a flood regulation pond.
2	Tumpun Area (17.5 km^2)	- Upstream reach of this area is Urban center and an important watershed in the City Center area. - Midstream reach is dense residential area. - Downstream reach is low dense residential area. - There are two marshes called Boeng Salang and Boeng Tumoun, which are utilized as hydroponic fields. - Many houses encroach on the Boeng Salang. - Houses encroached on the Boeng Tumpun had been evacuated in 2003, but some houses living around there are trying to trespass on there. Note: Boeng Tumpun and Boeng Salang must not be reclaimed and must be preserved with present condition as a flood regulation pond.
3	Tuol Kouk Area (3.8 km^2)	- Housing area with high to medium density
4	Boeng Kak Area (2.1 km^2)	- Offices, a hospital, French embassy, houses, etc. are located. - Lake area may become a recreational zone in the city in the future.
5	Wat Phnom Area (1.2 km^2)	- Offices, hotels, houses, etc. are densely located. - Ground elevation is high (over EL.10.5 m).
Outskirts Area		**(450.9 km^2)**
1	Pochentong Area (16 km^2)	- Newly developing area - Airport, factories, warehouses, offices, schools, shops and houses are located and decreasing farmland is left in the center of area. - Factories rapidly are developing with reclamation works along the southern border of this area.
2	Northeast Area (41 km^2)	- Approx. 25% of the area is lake/marsh, fishponds and farmlands. - Lake/marsh area is keep decreasing by land development and reclamation. - Some factories are found in the southern part. - Many factories, workshops, schools, shops, houses, etc. are located along NR.5.
3	Northwest Area (87 km^2)	- Most of area is farmland of paddy field and small villages are scattering. - Rainfall is mostly reserved in the paddy fields and stored in ponds for irrigation, then less flow down into the Northeast Area. - Many land developments are ongoing along NR.4.
4	Southeast Area (56 km^2)	- Large lake/marsh is located. A part of lake/marsh is utilized as hydroponic fields. - Most of area is lake/marsh and farmland of paddy field. - Ta Khmau City and area along NR.2 are dense residential area. - Many factories are located along NR.2 between Phnom Penh and Ta Khmau.
5	Southwest Area (136 km^2)	- Most of area is farmland of paddy field and small villages are scattering. - Less developed area
6	East Area (83 km^2)	- Most of area is farmland and lake/marsh, and small villages are scattering. - Along NR.1 and NR.6 are residential areas.
7	Preak Pnov Area (31.9 km^2)	- Lake located outside of Kop Srov Dike

Table SR6.1.3 Inundation Condition in Study Area in 2004

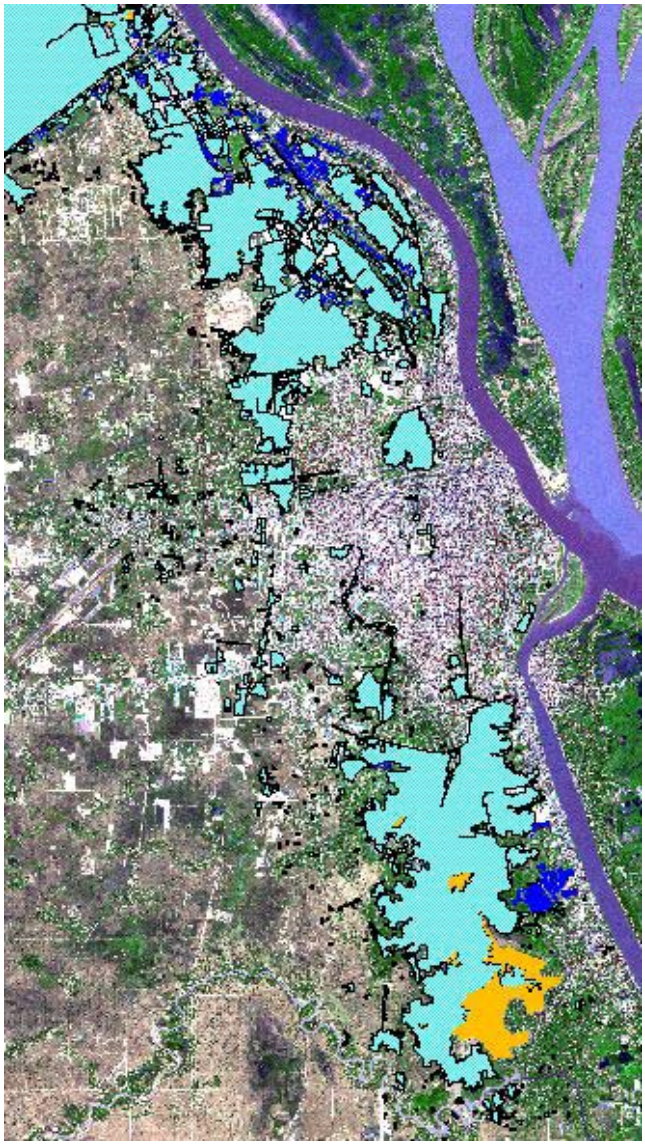
No.	Area	Inundation Condition in 2004
	City Center Area	**(37.1 km^2)**
1	Trabek Area (12.5 km^2)	- Main drainage channels and pumping station have been rehabilitated, so that inundation in this area became much slighter than before in magnitude. - Inundation still occurs in some areas, such as around Central Market and around Royal Palace, due to insufficient capacity of sewer pipes and high water level of river. It occurs with heavy rain in the rainy season and most of them last several hours with less than 1 m of water depths.
Has 2	Tumpun Area (17.5 km^2)	- Main drainage channels in the midstream and downstream reach and pumping station have been rehabilitated. - There is no problematic inundation in the midstream and downstream area. - Inundation still occurs in the upstream reach and catchment area due to insufficient capacity of drainage channel and sewer pipes, though inundation damage in this area became much slighter than before in magnitude and inundation period become shorter than before.
3	Tuol Kouk Area (3.8 km^2)	- Inundation occurs with heavy rain in the rainy season due to lack of drainage capacity of pumping stations. However, there is no serious inundation problem in this area because of small volume of rainwater runoff.
4	Boeng Kak Area (2.1 km^2)	- There is no serious inundation problem in this area.
5	Wat Phnom Area (1.2 km^2)	- While the river water level is high in the rainy season, sewer pipes cannot drain rainwater by gravity flow rapidly, so that inundation occurs with less than 1 m of water depths by heavy rain.
	Outskirts Area	**(450.9 km^2)**
1	Pochentong Area (16 km^2)	- Drainage facilities are under developing in this area, so that inundation occurs by heavy rain at the airport and on the road. Inundation damage is not so serious at present.
2	Northeast Area (41 km^2)	- This is actually a swampy area, storing runoff from the northern half of the Study Area without problematic inundation
3	Northwest Area (87 km^2)	- Paddy fields spread over the area. Rainfalls are reserved in the paddy fields for planting/growing rice, of course, without inundation problem.
4	Southeast Area (56 km^2)	- Most of this area is swampy area, receiving runoff from the southern half of the city without problematic inundation. Water level in this area is linked with river water level.
5	Southwest Area (136 km^2)	- Paddy fields spread over the area. Rainfalls are reserved in the paddy fields for planting/growing rice, of course, without inundation problem.
6	East Area (83 km^2)	- There is no serious inundation problem in this area.
7	Preak Pnov Area (31.9 km^2)	- There is no inundation problem in this area.

Supporting Report 6.2 Result of Satellite Image Analysis

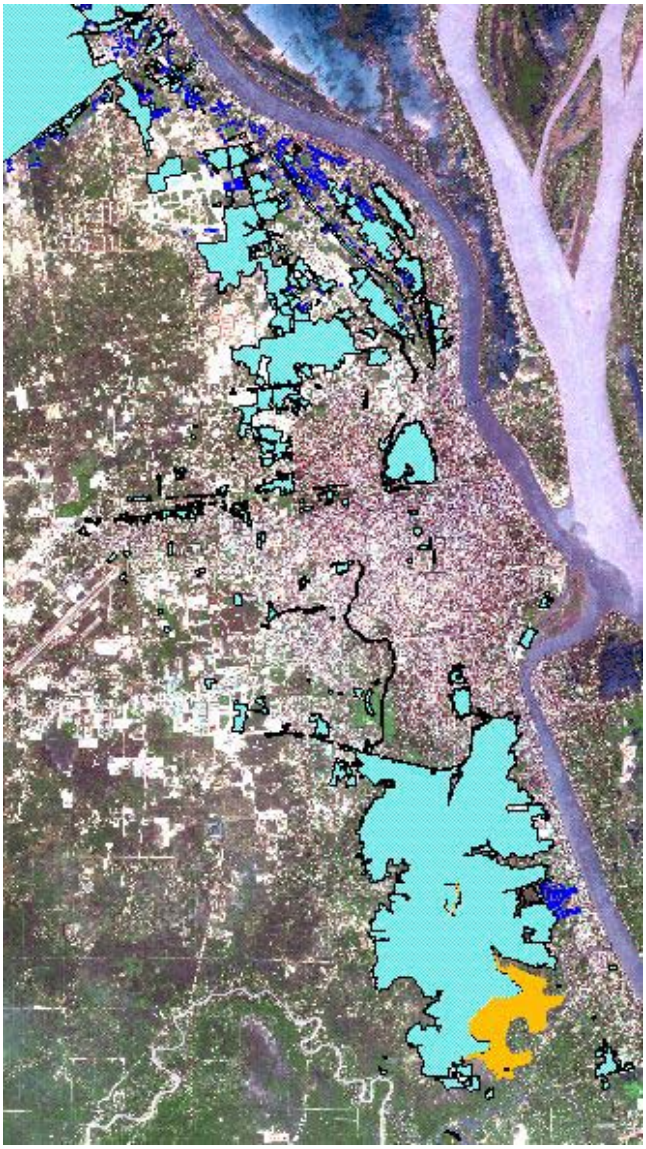
Result of Satellite Image Analysis

Legend

: Water Surface : Fish Pond : Ground



January 2003



November 2004

Supporting Report 6.3 Extract from Unofficial Translation of Sub-Decree on Water Pollution Control

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Council of Ministers, No: 27 ANRK.BK Phnom Penh, April 06, 1999

Sub-Decree on Water Pollution Control

CHAPTER 2
Provisions on waste and hazardous discharge

Article 4： Standards for effluent discharge from any sources of pollution shall be specified in the **annex 2** of this sub-decree.

Annex 2

Effluent standard for pollution sources discharging wastewater to public water areas or sewer

Nº	Parameters	Unit	Allowable limits for pollutant substance discharging to	
			Protected public water area	Public water area and sewer
1	Temperature	^0C	< 45	< 45
2	pH		6 – 9	5 - 9
3	BOD_5 (5 days at 200 C)	mg/l	< 30	< 80
4	COD	mg/l	< 50	< 100
5	Total Suspended Solids	mg/l	< 50	< 80
6	Total Dissolved Solids	mg/l	< 1000	< 2000
7	Grease and Oil	mg/l	< 5.0	< 15
8	Detergents	mg/l	< 5.0	< 15
9	Phenols	mg/l	< 0.1	< 1.2
10	Nitrate (NO_3)	mg/l	< 10	< 20
11	Chlorine (free)	mg/l	< 1.0	< 2.0
12	Chloride (ion)	mg/l	< 500	< 700
13	Sulphate (as SO_4)	mg/l	< 300	< 500
14	Sulphide (as Sulphur)	mg/l	< 0.2	< 1.0
15	Phosphate (PO_4)	mg/l	< 3.0	< 6.0
16	Cyanide (CN)	mg/l	< 0.2	< 1.5
17	Barium (Ba)	mg/l	< 4.0	< 7.0

18	Arsenic (As)	mg/l	< 0.10	< 1.0
19	Tin (Sn)	mg/l	< 2.0	< 8.0
20	Iron (Fe)	mg/l	< 1.0	< 20
21	Boron (B)	mg/l	< 1.0	< 5.0
22	Manganese (Mn)	mg/l	< 1.0	< 5.0
23	Cadmium (Cd)	mg/l	< 0.1	< 0.5
24	Chromium (Cr)$^{+3}$	mg/l	< 0.2	< 1.0
25	Chromium (Cr)$^{+6}$	mg/l	< 0.05	< 0.5
26	Copper (Cu)	mg/l	< 0.2	< 1.0
27	Lead (Pb)	mg/l	< 0.1	< 1.0
28	Mercury (Hg)	mg/l	< 0.002	< 0.05
29	Nickel (Ni)	mg/l	< 0.2	< 1.0
30	Selenium (Se)	mg/l	< 0.05	< 0.5
31	Silver (Ag)	mg/l	< 0.1	< 0.5
32	Zinc (Zn)	mg/l	< 1.0	< 3.0
33	Molybdenum (Mo)	mg/l	< 0.1	< 1.0
34	Ammonia (NH_3)	mg/l	< 5.0	< 7.0
35	DO	mg/l	>2.0	>1.0
36	Polychlorinated Byphemyl	mg/l	<0.003	<0.003
37	Calcium	mg/l	<150	<200
38	Magnesium	mg/l	<150	<200
39	Carbon tetrachloride	mg/l	<3	<3
40	Hexachloro benzene	mg/l	<2	<2
41	DTT	mg/l	<1.3	<1.3
42	Endrin	mg/l	<0.01	<0.01
43	Dieldrin	mg/l	<0.01	<0.01
44	Aldrin	mg/l	<0.01	<0.01
45	Isodrin	mg/l	<0.01	<0.01
46	Perchloro ethylene	mg/l	<2.5	<2.5
47	Hexachloro butadiene	mg/l	<3	<3
48	Chloroform	mg/l	<1	<1
49	1,2 Dichloro ethylene	mg/l	<2.5	<2.5
50	Trichloro ethylene	mg/l	<1	<1
51	Trichloro benzene	mg/l	<2	<2
52	Hexaxhloro cyclohexene	mg/l	<2	<2

Remark: The Ministry of Environment and the Ministry of Agriculture, Forestry and Fishery shall collaborate to set up the standard of pesticides which discharged from pollution sources.

Supporting Report – 7

Study on Development of Drainage/Sewerage/ Sanitation Systems

Supporting Report 7.1 Simulated Outflow Water Quality of Marsh/Lake

BOD

Year	Lake/ Marsh	Data of Lake/Marsh					Purification Effect (BOD [<30mg/L])						
		Inflow (m^3/d)	Outflow (m^3/d)	Surface Area (m^2)	Volume (m^3)	Depth (m)	Inflow Water Quality (mg/L)	Outflow Water Quality (mg/L)	Inflow Pollution Load (g/d)	Outflow Pollution Load (g/d)	Elimination Rate (%)	Purification Rate per Area (g/m^2/d)	Purification Rate per Volume (g/m^3/d)
2005	North (Present)	18,600	15,000	6,529,000	7,133,000	0～3	66.24	14.31	1,232,064	214,650	82.6	0.156	0.143
2020	North (Future)	51,900	50,000	3,824,000	4,177,760	0～3	66.24	**56.84**	3,437,856	2,841,962	17.3	0.156	0.143
2005	South (Present)	92,300	85,400	13,962,000	16,807,000	0～4	102.40	29.65	9,451,520	2,532,110	73.2	0.496	0.412
2020	South (Future)	141,600	137,000	9,294,000	11,187,814	0～4	102.40	**72.22**	14,499,840	9,893,838	31.8	0.496	0.412

COD

Year	Lake/ Marsh	Data of Lake/Marsh					Purification Effect (COD [<50mg/L])						
		Inflow (m^3/d)	Outflow (m^3/d)	Surface Area (m^2)	Volume (m^3)	Depth (m)	Inflow Water Quality (mg/L)	Outflow Water Quality (mg/L)	Inflow Pollution Load (g/d)	Outflow Pollution Load (g/d)	Elimination Rate (%)	Purification Rate per Area (g/m^2/d)	Purification Rate per Volume (g/m^3/d)
2005	North (Present)	18,600	15,000	6,529,000	7,133,000	0～3	129.41	23.52	2,407,026	352,800	85.3	0.315	0.288
2020	North (Future)	51,900	50,000	3,824,000	4,177,760	0～3	129.41	**110.26**	6,716,379	5,513,230	17.9	0.315	0.288
2005	South (Present)	92,300	85,400	13,962,000	16,807,000	0～4	161.30	88.20	14,887,990	7,532,280	49.4	0.527	0.438
2020	South (Future)	141,600	137,000	9,294,000	11,187,814	0～4	161.30	**130.98**	22,840,080	17,943,649	21.4	0.527	0.438

T-N

Year	Lake/ Marsh	Data of Lake/Marsh					Purification Effect (T-N)						
		Inflow (m^3/d)	Outflow (m^3/d)	Surface Area (m^2)	Volume (m^3)	Depth (m)	Inflow Water Quality (mg/L)	Outflow Water Quality (mg/L)	Inflow Pollution Load (g/d)	Outflow Pollution Load (g/d)	Elimination Rate (%)	Purification Rate per Area (g/m^2/d)	Purification Rate per Volume (g/m^3/d)
2005	North (Present)	18,600	15,000	6,529,000	7,133,000	0～3	18.218	5.903	338,855	88,545	73.9	0.038	0.035
2020	North (Future)	51,900	50,000	3,824,000	4,177,760	0～3	18.218	**15.978**	945,514	798,909	15.5	0.038	0.035
2005	South (Present)	92,300	85,400	13,962,000	16,807,000	0～4	22.865	3.453	2,110,440	294,886	86.0	0.130	0.108
2020	South (Future)	141,600	137,000	9,294,000	11,187,814	0～4	22.865	**14.811**	3,237,684	2,029,136	37.3	0.130	0.108

T-P

Year	Lake/ Marsh	Data of Lake/Marsh					Purification Effect (T-P)						
		Inflow (m^3/d)	Outflow (m^3/d)	Surface Area (m^2)	Volume (m^3)	Depth (m)	Inflow Water Quality (mg/L)	Outflow Water Quality (mg/L)	Inflow Pollution Load (g/d)	Outflow Pollution Load (g/d)	Elimination Rate (%)	Purification Rate per Area (g/m^2/d)	Purification Rate per Volume (g/m^3/d)
2005	North (Present)	18,600	15,000	6,529,000	7,133,000	0～3	5.790	0.200	107,694	3,000	97.2	0.016	0.015
2020	North (Future)	51,900	50,000	3,824,000	4,177,760	0～3	5.790	**4.784**	300,501	239,182	20.4	0.016	0.015
2005	South (Present)	92,300	85,400	13,962,000	16,807,000	0～4	5.091	2.052	469,899	175,241	62.7	0.021	0.018
2020	South (Future)	141,600	137,000	9,294,000	11,187,814	0～4	5.091	**3.830**	720,886	524,742	27.2	0.021	0.018

Supporting Report 7.2 Recommendation for Development of Sewerage/Sanitation System

1. Recommendation

As a result of this study, it is considered that wastewater production in 2020 will be described in Figure A7.6.1. Wastewater produced in city center, will inflow into north and south Lake/Marsh. Wastewater into north Lake/Marsh will be treated to BOD 60 mg/L, which will be discharged to the Tonle Sap River. South one will be treated to BOD 72 mg/L which discharge to the Tonle Bassac River. While wastewater occurred in outskirts area will be treated by septic tank that installed in each houses and buildings, will be discharged by BOD 80 mg/L.

This predicted BOD value is considerably over 30 mg/L of the effluent standard determined by Ministry of Environment. It is considered that this wastewater will have a huge influence to the water environment in Phnom Penh City. Therefore, sewerage system is essential to conserve the public water body and to create wholesome urban environment.

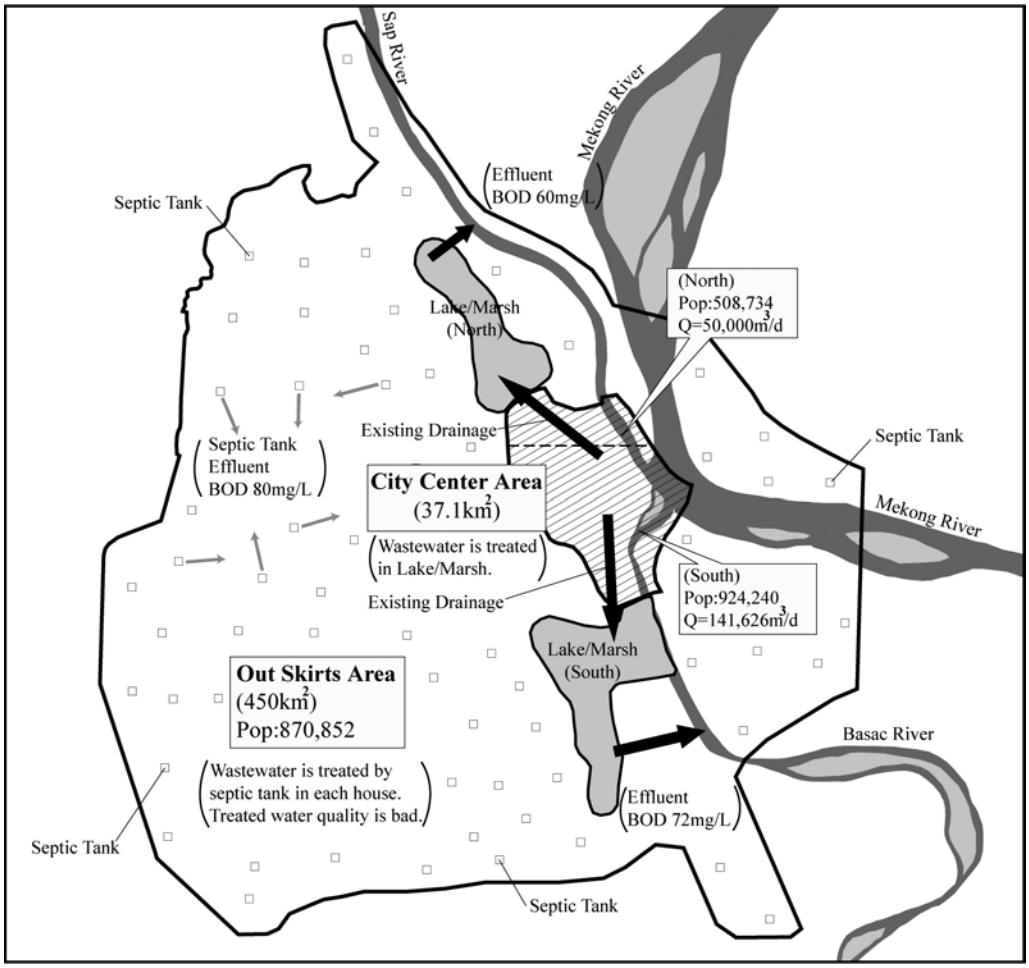


Figure A7.6.1 Wastewater Flow in 2020 (Without Sewerage System)

It is recommended that the future sewerage system in Phnom Penh City will be planned with taking into account the state of wastewater source and collection system and sewerage area will be divided into two area such as “City Center Area” and “Outskirts Area” as follows.

AREA- A Sewerage System for City Center Area

The drainages runs in City Center Area will be utilized for main trunk sewer to collect wastewater and rain water. One or more-than-one sewage treatment plants will be constructed in north and south Lake/marsh respectively in order to treat wastewater into 30 mg/L of BOD and discharge to the river.

AREA- B Sewerage System for Outskirts Area

Sewerage treatment district shall be chosen with examining invest effect and environment effect sufficiently. Sewage treatment plant for septic tank effluent will be constructed in each treatment district in order to treat wastewater into 30 mg/L of BOD and discharge to public water body. However, construction cost for sewerage system in Outskirts Area is larger than the cost for sewerage system in City Center Area, since sewer pipe and pump station must be installed in each treatment district. Separate sewerage system, which collects wastewater and rainwater by separate pipe, will be introduced in this treatment district for newly sewerage system to consider the environment effect caused by water pollution of the time for rainfall.

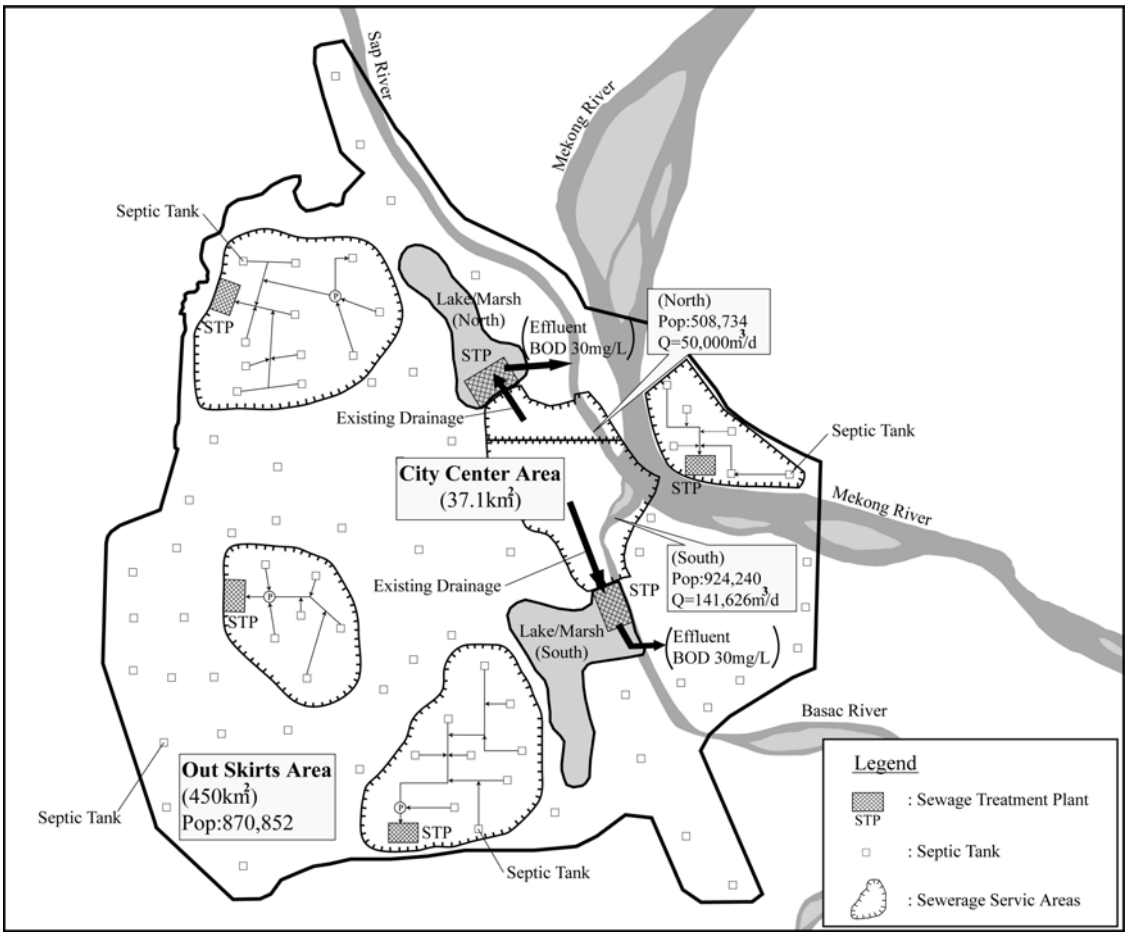


Figure A7.6.2 Wastewater Flow in 2020 (Sewerage System Implementation)

2. Research and Important Notice for Sewerage Study

Research/Study is necessary to implement of planning for sewerage system in Phnom Penh City. There are some problems to be solved for each sewerage area shown below.

2.1 Sewerage System for City Center Area (AREA- A)

(1)Survey for Existing Drainage as a Trunk Sewer Usage

Pipe capacity for future flow and actual house/building connection should be investigated.

As a result of this study, population of north area is 508,734 for 50,000m^3/d of flow (Per capita flow: 98 lpcd), while population of south area is 924,240 for 141,626m^3/d of flow (Per capita flow: 153 lpcd). Per capita flow of north area is seemed very small, which indicates the possibility that the existing drainage in north area has not been collected enough wastewater flow.

(2) Study for Wastewater Treatment Method

Considering following matter, wastewater treatment method should be examined;

- Water quality standard for discharging river.
- Spacious land is available since sewage treatment plant will be constructed in existing Lake/Marsh.
- Mechanical operation system should not be adopted due to the difficulty of operation/maintenance and breakdown.

(3) Countermeasure for Rainfall

Rainwater as well as wastewater flows into sewage treatment plan when it rains for combined sewerage system, which is introduced to utilize the existing drainage in City Center Area. Several times as design flow wastewater will flow into sewage treatment plant at the time for rain, even if it is short time. Therefore, countermeasure for the large amount of rainwater inflow is required for sewerage system plan. It is considered that following investigation and study are necessary.

- To estimate influent flow at the time for rain
- Installation of storm water reservoir for pollution
- To evaluate for public water body in case of discharge non-treated wastewater at the time for rain

2.2 Sewerage System for Outskirts Area (AREA- B)

In spacious Outskirts Area where houses are dotted widely, individual wastewater treatment has been done by septic tank. However, treated water quality is not good condition of BOD 80mg/L, environment problem is worried in a densely built-up area especially. Construction cost for sewer pipe instillation is necessary since there are no existing drainages in this area.

Therefore, it is necessary for this area to classify two categories such as sewerage system area and on site system area (treated by septic tank) shown in Table A7.6.1.

Table A7.6.1 Classification of Sewerage Service Area

Sewerage Service Area	- A densely built-up area. - Area for future development plan. - Area where environmental condition is worse due to outflow from septic tank.
On Site System Area (Treated by Septic Tank)	- Non-densely built-up area where outflow from septic tank affects surrounding environmental condition and public water body a little. - Area where invest effect is small.

Considering above table, Investigation for sewerage plan in Outskirts Area will be implemented with taking into account following items.

- Distribution of houses, office, building etc.
- Determining of sewerage population and design flow
- Effluent water quality from septic tank
- Environmental effect by effluent from septic tank

  (This is divided by area that classified into house distribution)
- Existing drainage and Existing sewer pipe
- Secured sewage treatment plant site
- Invest effect considering newly sewer pipe length and number of pump stations.

2.3 Superannuated Existing Sewer Pipe

Installation year for sewer pipe diameter of 300mm to 1500mm is unknown before 1995, since data for sewer pipe installation record is only from 1996. It is assumed that a lot of infrastructure was not constructed around the civil war period. The great part of sewer pipe was installed in the period under the rule of French, which is more than fifty years old now. Although, pipe material is unknown, clay pipe is strong for corrosion, which can be used even now. However, the life of concrete pipe is about 40 years and not strong for corrosion. It is assumed that corrosion of concrete pipe has been made progress especially hot temperature condition in Cambodia.

It is necessary for making use of existing pipe to prevent expense of newly pipe installation and traffic jam due to construction works. When sewerage plan will be implemented, it is preferable that existing sewer pipe should be surveyed to perceive the status condition and make sewer pipe repair/improvement plan.

Supporting Report – 8

Institutional Development

Supporting Report 8.1 Project Formulation Note:

Institutional Development Project for Stage I (2006 – 2010)

1. Introduction

As PPWSA is, at present, a well-functioning organization, the interventions to be introduced into the current arrangements have to be approached with extreme care and planning. In the Master Plan, a broad framework for organizational growth was explained. Building on that framework, the priority strategy at Stage I of growth has to focus on enhancing the stability of the organization – so that its present high performance is sustained in spite of whatever events or changes may occur beyond its control. Stage I institutional development will be done by **organizational restructuring** (to help build a broader team of managers and supervisors with clear roles and responsibilities and set the stage for even higher levels of coordination among the management team and delegation of authority and responsibility); **intensified training programs** for all staff on all aspects of utility management and operations (not just technical aspects) and **strengthening of existing management information system** (based on Navision Financials).

This is the basic concept behind this institutional development plan. While the management information system (MIS) seeks to address some current issues, its bases also lie in taking advantage of opportunities to prepare and organize for its future. These are presented in the succeeding section. The institutional development is presented in modules following the institutional assessment framework in the Master Plan.

Some of activities identified are recommended for PPWSA action; other institutional development activities which require external assistance are proposed for inclusion in this project for institutional development.

2. The basis for this institutional development plan

The table below refocuses the assessment of strengths and weaknesses and the new opportunities for preparing PPWSA for the future following the organizational framework model presented in the action plan. The last column defines the institutional capacity which will be strengthened in Stage 1. These are the objectives of this institutional development plan.

Current weakness and opportunities to be addressed	Recommended Activities	Expected 2010 Outcome
A. Physical (operating) system		
▪ Not all O&M procedures and standards written and documented. ▪ Limited operation skills. ▪ Untested maintenance systems and skills. ▪ O&M procedures and standards under preparation ▪ Data management and analysis can be improved. ▪ Untested maintenance systems and skills ▪ Data monitoring and telemetry system is new (for NRW)	A-1 Review of existing technical standards used (construction, materials, inspection standards, etc) including comparison with local mandated standards, if any. A-2 Adoption and approval of the new PPWSA standards (including construction standards, materials standards, inspection and testing procedures). A3 Review of existing policies, systems and procedures used (procurement, project planning and monitoring, project supervision, etc.) A4 Adoption and approval of a PPWSA Project Management Manual and Standards. A5 Agree on overall scope, content and structure of the PPWSA Operation and Maintenance Guidelines. Organize and assign work groups to draft (or update) various parts of guidelines. A6 Gather and review all existing O&M documents, Draft/update OMGs. A7 Detailed technical review of the OMG drafts. A8 Design & implement a system for regular internal review, upgrading and formal adoption of the OMG by PPWSA. A9 Review of existing asset management system. A-10 Introduction of an upgraded asset maintenance management program to integrate a preventive maintenance program for all electro-mechanical assets of PPWSA. A-11 Implementation of the Resources Module of the Navision Financials for planning and monitoring of all capital investment activities.	PPWSA will be able to: ▪ Manage capital investment and project management effectively through formally adopted technical & operating standards and procedures and formally established standard project management systems and procedures. ▪ Operate and monitor properly water supply production, treatment and distribution facilities through expanded operation and maintenance standards & guidelines. ▪ Maintain all water supply facilities properly through expanded preventive maintenance programs.
B. Organization planning system		
▪ Development of next line of managers. ▪ Participation of more managers and supervisors in the company planning process	B-1 Review of the formal 5-year and annual business planning process, structure and tools. Identification of information required from the MIS. B-2 Facilitate a series of discussion meetings with participation down to section heads and supervisors. B-3 Assess and develop the process for due consideration of consumers' views (through a "consumers forum") in the planning. B-4 Introduce a system for annual review of organization structure and staff competency	PPWSA will be able to: ▪ Prepare, update and monitor annual and 5-year plans through more input and participation from more managers and staff; and customer inputs in the process. ▪ Establish a flexible and responsive

	mix in each of the working groups.	organization by implementing a policy & system for regular review and updating of departmental and section responsibilities, functions and restructuring.
C. Commercial system		
▪ Human errors in meter reading. ▪ Some low-income residents still cannot afford to connect (min of $112; equivalent to about 2-3 months salary)	C-1 Review current PPWSA customer policies and practices. C-2 Update customer service standards. C-3 Design and implement a more pro-active customer feedback system (Go out and get feedback; do not just wait for it to come; engage in dialogue with customers and customer groups). C-4 Assess, formulate and implement an expanded and continuous public relations program for current and prospective customers.	PPWSA will be able to ▪ Serve customers at their convenience by streamlined procedures and more responsiveness to customer service requests. ▪ Get timely feedback from customers by implementing a systematic customer feedback system and promoting more dialogue with the public.
D. Financial management system		
▪ Financial analysis skills limited. ▪ Improved affordability of low-income groups to water services	D-1 Formulate a simulation model to regularly examine the impact of adjusting tariff structure on consumption patterns of customer groups to forecast revenues.	PPWSA will be able to: ▪ Determine, on an objective and continuing basis, the most appropriate tariff structure (including blocking) with due consideration for access of the low-income groups.
E. Administrative support system		
▪ Navision module for inventory management not fully utilized	E-1 Examine the current inventory planning and control policies and practices in PPWSA. 3-2 Recommend and implement policy and system management improvements to inventory and property management systems.	PPWSA will be able to: ▪ Efficiently manage level of supplies and materials inventories.

F. Human Resources Management System		
▪ Absence of a "back-up" (or understudy) system. ▪ Lack of long-term human resources development plan. ▪ Training plans still under preparation. ▪ Financial analysis skills limited ▪ Navision module for human resources management not fully utilized	F-1 Identify and define practical (more job-specific) staffing indicators to be introduced. F-2 Conduct simple observation, work load analysis to propose a reasonable initial staffing criteria or target to apply. F-3 Propose a system for regular annual updating of manpower needs based on type of skills and competency needs (not only number of staff needed). F-4 Review and update existing job descriptions. F-5 Propose practical qualification requirements and productivity standards and indicators for each job title. F-6 Identify and assess all possible areas of current operations which may be outsourced or provided through service contracts and assess the advantages/benefits. F-7 Draft a policy note adopting principles to use in deciding when to outsource: how to outsource, including sample agreements. F-8 Formulate and implement a pro-active recruitment program to go out and seek "the best and the brightest" coming out of the country's education system. F-9 Develop a systematic applicant screening (testing?) program. F-10 Review and adoption of the overall framework for technical and managerial training proposed; Develop and implement training plan following the framework. F-11 Adopt a training management system (planning & monitoring) which provides for an annual program of training activities organized and implemented by PPWSA Training Center. F-12 Establishment of more linkages with other training and development centers in the country and Asia. F-13 Intensify trainer training and materials development. F-14 Establish a staff library (for information and research) at a central location with hi-speed Internet access as part of the Training Center for use of all staff.	PPWSA will be able to: ▪ Implement new methods for planning, recruitment, evaluation of staff, including manpower projection methods; review of job descriptions for all positions; set up practical qualification requirements for each job; establishing a clearer outsourcing policy and implementing a pro-active recruitment program and introduction of additional performance- based incentives. ▪ Provide high quality training opportunities for all staff by expansion of in-company training systems and capacity.
G. Management information system		
▪ Limited familiarity with information systems and information technology. (Navision not fully utilized)	G-1 Review and if viable, expand application of existing Navision MIS software – focus on linked applications for the operations department (or replace with new software). G-2 Propose an MIS enhancement plan (addressing the information needs for the other system)	PPWSA will be able to: ▪ Share and exchange information <u>across</u> departments on a regular and continuing basis for sound decision making.

3. Organizational sub-system improvements

This section describes the various interventions to be implemented to improve the performance of PPWSA. The implementation of the activities has been classified as either a responsibility of PPWSA (left column) or as a part of this external assistance project (right column). Activities which have been initiated at PPWSA (or are ongoing) will continue to be led by PPWSA.

Improvements in the physical (operation and maintenance) system

Basis:

Process for introduction of O&M guidelines (OMG) is now done through "The Project on Capacity Building of the Water Supply System in Cambodia". This system will be further enhanced and promoted in Stage 1 through updating and upgrading of the Operation and Maintenance Guidelines (OMG's) and introduction of OMG's, particularly on water treatment. The OMG will also be the source materials of the training of technicians and operators of PPWSA.

The system monitoring facilities will also be enhanced during Stage I. The activities in this module will ensure that these new monitoring facilities are properly used and the monitoring reports are processed adequately.

The asset management system will be linked with (or include) a spare parts inventory and procurement program. These, of course, should be integrated into the MIS.

Specific Objective/s:

The specific objectives of this module are to enhance PPWSA's ability to: operate and monitor properly water supply production, treatment and distribution facilities; maintain all water supply facilities properly; and manage capital investment and project management effectively.

Approach:

This will be done through: formal adoption of technical & operating standards and procedures; formal standards for project management systems and procedures; expanded operation and maintenance standards & guidelines; and expanded preventive maintenance programs. These procedures and systems will be fully integrated with the MIS of the company which is based on Navision Financials.

The implementation of these improvements is proposed to be led and coordinated by the Technical Planning Department and Operation and Maintenance Department.

Activities and tasks to be implemented

Recommended as PPWSA responsibility	Included in this External Assistance Project
A-1 Review of existing technical standards used (construction, materials, inspection, service standards, etc) including comparison with local mandated standards, if any. A-2 & 4 Adoption and formal approval of the new PPWSA standards.	A-3 Review of existing policies, systems and procedures used (procurement, project planning and monitoring, project supervision, etc.)
	A-5 Agree on overall scope, content and structure of the PPWSA Operation and Maintenance Guidelines – from specific intake structures to specific pumping stations to specific brands of water meters (in use). Organize and assign work groups to draft (or update) various parts of guidelines. A-6 Gather and review all existing O&M documents, Draft/update OMGs. A-7 Detailed technical review of the OMG drafts. A-8 Design & implement a system for regular internal review, upgrading and formal adoption of the OMG by PPWSA.
A-9 Review of existing asset management system and adoption of the Asset Management Module of the MIS (based on Navision Financials).	A-10 Introduction of an upgraded asset maintenance management program to integrate a preventive maintenance program for all electro-mechanical assets of PPWSA.
A-11 Implementation of the Resources Module of the Navision Financials for planning and monitoring of all capital investment activities.	

Improvements in the PPWSA organization planning system

Basis:

PPWSA has already adopted and is implementing the preparation of a rolling five year corporate planning and an annual business planning system. This improvements suggested in this module is towards broadening the participation of more managers and supervisors, and possibly other stakeholders, in the process.

As the demands on the PPWSA evolve, a rational basis for making structural and staffing adjustments will have to be developed and used. There is a need to pursue better balancing of the responsibilities of the work teams and the management levels (as presented in the Main Report).

Specific Objective/s:

The specific objective of this module is to enhance PPWSA's ability to: prepare, update and monitor annual and 5-year plans; and establish a flexible and responsive organization.

Approach:

This will be done through: input and participation from more managers and staff; and customer inputs in the process; annual planning and budgeting process more participatory; and establishing a policy & system for regular review and updating of departmental and section responsibilities, functions and restructuring. This could be best done as part of the business planning process.

The implementation of these improvements is proposed to be led and coordinated by the Corporate Planning Office and the Human Resources Management Section.

Activities and tasks to be implemented

Recommended as PPWSA responsibility	Included in this External Assistance Project
B-1 Review of the formal 5-year and annual business planning process, structure and tools. Identification of information required from the MIS.	B-2 Facilitate a series of discussion meeting with participation up to section heads and supervisors in the process. B-3 Assess and develop the process for due consideration of consumers' views (through a "consumers forum") in the planning. Information and training on strategic thinking and creativity; information on broader urban, political and environmental developments. B-4 Introduce a system for annual review of organization structure and staff competency mix in each of the working groups. (Changes in working relationships, staffing mix, in the working units may be needed.)

Improvements in the commercial system to meet demand of expanded customer base by 2010

Basis:

The plan to physically decentralize the revenue collection activities of PPWSA has been started. This is intended to make payment for water services more convenient to the customers. Two (2) field collection zones have already been established; another 2 will be established shortly.

It is envisaged that other customer services (and possibly, minor distribution maintenance) will be de-centralized during Stage II. The feasibility of implementing this will depend on the alignment of the maintenance management zones and the customer revenue zones. Performance measurement by zones is now possible within the customer database managed by the Commercial Department. The

general objective is to improve and be able to respond more readily to customer services to a geographically expanding area and more customers. PPWSA should, on a continuing basis, always maintain close relationship with current and future customers, and come out with programs and services which respond to customer demands and to convey key messages like water conservation and hygienic use of water.

Specific Objective/s:

The specific objective of this module is to enhance PPWSA's ability to: serve customers at their convenience; and get timely feedback from customers.

Approach:

This will be achieved through: streamlined procedures for convenience of customers and increase responsiveness to customer service requests; establishment of a functioning and systematic customer feedback system; and expanded implementation of an ongoing public awareness, information and education program.

Build on the good public education program and the town meeting approach now used by PPWSA for new customers. This expanded awareness program will include the "greater Phnom Penh" area – possibly with MRD. Also, a conservation education program may be needed as we near the 2008 milestone in case of contingencies in the implementation of the physical facilities.

The implementation of these improvements is proposed to be led and coordinated by the Commercial Department.

Activities and tasks to be implemented

Recommended as PPWSA responsibility	Included in this External Assistance Project
C-3 Design and implement a more pro-active customer feedback system to engage in dialogue with customers and customer groups).	C-1 Review current PPWSA customer policies and practices. C-2 Update customer service standards. C-4 Assess, formulate and implement an expanded and continuous public relations program for current and prospective customers.

Improvements in the financial management and control system

Basis:

The simulation model should enable PPWSA to determine the extent of cross-subsidization among the various income level groups occurring on a month by month basis. This system will enable PPWSA

to assess its impact on the lower-income consumers on a continuing basis and help in making tariff structure and pricing recommendations.

Specific Objective:

The specific objective of this module is to enhance PPWSA's ability to examine, on a continuing basis, the impact of adjusting tariff structure (including blocking) on overall revenues and access of the low-income groups. This will be achieved through the development and testing of simple simulation models to forecast revenues. Much of the other internal financial management and control systems and procedures are already in place and functioning well.

The implementation of these improvements is proposed to be led and coordinated by the Finance Department.

Activities and tasks to be implemented

Recommended as PPWSA responsibility	Included in this External Assistance Project
D-1 Formulate a simulation model to examine the impact of adjusting tariff structure on consumption patterns of customer groups.	

Improvements in the administrative support system

Basis:

This will enable PPWSA to protect against demand surges and variations in the level of operation, improve customer service and take advantage of favorable prices (but high surpluses result in increased cost due to high investment and low capital turnover, obsolescence, spoilage and/or deterioration, inefficient use of storage space, handling expense and lost opportunities).

Specific Objective:

The specific objective of this module is to enhance PPWSA's ability to efficiently manage level of supplies and materials inventories through better inventory controls. This can be achieved by full adoption of the inventory management and procurement module of Navision Financial.

Approach:

The implementation of these improvements is proposed to be led and coordinated by the Administrative Department

Activities and tasks to be implemented

Recommended as PPWSA responsibility	Included in this External Assistance Project
	E-1 Examine the current inventory planning and control policies and practices in PPWSA. E-2 Recommend and implement policy and system management improvements to inventory and property management systems.

Improvements in the human resources management & development system

Basis:

PPWSA considers its management and staff as its most important resource. It has already implemented various systems for managing and training of its staff. This module seeks to enhance and improve on the systems already introduced.

Specific Objectives:

The specific objective of this module is to enhance PPWSA' ability to: implement new methods for planning, recruitment, evaluation of staff; and provide high quality training opportunities for all staff.

Approach

This can be achieved through: adoption of rational manpower projection methods; review of job descriptions for all positions; set up practical qualification requirements for each job; establishment of a clearer policy on outsourcing; implementation of a pro-active recruitment program; introduction of additional performance-based incentives; and expansion of in-company training systems and capacity.

Proposed training priorities in Stage 1 will be on:

1. Management Development – focus on middle managers & supervisors. Management of sections and even smaller work teams and crews; communications, leadership, motivation and working relationships. Include computer training.
2. Operation & Maintenance. Expansion of on-going "The Project on Capacity Building of the Water Supply System in Cambodia" commissioned by JICA. Exact content of this plan will depend on actual results achieved under the current project and future discussions. Development of local O&M specialists, for such areas as pipes and appurtenances, treatment processes, electro-mechanical & telemetry equipment, etc).
3. Project Management (PM). Development of local PM specialists, such as designers (hydraulics, treatment, electro-mechanical, etc), construction specialists and inspectors, socio-

economist and financial analysts for future feasibility study, design and construction activities. Include computer training (and possibly language training).

In addition to the benefits of having clear job descriptions, practical qualification and performance standards will be needed to help set the goals/directions to be achieved. Qualification and performance standards do not exist at present.

The implementation of these improvements is proposed to be led and coordinated by the Human Resources Management Section and the Training Center.

Activities and tasks to be implemented

Recommended as PPWSA responsibility	Included in this External Assistance Project
	F-1 Identify and define practical (more job specific) staffing indicators to be introduced, for example, no. of treatment operators/process train or no of water meter readers/HH/month, etc. in each department. F-2 Conduct simple observation, work load analysis to propose a reasonable initial criteria or target to apply. F-3 Propose a system for regular annual updating of manpower needs based on type of skills and competency needs (not only number of staff needed).
F-4 Review and update existing job descriptions. F-5 Propose practical qualification requirements and productivity standards and indicators for each of the job titles.	
	F-6 Identify and assess all possible areas of current operations which may be outsourced or provided through service contracts and assess the advantages/benefits of doing so. F-7 Draft a policy note adopting principles to use in deciding when to outsource: how to outsource (transparency), including sample agreements.
F-8 Formulate and implement a pro-active recruitment program to go out and seek "the brightest and the best" coming out of the country's education system. Plan may include: regular talks to graduating management, engineering and vocational students; or special letters to specific students (say, top 10 graduates) inviting them to apply (but not yet offering a job) or "meet the	

General Director". F-9 Develop a systematic applicant-screening (testing) program.	
F-10 Review and adoption of the overall framework for technical and managerial training proposed in this report. F-11 Adopt a training management system (planning & monitoring, including records keeping) which provides for an annual program of training activities organized and implemented by PPWSA Training Center. F-12 Establishment of more linkages with other training and development centers in the country and Asia. F-14 Establish a staff library (for information and research) at a central location with hi-speed Internet access as part of the Training Center for use of all staff.	F-13 Intensify trainer training and materials development. Assist Training Center in design and delivery of training programs.

Improvements in the management information system (MIS)

Basis:

The current under implementation of the existing MIS (based on MS Navision Financials) has been discussed and identified. Success in the MIS implementation is crucial to the planned decentralization of operating responsibilities.

The areas to be improved are in utilization of the Asset Management Module, the Human Resources Management Module, the Resources Module (for project management) and the Inventory (and Procurement) Module. A workshop will be implemented in January 2006, together with the company providing software technical services. A detailed plan to bring up-to-speed the implementation of Navision Financials will be jointly formulated. The software needs to be viewed more as software of the entire company – not just the Financial and Accounting Department. There is already high level of integration between the commercial and financial planning operations. The priority at this time is better integration of operation & maintenance data with finance data.

Similarly, with the expansion and actual relocation of the revenue offices now underway, the MIS will have to be enhanced to enable interface of these satellite offices will have to be re-established.

Specific Objective/s:

The specific objective of this module is to enhance PPWSA' ability to share and exchange information across departments on a regular and continuing basis for sound decision making through improved data collection, processing, reporting and dissemination.

Approach:

The implementation of these improvements is proposed to be led and coordinated by the Finance Department, with the urgent attention of all Department Managers and Section Heads.

Activities and tasks to be implemented

Recommended as PPWSA responsibility	Included in this External Assistance Project
G-1 Review and if viable, expand application of existing Navision MIS software – focus on linked applications for the operations department (or replace with new software). G-2 Propose an MIS enhancement plan (addressing the information needs and required reporting formats for the other system)	

4. External support for institutional development

PPWSA has been financing much of the institutional development activities including the needed manpower and other resources and will likely continue to do so, having recognized the benefits.

Many of the institutional development activities proposed in Stage I can be achieved with internal resources. Some external technical and managerial support will be useful to assist PPWSA in implementing those activities it will take the lead on (left column) and to take the lead in implementing the activities recommended for external support (right column).

5. Indicative Budget Requirements

The inclusion of a full-time utility management adviser to provide guidance in management development and inputs from various short-term consultants and experts would be useful.

It is estimated that a budget[1] of about US$ 2.06 M will be needed to support this external assistance project for institutional development during the period 2007-2010. The following is an indicative budget (in US$) for the external support for institutional development.

[1] Budgeting Assumptions Used: Full-time adviser for 48 m-m at $30,000 per man-month, including daily subsistence allowance (DSA); Short term consultants for 4 m-m/year @ $ 25,000/m-m, including DSA.

	2007	2008	2009	2010
Full-time Utility Management Adviser	360,000	360,000	360,000	360,000
Short-term Consultants	100,000	100,000	100,000	100,000
International Travel	25,000	25,000	25,000	25,000
Training activities	10,000	20,000	15,000	10,000
Supplies/Materials	10,000	10,000	10,000	10,000
Equipment	10,000		5,000	10,000
Contingencies	3,000	3,000	3,000	3,000
Annual Total	518,000	518,000	518,000	508,000
				$2,062,000

6. Indicative Time Table for Implementation (<u>External Support only</u>)

		2007				2008				2009				2010			
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Coordination Responsibility for A: Technical Planning Department and Operation & Maintenance Department																	
A-3	Review of existing policies, systems and procedures used (procurement, project planning and monitoring, project supervision, etc.)																
A-5	Agree on overall scope, content and structure of the PPWSA Operation and Maintenance Guidelines.																
A-6	Gather and review all existing O&M documents, Draft/update OMGs.																
A-7	Detailed technical review of the OMG drafts.																
A-8	Design & implement a system for regular internal review, upgrading and formal adoption of the OMG by PPWSA.																
A-10	Introduction of an upgraded asset maintenance management program to integrate a preventive maintenance program for all electro-mechanical assets of PPWSA.																

		2007				2008				2009				2010			
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Coordination Responsibility for B: Corporate Planning Office and the Human Resources Management Section																	
B-2	Facilitate a series of discussion meeting with participation up to section heads and supervisors.																
B-3	Assess and develop the process for due consideration of consumers' views in the planning (through a "consumers forum").																
B-4	Introduce a system for annual review of organization structure and staff competency mix in each of the working groups.																
Coordination Responsibility for C: Commercial Department																	
C-1	Review current PPWSA customer policies and practices.																
C-2	Update customer service standards.																
C-4	Assess, formulate and implement an expanded and continuous public relations program for current and prospective customers.																
Coordination Responsibility for E: Administrative Department																	
E-1	Examine the current inventory planning and control policies and practices in PPWSA.																
E-2	Recommend and implement policy and system management improvements to inventory and property management systems.																
Coordination Responsibility for F: Human Resources Management Section and Training Center																	
F-1	Identify and define practical (more job-specific) staffing indicators to be introduced.																
F-2	Conduct simple observation, work load analysis to propose a reasonable initial staffing criteria or target to apply.																
F-3	Propose a system for regular annual updating of manpower needs based on type of skills and competency needs (not only number of																

		2007				2008				2009				2010			
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
	staff needed).																
F-6	Identify and assess all possible areas of current operations which may be outsourced or provided through service contracts and assess the advantages/benefits.																
F-7	Draft a policy note adopting principles to use in deciding when to outsource: how to outsource, including sample agreements.																
F-13	Intensify trainer training and materials development.																

Supporting Report – 9

Institutional Strengthening of Water Supply Services in Siem Reap

Supporting Report 9.1 Options for Institutional Strengthening of Water Supply Services in Siem Reap

1 Overall Objectives

The key condition to be addressed in Siem Reap is the need to strengthen the management and operation of the existing public water supply service operator in order to receive the nearly completed JICA project. The supervising Ministry (MIME) has signaled its intention to make the operator into an autonomous institution under the Cambodian law of public corporations. The SR staff has recently increased from about 14 (7 permanent + 7 contract workers) to 37. Both new and old staffs need training and the institution as a whole needs help to establish clear policies, procedures and operating systems in line with the requirements for a modern, efficient, self-sustaining water supply company. These are reasonable and achievable objectives for Siem Reap's water supply system.

2 Options for Achieving Objectives

Following are various proposals (some overlapping) that have been discussed among stakeholders:

2.1 Technical Assistance

Implementation Modality: Technical Assistance Agreement between PPWSA & SR

PPWSA could provide, charging only nominal out-of-pocket expenses, ad hoc technical assistance and advisory services in response to SR's emerging needs. PPWSA would send people to train SR staff (twinning and OJT modalities) as well as directly transfer their specific know-how and experience. This can include transfer of operating procedures, manuals, software and so on. SR staff would also come to PPWSA for training and OJT. In some cases, PPWSA's practices may need to be adapted to local circumstances and to the particular operating history (consumer expectations etc.) of SR. In other areas, PPWSA's procedures, manuals, etc. may be directly transferable.

Following are some of the advantages and disadvantages (pros and cons) to this approach:

Pros:

- simple
- flexible
- inexpensive
- preserves/builds on the existing management, they must learn to do by themselves

- highly consistent with sector policy (decentralization, autonomy)

Cons:

- PPWSA cannot control/guarantee outcome
- PPWSA does not have strong incentive; their level of effort is voluntary

2.2 Resident Advisor

Implementation Modality: Technical Assistance Agreement between PPWSA and SR which includes TOR of Advisor, basically similar to a typical consulting services agreement with team leader + specialists etc.

PPWSA to provide a Senior Advisor for some period (say one year full time) to help SR Director General. Advisor would also serve as a window to access/channel PPWSA ad hoc advisory services effectively. Other short-term advisors may be brought from time to time as needed.

Pros:

- Relatively simple, flexible and inexpensive
- Good information flow between PPWSA and SR
- highly consistent with sector policy (decentralization, autonomy)

Cons:

- Although PPWSA will have greater influence than above technical assistance option, still cannot guarantee outcome
- PPWSA incentive is a little stronger in the sense that its reputation is more clearly at stake, but no meaningful penalties or financial risks.

2.3 Service Contract

Implementation Modality: One or more contracts (framework or case by case) between PPWSA and SR.

PPWSA would provide its own staff to perform actual services for SR, either as a pre-defined package, or on an ad hoc, case by case basis as needed. Such services might encompass, for example, contract/project management, design and implementation of NRW Control Program, direct assistance with laying of pipes or conducting specific maintenance activities etc. Instead of making a new contract each time, there could be a framework contract providing pre-agreed terms for types and costs of services offered but with specific quantities and schedules to be determined during implementation.[1] PPWSA could also bring its subcontractors to provide specific kinds of assistance that PPWSA itself is not presently in a position to provide, perhaps recruiting experts from capable utilities of neighboring countries in ASEAN region as well as other specialized consultants.

[1] This type of contract is not uncommon, e.g., USAID Indefinite Quantity Contracts.

An example might be the preliminary preparation of detailed training plans and syllabi.

Pros:

- Flexible
- More Comprehensive

Cons:

- Potentially expensive
- PPWSA cannot guarantee overall SR performance, only outcome of specific tasks

2.4 Management Contract

Implementation Modality: Contract between PPWSA and MIME or SR Board of Directors (if/when established)

Under a Management Contract, the operation of SR would be handed over to PPWSA for a certain period, during which time PPWSA would be required to train the staff and build the institution while gradually handing control back to the permanent management appointed by the new Board of Directors (assuming autonomous institution established). PPWSA would recommend the management structure of the new institution and assist in filling the positions. PPWSA would be responsible for ensuring a smooth exit and handover to local management team.

Pros:

- Comprehensive approach
- PPWSA partially responsible for outcomes

Cons:

- Loss of local control
- Risks to PPWSA – may be difficult for PPWSA to spare enough capable staff to fulfill contractual responsibility without endangering PPWSA's ongoing operations.

2.5 PPWSA Subsidiary

Implementation Modality: PPWSA Board of Directors creates subsidiary; MIME transfers (by executive decision) temporary control of SR to Subsidiary.

The idea is to make a phased transition to autonomy under PPWSA's supervision and monitoring. SR would come under PPWSA's umbrella during a "pre-autonomy" stage and PPWSA would tutor the institution while assuring its performance and compliance with external legal and regulatory requirements. In the process, PPWSA would establish procedures, rules and standards that could be applicable in future to other provincial water service providers, in the process develop some regulatory skills of its own. An "Advisory Board" would be

established to act as a transitional Board of Directors for SR until it could be made fully autonomous. The existing management may be kept in place, but PPWSA would have power to change as needed.

Pros:

- Comprehensive approach
- PPWSA fully committed and accountable for results

Cons:

- Potential loss of local control
- Difficult to guarantee schedule of transition to autonomy
- May take some time to organize first time, but once established becomes highly replicable.

3 Analysis of Options

The options described above are arranged more or less along a continuum of trade-off between local control and external intervention. As one of the more successful water service providers in the ASEAN Region, PPWSA unquestionably has the capacity to operate the SR system effectively. However, there are significant risks associated with over-centralization of what are inherently local services. The *National Policy on Water Supply & Sanitation* (Feb. 2003) appropriately and unambiguously calls for decentralization and financial autonomy of sector utilities.

The first three options (1 to 3) described in the previous section essentially represent increasing levels of technical assistance and service provision to SR on a contractual/ for-hire basis, with all final authority and responsibility remaining with SR. These modalities are most meaningful in the context of autonomy. If SR is not to be granted autonomy, the impact of the contemplated assistance is more likely to be muted. That is because they key ingredient in any successful technical assistance effort is participation, and participation is significantly enhanced by ownership. If the staff of SR really understand and feel the extent of the responsibility on their shoulders, they will respond strongly, they will appreciate the technical assistance, and they will demand that the assistance be useful and relevant to their felt needs and not wasting their time.

The key ingredient in the design of the TA program is that it be based on the proper/accurate analysis of needs and joint agreement on the objectives. The key ingredient for implementation is that it be carried out with a strong spirit of collaboration, good coordination and open communication.

The latter two options (4 and 5) described above represent direct interventions by PPWSA in the operation of the system. In these cases, PPWSA accepts some degree of responsibility for the outcomes, in exchange for which it requires deeper control, or at least the option to exercise deeper control as necessary and needed to ensure the expected results. The major advantage of these options is that they more or less guarantee effective operation of the SR system over the short to medium term, while the SR organization is built up to take over the responsibility

in the future. What is most problematic about these approaches is the matter of the “hand-over”.

If we take the analogy of learning to drive a bus, in the first three (TA-type) options, SR stays in the driver’s seat from the beginning and is coached from behind. Some risk is surely present. In the latter two options, PPWSA takes the driver’s seat while SR watches and learns, then steering wheel is transferred back to them. Risk is reduced, but cost and involvement of PPWSA may be much higher and actual moment of transfer is critical and maybe risky. There is also a natural tendency for the teacher to occupy the driver’s seat for too long, showing off own ability instead of showing how to learn.

These options are not entirely exclusive. All require significant technical assistance inputs. The first three can be effectively accumulated into a Service Framework Agreement with TA and Advisory Services. The latter two, even if not selected at the outset, can be kept as backup options for stronger intervention if the initial efforts by SR’s responsibility prove inadequate.

Attachment 1

Terms of Reference for PPWSA Resident Advisor to Siem Reap Water Supply Authority

The newly autonomous Siem Reap Water Supply Authority (SRWSA) will operate the existing reticulated facilities in Siem Reap, to be transferred from MIME, and will receive major additional facilities constructed under a grant aid project by the Government of Japan, to be transferred from the contractor. The challenge of integrating these facilities combined with the doubling of the staff and the need to generally upgrade the system performance and standards of service, have resulted in a request to the PPWSA for assistance. Among the types of assistance that PPWSA has agreed to provide under this Agreement, a senior Resident Advisor will be dispatched to Siem Reap for a period of one year, renewable in accordance with the wishes of both parties. The Resident Advisor will have among his duties and responsibilities the following:

1. Advise and assist the Director General and the Board of Directors of the SRWSA on all aspects of the policy and management of the enterprise, including operation and maintenance of the facilities, customer services and financial management.

2. In close coordination with the management of the SRWSA, design and manage the implementation of an annual program of institutional strengthening (training, capacity-building etc.) integrated with other institutional strengthening activities (including the proposed second phase of "The Project on Capacity Building of the Water Supply System in Cambodia") to ensure that the institutional strengthening requirements of the SRWSA are being addressed in an efficient, comprehensive and effective manner.

3. Identify other short-term assistance needs and facilitate mobilization of required inputs from PPWSA or other sources, as appropriate. This includes the identification and mobilization of both technical assistance experts, as well as the provision of specific services from PPWSA or other sources for critical tasks that SRWSA is not presently fully prepared to undertake with its own resources, e.g., pipe-laying.

4. Monitor compliance by the Parties to this agreement and raise any concerns or issues requiring their attention.

Attachment 2

Service Contract Agreement

Recognizing that:

1. The Ministry of Industry, Mines and Energy (MIME) has stated its intention to recommend to the Council of Ministers of the Royal Government of Cambodia that the Siem Reap Water Supply System (SRWSS) be declared an autonomous institution under the Law of Public Corporations from _date__.

2. Demand for water services in Siem Reap has been increasing and the staff of the SRWSS has recently doubled in anticipation of the transfer of the completed grant aid project by the Government of Japan.

3. Managing the new staff and facilities under the autonomy framework will present key challenges and opportunities for the SRWSS and stakeholders.

4. The Phnom Penh Water Supply Authority (PPWSA), as the leading water supply utility in the country and one of the best-managed water supply companies in Asia, has expressed a willingness to share its experience and expertise to assist in the development of other water utilities in Cambodia.

5. Both companies have expressed their desire to cooperate and develop further the institutional capacity of SRWSS.

6. This local cooperation may serve as a new and innovative model for institutional strengthening in the water sector, contributing positively to the health and well-being of the public and the economic development of the country.

Both companies, under the guidance and advice of MIME, now enter into an agreement, whereby:

1. PPWSA will:

    a. Provide the services of a Resident Adviser (RA) for a period of 1 year. The initial Terms of Reference of the RA are in Attachment 1. The services (and required expertise) of the RA will be reviewed every year.

    b. Organize and implement on-the-job and formal training to all staff of the SRWSS.

    c. Install appropriate financial planning and control systems, including billing and collection systems.

    d. Install appropriate customer service systems and practices.

    e. Install and introduce appropriate operation and maintenance practices

2. SRWSS will:

    a. Provide adequate office space and supporting services for the RA and other experts who may be assigned to provide assistance.

    b. Provide the RA and other experts access to all facilities and available data.

3. An initial Institutional Strengthening Plan, based on previous analysis and discussion between the Parties, may be found. Other specific areas of technical support may be identified and mutually agreed upon during the course of implementation. The impact and effectiveness of this service contract on SRWSS capacity will be reviewed annually during a joint meeting organized by MIME.

4. This Agreement lays out the fundamental principles and general terms and conditions, as follows:

    a. SRWSS, as an autonomous entity, will continue to bear full management responsibility for its operations. The role of PPWSA is principally to guide and assist in the institutional strengthening of the company.

    b. This Agreement, unless terminated by mutual consent of both parties, shall be in effect for five (5) years from date of signing.

    c. All direct costs incurred by PPWSA for providing the services shall be paid by SRWSS.

Agreed upon this __th day of _____, 2005.

Mr. Ek Sonn Chan General Director, Phnom Penh Water Supply Authority		MIME/Siem Reap Water Supply System

Supporting Report – 10

Note on Private Sector Participation

Supporting Report 10.1 Note on Private Sector Participation

Purpose of this Note

In preparing this Master Plan, the Consultants conducted a rapid and objective review of various urban water services in Asia managed with private sector involvement, highlighting the problems experienced in cities which have made extensive use of private companies. Various recent documents and reports were reviewed. This Note summarizes findings and offers a commentary relevant to the Penom Penh situation.

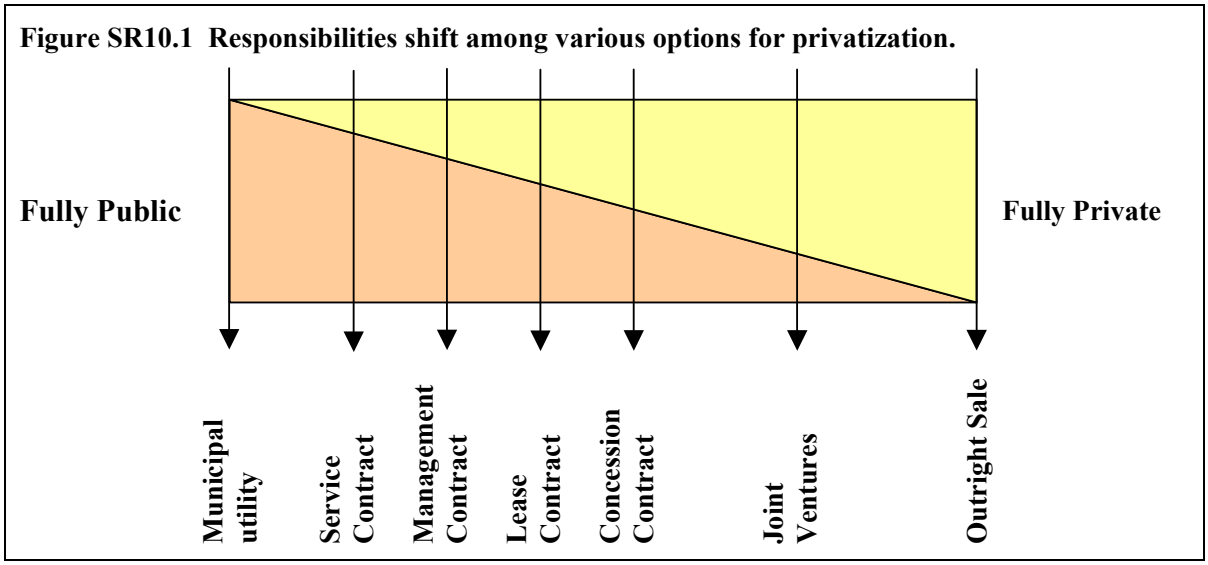
Objectives and Options for Private Sector Participation in water services

It is useful to have a common understanding of some private sector participation (PSP) concepts. The objectives and justification for PSP may include any one or all of the following: a.) improved efficiency and effectiveness; b) access to private funds to finance capital improvements (and O&M); and, c.) conservation of public funds (or reallocation to less viable activities).

There are various risks and benefits to both the public sector and the private sector, including: commercial risks; financial risks; technical risks; and, legal and political risks.

The institutional arrangements for provision of public service can generally be described in terms of: who owns the facilities? (ownership of assets); who is responsible for O&M (or who actually does O&M)?; and who is responsible for service expansion, including financing? The figure below shows how the ownership, management and expansion responsibilities shift from public to private.

Figure SR10.1 Responsibilities shift among various options for privatization.



There is a wide range of institutional options for the delivery of public services. There are options where ownership of the assets remains with the public sector. These include: outsourcing through service contracts, management contracts, lease contracts and concession contracts. However, there are options where ownership is in fact, private (either totally, partially or under gradual transfer from private to public). These include: Build-Operate-Transfer agreements, joint ventures, or outright purchase of assets. There are many other variations of the basic models, in practice.

Table SR10.1 PSP Options (according to asset ownership, responsibility for financing expansion and for asset management)

Option	Ownership	Financing	Management
Service Contract	Public	Public	Public, some Private
Management Contract	Public	Public	Private
Lease Contract	Public	Public	Private
Concession Contract	Public	Private	Private
BOT	Private, then Public	Private	Private
Reverse BOT	Public, then Private	Public	Private
Joint Venture	Private and Public	Private and Public	Private and Public
Sale of Assets	Private	Private	Private

Table SR10.2 Summary of PSP Options (with public ownership of assets).

Options (with public ownership)	Service Contract	Management Contract	Lease Contract	Concession Contract
Financing of investments	Public	Public	Public	Private
Financing of working capital	Public	Public	Private	Private
Relationship with customers	Public	Private	Private	Private
Typical duration of contract (yrs.)	1-2	3-5	5-10	20-30
Private sector responsibility, autonomy, capital needs and financial risk	Low	- - - - - - -	- - - - - - ▶	High

The development of clear regulatory arrangements is very important. The attractiveness of PSP approaches is dependent on whether viable, credible and effective regulatory arrangements can be established. Regulatory arrangements are intended to ensure that the service provider (whether private or public) is effectively and efficiently delivering the service to its customers and at a reasonable price. It also seeks to ensure that the environment is not adversely affected. The regulatory arrangement also aims to ensure that the provider is fairly compensated for the costs incurred to provide the service. Regulatory arrangements are established to benefit both customers (individual households, businesses and the city authorities) and the service provider.

Recent PSP Experiences in Asia

This section covers Asian countries where there has been significant experience of water privatization or significant moves towards it.

Malaysia

Malaysia's water policy include universal servicing, federal funding of capital works, universal metering and user tariffs, and corporatization (and privatization) of state water supply authorities (SWA) operations to the *bumiputra* or Malaysian nationals. By 1996, 57 water treatment plants with a total capacity of 3.8 MCMD had been placed in the hands of the private sector. The major problem in Malaysia's water sector - the high level of non-revenue water (NRW) - has not been addressed.

From the focus on production and treatment BOT projects in the early 1990's, government policy shifted to PSP in the entire system - from source to consumer. In March 2004, the government decided to review all water projects pending its studies and the creation of the National Water Services Commission to oversee the development of water resources in the country. A National Water Policy is due by year-end and will chart the future of the water industry.

Malaysia's policy has attracted much attention due to the unusual extent of involvement of locally-owned private sector companies. Despite generalized claims, this has not so far resulted in a significant amount of independent international activity by Malaysian companies.

The private sector bulk water BOTs have placed a huge financial burden on the water distribution companies which had remained public. These public companies have thus not been able to invest in badly-needed leakage reduction and other programs. Much of its internal revenues were paid to the bulk water suppliers. The government has already re-nationalized the privatized utility in Kelantan, buying it back from Thames Water in 2000.

In Kuala Lumpur, the municipal Selangor Water Supply Department was incorporated as a public enterprise - the Selangor Water Management Corporation Ltd. (or PUAS Bhd.) in March 2002. Three companies have 20-25 year concession agreements to sell treated water to PUAS, at a set price. PUS, in turn, distributes this water to consumers. While the private companies made annual profits (in 2001) from their water businesses that ranged from $10 - $47 M, PUAS faced a deficit of around $100 M. PUAS has argued for a reduction of bulk water priced from the private BOTs. The government is however considering selling PUAS to the bulk water suppliers. Either way, the government is likely to have to bail out the accumulated debts of PUAS.

Through its subsidiaries, Thames Water has operated in Malaysia for the past 30 years. It provides specialist management and operations support to both Johor Water and Timatch Water, who operate water treatment facilities in Sabah. In 1998, Vivendi acquired a 26 percent stake in Intan Utilities, the concessionaire for the potable water production in the state of Perak, Malaysian for FF 144.0 M. It expects to triple Intan's annual turnover of FF 90.0 M by 2008.

By contrast, there is an effective public water utility Perbadanan Bekalan Air Pulau Pinang (PBA), which has the lowest non-revenue water in Malaysia (18%), the lowest water tariffs in Malaysia, and generates a surplus. Similarly, the Penang state government owns a controlling 55% (plus a special share) in the Penang Water Supply Company; other state-related agencies hold 20%; and the remainder held by the public through listed shares in the Kuala Lumpur Stock Exchange, in 2002. The Penang Water Supply Company is an example of successful public-public partnership. Its supply coverage is 100% in urban areas and 99 % in rural areas. NRW is 18% - half the national average of 39% enabling it to offer among the lowest water tariffs in Malaysia. In contrast, Johor and Selangor - states where water supply is privatized have among the highest water tariffs in the country. Instead of a concession, there is a licensing agreement, whereby Penang Water Suppyl Company pays lease charges and an annual charge to the state.

Indonesia

After much debate, the Parliament enacted a new Water Resources Law in February 2004. Three months after the controversial water law was approved, the government is now set to privatize state-run regional water companies and "revive over 300 ailing regional water companies across the country". The World Bank is supporting a US$300 M Water Resources Sector Adjustment Loan. ADB has also been working directly with several regional water municipal companies in Indonesia to prepare a policy framework for PSP. However, while these institutional and policy reforms in the water sector have been slow, the actual privatization of water has been underway in Indonesia, particularly the privatization of municipal waterworks (PDAM), including the Jakarta water system.

Jakarta is already experiencing the effects of a difficult water privatization. In 1998, the Jakarta Water Supply Enterprise (PAM Jaya) entered into 2 separate 25-year concession contracts without the benefit of public bidding with PT Thames Pam Jaya (TPJ) and PT Pam Lyonnaise Jaya (Palyja).

Since February 1998, the two private operators have been responsible for the management, operation, and maintenance of the city's water supply system including the provision of capital investment, billing, and

collection. The concession contracts were negotiated directly (no bidding). Originally the concessionaires were joined by local partners, but after the change in government the Indonesian partners relinquished their shareholdings.

Starting as contractor to build water distribution system for PAM Jaya in 1994, Thames Water and PT Kekar Airindo (a Sigit Group company), established a joint venture - PT Thames PAM Jaya (TPJ) - and obtained the concession to manage water supply for the eastern part of Jakarta in February1998. Thames later bought out Kekar Airindo and currently has full control of the joint venture. On the other hand, Lyonnaise des Eaux (LDE) starting operation in Indonesia in 1997, when it founded a joint venture - PT Lyonnaise PAM Jaya (Palyja) - with its local partner PT Garuda Dipta Semesta (a Salim Group company). Palyja operates water supply for the western part of Jakarta. Government bailed out these companies after the 1997 financial crisis.

In 2003, the ADB reported that "the private operator concessions in Jakarta have not been too successful in investments and efficiency improvements."[i] Seven years into the privatization, consumers complain of poor service and frequent water disruptions, leaving Jakarta citizens with no water for days.[ii] Without any significant improvement in the service, water rates were raised by 30% in January 2004. Water rates have already increased thrice in the past – by 15 percent in February 1998, by 35 percent in April 2001, and by 40 percent in April 2003.

Other Cities.

Medan.

In July 2001, Lyonnaise desEaux signed a contract with Medan (North Sumatra) municipal water company, PDAM Tirtanadi, to build a water treatment plant. LDE operates the plant for 25 years, during which Tirtanadi purchases water from LDE before selling it to customers, then transfer it to Tirtanadi. The joint venture company is PT Tirta Lyonnaise (TL). LDE is obliged to build three water treatment plants with capacity of 100 lps to 200 lps. In September 2002, the Medan city council brought up alleged corruption concerning the contract.

Batam

Biwater/Cascal started operation in Indonesia through its subsidiary PT Adhya Tirta Batam (ATB) in the Batam Industrial Development Authority, Batam Island. ATB is a joint venture of Biwater and its two local partners, Bangun Cipta Kontraktor and Syabata Cemerlang. ATB obtained a 25-year concession to manage water facilities in the island: 7 water treatment plants. In 1999-2000, ATB built water treatment plants for Riau (and Pekanbaru).

Yogyakarta

July 2003, Yogyakarta governor signed an MoU with a Swiss-based subsidiary of Amywater - owned by Saudi Khalif Khaled A Kordi. Amywater would built and manage the pipe network in the districts of Sleman and Bantul, and the City of Yogyakarta through a DBOT (design-build-operate-transfer) scheme, investing US$ 25.0 M.

Surabaya

The Australian water technology provider, Aquatec-Maxcon Pty Ltd, started operation in Indonesia in 1992 when it built sewerage and water treatment plant for PT Freeport Indonesia. Currently, it has a subsidiary in Indonesia, PT Aquatec-Maxcon Indonesia, in which it holds 80 % of the shares. The company built potable water treatment in Surabaya.

Ambon

Starting with twinning with Ambon PDAM in 1993, Waterleiding Matscappij Drenthe (WMD) and the PDAM decided to establish DreAm Sukses Airindo (DSA), a joint venture, with WMD holding the controlling share. Four years later, DSA acquired a full concession and projected to cover 80 % of the city's population in 15 to 20 years.

Manado and Ternate

In 2002,WMD signed a MOU on partnership with PDAM Ternate (North Maluku) to establish a joint venture, Indowater, in which it would hold a controlling share. WMD is ready to sign a similar partnership with PDAM Manado and to establish an office in the North Sulawesi.

Jatiluhur Lake and River Basin Authority

South Australian Water Corporation, a water supply company of the South Australian government signed an MoU with Jatiluhur management body, PO Jatiluhur, October 2004. The MoU opens the door to partnership in 4 aspects: legal/regulatory, institutional, engineering and finance. PO Jatiluhur is the authority managing the lake and the river basin of Jatiluhur, which covers ten districts in West Java: Bekasi, Karawang, Purwakarta, Subang, Indramayu, Garut, Sumedang, Bogor, Cianjur and Bandung. Water services in these towns and cities are provided by their respective PDAMs, most of which are being offered for private investment.

The debate continues within local governments and communities on the need for privatization. The plan to privatize PDAM Bandung, West Java, has not progressed smoothly because not all stakeholders agree with the privatization plan. PDAM Bandung itself rejected the plan since it claimed that it would be the other partner company that would get more benefits. The provincial government, on the other hand, wanted to take control of the management of basic water resources which it viewed as a marketable commodity.

Tangerang

PT Bintang Hytien Jaya (BHJ) was contracted to build a water treatment plant and to manage water supply for about 3,000 families in Ciledug, Tangerang, West Java, under a 25-year concession. PDAM Tangerang is to receive 5% royalty from the private company after six years of operation.

Overall, it would seem that many sectors, particularly NGOs, consumer groups, labor unions and farmers' associations in Indonesia, oppose water privatisation because of concerns over price increases which will in effect reduce poor people's access to clean water and sanitation. In addition, the multinational companies which control 70% of the global water business - Suez-Lyonaisse and Vivendi - have been accused of anti-competitive practices. In fact, Suez-Lyonaisse has been accused of bribery and corruption.

Philippines

The Philippines is among the first countries in the region to consider private sector participation in its water sector. The first privatization of a waterworks utility in Asia was in the Subic Freeport in 1996, a year earlier than the privatization of the Metro Manila system in 1997. Two BOT laws in the early 90's aimed to enhance private sector participation in basic infrastructure, mainly power generation, but including water services. The 1995 Water Crisis Act was enacted by Congress to facilitate PSP in the water sector.

The privatization of Manila's Metropolitan Waterworks and Sewerage System (MWSS) in 1997 was the biggest privatization of a water utility in the world. MetroManila was divided into a west and an east zone. Two concessions contracts were bidded out.

Maynilad Water Services, Inc. (MWSI) and Manila Water Company (MWC) won the east and west zone, respectively. MWSI is a joint venture among Suez and local partners, Benpres. Manila Water is a consortium of local Ayala corporation with United Utilities, Bechtel, and Mitsubishi Corporation. The private operators promised to provide 24-hour water service and universal connection; reduce system losses, plug leaks and maintain the pipe network; and bring in some US$7.5b in new investments. The 25-year concession contracts with the two operators did not provide for any government guarantees. Formulas for tariff adjustments due to foreign currency adjustments, inflations, were. Operators were required to pay an annual concession fee to MWSS (from which debt service obligations would be paid). A capital investment plan was also required of the concessionaires.

Citing financial losses, Maynilad – since March 2001 -- stopped paying monthly concession fees to the government; the arrears is now nearly PhP 8.0 B. Maynilad's non-payment of the concession fees forced the MWSS to incur more debts which continue to accumulate and totalled US$240m by end-2003. In December 2002, when Maynilad failed to win approval for tariff increases it sought – it decided to preterminate its 25-year concession. Maynilad alleged that government failed to comply with the terms of

the concession agreement; the case went into international arbitration. While the case was pending, the government sought to resolve the impasse through various means, including a controversial debt-to-equity swap in March 2004. A strong public outcry forced government to cancel the deal.

A new rehabilitation plan is now being worked out, with similar bail-out terms for Maynilad. Benpres, the local partner will relinquish its 60% control in Maynilad, but will walk away debt-free. Suez will reduce by half its shareholding in Maynilad, to 20%. Maynilad, which is bankrupt, is hurting not just Suez' balance sheets but also its reputation as a technical operator. After all, Suez was expected to bring to bear its considerable international experience in water management to cut manila's massive water losses.

However, the "success" story of Manila's privatization is found in the east zone. Manila Water has been doing a much better job in meeting its obligations under the concession agreement, particularly, the expansion plan and customer service. Manila Water has since listed publicly in the Manila Stock Exchange.

As early as 1994, WB-funded studies identified local water districts viable for pilot privatization, including those in the key urban centers of Davao, Cagayan de Oro, Zamboanga, Metro Cebu, etc. An earlier study proposed that the country's water districts be classified into "credit-worthy" institutions that could then be offered for investment by the private sector. These public water districts were already operating on a full cost recovery basis and were reasonably well-managed. Their main concern was its lack of access to adequate capital to finance its expansion plans. Available sector grants and subsidies were directed more for rural water and sanitation. Many unsolicited proposals from private investors have been received by the water districts who have themselves turned down the proposals due to various unacceptable provisions and conditions. Solicited proposals (which generally have clearer provisions and conditions), have been rejected because of tariff implications. No major BOT proposal for public water supply has yet been approved to date.

- In Cebu City, an unsolicited take-or-pay bulk water supply project proposed by an Ayala-led consortium is now in final stages of project approval. The water district union has, however, opposed theP1.8-B BOO project, citing some unacceptable terms of the contract.
- In Baguio City, attempts to bid out a US$ 70.0 M bulk water supply project to the private sector have already twice failed twice. In August 2004, losing bidder Benguet Corporation filed a formal protest challenging grounds for its disqualification. The company wanted to convert its idle open mining pit into a large water reservoir to supply drinking water to residents of Baguio City. Benguet Corp., a giant mining company, has moved into the water development business, with business interests in Bukidnon, Subic Water District, Metro Roxas Water District, San Pedro (Laguna) Water District, Masinloc (Zambales), among others.
- Vivendi Water Philippines has a 25- year build-operate- transfer proposal to operate and develop the water systems in Roxas City, Capiz,. This has been put on hold by the Regional Development Council indicating that Vivendi's proposal was not clear in the way the outstanding loans of the Metro Roxas Water District would be assumed by Vivendi.

Various WB, ADB, Japan and other donor funds had been released to assist LGU-managed water utilities to operate on commercial basis in secondary towns and cities in the Philippines. In 2006, the Japan Bank for International Cooperation (JBIC), with USAID, will set up a 10- B yen (US$ 90 M) public-private fund for maintenance of water supply and sewerage in the Philippines.[iii] The fund will be the first in Asia and will leverage finances and credit guarantees from Japanese and American financial institutions for the inflow of private funds to water supply and sewerage business.

Thailand

Thailand's water system is managed by two bodies -- the Metropolitan Waterworks Authority (MWA) for tap water in Bangkok and vicinity, and the Provincial Waterworks Authority (PWA) for tap water in 73

provinces. Due to the 1997 Asian financial crisis, Thailand committed to an IMF- led bailout program (with WB and ADB) which promoted privatizing state-owned enterprises, including MWA and PWA.

The MWA operates one of the world's largest waterworks operations. According to ADB, MWA has addressed the two key issues of water utilities in Asia, namely governance and tariffs, and as a consequence "it provides good service to the people in its service area".[iv] With its sizeable operation, high gross-profit margins and relatively small debt, the Bt 100.0 B tap water monopoly was expected to enjoy a successful privatization.[v]

In June 1998, Thailand had taken the first step towards the nationwide privatization of water services with the approval of a "corporatization" plan for MWA and PWA.[vi] With World Bank funding, the finance ministry in December 2000 to draft a national master plan that has three main components: privatization of the MWA, PWA and the wastewater management organization; establishing an independent regulatory framework; and setting up a water-tariff structure.[vii]

In the end, the government instead decided to offer shares of MWA as a company to the public through the stock exchange, but with the government holding a majority of those shares. Since late 2002, however, several attempts to list MWA and PWA, and other SOE's, have been resisted by the workers.

Thames Water has worked in Thailand for over 10 years. In 1995, the company was awarded the country's first privately financed water supply scheme. The aim of the project was to secure a reliable, safe and affordable supply of water for the rapidly expanding Pathum Thani and Rangsit industrial districts to the north of Bangkok. Subsidiary Thames Water Projects, designed the new 288 M LPD facility. Construction was done in partnership with a local company, but Thames Water now operates the plant.

Viet Nam

The Quang Ninh Water Supply Company (in Quang Ninh Province) chose Saur to rehabilitate and extend the drinking water network for Halong City and Campha. Its turnover for 2000 was about 3.96 M euros. The network serves the cities of Halong, Campha and the districts of Viet Hing and Hoang Bo. The company intends to raise the population served to 60% with 110 lpcd.

In July 2001, a Suez Lyonniase subsidiary, Lyonnaise Vietnam Water Company (LVWC), was given the contract to construct and operate a treatment plant with a daily capacity of 300,000 cubic meters under a 25-year BOT contract in Ho Chi Minh City.

The LVWC is a private company. Suez owns 70 percent; Tractebel of Belgium owns 20 percent and Pilecon Engineering Berhad of Malaysia owns 10 percent of LVWC. The ADB views this project as encouraging step towards promoting private sector participation in the country.

Singapore

Singapore's water and sewerage services are run by the state-owned Public Utilities Board, widely regarded as a model of efficiency. The main challenge facing the PUB is the lack of water resources, which is being addressed through demand management, renegotiating water supply agreements with Malaysia, supplying industrial users with treated used water (NEWater), desalination and other measures. A BOT has been signed with a Singaporean contractor for a desalination plant due to start operating in 2005: this is also expected to boost the export capacity of the contractor.

The PUB also owns an international consultancy, contracting and operating subsidiary, Singapore Utilities International Pte Ltd (SUI). SUI has a 20% stake in a joint venture which won a 30-year BOT concession for a wastewater treatment plant for a chemical industry zone in Nanjing, China.[viii]

Japan

The government has, in recent years, adopted policies to facilitate private operation of public services. These include a law promoting Public Finance Initiatives (PFI), a new Water Act in 2002 which enabled delegation of water services management, and new laws enabling local governments to outsource municipal services more generally. The Development Bank of Japan (DBJ) launched a new financing mechanism in 2003 to provide low interest funds for private companies to invest in acquiring and running municipal assets. The DBJ itself prepared to become an equity investor holding a stake of up to 50%.

In October 2003, the DBJ made a specific proposal to Zentsuji city (pop 36,000) for a feasibility study. Zentsuji faces problems of a deteriorating pipe network, together with a municipal shortage of finance – in common with many municipalities in Japan (and elsewhere). The city is considering the plan. In practice, municipalities have been slow to respond to the various pressures for more privatization. Opposition by the unions reinforces this reluctance.

Thames Water is working in partnership with Mitsui & Co Ltd, a trading company to develop long-term relationships with local water and wastewater authorities in Japan. The company also works with the local authorities on operational and maintenance projects, including in non-revenue water projects.

Japan has some of the most efficient water utilities in the world. In the ADB's survey of water in Asian cities, the city of Osaka was described as providing "an excellent water service", and its level of non-revenue water, at 7%, is outstandingly low, by international standards.

South Korea

Ondeo Services has entered into a BOT contract with Yangju County for construction and management of wastewater facilities. The 24-year contract requires an investment of nearly $71 M, with a turnover potential of $178 M over the agreement period. The plants will have a total daily sewage treatment capacity of 75,000 m^3 and a collection network of about 85 km. Vivendi Water has partnered with Hyundai Construction and Samsung Engineering, to construct three new wastewater treatment facilities and manage the existing ones, in Chilgok State and Inchon city respectively. Vivendi will invest about $26.7 M and expects to reach an annual turnover of $17.8 M annually over a 20-year-period.

China

As China opens its doors with more favorable governmental policies to encourage investment, the world's largest and most capable water firms are flooding into China's US$120 B market for water and sewage treatment services projects. China has set an ambitious target of treating 45% of urban waste water and recycling 60 % of industrial waste water by 2005. To achieve this goal, China would need 10,000 new sewage treatment plants.

As part of efforts to lure foreign technology, management expertise and capital, the central government opened the utilities sector further, allowing overseas investors into water, gas and heat supply as well as public transport and sewage and refuse treatment. To speed up investment, the State Council has empowered local governments to grant franchises. This has led to a large number of awards for waste water treatment contracts and water concession contracts, which involve the supply of drinking water, billing and construction of pipelines.

The sector has drawn interest from Veolia Environment and Suez of France as well as Singapore's SembCorp Industries. Also entering the industry are companies, such as Hong Kong-listed NWS Holdings and China Everbright International, as well as, Shanghai Industrial Holdings and Tianjin Capital Environmental Protection. Thames Water has operated in the People's Republic of China since 1989 and has been operating in Hong Kong for decades. In 1995, the company won the contract for China's first privately funded water treatment project in Da Chang, Shanghai. Starting in 1996, construction of the major wa-

ter treatment works for the city was completed in 1998. That year, Thames Water took charge of running the new plant. In July 2002, Thames Water acquired the largest single shareholding in the China Water Company, which has 4.0 M customers in China The purchase made Thames Water the second largest foreign private water company in China with 6.5 million customers. Thames Water's involvement in Hong Kong includes the building of a major water treatment plant for the new International Airport. The company has also signed a memorandum of understanding with the Ministry of Water Resources in Beijing to do integrated water resource management activities across China.

Vivendi secured in March 2001 a US $ 20 million, 20-year contract to operate and renovate a water plant in Tianjin, China. In 2002, both Suez and Vivendi signed long-term deals, some for up to 50 years, to manage municipal water systems in China. In March 2002, ONDEO, Suez's water division, was given a 50- year contract worth 600 M euros to design, finance, and manage water treatment installations and services for the Shanghai Industrial Park's industrial wastes.

Vivendi's Generale des Eaux and Marubeni Waterworks Company Limited are involved in bulk water schemes in Chengdu, China, with 'take or pay' provisions to guarantee revenues. The European Investment Bank loaned US$ 26.5 million and the ADB lent US $ 48 million towards financing the projects.

Saur has been operating a drinking water production plant in Harbin, China (225,000 MCMD) since 1995 serving 2.8 M people. The BOT project is a partnership between Saur and the Harbin Water Company. The contract term is 28 years. Turnover in 2000 is estimated at 5.49 M euros.

Since January 2001, SFSW (Shanghai Fengxian Saur Water), a Saur subsidiary, has been operating the Shanghai Fengxian drinking water plant which serves 700,000 inhabitants (south-west district of Shanghai). The contract will last for 28 years.

Shenzhen Water Group has signed an agreement with France-based Veolia Water, to transfer its 45% of the French company to Veolia. In exchange, Veolia Water will inject US $390 M in capital into the group. With net assets of about US $722.89 M, Shenzhen Water Group has five water plants and four wastewater treatment plants, and a daily water supply capacity of 1.67 M tons and a wastewater disposal capacity of 1.08 M tons. The deal is the largest property right purchase involving foreign investment in China this year as well as the largest water project purchase ever in China. The partnership will last 30 years. Veolia Water will be involved not only in water supply but also in a wastewater treatment system covering the whole city, the first system of this scale in China. The city aims to be treating 80 percent of its wastewater by 2005 and 90 percent by 2009; it aims at providing directly drinkable tap water by 2010.

Veolia Water has successfully won bids for eight other water projects in China with a total investment of 600 M euros (US $744 M).

NWS Holdings, the infrastructure flagship unit of New World Development, is in talks to invest in 10 mainland water-treatment projects as part of its efforts to capitalize on the fast-growing mainland China water sector. The projects include building water treatment plants and pipelines, and supplying drinking water in the Yangtze River delta area and Fujian and Liaoning provinces. Each project involves a separate investment of about 150 M yuan.

InterChina Holdings Co Ltd intends to invest about US$ 24.16 M in a water treatment plant in Xianyang city, Shaanxi Province. It plans to set up a wholly-owned company specifically for the project with registered capital of US$ 7.25 M. The plant should be completed within two years and is expected to have a maximum capacity of 300,000 tons of water a day. Xianyang city government has committed to taking

60-80 % of the plant's projected water capacity for the first three years immediately after operations commence.

Brite-Tech Berhad signed a memorandum of understanding with the government of Xin Yi city in China's southern province of Guangdong to consider investment in utility firm Guangdong Xin Yi Kai Yuen Co Ltd and study the feasibility of a proposed sewerage treatment plant.

Vivendi won a BOT concession for a water supply project in Chengdu (China) last year which provided for a 'take-or-pay off-take agreement' - a 20 year obligation by the public authority to buy a fixed volume of water from the company, whether it was needed or not.

Bangladesh

Bangladesh has been under considerable pressure to introduce water privatization, but this has so far been largely resisted. In Dhaka, as an alternative, the trade union offered to take over part of the city to show what could be done.

The Dhaka Water and Sanitation Authority (DWASA) was created in 1963 as a public sector utility to provide water supply, sewerage and drainage services of the capital. By the 1990s DWASA had gone financially and operationally inefficient, with high system losses. The World Bank (IDA) proposed a new loan, conditional on institutional reform, a privatization study and a privatization of revenue billing, collection and other activities. The union countered with a proposal to test the supposed virtues of privatization. The IDA, DWASA, government representatives and trade unions agreed to test one revenue zone under the private sector and another under the employees' cooperative, for a period of one year.

In the employees' cooperative (EC) area, revenue increased substantially, "unaccounted-for-water" was reduced; and consumer satisfaction also went up. The EC result was better than both DWASA and the private contractors. The EC's success was based on performance-based incentives and the use of field experience and knowledge of the workforce through participative decision making. The private company did not do as well, due to lack of previous experience, a top heavy management and a failure to draw on grass roots knowledge. DWASA's other zones continued to fail because of bureaucracy, poor pay, corruption and inefficiency. The ADB report acknowledges that: "Part of the distribution, billing, and collection has been outsourced to the union, whose members were rewarded based on revenue gained. This has been relatively successful, but is limited to operations in high-income areas."

India

New Delhi's water supply is being privatized to Vivendi. In 2000, Vivendi also secured a US $ 7.2 M drinking water management in the State of Calcutta, according to the Global Water Report. Degremont, a subsidiary of Suez is undertaking a design build and operate drinking water production in Sonia Vihar, New Delhi. The contract is worth Euro 50 million. The plant is expected to provide water services to a population of 3 million people in New Delhi. The water for the Suez-Degremont plant in Delhi will come from Tehri Dam. Vivendi Water, was given the contract to manage the water services in Chennai, a major port city in southern India

Nepal

The Nepal Water Supply Corporation (NWSC) is a government corporation set up in 1990 to provide water supply and sewerage services for Kathmandu and 11 other towns. In 1997, the Government decided to privatize management of the water supply in the Kathmandu Valley under a lease contract. In 1998, a National Water Supply and Sanitation Sector Policy was enacted promoting PSP for services in Kathmandu Valley towns. Similarly, the Kathmandu Valley Water Supply and Sanitation Strategy was drafted which includes full cost recovery for urban water supplies and integration of sanitation with water supply. A regulatory commission is being organized prior to the introduction of PSP. In 1997, the World Bank

agreed to provide financial support to the PSP process but pulled out in mid-2002 after two unsuccessful attempts to pre-qualify contractors for a 10-year management lease contract ended with only one pre-qualified bidder each time. ADB then requested that joint ventures of water utilities from developed countries and international consultants with experience in developing countries be allowed to bid.

ADB is now helping prepare a 5-year management contract as part of the US$464 M Melamchi Water Supply Project, approved in December 2000 with co-financing from JBIC and other donors. Due for completion in September 2006, the Melamchi project involves the construction of a 26-kilometer tunnel primarily to divert 170 M liters of water daily from the Melamchi River. The NWSC would gradually escalate the current price of water at least five times more in Kathmandu to support operation and maintenance requirements. NGOs and local communities however continue to oppose the Melamchi project on issues ranging from water tariffs to increased national debt at the expense of cheaper and more local options. This includes addressing leakages and non-revenue water estimated at 40-70%.

Sri Lanka

For some time now, Greater Colombo has been eyed by financial institutions and contractors as a "prime candidate to lead South Asia into PSP in water supplies." The National Policy on Private Sector Participation in Water Supply and Sanitation was approved in 2001. In 1993, ADB formulated a national water sector profile and reform action plan for Sri Lanka. A 2001 loan supported the drafting of a new water policy. With World Bank support, the government identified in 2001 several urban water supply schemes for PSP in Greater Negambo and the Kalutara to Galle Coastal Strip as pilot projects for immediate implementation. The lease-concession hybrid model was developed; a capital investment fund and an operational investment fund are proposed to cushion the effect of higher tariffs. In December 2003, a coalition of NGOs and trade unions challenged in the Supreme Court a controversial Water Services Reform Bill introduced in parliament saying it will deprive the poor of access to freshwater. The Supreme Court effectively blocked the bill, saying that its provisions came under the 13th amendment and therefore must be approved by all provincial councils.

Cambodia

The DPWS (Dept of Potable Water Supply) of MIME has jurisdiction over all water supplies in provincial cities, including licensing of private water suppliers. They also control small-scale WS businesses which distribute water from rivers and ponds (not controlled by MIME).

From previous survey of provincial water services, there are water supply services in 18 of the 23 provincial capitals (excluding Phnom Penh). In addition, there are existing distribution networks in additional 2 cities (non-capital). These 20 systems are managed through the Provincial Water Supply Unit of the Provincial DIME or by private investors.

Relevant to this Master Plan, MIME has currently several live contracts with small private service providers in Kandal Province. One contract (#5 below) is inside the study area; the other (#4) is immediately adjacent to the study area.

	Name	PSP form	License	Issued	Status
1	Banteay Mean Chey	BOT	30	10-6-97	Operating
2	Kampong Spueu	BOT	23	3-10-97	Operating
3	Kampong Spueu (Odingk)			21-3-00	Operating
4	Kandal (Kien Svay)	BO		5-6-98	Operating
5	Kandal (Prek Pnov, Ponnear Lear)	BO		23-9-04	Operating
6	Takaev	BOT	40	21-11-97	Operating
7	Poi Pet			16-6-00	
8	Srae Ambel		30	13-12-00	
9	Barray (Kampong Thum)			20-2-01	

In Phnom Penh, the ADB has cited Phnom Penh Water Supply Authority (PPWSA) as "one of the better run utilities in the Asian region". It has improved performance since the early 1990s, in terms of extension of connections, financial efficiency, ending of corrupt practices and control of non-revenue water. All connections have been metered, and revenue has risen from covering half of the costs to covering total costs; the public participate in reporting leaks. PPWSA has been cited in several studies and reports as a model for how public enterprises should be managed. It has been cited as evidence that privatization is not necessary to achieve dramatic improvement.

Closing commentary

By the end of 2000, at least 93 countries had partially privatized water or wastewater services or were in the process of doing so. Privatization appeared in all regions of the world. They included local, provincial, or national governments in North America's three countries, 23 countries in Latin America and the Caribbean, 20 in Europe, 30 in Africa and the Middle East, and 17 in Asia. Private water companies now serve vast numbers of consumers. The two largest companies, Suez and Vivendi, each provide water and/or wastewater services to 110.0 M people.

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

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

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

In Phnom Penh, the outsourcing and management contract options, mostly to the local private sector businesses, are most promising. This will enable PPWSA to concentrate on its core business. At this point in its development, it is difficult to make a case for opening PPWSA for concessions and higher forms of PSP. Conditions do not seem to exist warranting such responses. The higher forms of PSP (concessions and BOT) may, in fact, be an impediment to achieving economic development objectives. This occurs when:

- Consumers are charged excessively in correspondence of deteriorating quality;
- Commercial considerations distort development priorities, such as service coverage to low-income urban areas;
- Guarantees offered by governments and local authorities to water multinationals reintroduce debt-like obligations;
- Multinationals' strategy subordinate investment in local water systems to cross-subsidizing speculations in other countries and sectors.

Some of the reports have in fact cited that cities such as Phnom Penh, run by effective public sector water operators, can clearly provide lessons for other water undertakings in Asia.

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

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

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[i] *"Asian Water Supplies – Reaching the Urban Poor", By Arthur C. Mcintosh, Asian Development Bank and International Water Association, August 2003, p. 148.*
http://www.adb.org/Documents/Books/Asian_Water_Supplies/asian_water_supplies.pdf

[ii] The City Water Regulatory Body said that 17 percent of the 30 percent hike would be used to pay off PAM Jaya's Rp 900 B (US$106 M) debt to the international operators, a cumulative result of the difference between the water rate paid by customers and the water charges that PAM Jaya pays TPJ and Palyja. In: *The Jakarta Post,* August 30, 2004, "Customers kept in dark about water disruptions"
http://www.thejakartapost.com/detailcity.asp?fileid=20040830.G01&irec=0

[iii] *Masakado Ishizawa, Nikkei Shinbun, "JBIC's new fund for water supply and sanitation projects in the Philippines, the first case in Asia", Oct 12, 2004*

[iv] In 2001, it had an annual turnover of about $281 M and a net income after all expenses (including debt servicing) of about $62 M. The number of MWA staff per 1,000 connections is a "relatively efficient" 3.6. NRW throughout the MWA service area is about 37% of production. In: "Asian Water Supplies – Reaching the Urban Poor", by Arthur C. McIntosh. Asian Development Bank and International Water Association, August 2003.
http://www.adb.org/Documents/Books/Asian_Water_Supplies/asian_water_supplies.pdf

[v] Water utilities are seen as offering lucrative returns on investments. In 2000, the total value of the Thai water industry was estimated at Bt100 B; there are 100 water supply system projects nationwide, of which between 20 and 30 projects are very large, requiring investment of more than Bt3 B.. In Nareerat Wiriyapong, *The Nation (Thailand),* "East Water waiting for privatization plan", April 17, 2000; Pichaya Changsorn, *The Nation (Thailand)*, "MWA plans to privatize, list on SET", November 6, 2000

[vi] FT Energy Newsletters - Global Water Report*, "First steps toward privatization", 26 June 1998*

[vii] *Watcharapong Thongrung,* The Nation (Thailand)*, "Privatization of water sector set for February", December 21, 2000*

[viii] *Singapore PUB Annual Report 2003 http://www.pub.gov.sg/downloads/pdf/03Pg28-30.pdf*

Supporting Report – 11

Engineer's Cost Estimates

Supporting Report 11.1 Unit Price for Civil Work

	Items	Specification	unit	Unit Cost (US$) Direct Cost	Unit Cost (US$) Direct+Indirect	Foreign Portion Ratio	Foreign Portion Unit Cost (US$)	Local Portion Ratio	Local Portion Unit Cost (US$)	Reference
<Civil/Architecture>										
1	Excavation		m^3	1	1.3	15%	0.20	85%	1.11	Overhead is estimated 20% for foreign portion. 100/120=0.83, say 85%
2	Surplus Soil Transport		m^3	3.5	4.6	15%	0.69	85%	3.91	Ditto
3	Backfilling	BAH	m^3	4	5.2	15%	0.78	85%	4.42	Ditto
4	Backfilling	Bulldozer	m^3	2	2.6	15%	0.39	85%	2.21	Ditto
5	Pile Driving Work	400 x 400	m	50	65	15%	9.75	85%	55.25	Ditto
6	Pile Driving Work	300 x 300	m	30	39	15%	5.85	85%	33.15	Ditto
7	Pile Head Treatment	400 x 400	pc	15	19.5	15%	2.93	85%	16.58	Ditto
8	Pile Head Treatment	300 x 300	pc	9	11.7	15%	1.76	85%	9.95	Ditto
9	Gravel	Less than Diaz 40mm	m^3	35	45.5	15%	6.83	85%	38.58	Ditto
10	Reinforced Concrete	Pump	m^3	80	104	15%	15.60	85%	88.40	Ditto
11	Plain Concrete	Manpower	m^3	75	97.5	15%	14.63	85%	82.88	Ditto
12	Formwork		m^2	15	19.5	50%	9.75	50%	9.75	Material is imported FC: 50%, LC: 50%
13	Rebar Fabrication and Assembly		t	800	1040	80%	832.00	20%	208.00	Material is imported FC: 80%, LC: 20%
14	Sheet Pile Driving Work	Type III	m	12	15.6	15%	2.34	85%	13.26	Overhead is estimated 20% for foreign portion. 100/120=0.83, say 85%
15	Sheet Pile	Type III	t	900	1170	90%	1053.00	10%	117.00	Local portion for transportation is estimated 10%.
16	Support Installation Works		t	60	78	15%	11.70	85%	66.30	Overhead is estimated 20% for foreign portion. 100/120=0.83 say 85%
17	Support Removal Works		t	35	45.5	15%	6.83	85%	38.58	Ditto
18	H Section Steel		t	800	1040	90%	936.00	10%	104.00	Local portion for transportation is estimated 10%.
19	Building	For Administration Building etc.	m^2	600	780	25%	195.00	75%	585.00	Foreign portion for Materials are estimated 10%. Overhead is estimated 20% for foreign portion. 85%×(1-0.1)=76.5% say 75%
20	Building	For Storage	m^2	450	585	25%	146.25	75%	438.75	Ditto
<Pipe>										
1	Pavement Cutting Work	Less than 20cm	m	0.3	0.4	15%	0.10	85%	0.30	Overhead is estimated 20% for foreign portion. 100/120=0.83 say 85%
2	Pavement Break Work	Less than 10cm	m^3	1.5	2	15%	0.30	85%	1.70	Ditto
3	Excavation for Pipe Works		m^3	4	5.2	15%	0.78	85%	4.42	Ditto
4	Sand Backfilling	Sand	m^3	11	14.3	15%	2.15	85%	12.16	Ditto
4-1	Backfilling		m^3	7	9.1	15%	1.37	85%	7.74	Ditto
5	Asphalt Piece Disposal		m^3	3.5	4.6	15%	0.69	85%	3.91	Ditto
6	Subbase Course	t = 200mm	m^2	7	9.1	15%	1.37	85%	7.74	Ditto
7	Pavement Work	t = 70mm	m^2	14	18.2	15%	2.73	85%	15.47	Ditto
8	Timber Retaining Wall	H=1.5m	m	18	23.4	15%	3.51	85%	19.89	Ditto
9	Timber Retaining Wall	H=2.0m	m	20	26	15%	3.90	85%	22.10	Ditto
10	Timber Retaining Wall	H=2.5m	m	22	28.6	15%	4.29	85%	24.31	Ditto
11	HDPE Pipe	Dia 63	m	3.5	4.6	90%	4.14	10%	0.46	Local portion for transportation is estimated 10%.
12	HDPE Pipe	Dia 90	m	7	9.1	90%	8.19	10%	0.91	Ditto
13	HDPE Pipe	Dia 110	m	11	14.3	90%	12.87	10%	1.43	Ditto
14	HDPE Pipe	Dia 150	m	20	26	90%	23.40	10%	2.60	Ditto
15	HDPE Pipe	Dia 160	m	22	28.6	90%	25.74	10%	2.86	Ditto
16	HDPE Pipe	Dia 200	m	35	45.5	90%	40.95	10%	4.55	Ditto
17	HDPE Pipe	Dia 225	m	45	58.5	90%	52.65	10%	5.85	Ditto
18	Ductile Cast Iron Pipe	Dia 250	m	75	97.5	90%	87.75	10%	9.75	Ditto
19	Ductile Cast Iron Pipe	Dia 300	m	100	130	90%	117.00	10%	13.00	Ditto
20	Ductile Cast Iron Pipe	Dia 350	m	115	149.5	90%	134.55	10%	14.95	Ditto
21	Ductile Cast Iron Pipe	Dia 400	m	140	182	90%	163.80	10%	18.20	Ditto
22	Ductile Cast Iron Pipe	Dia 450	m	170	221	90%	198.90	10%	22.10	Ditto
23	Ductile Cast Iron Pipe	Dia 500	m	200	260	90%	234.00	10%	26.00	Ditto

Supporting Report 11.1 Unit Price for Civil Work

	Items	Specification	unit	Unit Cost (US$)		Foreign Portion		Local Portion		Reference
				Direct Cost	Direct+Indirect	Ratio	Unit Cost (US$)	Ratio	Unit Cost (US$)	
24	Ductile Cast Iron Pipe	Dia 600	m	260	338	90%	304.20	10%	33.80	Ditto
25	Ductile Cast Iron Pipe	Dia 700	m	320	416	90%	374.40	10%	41.60	Ditto
26	Ductile Cast Iron Pipe	Dia 800	m	400	520	90%	468.00	10%	52.00	Ditto
27	Ductile Cast Iron Pipe	Dia 900	m	490	637	90%	573.30	10%	63.70	Ditto
28	Ductile Cast Iron Pipe	Dia 1000	m	600	780	90%	702.00	10%	78.00	Ditto
29	Ductile Cast Iron Pipe	Dia 1100	m	700	910	90%	819.00	10%	91.00	Ditto
30	Ductile Cast Iron Pipe	Dia 1200	m	800	1040	90%	936.00	10%	104.00	Ditto
36	HDPE Pipe Laying Work	Dia 60	m	0.4	0.5	15%	0.08	85%	0.43	Overhead is estimated 20% for foreign portion. 100/120=0.83 say 85%
37	HDPE Pipe Laying Work	Dia 100	m	0.5	0.7	15%	0.11	85%	0.60	Ditto
38	HDPE Pipe Laying Work	Dia 110	m	0.5	0.7	15%	0.11	85%	0.60	Ditto
39	HDPE Pipe Laying Work	Dia 150	m	0.6	0.8	15%	0.12	85%	0.68	Ditto
40	HDPE Pipe Laying Work	Dia 160	m	0.7	0.9	15%	0.14	85%	0.77	Ditto
41	HDPE Pipe Laying Work	Dia 200	m	1	1.3	15%	0.20	85%	1.11	Ditto
42	HDPE Pipe Laying Work	Dia 225	m	1.3	1.7	15%	0.26	85%	1.45	Ditto
43	Cast Iron Pipe Laying Work	Dia 250	m	4.3	5.6	15%	0.84	85%	4.76	Ditto
44	Cast Iron Pipe Laying Work	Dia 300	m	4.5	5.9	15%	0.89	85%	5.02	Ditto
45	Cast Iron Pipe Laying Work	Dia 350	m	5	6.5	15%	0.98	85%	5.53	Ditto
46	Cast Iron Pipe Laying Work	Dia 400	m	6	7.8	15%	1.17	85%	6.63	Ditto
47	Cast Iron Pipe Laying Work	Dia 450	m	7	9.1	15%	1.37	85%	7.74	Ditto
48	Cast Iron Pipe Laying Work	Dia 500	m	8	10.4	15%	1.56	85%	8.84	Ditto
49	Cast Iron Pipe Laying Work	Dia 600	m	9	11.7	15%	1.76	85%	9.95	Ditto
50	Cast Iron Pipe Laying Work	Dia 700	m	10	13	15%	1.95	85%	11.05	Ditto
51	Cast Iron Pipe Laying Work	Dia 800	m	11	14.3	15%	2.15	85%	12.16	Ditto
52	Cast Iron Pipe Laying Work	Dia 900	m	12	15.6	15%	2.34	85%	13.26	Ditto
53	Cast Iron Pipe Laying Work	Dia 1000	m	13	16.9	15%	2.54	85%	14.37	Ditto
54	Cast Iron Pipe Laying Work	Dia 1100	m	15	19.5	15%	2.93	85%	16.58	Ditto
55	Cast Iron Pipe Laying Work	Dia 1200	m	17	22.1	15%	3.32	85%	18.79	Ditto

Unit Price of DCIP Pipe Laying

			Diameter (mm) D		63		90		110		160		225		250		300		350		400		450		500		600	
			Material		HDPE		HDPE		HDPE		HDPE		HDPE		DCIP		DCIP		DCIP		DCIP		DCIP		DCIP		DCIP	
					FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC
Quantity (per m)																												
Excavation Depth (m) H	1.2m + D + h1 + 0.1m				1.363		1.39		1.41		1.46		1.525		1.6		1.65		1.7		1.75		1.8		1.85		1.95	
Width of Excavation(m) W					0.6		0.65		0.65		0.7		0.8		0.8		0.95		1.0		1.05		1.15		1.2		1.3	
Pavement Cutting (m)					2.0		2.0		2.0		2.0		2.0		2.0		2.0		2.0		2.0		2.0		2.0		2.0	
Pavement Excavation (m3)	t1×W				0.210		0.228		0.228		0.245		0.280		0.280		0.333		0.350		0.368		0.403		0.420		0.455	
Excavation (m3)	(H-t1)×W				0.818		0.904		0.917		1.022		1.220		1.280		1.568		1.700		1.838		2.070		2.220		2.535	
Backfill of Sand (m3)	{(h1 + D + 0.1m)×W} - D^2×3.14/4				0.095		0.117		0.127		0.162		0.220		0.231		0.309		0.354		0.399		0.474		0.524		0.627	
Backfill of Site Soil (m3)	(H - h1 - D - 0.1m - t2 - t1)×W				0.300		0.325		0.325		0.350		0.400		0.440		0.523		0.550		0.578		0.633		0.660		0.715	
Residual Soil (m3)					0.518		0.579		0.592		0.672		0.820		0.840		1.045		1.150		1.260		1.438		1.560		1.820	
Pavement (m2)					0.60		0.65		0.65		0.70		0.80		0.80		0.95		1.00		1.05		1.15		1.20		1.30	
Construction Cost (US $ /m)			Unit Price																									
			FC	LC																								
Pavement Cutting Work		m	0.10	0.30	0.20	0.60	0.20	0.60	0.20	0.60	0.20	0.60	0.20	0.60	0.20	0.60	0.20	0.60	0.20	0.60	0.20	0.60	0.20	0.60	0.20	0.60	0.20	0.60
Pavement Excavation		m^3	0.30	1.70	0.06	0.36	0.07	0.39	0.07	0.39	0.07	0.42	0.08	0.48	0.08	0.48	0.10	0.57	0.11	0.60	0.11	0.62	0.12	0.68	0.13	0.71	0.14	0.77
Excavation		m^3	0.78	4.42	1.00	4.00	1.00	4.00	1.00	4.00	1.00	5.00	1.00	5.00	1.00	6.00	1.00	7.00	1.00	8.00	1.00	8.00	2.00	9.00	2.00	10.00	2.00	11.00
Backfill of Sand		m^3	2.15	12.16	0.00	1.00	0.00	1.00	0.00	2.00	0.00	2.00	0.00	3.00	0.00	3.00	1.00	4.00	1.00	4.00	1.00	5.00	1.00	6.00	1.00	6.00	1.00	8.00
Backfill of Site Soil		m^3	1.37	7.74	0.41	2.32	0.44	2.51	0.44	2.51	0.48	2.71	0.55	3.09	0.60	3.40	0.71	4.04	0.75	4.25	0.79	4.47	0.86	4.89	0.90	5.11	0.98	5.53
Removal of Residual Soil		m^3	0.69	3.91	0.00	2.02	2.02	2.26	2.26	2.31	2.31	2.63	2.63	3.21	3.21	3.28	3.28	4.09	4.09	4.50	4.50	4.93	4.93	5.62	5.62	6.10	6.10	7.12
Asphalt Piece Disposal		m^3	0.69	3.91	0.14	0.82	0.16	0.89	0.16	0.89	0.17	0.96	0.19	1.09	0.19	1.09	0.23	1.30	0.24	1.37	0.25	1.44	0.28	1.57	0.29	1.64	0.31	1.78
Subbase Course		m2	1.37	7.74	0.82	4.64	0.89	5.03	0.89	5.03	0.96	5.41	1.09	6.19	1.09	6.19	1.30	7.35	1.37	7.74	1.43	8.12	1.57	8.90	1.64	9.28	1.77	10.06
Reinstatement of Pavement		m2	2.73	15.47	1.64	9.28	1.77	10.06	1.77	10.06	1.91	10.83	2.18	12.38	2.18	12.38	2.59	14.70	2.73	15.47	2.87	16.24	3.14	17.79	3.28	18.56	3.55	20.11
Pipe Laying (per m)					0.08	0.43	0.08	0.43	0.11	0.60	0.14	0.77	0.26	1.45	0.84	4.76	0.89	5.02	0.98	5.53	1.17	6.63	1.37	7.74	1.56	8.84	1.76	9.95
Pipe Material (per m)					4.14	0.46	8.19	0.91	12.87	1.43	25.74	2.86	52.65	5.85	87.75	9.75	117.00	13.00	134.55	14.95	163.80	18.20	198.90	22.10	234.00	26.00	304.20	33.80
Bent Pipe, Valve etc.	Pipe Cost of			30%	1.24	0.14	2.46	0.27	3.86	0.43	7.72	0.86	15.80	1.76	26.33	2.93	35.10	3.90	40.37	4.49	49.14	5.46	59.67	6.63	70.20	7.80	91.26	10.14
Retaining Wall (per m)	H= 2.0 m														3.90	22.10	3.90	22.10	3.90	22.10	3.90	22.10	3.90	22.10	3.90	22.10	3.90	22.10
Retaining Wall (per m)	H= 2.5 m																											
Retaining Wall (per m)	H= 3.0 m																											
Total (per m)					9.73	26.07	17.28	28.34	23.63	30.24	40.70	35.04	76.63	44.09	127.38	75.96	167.30	87.65	191.27	93.58	230.16	101.81	277.93	113.62	324.71	122.75	417.16	140.95
Roundup						**36**		**46**		**54**		**76**		**121**		**203**		**255**		**285**		**332**		**392**		**447**		**558**

Unit Price of DCIP Pipe Laying

					Diameter (mm) D	700		800		900		1000		1100		1200	
					Material	DCIP		DCIP		DCIP		DCIP		DCIP		DCIP	
						FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC
Quantity (per m)																	
Excavation Depth (m) H	1.2m + D + h1 + 0.1m					2.1		2.15		2.25		2.35		2.45		2.55	
Width of Excavation(m) W						1.55		1.65		1.95		2.05		2.15		2.25	
Pavement Cutting (m)						2.0		2.0		2.0		2.0		2.0		2.0	
Pavement Excavation (m3)	t1×W					0.543		0.578		0.683		0.718		0.753		0.788	
Excavation (m3)	(H-t1)×W					3.178		3.548		4.388		4.818		5.268		5.738	
Backfill of Sand (m3)	{(h1 + D + 0.1m)×W} - D^2×3.14/4					0.855		0.983		1.314		1.470		1.630		1.795	
Backfill of Site Soil (m3)	(H - h1 - D - 0.1m - t2 - t1)×W					0.853		0.908		1.073		1.128		1.183		1.238	
Residual Soil (m3)						2.325		2.640		3.315		3.690		4.085		4.500	
Pavement (m2)						1.55		1.65		1.95		2.05		2.15		2.25	
Construction Cost (US $ /m)				Unit Price													
				FC	LC												
Pavement Cutting Work			m	0.10	0.30	0.20	0.60	0.20	0.60	0.20	0.60	0.20	0.60	0.20	0.60	0.20	0.60
Pavement Excavation			m^3	0.30	1.70	0.16	0.92	0.17	0.98	0.20	1.16	0.22	1.22	0.23	1.28	0.24	1.34
Excavation			m^3	0.78	4.42	2.00	14.00	3.00	16.00	3.00	19.00	4.00	21.00	4.00	23.00	4.00	25.00
Backfill of Sand			m^3	2.15	12.16	2.00	10.00	2.00	12.00	3.00	16.00	3.00	18.00	3.00	20.00	4.00	22.00
Backfill of Site Soil			m^3	1.37	7.74	1.16	6.59	1.24	7.02	1.46	8.30	1.54	8.72	1.61	9.15	1.69	9.57
Removal of Residual Soil			m^3	0.69	3.91	7.12	9.09	9.09	10.32	10.32	12.96	12.96	14.43	14.43	15.97	15.97	17.60
Asphalt Piece Disposal			m^3	0.69	3.91	0.37	2.12	0.40	2.26	0.47	2.67	0.50	2.81	0.52	2.94	0.54	3.08
Subbase Course			m2	1.37	7.74	2.12	11.99	2.25	12.76	2.66	15.08	2.80	15.86	2.93	16.63	3.07	17.40
Reinstatement of Pavement			m2	2.73	15.47	4.23	23.98	4.50	25.53	5.32	30.17	5.60	31.71	5.87	33.26	6.14	34.81
Pipe Laying (per m)						1.95	11.05	2.15	12.16	2.34	13.26	2.54	14.37	2.93	16.58	3.32	18.79
Pipe Material (per m)						374.40	41.60	468.00	52.00	573.30	63.70	702.00	78.00	819.00	91.00	936.00	104.00
Bent Pipe, Valve etc.	Pipe Cost of				30%	112.32	12.48	140.40	15.60	171.99	19.11	210.60	23.40	245.70	27.30	280.80	31.20
Retaining Wall (per m)	H= 2.0 m																
Retaining Wall (per m)	H= 2.5 m					4.29	24.31	4.29	24.31	4.29	24.31	4.29	24.31	4.29	24.31	4.29	24.31
Retaining Wall (per m)	H= 3.0 m																
Total (per m)						512.32	168.74	637.69	191.53	778.57	226.32	950.23	254.42	1,104.71	282.02	1,260.26	309.69
Roundup							**681**		**829**		**1,005**		**1,205**		**1,387**		**1,570**

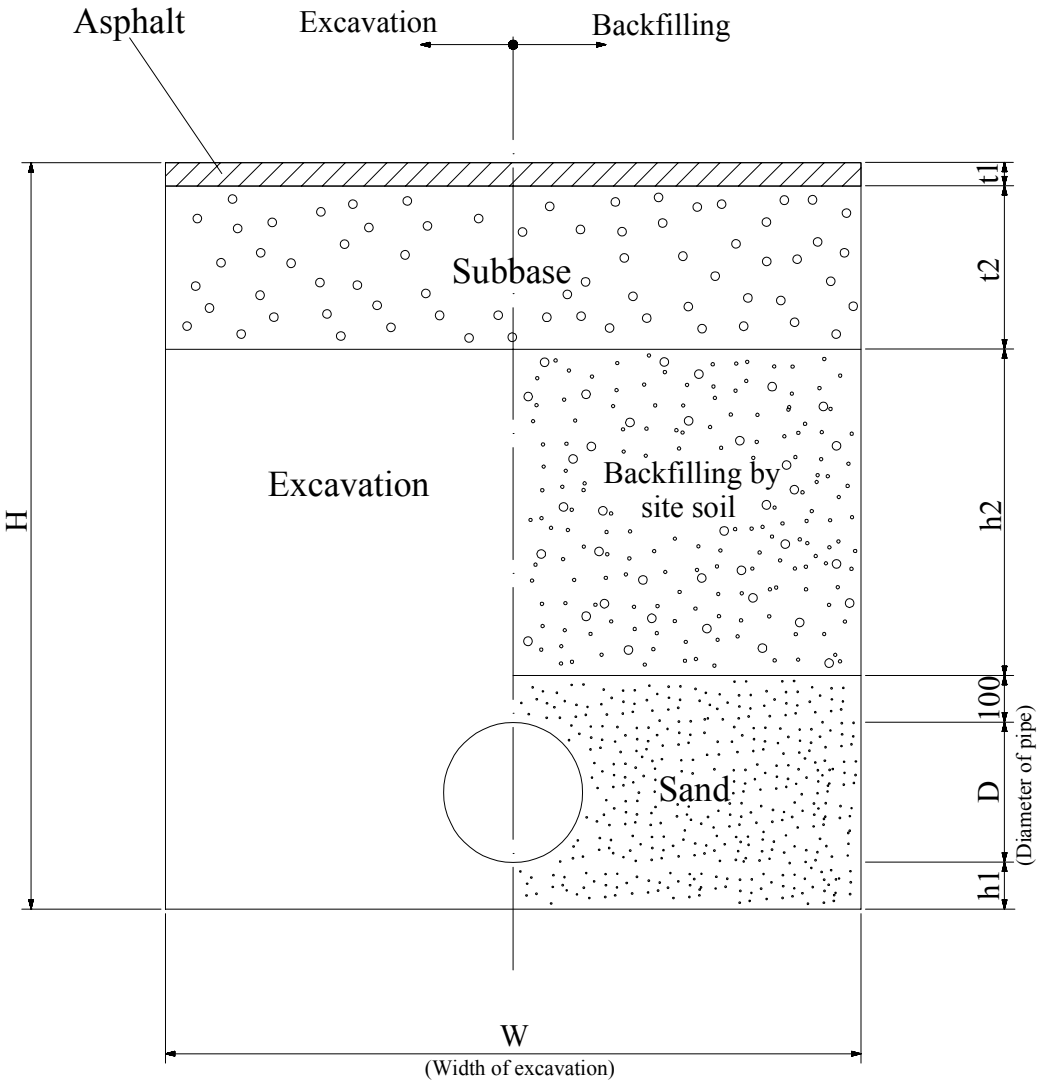
PPWSA Unit Price → <Case A> Gravel Road & Normal Joint & No Retention Wall : 80% of Pipe Length

Diameter (mm)		63		90		110		160		225		250		300		350		400		450		500		600	
Material		HDPE		HDPE		HDPE		HDPE		HDPE		DCIP		DCIP		DCIP		DCIP		DCIP		DCIP		DCIP	
		FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC
Cost of Pipe (per m)	DCIP: Normal Joint	1.60	0.18	4.41	0.49	4.76	0.53	10.04	1.12	20.23	2.25	34.20	3.80	40.50	4.50	49.61	5.51	85.50	9.50	97.39	10.82	120.23	13.36	173.14	19.24
Fittings (per m)	15% of Pipe Cost	0.24	0.03	0.66	0.07	0.71	0.08	1.51	0.17	3.03	0.34	5.13	0.57	6.08	0.68	7.44	0.83	12.83	1.43	14.61	1.62	18.04	2.00	25.97	2.89
Pipe Laying (per m)			1.93		3.35		3.38		4.26		4.51		4.98		5.37		6.27		6.47		7.28		8.09		9.71
Road Repair (per m)	60% of Pipe Laying Cost		1.16		2.01		2.03		2.56		2.71		2.99		3.22		3.76		3.88		4.37		4.85		5.82
Civil Structure (per m)	20% of Pipe Laying Cost		0.39		0.67		0.68		0.85		0.90		1.00		1.07		1.25		1.29		1.46		1.62		1.94
Total (per m)		1.84	3.68	5.07	6.59	5.48	6.69	11.55	8.95	23.27	10.70	39.33	13.33	46.58	14.84	57.05	17.62	98.33	22.57	112.00	25.55	138.27	29.92	199.11	39.59
			5.52		*11.66*		*12.17*		*20.50*		*33.97*		*52.66*		*61.42*		*74.67*		*120.90*		*137.55*		*168.19*		*238.70*

PPWSA Unit Price → <Case B> Asphalt Road & Mechanical Joint & Retention Wall Required : 20% of Pipe Length

Diameter (mm)		63		90		110		160		225		250		300		350		400		450		500		600	
Material		HDPE		HDPE		HDPE		HDPE		HDPE		DCIP		DCIP		DCIP		DCIP		DCIP		DCIP		DCIP	
		FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC
Cost of Pipe (per m)	DCIP: Mechanical Joint	1.60	0.18	4.41	0.49	4.76	0.53	10.04	1.12	20.23	2.25	55.80	6.20	67.50	7.50	82.69	9.19	142.50	15.83	162.32	18.04	200.39	22.27	288.56	32.06
Fittings (per m)	15% of Pipe Cost	0.24	0.03	0.66	0.07	0.71	0.08	1.51	0.17	3.03	0.34	8.37	0.93	10.13	1.13	12.40	1.38	21.38	2.38	24.35	2.71	30.06	3.34	43.28	4.81
Pipe Laying (per m)			1.93		3.35		3.38		4.26		4.51		4.98		5.37		6.27		6.47		7.28		8.09		9.71
Road Repair (per m)		2.46	13.92	2.66	15.08	2.66	15.08	2.87	16.24	3.28	18.56	3.28	18.56	3.89	22.04	4.10	23.21	4.30	24.37	4.71	26.69	4.91	27.85	5.32	30.17
Civil Structure (per m)	20% of Pipe Laying Cost		0.39		0.67		0.68		0.85		0.90		1.00		1.07		1.25		1.29		1.46		1.62		1.94
Retention Wall (per m)												3.90	22.10	3.90	22.10	3.90	22.10	3.90	22.10	3.90	22.10	3.90	22.10	3.90	22.10
Total (per m)		4.30	16.44	7.73	19.67	8.14	19.75	14.42	22.64	26.54	26.56	71.35	53.77	85.42	59.21	103.09	63.39	172.07	72.44	195.27	78.26	239.26	85.26	341.07	100.78
			20.74		*27.40*		*27.89*		*37.06*		*53.10*		*125.12*		*144.63*		*166.48*		*244.51*		*273.53*		*324.52*		*441.85*

Overexcavation (HDPE)	h1 =	0.1	m
Overexcavation (DCIP)	h1 =	0	m
Pavement Thickness	t1 =	0.05	m
Subbase Course Thickness	t2 =	0.35	m
Subbase Course Thickness	t2 =	0.35	m



Unit Construction Cost (Well Costruction)

	Items	Specification	unit	Unit Cost (US$)		Foreign Portion		Local Portion		Reference
				Direct Cost	Direct +Indirect (×1.4)	Ratio	Unit Cost (US$)	Ratio	Unit Cost (US$)	
<Civil/Architecture>										
1	Well Construction	Drilling Diameter: 10' 5/8 inches	m	260.00	364	20%	72.80	80%	291.20	Installation/Unit Cost=12,645/13,320=0.95 0.95×0.85=0.80 (LC)
3	Hand Pump	Equipment (including Lift Pipe) ＋Installation	pc	870.00	1218	15%	182.70	85%	1035.30	Overhead is estimated 20% for foreign portion. 100/120=0.83, say 85%
4	Platform	RC	pc	400.00	560	15%	84.00	85%	476.00	Ditto
5	Iron Removal Facility		pc	1100.00	1540	15%	231.00	85%	1309.00	Ditto
6	Pumping Test		pc	240.00	336	15%	50.40	85%	285.60	Ditto
7	Water Analysis		pc	130.00	182	15%	27.30	85%	154.70	Ditto

Supporting Report 11.2 Breakdown of Construction Cost for Master Plan

	Urban Water Supply Projects					Peri-Urban Water Supply Projects		Total
	Civil/Building	Mechanical	Electrical	Sub Total	Total	Sub Total	Total	
100 Stage I (Q= 65,000m^3/d) - 2010					**51,865,000**		**6,305,000**	**58,170,000**
<Urban Water Supply Projects>								
110 Chrouy Changva WTP -2nd Stage					22,630,000			
111 Intake Tower (for Chrouy Changva WTP)	1,058,000	1,946,000	958,000	3,962,000				
112 Raw Water Transmission Facilities	219,000	0	0	219,000				
113 Chrouy Changva WTP -2nd Stage (Q=65,000m^3/d)	7,374,000	6,732,000	4,343,000	18,449,000				
120 Water Tank					2,555,000			
121 Ta Khmau Water Tank	1,182,000	335,000	150,000	1,667,000				
122 Booster Pump for Existing Water Tower	0	598,000	290,000	888,000				
130 Transmission/Distribution Pipe					11,880,000			
131 Transmission/Distribution Pipe (Dia 63 to 600)	9,126,000			9,126,000				
132 Transmission/Distribution Pipe (Dia 700 to 1200)	2,754,000			2,754,000				
135 Monitoring Facility			5,000,000	5,000,000	5,000,000			
140 Rehabilitation of M&E Equipment		9,800,000		9,800,000	9,800,000			
<Peri-Urban Water Supply Projects>								
150 Well Facilities							6,305,000	
151 Well Facilities -1 (MRD)						307,000		
152 Well Facilities -2 (Grant/Loan)						5,998,000		
200 Stage II (Q= 100,000m^3/d) - 2015					**100,462,000**		**6,762,000**	**107,224,000**
<Urban Water Supply Projects>								
210 **Nirouth WTP -1st Stage**					40,106,000			
211 Intake Tower (for Nirouth WTP)	1,158,000	1,673,000	1,553,000	4,384,000				
212 Raw Water Transmission Facilities	783,000	0	0	783,000				
213 Nirouth WTP -1st Stage (Q=100,000m^3/d)	18,358,000	10,317,000	6,264,000	34,939,000				
215 Clear Water Reservoir Expansion in Phum Prek WTP	1,184,000			1,184,000	1,184,000			
220 Transmission/Distribution Pipe					23,923,000			
221 Transmission/Distribution Pipe (Dia 63 to 600)	5,207,000			5,207,000				
222 Transmission/Distribution Pipe (Dia 700 to 1200)	18,716,000			18,716,000				
230 Sludge Treatment Facility for Chrouy Changva & Phum Prek WTP	5,792,000	13,057,000		18,849,000	18,849,000			
240 Rehabilitation of M&E Equipment		16,400,000		16,400,000	16,400,000			
<Peri-Urban Water Supply Projects>								
250 Well Facilities							6,762,000	
251 Well Facilities -1 (MRD)						435,000		
252 Well Facilities -2 (Grant/Loan)						6,327,000		
300 Stage III (Q= 100,000m^3/d) - 2020					**44,767,000**		**8,696,000**	**53,463,000**
<Urban Water Supply Projects>								
310 **Nirouth WTP -2nd Stage**					25,982,000			
311 Intake Tower (for Nirouth WTP)	0	853,000	811,000	1,664,000				
312 Raw Water Transmission Facilities	783,000	0	0	783,000				
313 Nirouth WTP -2nd Stage (Q=100,000m^3/d)	11,336,000	7,870,000	4,329,000	23,535,000				
320 Transmission/Distribution Pipe					7,238,000			
321 Transmission/Distribution Pipe (Dia 63 to 600)	7,238,000			7,238,000				
322 Transmission/Distribution Pipe (Dia 700 to 1200)	0			0				
330 Sludge Treatment Facility for Chamkar Mon WTP	1,278,000	2,069,000		3,347,000	3,347,000			
340 Rehabilitation of M&E Equipment		8,200,000		8,200,000	8,200,000			
<Peri-Urban Water Supply Projects>								
350 **Well Facilities**							8,696,000	
351 Well Facilities -1 (MRD)						435,000		
352 Well Facilities -2 (Grant/Loan)						8,261,000		
Total					**197,094,000**		**21,763,000**	**218,857,000**

112 Raw Water Transmission Facilities (Stage 1 Chrouy Changva)

Diameter (mm)	Pipe Material	Length (m)	FC Portion (US$)		LC Portion (US$)		Reference
			Unit Price	Amount	Unit Price	Amount	
800	DCIP	0	0.00	0			
900	DCIP	0	0.00	0			
1000	DCIP	0	0.00	0			
1100	DCIP	0	0.00	0			
1200	DCIP	140	1,260.26	176,436	310	43,357	L = 140m × 1
Total		140	m	176,436		43,357	
FC+LC			**219,793**				

212 Raw Water Transmission Facilities (Nirouth WTP - 1st Stage)

Diameter (mm)	Pipe Material	Length (m)	Unit Price (US $)	Direct Cost (US $)	Reference
500	DCIP	0	0.00	0	
600	DCIP	0	0.00	0	
700	DCIP	0	0.00	0	
800	DCIP	0	0.00	0	
900	DCIP	0	0.00	0	
1000	DCIP	0	0.00	0	
1100	DCIP	0	0.00	0	
1200	DCIP	500	1,569.95	784,975	L = 500m × 1
Total		500	m	784,975	

312 Raw Water Transmission Facilities (Nirouth WTP - 2nd Stage)

Diameter (mm)	Pipe Material	Length (m)	Unit Price (US $)	Direct Cost (US $)	Reference
500	DCIP	0	0.00	0	
600	DCIP	0	0.00	0	
700	DCIP	0	0.00	0	
800	DCIP	0	0.00	0	
900	DCIP	0	0.00	0	
1000	DCIP	0	0.00	0	
1100	DCIP	0	0.00	0	
1200	DCIP	500	1,569.95	784,975	L = 500m × 1
Total		500	m	784,975	

Summary of Distribution Pipe Length

(m)

Diameter (mm)	Stage I Total	Stage II	Stage III	Total
63	1,760	2,930	4,530	9,220
90	6,260	4,520	7,460	18,240
110	33,090	23,280	78,600	134,970
160	22,740	13,430	33,140	69,310
200	15,320	9,350	12,560	37,230
225	1,351	16,320	24,500	42,171
250	5,834	10,140	8,100	24,074
300	10,056	14,570	13,800	38,426
350	0	0	0	0
400	10,718	1,720	0	12,438
450	0	0	0	0
500	16,672	5,100	9,000	30,772
600	4,572	1,370	1,000	6,942
				0
Sub-total	**128,373**	**102,730**	**192,690**	**423,793**
				0
700	0	0	0	0
800	967	4,340	0	5,307
900	1,955	0	0	1,955
1000	0	6,960	0	6,960
1100	0	0	0	0
1200	0	3,510		3,510
				0
				0
sub-total	**2,922**	**14,810**	**0**	**17,732**
Total	**131,295**	**117,540**	**192,690**	**441,525**

131 Transmission/Distribution Pipe Cost (Dia 63 - 600mm) -Stage I (2010)

- Stage I Total

Diameter (mm)	Pipe Material	Length (m)	FC Portion (US$)		LC Portion (US$)		Reference
			Unit Price	Amount	Unit Price	Amount	
<Case A> Gravel Road & Normal Joint & No Retention Wall : 80% of Pipe Length							
63	HDPE	1,408	1.84	2,590.72	3.68	5,181.44	
90	HDPE	5,008	5.07	25,390.56	6.59	33,002.72	
110	HDPE	26,472	5.48	145,066.56	6.69	177,097.68	
160	HDPE	18,192	11.55	210,117.60	8.95	162,818.40	
225	HDPE	13,337	23.27	310,347.34	10.70	142,703.76	
250	DCIP	4,667	39.33	183,560.98	13.33	62,213.78	
300	DCIP	8,045	46.58	374,726.78	14.84	119,384.83	
350	DCIP	0	57.05	0.00	17.62	0.00	
400	DCIP	8,574	98.33	843,120.75	22.57	193,524.21	
450	DCIP	0	112.00	0.00	25.55	0.00	
500	DCIP	13,338	138.27	1,844,189.95	29.92	399,060.99	
600	DCIP	3,658	199.11	728,264.74	39.59	144,804.38	
Sub-total (CASE A)		102,698	m	4,667,375.98		1,439,792.19	
FC+LC			6,107,168				
<Case B> Asphalt Road & Mechanical Joint & Retention Wall Required : 20% of Pipe Length							
63	HDPE	352	4.30	1,513.60	16.44	5,786.88	
90	HDPE	1,252	7.73	9,677.96	19.67	24,626.84	
110	HDPE	6,618	8.14	53,870.52	19.75	130,705.50	
160	HDPE	4,548	14.42	65,582.16	22.64	102,966.72	
225	HDPE	3,334	26.54	88,489.67	26.56	88,556.35	
250	DCIP	1,167	71.35	83,251.18	53.77	62,738.84	
300	DCIP	2,011	85.42	171,796.70	59.21	119,083.15	
350	DCIP	0	103.09	0.00	63.39	0.00	
400	DCIP	2,144	172.07	368,849.25	72.44	155,282.38	
450	DCIP	0	195.27	0.00	78.26	0.00	
500	DCIP	3,334	239.26	797,788.54	85.26	284,290.94	
600	DCIP	914	341.07	311,874.41	100.78	92,153.23	
Sub-total (CASE B)		25,675	m	1,952,694.00		1,066,190.84	
FC+LC			3,018,885				
Total		128,373	m	6,620,069.97		2,505,983.03	
FC+LC			**9,126,053.00**				

132 Transmission/Distribution Pipe Cost (Dia 700 - 1200mm) -Stage I (2010)

- Stage I Total

Diameter (mm)	Pipe Material	Length (m)	FC Portion (US$)		LC Portion (US$)		Reference
			Unit Price	Amount	Unit Price	Amount	
700	DCIP	0	512.32	0.00	168.74	0.00	
800	DCIP	967	637.69	616,646.23	191.53	185,209.51	
900	DCIP	1,955	778.57	1,522,104.35	226.32	442,455.60	
1000	DCIP	0	950.23	0.00	254.42	0.00	
1100	DCIP	0	1,104.71	0.00	282.02	0.00	
1200	DCIP	0	1,260.26	0.00	309.69	0.00	
Total		2,922	m	2,138,750.58		627,665.11	
FC+LC			**2,766,416**				

221 Transmission/Distribution Pipe Cost (Dia 63 - 600mm) -Stage II (2015)

Diameter (mm)	Pipe Material	Length (m)	Unit Price (US $)	Cost (US $)	Reference
<Case A> Gravel Road & Normal Joint & No Retention Wall : 80% of Pipe Length					
63	HDPE	2,344	5.52	12,939	
90	HDPE	3,616	11.66	42,163	
110	HDPE	18,624	12.17	226,654	
160	HDPE	10,744	20.50	220,252	
225	HDPE	20,536	33.97	697,608	
250	DCIP	8,112	52.66	427,178	
300	DCIP	11,656	61.42	715,912	
350	DCIP	0	74.67	0	
400	DCIP	1,376	120.90	166,358	
450	DCIP	0	137.55	0	
500	DCIP	4,080	168.19	686,215	
600	DCIP	1,096	238.70	261,615	
Sub-total (CASE A)		82,184	m	3,456,894	
<Case B> Asphalt Road & Mechanical Joint & Retention Wall Required : 20% of Pipe Length					
63	HDPE	586	20.74	12,154	
90	HDPE	904	27.40	24,770	
110	HDPE	4,656	27.89	129,856	
160	HDPE	2,686	37.06	99,543	
225	HDPE	5,134	53.10	272,615	
250	DCIP	2,028	125.12	253,743	
300	DCIP	2,914	144.63	421,452	
350	DCIP	0	166.48	0	
400	DCIP	344	244.51	84,111	
450	DCIP	0	273.53	0	
500	DCIP	1,020	324.52	331,010	
600	DCIP	274	441.85	121,067	
Sub-total (CASE B)		20,546	m	1,750,322	
Total		102,730	m	**5,207,215**	

222 Transmission/Distribution Pipe Cost (Dia 700 - 1200mm) -Stage II (2015)

Diameter (mm)	Pipe Material	Length (m)	Unit Price (US $)	Cost (US $)	Reference
700	DCIP	0	681	0	
800	DCIP	4,340	829	3,598,815	
900	DCIP	0	1,005	0	
1000	DCIP	6,960	1,205	8,384,364	
1100	DCIP	0	1,387	0	
1200	DCIP	3,510	1,570	5,510,525	
1200	DCIP	500	2,565	1,282,500	Pipe Installation in the River
					(1,565+1,000) US$/m
Total		14,810	m	**18,776,203**	

321 Transmission/Distribution Pipe Cost (Dia 63 - 600mm) -Stage III (2020)

Diameter (mm)	Pipe Material	Length (m)	Unit Price (US $)	Cost (US $)	Reference
<Case A> Gravel Road & Normal Joint & No Retention Wall : 80% of Pipe Length					
63	HDPE	3,624	5.52	20,004	
90	HDPE	5,968	11.66	69,587	
110	HDPE	62,880	12.17	765,250	
160	HDPE	26,512	20.50	543,496	
225	HDPE	29,648	33.97	1,007,143	
250	DCIP	6,480	52.66	341,237	
300	DCIP	11,040	61.42	678,077	
350	DCIP	0	74.67	0	
400	DCIP	0	120.90	0	
450	DCIP	0	137.55	0	
500	DCIP	7,200	168.19	1,210,968	
600	DCIP	800	238.70	190,960	
Sub-total (CASE A)		154,152	m	4,826,721	
<Case B> Asphalt Road & Mechanical Joint & Retention Wall Required : 20% of Pipe Length					
63	HDPE	906	20.74	18,790	
90	HDPE	1,492	27.40	40,881	
110	HDPE	15,720	27.89	438,431	
160	HDPE	6,628	37.06	245,634	
225	HDPE	7,412	53.10	393,577	
250	DCIP	1,620	125.12	202,694	
300	DCIP	2,760	144.63	399,179	
350	DCIP	0	166.48	0	
400	DCIP	0	244.51	0	
450	DCIP	0	273.53	0	
500	DCIP	1,800	324.52	584,136	
600	DCIP	200	441.85	88,370	
Sub-total (CASE B)		38,538	m	2,411,692	
Total		192,690	m	**7,238,413**	

322 Transmission/Distribution Pipe Cost (Dia 700 - 1200mm) -Stage III (2020)

Diameter (mm)	Pipe Material	Length (m)	Unit Price (US $)	Cost (US $)	Reference
700	DCIP	0	681	0	
800	DCIP	0	829	0	
900	DCIP	0	1,005	0	
1000	DCIP	0	1,205	0	
1100	DCIP	0	1,387	0	
1200	DCIP	0	1,570	0	
Total		0	m	0	

Breakdown of Well Construction

			pcs	Cost (US$)
Stage I	MRD Work	Well (L=60m)	35	307,000
	Grnt/Loan	Well (L=60m)	194	5,998,000
	Subtotal (Stage I)		**229**	**6,305,000**
Stage II	MRD Work	Well (L=40m)	60	435,000
	Grnt/Loan	Well (L=40m, 60m)	208	6,327,000
	Subtotal (Stage II)		**268**	**6,762,000**
Stage III	MRD Work	Well (L=40m)	60	435,000
	Grnt/Loan	Well (L=40m, 60m)	310	8,261,000
	Subtotal (Stage III)		**370**	**8,696,000**
Total			**867**	**21,763,000**

Supporting Report 11.3 Breakdown of Operation and Maintenance Cost for Master Plan

WTP Annual Personnel Expenses (Year 2010) for Expansion

		Salary US$/year	Chrouy Changva WTP (for 65,000m3/d)		New WTP (0 m3/d)		Booster PS		Total (300,000m3/d)	
			Person	Cost (per year) US$	Person	Cost (per year) US$	Person	Cost (per year) US$	Person	Cost (per year) US$
1	Manager	3,000	0	0	0	0	0	0	0	0
2	Engineer	2,400	0	0	0	0	1	2,400	1	2,400
3	Skilled Operator	1,500	2	3,000	0	0	4	6,000	6	9,000
4	Operator	1,000	0	0	0	0	4	4,000	4	4,000
Total			2	3,000	0	0	9	12,400	11	15,400

WTP Annual Personnel Expenses (Year 2015) for Expansion

		Salary US$/year	Chrouy Changva WTP (for 65,000m3/d)		New WTP (100,000m3/d)		Booster PS		Total (400,000m3/d)	
			Person	Cost (per year) US$	Person	Cost (per year) US$	Person	Cost (per year) US$	Person	Cost (per year) US$
1	Manager	3,000	0	0	1	3,000	0	0	1	3,000
2	Engineer	2,400	0	0	6	14,400	1	2,400	7	16,800
3	Skilled Operator	1,500	2	3,000	9	13,500	4	6,000	15	22,500
4	Operator	1,000	0	0	9	9,000	4	4,000	13	13,000
5	Labour/Guard	1,000			10	10,000			10	10,000
Total			2	3,000	35	49,900	9	12,400	46	65,300

WTP Annual Personnel Expenses (Year 2020) for Expansion

		Salary US$/year	Chrouy Changva WTP (for 65,000m3/d)		New WTP (200,000m3/d)		Booster PS		Total (500,000m3/d)	
			Person	Cost (per year) US$	Person	Cost (per year) US$	Person	Cost (per year) US$	Person	Cost (per year) US$
1	Manager	3,000	0	0	1	3,000	0	0	1	3,000
2	Engineer	2,400	0	0	6	14,400	1	2,400	7	16,800
3	Skilled Operator	1,500	2	3,000	14	21,000	4	6,000	20	30,000
4	Operator	1,000	0	0	10	10,000	4	4,000	14	14,000
5	Labour/Guard	1,000			15	15,000			15	15,000
Total			2	3,000	46	63,400	9	12,400	57	78,800

Pipe Maintenance Stuff for Expansion

		Salary	Year			
		US$/year	2005	2010	2015	2020
Distribution Pipe Length (Expansion) (km)				131	117	192
Total Distribution Pipe Length (km)			990	1121	1238	1430
Pipe Maintenance Stuff	PPWSA		61	8	15	27
	Contract		22	3	6	10
Pipe Maintenance Cost (UD$/year)	PPWSA	1,500	91,500	**12,000**	**22,500**	**40,500**
	Contract	600	13,200	**1,800**	**3,600**	**6,000**
	Total		104,700	**13,800**	**26,100**	**46,500**

Power Cost in WTP (Year 2010) for Expansion

		Chrouy Changva	New WTP	Total
Production (m3/d)		42,450	0	42,450
Power				
Unit Consumption	(W/m3)	268	268	-
Consumption	(kW)	11,377	0	11,377
Unit Price	(US$/kW)	0.120		-
Price	(US$/day)	1,368	0	-
	(US$/year)	499,169	0	**499,169**

Power Cost in WTP (Year 2015) for Expansion

		Chrouy Changva	New WTP	Total
Production (m3/d)		40,000	61,600	101,600
Power				
Unit Consumption	(W/m3)	268	268	-
Consumption	(kW)	10,720	16,509	27,229
Unit Price	(US$/kW)	0.120		-
Price	(US$/day)	1,289	1,985	-
	(US$/year)	470,359	724,353	**1,194,712**

Power Cost in WTP (Year 2020) for Expansion

		Chrouy Changva	New WTP	Total
Production (m3/d)		45,800	141,000	186,800
Power				
Unit Consumption	(W/m3)	268	268	-
Consumption	(kW)	12,274	37,788	50,062
Unit Price	(US$/kW)	0.120		-
Price	(US$/day)	1,476	4,543	-
	(US$/year)	538,561	1,658,016	**2,196,577**

Power Cost in Booster PS (Year 2010) for Expansion

		No1 Tower	No.2 Tower	No. Tower	New Tower	Total
Pump (kW)		55.0	55.0	55.0	75.0	240.0
Power						
Daily Consumption	(kWH)	1,320	1,320	1,320	1,800	5,760
Unit Price	(US$/kW)	0.120				-
Price	(US$/day)	159	159	159	216	-
	(US$/year)	57,917	57,917	57,917	78,978	**252,730**

Power Cost in Booster PS (Year 2015) for Expansion

		No1 Tower	No.2 Tower	No. Tower	New Tower	Total
Pump (kW)		55.0	55.0	55.0	75.0	240.0
Power						
Daily Consumption	(kWH)	1,320	1,320	1,320	1,800	5,760
Unit Price	(US$/kW)	0.120				-
Price	(US$/day)	159	159	159	216	-
	(US$/year)	57,917	57,917	57,917	78,978	**252,730**

Power Cost in Booster PS (Year 2020) for Expansion

		No1 Tower	No.2 Tower	No. Tower	New Tower	Total
Pump (kW)		55.0	55.0	55.0	150.0	315.0
Power						
Daily Consumption	(kWH)	1,320	1,320	1,320	3,600	7,560
Unit Price	(US$/kW)	0.120				-
Price	(US$/day)	159	159	159	433	-
	(US$/year)	57,917	57,917	57,917	157,956	**331,708**

Chemical Cost (Year 2010) for Expansion

		Chrouy Changva	New WTP	Total
Production (m3/d)		42,450	0	42,450
Alum				
Unit Consumption	(g/m3)	18	18	-
Consumption	(t)	0.76	0.00	0.76
Unit Price	(US$/t)	253		-
Price	(US$/day)	193	0	-
	(US$/year)	70,561	0	**70,561**
Lime				
Unit Consumption	(g/m3)	0	0	-
Consumption	(t)	0.00	0.00	0.00
Unit Price	(US$/t)	145		-
Price	(US$/day)	0	0	-
	(US$/year)	0	0	**0**
Chlorine				
Unit Consumption	(g/m3)	2	2	-
Consumption	(t)	0.08	0.00	0.08
Unit Price	(US$/t)	627		-
Price	(US$/day)	53	0	-
	(US$/year)	19,430	0	**19,430**
Total O&M Cost (US$/year)		89,991	0	**89,991**

Chemical Cost (Year 2015) for Expansion

		Chrouy Changva	New WTP	Total
Production (m3/d)		40,000	61,600	101,600
Alum				
Unit Consumption	(g/m3)	18	18	-
Consumption	(t)	0.72	1.11	1.83
Unit Price	(US$/t)	253		-
Price	(US$/day)	182	281	-
	(US$/year)	66,488	102,392	**168,881**
Lime				
Unit Consumption	(g/m3)	0	0	-
Consumption	(t)	0.00	0.00	0.00
Unit Price	(US$/t)	145		-
Price	(US$/day)	0	0	-
	(US$/year)	0	0	**0**
Chlorine				
Unit Consumption	(g/m3)	2	2	-
Consumption	(t)	0.08	0.12	0.20
Unit Price	(US$/t)	627		-
Price	(US$/day)	50	77	-
	(US$/year)	18,308	28,195	**46,503**
Total O&M Cost (US$/year)		84,797	130,587	**215,384**

Chemical Cost (Year 2020) for Expansion

		Chrouy Changva	New WTP	Total
Production (m3/d)		45,800	141,000	186,800
Alum				
Unit Consumption	(g/m3)	18	18	-
Consumption	(t)	0.82	2.54	3.36
Unit Price	(US$/t)	253		-
Price	(US$/day)	209	642	-
	(US$/year)	76,129	234,372	**310,501**
Lime				
Unit Consumption	(g/m3)	0	0	-
Consumption	(t)	0.00	0.00	0.00
Unit Price	(US$/t)	145		-
Price	(US$/day)	0	0	-
	(US$/year)	0	0	**0**
Chlorine				
Unit Consumption	(g/m3)	2	2	-
Consumption	(t)	0.09	0.28	0.37
Unit Price	(US$/t)	627		-
Price	(US$/day)	57	177	-
	(US$/year)	20,963	64,537	**85,500**
Total O&M Cost (US$/year)		97,092	298,909	**396,001**

Repair Cost per Year

1000US$/year

		2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Construction Cost	per year	0	7,500	18,613	22,782	2,970	0	1,184	37,858	44,339	5,981	11,100	0	0	23,712	19,246	1,810
	Accumulation		7,500	26,113	48,895	51,865	51,865	53,049	90,907	135,246	141,227	152,327	152,327	152,327	176,039	195,285	197,094
Repair Cost	0.15%	0	11	39	73	78	78	80	136	203	212	228	228	228	264	293	296

Operation & Maintenance Cost per Year for Expansion (Peri Urban Water Projects)

1000 US$

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
1. Hand Pump											
Hand Pump No.	229	283	336	390	443	497	571	645	719	793	867
Unit Cost (US$/pcs.year)	430	430	430	430	430	430	430	430	430	430	430
Subtotal	98	122	145	168	191	214	246	277	309	341	373
2. Contingency	3	4	4	5	6	6	7	8	9	10	11
3%											
Total	101	125	149	173	196	220	253	286	318	351	384

Supporting Report 11.4 Breakdown of Construction Cost for Priority Projects

111 Chrouy Changva Intake Tower (Civil/Building Work)

For Q=130,000 m3/d

Code	Items	Specification	Unit	Qty	FC Portion (US%)		LC Portion (US$)		Reference
					Unit Price	Amount	Unit Price	Amount	
111-1	Intake Tower	Q = 130,000 m3/d	Ls	1	436,000	436,000	335,000	335,000	
111-2	Intake Tower Connection Bridge		Ls	1	182,000	182,000	55,000	55,000	
111-3	Pantoon Rental	12m×36m	Ls	1	8,000	8,000	42,000	42,000	
	Total					626,000		432,000	
	Total Cost (FC+LC)				1,058,000				

111-1 Chrouy Changva Intake Tower

Items	Specification	Unit	Qty	FC Portion (US$)		LC Portion (US$)		Reference
				Unit Price	Amount	Unit Price	Amount	
Sheet Pile Driving Work	Type III, L = 20m	m	2,730	2.34	6,388.20	13.26	36,199.80	
Sheet Pile	Type III, L = 20m, Remain	t	170	1,053.00	179,010.00	117.00	19,890.00	
Supporting Works		t	10	18.53	185.25	104.88	1,048.75	
Supporting Lease		t	10	210.60	2,106.00	23.40	234.00	1/5 of Purchase Price
Excavation	in water	m^3	400	0.39	156.00	2.21	884.00	Twice as ground excavation
Surplus Soil Transport		m^3	400	0.69	276.00	3.91	1,564.00	
Pile Driving Work	400×400, L = 10m Including Materials	m	500	9.75	4,875.00	55.25	27,625.00	L=50pcs×10m
Pile Head Treatment	400×400	pcs	50	2.93	146.25	16.58	828.75	
Reinforced Concrete		m^3	1,100	15.60	17,160.00	88.40	97,240.00	
Formwork		m^2	1,000	9.75	9,750.00	9.75	9,750.00	
Rebar Fabrication and Assembly		t	187	832.00	155,584.00	208.00	38,896.00	R-bar/Concrete = 170kg/m3
Other Works		Ls	1		37,503.05		34,867.95	Above Structure of 20%
Building Works		m^2	150	146.25	21,937.50	438.75	65,812.50	
Total Cost					435,077.25		334,840.75	
Total Cost (roundup)					436,000		335,000	1000 US$ roundup

111-2 Chrouy Changva Intake Bridge

Items	Specification	Unit	Qty	FC Portion (US%)		LC Portion (US$)		Reference
				Unit Price	Amount	Unit Price	Amount	
Bridge	including pipe (Dia1000×2)	m	40	3,276.00	131,040.00	364.00	14,560.00	Foreign Portion: 90% 2800$ × 1.3
Excavation		m^3	500	0.20	97.50	1.11	552.50	Bank Base, 8×5×12
Surplus Soil Transport		m^3	500	0.69	345.00	3.91	1,955.00	
Pile Driving Work	400×400, L = 10m Including Materials	m	100	9.75	975.00	55.25	5,525.00	L=10pcs×10m
Pile Head Treatment	400×400	pcs	10	2.93	29.25	16.58	165.75	
Gravel		m^3	10	6.83	68.25	38.58	385.75	
Reinforced Concrete		m^3	180	15.60	2,808.00	88.40	15,912.00	Bank Base, 6×3×10
Formwork		m^2	400	9.75	3,900.00	9.75	3,900.00	
Rebar Fabrication and Assembly		t	30.6	832.00	25,459.20	208.00	6,364.80	R-bar/Concrete = 170kg/m3
Other Works		Ls	1		16,472.22		4,932.08	Above of 10%
Total Cost					181,194.42		54,252.88	
Total Cost (roundup)					182,000		55,000	1000 US$ roundup

113 Chrouy Changva WTP (Civil/Building Work)

Code	Items	Specification	Unit	Qty	FC Portion (US%)		LC Portion (US$)		Reference
					Unit Price	Amount	Unit Price	Amount	
113-1	Receiving Well		pc	1	31,000	31,000	39,000	39,000	
113-2	Sedimentation Tank		pc	1	797,000	797,000	1,343,000	1,343,000	Including Flocculation Basin
113-3	Rapid Sand Filter		pc	1	173,000	173,000	247,000	247,000	
113-4	Clear Water Reservoir	V= 15,000m3	pc	1	1,491,000	1,491,000	1,707,000	1,707,000	
113-5	Clear Water Reservoir	V= 4,500m3	pc	1	528,000	528,000	598,000	598,000	
113-6	Inplant Pipe		Ls	1		90,600		118,020	Above of 3%
113-7	Inplant Work		m2	14,000	2.25	31,500	12.75	178,500	15$/m2, Local Portion: 85% W210m×L1300m×50%
	Total					3,142,100		4,230,520	
	Total (roundup)	1000 US$ roundup				3,143,000		4,231,000	
	Total (FC+LC)				7,374,000				

113-1 Receiving Well

Items	Specification	Unit	Qty	FC Portion (US%)		LC Portion (US$)		Reference
				Unit Price	Amount	Unit Price	Amount	
Pile Driving Work	300×300, L = 14m Including Materials	m	350	5.85	2,047.50	33.15	11,602.50	L=25pcs×14m
Pile Head Treatment	300×300	pcs	25	1.76	43.88	9.95	248.63	
Gravel		m^3	22	6.83	150.15	38.58	848.65	
Reinforced Concrete		m^3	110	15.60	1,716.00	88.40	9,724.00	
Formwork		m^2	600	9.75	5,850.00	9.75	5,850.00	
Rebar Fabrication and Assembly		t	19	832.00	15,558.40	208.00	3,889.60	R-bar/Concrete = 170kg/m3
Other Works		Ls	1		5,073.19		6,432.68	Above of 20%
Total Cost					30,439.11		38,596.05	
Total Cost (roundup)					31,000		39,000	1000 US$ roundup

113-2 Sedimentation Basin

Items	Specification	Unit	Qty	FC Portion (US%)		LC Portion (US$)		Reference
				Unit Price	Amount	Unit Price	Amount	
Pile Driving Work	300×300, L = 14m Including Materials	m	7,700	5.85	45,045.00	33.15	255,255.00	L=550pcs×14m
Pile Head Treatment	300×300	pcs	550	1.76	965.25	9.95	5,469.75	Same as existing
Excavation		m^3	2,600	0.20	507.00	1.11	2,873.00	
Backfilling		m^3	600	0.78	468.00	4.42	2,652.00	
Surplus Soil Transport		m^3	2,100	0.69	1,449.00	3.91	8,211.00	
Gravel		m^3	350	6.83	2,388.75	38.58	13,501.25	
Concrete		m^3	180	14.63	2,632.50	82.88	14,917.50	
Reinforced Concrete		m^3	2,600	15.60	40,560.00	88.40	229,840.00	
Formwork		m^2	5,700	9.75	55,575.00	9.75	55,575.00	
Rebar Fabrication and Assembly		t	442	832.00	367,744.00	208.00	91,936.00	R-bar/Concrete = 170kg/m3
Other Works		Ls	1		103,466.90		136,046.10	Above of 20%
Building		m^2	1,200	146.25	175,500.00	438.75	526,500.00	
Total Cost					796,301.40		1,342,776.60	
Total Cost (roundup)					797,000		1,343,000	1000 US$ roundup

113-3 Rapid Sand Filter

4 tanks

Items	Specification	Unit	Qty	FC Portion (US%)		LC Portion (US$)		Reference
				Unit Price	Amount	Unit Price	Amount	
Pile Driving Work	300×300, L = 13m Including Materials	m	1,625	5.85	9,506.25	33.15	53,868.75	L=125pcs×13m
Pile Head Treatment	300×300	pcs	125	1.76	219.38	9.95	1,243.13	Same as existing
Excavation		m^3	800	0.20	156.00	1.11	884.00	
Backfilling		m^3	300	0.78	234.00	4.42	1,326.00	
Surplus Soil Transport		m^3	500	0.69	345.00	3.91	1,955.00	
Gravel		m^3	85	6.83	580.13	38.58	3,278.88	
Concrete		m^3	45	14.63	658.13	82.88	3,729.38	
Reinforced Concrete		m^3	600	15.60	9,360.00	88.40	53,040.00	
Formwork		m^2	2,500	9.75	24,375.00	9.75	24,375.00	
Rebar Fabrication and Assembly		t	102	832.00	84,864.00	208.00	21,216.00	R-bar/Concrete = 170kg/m3
Other Works		Ls			26,059.58		32,983.23	Above of 20%
Filter Operation Gallery		m^2	110	146.25	16,087.50	438.75	48,262.50	
Total Cost					172,444.95		246,161.85	
Total Cost (roundup)					173,000		247,000	1000 US$ roundup

113-4 Clear Water Reservoir (V=15,000m3)

For V=15,000m3

Items	Specification	Unit	Qty	FC Portion (US%)		LC Portion (US$)		Reference
				Unit Price	Amount	Unit Price	Amount	
Pile Driving Work	400×400, L = 10m Including Materials	m	7,000	9.75	68,250.00	55.25	386,750.00	L=700pcs×10m
Pile Head Treatment	400×400	pcs	700	2.93	2,047.50	16.58	11,602.50	
Sheet Pile Driving Work	III型, L = 10m	m	7,200	2.34	16,848.00	13.26	95,472.00	
Sheet Pile	III型, L = 10m, Remain	t	440	210.60	92,664.00	23.40	10,296.00	1/5 of Purchase Price
Supporting Works		t	660	18.53	12,226.50	104.88	69,217.50	
Supporting Lease		t	660	210.60	138,996.00	23.40	15,444.00	1/5 of Purchase Price
Excavation		m^3	22,000	0.20	4,290.00	1.11	24,310.00	
Backfilling		m^3	6,500	0.78	5,070.00	4.42	28,730.00	
Surplus Soil Transport		m^3	15,000	0.69	10,350.00	3.91	58,650.00	
Gravel		m^3	600	6.83	4,095.00	38.58	23,145.00	
Concrete		m^3	300	14.63	4,387.50	82.88	24,862.50	
Reinforced Concrete		m^3	5,000	15.60	78,000.00	88.40	442,000.00	
Formwork		m^2	11,000	9.75	107,250.00	9.75	107,250.00	
Rebar Fabrication and Assembly		t	850	832.00	707,200.00	208.00	176,800.00	R-bar/Concrete = 170kg/m3
Other Works		Ls	1		224,209.38		187,728.13	Structure of 25%
Building Work		m^2	100	146.25	14,625.00	438.75	43,875.00	
Total Cost					1,490,508.88		1,706,132.63	
Total Cost (roundup)					1,491,000		1,707,000	1000 US$ roundup

113-5 Clear Water Reservoir (V=4,500m3)

For V=4,500m3

Items	Specification	Unit	Qty	FC Portion (US%)		LC Portion (US$)		Reference
				Unit Price	Amount	Unit Price	Amount	
Pile Driving Work	400×400, L = 10m Including Materials	m	2,300	9.75	22,425.00	55.25	127,075.00	L=230pcs×10m
Pile Head Treatment	400×400	pcs	230	2.93	672.75	16.58	3,812.25	
Sheet Pile Driving Work	III型, L = 10m	m	4,500	2.34	10,530.00	13.26	59,670.00	
Sheet Pile	III型, L = 10m, Remain	t	270	210.60	56,862.00	23.40	6,318.00	1/5 of Purchase Price
Supporting Works		t	280	18.53	5,187.00	104.88	29,365.00	
Supporting Lease		t	280	210.60	58,968.00	23.40	6,552.00	1/5 of Purchase Price
Excavation		m^3	7,500	0.20	1,462.50	1.11	8,287.50	
Backfilling		m^3	2,100	0.78	1,638.00	4.42	9,282.00	
Surplus Soil Transport		m^3	5,400	0.69	3,726.00	3.91	21,114.00	
Gravel		m^3	200	6.83	1,365.00	38.58	7,715.00	
Concrete		m^3	100	14.63	1,462.50	82.88	8,287.50	
Reinforced Concrete		m^3	1,600	15.60	24,960.00	88.40	141,440.00	
Formwork		m^2	3,500	9.75	34,125.00	9.75	34,125.00	
Rebar Fabrication and Assembly		t	272	832.00	226,304.00	208.00	56,576.00	R-bar/Concrete = 170kg/m3
Other Works		Ls	1		71,712.88		60,107.13	Structure of 25%
Building Work		m^2	40	146.25	5,850.00	438.75	17,550.00	
Total Cost					527,250.63		597,276.38	
Total Cost (roundup)					528,000		598,000	1000 US$ roundup

121 Ta Khmau Water Tank (Civil/Building Work)

Code	Items	Specification	Unit	Qty	FC Portion (US%)		LC Portion (US$)		Reference
					Unit Price	Amount	Unit Price	Amount	
121-1	Water Tower		Ls	1	399,000	399,000	541,000	541,000	
121-2	Pipe Work		Ls	1	65,000	65,000	8,000	8,000	
121-3	Site Arrangement		m^2	4500	2.25	10,125	12.75	57,375	
121-4	Tower Crane		Ls	1	90,000	90,000	10,000	10,000	
	Total					564,125		616,375	
	Total (roundup)	1000 US$ roundup				565,000		617,000	
	Total (FC+LC)				1,182,000				

121-1 Ta Khmau Water Tank -Structure

Items	Specification	Unit	Qty	FC Portion (US%)		LC Portion (US$)		Reference
				Unit Price	Amount	Unit Price	Amount	
Pile Driving Work	400×400, L = 12m Including Materials	m	1,080	9.75	10,530.00	55.25	59,670.00	L=90pcs×12m
Pile Head Treatment	400×400	pcs	90	2.93	263.25	16.58	1,491.75	
Excavation		m^3	1,100	0.20	214.50	1.11	1,215.50	
Backfilling	Backhoe	m^3	500	0.78	390.00	4.42	2,210.00	
Surplus Soil Transport		m^3	600	0.69	414.00	3.91	2,346.00	
Gravel		m^3	70	6.83	477.75	38.58	2,700.25	
Concrete		m^3	40	14.63	585.00	82.88	3,315.00	
Reinforced Concrete		m^3	1,330	15.60	20,748.00	88.40	117,572.00	
Formwork		m^2	6,600	9.75	64,350.00	9.75	64,350.00	
Rebar Fabrication and Assembly		t	226	832.00	188,115.20	208.00	47,028.80	R-bar/Concrete = 170kg/m3
Scaffolding/Supporting		m^3	17,200	1.50	25,800.00	8.50	146,200.00	
Other Works		Ls	1		85,826.31		90,569.79	Structure of 30%
Building Work		m^2	5	146.25	731.25	438.75	2,193.75	
Total Cost					398,445.26		540,862.84	
Total Cost (roundup)					399,000		541,000	1000 US$ roundup

121-2 Ta Khmau Water Tank - Pipe

Items	Specification	Unit	Qty	FC Portion (US%)		LC Portion (US$)		Reference
				Unit Price	Amount	Unit Price	Amount	
Pipe	Dia 400mm DIP	m	220	163.80	36,036.00	18.20	4,004.00	
Pipe Fitting		Ls	1		18,018.00		2,002.00	Pipe of 50%
Pipe Installation		Ls	1		10,810.80		1,201.20	Pipe of 20%
Total Cost					64,864.80		7,207.20	
Total Cost (roundup)					65,000		8,000	1000 US$ roundup

112 Raw Water Transmission Facilities (Stage 1 Chrouy Changva)

Diameter (mm)	Pipe Material	Length (m)	FC Portion (US$)		LC Portion (US$)		Reference
			Unit Price	Amount	Unit Price	Amount	
800	DCIP	0	0.00	0			
900	DCIP	0	0.00	0			
1000	DCIP	0	0.00	0			
1100	DCIP	0	0.00	0			
1200	DCIP	140	1,260.26	176,436	310	43,357	L = 140m × 1
Total		140	m	176,436		43,357	
FC+LC			**219,793**				

Summary of Distribution Pipe Length

Diameter (mm)	Ta Khumau Transmission	Prey Pring Cheung Loop	Russei Kaev Loop	WTP Churouy Chanva -2	Transmission Extend	Stage I Total
63	192	377	495	0	696	1,760
90	682	1,341	1,761	0	2,476	6,260
110	3,605	7,087	9,310	0	13,088	33,090
160	2,478	4,870	6,398	0	8,994	22,740
200	1,669	3,281	4,310	0	6,059	15,320
225	0	0	0	0	1,351	1,351
250	0	0	0	0	5,834	5,834
300	0	1,622	0	0	8,434	10,056
350	0	0	0	0	0	0
400	153	3,161	3,180	0	4,224	10,718
450	0	0	0	0	0	0
500	5,313	5,962	5,397	0	0	16,672
600	0	0	4,572	0	0	4,572
Sub-total	**14,092**	**27,701**	**35,425**	**0**	**51,156**	**128,373**
700	0	0	0	0	0	0
800	0	0	967	0	0	967
900	0	0	0	1,955	0	1,955
1000	0	0	0	0	0	0
1100	0	0	0	0	0	0
1200	0	0	0	0	0	0
sub-total	**0**	**0**	**967**	**1,955**	**0**	**2,922**
Total	**14,092**	**27,701**	**36,392**	**1,955**	**51,156**	**131,295**

131 Transmission/Distribution Pipe Cost (Dia 63 - 600mm) -Stage I (2010)

- Stage I Total

Diameter (mm)	Pipe Material	Length (m)	FC Portion (US$)		LC Portion (US$)		Reference
			Unit Price	Amount	Unit Price	Amount	
<Case A> Gravel Road & Normal Joint & No Retention Wall : 80% of Pipe Length							
63	HDPE	1,408	1.84	2,590.72	3.68	5,181.44	
90	HDPE	5,008	5.07	25,390.56	6.59	33,002.72	
110	HDPE	26,472	5.48	145,066.56	6.69	177,097.68	
160	HDPE	18,192	11.55	210,117.60	8.95	162,818.40	
225	HDPE	13,337	23.27	310,347.34	10.70	142,703.76	
250	DCIP	4,667	39.33	183,560.98	13.33	62,213.78	
300	DCIP	8,045	46.58	374,726.78	14.84	119,384.83	
350	DCIP	0	57.05	0.00	17.62	0.00	
400	DCIP	8,574	98.33	843,120.75	22.57	193,524.21	
450	DCIP	0	112.00	0.00	25.55	0.00	
500	DCIP	13,338	138.27	1,844,189.95	29.92	399,060.99	
600	DCIP	3,658	199.11	728,264.74	39.59	144,804.38	
Sub-total (CASE A)		102,698	m	4,667,375.98		1,439,792.19	
FC+LC			6,107,168				
<Case B> Asphalt Road & Mechanical Joint & Retention Wall Required : 20% of Pipe Length							
63	HDPE	352	4.30	1,513.60	16.44	5,786.88	
90	HDPE	1,252	7.73	9,677.96	19.67	24,626.84	
110	HDPE	6,618	8.14	53,870.52	19.75	130,705.50	
160	HDPE	4,548	14.42	65,582.16	22.64	102,966.72	
225	HDPE	3,334	26.54	88,489.67	26.56	88,556.35	
250	DCIP	1,167	71.35	83,251.18	53.77	62,738.84	
300	DCIP	2,011	85.42	171,796.70	59.21	119,083.15	
350	DCIP	0	103.09	0.00	63.39	0.00	
400	DCIP	2,144	172.07	368,849.25	72.44	155,282.38	
450	DCIP	0	195.27	0.00	78.26	0.00	
500	DCIP	3,334	239.26	797,788.54	85.26	284,290.94	
600	DCIP	914	341.07	311,874.41	100.78	92,153.23	
Sub-total (CASE B)		25,675	m	1,952,694.00		1,066,190.84	
FC+LC			3,018,885				
Total		128,373	m	6,620,069.97		2,505,983.03	
FC+LC			**9,126,053.00**				

132 Transmission/Distribution Pipe Cost (Dia 700 - 1200mm) -Stage I (2010)

- Stage I Total

Diameter (mm)	Pipe Material	Length (m)	FC Portion (US$)		LC Portion (US$)		Reference
			Unit Price	Amount	Unit Price	Amount	
700	DCIP	0	512.32	0.00	168.74	0.00	
800	DCIP	967	637.69	616,646.23	191.53	185,209.51	
900	DCIP	1,955	778.57	1,522,104.35	226.32	442,455.60	
1000	DCIP	0	950.23	0.00	254.42	0.00	
1100	DCIP	0	1,104.71	0.00	282.02	0.00	
1200	DCIP	0	1,260.26	0.00	309.69	0.00	
Total		2,922	m	2,138,750.58		627,665.11	
FC+LC			**2,766,416**				

Transmission/Distribution Pipe Cost (Dia 63 - 600mm) -Stage I (2010)

- Ta Khumau Transmission

Diameter (mm)	Pipe Material	Length (m)	FC Portion (US$)		LC Portion (US$)		Reference
			Unit Price	Amount	Unit Price	Amount	
<Case A> Gravel Road & Normal Joint & No Retention Wall : 80% of Pipe Length							
63	HDPE	153	1.84	282.26	3.68	564.52	
90	HDPE	546	5.07	2,766.29	6.59	3,595.63	
110	HDPE	2,884	5.48	15,804.94	6.69	19,294.72	
160	HDPE	1,982	11.55	22,892.22	8.95	17,738.99	
225	HDPE	1,335	23.27	31,072.10	10.70	14,287.56	
250	DCIP	0	39.33	0.00	13.33	0.00	
300	DCIP	0	46.58	0.00	14.84	0.00	
350	DCIP	0	57.05	0.00	17.62	0.00	
400	DCIP	122	98.33	12,035.59	22.57	2,762.57	
450	DCIP	0	112.00	0.00	25.55	0.00	
500	DCIP	4,250	138.27	587,702.81	29.92	127,171.97	
600	DCIP	0	199.11	0.00	39.59	0.00	
Sub-total (CASE A)		11,273	m	672,556.21		185,415.95	
FC+LC			857,972				
<Case B> Asphalt Road & Mechanical Joint & Retention Wall Required : 20% of Pipe Length							
63	HDPE	38	4.30	164.91	16.44	630.48	
90	HDPE	136	7.73	1,054.41	19.67	2,683.08	
110	HDPE	721	8.14	5,869.17	19.75	14,240.31	
160	HDPE	496	14.42	7,145.15	22.64	11,218.18	
225	HDPE	334	26.54	8,859.62	26.56	8,866.30	
250	DCIP	0	71.35	0.00	53.77	0.00	
300	DCIP	0	85.42	0.00	59.21	0.00	
350	DCIP	0	103.09	0.00	63.39	0.00	
400	DCIP	31	172.07	5,265.34	72.44	2,216.66	
450	DCIP	0	195.27	0.00	78.26	0.00	
500	DCIP	1,063	239.26	254,237.68	85.26	90,597.28	
600	DCIP	0	341.07	0.00	100.78	0.00	
Sub-total (CASE B)		2,818	m	282,596.27		130,452.29	
FC+LC			413,049				
Total		14,092	m	955,152.49		315,868.24	
FC+LC			**1,271,020.73**				

Transmission/Distribution Pipe Cost (Dia 700 - 1200mm) -Stage I (2010)

- Ta Khumau Transmission

Diameter (mm)	Pipe Material	Length (m)	FC Portion (US$)		LC Portion (US$)		Reference
			Unit Price	Amount	Unit Price	Amount	
700	DCIP	0	512.32	0.00	168.74	0.00	
800	DCIP	0	637.69	0.00	191.53	0.00	
900	DCIP	0	778.57	0.00	226.32	0.00	
1000	DCIP	0	950.23	0.00	254.42	0.00	
1100	DCIP	0	1,104.71	0.00	282.02	0.00	
1200	DCIP	0	1,260.26	0.00	309.69	0.00	
Total		0	m	0.00		0.00	
FC+LC			0				

Transmission/Distribution Pipe Cost (Dia 63 - 600mm) -Stage I (2010)

- Prey Pring Cheung

Diameter (mm)	Pipe Material	Length (m)	FC Portion (US$)		LC Portion (US$)		Reference
			Unit Price	Amount	Unit Price	Amount	
<Case A> Gravel Road & Normal Joint & No Retention Wall : 80% of Pipe Length							
63	HDPE	302	1.84	554.86	3.68	1,109.72	
90	HDPE	1,073	5.07	5,437.94	6.59	7,068.25	
110	HDPE	5,670	5.48	31,069.17	6.69	37,929.33	
160	HDPE	3,896	11.55	45,001.27	8.95	34,871.11	
225	HDPE	2,625	23.27	61,081.19	10.70	28,086.32	
250	DCIP	0	39.33	0.00	13.33	0.00	
300	DCIP	1,298	46.58	60,442.21	14.84	19,256.38	
350	DCIP	0	57.05	0.00	17.62	0.00	
400	DCIP	2,529	98.33	248,656.90	22.57	57,075.02	
450	DCIP	0	112.00	0.00	25.55	0.00	
500	DCIP	4,770	138.27	659,492.59	29.92	142,706.43	
600	DCIP	0	199.11	0.00	39.59	0.00	
Sub-total (CASE A)		22,161	m	1,111,736.13		328,102.57	
FC+LC			1,439,839				
<Case B> Asphalt Road & Mechanical Joint & Retention Wall Required : 20% of Pipe Length							
63	HDPE	75	4.30	324.17	16.44	1,239.39	
90	HDPE	268	7.73	2,072.75	19.67	5,274.38	
110	HDPE	1,417	8.14	11,537.55	19.75	27,993.43	
160	HDPE	974	14.42	14,045.85	22.64	22,052.57	
225	HDPE	656	26.54	17,416.14	26.56	17,429.27	
250	DCIP	0	71.35	0.00	53.77	0.00	
300	DCIP	324	85.42	27,710.25	59.21	19,207.72	
350	DCIP	0	103.09	0.00	63.39	0.00	
400	DCIP	632	172.07	108,782.65	72.44	45,796.57	
450	DCIP	0	195.27	0.00	78.26	0.00	
500	DCIP	1,192	239.26	285,293.62	85.26	101,664.02	
600	DCIP	0	341.07	0.00	100.78	0.00	
Sub-total (CASE B)		5,540	m	467,182.98		240,657.35	
FC+LC			707,840				
Total		27,701	m	1,578,919.11		568,759.92	
FC+LC			**2,147,679.03**				

Transmission/Distribution Pipe Cost (Dia 700 - 1200mm) -Stage I (2010)

- Prey Pring Cheung Loop

Diameter (mm)	Pipe Material	Length (m)	FC Portion (US$)		LC Portion (US$)		Reference
			Unit Price	Amount	Unit Price	Amount	
700	DCIP	0	512.32	0.00	168.74	0.00	
800	DCIP	0	637.69	0.00	191.53	0.00	
900	DCIP	0	778.57	0.00	226.32	0.00	
1000	DCIP	0	950.23	0.00	254.42	0.00	
1100	DCIP	0	1,104.71	0.00	282.02	0.00	
1200	DCIP	0	1,260.26	0.00	309.69	0.00	
Total		0	m	0.00		0.00	
FC+LC			0				

Transmission/Distribution Pipe Cost (Dia 63 - 600mm) -Stage I (2010)

- Russei Kaev Loop

Diameter (mm)	Pipe Material	Length (m)	FC Portion (US$)		LC Portion (US$)		Reference
			Unit Price	Amount	Unit Price	Amount	
<Case A> Gravel Road & Normal Joint & No Retention Wall : 80% of Pipe Length							
63	HDPE	396	1.84	728.93	3.68	1,457.87	
90	HDPE	1,409	5.07	7,143.97	6.59	9,285.76	
110	HDPE	7,448	5.48	40,816.42	6.69	49,828.80	
160	HDPE	5,119	11.55	59,119.39	8.95	45,811.13	
225	HDPE	3,448	23.27	80,244.02	10.70	36,897.77	
250	DCIP	0	39.33	0.00	13.33	0.00	
300	DCIP	0	46.58	0.00	14.84	0.00	
350	DCIP	0	57.05	0.00	17.62	0.00	
400	DCIP	2,544	98.33	250,151.52	22.57	57,418.08	
450	DCIP	0	112.00	0.00	25.55	0.00	
500	DCIP	4,318	138.27	596,994.55	29.92	129,182.59	
600	DCIP	3,658	199.11	728,264.74	39.59	144,804.38	
Sub-total (CASE A)		28,340	m	1,763,463.55		474,686.38	
FC+LC			2,238,150				
<Case B> Asphalt Road & Mechanical Joint & Retention Wall Required : 20% of Pipe Length							
63	HDPE	99	4.30	425.87	16.44	1,628.22	
90	HDPE	352	7.73	2,723.02	19.67	6,929.09	
110	HDPE	1,862	8.14	15,157.19	19.75	36,775.74	
160	HDPE	1,280	14.42	18,452.42	22.64	28,971.06	
225	HDPE	862	26.54	22,880.06	26.56	22,897.31	
250	DCIP	0	71.35	0.00	53.77	0.00	
300	DCIP	0	85.42	0.00	59.21	0.00	
350	DCIP	0	103.09	0.00	63.39	0.00	
400	DCIP	636	172.07	109,436.52	72.44	46,071.84	
450	DCIP	0	195.27	0.00	78.26	0.00	
500	DCIP	1,079	239.26	258,257.24	85.26	92,029.64	
600	DCIP	914	341.07	311,874.41	100.78	92,153.23	
Sub-total (CASE B)		7,085	m	739,206.74		327,456.13	
FC+LC			1,066,663				
Total		35,425	m	2,502,670.29		802,142.51	
FC+LC			**3,304,812.79**				

Transmission/Distribution Pipe Cost (Dia 700 - 1200mm) -Stage I (2010)

- Russei Kaev Loop

Diameter (mm)	Pipe Material	Length (m)	FC Portion (US$)		LC Portion (US$)		Reference
			Unit Price	Amount	Unit Price	Amount	
700	DCIP	0	512.32	0.00	168.74	0.00	
800	DCIP	967	637.69	616,646.23	191.53	185,209.51	
900	DCIP	0	778.57	0.00	226.32	0.00	
1000	DCIP	0	950.23	0.00	254.42	0.00	
1100	DCIP	0	1,104.71	0.00	282.02	0.00	
1200	DCIP	0	1,260.26	0.00	309.69	0.00	
Total		967	m	616,646.23		185,209.51	
FC+LC			**801,856**				

Transmission/Distribution Pipe Cost (Dia 700 - 1200mm) -Stage I (2010)

- WTP Churouy Chanva -2

Diameter (mm)	Pipe Material	Length (m)	FC Portion (US$)		LC Portion (US$)		Reference
			Unit Price	Amount	Unit Price	Amount	
700	DCIP	0	512.32	0.00	168.74	0.00	
800	DCIP	0	637.69	0.00	191.53	0.00	
900	DCIP	1,955	778.57	1,522,104.35	226.32	442,455.60	
1000	DCIP	0	950.23	0.00	254.42	0.00	
1100	DCIP	0	1,104.71	0.00	282.02	0.00	
1200	DCIP	0	1,260.26	0.00	309.69	0.00	
Total		1,955	m	1,522,104.35		442,455.60	
FC+LC			1,964,560				

Transmission/Distribution Pipe Cost (Dia 63 - 600mm) -Stage I (2010)

- Transmission Extend

Diameter (mm)	Pipe Material	Length (m)	FC Portion (US$)		LC Portion (US$)		Reference
			Unit Price	Amount	Unit Price	Amount	
<Case A> Gravel Road & Normal Joint & No Retention Wall : 80% of Pipe Length							
63	HDPE	557	1.84	1,024.67	3.68	2,049.34	
90	HDPE	1,981	5.07	10,042.35	6.59	13,053.08	
110	HDPE	10,470	5.48	57,376.04	6.69	70,044.83	
160	HDPE	7,195	11.55	83,104.71	8.95	64,397.16	
225	HDPE	5,928	23.27	137,950.03	10.70	63,432.11	
250	DCIP	4,667	39.33	183,560.98	13.33	62,213.78	
300	DCIP	6,747	46.58	314,284.58	14.84	100,128.45	
350	DCIP	0	57.05	0.00	17.62	0.00	
400	DCIP	3,379	98.33	332,276.74	22.57	76,268.54	
450	DCIP	0	112.00	0.00	25.55	0.00	
500	DCIP	0	138.27	0.00	29.92	0.00	
600	DCIP	0	199.11	0.00	39.59	0.00	
Sub-total (CASE A)		40,925	m	1,119,620.09		451,587.29	
FC+LC			1,571,207				
<Case B> Asphalt Road & Mechanical Joint & Retention Wall Required : 20% of Pipe Length							
63	HDPE	139	4.30	598.65	16.44	2,288.80	
90	HDPE	495	7.73	3,827.78	19.67	9,740.29	
110	HDPE	2,618	8.14	21,306.61	19.75	51,696.02	
160	HDPE	1,799	14.42	25,938.74	22.64	40,724.91	
225	HDPE	1,482	26.54	39,333.84	26.56	39,363.48	
250	DCIP	1,167	71.35	83,251.18	53.77	62,738.84	
300	DCIP	1,687	85.42	144,086.46	59.21	99,875.43	
350	DCIP	0	103.09	0.00	63.39	0.00	
400	DCIP	845	172.07	145,364.74	72.44	61,197.31	
450	DCIP	0	195.27	0.00	78.26	0.00	
500	DCIP	0	239.26	0.00	85.26	0.00	
600	DCIP	0	341.07	0.00	100.78	0.00	
Sub-total (CASE B)		10,231	m	463,708.00		367,625.07	
FC+LC			831,333				
Total		51,156	m	1,583,328.09		819,212.36	
FC+LC			**2,402,540.45**				

Transmission/Distribution Pipe Cost (Dia 700 - 1200mm) -Stage I (2010)

- Transmission Extend

Diameter (mm)	Pipe Material	Length (m)	FC Portion (US$)		LC Portion (US$)		Reference
			Unit Price	Amount	Unit Price	Amount	
700	DCIP	0	512.32	0.00	168.74	0.00	
800	DCIP	0	637.69	0.00	191.53	0.00	
900	DCIP	0	778.57	0.00	226.32	0.00	
1000	DCIP	0	950.23	0.00	254.42	0.00	
1100	DCIP	0	1,104.71	0.00	282.02	0.00	
1200	DCIP	0	1,260.26	0.00	309.69	0.00	
Total		0	m	0.00		0.00	
FC+LC			0				

M&E Rehabilitation Cost

Facility	Construction Year	M&E Construction Cost (1000US$)	Rehabilitation Cost (1000 US$)		
			First 10 year	Second 10 year	Third 10 year
			20%	30%	50%
Chamkar Mon WTP -1 (Q=10,000m3/d)	1988	7,800	1,600	2,300	3,900
Chamkar Mon WTP -2 (Q=10,000m3/d)	1995	7,800	1,600	2,300	3,900
Phum Prek WTP –1 (Q=100,000m3/d)	1995	29,400	5,900	8,800	14,700
Phum Prek WTP –2 (Q=50,000m3/d) + Intake Station	2003	17,300	3,500	5,200	8,650
Chrouy Changva WTP -1	2002	9,200	1,800	2,800	4,600
Intake + Chrouy Changva WTP -2	2008	13,200	2,600	4,000	6,600
Reservoir Pump	2008	2,500	500	800	1,250
Sludge Treatment Facility for Chrouy Changva WTP	2008	6,200	1,200	1,900	3,100
Intake + New WTP -1	2014	19,800	4,000	5,900	9,900
Sludge Treatment Facility for Phum Prek WTP	2014	6,900	1,400	2,100	3,450
Intake + New WTP -2	2019	13,900	2,800	4,200	6,950
Sludge Treatment Facility for Chamkar Mon WTP	2019	2,100	400	600	1,050

151 Well Construction (MRD Work)

Code	Items	Specification	Unit	Qty	FC Portion (US%)		LC Portion (US$)		Reference
					Unit Price	Amount	Unit Price	Amount	
151-1	Well Construction	Drilling Diameter: 10' 5/8 inches, L=60m（Soil 30m, Rock 30m)	pc	35	500.00	17,500.00	4,200.00	147,000.00	
151-2	Well Construction (Fail)	10' 5/8 inches, L=60m（Soil 30m, Rock 30m)	pc	11	500.00	5,500.00	4,200.00	46,200.00	Success Rate: 70%
151-3	Hand Pump	Eqipment (Including Lift Pipe) +Installtion	pc	35	182.70	6,394.50	1,035.30	36,235.50	
151-4	Platform	RC	pc	35	84.00	2,940.00	476.00	16,660.00	
151-5	Iron Removal Facility		pc	4	231.00	924.00	1,309.00	5,236.00	Well No. of 10%
151-6	Pumping Test		pc	46	50.40	2,318.40	285.60	13,137.60	
151-7	Water Analysis		pc	35	27.30	955.50	154.70	5,414.50	
	Total					36,532.40		269,883.60	
	Total (roundup)	1000 US$ roundup				37,000		270,000	
	Total (FC+LC)				307,000				

152 Well Construction (Grant/Loan)

Code	Items	Specification	Unit	Qty	FC Portion (US%)		LC Portion (US$)		Reference
					Unit Price	Amount	Unit Price	Amount	
152-1	Well Construction	Drilling Diameter: 10' 5/8 inches, L=60m（Soil 30m, Rock 30m)	pc	194	4,368.00	847,392.00	17,472.00	3,389,568.00	For Grant/Loan
152-2	Well Construction (Fail)	10' 5/8 inches, L=60m（Soil 30m, Rock 30m)	pc	58	4,368.00	253,344.00	17,472.00	1,013,376.00	Success Rate： 70%
152-3	Hand Pump	Eqipment (Including Lift Pipe) +Installtion	pc	194	182.70	35,443.80	1,035.30	200,848.20	
152-4	Platform	RC	pc	194	84.00	16,296.00	476.00	92,344.00	
152-5	Iron Removal Facility		pc	19	231.00	4,389.00	1,309.00	24,871.00	Well No. of 10%
152-6	Pumping Test		pc	252	50.40	12,700.80	285.60	71,971.20	
152-7	Water Analysis		pc	194	27.30	5,296.20	154.70	30,011.80	
	Total					1,174,861.80		4,822,990.20	
	Total (roundup)	1000 US$ roundup				1,175,000		4,823,000	
	Total (FC+LC)				5,998,000				

151-1 Well Costruction per one well (MRD Work)

For 1 Well

Items	Specification	Unit	Qty	FC Portion (US$)		LC Portion (US$)		Reference
				Unit Price	Amount	Unit Price	Amount	
Well Construction (excluding labor & equipment)	L=60m (Soil 30m, Rock 30m)	well	1	0.00	0.00	3,100.00	3,100.00	Estimated by JICA BD Price
Labor Cost		per･month	30	0.00	0.00	30.00	900.00	10 per/unit×3 units
Equipment		well	1	500.00	500.00	200.00	200.00	
Total Cost					500.00		4,200.00	

Unit Price

Well Construction (L=60m)

FC : nothing

LC : JICA BD Price = 1,342$+(68,817yen÷122.85yen/$) = 1,902$/well
1,902×1.15(Price Escalation) ×1.4 (Indirect Cost) = 3,062 $/well → 3,100 $/m
(excluding labor & equipment)

Equipment

FC : JICA BD Price = 388$×1.022(Transportation)×1.15 (Price Escaration) = 456 $/well → 500 $/v

LC : 456$×0.4 (Indirect Cost) = 182 $/well → 200 $/well

152-1 Well Costruction per one well (Grant/Loan)

For 1 Well

Items	Specification	Unit	Qty	FC Portion (US$)		LC Portion (US$)		Reference
				Unit Price	Amount	Unit Price	Amount	
Well Construction	L=60m（Soil 30m, Rock 30m	m	60	72.80	4,368.00	291.20	17,472.00	
Total Cost					4,368.00		17,472.00	