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MINISTRY OF INDUSTRY AND HANDICRAFT

URBAN WATER SUPPLY AND SANITATION PROJECT

(ADB PPTA: TA-8125-CAM)

SHORT FEASIBILITY STUDY FOR KAMPONG THOM SUBPROJECT

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Prepared by

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ABBREVIATIONS AND EQUIVALENTS

ADB	Asian Development Bank
ADF	Asian Development Fund
AP	Affected persons
APs/AHs	Affected persons/affected households
ASR	ADB's Annual Sector Review
BOO	Build-Operate-Own
BOT	Build-Operate-Transfer
COBP	Country Operations Business Plan
CPP	Community Participation Plan
CPS	Country Partnership Strategy
DMC	Developing Member Countries
DMF	Design and Monitoring Framework
DPWS	Department of Potable Water Supply
EA	Executing Agency
EGM	Effective Gender Mainstreaming
EMP	Environmental Management Plan
FAR	Feasibility Assessment Report
FS	Feasibility Study
GAP	Gender Action Plan
HHs	Households
IAs	Implementing Agencies
IEEs	Initial Environmental Examinations
IOL/SES	Inventory of Losses and Socioeconomic Survey
IR	Inception Report
ISCD	Institutional Strengthening & Capacity Development
JICA	Japan International Cooperation Agency
LARP	Land Acquisition and Resettlement Plan
LARF/LARP	Land Acquisition and Resettlement Framework and Plan
MEF	Ministry of Economy and Finance
MIH	Ministry of Industry and Handicraft
MOU	Memorandum of Understanding
MOWRAM	Ministry of Water Resources Management and Meteorology
MPWT	Ministry of Public Work and Transport
MRD	Ministry of Rural Development
NCB	National Competitive Bidding
NRW	Non-revenue Water
O&M	Operation and Maintenance
PAM	Project Administration Manual
PDIH	Provincial Department of Industry and Handicraft
PDR	People Democratic Republic
pm	Person-months
PMU	Project Management Unit
PPP	Public Private Participation
PPPs	Public-Private Partnership
PPTA	Project Preparation Technical Assistance
PPWSA	Phnom Penh Water Supply Authority
REA	Rapid Environmental Assessment

RRP	
SCS	Stakeholder Communication Survey
SPS	Safeguards Policy Statement
SRWSA	Siem Reap Water Supply Authority
SR	Safeguards Requirements
TA	Technical Assistance
TOR	Terms of Reference
WOPs	Water Operators' Partnerships
WTP	Water Treatment Plant

UNITS

ha	Hectare
lpcd	Liters per capita per day
l/s	Liters per second
m	Meter
mg/l	Milligrams per Liter
mm	Millimeter
m^3/day	Cubic meters per day

Figure 1-1 - Location of Project Towns

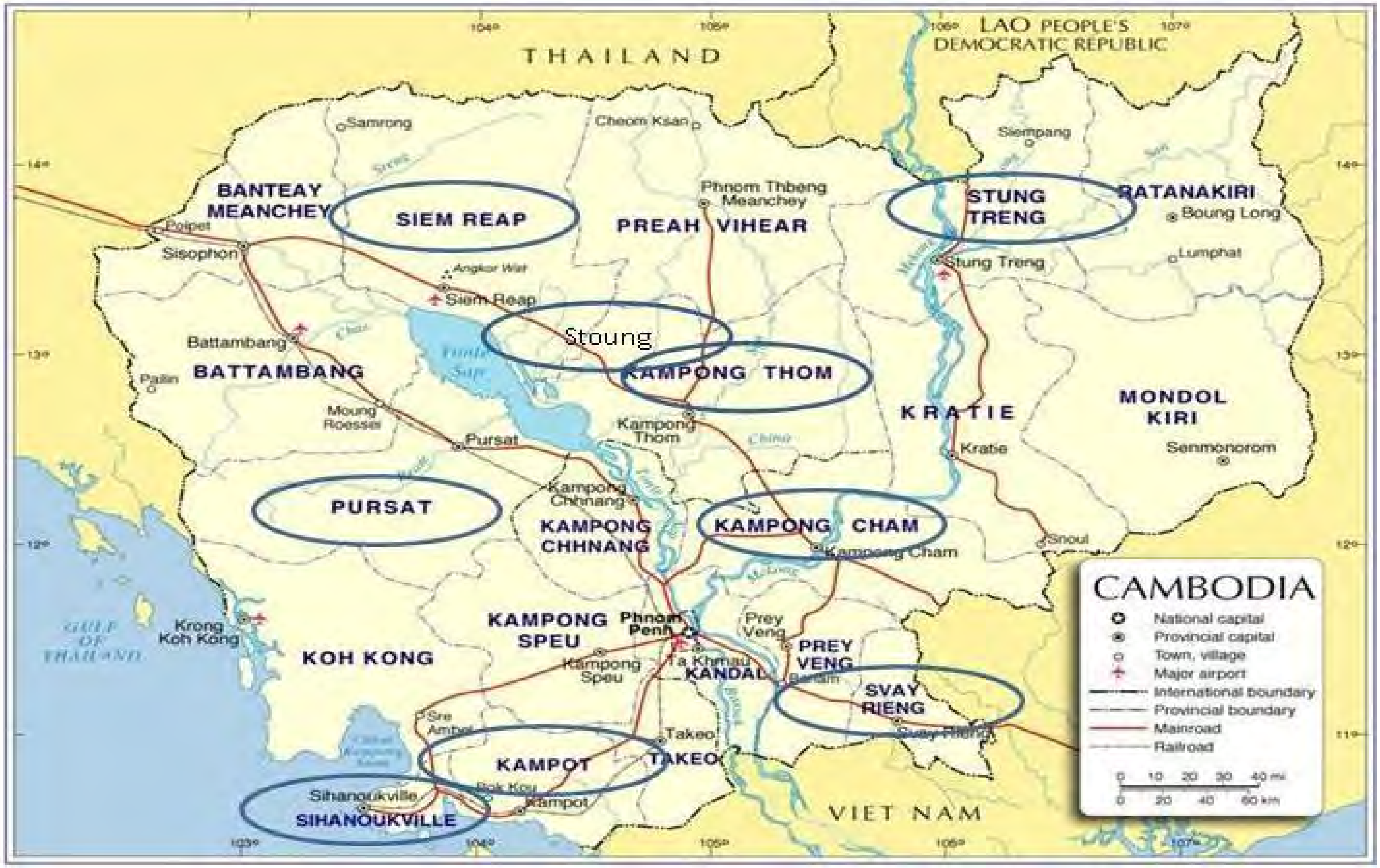
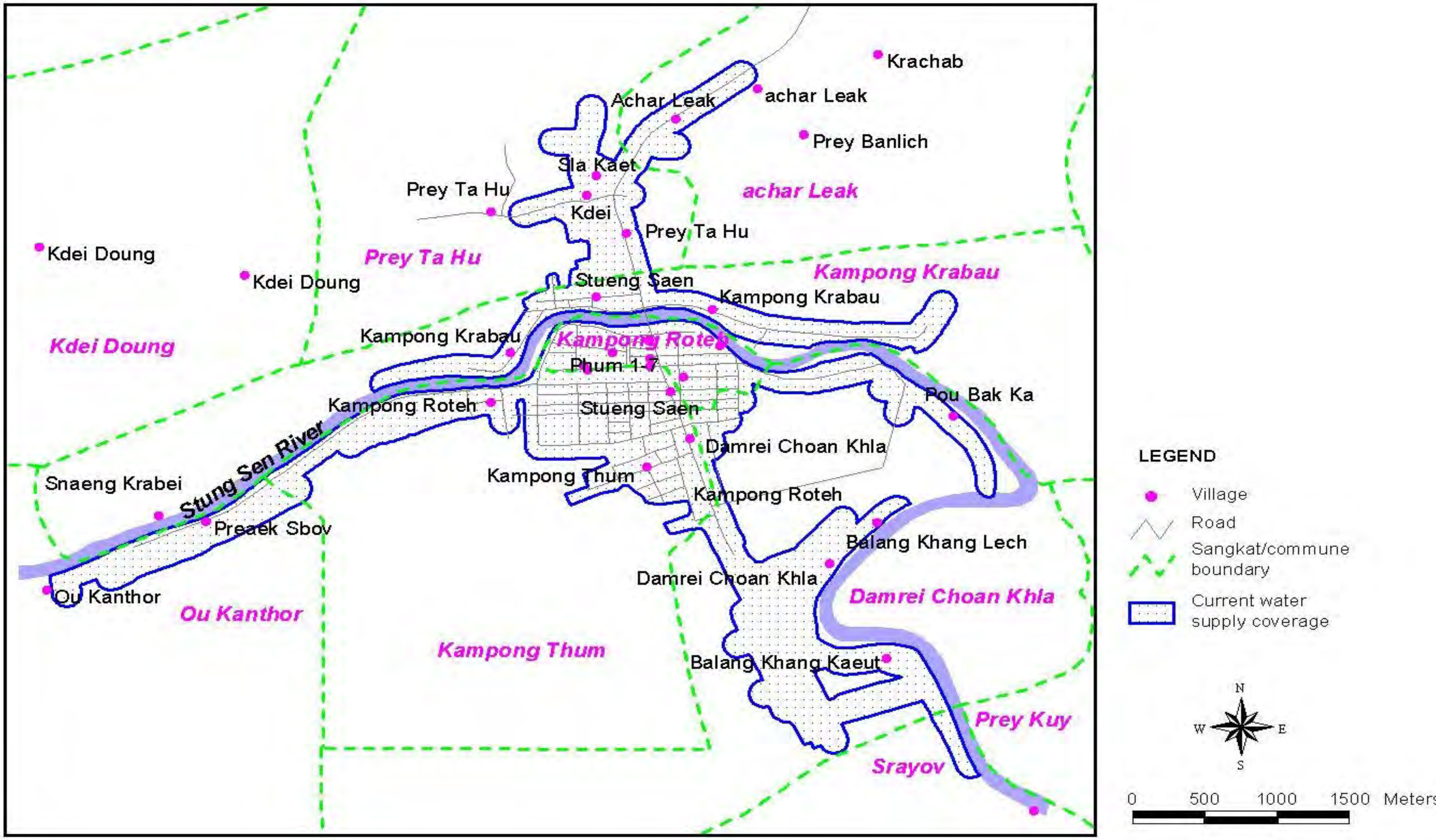


Figure 1-2 Location Plan of Proposed Kampong Thom Subproject



1. EXECUTIVE SUMMARY

1.1 Project Description

1. Expected outputs of the overall Project include: (i) water treatment plants provided or improved in eight towns; (ii) water distribution systems improved and coverage increased in six towns; (iii) existing pumping stations rehabilitated in five towns; and (iv) institutional capacity of MIH and regulatory system strengthened, under a piggy-backed technical assistance.

1.2 Rationale

2. During 2011, through the ADB's Water Operators' Partnerships Program, ADB was able to re-engage in the urban water supply sector with MIH. Consequently ADB's Country Operations Business Plan 2010-2013 includes an Asian Development Fund loan for the Project for approval in 2014. The UWSP will assist the government to address the three core constraints identified in the ADB Country Partnership Strategy (2011-2013): (i) insufficient funds to expand coverage and improve services; (ii) weak sector planning and implementation capacity of responsible authorities at the central and sub-national levels; and (iii) inadequate (or sometimes weak) institutional and legal framework.

1.3 Background

3. The proposed Project "Urban Water Supply Project " (UWSP) will provide necessary facility improvements to the six provincial towns previously funded by ADB and to three provincial towns that have been funded by other bilateral or multilateral agencies, and expand public access to sustainable and safe water supply services for the urban population in Cambodia. In addition, the Project will address institutional weaknesses through the development of improved institutional structures, a regulatory framework, and appropriate capacity development.

1.4 Project Impact and Outcome

4. The impact of the proposed Project will be expanded access to sustainable and safe water supply services for the urban population in Cambodia and better functioning water treatment plants providing higher quality water. MIH targets are to increase the proportion of the urban population in the project area with access to safe water to 85% by 2018 and 90% by 2025, and the project will assist these aims. The outcome of the project will be improved water supply infrastructure and service provisions in selected provincial waterworks.

1.5 Candidate Towns

5. There are nine candidate towns: Kampong Cham, Kampong Thom, Kampot, Pursat, Siem Reap, Sihanoukville, Stoung, Stung Treng and Svay Rieng. Originally Battambang was to be included but this was removed at the request of the Provincial Waterworks.

1.6 Feasibility Study Context

6. The feasibility studies include: (i) needs assessment, supply and demand analysis, (ii) selection of technology, equipment, and facilities for the identified subprojects considering least cost and life cycle approach and the capacities of the local authorities to manage, operate, and maintain; (iii) assessment of economic and financial viability and sustainability for each of the subprojects; (iv) assessment of policy and legal capacity, including other institutional issues and mechanisms related to the financial management, procurement, and anticorruption; (v) poverty, social, and gender analysis and preparation of a poverty and social strategy, a gender action plan, stakeholder communication survey (SCS), and a Community Participation Plan (CPP), where required; and (vi) review of impacts on environment, involuntary resettlement, and indigenous peoples.

1.7 Subproject Description

1.7.1 Output 1 - Water Supply Development

7. The Kampong Thom subproject aims to improve the provision of safe, affordable, reliable piped water supply to individual household connections to communities within the eight core sangkats having Y2012 population of about 45,947. The works proposed under the PPTA are summarised in Table 1.1 below and described in detail in Section 5.2.2.

1.7.2 Output 2 – Strengthening of Institutional capacity of MIH and Regulatory System

8. The Institutional Strengthening and Capacity Development is to (i) identify key stakeholders; (ii) assess institutional capacity constraints; (iii) develop institutional capacity building plan; and (iv) prepare terms of reference for strengthening sector regulation TA.

1.8 Cost Estimate

9. The subproject cost is estimated at $0.804 million equivalent, including taxes and duties. Table 1.1 provides a summary of the Kampong Thom Subproject cost estimate.

Table 1.1: Kampong Thom Subproject Cost Estimate ($'000's)

No	Description	Totals (inc tax) US$000
2	**Water Supply Development**	
2.1	Replace 2 raw water pumps with submersible pumps. Current pumps have long shafts which cause vibration & overheating. projections.	80.0
2.2	Replace motor fans and bearings on clear water pumps	5.0
2.3	Increase water storage with 2,000m^3 capacity. Demolish and remove existing 200m^3 tank	300.0
2.4	Riverbank protection with gabion baskets	60.0
2.5	Filters need 4 new manual gate valves for drains.	15.0
2.6	Replace old pipeline network with 3 km (DN110mm HDPE)	100.0
2.7	Replace filter block inlet gate valve 500mm	20.0
2.8	Replace current gas chlorination system	50.0
2.9	Addition of sludge drying bed	10.0
2.10	Bladder tank for clear water surge protection	10.0
2.11	Gate valves and meters for zoning purposes	15.0
2.12	Re-route alum dosing pipe with ABS pipe	5.0
	Total for Water Supply Development	
	TOTAL ESTIMATED BASE COST[a]	**670.0**
	Contingencies 20%	134.0
	TOTAL ESTIMATED SUBPROJECT COST	**804.0**

1.9 Executing Agency and Implementation Arrangements

10. MIH will be the Executing Agency, and the existing project management unit (PMU) based in the Department of Potable Water Supply (DPWS) will be expanded to execute and manage the Project on behalf of MIH with the consulting service to be provided by the project implementation

assistance consultants (PIAC). The Project implementing units (PIUs) are expected to be organized by the nine (9) implementation agencies (IAs) of the provincial waterworks. The nine (9) PIUs will be responsible for day-to-day coordination and supervision of subproject implementation in these provincial towns.

1.10 Implementation Period

11. The proposed Project is scheduled for implementation over five years from 2014 to 2018. The final design is proposed for a one year period between mid-2014 and mid-2015. Following this, a two year construction period would have the works commissioned in August 2017. A proposed Implementation schedule is included in Appendix A.

1.11 Procurement

12. The procurement shall be carried out under International Competetive Bidding (NCB) as three packages; one package Stung Treng; one package Siem Reap; and the remaining 7 subprojects as one package. The full Procurement Plan is contained in the Supplementary Appendices of the main PPTA report.

1.12 Consulting Services

13. The project implementation assistance consultants (PIAC) on the design and engineering review, tendering assistance, and construction management are provided under Bank financing will be selected in advance and engaged in accordance with the ADB's Guidelines on the Use of Consultants. An individual consultant will be engaged to prepare the PIAC terms of reference and to assist the EA on the preparation of the Request for Proposal. The PIAC consulting services will be signed once the loan becomes effective to provide under a single consulting package, by an association of international and domestic consulting firms. The lead consulting firm will provide the services of the Team Leader who will be responsible for managing the overall consulting services during the project implementation.

1.13 Subproject Benefits and Beneficiaries

14. The Kampong Thom subproject aims to improve the provision of safe, affordable, reliable piped water supply to individual household connections to communities within the eight core sangkats having Y2012 population of about 45,947.

1.14 Land Acquisition and Compensation

15. The overall project has Involuntary Resettlement Categorisation C because all of the improvement facilities are within the water treatment plant compound. The Land Acquisition Due Diligence report for Kampong Thom is contained in Appendix G.

1.15 Environmental Impacts

16. An Initial Environmental Examination (IEE) was carried out for Kampong Thom, and is contained in Appendix F. The subproject is classified as Category B. The overall conclusion is that providing the mitigation, compensation and enhancement measures are implemented in full, there should be no significant negative environmental impact as a result of location, planning, design, construction and operation of the project. There are benefits stemming from recommended mitigation and enhancement measures, and major improvements in quality of life and individual and public health once the project is in operation.

1.16 Economic and Financial Analyses

17. Economic and Financial analyses for Kampong Thom is contained Section 7, and in full in Appendix D.

1.17 Tariff and Affordability

18. Assuming a 0% loan, tariff increases required are 5 to 20% (average) in 2015, 2021, and in 2023 (Table 1.2). The proposed tariff rates for government and commercial customers are higher

than the first block tariff to allow cross subsidy between customer categories. For KTPWW service area, the estimated monthly income belonging to the poor households for 2013 is KR 670,000. Using the affordability criteria, the monthly water bill is about KR 10500 (KR 1500 x 7 m3) in 2015 is only 1.6% of the monthly income of poor households. In all subsequent years the monthly water bill is less than 5% of the estimated monthly income. Hence, the proposed level of water tariff is deemed affordable to the low income or poor households.

Table 1.2: KTPWW Proposed Tariff Rate - 0% Loan

Category	**2015**	**2018**	**2021**	**2023**
Household, 0 to 7 m3	1,500	1,500	1,600	1,650
above 7 m3	2,000	2,000	2,100	2,200
Government	2,000	2,000	2,100	2,200
Commercial	2,100	2,100	2,300	2,450
Tariff Increase (average)	20%	0%	6%	5%

Source: Consultant’s estimate

2. PROJECT RATIONALE, IMPACT AND OUTCOME

2.1 Rationale

19. During 2011, through the ADB's Water Operators' Partnerships Program, ADB was able to re-engage in the urban water supply sector with MIH. In January 2012, MIH signed a twinning agreement with the PPWSA, which is currently providing support to four provincial waterworks been included in the Project through direct peer-to-peer knowledge transfer. In February 2012, the Ministry of Economy and Finance (MEF) requested ADB to consider financing the Project in accordance with the strategy of Cambodia's Public Debt Management, to ensure sustainable economic growth. Consequently ADB's Country Operations Business Plan 2010-2013 includes an Asian Development Fund loan for the Project for approval in 2014. The project supports the ADB's annual sector review, country partnership strategy, and the water operational plan 2011–2020

20. The UWSP will assist the government to address the three core constraints identified in the ADB Country Partnership Strategy (2011-2013): (i) insufficient funds to expand coverage and improve services; (ii) weak sector planning and implementation capacity of responsible authorities at the central and sub-national levels; and (iii) inadequate (or sometimes weak) institutional and legal framework.

2.2 Background

21. The proposed Project "Urban Water Supply Project " (UWSP) will provide necessary facility improvements to the six provincial towns previously funded by ADB and to three provincial towns that have been funded by other bilateral or multilateral agencies, and expand public access to sustainable and safe water supply services for the urban population in Cambodia. In addition, the Project will address institutional weaknesses through the development of improved institutional structures, a regulatory framework, and appropriate capacity development.

22. This UWSP is in line with (i) Cambodian National Strategic Development Plan (2009-2013) and (ii) action plan of Ministry of Industry and Handicraft (MIH) to facilitate private sector partnerships, strengthening the management of public owned waterworks, and integration urban water supply with urban environmental management. The proportion of the urban population in the project area with access to safe water will be increased to 85% by 2018 and 90% by 2025 as targeted by MIH. In addition, a potential target date for 100% coverage could be assumed as 2030.

2.3 Project Outline

23. The feasibility studies include: (i) needs assessment, supply and demand analysis, (ii) selection of technology, equipment, and facilities for the identified subprojects considering least cost and life cycle approach and the capacities of the local authorities to manage, operate, and maintain; (iii) assessment of economic and financial viability and sustainability for each of the subprojects; (iv) assessment of policy and legal capacity, including other institutional issues and mechanisms related to the financial management, procurement, and anticorruption; (v) poverty, social, and gender analysis and preparation of a poverty and social strategy, a gender action plan, stakeholder communication survey (SCS), and a Community Participation Plan (CPP), where required; and (vi) review of impacts on environment, involuntary resettlement, and indigenous peoples.

2.4 Project Impact and Outcome

24. The impact of the proposed Project will be expanded access to sustainable and safe water supply services for the urban population in Cambodia and better functioning water treatment plants providing higher quality water. MIH targets are to increase the proportion of the urban population in the project area with access to safe water to 85% by 2018 and 90% by 2025, and the project will assist these aims. The outcome of the project will be improved water supply infrastructure and service provisions in selected provincial waterworks.

3. Profile of Kampong Thom Area

3.1 Town Location and Profile

25. Kampong Thom city is the capital of Kampong Thom Province and is on National Road 6 approximately half way between Phnom Penh and Siem Reap on the east side of the Tonle Sap lake. The Sen river runs through the city, the source of which is the Tonle Sap.

26. Agriculture is the primary industry in the Province

3.2 Natural Features

3.2.1 Topography

27. Kampong Thom is a flat area on the river Sen flood plain close to the centre of Cambodia and east of the Tonle Sap. There are no hills in the area

3.2.2 Climate

28. The climate, in common with other non-coastal areas of Cambodia, is hot all year with a distinct rain season May – October and a drier season November – February.

3.2.3 Surface water

29. There is only one surface water source in Kampong Thom, the Sen river. This is currently used by some private households and also by the Water Authority as the raw water source.

3.2.4 Groundwater

30. The existing water supply system uses groundwater from two older boreholes. Water quality is monitored regularly and is good, with close to neutral pH and turbidity, although with some colour especially during the wet season.

3.3 Population and Household Characteristics

31. The populations provided below are for the service area within Kampong Thom.

Table 3.1: Kampong Thom Population Characteristics

No	Core Sangkhat	2012 Pop'n.	No. HH	Persons/ HH	M/F Ratio
1	Domrey Chhan Klar	7,238	1,534	4.7	0.98
2	Kampong Thom	2,744	559	4.9	0.95
3	Kampong Rotes	5,035	1,168	4.3	0.83
4	O Kunthor	5,049	1,140	4.4	0.94
5	Kampong Krobav	4,791	1,015	4.7	0.99
6	Prey Tahuo	6,020	1,494	4.0	1.00
7	Archar Lak	6,241	1,480	4.2	0.93
8	Sro Yov Sangkat	8,829	1,925	4.5	0.96
		45,947	**10,315**		0.98

3.3.1 Population Growth and Migration

32. Population growth from the 2008 National Survey1 shows an average national urban growth rate of 2.21%. For the purposes of this study we have used growth rates for individual towns, provided by each Provincial Waterworks2. For Kampong Thom this is 0.15% showing a low growth rate.

3.4 Existing Water Supply and Sanitation

3.4.1 Water Supply

33. The existing water supply system was started in 1946 under the period of colonial rule, with only one commune served and with a low capacity of 50m3/day. In 1962 this was rehabilitated and expended to provide 350m3/day, and a 350m3 elevated reservoir added3. The current water treatment plant was built under the ADB Provincial Towns water supply project and commissioned in 2006, with a capacity of 5,760m3/day. There was a 5003m elevated reservoir under this project and the older 350m3 elevated reservoir is no longer used.

34. The system when commissioned served 6 communes, but currently in 2013 serves 8 communes with a population of 45,947. The Sen river is the source and raw water is delivered by two (duty/standby) pumps from an intake chamber which is filled through two intake pipes, one wet season (higher) and one dry season (lower). The Provincial Waterworks have problems with these raw water pumps, the shafts between motor and pump being too long. They vibrate and cause overheating and damage to the pumps. There is a makeshift floating pontoon with two smaller pumps in place to supply raw water when the main pumps are out for service for maintenance.

35. The conventional treatment plant includes flocculation, sedimentation, rapid sand filtration and storage.

36. Upon inspection, there is a lot of flocc being carried over onto the filter, blocking them and causing them to require backwashing more often than usual. The water is alkaline and so measured quantities of lime is needed to adjust pH before adding alum. The pH adjustment is not being done accurately causing the flocc problem. It was recommended to the IA (outside the scope of this PPTA) to substitute the use of polyaluminium chloride instead of lime and aluminium sulphate (alum).

37. The Provincial Waterworks has reported only 44% utilisation of the WTP capacity. These figures can be misleading. This percentage was based on the average 2012 annual production and the correct WTP capacity of 5,760m3/day. In reality the average annual production was estimated from pump running hours, as there are no working bulk meters at the WTP. Before using these utilisation figures for any future planning they must be confirmed with bulk metering and the establishment of an accurate NRW estimate based on bulk meter readings, domestic consumption and a top-down water balance.

[1] General Population Census 2008 National Report, August 2009

[2] Data collected by head of each commune

[3] Source:Water supply Master Plan 2009.

4. POPULATION GROWTH AND WATER DEMAND FORECASTS

4.1 General

38. Kampong Thom is the capital city of the Province and acts as a market for the surrounding area.

39. At present, there is no agro-processing or industrial development in Kampong Thom consuming water or which could affect water quality, and nothing planned. There is no mine in the region. The area has large rubber plantations as well as rice growing and fisheries from the Tonle Sap.

4.2 Population Projections

40. The population projections4 are set out in Table 4.1. Within the core villages, total population is forecast to increase from about 45,947 in 2012 to about 47,133 in 2030.

Table 4.1: Population Projections for Kampong Thom's Core Villages

Year 2012 Population	Growth Rate %	Forecast Population 2014	Forecast Population 2020	Forecast Population 2025	Forecast Population 2030
45,947	0.15	46,085	46,501	46,851	47,133

4.3 Water Demand Forecasts

4.3.1 General Approach

41. Whilst the scope of proposed works under this project does not include increasing the capacity of the Kampong Thom water supply system, demand forecasts have been produced to illustrate the shortfall of available treated water into the near future. Water demand forecasts for the Kampong Thom subproject were prepared by making separate projections of each component of demand, including:

- Demand for domestic use (based on per capita consumption, coverage targets and population projections);
- Demand for industry (based on a % of domestic use, and specific allowances for large industries);
- Demand for services (based on a % of domestic use, and specific allowances for large services areas);
- Physical losses as a % of total demand, excluding the demand of large industrial zones.
- Production losses in treatment plant (based % of total demands).

4.3.2 Domestic Consumption

42. Water demand and consumption data for other provincial and district towns in Cambodia show that domestic consumption accounts for about 90% of total demand. Per capita consumption figures for urban water supply systems in Cambodia can vary widely, particularly with strong reliance on rainwater collection during the wet season. Experience in other towns in Cambodia indicates that piped connections directly to the house will usually increase water consumption over time. The Feasibility Study has adopted a per capita consumption figure of 120 lpcd, plus 10% for non-domestic use which includes demand from industry and services, 15% for physical losses (leakage), and 50m3/day for backwashing filters in the WTP.

[4] 2012 populations and growth rate provided by the Provincial Waterworks

4.3.3 Water Demand Forecasts

43. Table 4.2 summarizes the demand forecasts and design criteria for the Kampong Thom subproject. By 2030, the average daily water production demand is expected to be 9,500m3/day, comprising 72% domestic consumption, with the remaining 28% being for institutions, public use, services, handicraft and small industries, and allowances for physical losses and backwashing the filters.

Table 4.2: Water Demand Forecasts for Kampong Thom Subproject

No.	Items	Unit	Forecasts				
			2012	2014	2020	2025	2030
A.	**Domestic Demand**						
1	Growth Rate	%	0.15	0.15	0.15	0.15	0.15
2	Population in Core Area		45,947	46,085	46,501	46,851	47,133
3	Coverage in Core Area	%	90	100	100	100	100
4	Population with Piped Water	No.	41,352	46,085	46,501	46,851	47,133
5	Per Capita Consumption	l/c/d	120	120	120	120	120
6	Total Domestic Demand	m3/d	4,962	5,530	5,580	5,622	5,656
B.	**Non-domestic demand**						
1	Services, Schools, Small Industry, Institutions, Hotels	%	20	20	20	20	20
2							
3	Total Non-domestic demand	m3/d	992	1,106	1,116	1,124	1,131
C.	**Subtotal Water Demand All Categories**	m3/d	5,955	6,636	6,696	6,747	6,787
D.	**Non Revenue Water (NRW) in Distribution system**						
1	NRW as % Average Daily Water Production	%	15	15	15	15	15
2	NRW (physical losses only-pipelines and WTP)	m3/d	893	995	1,004	1,012	1,018
E.	**Average Daily Water Production (C+D) rounded**	m3/d	6,850	7,630	7,700	7,760	7,810
F.	**Peak Annual Water Demand (Max day Max month)**						
1	Peak Annual Water Demand		1.20	1.20	1.20	1.20	1.20
2	Peak Annual Water Demand	m3/d	8,220	9,156	9,240	9,312	9,372
3	Peak Annual Water Demand	l/s	95	106	107	108	108
G.	**Required Treatment Plant Output (rounded)**	m3/d	8,220	9,160	9,240	9,310	9,370
H.	**Treatment Plant Backwashing**						
1	Treatment Plant Backwashing	m3/d	50	50	50	50	50
I.	**WTP Capacity**						
1	Required WTP Capacity	m3/d	8,270	9,210	9,290	9,360	9,420
2	Required WTP Capacity	l/s	95.72	106.60	107.52	108.33	109.03
	Total Required Source Capacity (Rounded)	**m3/d**					**9,500**
	Total Required Source Capacity	**l/s**					**110.00**

4.3.4 Future Demand Requirements

44. The table shows that the existing water treatment plant from 2006, at 5,760m3/day, is already insufficient to meet demand with 2014 demand projected at 9,210m3/day. This subproject is not intended to address future demands, but to rehabilitate the current existing WTP assets, improve water quality and improve security of supply.

45. A further 3,740m3/day of treated water will be required to meet projected 2030 demands.

5. SUBPROJECT DESCRIPTION

5.1 Introduction

46. The proposed works are designed to improve operational improvements, increased water quality and security of supply. This improved water supply scheme is not designed to increase capacity of supply.

5.2 Output 1: Water Supply Development

47. Expected outputs of the overall Project include: (i) water treatment plants provided or improved in eight towns; (ii) water distribution systems improved and coverage increased in six towns; (iii) existing pumping stations rehabilitated in five towns; and (iv) institutional capacity of MIH and regulatory system strengthened, under a piggy-backed technical assistance.

5.2.1 Preliminary Designs

48. The proposed water supply scheme design improvements are based on limited topographical, hydrological and water quality data, and are preliminary.

5.2.2 Description of Proposed Water Supply System

49. The Kampong Thom subproject aims to improve the provision of safe, affordable, reliable piped water supply to individual household connections to communities within the eight core sangkats having Y2012 population of about 45,947.

50. The works proposed under the PPTA are summarised in Table 5.1 below;

Table 5.1: Proposed new infrastructure for Kampong Thom

Kampong Thom	Short FS	A - Replace 2 raw water pumps with submersible pumps. Current pumps have long shafts which cause vibration & overheating. projections.
		B- Replace motor fans and bearings on clear water pumps
		C- Increase water storage with 2,000m^3 capacity. Demolish and remove existing 200m^3 tank
		D - Riverbank protection with gabion baskets
		E - Filters need 4 new manual gate valves for drains.
		F- Replace old pipeline network with 3 km (DN110mm HDPE)
		G - replace filter block inlet gate valve 500mm
		H- Replace current gas chlorination system
		I- Addition of sludge drying bed
		J - Bladder tank for clear water surge protection
		K - Gate valves and meters for zoning purposes
		L - Re-route alum dosing pipe with ABS pipe

5.2.2.1 Raw water pump replacement

51. The current raw water pumps were commissioned in 2006 and cause problems with the long shaft between motor (at the surface) and the pump approximately 15m below. They are Aurora vertical turbine pumps5. It is proposed to replace them with submersible pumps mounted

[5] 3 stage, 1475rpm, 30HP, Q=241m^3/hr at 25m dynamic head. Identical pumps were installed at Battambang.

on an auto-coupling with guide rails for easy removal from the well. As the WTP capacity is not being increased, new pumps will be sized to match current WTP capacity.

52. Friction loss calculations and the pump duty curve are in Appendix H.

5.2.2.2 Replace motor fans and bearings on clear water pumps.

53. The original motor fans no longer work and need replacing. Due to overheating, bearings have seized and require replacement.

5.2.2.3 Increase clear water storage

54. The current clear water storage is only 200m3, and is on limited space between the existing WTP inlet chamber, clear water pump building, and the flocculation/sedimentation tank. A 2,000m3 ground storage tank was requested but the size is dependent on the available space. The current 200m3 tank will have to be demolished prior to construction of the new larger storage facility.

5.2.2.4 Riverbank protection

55. An area of riverbank close to the intake has collapsed recently, very close to the boundary fence of the WTP. Some gabion basket protection is required to stop further land slippage occurring which could affect the structures of the clear water pump station or the proposed new clear water storage.

5.2.2.5 New gate valves for filters

56. There are eight 200mm gate valves on the top of the for filters, one inlet and one backwash for each. They were installed as actuated gate valves bit none of the actuators now work, and some of the gate valves are also inoperable. It is proposed that all actuators be removed and gate valves no longer working properly be replaced.

5.2.2.6 Replace 3km of pipe

57. Three kilometers of DN110mm is required for replacement of old cast iron pipe. The IA has requested PN10 as lower wall thicknesses have had problems with leakage when installing tapping saddles for domestic connections. The locations of the proposed pipeline can be seen in Appendix J.

5.2.2.7 Replace 500mm gate valve on filter inlet

58. This valve does not operate properly and needs replacement so that the combined filter block can be isolated if required.

5.2.2.8 Replacement of Gas Chlorination system

59. The current gas chlorination system installed under the 2006 ADB project is a high quality European brand, but has failed both at Kampong Thom and the other 5 towns under this previous project. This may be due to poor installation or lack of locally available spares. Repairs have been made with locally available materials rather than proprietary parts which is dangerous when used with pressurized chlorine gas.

60. Some design faults identified with the brand installed have been identified, being;

- The pressure gauges appear to have no diaphragm and no oil filled chamber to separate the chlorinated water from the meter workings. This has caused corrosion in all 6 towns.
- The existing set-up has hoses and pipes connecting the one tonne chlorine cylinders to a regulator. Leaks in this hose and pipe arrangement causes high pressure chlorine leaks. A better design is to have a vacuum regulator directly connected to the cylinder. If pipe downstream of the vacuum regulator leaks, the vacuum is broken and the regulator closed, sealing the valve and preventing leaks.

- The existing system does not have a heater on the cylinder outlet. This serves to ensure that the liquid chlorine in the cylinder turns to gas before it leaves the cylinder valve. During transportation of the cylinder to the site, the liquid chlorine is disturbed and often fills the fixed internal outlet tube. If not heated and vapourised this liquid chlorine can damage equipment downstream.
- A gas scrubber system should be provided with the gaseous chlorination system as a safety measure. This is lacking at Kampong Thom presently. The scrubber removes the chlorine from the air in the event of a serious leak in the system.
- It is recommended to replace the entire chlorination system with a brand that is available locally or at least regionally, with after sales service and easy access to spare parts. For the purpose of this Feasibility Study, the same manufacturer as used at PPWSA has been selected and invited to provide a proposal and budget price. This is contained in Appendix B.

5.2.2.9 Add sludge drying bed

61. There is currently no sludge drying bed for Kampong Thom. To meet environmental standards one is required.

5.2.2.10 Addition of bladder tank for clear water surge protection

62. The IA reported surge in the clear water system. To remedy this a bladder tank is recommended to be sited inside the WTP area just downstream of the clear water pumps.

5.2.2.11 Valves and meters for zoning

63. The IA wishes to set up several DMA's[6] close to the river bridge. The gate valves and meters required for this are listed in Table 5.2 below.

Table 5.2: Equipment for zoning

Size (mm)	Gate valve Qty	Bulk meter Qty
300	3	-
150	4	3
200	-	1

5.2.2.12 Replace and reroute alum dosing pipe

64. The alum delivery pipe from the 3 storey mixing building currently runs from the second storey down to ground level then back up the flocculation tank wall to the dosing point. This low point causes alum sludge to settle out and block the pipe. Additionally, the pipe is uPVC and is exposed to the elements and UV deterioration. The pipe is to be replaced with UV resistant ABS, and rerouted to pass directly from the mixing building to the top of the flocculation tank.

5.3 Consultation Activities during Preparation of Kampong Thom Feasibility Study

65. A series of community visits and consultations occurred during the finalization of the 2013 Feasibility Study to inform district and village authorities about the subproject and gather information and feedback from local authorities, people living in core villages and other stakeholders. Consultation activities during the project site visits in 2013 are detailed below:

(i) Initial reconnaissance visit March 2013: Team Leader and National water engineer visited the site for an initial inspection and discussion with the Provincial Waterworks.

[6] District metering areas

(ii) Second engineering site visit 1st May 2013:International and National water engineers visited Kampong Thom facility, collected data, and finalized scope following Inception workshop.

(iii) Socio-economic specialist visit: a visit for the purpose of carrying out the public consultation was undertaken on 18-27th June

(iv) Environmental and Resettlement specialist visit: This joint visit was carried out between June 3rd -11th to collect data to aid the finalization of the IEE and LACP.

5.4 Operation and Maintenance of Project Facilities

5.4.1 Capacity to Operate and Maintain the Proposed Water Supply System

66. The Kampong Thom Provincial Waterworks have many years experience in operating and maintaining their treatment plant, and have full time Operator staff. There is a good understanding of how pumps work and the routine maintenance required.

67. The proposed new submersible pumps will require far less maintenance than the current well pumps with their overly long rotating shafts which vibrate badly. The proposed pumps come with autocouplings and guide rails which enable the pumps to be disconnected from the pipework and raised to the surface easily by one man. In addition there is a service agent present in capital Phnom Penh should spares or assistance be required.

68. The proposed new gas chlorination equipment is similar to the current equipment, but if the recommended manufacturer is used, there will be far greater options for professional servicing and provision of spares as needed. The proposed model is the same as used in Phnom Penh by PPWSA, and there is an agent in Phnom Penh that can provide servicing. Problems faced with the current gas chlorination equipment are mainly due to a lack of a regional office to provide support, spares and technical assistance when required. Whilst the preferred equipment cannot be specified by manufacturer, for future operation it would be beneficial to the Water Authority.

5.4.2 Management Arrangements

69. The PIAC will provide Project technical, safeguards, accounting and management assistance on a daily basis as well as support the PIUs with project implementation

70. At the start of Project implementation, the PMU and PIAC will (i) update the initial environment examinations and due diligence reports (IEEs and DDRs) and prepare EMPs submit to MOE for review and approval; (ii) clear potential unexploded ordnance (UXO) remain on site; and (iii) acquire necessary land before subproject bids are tendered.

5.4.3 Operation and Maintenance Plans

71. The Operation and Maintenance plan for each subproject can be divided into two types, those with a full conventional WTP and those with chlorinated groundwater being pumped to an elevated tank and fed into supply. For Kampong Thom, an Operation and Maintenance Plan reflecting the former has been developed and is presented in full in Appendix I.

5.5 Lessons learned in Cambodia and the SE Asia region

72. There are several "lessons learned" in both the region and inside the national water sector that would benefit the 9 project towns under this PPTA;

- As at PPWSA, use of standardized chlorination equipment that has a regional office that can offer technical support, spares and specialist staff when needed. PPWSA has selected equipment supplied by Severn Trent Services (STS), and equipment from this manufacturer has been recommended for the towns requiring replacement chlorination equipment under this study. STS have a main office in Singapore, but have local representation in Phnom Penh. However, final selection of equipment of equal or better specifications will be decided at tendering as specific brands cannot be specified in Contract documents.

- High density polyethylene pipe (HDPE) is favoured in Cambodia, even for larger diameters. As most of Cambodia is flat, as are all of the 9 towns under this study, system pressures are not higher than 60m head. As such, a PN6 rated pipe would be sufficient. However, experience has shown that for the pipes un to and including 90mm diameter, which may have domestic connections tapped from them, a PN8 minimum pipe is required, even for very low pressures. The reason for this is that the tapping saddles used can deform the thinner pipe wall thicknesses on PN6 pipe, which causes leakage.
- Automated valves linked to a central control panel were designed and installed under the 2006 Provincial Towns project. All of these have failed in the 6 towns where they were installed. The lesson here is to keep the WTPs simple and keep valves as manually operated. With the relatively smaller size of these WTPs (mostly under 6,000m^3/day), valve automation is not necessary and inappropriate.
- Alum and poly dosing lines under the previous Provincial Towns project used long lengths of uPVC pipe that followed buildings and structures, necessitating several 90 degree bends and causing significant headloss in the delivery pipe. This has caused the pipes to get blocked by sediment. In addition, the uPVC dosing pipes are exposed to direct sunlight. UV light will break down uPVC pipe over time. A better solution, as used in two recent projects in Laos, is to use ABS (acrylonitrile butadiene styrene) pipe, and select a more direct route for the pipe, minimizing bends and low points.
- For the water sector as a whole, a database of all water projects could be set up, to include design drawings, calculations, contract documents, demand calculations, feasibility reports, final design reports and other useful documentation, for each system. This would serve as an easily accessible online resource library for all Water Authority staff in the country. It is relatively easy and inexpensive (under US$40,000) to set up and populate, and solves the common problem of drawings and documents getting lost. Many of the available hard copy resources for Cambodian water supply systems are either misplaced, or are reportedly stacked in disorder in a storeroom so dirty that nobody is willing to enter. Such a database was set up and released in neighbouring Laos in 2012-13 with assistance from UNHabitat, and can be viewed at;

http//:laowtp.info
by pressing “login as guest”.

- Several of the project towns under this PPTA have had extensions added to serve areas that were outside of the original design core area, without considering required design pressures or treatment plant capacity. This often results in the WTP being operated above its design capacity, which can reduce water quality, and often has negative effects on service pressure to other parts of the reticulation network. Typically, to increase system pressure to serve these unplanned extensions, water is diverted around any elevated storage tank and pumped directly into the system in order to increase delivery pressure by a few metres head. This is bad operating practice as it eliminates the storage facility and increases leakage loss. Any pipeline extensions should be made in a planned way and carried out simultaneously with WTP capacity upgrades as required.

5.6 Public Private Partnerships

73. Options and viability for potential PPP for Kampong Thom subproject was discussed with the Director of the Department of Potable Water Supply[7].

74. In common with all towns in general, the urban water supply systems are seen as best managed by the government where possible. Installation and commissioning of the elements of work under this subproject require specialist contractors and involvement of public bodies is limited.

75. There are some peri-urban areas in Cambodia where whole water supply concessions have been granted to private companies to construct and manage water supply systems. This is not strictly PPP, as the private company needs only to acquire a license – there is no partnership as such. There are both good and bad examples of these private concessions throughout the country.

76. A possible area where a PPP could be utilized in the future is in the supply of bulk treated water to customers who are either just outside of the WTP service area or are inside the area but receive low pressure. Private water tankers could be used to fill up with (and pay for) treated water from the WTP and deliver and sell to customers with their own storage tanks.

5.7 Contract Packaging of Subproject

77. A number of packaging options were examined and discussed between the PPTA team, MIH and ADB. These options are presented below in Table 5.3.

Table 5.3: Subproject Contract Packaging Options

No. packages	Subproject Towns included	Advantages/disadvantages
2	Stung Treng Siem Reap plus 7 rehab towns	**Advantages:** • Small number of packages reduces tendering and contract management admin. • Larger packages makes them more attractive to international bidders. • Easier to standardise on equipment. **Disadvantages:** • Limited opportunity for NCB
3	Stung Treng Siem Reap 7 rehab towns	**Advantages:** • Three good sized packages attractive to ICB bidders • Small number of packages reduces tendering and contract management admin. • Easier to standardise on equipment **Disadvantages:**

[7] Mr Tan Sokchea

		• Limited opportunity for NCB
4	Stung Treng Siem Reap 3 southern rehab towns (Svay Rieng, Kampot, Sihanoukville) 4 northern towns (Kampong Cham, Kampong Thom, Pursat, Stoung)	**Advantages:** • 2 larger and 2 smaller packages, the smaller of which could be NCB if an exception to the $1M limit relaxed **Disadvantages:** • More tender and contract management admin • More difficult to standardise on equipment with larger number of packages.
9	9 separate contracts	**Advantages:** • Each IA is responsibe for their own subproject and has direct ownership • 7 of the 9 subprojects could be let as NCB **Disadvantages:** • More tender and contract management admin • Some activities may not be suitable for many national contractors due to lack of specialist experience. • More difficult to standardise on equipment with larger number of packages.

78. During discussions, initially the option of two large contracts, one for Stung Treng and one for the other 8 towns, was favoured for the simplicity of the bidding process, contract administration, and the attractiveness of the larger packages to international bidders.

79. After further discussion, 9 separate contracts was favoured, as greater weight was put on having the contracts out to tender quickly, and having 7 of them of a size that would permit NCB would help achieve this. The procedures for approving and tendering NCB are far less time consuming compared to ICB. Additional benefits would be that each IA would have ownership of their own subproject, and that national contractors would benefit from both the experience and the business.

80. A perceived obstacle with having 7 of the subprojects as NCB is the technical nature of some of the rehabilitation work. Installation and commissioning of gas chlorination equipment, bladder tanks for surge protection, and proper construction of filter underdrains are all areas requiring a degree of specialist knowledge and experience. For this reason, coupled with the simplicity of having a lesser number of contract packages, a compromise of three packages was selected, being Stung Treng, Siem Reap, and the 7 rehabliitation subprojects.

81. These 3 packages will all need to be ICB due to their value, but this does not exclude national contractors from bidding, provided they meet the prequalification requirements.

Additionally, if national contractors have difficulty meeting prequalification requirements, they can still benefit from these contracts by subcontracting.

6. COST ESTIMATE AND LEAST COST ANALYSIS

6.1 Cost Estimates

82. The subproject cost is estimated at $0.804 million equivalent, including taxes. A summary of the cost estimates is given in Table 6-1.

Table 6-1 - Subproject Capital Cost

No	Description	Totals (inc tax)
		US$000
2	**Water Supply Development**	
2.1	Replace 2 raw water pumps with submersible pumps. Current pumps have long shafts which cause vibration & overheating. projections.	80.0
2.2	Replace motor fans and bearings on clear water pumps	5.0
2.3	Increase water storage with 2,000m^3 capacity. Demolish and remove existing 200m^3 tank	300.0
2.4	Riverbank protection with gabion baskets	60.0
2.5	Filters need 4 new manual gate valves for drains.	15.0
2.6	Replace old pipeline network with 3 km (DN110mm HDPE)	100.0
2.7	Replace filter block inlet gate valve 500mm	20.0
2.8	Replace current gas chlorination system	50.0
2.9	Addition of sludge drying bed	10.0
2.10	Bladder tank for clear water surge protection	10.0
2.11	Gate valves and meters for zoning purposes	15.0
2.12	Re-route alum dosing pipe with ABS pipe	5.0
2.13	**Total for Water Supply Development**	
	TOTAL ESTIMATED BASE COST[a]	**670.0**
	Contingencies 20%	134.0
	TOTAL ESTIMATED SUBPROJECT COST	**804.0**

Source: Consultant's estimate, 2013

6.2 Least cost analysis

83. No least cost analysis was carried out for Kampong Thom as alternative solutions were not presented for consideration.

7. SUBPROJECT FINANCIAL AND ECONOMIC ASSESSMENT

7.1 Approach and Methodology: Financial Assessment

84. The financial analysis was done in three levels: (i) examination of the historical and current financial performance; (ii) evaluation of the feasibility of the proposed subproject under UWSP; and (iii) evaluation of the financial sustainability taking into account the impact of the proposed subproject to the future operation of PWWs and WSA.

85. Following the Asian Development Bank (ADB) guidelines8, four basic indicators for the financial viability of a water supply project have been identified. These are the following:

- Financial Internal Rate of Return (FIRR). It is the discount rate at which the revenues and costs generated by the project are equal to zero. A project is considered financially viable if the computed FIRR is equal to or higher than the weighted average cost of capital (WACC) that is used in financing the development of the proposed water supply project.
- Debt Service Coverage Ratio (DSCR). It measures the solvency of the PWWs/WSA and shows how many times debt service for a given period is covered by operations. DSCR should at least be 1.3 after project completion.
- Annual cash balance. Projected annual cash balances should be positive all throughout the projection period.
- Tariff affordability. Household monthly water bill should not be more than 5% of the average monthly household income of the low income group.

7.1.1 Financing Plan.

86. The project will be financed by ADB and the national government. Part of the ADB and national government funds will be on-lent to the PWWs/ WSA. Annual debt service was estimated based on preliminary discussions with MIH and MEF. The on-lending terms for the purpose of this study are as follow:

- Maturity period of 32 years, including 8 years grace period on principal payment while interest is capitalized during construction;
- Fixed interest rate[9] of 1.25% per annum for the first 8 years and 1.75% per annum for the next 24 years; and
- Foreign exchange risk to be borne by the national government.

7.1.2 Proposed Water Tariff.

87. Three scenarios were tested in the design of the water tariff based on the amount of loan, as a percent of project costs, passed on to the 8 PWWs. For Siem Reap WSA, 100% loan was assumed. For the 8 PWWs, the three scenarios tested were: (1) 0% loan-100% grant; (2) 50% loan-50% grant; and (3) 100% loan-0% grant.

7.1.3 Other Assumptions

88. The main assumptions used in the financial projections include:

- Estimates of annual water revenues are based on the total water billed for the year and the corresponding tariffs for the same year. Connection fees, for non-poor household customers

[8] ADB, *Financial Management and Analysis of Projects* (2005).

[9] ADB's interest rate to the national government is 1% and 1.5% respectively.

are included as other revenues and assumed to be paid by the customers in 24 equal installments.

- The investment cost of the proposed project and the O&M costs are prepared on an annual basis in August 2013 prices. Increases in costs due to inflation are covered through a provision for price contingencies both for the investment costs and the O&M costs.

- The incremental O&M costs, which is the difference between "with the project" and "without the project" scenario, were used in the evaluation. O&M costs include: 1) administration; 2) chemical; 3) power; 4) maintenance of facilities; 5) salaries and wages; and 6) other O&M items.

- Projected O&M costs "without the project" are based on actual O&M costs as presented in the historical revenue and expense statements. It is assumed that there will be minimal increases in the service connections as water supply demand approaches the maximum water supply capacity of the existing system, hence there will be no increases in the number of personnel. The unit cost of O&M is assumed to increase following the local inflation rate.

- Projected O&M costs "with the project", except maintenance of facilities, are based on historical unit costs. Maintenance of facilities cost is based on engineering estimate of the required maintenance level of the facilities.

- Depreciation allowance is considered a non-cash item. However, for purposes of estimating the net income, it was included as expense in the projected income statement. Annual depreciation costs for the new facilities were calculated using the straight-line method based on the service life[10] of each type of asset.

- Water tariff "without the project", is assumed to increase in the future to cover increases in O&M. For purposes of the projection, it is assumed that water tariffs will have to be increased by 5% starting 2015 and every four years thereafter until 2027 for Siem Reap, Stung Treng and Svay Rieng; for Kampong, because current tariff is low, the assumed increases are 10%.

- Water Revenue "without the project". As mentioned earlier, since the existing facilities are already nearing its maximum operating capacities, it is assumed that there will be no further additional connections after the water supply capacities are reached in 2017. Volume of water sold after this period will remain constant. Any increase in projected revenue is then due to the assumed increase in water tariff.

- Water Revenue "with the project". Based on the technical study, the proposed improvements in the water supply system can provide the water requirements of the projected beneficiaries up to year 2019 (Siem Reap) to 2023 (Kampong Cham, Stung Treng and Svay Rieng). The volume of water sold is therefore assumed to increase up to that year and is assumed to remain constant at the that level. Any increase in projected revenue after this period is then due to the assumed increase in water tariff.

7.2 Approach and Methodology: Economic Assessment

89. The economic analysis was undertaken in accordance with the procedures set out in the ADB Handbook for the Economic Analysis of Water Supply Projects (1999) and related ADB guidelines11. The period of analysis extends over 30 years from the start of project implementation in 2015 up until 2044. Costs and benefits were quantified at August 2013 prices and were converted to their economic cost equivalents using shadow prices. Both costs and benefits were treated as increments to a "without the project" situation.

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[10] Using PWWs/WSA asset life schedule.

[11] *Guidelines for the Economic Analysis of Projects (1997).*

90. The economic viability of the project was determined by computing the economic internal rate of return (EIRR) and comparing the result with the economic opportunity cost of capital (EOCC) of 12%. An EIRR exceeding the assumed EOCC indicates that the project is economically viable. The viability of the investments was then tested for changes in key variables such as capital costs, O&M costs and benefits through sensitivity analysis. Distribution of project benefits and poverty impact analysis were also undertaken to determine how much of the net economic benefits resulting from the investments will directly benefit the poor.

91. The economic viability of the proposed investments in water supply was determined considering the following benefits: (1) incremental gross revenue; (2) the value of time saved for not having to collect water from existing non-piped sources; (3) medical cost savings due to reduced morbidity from waterborne diseases; and (4) avoided income loss (productivity savings) because of reduced incidence of diseases. Economic costs were derived from the estimates of capital investments and O&M costs in financial terms, removing all duties and taxes and multiplying the net results by the conversion factors (CF). The following CFs were applied: 1.0 for traded goods and non-traded goods, and 0.7 for unskilled labor.

92. The proposed investments which aim to improve the population's access to piped water supply in the area, will form part of the Government's overall development plan for the water supply sector, which also aims to achieve the targets set under the Millennium Development Goal12.

7.3 Kampong Thom Provincial Waterworks (KTPWW)

93. A full financial and economic analysis report can be found in Appendix D.

7.3.1 Historical Financial Performance

94. From 2008 to 2012, KTPWW's revenue was able to cover total expenses but with a small margin. For the same period, only 60 to 90% of total expenses and depreciation were covered by total revenues. Operating ratio ranged from 1.1 to 1.7 from 2008 to 2012. Current ratios were high for the five-year period while account receivable as of end 2012 was high at 65 days equivalent of annual water sales.

Table 7.1: KTPWW Financial Indicators, 2008-2012

Financial Indicators	2008	2009	2010	2011	2012
Cost Recovery:					
Total expenses	1.0	1.2	1.2	1.1	1.2
Total expenses & Depreciation	0.6	0.7	0.7	0.7	0.9
Current Ratio	15.4	44.4	244.1	101.4	30.1
Operating Ratio	1.7	1.5	1.4	1.4	1.1
Account Receivable (Days)	69	64	59	62	65

[12] MDG's Target No. 10, Goal No. 7: Halve, by 2015 the proportion of people without sustainable access to safe drinking water and sanitation. For urban water supply in Cambodia, people with access to safe drinking water is about 64% in 2004. Per MDG, this should reach 80% by 2015. Source: Key Indicators of Developing Asian and Pacific Countries, 2006, ADB.

7.3.2 Projected Financial Performance

7.3.2.1 Investment Costs.

95. Assuming a 50% loan, the total investment cost for the water supply project is about KR 3750 million, including price and physical contingencies and interest during construction. Table 7.2 presents a summary of the investment costs.

Table 7.2: KTPWW Total Investment Cost (KR million)

Items	% Total	Total
Civil Works	57.2	2,145
Equipment and Materials	7.8	291
Total Base Cost	65.0	2,436
Physical Contingency	13.0	487
Price Contingency	12.2	457
Total Contingencies	25.2	944
Interest During Construction	0.8	31
Taxes and Duties	9.0	338
Total Cost	100.0	3,750

Source: Consultant's estimate

7.3.2.2 Financing Plan.

96. The project based on a 50% loan, will be financed by KR 1890 million loan including interest during construction of KR 31 million. Grant will come from the government (KR 372 million) and from ADB fund (KR 1488 million). The financing plan is shown in Table 7.3.

Table 7.3: KTPWW Financing Plan (KR million)

Items	% Total	Total
ADB Loan (on-lending)	50.4	1,890
Disbursement	49.6	1,859
Interest During Construction	0.8	31
Government (grant)	49.6	1,859
Own Fund	9.9	372
ADB Fund	39.7	1,488
Total	100.0	3,750

Source: Consultant's estimate

7.3.2.3 Water Tariff.

97. Assuming a 0% loan, tariff increases required are 5 to 20% (average) in 2015, 2021, and in 2023 (Table 7.4). For loans of 50% and 100%, the required tariffs are shown in Table 7.5. The proposed tariff rates for government and commercial customers are higher than the first block tariff to allow cross subsidy between customer categories.

Table 7.4: KTPWW Proposed Tariff Rate - 0% Loan

Category	2015	2018	2021	2023
Household, 0 to 7 m3	1,500	1,500	1,600	1,650
above 7 m3	2,000	2,000	2,100	2,200
Government	2,000	2,000	2,100	2,200
Commercial	2,100	2,100	2,300	2,450
Tariff Increase (average)	20%	0%	6%	5%

Source: Consultant's estimate

Table 7.5: KTPWW Proposed Tariff Rate – 50 or 100% Loan

Category	2015	2018	2021	2023
Household, 0 to 7 m3	1,500	1,500	1,600	1,650
above 7 m3	2,000	2,000	2,100	2,300
Government	2,000	2,000	2,100	2,300
Commercial	2,100	2,100	2,300	2,650
Tariff Increase (average)	26%	0%	6%	9%

Source: Consultant's estimate

7.3.2.4 Affordability of Water Rates.

98. For KTPWW service area, the estimated monthly income belonging to the poor households for 2013 is KR 670,000. Using the affordability criteria, the monthly water bill is about KR 10500 (KR 1500 x 7 m3) in 2015 is only 1.6% of the monthly income of poor households. In all subsequent years the monthly water bill is less than 5% of the estimated monthly income. Hence, the proposed level of water tariff is deemed affordable to the low income or poor households.

7.3.2.5 Impact of the Project on the KTPWW's Financial Operation.

99. Selected financial indicators were computed to provide an indication of the KTPWW's future financial performance (Table 7.6).

- Revenues can cover O&M cost and depreciation allowance from 2015 to 2025;
- Current ratio is high between 6 and 11;
- Operating ratio is less than 1 starting in 2015 indicating that total operating revenue is higher than total operating cost;
- Debt service coverage ratio is higher than 1.3 for all the projection years; and
- Accounts receivable is 18 days equivalent of annual revenue.

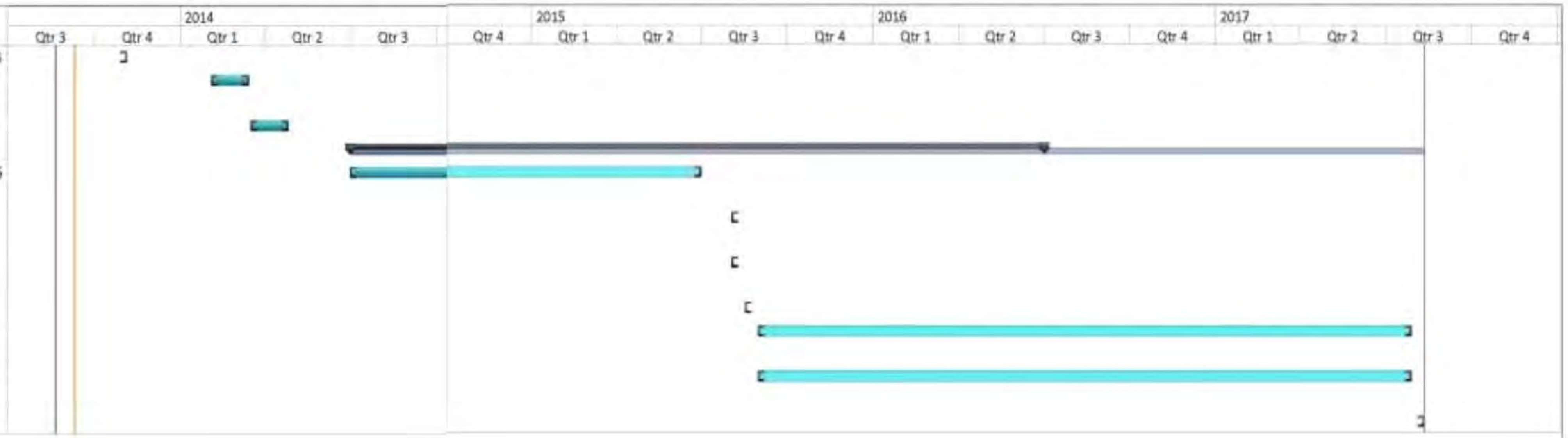
Table 7.6: KTPWW Summary of Financial Indicators (50% Loan)

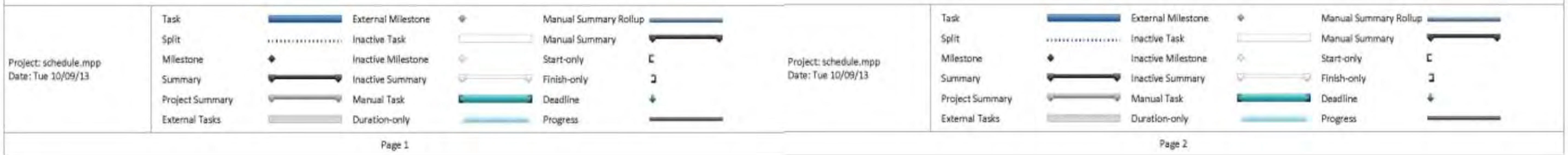
Financial Indicators	2015	2016	2017	2018	2019	2020	2025
Cost Recovery:							
O&M	1.43	1.40	1.56	1.51	1.44	1.40	1.39
O&M + Depreciation	1.10	1.08	1.14	1.09	1.06	1.04	1.08
Current Ratio	6.79	7.58	8.88	9.58	10.30	11.07	10.99
Operating Ratio	0.93	0.94	0.90	0.93	0.95	0.96	0.94
Debt Service Coverage Ratio	-	-	-	-	36.99	34.96	8.97
Account Receivable (Days)	18	18	18	18	18	18	18

Source: Consultant’s estimate

Appendix A: Kampong Thom Subproject Implementation Schedule

ID		Task Mode	Task Name	Duration	Start	Finish
1			Completion of PPTA			Mon 4/11/13
2			Tendering of Implementation project	30 days	Mon 3/02/14	Fri 14/03/14
3			Tender evaluation	30 days	Mon 17/03/14	Fri 25/04/14
4			**Final design & contract management**	**524 days**	**Tue 1/07/14**	**Fri 1/07/16**
5			Final design & contract documentation	261 days	Tue 1/07/14	Tue 30/06/15
6			Tenders close - construction package 1		Mon 3/08/15	
7			Tenders close - construction package 2		Mon 3/08/15	
8			Tender award - package 1 & 2		Mon 17/08/15	
9			Construction Package 1 - Stung Treng	500 days	Mon 31/08/15	Fri 28/07/17
10			Construction Package 2 - Siem Reap plus 7 others	500 days	Mon 31/08/15	Fri 28/07/17
11			Commissioning			Fri 11/08/17





Appendix B: Cost Estimate Breakdowns for Kampong Thom Subproject

Appendix C: Water Quality Test Results for Kampong Thom Subproject

Annual test results are published for all 9 subproject towns. The data presented here is from the "Annual Report on Water Quality Analysis 2010, 1st Edition, MIH".

Month average	Temp (C)	Turbidity NTU	Res chlorine (mg/l)	pH	Colour TCU	TDS (mg/l)	Conductivity (us/cm)
LIMIT		**<5**	**0.2-0.5**	**6.5-8.5**	**<5**	**800**	**1600**
Jan	27.8	1	0.96	6.82	4.8		83
Feb	29.4	1	0.83	6.81	4.7		83
Mar	29.8	1	0.86	6.75	5		83
Apr	30.6	1	0.9	6.81	4.8		94
May	30.9	1.2	0.74	6.72	4.9	49	99
Jun	29.3	3.2	0.7	6.7	9.8	49	97
Jul	27.5	2.9	0.61	6.68	5.6	52	103
Aug	28.5	2.5	0.53	6.46	6.3	45	90
Sept	28.9	1.8	0.73	6.69	4.7	43	86
Oct	28.4	1.2	0.83	6.68	3.8	40	80
Nov	28.1	1.5	0.94	6.69	4.2	44	88
Dec	27.7	1.1	0.81	6.68	2.6	43	87

Appendix D: Kampong Thom Subproject Financial and Economic Analysis

Appendix E: deleted

Appendix F: Environmental Due Diligence report for Kampong Thom Subproject

Appendix G: Land acquisition due diligence report

Appendix H: Pump calculations and duty curves

Appendix I - Outline Operation and Maintenance Plan

Operational Procedures

WTP area	Procedure
Raw water pumps	Can be controlled (on/off) by level transducers in the main clear water tank, or manually by Operator.
Flocculation tank inlet weir	Set so that there is always a hydraulic break between water in the inlet channel and the first flocc channel.
Flocculation tank baffles	Baffle slot sizes on lower end of alternate baffles, which are calculated and specified during final design, should be adhered to. When baffles are moved during cleaning of the flocc tank, these slot sizes should be reset to the design dimensions. Failure to do this may result in incorrect velocity gradient across the flocc tank resulting in poor flocc formation.
Sed tank collection launders	The stainless steel collection launders should be set at a level that allows for the prescribed headloss across the flocc tank. If the launders are set too high it has the effect of "backing up" the flocc tank and reducing the hydraulic gradient across it. This is normally set during design by calculating the hydraulics across the full WTP, but is sometimes neglected.
Filters – bypass of water	For filters to operate properly, the plenum floor that holds up the gravel and sand layers needs to be sealed. No water should pass between the plenum floor and the vertical filter walls, or through the plenum floor except through the inserted filter nozzles. Additionally, water should not be allowed to take a "short cut" between the edge of the sand layer and the filter wall. This can be stopped by roughening the inside filter wall with a sand/cement mix.
Filters – backwashing	Filters should be backwashed when the sand becomes sufficiently blocked with debris and silt to slow the passage of water through the media. This can be judged by marking a dirty water level inside the filter, and when it is reached, a backwash is due. Similarly a low water level mark should be visible and this minimum water level in the filter kept by partially closing the clean water outlet valve to the clear water tank. The backwash cycle begins with air scour by itself to loosen the sand media and help release dirt. This should carry on for around 3-5 minutes. The air blower is then turned off and backwash valve opened partially at first and then gradually opened further, in order to maintain the design backwash flowrate as the head in the backwash tank decreases. The backwash valve should never be just opened fully for the backwash cycle.
Reticulation	
Washout valves	All washout valves on the system, installed at low points, should be opened every month to flush out the line as required.
Valves on the distribution system	Valves should be kept either fully open or fully closed.

Maintenance Schedule

Raw water pumps	New submersible pumps should be raised using the auto-coupling & guiderails once per year to inspect the pumps and perform routine maintenance.
Flocculation tank	The flocc tank should be taken offline, one chamber at a time (there are 2 chambers), and cleaned out using shovels and a water blaster. Any repairs to baffles or replacement of rotten wooden baffles can take place at this time.
Sedimentation tank	The sedimentation tank should be taken offline, one at a time, and cleaned out annually.
Slide gates on all tanks	These should be inspected regularly and if not opening and closing easily, remedial action taken – either lubrication of threads or replacement of rubber seals.
Filters	Filter media will gradually become more blocked over time despite regular backwashing. Approximately every 5 years the sand and gravel media will need either removing and thoroughly washing before replacement, or new graded & washed sand placed. At this time, the nozzles and underdrains can also be inspected for damage.
Dosing pipelines	Check for leaks regularly and fix. Clean up spills and leaks.
Chemical mixing area	Keep floor clean
Chemical mixing tanks	When alum and poly tanks start to fill to the outlet pipe level with sediment they should be taken offline and cleaned out.
Pumps & blowers – general	Maintenance plan to follow manufacturers manual
Chlorination equipment - general	Maintenance plan to follow manufacturers manual
Reticulation	
Gate valves	All gate valves on the pipelines should be kept either fully shut or fully open as required.
Washout valves	Any washout valves, normally installed at low points, should be periodically (6 monthly) opened to flush out any debris.
Chambers	All valve chambers should be kept dry, clean and accessible.
Domestic connections	Any leaks on the upstream side of the meter should be recorded by meter readers and repaired promptly.
Physical leaks	All leaks reported or noticed by WA staff should be repaired promptly.

Appendix J - Map of proposed pipelines

KINGDOM OF CAMBODIA
MINISTRY OF INDUSTRY AND HANDICRAFT

URBAN WATER SUPPLY AND SANITATION PROJECT

(ADB PPTA: TA-8125-CAM)

SHORT FEASIBILITY STUDY FOR KAMPOT SUBPROJECT

November 2013

Prepared by

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APPENDICES

ABBREVIATIONS AND EQUIVALENTS

ADB	Asian Development Bank
ADF	Asian Development Fund
AP	Affected persons
APs/AHs	Affected persons/affected households
ASR	ADB's Annual Sector Review
BOO	Build-Operate-Own
BOT	Build-Operate-Transfer
COBP	Country Operations Business Plan
CPP	Community Participation Plan
CPS	Country Partnership Strategy
DMC	Developing Member Countries
DMF	Design and Monitoring Framework
DPWS	Department of Potable Water Supply
EA	Executing Agency
EGM	Effective Gender Mainstreaming
EMP	Environmental Management Plan
FAR	Feasibility Assessment Report
FS	Feasibility Study
GAP	Gender Action Plan
HHs	Households
IAs	Implementing Agencies
IEEs	Initial Environmental Examinations
IOL/SES	Inventory of Losses and Socioeconomic Survey
IR	Inception Report
ISCD	Institutional Strengthening & Capacity Development
JICA	Japan International Cooperation Agency
LARP	Land Acquisition and Resettlement Plan
LARF/LARP	Land Acquisition and Resettlement Framework and Plan
MEF	Ministry of Economy and Finance
MIH	Ministry of Industry, Mines and Energy
MOU	Memorandum of Understanding
MOWRAM	Ministry of Water Resources Management and Meteorology
MPWT	Ministry of Public Work and Transport
MRD	Ministry of Rural Development
NCB	National Competitive Bidding
NRW	Non-revenue Water
O&M	Operation and Maintenance
PAM	Project Administration Manual
PDIH	Provincial Department of Industry and Handicraft
PDR	People Democratic Republic
pm	Person-months
PMU	Project Management Unit
PPP	Public Private Participation
PPPs	Public-Private Partnership
PPTA	Project Preparation Technical Assistance
PPWSA	Phnom Penh Water Supply Authority
REA	Rapid Environmental Assessment

RRP	
SCS	Stakeholder Communication Survey
SPS	Safeguards Policy Statement
SRWSA	Siem Reap Water Supply Authority
SR	Safeguards Requirements
TA	Technical Assistance
TOR	Terms of Reference
WOPs	Water Operators' Partnerships
WTP	Water Treatment Plant

UNITS

ha	Hectare
lpcd	Liters per capita per day
l/s	Liters per second
m	Meter
mg/l	Milligrams per Liter
mm	Millimeter
m^3/day	Cubic meters per day

Figure 1-1 - Location of Project Towns

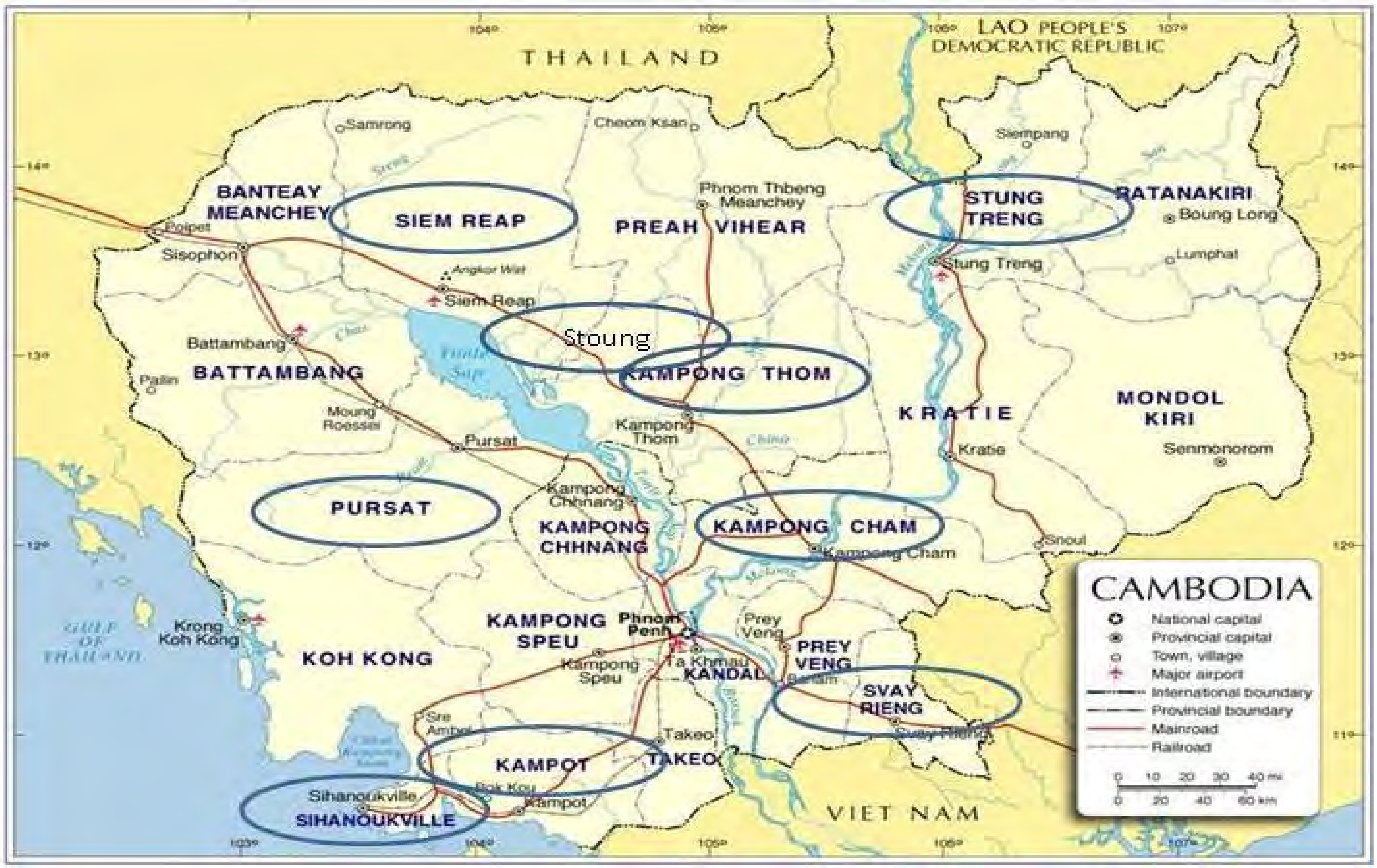
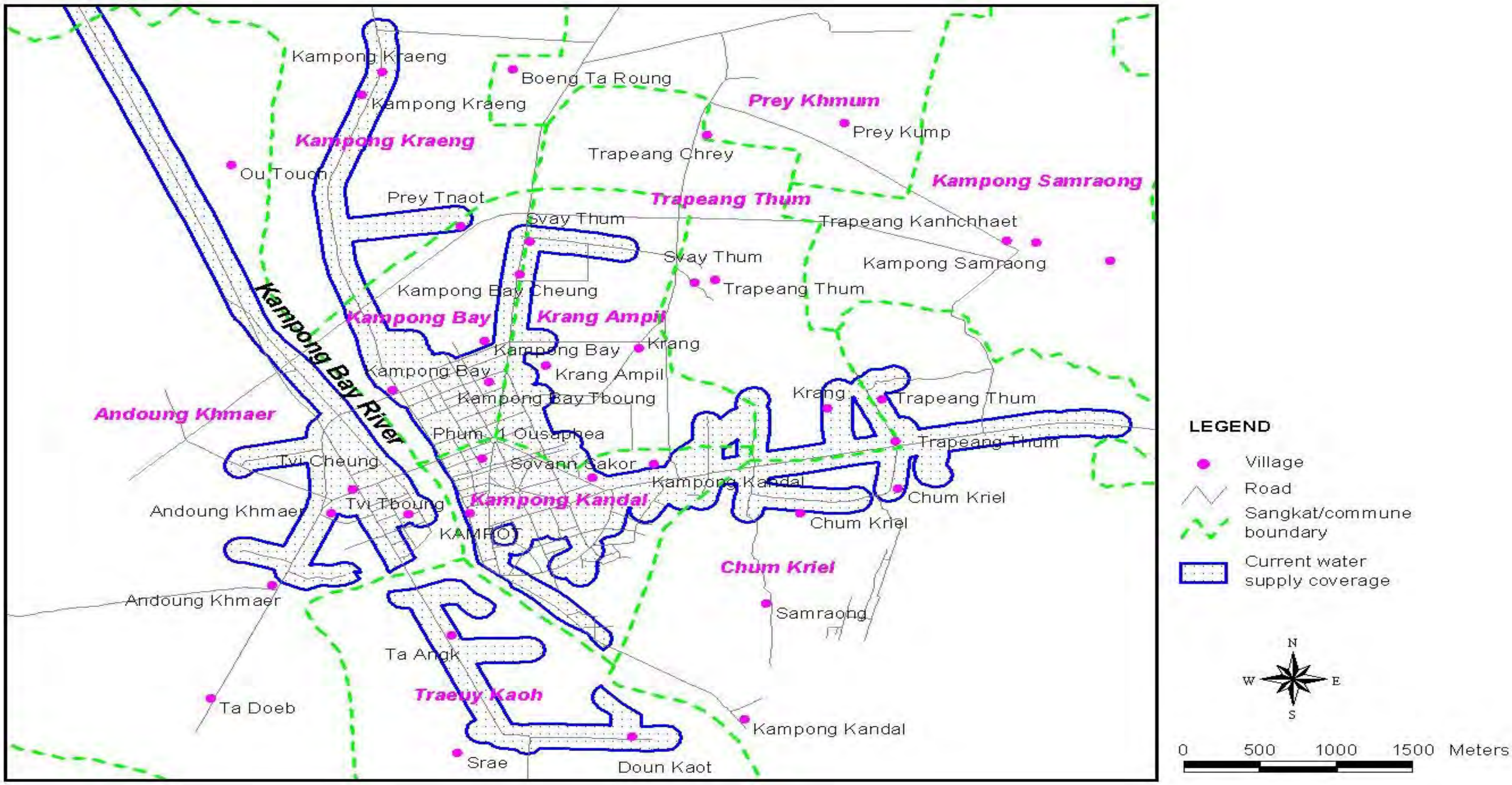


Figure 1-2 Location Plan of Proposed Kampot Subproject



1. EXECUTIVE SUMMARY

1.1 Project Description

1. Expected outputs of the overall Project include: (i) water treatment plants provided or improved in eight towns; (ii) water distribution systems improved and coverage increased in six towns; (iii) existing pumping stations rehabilitated in five towns; and (iv) institutional capacity of MIH and regulatory system strengthened, under a piggy-backed technical assistance.

1.2 Rationale

2. During 2011, through the ADB's Water Operators' Partnerships Program, ADB was able to re-engage in the urban water supply sector with MIH. Consequently ADB's Country Operations Business Plan 2010-2013 includes an Asian Development Fund loan for the Project for approval in 2014. The UWSP will assist the government to address the three core constraints identified in the ADB Country Partnership Strategy (2011-2013): (i) insufficient funds to expand coverage and improve services; (ii) weak sector planning and implementation capacity of responsible authorities at the central and sub-national levels; and (iii) inadequate (or sometimes weak) institutional and legal framework.

1.3 Background

3. The proposed Project "Urban Water Supply Project " (UWSP) will provide necessary facility improvements to the six provincial towns previously funded by ADB and to three provincial towns that have been funded by other bilateral or multilateral agencies, and expand public access to sustainable and safe water supply services for the urban population in Cambodia. In addition, the Project will address institutional weaknesses through the development of improved institutional structures, a regulatory framework, and appropriate capacity development.

1.4 Project Impact and Outcome

4. The impact of the proposed Project will be expanded access to sustainable and safe water supply services for the urban population in Cambodia and better functioning water treatment plants providing higher quality water. MIH targets are to increase the proportion of the urban population in the project area with access to safe water to 85% by 2018 and 90% by 2025, and the project will assist these aims. The outcome of the project will be improved water supply infrastructure and service provisions in selected provincial waterworks.

1.5 Candidate Towns

5. There are nine candidate towns: Kampong Cham, Kampong Thom, Kampot, Pursat, Siem Reap, Sihanoukville, Stoung, Stung Treng and Svay Rieng. Originally Battambang was to be included but this was removed at the request of the Provincial Waterworks.

1.6 Feasibility Study Context

6. The feasibility studies include: (i) needs assessment, supply and demand analysis, (ii) selection of technology, equipment, and facilities for the identified subprojects considering least cost and life cycle approach and the capacities of the local authorities to manage, operate, and maintain; (iii) assessment of economic and financial viability and sustainability for each of the subprojects; (iv) assessment of policy and legal capacity, including other institutional issues and mechanisms related to the financial management, procurement, and anticorruption; (v) poverty, social, and gender analysis and preparation of a poverty and social strategy, a gender action plan, stakeholder communication survey (SCS), and a Community Participation Plan (CPP), where required; and (vi) review of impacts on environment, involuntary resettlement, and indigenous peoples.

1.7 Subproject Description

1.7.1 Output 1 - Water Supply Development

7. The Kampot subproject aims to improve the provision of safe, affordable, reliable piped water supply to individual household connections to communities within the nine core sangkats/communes having Y2012 population of about 47,725. The works proposed under the PPTA are summarised in Table 1.1 below and are described in detail in Section 5.2.2.

1.7.2 Output 2 – Strengthening of Institutional capacity of MIH and Regulatory System

8. The Institutional Strengthening and Capacity Development is to (i) identify key stakeholders; (ii) assess institutional capacity constraints; (iii) develop institutional capacity building plan; and (iv) prepare terms of reference for strengthening sector regulationTA.

1.8 Cost Estimate

9. The subproject cost is estimated at $0.11 million equivalent, including taxes and duties. Table 1.1 provides a summary of the Kampot Subproject cost estimate.

Table 1.1: Kampot Subproject Cost Estimate ($'000's)

No	Description	Totals (inc tax) US$000
2	**Water Supply Development**	
2.1	**Replace old chlorination system**	50.0
2.2	Replace 4 gate valves with dia. 500mm of drains and 4 Airscour Valves with dia. 160mm of backwash for WTP	18.0
2.3	Replace 200mm restriction on elevated tank line with 250mm and install 2 bulk clear water meters (east & west).	15.0
2.4	Add bladder tank for surge protection on direct pumping line to town.	5.0
2.5	Re-route alum dosing pipe with ABS pipe	5.0
	Total for Water Supply Development	
	TOTAL ESTIMATED BASE COST[a]	**93.0**
	Contingencies 20%	**18.6**
	TOTAL ESTIMATED SUBPROJECT COST	**111.6**

1.9 Executing Agency and Implementation Arrangements

10. MIH will be the Executing Agency, and the existing project management unit (PMU) based in the Department of Potable Water Supply (DPWS) will be expanded to execute and manage the Project on behalf of MIH with the consulting service to be provided by the project implementation assistance consultants (PIAC). The Project implementing units (PIUs) are expected to be organized by the nine (9) implementation agencies (IAs) of the provincial waterworks. The nine (9) PIUs will be responsible for day-to-day coordination and supervision of subproject implementation in these provincial towns.

1.10 Implementation Period

11. The proposed Project is scheduled for implementation over five years from 2014 to 2018. The final design is proposed for a one year period between mid-2014 and mid-2015. Following this, a two year construction period would have the works commissioned in August 2017. A proposed Implementation schedule is included in Appendix A.

1.11 Procurement

12. The procurement shall be carried out under International Competetive Bidding (NCB) as three packages; one package Stung Treng; one package Siem Reap; and the remaining 7 subprojects as one package. The full Procurement Plan is contained in the Supplementary Appendices of the main PPTA report.

1.12 Consulting Services

13. The project implementation assistance consultants (PIAC) on the design and engineering review, tendering assistance, and construction management are provided under Bank financing will be selected in advance and engaged in accordance with the ADB's Guidelines on the Use of Consultants. An individual consultant will be engaged to prepare the PIAC terms of reference and to assist the EA on the preparation of the Request for Proposal. The PIAC consulting services will be signed once the loan becomes effective to provide under a single consulting package, by an association of international and domestic consulting firms. The lead consulting firm will provide the services of the Team Leader who will be responsible for managing the overall consulting services during the project implementation.

1.13 Subproject Benefits and Beneficiaries

14. The Kampot subproject aims to improve the provision of safe, affordable, reliable piped water supply to individual household connections to communities within the nine core sangkats/communes having Y2012 population of about 47,725.

1.14 Land Acquisition and Compensation

15. The overall project has Involuntary Resettlement Categorisation C because all of the improvement facilities are within the water treatment plant compound. The Land Acquisition Due Diligence report for Kampot is contained in Appendix G.

1.15 Environmental Impacts

16. An Environmental Due Diligence Report was done for Kampot and is contained in Appendix F. The subproject is classified as Category C.

1.16 Economic and Financial Analyses

17. Economic and Financial analyses for Kampot is contained Section 7, and in full in Appendix D.

1.17 Tariff and Affordability

18. At 0, 50 or 100% loan, the required tariff to cover O&M costs, depreciation and debt service by 2023 are shown in Table 1.2. It is recommended that customers are categorized into households, government and commercial so that block tariff and cross subsidy between customer categories can be implemented. For household customers, the proposal is to use 1 to 7 m3 as the lifeline consumption (first block) and 7 m3 and above as the second block.

Table 1.2: KPWW Proposed Tariff Rate – 0, 50 or 100% Loan

Category	2015	2018	2021	2023
Household, 0 - 7 m3	1,400	1,550	1,650	1,750
above 7 m3	1,700	1,900	2,100	2,400
Government	1,700	1,900	2,100	2,400
Commercial	2,000	2,250	2,500	2,800
Tariff Increase (average)	15%	11%	9%	12%

Source: Consultant's estimate

2. PROJECT RATIONALE, IMPACT AND OUTCOME

2.1 Rationale

19. During 2011, through the ADB's Water Operators' Partnerships Program, ADB was able to re-engage in the urban water supply sector with MIH. In January 2012, MIH signed a twinning agreement with the PPWSA, which is currently providing support to four provincial waterworks been included in the Project through direct peer-to-peer knowledge transfer. In February 2012, the Ministry of Economy and Finance (MEF) requested ADB to consider financing the Project in accordance with the strategy of Cambodia's Public Debt Management, to ensure sustainable economic growth. Consequently ADB's Country Operations Business Plan 2010-2013 includes an Asian Development Fund loan for the Project for approval in 2014. The project supports the ADB's annual sector review, country partnership strategy, and the water operational plan 2011–2020

20. The UWSP will assist the government to address the three core constraints identified in the ADB Country Partnership Strategy (2011-2013): (i) insufficient funds to expand coverage and improve services; (ii) weak sector planning and implementation capacity of responsible authorities at the central and sub-national levels; and (iii) inadequate (or sometimes weak) institutional and legal framework.

2.2 Background

21. The proposed Project "Urban Water Supply Project " (UWSP) will provide necessary facility improvements to the six provincial towns previously funded by ADB and to three provincial towns that have been funded by other bilateral or multilateral agencies, and expand public access to sustainable and safe water supply services for the urban population in Cambodia. In addition, the Project will address institutional weaknesses through the development of improved institutional structures, a regulatory framework, and appropriate capacity development.

22. This UWSP is in line with (i) Cambodian National Strategic Development Plan (2009-2013) and (ii) action plan of Ministry of Industry, Mines and Energy (MIH) to facilitate private sector partnerships, strengthening the management of public owned waterworks, and integration urban water supply with urban environmental management. The proportion of the urban population in the project area with access to safe water will be increased to 85% by 2018 and 90% by 2025 as targeted by MIH. In addition, a potential target date for 100% coverage could be assumed as 2030.

2.3 Project Outline

23. The feasibility studies include: (i) needs assessment, supply and demand analysis, (ii) selection of technology, equipment, and facilities for the identified subprojects considering least cost and life cycle approach and the capacities of the local authorities to manage, operate, and maintain; (iii) assessment of economic and financial viability and sustainability for each of the subprojects; (iv) assessment of policy and legal capacity, including other institutional issues and mechanisms related to the financial management, procurement, and anticorruption; (v) poverty, social, and gender analysis and preparation of a poverty and social strategy, a gender action plan, stakeholder communication survey (SCS), and a Community Participation Plan (CPP), where required; and (vi) review of impacts on environment, involuntary resettlement, and indigenous peoples.

2.4 Project Impact and Outcome

24. The impact of the proposed Project will be expanded access to sustainable and safe water supply services for the urban population in Cambodia and better functioning water treatment plants providing higher quality water. MIH targets are to increase the proportion of the urban population in the project area with access to safe water to 85% by 2018 and 90% by 2025, and the project will assist these aims. The outcome of the project will be improved water supply infrastructure and service provisions in selected provincial waterworks.

3. Profile of Kampot Area

3.1 Town Location and Profile

25. Kampot city is the capital of Kampot Province and is on National Road 3 approximately 150km from Phnom Penh on the south coast. The town is built around the Tekchhou river approximately 3km upstream from where the river meets the sea. Kampot is a growing tourism destination and is the gateway to reach the Bokor Hill Station which was recently renovated.

26. Agriculture is the primary industry in the Province and pepper production is one of the main crops. Coastal fishing is another main industry in the Province.

3.2 Natural Features

3.2.1 Topography

27. Kampot is coastal and whilst the town is flat, running along both sides of the Tekchhou river, there are mountains to the north west.

3.2.2 Climate

28. The climate, in common with other coastal areas of Cambodia, is hot all year with a distinct rain season May – October and a drier season November – February. There is typically more rain close to the south coast of Cambodia than other areas.

3.2.3 Surface water

29. There is only one surface water source in Kampot, the Tekchhou river. This is currently used by some private households and also by the Water Authority as the raw water source.

3.2.4 Groundwater

30. Groundwater is not used in Kampot other than a small number of shallow open wells. The groundwater has a known hardness problem and is not favoured.

3.3 Population and Household Characteristics

31. The populations provided below are for the service area within Kampot.

Table 3.1: Kampot Population Characteristics

No	Core Sangkhat/Commune	2012 Pop'n.	No. HH	Persons/ HH
1	Kampong Kondal	6,885	1,377	5
2	Krang Ambil	4,485	897	5
3	Kompong Bay	5,535	1,107	5
4	Andong Khner	10,415	2,083	5
5	Trey Koh	6,780	1,356	5
6	Chhum Kriel	5,290	1,058	5
7	Kampong Krenh	2,115	423	5
8	Mak Prang	3,145	629	5
9	Tror Peng Thom	3,075	615	5
	Total	**47,725**	**9,545**	

3.3.1 Population Growth and Migration

32. Population growth from the 2008 National Survey1 shows an average national urban growth rate of 2.21%. For the purposes of this study we have used growth rates for individual towns, provided by each Water Supply Authority2. For Kampot this is 0.64% showing a low growth rate.

3.4 Existing Water Supply and Sanitation

3.4.1 Water Supply

33. The water supply system was originally established in 1951 under the French colonial time. During the Pol Pot regime (1975-1979), nearly all water work facilities were destroyed. After the Pol Pot regime the water work was rebuilt and produced 600m3/day servicing 3,500 people in 4 communes with untreated water.

34. From 1993 to 1996 under the SAWA3 project, the capacity of the treatment plant was increased to 2,800m3/day.

35. Later, in response to increasing water demands due to the expansion of the urban area and increase of population, the system was upgraded by an ADB project4 in 2002.

36. A new treatment plant was built with capacity 5,760m3/day, and pipelines were rehabilitated from 2002 to 2006 under this project.

37. Water is pumped from the river upstream of the town from an inlet (“grit”) chamber which is fed from two separate inlet pipes, one lower than the other for dry season use. Three raw water pumps (2 duty, 1 standby) of capacity 120m3/day deliver water from this chamber to the WTP. The current output of two pumps is 4,500m3/day, lower than the WTP maximum design flow. The WTP is therefore operating at 78% capacity, probably due to pumps not being specified for the correct dynamic head requirements rather than the current demand from the town.

38. The conventional treatment plant includes flocculation, sedimentation, rapid sand filtration and storage.

39. The existing reticulation serves areas up to 5km from the WTP. Many old mains have been replaced under a JICA project but there are still some old AC pipes near the centre which require replacement.

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[1] General Population Census 2008 National Report, August 2009

[2] Data collected by head of each commune

[3] Sanitation and Water Action, a Dutch NGO.

[4] Provincial Towns Water Supply Project

4. POPULATION GROWTH AND WATER DEMAND FORECASTS

4.1 General

40. Kampot is the capital city of the Province and acts as a market for the surrounding area.

41. At present, there is no agro-processing or industrial development in Kampot consuming water or which could affect water quality, and nothing planned. There is no mine in the region.

4.2 Population Projections

42. The population projections5 are set out in Table 4.1. Within the core villages, total population is forecast to increase from about 47,725 in 2012 to about 53,532 in 2030.

Table 4.1: Population Projections for Kampot's Core Villages

Year 2012 Population	Growth Rate %	Forecast Population 2014	Forecast Population 2020	Forecast Population 2025	Forecast Population 2030
47,725	0.64	48,338	50,224	51,852	53,532

4.3 Water Demand Forecasts

4.3.1 General Approach

43. Whilst the scope of proposed works under this project does not include increasing the capacity of the Kampot water supply system, demand forecasts have been produced to illustrate the shortfall of available treated water into the near future. Water demand forecasts for the Kampot subproject were prepared by making separate projections of each component of demand, including:

- Demand for domestic use (based on per capita consumption, coverage targets and population projections);
- Demand for industry (based on a % of domestic use, and specific allowances for large industries);
- Demand for services (based on a % of domestic use, and specific allowances for large services areas);
- Physical losses as a % of total demand, excluding the demand of large industrial zones.
- Production losses in treatment plant (based % of total demands).

4.3.2 Domestic Consumption

44. Water demand and consumption data for other provincial and district towns in Cambodia show that domestic consumption accounts for about 90% of total demand. Per capita consumption figures for urban water supply systems in Cambodia can vary widely, particularly with strong reliance on rainwater collection during the wet season. Experience in other towns in Cambodia indicates that piped connections directly to the house will usually increase water consumption over time. The Feasibility Study has adopted a per capita consumption figure of 120 lpcd, plus 10% for non-domestic use which includes demand from industry and services, 15% for physical losses (leakage), and 50m3/day for backwashing filters in the WTP.

4.3.3 Water Demand Forecasts

45. Table 4.2 summarizes the demand forecasts and design criteria for the Kampot subproject. By 2030, the average daily water demand is expected to be 10,700m3/day, comprising 72% domestic

[5] 2012 populations and growth rate provided by the Provincial Waterworks

consumption, with the remaining 28% being for institutions, public use, services, handicraft and small industries, and allowances for physical losses and backwashing the filters.

Table 4.2: Water Demand Forecasts for Kampot Subproject

No.	Items	Unit	Forecasts 2012	2014	2020	2025	2030
A.	**Domestic Demand**						
1	Growth Rate	%	0.64	0.64	0.64	0.64	0.64
2	Population in Core Area		47,725	48,338	50,224	51,852	53,532
3	Coverage in Core Area	%	90	100	100	100	100
4	Population with Piped Water	No.	42,953	48,338	50,224	51,852	53,532
5	Per Capita Consumption	l/c/d	120	120	120	120	120
6	Total Domestic Demand	m3/d	5,154	5,801	6,027	6,222	6,424
B.	**Non-domestic demand**						
1	Services, Schools, Small Industry, Institutions, Hotels	%	20	20	20	20	20
2							
3	Total Non-domestic demand	m3/d	1,031	1,160	1,205	1,244	1,285
C.	**Subtotal Water Demand All Categories**	m3/d	6,185	6,961	7,232	7,467	7,709
D.	**Non Revenue Water (NRW) in Distribution system**						
1	NRW as % Average Daily Water Production	%	15	15	15	15	15
2	NRW (physical losses only-pipelines and WTP)	m3/d	928	1,044	1,085	1,120	1,156
E.	**Average Daily Water Production (C+D) rounded**	m3/d	7,110	8,000	8,320	8,590	8,860
F.	**Peak Annual Water Demand (Max day Max month)**						
1	Peak Annual Water Demand		1.20	1.20	1.20	1.20	1.20
2	Peak Annual Water Demand	m3/d	8,532	9,600	9,984	10,308	10,632
3	Peak Annual Water Demand	l/s	99	111	116	119	123
G.	**Required Treatment Plant Output (rounded)**	m3/d	8,530	9,600	9,980	10,310	10,630
H.	**Treatment Plant Backwashing**						
1	Treatment Plant Backwashing	m3/d	50	50	50	50	50
I.	**WTP Capacity**						
1	Required WTP Capacity	m3/d	8,580	9,650	10,030	10,360	10,680
2	Required WTP Capacity	l/s	99.31	111.69	116.09	119.91	123.61
	Total Required Source Capacity (Rounded)	**m3/d**					**10,700**
	Total Required Source Capacity	**l/s**					**125.00**

4.3.4 Future Demand Requirements

46. The table shows that the existing water treatment plant from 2006, at 5,760m3/day, is already insufficient to meet demand with 2014 demand projected at 8,580m3/day. This subproject is not intended to address future demands, but to rehabilitate the current existing WTP assets, improve water quality and improve security of supply.

47. A further 2,820m3/day of treated water will be required to meet projected 2030 demands.

5. SUBPROJECT DESCRIPTION

5.1 Introduction

48. The proposed works are designed to improve operational improvements, increased water quality and security of supply. This improved water supply scheme is not designed to increase capacity of supply.

5.2 Output 1: Water Supply Development

49. Expected outputs of the overall Project include: (i) water treatment plants provided or improved in eight towns; (ii) water distribution systems improved and coverage increased in six towns; (iii) existing pumping stations rehabilitated in five towns; and (iv) institutional capacity of MIH and regulatory system strengthened, under a piggy-backed technical assistance.

5.2.1 Preliminary Designs

50. The proposed water supply scheme design improvements are based on limited topographical, hydrological and water quality data and are preliminary.

5.2.2 Description of Proposed Water Supply System

51. The Kampot subproject aims to improve the provision of safe, affordable, reliable piped water supply to individual household connections to communities within the nine core sangkats/communes having Y2012 population of about 47,725.

52. The works proposed under the PPTA are summarised in Table 5.1 below;

Table 5.1: Proposed new infrastructure for Kampot

Kampot	Short FS	
		A- Replace old chlorination system
		B - Replace 4 gate valves with dia. 500mm of drains and 4 Airscour Valves with dia. 160mm of backwash for WTP
		C - Replace 200mm restriction on elevated tank line with 250mm and install 2 bulk clear water meters (east & west).
		D - Add bladder tank for surge protection on direct pumping line to town.
		E - Re-route alum dosing pipe with ABS pipe

5.2.2.1 Replacement of Gas Chlorination system

53. The current gas chlorination system installed under the 2006 ADB project is a high quality European brand, but has failed both at Kampong Thom and the other 5 towns under this previous project. This may be due to poor installation or lack of locally available spares. Repairs have been made with locally available materials rather than proprietary parts which is dangerous when used with pressurized chlorine gas. It is recommended to replace the entire chlorination system with a brand that is available locally or at least regionally, with after sales service and easy access to spare parts. Some design faults identified with the brand installed have been identified, being;

- The existing set-up has hoses and pipes connecting the one tonne chlorine cylinders to a regulator. Leaks in this hose and pipe arrangement causes high pressure chlorine leaks. A better design is to have a vacuum regulator directly connected to the cylinder. If pipe downstream of the vacuum regulator leaks, the vacuum is broken and the regulator closed, sealing the valve and preventing leaks.

- The existing system does not have a heater on the cylinder outlet. This serves to ensure that the liquid chlorine in the cylinder turns to gas before it leaves the cylinder valve. During transportation of the cylinder to the site, the liquid chlorine is disturbed and often fills the fixed internal outlet tube. If not heated and vapourised this liquid chlorine can damage equipment downstream.

- A gas scrubber system should be provided with the gaseous chlorination system as a safety measure. This is lacking at Kampot presently. The scrubber removes the chlorine from the air in the event of a serious leak in the system.
- The existing system does not have a heater on the cylinder outlet. This serves to ensure that the liquid chlorine in the cylinder turns to gas before it enters the internal outlet tube which leads to the cylinder valve. During transportation of the cylinder to the site the liquid chlorine is disturbed and fills the internal outlet tube. If not heated and vapourised this liquid chlorine can damage equipment downstream.

54. For the purpose of this Feasibility Study, the same manufacturer as used at PPWSA has been selected and invited to provide a proposal and budget price. This is contained in Appendix B.

5.2.2.2 Replace gate valves right through WTP

55. During the 2006 WTP improvement works, the contractor selected valves for use throughout the WTP that were of lower quality and as such the IA have requested that they all be changed.

5.2.2.3 Replace pipeline restriction on elevated tank line

56. When pipework was laid to enable water to be delivered directly into supply, bypassing the elevated reservoir, a restriction from 250mm down to 200mm was installed. This required correction and the current and proposed arrangement is shown in Appendix M.

5.2.2.4 Addition of bladder tank for clear water surge protection

57. The IA reported surge in the clear water system. To remedy this a bladder tank is recommended to be sited inside the WTP area just downstream of the clear water pumps.

5.2.2.5 Replace dosing lines

58. The alum delivery pipe from the 3 storey mixing building currently runs from the second storey down to ground level then back up the flocculation tank wall to the dosing point. This low point causes alum sludge to settle out and block the pipe. Additionally, the pipe is uPVC and is exposed to the elements and UV deterioration. The pipe is to be replaced with UV resistant ABS, and rerouted to pass directly from the mixing building to the top of the flocculation tank.

5.3 Consultation Activities during Preparation of Kampot Feasibility Study

59. A series of community visits and consultations occurred during the finalization of the 2013 Feasibility Study to inform district and village authorities about the subproject and gather information and feedback from local authorities, people living in core villages and other stakeholders. Consultation activities during the project site visits in 2013 are detailed below:

(i) Initial reconnaissance visit March 2013: Team Leader and National water engineer visited the site for an initial inspection and discussion with the Water Aiuthority.

(ii) Second engineering site visit 23rd April 2013:International and National water engineers visited Kampot facility, collected data, and finalized scope following Inception workshop.

(iii) Socio-economic specialist visit: a visit for the purpose of carrying out the public consultation was undertaken on 18-27th June

(iv) Environmental and Resettlement specialist visit: This joint visit was carried out between June 3rd -11th to collect data to aid the finalization of the IEE and LACP.

5.4 Operation and Maintenance of Project Facilities

5.4.1 Capacity to Operate and Maintain the Proposed Water Supply System

60. The Kampot Provincial Waterworks have many years experience in operating and maintaining their treatment plant, and have full time Operator staff. There is a good understanding of how pumps work and the routine maintenance required.

61. The proposed new gas chlorination equipment is similar to the current equipment, but if the recommended manufacturer is used, there will be far greater options for professional servicing and provision of spares as needed. The proposed model is the same as used in Phnom Penh by PPWSA, and there is an agent in Phnom Penh that can provide servicing. Problems faced with the current gas chlorination equipment are mainly due to a lack of a regional office to provide support, spares and technical assistance when required. Whilst the preferred equipment cannot be specified by manufacturer, for future operation it would be beneficial to the Water Authority.

5.4.2 Management Arrangements

62. The PIAC will provide Project technical, safeguards, accounting and management assistance on a daily basis as well as support the PIUs with project implementation

63. At the start of Project implementation, the PMU and PIAC will (i) update the initial environment examinations and due diligence reports (IEEs and DDRs) and prepare EMPs submit to MOE for review and approval; (ii) clear potential unexploded ordnance (UXO) remain on site; and (iii) acquire necessary land before subproject bids are tendered.

5.4.3 Operation and Maintenance Plans

64. The Operation and Maintenance plan for each subproject can be divided into two types, those with a full conventional WTP and those with chlorinated groundwater being pumped to an elevated tank and fed into supply. For Kampot, an Operation and Maintenance Plan reflecting the former has been developed and is presented in full in Appendix H.

5.5 Lessons learned in Cambodia and the SE Asia region

65. There are several "lessons learned" in both the region and inside the national water sector that would benefit the 9 project towns under this PPTA;

- As at PPWSA, use of standardized chlorination equipment that has a regional office that can offer technical support, spares and specialist staff when needed. PPWSA has selected equipment supplied by Severn Trent Services (STS), and equipment from this manufacturer has been recommended for the towns requiring replacement chlorination equipment under this study. STS have a main office in Singapore, but have local representation in Phnom Penh. However, final selection of equipment of equal or better specifications will be decided at tendering as specific brands cannot be specified in Contract documents.
- High density polyethylene pipe (HDPE) is favoured in Cambodia, even for larger diameters. As most of Cambodia is flat, as are all of the 9 towns under this study, system pressures are not higher than 60m head. As such, a PN6 rated pipe would be sufficient. However, experience has shown that for the pipes un to and including 90mm diameter, which may have domestic connections tapped from them, a PN8 minimum pipe is required, even for very low pressures. The reason for this is that the tapping saddles used can deform the thinner pipe wall thicknesses on PN6 pipe, which causes leakage.
- Automated valves linked to a central control panel were designed and installed under the 2006 Provincial Towns project. All of these have failed in the 6 towns where they were installed. The lesson here is to keep the WTPs simple and keep valves as manually

operated. With the relatively smaller size of these WTPs (mostly under 6,000m^3/day), valve automation is not necessary and inappropriate.

- Alum and poly dosing lines under the previous Provincial Towns project used long lengths of uPVC pipe that followed buildings and structures, necessitating several 90 degree bends and causing significant headloss in the delivery pipe. This has caused the pipes to get blocked by sediment. In addition, the uPVC dosing pipes are exposed to direct sunlight. UV light will break down uPVC pipe over time. A better solution, as used in two recent projects in Laos, is to use ABS (acrylonitrile butadiene styrene) pipe, and select a more direct route for the pipe, minimizing bends and low points.
- For the water sector as a whole, a database of all water projects could be set up, to include design drawings, calculations, contract documents, demand calculations, feasibility reports, final design reports and other useful documentation, for each system. This would serve as an easily accessible online resource library for all Water Authority staff in the country. It is relatively easy and inexpensive (under US$40,000) to set up and populate, and solves the common problem of drawings and documents getting lost. Many of the available hard copy resources for Cambodian water supply systems are either misplaced, or are reportedly stacked in disorder in a storeroom so dirty that nobody is willing to enter. Such a database was set up and released in neighbouring Laos in 2012-13 with assistance from UNHabitat, and can be viewed at;

http//:laowtp.info
by pressing “login as guest”.

- Several of the project towns under this PPTA have had extensions added to serve areas that were outside of the original design core area, without considering required design pressures or treatment plant capacity. This often results in the WTP being operated above its design capacity, which can reduce water quality, and often has negative effects on service pressure to other parts of the reticulation network. Typically, to increase system pressure to serve these unplanned extensions, water is diverted around any elevated storage tank and pumped directly into the system in order to increase delivery pressure by a few metres head. This is bad operating practice as it eliminates the storage facility and increases leakage loss. Any pipeline extensions should be made in a planned way and carried out simultaneously with WTP capacity upgrades as required.

5.6 Public Private Partnerships

66. Options and viability for potential PPP for Kampot subproject was discussed with the Director of the Department of Potable Water Supply6.

67. In common with all towns in general, the urban water supply systems are seen as best managed by the government where possible. Installation and commissioning of the elements of work under this subproject require specialist contractors and involvement of public bodies is limited.

68. There are some peri-urban areas in Cambodia where whole water supply concessions have been granted to private companies to construct and manage water supply systems. This is not strictly PPP, as the private company needs only to acquire a license – there is no partnership

[6] Mr Tan Sokchea

as such. There are both good and bad examples of these private concessions throughout the country.

69. A possible area where a PPP could be utilized in the future is in the supply of bulk treated water to customers who are either just outside of the WTP service area or are inside the area but receive low pressure. Private water tankers could be used to fill up with (and pay for) treated water from the WTP and deliver and sell to customers with their own storage tanks.

5.7 Contract Packaging of Subproject

70. A number of packaging options were examined and discussed between the PPTA team, MIH and ADB. These options are presented below in Table 5.2.

Table 5.2: Subproject Contract Packaging Options

No. packages	Subproject Towns included	Advantages/disadvantages
2	Stung Treng Siem Reap plus 7 rehab towns	**Advantages:** • Small number of packages reduces tendering and contract management admin. • Larger packages makes them more attractive to international bidders. • Easier to standardise on equipment. **Disadvantages:** • Limited opportunity for NCB
3	Stung Treng Siem Reap 7 rehab towns	**Advantages:** • Three good sized packages attractive to ICB bidders • Small number of packages reduces tendering and contract management admin. • Easier to standardise on equipment **Disadvantages:** • Limited opportunity for NCB
4	Stung Treng Siem Reap 3 southern rehab towns (Svay Rieng, Kampot, Sihanoukville) 4 northern towns (Kampong Cham, Kampong Thom, Pursat, Stoung)	**Advantages:** • 2 larger and 2 smaller packages, the smaller of which could be NCB if an exception to the $1M limit relaxed **Disadvantages:** • More tender and contract management admin • More difficult to standardise on equipment with larger number of packages.

9	9 separate contracts	**Advantages:** • Each IA is responsibe for their own subproject and has direct ownership • 7 of the 9 subprojects could be let as NCB **Disadvantages:** • More tender and contract management admin • Some activities may not be suitable for many national contractors due to lack of specialist experience. • More difficult to standardise on equipment with larger number of packages.

71. During discussions, initially the option of two large contracts, one for Stung Treng and one for the other 8 towns, was favoured for the simplicity of the bidding process, contract administration, and the attractiveness of the larger packages to international bidders.

72. After further discussion, 9 separate contracts was favoured, as greater weight was put on having the contracts out to tender quickly, and having 7 of them of a size that would permit NCB would help achieve this. The procedures for approving and tendering NCB are far less time consuming compared to ICB. Additional benefits would be that each IA would have ownership of their own subproject, and that national contractors would benefit from both the experience and the business.

73. A perceived obstacle with having 7 of the subprojects as NCB is the technical nature of some of the rehabilitation work. Installation and commissioning of gas chlorination equipment, bladder tanks for surge protection, and proper construction of filter underdrains are all areas requiring a degree of specialist knowledge and experience. For this reason, coupled with the simplicity of having a lesser number of contract packages, a compromise of three packages was selected, being Stung Treng, Siem Reap, and the 7 rehabliitation subprojects.

74. These 3 packages will all need to be ICB due to their value, but this does not exclude national contractors from bidding, provided they meet the prequalification requirements. Additionally, if national contractors have difficulty meeting prequalification requirements, they can still benefit from these contracts by subcontracting.

6. COST ESTIMATE AND LEAST COST ANALYSIS

6.1 Cost Estimates

75. The subproject cost is estimated at $0.11 million equivalent, including taxes. A summary of the cost estimates is given in Table 6.1.

Table 6.1 - Subproject Capital Cost

No	Description	Totals (inc tax) US$000
2	**Water Supply Development**	
2.1	Replace old chlorination system	50.0
2.2	Replace 4 gate valves with dia. 500mm of drains and 4 Airscour Valves with dia. 160mm of backwash for WTP	18.0
2.3	Replace 200mm restriction on elevated tank line with 250mm and install 2 bulk clear water meters (east & west).	15.0
2.4	Add bladder tank for surge protection on direct pumping line to town.	5.0
2.5	Re-route alum dosing pipe with ABS pipe	5.0
	Total for Water Supply Development	
	TOTAL ESTIMATED BASE COST[a]	**93.0**
	Contingencies 20%	**18.6**
	TOTAL ESTIMATED SUBPROJECT COST	**111.6**

Source: Consultant's estimate, 2013.

6.2 Least cost analysis

76. No least cost analysis was carried out for Kampot as alternative solutions were not presented for consideration.

7. SUBPROJECT FINANCIAL AND ECONOMIC ASSESSMENT

7.1 Approach and Methodology: Financial Assessment

77. The financial analysis was done in three levels: (i) examination of the historical and current financial performance; (ii) evaluation of the feasibility of the proposed subproject under CUWSP; and (iii) evaluation of the financial sustainability taking into account the impact of the proposed subproject to the future operation of PWWs and WSA.

78. Following the Asian Development Bank (ADB) guidelines7, four basic indicators for the financial viability of a water supply project have been identified. These are the following:

- Financial Internal Rate of Return (FIRR). It is the discount rate at which the revenues and costs generated by the project are equal to zero. A project is considered financially viable if the computed FIRR is equal to or higher than the weighted average cost of capital (WACC) that is used in financing the development of the proposed water supply project.

- Debt Service Coverage Ratio (DSCR). It measures the solvency of the PWWs/WSA and shows how many times debt service for a given period is covered by operations. DSCR should at least be 1.3 after project completion.

- Annual cash balance. Projected annual cash balances should be positive all throughout the projection period.

- Tariff affordability. Household monthly water bill should not be more than 5% of the average monthly household income of the low income group.

7.1.1 Financing Plan.

79. The project will be financed by ADB and the national government. Part of the ADB and national government funds will be on-lent to the PWWs/ WSA. Annual debt service was estimated based on preliminary discussions with MIH and MEF. The on-lending terms for the purpose of this study are as follow:

- Maturity period of 32 years, including 8 years grace period on principal payment while interest is capitalized during construction;

- Fixed interest rate[8] of 1.25% per annum for the first 8 years and 1.75% per annum for the next 24 years; and

- Foreign exchange risk to be borne by the national government.

7.1.2 Proposed Water Tariff.

80. Three scenarios were tested in the design of the water tariff based on the amount of loan, as a percent of project costs, passed on to the 8 PWWs. For Siem Reap WSA, 100% loan was assumed. For the 8 PWWs, the three scenarios tested were: (1) 0% loan-100% grant; (2) 50% loan-50% grant; and (3) 100% loan-0% grant.

7.1.3 Other Assumptions

81. The main assumptions used in the financial projections include:

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[7] ADB, *Financial Management and Analysis of Projects* (2005).

[8] ADB's interest rate to the national government is 1% and 1.5% respectively.

- Estimates of annual water revenues are based on the total water billed for the year and the corresponding tariffs for the same year. Connection fees, for non-poor household customers are included as other revenues and assumed to be paid by the customers in 24 equal installments.

- The investment cost of the proposed project and the O&M costs are prepared on an annual basis in August 2013 prices. Increases in costs due to inflation are covered through a provision for price contingencies both for the investment costs and the O&M costs.

- The incremental O&M costs, which is the difference between "with the project" and "without the project" scenario, were used in the evaluation. O&M costs include: 1) administration; 2) chemical; 3) power; 4) maintenance of facilities; 5) salaries and wages; and 6) other O&M items.

- Projected O&M costs "without the project" are based on actual O&M costs as presented in the historical revenue and expense statements. It is assumed that there will be minimal increases in the service connections as water supply demand approaches the maximum water supply capacity of the existing system, hence there will be no increases in the number of personnel. The unit cost of O&M is assumed to increase following the local inflation rate.

- Projected O&M costs "with the project", except maintenance of facilities, are based on historical unit costs. Maintenance of facilities cost is based on engineering estimate of the required maintenance level of the facilities.

- Depreciation allowance is considered a non-cash item. However, for purposes of estimating the net income, it was included as expense in the projected income statement. Annual depreciation costs for the new facilities were calculated using the straight-line method based on the service life[9] of each type of asset.

- Water tariff "without the project", is assumed to increase in the future to cover increases in O&M. For purposes of the projection, it is assumed that water tariffs will have to be increased by 5% starting 2015 and every four years thereafter until 2027 for Siem Reap, Stung Treng and Svay Rieng; for Kampong, because current tariff is low, the assumed increases are 10%.

- Water Revenue "without the project". As mentioned earlier, since the existing facilities are already nearing its maximum operating capacities, it is assumed that there will be no further additional connections after the water supply capacities are reached in 2017. Volume of water sold after this period will remain constant. Any increase in projected revenue is then due to the assumed increase in water tariff.

- Water Revenue "with the project". Based on the technical study, the proposed improvements in the water supply system can provide the water requirements of the projected beneficiaries up to year 2019 (Siem Reap) to 2023 (Kampong Cham, Stung Treng and Svay Rieng). The volume of water sold is therefore assumed to increase up to that year and is assumed to remain constant at the that level. Any increase in projected revenue after this period is then due to the assumed increase in water tariff.

7.2 Approach and Methodology: Economic Assessment

82. The economic analysis was undertaken in accordance with the procedures set out in the ADB Handbook for the Economic Analysis of Water Supply Projects (1999) and related ADB guidelines10. The period of analysis extends over 30 years from the start of project implementation in 2015 up until 2044. Costs and benefits were quantified at August 2013 prices and were converted to their economic

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[9] Using PWWs/WSA asset life schedule.

[10] *Guidelines for the Economic Analysis of Projects (1997)*.

cost equivalents using shadow prices. Both costs and benefits were treated as increments to a "without the project" situation.

83. The economic viability of the project was determined by computing the economic internal rate of return (EIRR) and comparing the result with the economic opportunity cost of capital (EOCC) of 12%. An EIRR exceeding the assumed EOCC indicates that the project is economically viable. The viability of the investments was then tested for changes in key variables such as capital costs, O&M costs and benefits through sensitivity analysis. Distribution of project benefits and poverty impact analysis were also undertaken to determine how much of the net economic benefits resulting from the investments will directly benefit the poor.

84. The economic viability of the proposed investments in water supply was determined considering the following benefits: (1) incremental gross revenue; (2) the value of time saved for not having to collect water from existing non-piped sources; (3) medical cost savings due to reduced morbidity from waterborne diseases; and (4) avoided income loss (productivity savings) because of reduced incidence of diseases. Economic costs were derived from the estimates of capital investments and O&M costs in financial terms, removing all duties and taxes and multiplying the net results by the conversion factors (CF). The following CFs were applied: 1.0 for traded goods and non-traded goods, and 0.7 for unskilled labor.

85. The proposed investments which aim to improve the population's access to piped water supply in the area, will form part of the Government's overall development plan for the water supply sector, which also aims to achieve the targets set under the Millennium Development Goal11.

7.3 Kampot Provincial Waterworks (KPWW)

7.3.1 Historical Financial Performance

86. From 2009 to 2012, KPWW's revenue was able to cover O&M and part of depreciation (37 to 84% of depreciation). Operating ratio ranged from 1.1 to 1.3 from 2009 to 2012. Current ratios were high for the four-year period while account receivable as of end 2012 was high at 61 days equivalent of annual water sales.

Table 7.1: KPWW Financial Indicators, 2009-2012

Financial Indicators	2009	2010	2011	2012
Cost Recovery:				
Total expenses	1.24	1.21	1.25	1.41
Total expenses & Depreciation	0.76	0.78	0.86	0.95
Current Ratio	5.88	5.90	5.95	6.85
Operating Ratio	1.32	1.28	1.16	1.06
Account Receivable (Days)	73	49	54	61

[11] MDG's Target No. 10, Goal No. 7: Halve, by 2015 the proportion of people without sustainable access to safe drinking water and sanitation. For urban water supply in Cambodia, people with access to safe drinking water is about 64% in 2004. Per MDG, this should reach 80% by 2015. Source: Key Indicators of Developing Asian and Pacific Countries, 2006, ADB.

7.3.2 Projected Financial Performance

7.3.2.1 Investment Costs

87. The total investment cost for the water supply project is approximately KR 484 million (assuming a 50% loan), including price and physical contingencies and interest during construction. Table 7.2 presents a summary of the investment costs.

Table 7.2: KPWW Total Investment Cost (KR million)

Items	% Total	Total
Civil Works	0.0	-
Equipment and Materials	69.9	338
Total Base Cost	69.9	338
Physical Contingency	14.0	68
Price Contingency	6.4	31
Total Contingencies	20.4	99
Interest During Construction	0.6	3
Taxes and Duties	9.0	44
Total	100.0	484

Source: Consultant's estimate

7.3.2.2 Financing Plan

88. The project will be financed by ADB loan (KR 243 million) including interest during construction and the national government (KR 240 million). The financing plan is shown in Table 7.3.

Table 7.3: KPWW Financing Plan (KR million)

Items	% Total	Total
ADB Loan (on-lending)	50.3	243
Disbursement	49.7	240
Interest During Construction	0.6	3
Government Grant	49.7	240
Own Fund	9.9	48
ADB Fund	39.8	192
Total Financed	100.0	484

Source: Consultant's estimate

7.3.2.3 Water Tariff.

89. At 0, 50 or 100% loan, the required tariff to cover O&M costs, depreciation and debt service by 2023 are shown in Table 7.4. It is recommended that customers are categorized into households, government and commercial so that block tariff and cross subsidy between customer categories can be implemented. For household customers, the proposal is to use 1 to 7 m3 as the lifeline consumption (first block) and 7 m3 and above as the second block.

Table 7.4: KPWW Proposed Tariff Rate – 0, 50 or 100% Loan

Category	2015	2018	2021	2023
Household, 0 - 7 m3	1,400	1,550	1,650	1,750
above 7 m3	1,700	1,900	2,100	2,400
Government	1,700	1,900	2,100	2,400
Commercial	2,000	2,250	2,500	2,800
Tariff Increase (average)	15%	11%	9%	12%

Source: Consultant's estimate

7.3.2.4 Affordability of Water Rates

90. A major consideration in the development of the tariff schedule is the ability of target beneficiaries to pay for their monthly water bill. For KPWW service area, the estimated monthly income belonging to the poor households for 2013 is KR 720,000. Using the affordability criteria, the monthly water bill is about KR 9800 (KR 1400 x 7 m3) in 2015 is only 1.4% of the monthly income of poor households. In all subsequent years the monthly water bill is less than 5% of the estimated monthly income. Hence, the proposed level of water tariff is deemed affordable to the low income or poor households.

7.3.2.5 Impact of the Project on the KPWW's Financial Operation.

91. Selected financial ratios were computed to provide an indication of the KPWW's future financial performance (Table 7.5).

- Revenues can cover O&M cost and depreciation allowance from 2015 to 2025 except in 2017 where only 90% are covered;
- Current ratio are high ranging from 6 to 9;
- Operating ratio is less than or equal to 1 from 2015 to 2025 except in 2017;
- Debt service coverage ratio is higher than 1.3 for all the projection years; and
- Account receivables is 18 days equivalent of annual revenue.

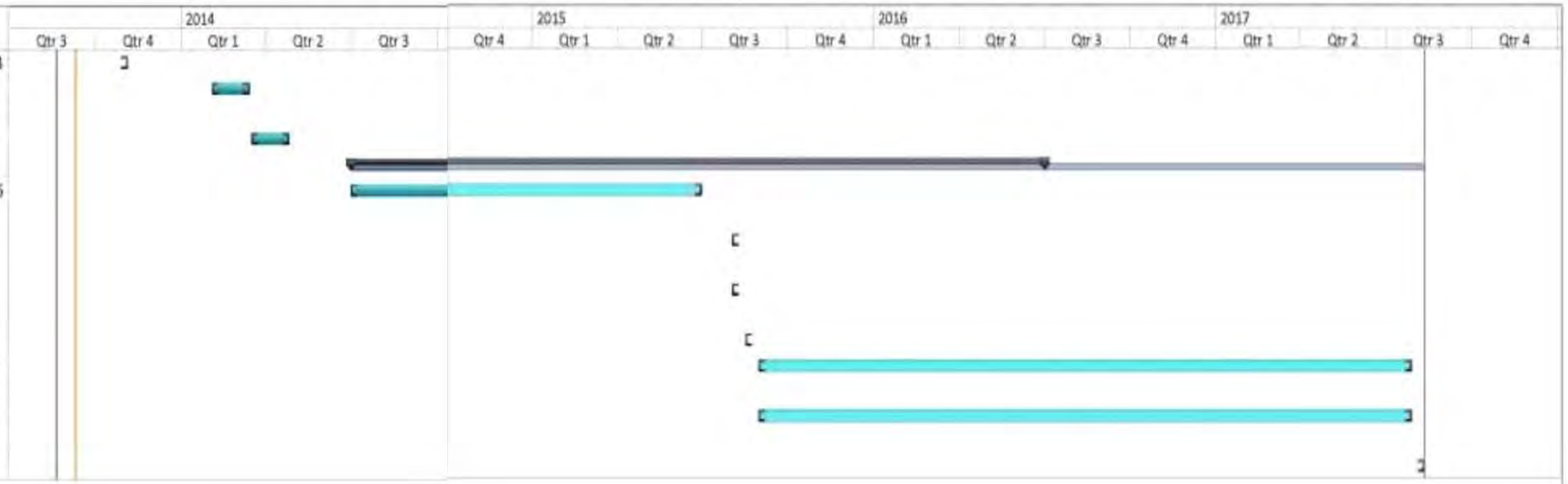
Table 7.5: KPWW Summary of Financial Indicators (50% Loan)

Financial Indicators	2015	2016	2017	2018	2019	2020	2025
Cost Recovery:							
O&M	1.4	1.4	1.2	1.3	1.3	1.3	1.3
O&M + Depreciation	1.0	1.0	0.9	1.0	1.0	1.0	1.1
Current Ratio	6.6	7.3	6.8	7.4	8.0	8.6	9.8
Operating Ratio	1.0	1.0	1.1	1.0	1.0	1.0	1.0
Debt Service Coverage Ratio	-	-	-	224.3	228.4	202.8	61.2
Account Receivable (Days)	18	18	18	18	18	18	18

Source: Consultant's estimate

Appendix A: Kampot Subproject Implementation Schedule

ID	Task Mode	Task Name	Duration	Start	Finish
1		Completion of PPTA			Mon 4/11/13
2		Tendering of implementation project	30 days	Mon 3/02/14	Fri 14/03/14
3		Tender evaluation	30 days	Mon 17/03/14	Fri 25/04/14
4		**Final design & contract management**	**524 days**	**Tue 1/07/14**	**Fri 1/07/16**
5		Final design & contract documentation	261 days	Tue 1/07/14	Tue 30/06/15
6		Tenders close - construction package 1		Mon 3/08/15	
7		Tenders close - construction package 2		Mon 3/08/15	
8		Tender award - package 1 & 2		Mon 17/08/15	
9		Construction Package 1 - Stung Treng	500 days	Mon 31/08/15	Fri 28/07/17
10		Construction Package 2 - Siem Reap plus 7 others	500 days	Mon 31/08/15	Fri 28/07/17
11		Commissioning			Fri 11/08/17



Project: schedule.mpp
Date: Tue 10/09/13

Task | Split | Milestone | Summary | Project Summary | External Tasks | External Milestone | Inactive Task | Inactive Milestone | Inactive Summary | Manual Task | Duration-only | Manual Summary Rollup | Manual Summary | Start-only | Finish-only | Deadline | Progress

Page 1

Project: schedule.mpp
Date: Tue 10/09/13

Task | Split | Milestone | Summary | Project Summary | External Tasks | External Milestone | Inactive Task | Inactive Milestone | Inactive Summary | Manual Task | Duration-only | Manual Summary Rollup | Manual Summary | Start-only | Finish-only | Deadline | Progress

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Appendix B: Cost Estimate for Kampot Subproject – water supply development

Appendix C: Water Quality Test Results for Kampot Subproject

Month average	**Temp (C)**	**Turbidity NTU**	**Res chlorine (mg/l)**	**pH**	**Colour TCU**	**Alkalinity (mg/l as $CaCO_3$**	**Conductivity (us/cm)**
LIMIT		**<5**	**0.2-0.5 at end user**	**6.5-8.5**	**<5**		**1600**
			in reservoir				
Jan		0.7	1.5	6.9	1.5	25	83
Feb		0.8	1.6	6.9	1.6	28	70
Mar		1.0	1.5	7	1.5	24	92
Apr		1.1	1.4	7	1.2	25	88
May	25.9	0.9	-	7	1.1	35	66
Jun	26.2	1.2	-	7.4	1.2	31	67
Jul	26.1	1.9	-	7.4	3.3	22	60
Aug	25.4	1.1	-	7.1	1.3	19	60
Sept	25.1	1	-	7.3	1	19	46
Oct	25.5	1.3	-	7	1.9	15	38
Nov	25.2	1.3	-	7.1	1.8	18	43
Dec	25.3	0.7	-	7	0.7	17	38

Appendix D: Kampot Financial & Economic Assessment

Appendix E: deleted

Appendix F: Environmental Due Diligence report

Appendix G: Land acquisition due diligence report

Appendix H: Outline Operation and Maintenance Plan

Operational Procedures

WTP area	**Procedure**
Raw water pumps	Can be controlled (on/off) by level transducers in the main clear water tank, or manually by Operator.
Flocculation tank inlet weir	Set so that there is always a hydraulic break between water in the inlet channel and the first flocc channel.
Flocculation tank baffles	Baffle slot sizes on lower end of alternate baffles, which are calculated and specified during final design, should be adhered to. When baffles are moved during cleaning of the flocc tank, these slot sizes should be reset to the design dimensions. Failure to do this may result in incorrect velocity gradient across the flocc tank resulting in poor flocc formation.
Sed tank collection launders	The stainless steel collection launders should be set at a level that allows for the prescribed headloss across the flocc tank. If the launders are set too high it has the effect of “backing up” the flocc tank and reducing the hydraulic gradient across it. This is normally set during design by calculating the hydraulics across the full WTP, but is sometimes neglected.
Filters – bypass of water	For filters to operate properly, the plenum floor that holds up the gravel and sand layers needs to be sealed. No water should pass between the plenum floor and the vertical filter walls, or through the plenum floor except through the inserted filter nozzles. Additionally, water should not be allowed to take a “short cut” between the edge of the sand layer and the filter wall. This can be stopped by roughening the inside filter wall with a sand/cement mix.
Filters – backwashing	Filters should be backwashed when the sand becomes sufficiently blocked with debris and silt to slow the passage of water through the media. This can be judged by marking a dirty water level inside the filter, and when it is reached, a backwash is due. Similarly a low water level mark should be visible and this minimum water level in the filter kept by partially closing the clean water outlet valve to the clear water tank. The backwash cycle begins with air scour by itself to loosen the sand media and help release dirt. This should carry on for around 3-5 minutes. The air blower is then turned off and backwash valve opened partially at first and then gradually opened further, in order to maintain the design backwash flowrate as the head in the backwash tank decreases. The backwash valve should never be just opened fully for the backwash cycle.
Reticulation	
Washout valves	All washout valves on the system, installed at low points, should be opened every month to flush out the line as required.
Valves on the distribution system	Valves should be kept either fully open or fully closed.

Maintenance Schedule

Raw water pumps	New submersible pumps should be raised using the auto-coupling & guiderails once per year to inspect the pumps and perform routine maintenance.
Flocculation tank	The flocc tank should be taken offline, one chamber at a time (there are 2 chambers), and cleaned out using shovels and a water blaster. Any repairs to baffles or replacement of rotten wooden baffles can take place at this time.
Sedimentation tank	The sedimentation tank should be taken offline, one at a time, and cleaned out annually.
Slide gates on all tanks	These should be inspected regularly and if not opening and closing easily, remedial action taken – either lubrication of threads or replacement of rubber seals.
Filters	Filter media will gradually become more blocked over time despite regular backwashing. Approximately every 5 years the sand and gravel media will need either removing and thoroughly washing before replacement, or new graded & washed sand placed. At this time, the nozzles and underdrains can also be inspected for damage.
Dosing pipelines	Check for leaks regularly and fix. Clean up spills and leaks.
Chemical mixing area	Keep floor clean
Chemical mixing tanks	When alum and poly tanks start to fill to the outlet pipe level with sediment they should be taken offline and cleaned out.
Pumps & blowers – general	Maintenance plan to follow manufacturers manual
Chlorination equipment - general	Maintenance plan to follow manufacturers manual
Reticulation	
Gate valves	All gate valves on the pipelines should be kept either fully shut or fully open as required.
Washout valves	Any washout valves, normally installed at low points, should be periodically (6 monthly) opened to flush out any debris.
Chambers	All valve chambers should be kept dry, clean and accessible.
Domestic connections	Any leaks on the upstream side of the meter should be recorded by meter readers and repaired promptly.
Physical leaks	All leaks reported or noticed by WA staff should be repaired promptly.

Appendix H: Outline Operation and Maintenance Plan

Appendix I: Rearrangement of pipework to elevated tank

KINGDOM OF CAMBODIA

MINISTRY OF INDUSTRY AND HANDICRAFT

URBAN WATER SUPPLY AND SANITATION PROJECT

(ADB PPTA: TA-8125-CAM)

SHORT FEASIBILITY STUDY FOR PURSAT SUBPROJECT

November 2013

Prepared by

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ABBREVIATIONS AND EQUIVALENTS

ADB	Asian Development Bank
ADF	Asian Development Fund
AP	Affected persons
APs/AHs	Affected persons/affected households
ASR	ADB's Annual Sector Review
BOO	Build-Operate-Own
BOT	Build-Operate-Transfer
COBP	Country Operations Business Plan
CPP	Community Participation Plan
CPS	Country Partnership Strategy
DMC	Developing Member Countries
DMF	Design and Monitoring Framework
DPWS	Department of Potable Water Supply
EA	Executing Agency
EGM	Effective Gender Mainstreaming
EMP	Environmental Management Plan
FAR	Feasibility Assessment Report
FS	Feasibility Study
GAP	Gender Action Plan
HHs	Households
IAs	Implementing Agencies
IEEs	Initial Environmental Examinations
IOL/SES	Inventory of Losses and Socioeconomic Survey
IR	Inception Report
ISCD	Institutional Strengthening & Capacity Development
JICA	Japan International Cooperation Agency
LARP	Land Acquisition and Resettlement Plan
LARF/LARP	Land Acquisition and Resettlement Framework and Plan
MEF	Ministry of Economy and Finance
MIH	Ministry of Industry and Handicraft
MOU	Memorandum of Understanding
MOWRAM	Ministry of Water Resources Management and Meteorology
MPWT	Ministry of Public Work and Transport
MRD	Ministry of Rural Development
NCB	National Competitive Bidding
NRW	Non-revenue Water
O&M	Operation and Maintenance
PAM	Project Administration Manual
PDIH	Provincial Department of Industry and Handicraft
PDR	People Democratic Republic
pm	Person-months
PMU	Project Management Unit
PPP	Public Private Participation
PPPs	Public-Private Partnership
PPTA	Project Preparation Technical Assistance
PPWSA	Phnom Penh Water Supply Authority
REA	Rapid Environmental Assessment

RRP	
SCS	Stakeholder Communication Survey
SPS	Safeguards Policy Statement
SRWSA	Siem Reap Water Supply Authority
SR	Safeguards Requirements
TA	Technical Assistance
TOR	Terms of Reference
WOPs	Water Operators' Partnerships
WTP	Water Treatment Plant

UNITS

ha	Hectare
lpcd	Liters per capita per day
l/s	Liters per second
m	Meter
mg/l	Milligrams per Liter
mm	Millimeter
m^3/day	Cubic meters per day

Figure 1-1 - Location of Project Towns

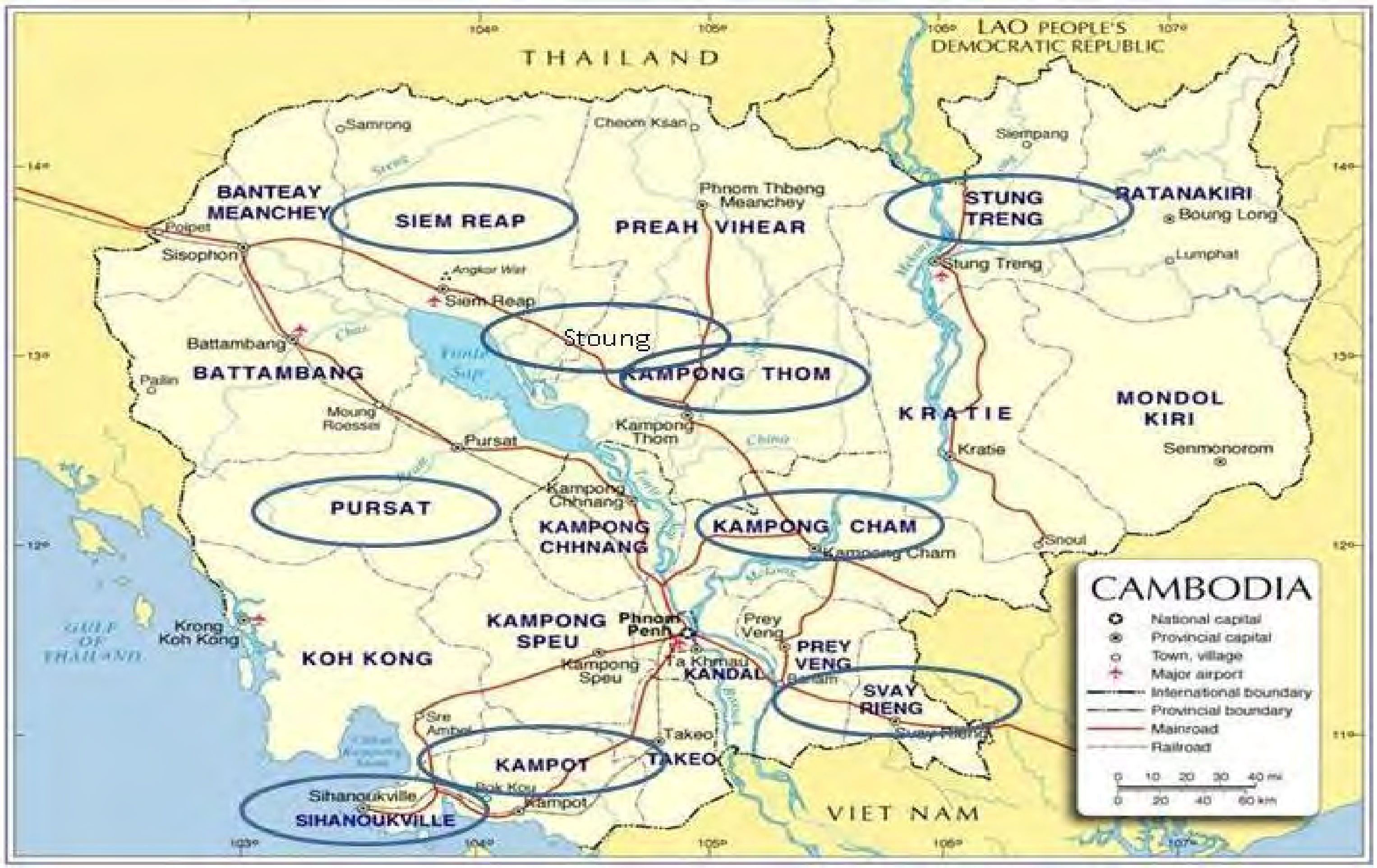
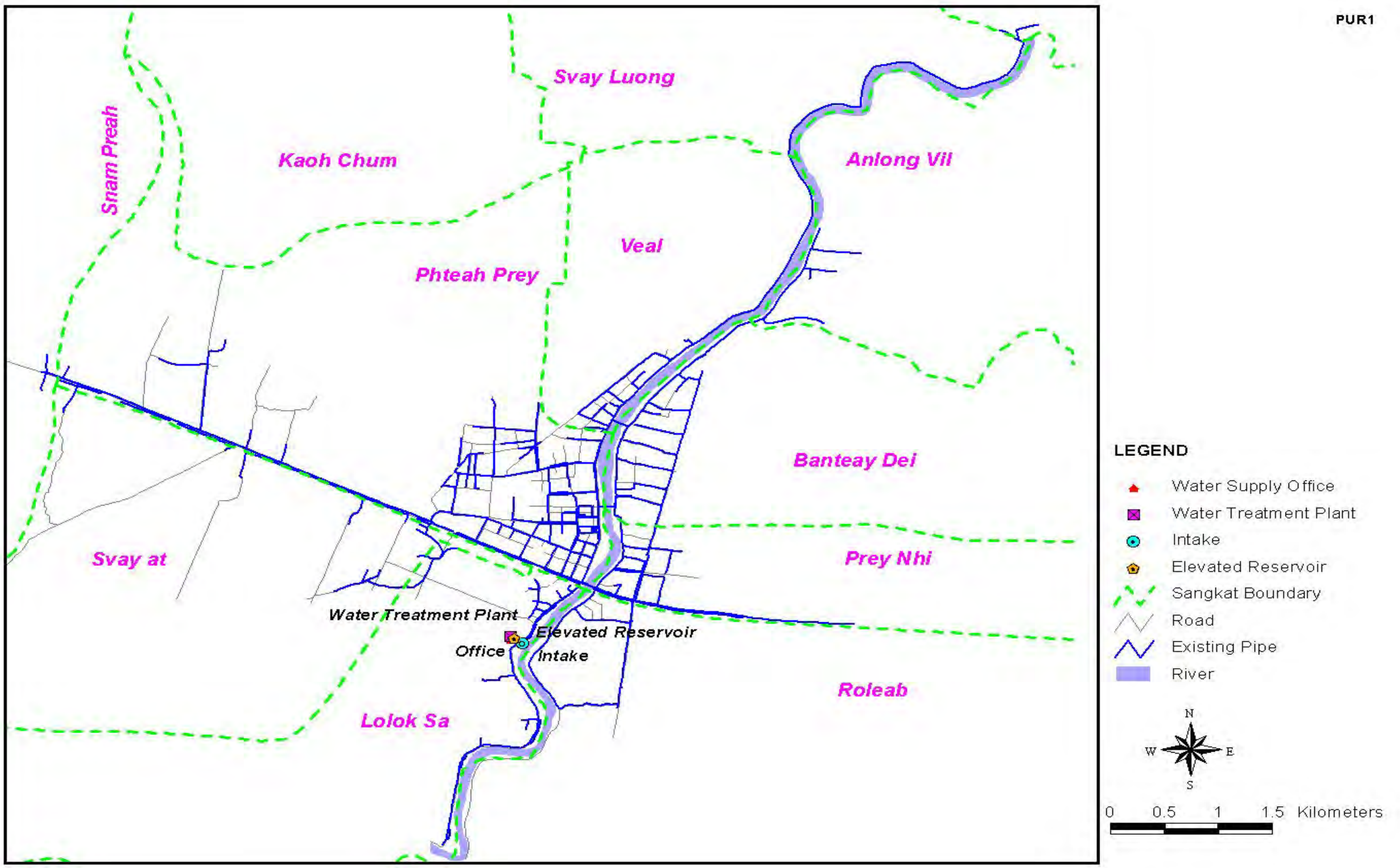


Figure 1-2 Location Plan of Proposed Pursat Subproject



1. EXECUTIVE SUMMARY

1.1 Project Description

1. Expected outputs of the overall Project include: (i) water treatment plants provided or improved in eight towns; (ii) water distribution systems improved and coverage increased in six towns; (iii) existing pumping stations rehabilitated in five towns; and (iv) institutional capacity of MIH and regulatory system strengthened, under a piggy-backed technical assistance.

1.2 Rationale

2. During 2011, through the ADB's Water Operators' Partnerships Program, ADB was able to re-engage in the urban water supply sector with MIH. Consequently ADB's Country Operations Business Plan 2010-2013 includes an Asian Development Fund loan for the Project for approval in 2014. The UWSP will assist the government to address the three core constraints identified in the ADB Country Partnership Strategy (2011-2013): (i) insufficient funds to expand coverage and improve services; (ii) weak sector planning and implementation capacity of responsible authorities at the central and sub-national levels; and (iii) inadequate (or sometimes weak) institutional and legal framework.

1.3 Background

3. The proposed Project "Urban Water Supply Project " (UWSP) will provide necessary facility improvements to the six provincial towns previously funded by ADB and to three provincial towns that have been funded by other bilateral or multilateral agencies, and expand public access to sustainable and safe water supply services for the urban population in Cambodia. In addition, the Project will address institutional weaknesses through the development of improved institutional structures, a regulatory framework, and appropriate capacity development.

1.4 Project Impact and Outcome

4. The impact of the proposed Project will be expanded access to sustainable and safe water supply services for the urban population in Cambodia and better functioning water treatment plants providing higher quality water. MIH targets are to increase the proportion of the urban population in the project area with access to safe water to 85% by 2018 and 90% by 2025, and the project will assist these aims. The outcome of the project will be improved water supply infrastructure and service provisions in selected provincial waterworks.

1.5 Candidate Towns

5. There are nine candidate towns: Kampong Cham, Kampong Thom, Kampot, Pursat, Siem Reap, Sihanoukville, Stoung, Stung Treng and Svay Rieng. Originally Battambang was to be included but this was removed at the request of the Provincial Waterworks.

1.6 Feasibility Study Context

6. The feasibility studies include: (i) needs assessment, supply and demand analysis, (ii) selection of technology, equipment, and facilities for the identified subprojects considering least cost and life cycle approach and the capacities of the local authorities to manage, operate, and maintain; (iii) assessment of economic and financial viability and sustainability for each of the subprojects; (iv) assessment of policy and legal capacity, including other institutional issues and mechanisms related to the financial management, procurement, and anticorruption; (v) poverty, social, and gender analysis and preparation of a poverty and social strategy, a gender action plan, stakeholder communication survey (SCS), and a Community Participation Plan (CPP), where required; and (vi) review of impacts on environment, involuntary resettlement, and indigenous peoples.

1.7 Subproject Description

1.7.1 Output 1 - Water Supply Development

7. The Pursat subproject aims to improve the provision of safe, affordable, reliable piped water supply to individual household connections to communities within the eleven core sangkats or communes having Y2013 population of about 51,324. The works proposed under the PPTA are summarised in Table 1.1 below and in more detail in Section 5.2.2.

1.7.2 Output 2 – Strengthening of Institutional capacity of MIH and Regulatory System

8. The Institutional Strengthening and Capacity Development is to (i) identify key stakeholders; (ii) assess institutional capacity constraints; (iii) develop institutional capacity building plan; and (iv) prepare terms of reference for strengthening sector regulation TA.

1.8 Cost Estimate

9. The subproject cost is estimated at $0.302 million equivalent, including taxes and duties. Table 1.1 provides a summary of the Pursat Subproject cost estimate.

Table 1.1: Pursat Subproject Cost Estimate ($'000's)

No	Description	Totals (inc tax) US$000
2	**Water Supply Development**	
2.1	Install one transformer 300KVA	25.0
2.2	Replace 2 raw water pumps with submersible pumps. Current pumps have long shafts which cause vibration & overheating.	80.0
2.3	New 500mm gate valve for upper inlet pipe	10.0
2.4	Filters need 2 new manual gate valves for inlets and drains.	15.0
2.5	Replace filter block inlet gate valve 500mm	10.0
2.6	Install 3Km parallel DN160mm HDPE pipe	52.0
2.7	Replace old chlorination system	50.0
2.8	Addition of sludge drying bed	10.0
	Total for Water Supply Development	
	TOTAL ESTIMATED BASE COST[a]	**252.0**
	Contingencies 20%	50.4
	TOTAL ESTIMATED SUBPROJECT COST	**302.4**

1.9 Executing Agency and Implementation Arrangements

10. MIH will be the Executing Agency, and the existing project management unit (PMU) based in the Department of Potable Water Supply (DPWS) will be expanded to execute and manage the Project on behalf of MIH with the consulting service to be provided by the project implementation assistance consultants (PIAC). The Project implementing units (PIUs) are expected to be organized by the nine (9) implementation agencies (IAs) of the provincial waterworks. The nine (9) PIUs will be responsible for day-to-day coordination and supervision of subproject implementation in these provincial towns.

1.10 Implementation Period

11. The proposed Project is scheduled for implementation over five years from 2014 to 2018. The final design is proposed for a one year period between mid-2014 and mid-2015. Following this, a two year construction period would have the works commissioned in August 2017. A proposed Implementation schedule is included in Appendix A.

1.11 Procurement

12. The procurement shall be carried out under International Competetive Bidding (NCB) as three packages; one package Stung Treng; one package Siem Reap; and the remaining 7 subprojects as one package. The full Procurement Plan is contained in the Supplementary Appendices of the main PPTA report.

1.12 Consulting Services

13. The project implementation assistance consultants (PIAC) on the design and engineering review, tendering assistance, and construction management are provided under Bank financing will be selected in advance and engaged in accordance with the ADB's Guidelines on the Use of Consultants. An individual consultant will be engaged to prepare the PIAC terms of reference and to assist the EA on the preparation of the Request for Proposal. The PIAC consulting services will be signed once the loan becomes effective to provide under a single consulting package, by an association of international and domestic consulting firms. The lead consulting firm will provide the services of the Team Leader who will be responsible for managing the overall consulting services during the project implementation.

1.13 Subproject Benefits and Beneficiaries

14. The Pursat subproject aims to improve the provision of safe, affordable, reliable piped water supply to individual household connections to communities within the eleven core sangkats or communes having Y2013 population of about 51,324.

1.14 Land Acquisition and Compensation

15. The overall project has Involuntary Resettlement Categorisation C because all of the improvement facilities are within the water treatment plant compound. The Land Acquisition Due Diligence report for Pursat is contained in Appendix G.

1.15 Environmental Impacts

16. An Initial Environmental Examination (IEE) was carried out for Pursat, and is contained in Appendix F. The subproject is classified as Category B. The overall conclusion is that providing the mitigation, compensation and enhancement measures are implemented in full, there should be no significant negative environmental impact as a result of location, planning, design, construction and operation of the project. There are benefits stemming from recommended mitigation and enhancement measures, and major improvements in quality of life and individual and public health once the project is in operation.

1.16 Economic and Financial Analyses

17. Economic and Financial analyses for Pursat is contained Section 7, and in full in Appendix D.

1.17 Tariff and Affordability

18. Assuming a 0% loan, tariff increases required to cover O&M costs and depreciation are shown in Table 7.4. Required tariffs for 50 or 100% loan amounts are shown in Table 1.2. It is recommended that the PPWW: (1) implement a block tariff for household consumers to reduce the impact of tariff increases to the poor households; and (2) implement a cross subsidy between different customer categories thru different tariff rates. The proposed tariff for government and commercial customers are higher than the first block tariff to allow for subsidy to poor household customers.

Table 1.2: PPWW Proposed Tariff Rate - 0% Loan

Category	2015	2018	2021	2023
Household, 0 to 7 m3	1,600	1,700	1,800	1,800
above 7 m3	2,100	2,300	2,500	2,600
Government	2,100	2,300	2,500	2,600
Commercial	2,150	2,500	2,800	2,900
Tariff Increase (average)	20%	8%	7%	2%

Source: Consultant's estimate

2. PROJECT RATIONALE, IMPACT AND OUTCOME

2.1 Rationale

19. During 2011, through the ADB's Water Operators' Partnerships Program, ADB was able to re-engage in the urban water supply sector with MIH. In January 2012, MIH signed a twinning agreement with the PPWSA, which is currently providing support to four provincial waterworks been included in the Project through direct peer-to-peer knowledge transfer. In February 2012, the Ministry of Economy and Finance (MEF) requested ADB to consider financing the Project in accordance with the strategy of Cambodia's Public Debt Management, to ensure sustainable economic growth. Consequently ADB's Country Operations Business Plan 2010-2013 includes an Asian Development Fund loan for the Project for approval in 2014. The project supports the ADB's annual sector review, country partnership strategy, and the water operational plan 2011–2020

20. The UWSP will assist the government to address the three core constraints identified in the ADB Country Partnership Strategy (2011-2013): (i) insufficient funds to expand coverage and improve services; (ii) weak sector planning and implementation capacity of responsible authorities at the central and sub-national levels; and (iii) inadequate (or sometimes weak) institutional and legal framework.

2.2 Background

21. The proposed Project "Urban Water Supply Project " (UWSP) will provide necessary facility improvements to the six provincial towns previously funded by ADB and to three provincial towns that have been funded by other bilateral or multilateral agencies, and expand public access to sustainable and safe water supply services for the urban population in Cambodia. In addition, the Project will address institutional weaknesses through the development of improved institutional structures, a regulatory framework, and appropriate capacity development.

22. This UWSP is in line with (i) Cambodian National Strategic Development Plan (2009-2013) and (ii) action plan of Ministry of Industry and Handicraft (MIH) to facilitate private sector partnerships, strengthening the management of public owned waterworks, and integration urban water supply with urban environmental management. The proportion of the urban population in the project area with access to safe water will be increased to 85% by 2018 and 90% by 2025 as targeted by MIH. In addition, a potential target date for 100% coverage could be assumed as 2030.

2.3 Project Outline

23. The feasibility studies include: (i) needs assessment, supply and demand analysis, (ii) selection of technology, equipment, and facilities for the identified subprojects considering least cost and life cycle approach and the capacities of the local authorities to manage, operate, and maintain; (iii) assessment of economic and financial viability and sustainability for each of the subprojects; (iv) assessment of policy and legal capacity, including other institutional issues and mechanisms related to the financial management, procurement, and anticorruption; (v) poverty, social, and gender analysis and preparation of a poverty and social strategy, a gender action plan, stakeholder communication survey (SCS), and a Community Participation Plan (CPP), where required; and (vi) review of impacts on environment, involuntary resettlement, and indigenous peoples.

2.4 Project Impact and Outcome

24. The impact of the proposed Project will be expanded access to sustainable and safe water supply services for the urban population in Cambodia and better functioning water treatment plants providing higher quality water. MIH targets are to increase the proportion of the urban population in the project area with access to safe water to 85% by 2018 and 90% by 2025, and the project will assist these aims. The outcome of the project will be improved water supply infrastructure and service provisions in selected provincial waterworks.

3. Profile of Pursat Area

3.1 Town Location and Profile

25. Pursat city is the capital of Pursat Province and is on National Road 6 approximately half way between Phnom Penh and Siem Reap on the east side of the Tonle Sap lake. The Pursat river runs from mountains to the west to the Tonle Sap lake and passes through the town centre.

26. Agriculture is the primary industry in the Province. The city is well known nationally for its stone carving.

3.2 Natural Features

3.2.1 Topography

27. The area around Pursat is flat, being along the Pursat river floodplain and to the west of the nearby Tonle Sap.

3.2.2 Climate

28. The climate, in common with other non-coastal areas of Cambodia, is hot all year with a distinct rain season May – October and a drier season November – February.

3.2.3 Surface water

29. There is only one surface water source in Pursat, the Pursat river. This is currently used by some private households and also by the Water Authority as the raw water source.

3.2.4 Groundwater

30. Groundwater use is not common in Pursat as, whilst the quality is acceptable, there is not a large quantity of groundwater resource in the area for geological reasons.

3.3 Population and Household Characteristics

31. The populations provided below are for the service area within Pursat.

Table 3.1: Pursat Population Characteristics

No	Core Sangkhat/Commune	2013 Pop'n.	No. HH	Persons/ HH
1	Sangkat Lolok Sor	3,505	701	5.00
2	Sangkat Rolap	7,770	1,725	4.50
3	Sangkat Pteah Prey	14,005	3,000	4.67
4	Sangkat Svay Art	4,789	864	5.54
5	Sangkat Bantiey Dey	5,020	1,004	5.00
6	Sangkat Prey Nhee	3,580	716	5.00
	Kon Dieng District			
7	Viel Veng Commune	5,020	1,004	5.00

No	Core Sangkhat/Commune	2013 Pop'n.	No. HH	Persons/ HH
8	Svay Luong Commune	2,070	414	5.00
9	Kondieng Commune	2,126	436	4.88
10	Anlong Vil	2,158	437	4.94
	Bakan District			
11	Snam Preah Commune	1,281	270	4.74
		51,324	**10,571**	4.86

3.3.1 Population Growth and Migration

32. Population growth from the 2008 National Survey1 shows an average national urban growth rate of 2.21%. For the purposes of this study we have used growth rates for individual towns, provided by each Provincial Waterworks2. For Pursat this is -0.57% showing negative growth. For the purposes of population and water demand projections a growth rate of zero has been used.

3.4 3.4 Existing Water Supply and Sanitation

3.4.1 Water Supply

33. The original water supply system for Pursat was constructed in 1926, supplying 150m3/day from the river to 600 customers. The WTP was destroyed during the late 1970's period. From 1993 to 2002 the WTP was rehabilitated and capacity increased to 250m3/day by Dutch NGO SaWa3.

34. The current WTP was constructed under the ADB Provincial Towns project, commissioned in 2006, and has a design capacity of 5,760m3/day. The intake is from the Pursat stream via two intake pipes feeding to an inlet/grit chamber from which three (two duty, one standby) centrifugal raw water pumps deliver to the WTP in the same compound.

35. Upstream of the intake there is a sand mining operation and a return of irrigation water, both of which make raw water more turbid than usual year-round.

36. The WTP consists of dosing, flocculation, sedimentation, rapid sand filtration and delivery to a clear water tank. Three clear water pumps (two duty, one standby) then deliver water either directly into supply during peak demand, or to an elevated reservoir.

37. An extension has recently been made up to 9km from the WTP and direct pumping into supply is now needed to service this area.

38. The Provincial Waterworks has reported only 63% utilisation of the WTP capacity. These figures can be misleading. This percentage was based on the average 2012 annual production and the correct WTP capacity of 5,760m3/day. In reality the average annual production was estimated from pump running hours, as there are no working bulk meters at the WTP. As there are no bulk meters on the clear water pumpstation outlet, there is no current way of knowing whether this low

[1] General Population Census 2008 National Report, August 2009

[2] Data collected by head of each commune

[3] Pursat Water Master Plan 2008

WTP capacity utilisation is due to low pumping rates or a lower domestic demand than expected from projections.

39. Before using these utilisation figures for any future planning they must be confirmed with bulk metering and the establishment of an accurate NRW estimate based on bulk meter readings, domestic consumption and a top-down water balance.

3.5 3.5 Previous recent assistance from JICA

40. During 2012-13 JICA funded the "Project for Replacement and Expansion of Water Distribution Systems in Provincial Capitals", which included Pursat, Sihanoukville and Battambang. In Pursat 5,160m of distribution pipelines were replaced, 9,440m of additional pipelines laid to expand the system, and one flow monitoring system installed. Materials for 700 reconnections and 900 new connections were purchased for the Provincial Waterworks. The water treatment plant capacity was not increased to complement and serve this increase in service area. The total costs for all 3 towns was 2.76 billion yen.

41. The 3km of parallel pipe proposed under this subproject is designed to increase the capacity of an existing pipeline. There are no additional customers to be served and the pipeline is not an extension of the existing system.

4. POPULATION GROWTH AND WATER DEMAND FORECASTS

4.1 General

42. Pursat is the capital city of the Province and acts as a market for the surrounding area.

43. At present, there is no agro-processing or industrial development in Pursat consuming water or which could affect water quality, and nothing planned. There is no mine in the region. Pursat is well known nationally for stone carving.

4.2 Population Projections

44. The population projections4 are set out in Table 4.1. Within the core villages, total population is forecast to increase from about 51,324 in 2013 to about 51,324 in 2030.

Table 4.1: Population Projections for Pursat's Core Villages

Year 2013 Population	Growth Rate %	Forecast Population 2014	Forecast Population 2020	Forecast Population 2025	Forecast Population 2030
51,324	0	51,324	51,324	51,324	51,324

4.3 Water Demand Forecasts

4.3.1 General Approach

45. Whilst the scope of proposed works under this project does not include increasing the capacity of the Pursat water supply system, demand forecasts have been produced to illustrate the shortfall of available treated water into the near future. Water demand forecasts for the Pursat subproject were prepared by making separate projections of each component of demand, including:

- Demand for domestic use (based on per capita consumption, coverage targets and population projections);
- Demand for industry (based on a % of domestic use, and specific allowances for large industries);
- Demand for services (based on a % of domestic use, and specific allowances for large services areas);
- Physical losses as a % of total demand, excluding the demand of large industrial zones.
- Production losses in treatment plant (based % of total demands).

4.3.2 Domestic Consumption

46. Water demand and consumption data for other provincial and district towns in Cambodia show that domestic consumption accounts for about 90% of total demand. Per capita consumption figures for urban water supply systems in Cambodia can vary widely, particularly with strong reliance on rainwater collection during the wet season. Experience in other towns in Cambodia indicates that piped connections directly to the house will usually increase water consumption over time. The Feasibility Study has adopted a per capita consumption figure of 120 lpcd, plus 10% for non-domestic use which includes demand from industry and services, 15% for physical losses (leakage), and 50m3/day for backwashing filters in the WTP.

4.3.3 Water Demand Forecasts

47. Table 4.2 summarizes the demand forecasts and design criteria for the Pursat subproject. By 2030, the average daily water demand is expected to be 9,850m3/day, comprising 75% domestic

[4] 2012 populations and growth rate provided by the Provincial Waterworks

consumption, with the remaining 25% being for institutions, public use, services, handicraft and small industries, and allowances for physical losses and backwashing the filters.

Table 4.2: Water Demand Forecasts for Pursat Subproject

Water Demand Forecasts for Pursat Sub-project							
No.	**Items**	**Unit**	**Forecasts**				
			2013	**2014**	**2020**	**2025**	**2030**
A.	**Domestic Demand**						
1	Growth Rate	%	-	-	-	-	-
2	Population in Core Area		51,324	51,324	51,324	51,324	51,324
3	Coverage in Core Area	%	90	100	100	100	100
4	Population with Piped Water	No.	46,192	51,324	51,324	51,324	51,324
5	Per Capita Consumption	l/c/d	120	120	120	120	120
6	Total Domestic Demand	m3/d	5,543	6,159	6,159	6,159	6,159
B.	**Non-domestic demand**						
1	Services, Schools, Small Industry, Institutions, Hotels	%	15	15	15	15	15
2							
3	Total Non-domestic demand	m3/d	831	924	924	924	924
C.	**Subtotal Water Demand All Categories**	m3/d	6,374	7,083	7,083	7,083	7,083
D.	**Non Revenue Water (NRW) in Distribution system**						
1	NRW as % Average Daily Water Production	%	15	15	15	15	15
2	NRW (physical losses only-pipelines and WTP)	m3/d	956	1,062	1,062	1,062	1,062
E.	**Average Daily Water Production (C+D) rounded**	m3/d	7,330	8,150	8,150	8,150	8,150
F.	**Peak Annual Water Demand (Max day Max month)**						
1	Peak Annual Water Demand		1.20	1.20	1.20	1.20	1.20
2	Peak Annual Water Demand	m3/d	8,796	9,780	9,780	9,780	9,780
3	Peak Annual Water Demand	l/s	102	113	113	113	113
G.	**Required Treatment Plant Output (rounded)**	m3/d	8,800	9,780	9,780	9,780	9,780
H.	**Treatment Plant Backwashing**						
1	Treatment Plant Backwashing	m3/d	50	50	50	50	50
I.	**WTP Capacity**						
1	Required WTP Capacity	m3/d	8,850	9,830	9,830	9,830	9,830
2	Required WTP Capacity	l/s	102.43	113.77	113.77	113.77	113.77
	Total Required Source Capacity (Rounded)	**m3/d**					**9,850**
	Total Required Source Capacity	**l/s**					**115.00**

4.3.4 Future Demand Requirements

48. The table shows that the existing water treatment plant from 2006, at 5,760m3/day, is already insufficient to meet demand with 2014 demand projected at 9,830m3/day. This subproject is not intended to address future demands, but to rehabilitate the current existing WTP assets, improve water quality and improve security of supply.

49. A further 4,070m3/day of treated water will be required to meet projected 2030 demands.

5. SUBPROJECT DESCRIPTION

5.1 Introduction

50. The proposed works are designed to improve operational improvements, increased water quality and security of supply. This improved water supply scheme is not designed to increase capacity of supply.

5.2 Output 1: Water Supply Development

51. Expected outputs of the overall Project include: (i) water treatment plants provided or improved in eight towns; (ii) water distribution systems improved and coverage increased in six towns; (iii) existing pumping stations rehabilitated in five towns; and (iv) institutional capacity of MIH and regulatory system strengthened, under a piggy-backed technical assistance.

5.2.1 Preliminary Designs

52. The proposed water supply scheme design improvements are based on limited topographical, hydrological and water quality data and are preliminary.

5.2.2 Description of Proposed Water Supply System

53. The Pursat subproject aims to improve the provision of safe, affordable, reliable piped water supply to individual household connections to communities within the eleven core sangkats or communes having Y2013 population of about 51,324.

54. The works proposed under the PPTA are summarised in Table 5.1 below;

Table 5.1: Proposed new infrastructure for Pursat

Pursat	Short FS	
		A- Install one transformer 300KVA
		B - Replace 2 raw water pumps with submersible pumps. Current pumps have long shafts which cause vibration & overheating.
		C - New 500mm gate valve for upper inlet pipe
		D - Filters need 2 new manual gate valves for inlets and drains.
		E - replace filter block inlet gate valve 500mm
		F - Install 3Km parallel DN160mm HDPE pipe
		G- Replace old chlorination system
		H- Addition of sludge drying bed

5.2.2.1 Install new transformer

55. Currently a generator is used for all WTP power. In order to connect to the mains, a transformer is required. At preliminary design stage, a 300KvA model is proposed.

5.2.2.2 Raw water pump replacement

56. The three current raw water pumps were commissioned in 2006 and cause problems with the long shaft between motor (at the surface) and the pump approximately 15m below. They are Aurora vertical turbine pumps[5]. It is proposed to replace them with submersible pumps mounted on an auto-coupling with guide rails for easy removal from the well. As the WTP capacity is not being increased, new pumps will be sized to match current WTP capacity. Friction loss calculations and the pump duty curve are in Appendix H.

[5] [5] Pentair Aurora Vertical turbine-1500, size 11EH-6 stage, 1475rpm, 75HP, nom. capacity 241m^3/hr, nom. head 57m, www.aurorapump.com. Identical pumps were installed at Kampong Cham

5.2.2.3 New gate valve for upper raw water inlet pipe

57. There is no gate valve on the wet season (upper) raw water intake pipe, as there is on the dry season pipe. One 500mm diameter gate valve is proposed.

5.2.2.4 New gate valves for filters

58. There are eight 200mm gate valves on the top of the four filters, one inlet and one backwash for each. They were installed as actuated gate valves but none of the actuators now work, and some of the gate valves are also inoperable. It is proposed that all actuators be removed and gate valves no longer working properly be replaced.

5.2.2.5 Replace 500mm gate valve on filter inlet

59. This valve does not operate properly and needs replacement so that the combined filter block can be isolated if required.

5.2.2.6 Install new parallel pipe to improve hydraulics

60. On the edge of town 9km from the WTP there has been a recent pipeline extension using DN110mm pipe. To improve hydraulics it is proposed to put in another pipe of DN 160mm in parallel to te existing pipe. The locations of the proposed pipeline can be seen in Appendix J.

5.2.2.7 Replacement of Gas Chlorination system

61. The current gas chlorination system installed under the 2006 ADB project is a high quality European brand, but has failed both at Pursat and the other 5 towns under this previous project. This may be due to poor installation or lack of locally available spares. Repairs have been made with locally available materials rather than proprietary parts which is dangerous when used with pressurized chlorine gas. It is recommended to replace the entire chlorination system with a brand that is available locally or at least regionally, with after sales service and easy access to spare parts. Some design faults identified with the brand installed have been identified, being;

- The pressure gauges appear to have no diaphragm and no oil filled chamber to separate the chlorinated water from the meter workings. This has caused corrosion in all 6 towns.
- The existing set-up has hoses and pipes connecting the one tonne chlorine cylinders to a regulator. Leaks in this hose and pipe arrangement causes high pressure chlorine leaks. A better design is to have a vacuum regulator directly connected to the cylinder. If pipe downstream of the vacuum regulator leaks, the vacuum is broken and the regulator closed, sealing the valve and preventing leaks.
- The existing system does not have a heater on the cylinder outlet. This serves to ensure that the liquid chlorine in the cylinder turns to gas before it leaves the cylinder valve. During transportation of the cylinder to the site, the liquid chlorine is disturbed and often fills the fixed internal outlet tube. If not heated and vapourised this liquid chlorine can damage equipment downstream.

62. A gas scrubber system should be provided with the gaseous chlorination system as a safety measure. This is lacking at Pursat presently. The scrubber removes the chlorine from the air in the event of a serious leak in the system.

63. For the purpose of this Feasibility Study, the same manufacturer as used at PPWSA has been selected and invited to provide a proposal and budget price. This is contained in Appendix B.

5.2.2.8 Add sludge drying bed

64. There is currently no sludge drying bed for Pursat. To meet environmental standards one is required.

5.3 Consultation Activities during Preparation of Pursat Feasibility Study

65. A series of community visits and consultations occurred during the finalization of the 2013 Feasibility Study to inform district and village authorities about the subproject and gather information and feedback from local authorities, people living in core villages and other stakeholders. Consultation activities during the project site visits in 2013 are detailed below:

(i) Initial reconnaissance visit March 2013: Team Leader and National water engineer visited the site for an initial inspection and discussion with the Provincial Waterworks.

(ii) Second engineering site visit 29th April 2013:International and National water engineers visited Pursat facility, collected data, and finalized scope following Inception workshop.

(iii) Socio-economic specialist visit: a visit for the purpose of carrying out the public consultation was undertaken on 18-27th June

(iv) Environmental and Resettlement specialist visit: This joint visit was carried out between June 3rd -11th to collect data to aid the finalization of the environmental and resettlement due diligence reports.

5.4 Operation and Maintenance of Project Facilities

5.4.1 Capacity to Operate and Maintain the Proposed Water Supply System

66. The Pursat Provincial Waterworks have many years experience in operating and maintaining their treatment plant, and have full time Operator staff. There is a good understanding of how pumps work and the routine maintenance required.

67. The proposed new submersible pumps will require far less maintenance than the current well pumps with their overly long rotating shafts which vibrate badly. The proposed pumps come with autocouplings and guide rails which enable the pumps to be disconnected from the pipework and raised to the surface easily by one man. In addition there is a service agent present in capital Phnom Penh should spares or assistance be required.

68. The proposed new gas chlorination equipment is similar to the current equipment, but if the recommended manufacturer is used, there will be far greater options for professional servicing and provision of spares as needed. The proposed model is the same as used in Phnom Penh by PPWSA, and there is an agent in Phnom Penh that can provide servicing. Problems faced with the current gas chlorination equipment are mainly due to a lack of a regional office to provide support, spares and technical assistance when required. Whilst the preferred equipment cannot be specified by manufacturer, for future operation it would be beneficial to the Water Authority.

5.4.2 Management Arrangements

69. The PIAC will provide Project technical, safeguards, accounting and management assistance on a daily basis as well as support the PIUs with project implementation

70. At the start of Project implementation, the PMU and PIAC will (i) update the initial environment examinations and due diligence reports (IEEs and DDRs) and prepare EMPs submit to MOE for review and approval; (ii) clear potential unexploded ordnance (UXO) remain on site; and (iii) acquire necessary land before subproject bids are tendered.

5.4.3 Operation and Maintenance Plans

71. The Operation and Maintenance plan for each subproject can be divided into two types, those with a full conventional WTP and those with chlorinated groundwater being pumped to an elevated tank and fed into supply. For Pursat, an Operation and Maintenance Plan reflecting the former has been developed and is presented in full in Appendix I.

5.5 Lessons learned in Cambodia and the SE Asia region

72. There are several "lessons learned" in both the region and inside the national water sector that would benefit the 9 project towns under this PPTA;

- As at PPWSA, use of standardized chlorination equipment that has a regional office that can offer technical support, spares and specialist staff when needed. PPWSA has selected equipment supplied by Severn Trent Services (STS), and equipment from this manufacturer has been recommended for the towns requiring replacement chlorination equipment under this study. STS have a main office in Singapore, but have local representation in Phnom Penh. However, final selection of equipment of equal or better specifications will be decided at tendering as specific brands cannot be specified in Contract documents.
- High density polyethylene pipe (HDPE) is favoured in Cambodia, even for larger diameters. As most of Cambodia is flat, as are all of the 9 towns under this study, system pressures are not higher than 60m head. As such, a PN6 rated pipe would be sufficient. However, experience has shown that for the pipes un to and including 90mm diameter, which may have domestic connections tapped from them, a PN8 minimum pipe is required, even for very low pressures. The reason for this is that the tapping saddles used can deform the thinner pipe wall thicknesses on PN6 pipe, which causes leakage.
- Automated valves linked to a central control panel were designed and installed under the 2006 Provincial Towns project. All of these have failed in the 6 towns where they were installed. The lesson here is to keep the WTPs simple and keep valves as manually operated. With the relatively smaller size of these WTPs (mostly under 6,000m^3/day), valve automation is not necessary and inappropriate.
- Alum and poly dosing lines under the previous Provincial Towns project used long lengths of uPVC pipe that followed buildings and structures, necessitating several 90 degree bends and causing significant headloss in the delivery pipe. This has caused the pipes to get blocked by sediment. In addition, the uPVC dosing pipes are exposed to direct sunlight. UV light will break down uPVC pipe over time. A better solution, as used in two recent projects in Laos, is to use ABS (acrylonitrile butadiene styrene) pipe, and select a more direct route for the pipe, minimizing bends and low points.
- For the water sector as a whole, a database of all water projects could be set up, to include design drawings, calculations, contract documents, demand calculations, feasibility reports, final design reports and other useful documentation, for each system. This would serve as an easily accessible online resource library for all Water Authority staff in the country. It is relatively easy and inexpensive (under US$40,000) to set up and populate, and solves the common problem of drawings and documents getting lost. Many of the available hard copy resources for Cambodian water supply systems are either misplaced, or are reportedly stacked in disorder in a storeroom so dirty that nobody is willing to enter. Such a database was set up and released in neighbouring Laos in 2012-13 with assistance from UNHabitat, and can be viewed at;

http//:laowtp.info
by pressing "login as guest".

- Several of the project towns under this PPTA have had extensions added to serve areas that were outside of the original design core area, without considering required design pressures or treatment plant capacity. This often results in the WTP being operated above its design capacity, which can reduce water quality, and often has negative effects on service pressure to other parts of the reticulation network. Typically, to increase system pressure to serve these unplanned extensions, water is diverted around any elevated storage tank and pumped directly into the system in order to increase delivery pressure by a few metres head. This is bad operating practice as it eliminates the storage facility and increases leakage loss. Any pipeline extensions should be made in a planned way and carried out simultaneously with WTP capacity upgrades as required.

5.6 Public Private Partnerships

73. Options and viability for potential PPP for Pursat subproject was discussed with the Director of the Department of Potable Water Supply6.

74. In common with all towns in general, the urban water supply systems are seen as best managed by the government where possible. Installation and commissioning of the elements of work under this subproject require specialist contractors and involvement of public bodies is limited.

75. There are some peri-urban areas in Cambodia where whole water supply concessions have been granted to private companies to construct and manage water supply systems. This is not strictly PPP, as the private company needs only to acquire a license – there is no partnership as such. There are both good and bad examples of these private concessions throughout the country.

76. A possible area where a PPP could be utilized in the future is in the supply of bulk treated water to customers who are either just outside of the WTP service area or are inside the area but receive low pressure. Private water tankers could be used to fill up with (and pay for) treated water from the WTP and deliver and sell to customers with their own storage tanks.

5.7 Contract Packaging of Subproject

77. A number of packaging options were examined and discussed between the PPTA team, MIH and ADB. These options are presented below in Table 5.2.

Table 5.2: Subproject Contract Packaging Options

No. packages	Subproject Towns included	Advantages/disadvantages
2	Stung Treng Siem Reap plus 7 rehab towns	**Advantages:** • Small number of packages reduces tendering and contract management admin. • Larger packages makes them more attractive to international bidders. • Easier to standardise on equipment. **Disadvantages:** • Limited opportunity for NCB
3	Stung Treng Siem Reap	**Advantages:** • Three good sized packages attractive

[6] Mr Tan Sokchea

	7 rehab towns	to ICB bidders • Small number of packages reduces tendering and contract management admin. • Easier to standardise on equipment **Disadvantages:** • Limited opportunity for NCB
4	Stung Treng Siem Reap 3 southern rehab towns (Svay Rieng, Kampot, Sihanoukville) 4 northern towns (Kampong Cham, Kampong Thom, Pursat, Stoung)	**Advantages:** • 2 larger and 2 smaller packages, the smaller of which could be NCB if an exception to the $1M limit relaxed **Disadvantages:** • More tender and contract management admin • More difficult to standardise on equipment with larger number of packages.
9	9 separate contracts	**Advantages:** • Each IA is responsibe for their own subproject and has direct ownership • 7 of the 9 subprojects could be let as NCB **Disadvantages:** • More tender and contract management admin • Some activities may not be suitable for many national contractors due to lack of specialist experience. • More difficult to standardise on equipment with larger number of packages.

78. During discussions, initially the option of two large contracts, one for Stung Treng and one for the other 8 towns, was favoured for the simplicity of the bidding process, contract administration, and the attractiveness of the larger packages to international bidders.

79. After further discussion, 9 separate contracts was favoured, as greater weight was put on having the contracts out to tender quickly, and having 7 of them of a size that would permit NCB would help achieve this. The procedures for approving and tendering NCB are far less time consuming compared to ICB. Additional benefits would be that each IA would have ownership of their own subproject, and that national contractors would benefit from both the experience and the business.

80. A perceived obstacle with having 7 of the subprojects as NCB is the technical nature of some of the rehabilitation work. Installation and commissioning of gas chlorination equipment, bladder tanks for surge protection, and proper construction of filter underdrains are all areas requiring a degree of specialist knowledge and experience. For this reason, coupled with the simplicity of having a lesser number of contract packages, a compromise of three packages was selected, being Stung Treng, Siem Reap, and the 7 rehabliitation subprojects.

81. These 3 packages will all need to be ICB due to their value, but this does not exclude national contractors from bidding, provided they meet the prequalification requirements. Additionally, if national contractors have difficulty meeting prequalification requirements, they can still benefit from these contracts by subcontracting.

6. COSTS AND FINANCING PLAN

6.1 Cost Estimates

82. The subproject cost is estimated at $0.302 million equivalent, including taxes. A summary of the cost estimates is given in Table 6.1.

Table 6.1 - Subproject Capital Cost

		Totals
No	**Description**	**(inc tax)**
		US$000
2	**Water Supply Development**	
2.1	Install one transformer 300KVA	25.0
2.2	Replace 2 raw water pumps with submersible pumps. Current pumps have long shafts which cause vibration & overheating.	80.0
2.3	New 500mm gate valve for upper inlet pipe	10.0
2.4	Filters need 8 new manual gate valves for inlets and drains.	15.0
2.5	Replace filter block inlet gate valve 500mm	10.0
2.6	Install parallel DN160mm HDPE pipe	52.0
2.7	Replace old chlorination system	50.0
2.8	Addition of sludge drying bed	10.0
	Total for Water Supply Development	
	TOTAL ESTIMATED BASE COST[a]	**252.0**
	Contingencies 20%	50.4
	TOTAL ESTIMATED SUBPROJECT COST	**302.4**

Source: Consultant's estimate, 2013

6.2 Least cost analysis

83. No least cost analysis was carried out for Pursat as alternative solutions were not presented for consideration.

7. SUBPROJECT FINANCIAL AND ECONOMIC ASSESSMENT

7.1 Approach and Methodology: Financial Assessment

84. The financial analysis was done in three levels: (i) examination of the historical and current financial performance; (ii) evaluation of the feasibility of the proposed subproject under UWSP; and (iii) evaluation of the financial sustainability taking into account the impact of the proposed subproject to the future operation of PWWs and WSA.

85. Following the Asian Development Bank (ADB) guidelines7, four basic indicators for the financial viability of a water supply project have been identified. These are the following:

- Financial Internal Rate of Return (FIRR). It is the discount rate at which the revenues and costs generated by the project are equal to zero. A project is considered financially viable if the computed FIRR is equal to or higher than the weighted average cost of capital (WACC) that is used in financing the development of the proposed water supply project.
- Debt Service Coverage Ratio (DSCR). It measures the solvency of the PWWs/WSA and shows how many times debt service for a given period is covered by operations. DSCR should at least be 1.3 after project completion.
- Annual cash balance. Projected annual cash balances should be positive all throughout the projection period.
- Tariff affordability. Household monthly water bill should not be more than 5% of the average monthly household income of the low income group.

7.1.1 Financing Plan.

86. The project will be financed by ADB and the national government. Part of the ADB and national government funds will be on-lent to the PWWs/ WSA. Annual debt service was estimated based on preliminary discussions with MIH and MEF. The on-lending terms for the purpose of this study are as follow:

- Maturity period of 32 years, including 8 years grace period on principal payment while interest is capitalized during construction;
- Fixed interest rate[8] of 1.25% per annum for the first 8 years and 1.75% per annum for the next 24 years; and
- Foreign exchange risk to be borne by the national government.

7.1.2 Proposed Water Tariff.

87. Three scenarios were tested in the design of the water tariff based on the amount of loan, as a percent of project costs, passed on to the 8 PWWs. For Siem Reap WSA, 100% loan was assumed. For the 8 PWWs, the three scenarios tested were: (1) 0% loan-100% grant; (2) 50% loan-50% grant; and (3) 100% loan-0% grant.

7.1.3 Other Assumptions

88. The main assumptions used in the financial projections include:

- Estimates of annual water revenues are based on the total water billed for the year and the corresponding tariffs for the same year. Connection fees, for non-poor household customers

[7] ADB, *Financial Management and Analysis of Projects* (2005).

[8] ADB's interest rate to the national government is 1% and 1.5% respectively.

are included as other revenues and assumed to be paid by the customers in 24 equal installments.

- The investment cost of the proposed project and the O&M costs are prepared on an annual basis in August 2013 prices. Increases in costs due to inflation are covered through a provision for price contingencies both for the investment costs and the O&M costs.

- The incremental O&M costs, which is the difference between “with the project” and “without the project” scenario, were used in the evaluation. O&M costs include: 1) administration; 2) chemical; 3) power; 4) maintenance of facilities; 5) salaries and wages; and 6) other O&M items.

- Projected O&M costs “without the project” are based on actual O&M costs as presented in the historical revenue and expense statements. It is assumed that there will be minimal increases in the service connections as water supply demand approaches the maximum water supply capacity of the existing system, hence there will be no increases in the number of personnel. The unit cost of O&M is assumed to increase following the local inflation rate.

- Projected O&M costs “with the project”, except maintenance of facilities, are based on historical unit costs. Maintenance of facilities cost is based on engineering estimate of the required maintenance level of the facilities.

- Depreciation allowance is considered a non-cash item. However, for purposes of estimating the net income, it was included as expense in the projected income statement. Annual depreciation costs for the new facilities were calculated using the straight-line method based on the service life[9] of each type of asset.

- Water tariff “without the project”, is assumed to increase in the future to cover increases in O&M. For purposes of the projection, it is assumed that water tariffs will have to be increased by 5% starting 2015 and every four years thereafter until 2027 for Siem Reap, Stung Treng and Svay Rieng; for Kampong, because current tariff is low, the assumed increases are 10%.

- Water Revenue “without the project”. As mentioned earlier, since the existing facilities are already nearing its maximum operating capacities, it is assumed that there will be no further additional connections after the water supply capacities are reached in 2017. Volume of water sold after this period will remain constant. Any increase in projected revenue is then due to the assumed increase in water tariff.

- Water Revenue “with the project”. Based on the technical study, the proposed improvements in the water supply system can provide the water requirements of the projected beneficiaries up to year 2019 (Siem Reap) to 2023 (Kampong Cham, Stung Treng and Svay Rieng). The volume of water sold is therefore assumed to increase up to that year and is assumed to remain constant at the that level. Any increase in projected revenue after this period is then due to the assumed increase in water tariff.

7.2 Approach and Methodology: Economic Assessment

89. The economic analysis was undertaken in accordance with the procedures set out in the ADB Handbook for the Economic Analysis of Water Supply Projects (1999) and related ADB guidelines10. The period of analysis extends over 30 years from the start of project implementation in 2015 up until 2044. Costs and benefits were quantified at August 2013 prices and were converted to their economic cost equivalents using shadow prices. Both costs and benefits were treated as increments to a “without the project” situation.

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[9] Using PWWs/WSA asset life schedule.

[10] *Guidelines for the Economic Analysis of Projects (1997).*

90. The economic viability of the project was determined by computing the economic internal rate of return (EIRR) and comparing the result with the economic opportunity cost of capital (EOCC) of 12%. An EIRR exceeding the assumed EOCC indicates that the project is economically viable. The viability of the investments was then tested for changes in key variables such as capital costs, O&M costs and benefits through sensitivity analysis. Distribution of project benefits and poverty impact analysis were also undertaken to determine how much of the net economic benefits resulting from the investments will directly benefit the poor.

91. The economic viability of the proposed investments in water supply was determined considering the following benefits: (1) incremental gross revenue; (2) the value of time saved for not having to collect water from existing non-piped sources; (3) medical cost savings due to reduced morbidity from waterborne diseases; and (4) avoided income loss (productivity savings) because of reduced incidence of diseases. Economic costs were derived from the estimates of capital investments and O&M costs in financial terms, removing all duties and taxes and multiplying the net results by the conversion factors (CF). The following CFs were applied: 1.0 for traded goods and non-traded goods, and 0.7 for unskilled labor.

92. The proposed investments which aim to improve the population's access to piped water supply in the area, will form part of the Government's overall development plan for the water supply sector, which also aims to achieve the targets set under the Millennium Development Goal[11].

7.3 Pursat Provincial Waterworks (PPWW)

93. A full financial and economic analysis report can be found in Appendix D.

7.3.1 Historical Financial Performance

94. From 2008 to 2012, PPWW was able to cover total expenses except in 2008 where cost recovery was only 80%. However only 50 to 80% of total expenses and depreciation were covered for the same period. Operating ratio ranged from 1.3 to 2.0 from 2008 to 2012. Current ratio was moderate to low for the five-year period while account receivable as of end 2012 was high at 51 days equivalent of annual water sales.

Table 7.1: PPWW Financial Indicators, 2008-2012

Financial Indicators	2008	2009	2010	2011	2012
Cost Recovery					
Total expenses	0.8	1.1	1.2	1.1	1.2
Total expenses & Depreciation	0.5	0.7	0.7	0.8	0.8
Current Ratio	2.4	2.1	3.0	2.0	1.9
Operating Ratio	2.0	1.5	1.4	1.3	1.3
Account Receivable (Days)	59	82	71	75	51

[11] MDG's Target No. 10, Goal No. 7: Halve, by 2015 the proportion of people without sustainable access to safe drinking water and sanitation. For urban water supply in Cambodia, people with access to safe drinking water is about 64% in 2004. Per MDG, this should reach 80% by 2015. Source: Key Indicators of Developing Asian and Pacific Countries, 2006, ADB.

7.3.2 Projected Financial Performance

7.3.2.1 Investment Costs.

95. The total investment cost for the water supply project is approximately KR 1355 million, including price and physical contingencies and interest during construction (assuming 50% loan). Table 7.2 presents a summary of the investment costs.

Table 7.2: PPWW Total Investment Cost (KR million)

Items	% Total	Total
Civil Works	26.0	353
Equipment and Materials	41.6	564
Total Base Cost	67.6	916
Physical Contingency	13.5	183
Price Contingency	8.8	119
Total Contingencies	22.3	302
Interest During Construction	1.1	14
Taxes and Duties	9.0	122
Total Cost	100.0	1,355

Source: Consultant's estimate

7.3.2.2 Financing Plan.

96. The project will be financed (assuming 50% loan) by ADB and the national government. ADB loan will finance KR 685 million (including interest during construction) while the government grant will finance KR 670 million (KR 134 from government funds and KR 536 million from ADB funds). The financing plan is shown in Table 7.3.

Table 7.3: PPWW Financing Plan (KR million)

Items	% Total	Total
ADB Loan (on-lending)	50.5	685
Disbursement	49.5	670
Interest During Construction	1.1	14
Government (grant)	49.5	670
Own Fund	9.9	134
ADB Fund	39.6	536
Total	100.0	1,355

Source: Consultant's estimate

7.3.2.3 Water Tariff.

97. Assuming a 0% loan, tariff increases required to cover O&M costs and depreciation are shown in Table 7.4. Required tariffs for 50 or 100% loan amounts are shown in Table 7.5. It is recommended that the PPWW: (1) implement a block tariff for household consumers to reduce the impact of tariff increases to the poor households; and (2) implement a cross subsidy between different customer categories thru different tariff rates. The proposed tariff for government and commercial customers are higher than the first block tariff to allow for subsidy to poor household customers.

Table 7.4: PPWW Proposed Tariff Rate - 0% Loan

Category	2015	2018	2021	2023
Household, 0 to 7 m3	1,600	1,700	1,800	1,800
above 7 m3	2,100	2,300	2,500	2,600
Government	2,100	2,300	2,500	2,600
Commercial	2,150	2,500	2,800	2,900
Tariff Increase (average)	20%	8%	7%	2%

Source: Consultant's estimate

Table 7.5: PPWW Proposed Tariff Rate – 50% and 100% Loan

Category	2015	2018	2021	2023
Household, 0 to 7 m3	1,600	1,700	1,800	1,800
above 7 m3	2,100	2,300	2,500	2,750
Government	2,100	2,300	2,500	2,750
Commercial	2,150	2,500	2,800	3,100
Tariff Increase	20%	8%	7%	6%

Source: Consultant's estimate

7.3.2.4 Affordability of Water Rates.

98. A major consideration in the development of the tariff schedule is the ability of target beneficiaries to pay for their monthly water bill. For PPWW service area, the estimated monthly income belonging to the poor households for 2013 is KR 700000. Using the affordability criteria, the monthly water bill is about KR 11200 (KR 1600 x 7 m3) in 2015 is only 1.6% of the monthly income of poor households. In all subsequent years the monthly water bill is less than 5% of the estimated monthly income. Hence, the proposed level of water tariff is deemed affordable to the low income or poor households.

7.3.2.5 Impact of the Project on the PPWW's Financial Operation.

99. Selected financial ratios were computed to provide an indication of the PPWW's future financial performance (Table 7.6).

- Revenues can cover O&M and depreciation starting from 2017;
- Current ratio are high ranging from 3 to 11;
- Operating ratio are projected to be less than or equal to 1 starting from 2017;
- Debt service coverage ratio is higher than 1.3 for all the projection years; and
- Accounts receivable is 44 days equivalent of annual revenues.

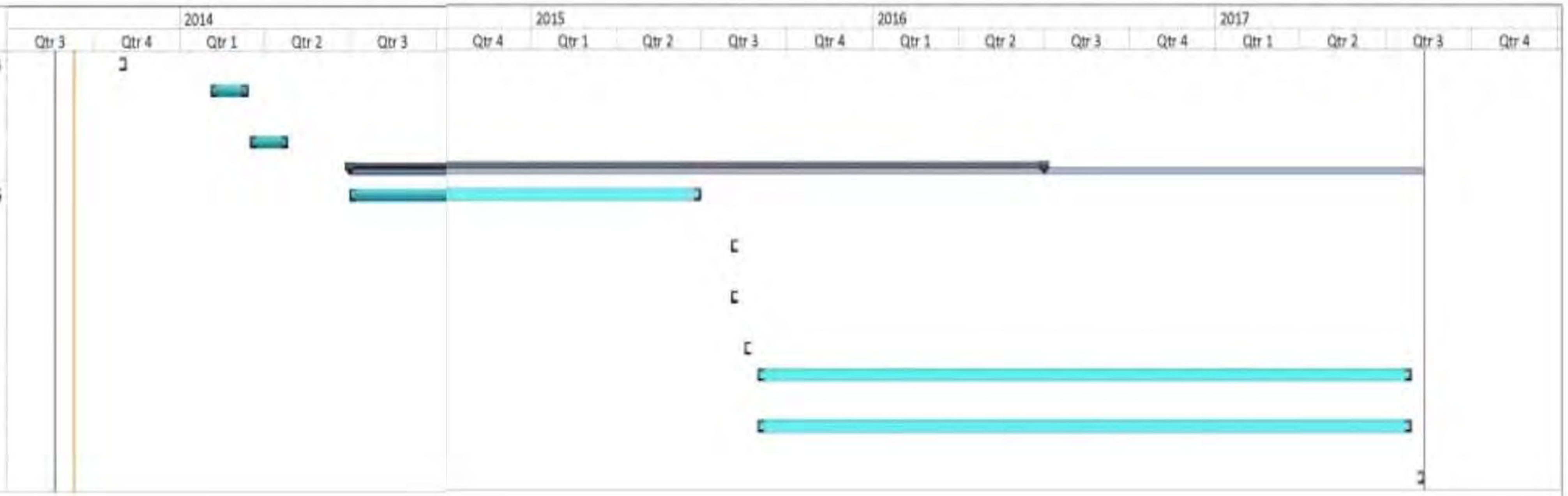
Table 7.6: PPWW Summary of Financial Indicators

Financial Indicators	2015	2016	2017	2018	2019	2020	2025
Cost Recovery:							
O&M	1.2	1.2	1.3	1.4	1.4	1.3	1.3
O&M + Depreciation	0.9	0.9	1.0	1.0	1.0	1.0	1.1
Current Ratio	3.2	4.1	5.7	7.1	8.3	9.5	11.4
Operating Ratio	1.1	1.1	1.0	1.0	1.0	1.0	0.9
Debt Service Coverage Ratio	5.6	6.9	9.9	13.1	12.1	12.2	10.5
Account Receivable (Days)	44	44	44	44	44	44	44

Source: Consultant's estimate

Appendix A: Pursat Subproject Implementation Schedule

ID	Task Mode	Task Name	Duration	Start	Finish
1		Completion of PPTA			Mon 4/11/13
2		Tendering of Implementation project	30 days	Mon 3/02/14	Fri 14/03/14
3		Tender evaluation	30 days	Mon 17/03/14	Fri 25/04/14
4		**Final design & contract management**	**524 days**	**Tue 1/07/14**	**Fri 1/07/16**
5		Final design & contract documentation	261 days	Tue 1/07/14	Tue 30/06/15
6		Tenders close - construction package 1		Mon 3/08/15	
7		Tenders close - construction package 2		Mon 3/08/15	
8		Tender award - package 1 & 2		Mon 17/08/15	
9		Construction Package 1 - Stung Treng	500 days	Mon 31/08/15	Fri 28/07/17
10		Construction Package 2 - Siem Reap plus 7 others	500 days	Mon 31/08/15	Fri 28/07/17
11		Commissioning			Fri 11/08/17



Project: schedule.mpp
Date: Tue 10/09/13

Task | Split | Milestone | Summary | Project Summary | External Tasks | External Milestone | Inactive Task | Inactive Milestone | Inactive Summary | Manual Task | Duration-only | Manual Summary Rollup | Manual Summary | Start-only | Finish-only | Deadline | Progress

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Project: schedule.mpp
Date: Tue 10/09/13

Task | Split | Milestone | Summary | Project Summary | External Tasks | External Milestone | Inactive Task | Inactive Milestone | Inactive Summary | Manual Task | Duration-only | Manual Summary Rollup | Manual Summary | Start-only | Finish-only | Deadline | Progress

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Appendix B: Cost Estimate for Pursat Subproject – water supply development

Appendix C: Water Quality Test Results for Pursat Subproject

Month average	**Temp (C)**	**Turbidity NTU**	**Res chlorine (mg/l)**	**pH**	**Colour TCU**	**TDS (mg/l)**	**Conductivity (us/cm)**
LIMIT		**<5**	**0.2-0.5**	**6.5-8.5**	**<5**	**800**	**1600**
Jan	25.4	0.91	0.64	7.12	2.2	-	136.3
Feb	27.4	2.01	0.73	7	3.9	-	155
Mar	27.3	0.93	0.85	7.12	2.63	-	140.6
Apr	26.46	0.87	0.75	7.19	2.42	-	145.45
May	25.86	0.92	0.78	6.96	2.74	-	109.9
Jun	28.15	0.95	0.74	6.61	1.89	-	77.2
Jul	30	1.1	0.7	6.8	3.5	35.6	71.2
Aug	28.4	1.1	0.7	6.7	3.4	36.7	71.9
Sept	28	1	0.7	7.1	2.5	43.6	87.2
Oct	26.4	0.9	0.8	7	2.3	43.8	85.4
Nov	27.5	0.9	0.9	6.9	1.9	43.9	87.9
Dec	27.1	0.7	0.8	7	3	42.3	884.6

Appendix D: 9 Subproject Towns Financial and Economic Analysis

Appendix E: deleted

Appendix F: Environmental Due Diligence report for Pursat Subproject

Appendix G: Land acquisition due diligence report

Appendix H: Pump calculations and duty curves

Appendix I: Outline Operation & Maintenance Plan

Operational Procedures

WTP area	**Procedure**
Raw water pumps	Can be controlled (on/off) by level transducers in the main clear water tank, or manually by Operator.
Flocculation tank inlet weir	Set so that there is always a hydraulic break between water in the inlet channel and the first flocc channel.
Flocculation tank baffles	Baffle slot sizes on lower end of alternate baffles, which are calculated and specified during final design, should be adhered to. When baffles are moved during cleaning of the flocc tank, these slot sizes should be reset to the design dimensions. Failure to do this may result in incorrect velocity gradient across the flocc tank resulting in poor flocc formation.
Sed tank collection launders	The stainless steel collection launders should be set at a level that allows for the prescribed headloss across the flocc tank. If the launders are set too high it has the effect of "backing up" the flocc tank and reducing the hydraulic gradient across it. This is normally set during design by calculating the hydraulics across the full WTP, but is sometimes neglected.
Filters – bypass of water	For filters to operate properly, the plenum floor that holds up the gravel and sand layers needs to be sealed. No water should pass between the plenum floor and the vertical filter walls, or through the plenum floor except through the inserted filter nozzles. Additionally, water should not be allowed to take a "short cut" between the edge of the sand layer and the filter wall. This can be stopped by roughening the inside filter wall with a sand/cement mix.
Filters – backwashing	Filters should be backwashed when the sand becomes sufficiently blocked with debris and silt to slow the passage of water through the media. This can be judged by marking a dirty water level inside the filter, and when it is reached, a backwash is due. Similarly a low water level mark should be visible and this minimum water level in the filter kept by partially closing the clean water outlet valve to the clear water tank. The backwash cycle begins with air scour by itself to loosen the sand media and help release dirt. This should carry on for around 3-5 minutes. The air blower is then turned off and backwash valve opened partially at first and then gradually opened further, in order to maintain the design backwash flowrate as the head in the backwash tank decreases. The backwash valve should never be just opened fully for the backwash cycle.
Reticulation	
Washout valves	All washout valves on the system, installed at low points, should be opened every month to flush out the line as required.
Valves on the distribution system	Valves should be kept either fully open or fully closed.

Maintenance Schedule

Raw water pumps	New submersible pumps should be raised using the auto-coupling & guiderails once per year to inspect the pumps and perform routine maintenance.
Flocculation tank	The flocc tank should be taken offline, one chamber at a time (there are 2 chambers), and cleaned out using shovels and a water blaster. Any repairs to baffles or replacement of rotten wooden baffles can take place at this time.
Sedimentation tank	The sedimentation tank should be taken offline, one at a time, and cleaned out annually.
Slide gates on all tanks	These should be inspected regularly and if not opening and closing easily, remedial action taken – either lubrication of threads or replacement of rubber seals.
Filters	Filter media will gradually become more blocked over time despite regular backwashing. Approximately every 5 years the sand and gravel media will need either removing and thoroughly washing before replacement, or new graded & washed sand placed. At this time, the nozzles and underdrains can also be inspected for damage.
Dosing pipelines	Check for leaks regularly and fix. Clean up spills and leaks.
Chemical mixing area	Keep floor clean
Chemical mixing tanks	When alum and poly tanks start to fill to the outlet pipe level with sediment they should be taken offline and cleaned out.
Pumps & blowers – general	Maintenance plan to follow manufacturers manual
Chlorination equipment - general	Maintenance plan to follow manufacturers manual
Reticulation	
Gate valves	All gate valves on the pipelines should be kept either fully shut or fully open as required.
Washout valves	Any washout valves, normally installed at low points, should be periodically (6 monthly) opened to flush out any debris.
Chambers	All valve chambers should be kept dry, clean and accessible.
Domestic connections	Any leaks on the upstream side of the meter should be recorded by meter readers and repaired promptly.
Physical leaks	All leaks reported or noticed by WA staff should be repaired promptly.

Appendix J: Locations of proposed Parallel DN160mm pipelines

KINGDOM OF CAMBODIA

MINISTRY OF INDUSTRY AND HANDICRAFT

URBAN WATER SUPPLY AND SANITATION PROJECT

(ADB PPTA: TA-8125-CAM)

SHORT FEASIBILITY STUDY FOR SIHANOUKVILLE SUBPROJECT

November 2013

Prepared by

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0	**Andrew Henricksen**	**Michael Lee**		**Michael Lee**		

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APPENDICES

ABBREVIATIONS AND EQUIVALENTS

ADB	Asian Development Bank
ADF	Asian Development Fund
AP	Affected persons
APs/AHs	Affected persons/affected households
ASR	ADB's Annual Sector Review
BOO	Build-Operate-Own
BOT	Build-Operate-Transfer
COBP	Country Operations Business Plan
CPP	Community Participation Plan
CPS	Country Partnership Strategy
DMC	Developing Member Countries
DMF	Design and Monitoring Framework
DPWS	Department of Potable Water Supply
EA	Executing Agency
EGM	Effective Gender Mainstreaming
EMP	Environmental Management Plan
FAR	Feasibility Assessment Report
FS	Feasibility Study
GAP	Gender Action Plan
HHs	Households
IAs	Implementing Agencies
IEEs	Initial Environmental Examinations
IOL/SES	Inventory of Losses and Socioeconomic Survey
IR	Inception Report
ISCD	Institutional Strengthening & Capacity Development
JICA	Japan International Cooperation Agency
LARP	Land Acquisition and Resettlement Plan
LARF/LARP	Land Acquisition and Resettlement Framework and Plan
MEF	Ministry of Economy and Finance
MIH	Ministry of Industry and Handicraft
MOU	Memorandum of Understanding
MOWRAM	Ministry of Water Resources Management and Meteorology
MPWT	Ministry of Public Work and Transport
MRD	Ministry of Rural Development
NCB	National Competitive Bidding
NRW	Non-revenue Water
O&M	Operation and Maintenance
PAM	Project Administration Manual
PDIH	Provincial Department of Industry and Handicraft
PDR	People Democratic Republic
pm	Person-months
PMU	Project Management Unit
PPP	Public Private Participation
PPPs	Public-Private Partnership
PPTA	Project Preparation Technical Assistance
PPWSA	Phnom Penh Water Supply Authority
REA	Rapid Environmental Assessment

RRP	
SCS	Stakeholder Communication Survey
SPS	Safeguards Policy Statement
SRWSA	Siem Reap Water Supply Authority
SR	Safeguards Requirements
TA	Technical Assistance
TOR	Terms of Reference
WOPs	Water Operators' Partnerships
WTP	Water Treatment Plant

UNITS

ha	Hectare
lpcd	Liters per capita per day
l/s	Liters per second
m	Meter
mg/l	Milligrams per Liter
mm	Millimeter
m^3/day	Cubic meters per day

Figure 1-1 - Location of Project Towns

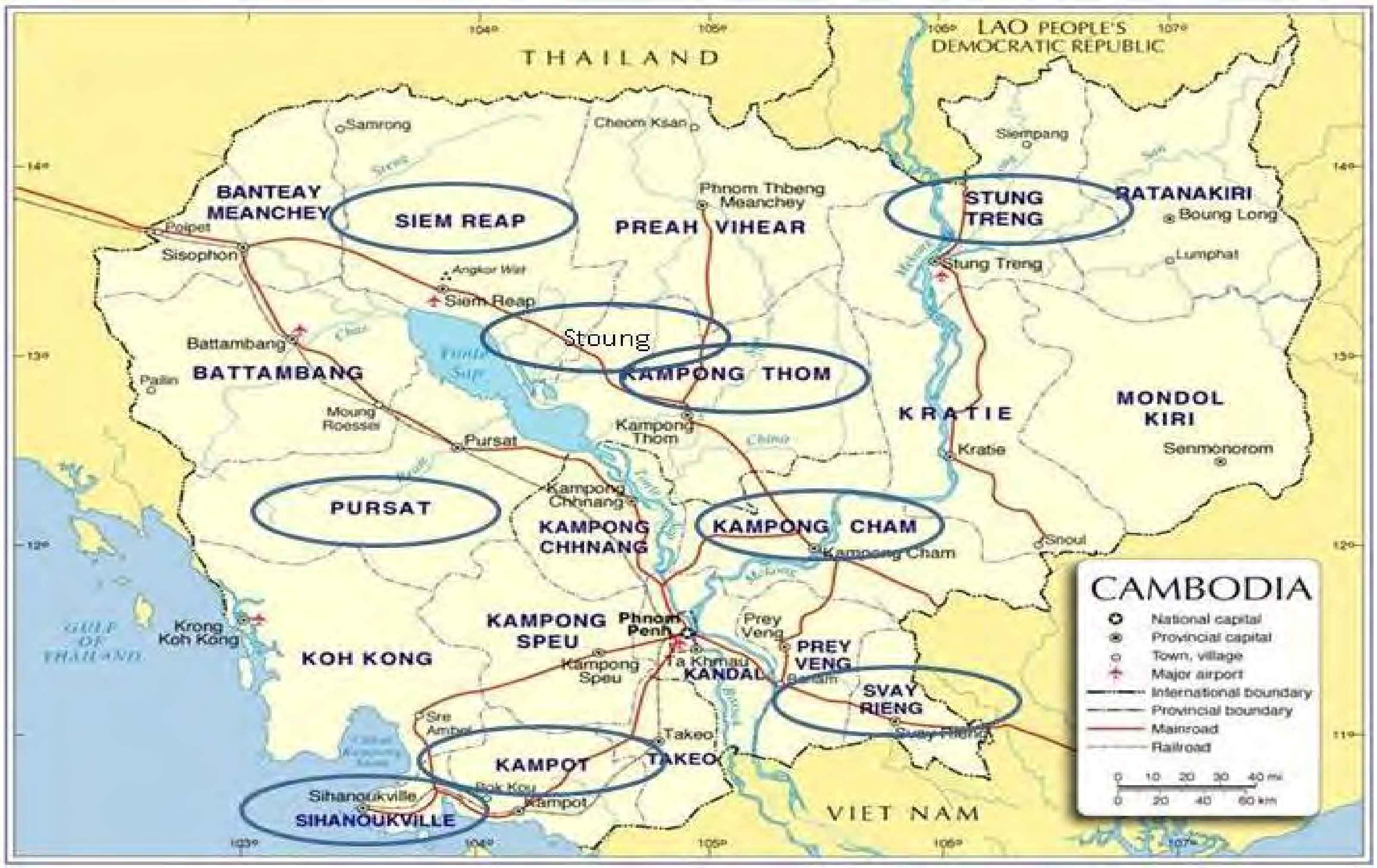
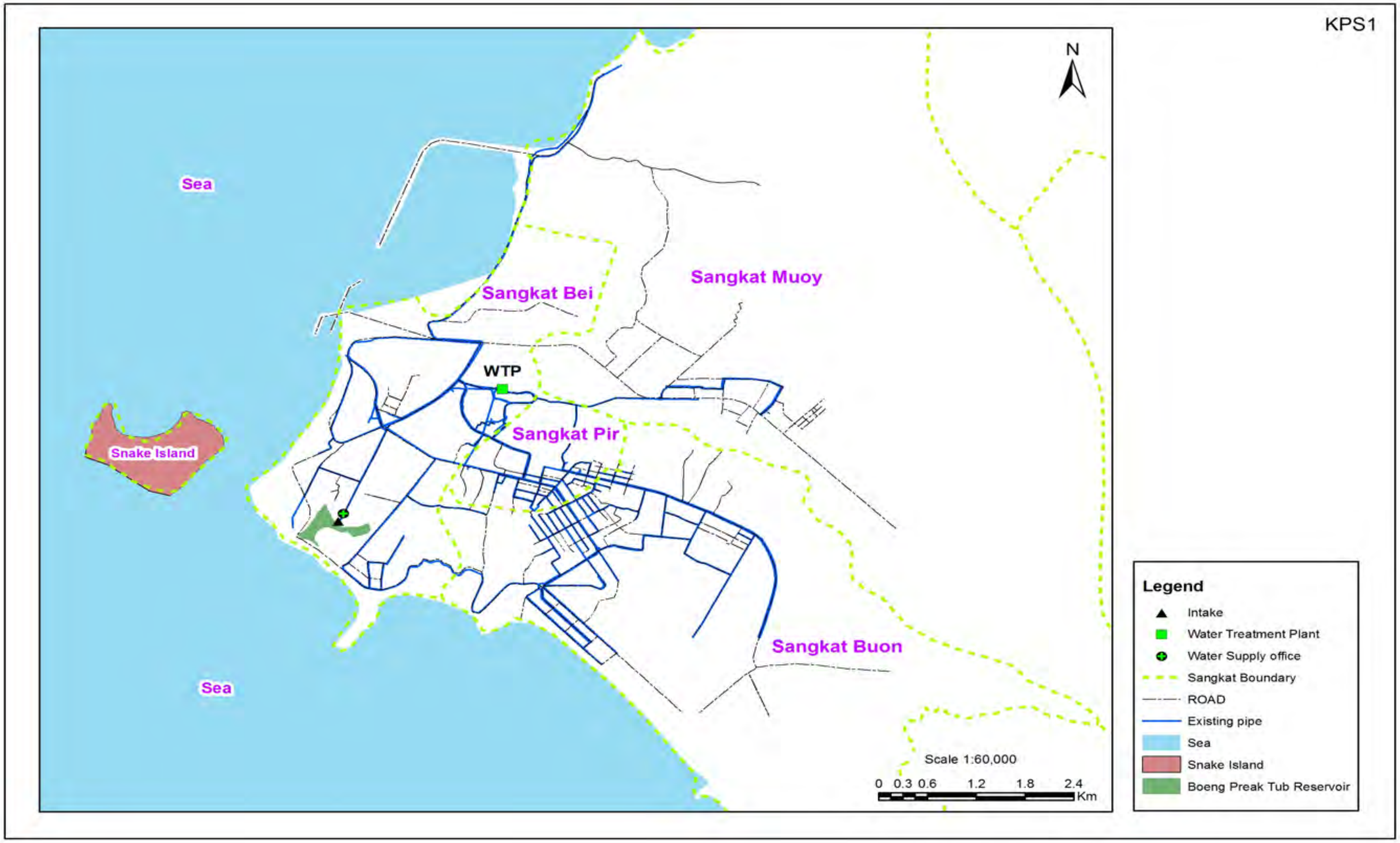


Figure 1-2 Location Plan of Proposed Sihanoukville Subproject



1. EXECUTIVE SUMMARY

1.1 Project Description

1. Expected outputs of the overall Project include: (i) water treatment plants provided or improved in eight towns; (ii) water distribution systems improved and coverage increased in six towns; (iii) existing pumping stations rehabilitated in five towns; and (iv) institutional capacity of MIH and regulatory system strengthened, under a piggy-backed technical assistance.

1.2 Rationale

2. During 2011, through the ADB's Water Operators' Partnerships Program, ADB was able to re-engage in the urban water supply sector with MIH. Consequently ADB's Country Operations Business Plan 2010-2013 includes an Asian Development Fund loan for the Project for approval in 2014. The UWSP will assist the government to address the three core constraints identified in the ADB Country Partnership Strategy (2011-2013): (i) insufficient funds to expand coverage and improve services; (ii) weak sector planning and implementation capacity of responsible authorities at the central and sub-national levels; and (iii) inadequate (or sometimes weak) institutional and legal framework.

1.3 Background

3. The proposed Project "Urban Water Supply Project " (UWSP) will provide necessary facility improvements to the six provincial towns previously funded by ADB and to three provincial towns that have been funded by other bilateral or multilateral agencies, and expand public access to sustainable and safe water supply services for the urban population in Cambodia. In addition, the Project will address institutional weaknesses through the development of improved institutional structures, a regulatory framework, and appropriate capacity development.

1.4 Project Impact and Outcome

4. The impact of the proposed Project will be expanded access to sustainable and safe water supply services for the urban population in Cambodia and better functioning water treatment plants providing higher quality water. MIH targets are to increase the proportion of the urban population in the project area with access to safe water to 85% by 2018 and 90% by 2025, and the project will assist these aims. The outcome of the project will be improved water supply infrastructure and service provisions in selected provincial waterworks.

1.5 Candidate Towns

5. There are nine candidate towns: Kampong Cham, Kampong Thom, Kampot, Pursat, Siem Reap, Sihanoukville, Stoung, Stung Treng and Svay Rieng. Originally Battambang was to be included but this was removed at the request of the Provincial Waterworks.

1.6 Feasibility Study Context

6. The feasibility studies include: (i) needs assessment, supply and demand analysis, (ii) selection of technology, equipment, and facilities for the identified subprojects considering least cost and life cycle approach and the capacities of the local authorities to manage, operate, and maintain; (iii) assessment of economic and financial viability and sustainability for each of the subprojects; (iv) assessment of policy and legal capacity, including other institutional issues and mechanisms related to the financial management, procurement, and anticorruption; (v) poverty, social, and gender analysis and preparation of a poverty and social strategy, a gender action plan, stakeholder communication survey (SCS), and a Community Participation Plan (CPP), where required; and (vi) review of impacts on environment, involuntary resettlement, and indigenous peoples.

1.7 Subproject Description

1.7.1 Output 1 - Water Supply Development

7. The Sihanoukville subproject aims to improve the provision of safe, affordable, reliable piped water supply to individual household connections to communities within the four core sangkats having Y2013 population of about 71,134. The improved water supply scheme will improve the quality of the treated water and improve the operation of the WTP. The works proposed under the PPTA are summarised in Table 1.1 below and described in detail in Section 5.2.2.

1.7.2 Output 2 – Strengthening of Institutional capacity of MIH and Regulatory System

8. The Institutional Strengthening and Capacity Development is to (i) identify key stakeholders; (ii) assess institutional capacity constraints; (iii) develop institutional capacity building plan; and (iv) prepare terms of reference for strengthening sector regulation TA.

1.8 Cost Estimate

9. The subproject cost is estimated at $0.34 million equivalent, including taxes and duties. Table 1.1 provides a summary of the Sihanoukville Subproject cost estimate.

Table 1.1: Sihanoukville Subproject Cost Estimate ($'000's)

No	Description	Totals (inc tax) US$000
2	**Water Supply Development**	
2.1	Rehabilitation of filters with introduction of mixed air/water stage	55.0
2.2	Additional clearwater storage 500m^3 with necessary slope protection	200.0
2.3	Install raw water flow meter	10.0
2.4	Improve control panel for raw water pump security	10.0
2.5	Replace intake pump gate valve (Dia 200mm)	3.0
2.6	Re-route alum dosing pipe with ABS pipe	5.0
	Total for Water Supply Development	
	TOTAL ESTIMATED BASE COST[a]	283.0
	Contingencies 20%	56.6
	TOTAL ESTIMATED SUBPROJECT COST	**339.6**

1.9 Executing Agency and Implementation Arrangements

10. MIH will be the Executing Agency, and the existing project management unit (PMU) based in the Department of Potable Water Supply (DPWS) will be expanded to execute and manage the Project on behalf of MIH with the consulting service to be provided by the project implementation assistance consultants (PIAC). The Project implementing units (PIUs) are expected to be organized by the nine (9) implementation agencies (IAs) of the provincial waterworks. The nine (9) PIUs will be responsible for day-to-day coordination and supervision of subproject implementation in these provincial towns.

1.10 Implementation Period

11. The proposed Project is scheduled for implementation over five years from 2014 to 2018. The final design is proposed for a one year period between mid-2014 and mid-2015. Following this, a two year construction period would have the works commissioned in August 2017. A proposed Implementation schedule is included in Appendix A.

1.11 Procurement

12. The procurement shall be carried out under International Competetive Bidding (NCB) as three packages; one package Stung Treng; one package Siem Reap; and the remaining 7 subprojects as one package. The full Procurement Plan is contained in the Supplementary Appendices of the main PPTA report.

1.12 Consulting Services

13. The project implementation assistance consultants (PIAC) on the design and engineering review, tendering assistance, and construction management are provided under Bank financing will be selected in advance and engaged in accordance with the ADB's Guidelines on the Use of Consultants. An individual consultant will be engaged to prepare the PIAC terms of reference and to assist the EA on the preparation of the Request for Proposal. The PIAC consulting services will be signed once the loan becomes effective to provide under a single consulting package, by an association of international and domestic consulting firms. The lead consulting firm will provide the services of the Team Leader who will be responsible for managing the overall consulting services during the project implementation.

1.13 Subproject Benefits and Beneficiaries

14. The Sihanoukville subproject aims to improve the provision of safe, affordable, reliable piped water supply to individual household connections to communities within the four core sangkats having Y2013 population of about 71,134.

1.14 Land Acquisition and Compensation

15. The overall project has Involuntary Resettlement Categorisation C because all of the improvement facilities are within the water treatment plant compound. The Land Acquisition Due Diligence report for Sihanoukville is contained in Appendix G.

1.15 Environmental Impacts

16. An Environmental Due Diligence Report was done for Sihanoukville and is contained in Appendix F. The subproject is classified as Category C.

1.16 Economic and Financial Analyses

17. Economic and Financial analyses for Sihanoukville is contained in Section 7, and in full in Appendix D.

1.17 Tariff and Affordability

18. SPWW needs the following tariff increases (average) to cover O&M costs and depreciation: 8% in 2015 and 2018, 9% in 2021 and 13% in 2023 (Table 1.2). It is recommended that the SPWW categorize its customer into household, government and commercial to facilitate the application of cross subsidy between different categories of customer. For a 50 or 100% loan, Table 7.5 shows the required tariffs. An average increase of 16% in 2023 is required such that revenues can cover O&M costs, depreciation and debt service.

Table 1.2: SPWW Proposed Tariff Rate - 0% Loan

Category		2015	2018	2021	2023
Household	0 to 7 m3	1,700	1,800	2,000	2,250
	8 to 15 m3	2,000	2,100	2,300	2,700
	>15 m3	2,250	2,500	2,750	3,150
Government		2,000	2,100	2,300	2,700
Commercial		2,250	2,500	2,750	3,150
Tariff Increase		8%	8%	9%	13%

Source: Consultant’s estimate

2. PROJECT RATIONALE, IMPACT AND OUTCOME

2.1 Rationale

19. During 2011, through the ADB's Water Operators' Partnerships Program, ADB was able to re-engage in the urban water supply sector with MIH. In January 2012, MIH signed a twinning agreement with the PPWSA, which is currently providing support to four provincial waterworks been included in the Project through direct peer-to-peer knowledge transfer. In February 2012, the Ministry of Economy and Finance (MEF) requested ADB to consider financing the Project in accordance with the strategy of Cambodia's Public Debt Management, to ensure sustainable economic growth. Consequently ADB's Country Operations Business Plan 2010-2013 includes an Asian Development Fund loan for the Project for approval in 2014. The project supports the ADB's annual sector review, country partnership strategy, and the water operational plan 2011–2020

20. The UWSP will assist the government to address the three core constraints identified in the ADB Country Partnership Strategy (2011-2013): (i) insufficient funds to expand coverage and improve services; (ii) weak sector planning and implementation capacity of responsible authorities at the central and sub-national levels; and (iii) inadequate (or sometimes weak) institutional and legal framework.

2.2 Background

21. The proposed Project "Urban Water Supply Project " (UWSP) will provide necessary facility improvements to the six provincial towns previously funded by ADB and to three provincial towns that have been funded by other bilateral or multilateral agencies, and expand public access to sustainable and safe water supply services for the urban population in Cambodia. In addition, the Project will address institutional weaknesses through the development of improved institutional structures, a regulatory framework, and appropriate capacity development.

22. This UWSP is in line with (i) Cambodian National Strategic Development Plan (2009-2013) and (ii) action plan of Ministry of Industry and Handicraft (MIH) to facilitate private sector partnerships, strengthening the management of public owned waterworks, and integration urban water supply with urban environmental management. The proportion of the urban population in the project area with access to safe water will be increased to 85% by 2018 and 90% by 2025 as targeted by MIH. In addition, a potential target date for 100% coverage could be assumed as 2030.

2.3 Project Outline

23. The feasibility studies include: (i) needs assessment, supply and demand analysis, (ii) selection of technology, equipment, and facilities for the identified subprojects considering least cost and life cycle approach and the capacities of the local authorities to manage, operate, and maintain; (iii) assessment of economic and financial viability and sustainability for each of the subprojects; (iv) assessment of policy and legal capacity, including other institutional issues and mechanisms related to the financial management, procurement, and anticorruption; (v) poverty, social, and gender analysis and preparation of a poverty and social strategy, a gender action plan, stakeholder communication survey (SCS), and a Community Participation Plan (CPP), where required; and (vi) review of impacts on environment, involuntary resettlement, and indigenous peoples.

2.4 Project Impact and Outcome

24. The impact of the proposed Project will be expanded access to sustainable and safe water supply services for the urban population in Cambodia and better functioning water treatment plants providing higher quality water. MIH targets are to increase the proportion of the urban population in the project area with access to safe water to 85% by 2018 and 90% by 2025, and the project will assist these aims. The outcome of the project will be improved water supply infrastructure and service provisions in selected provincial waterworks.

3. Profile of Sihanoukville Area

3.1 Town Location and Profile

25. Sihanoukville city is the capital of Sihanoukville Province and is on National Road 4 approximately 230km from Phnom Penh on the south coast. The town is built around the port, constructed in the 1950s, which was the original reason for the development of the area. Sihanoukville is a growing tourism destination and faces water resource challenges to meet the associated growing demand.

26. Agriculture and coastal fishing are main industries in the Province. In Sihanoukville town, the national port and national brewery are also main industries.

3.2 Natural Features

3.2.1 Topography

27. Sihanoukville is coastal and relatively flat along the coastal strip but with hills surrounding the town. The WTP is on the highest hill in Sihanoukville overlooking the town.

3.2.2 Climate

28. Cambodia has two distinct seasons, a rain season from May until October, and a dry season from November to April. Sihanoukville, being coastal, has more rain than most areas of Cambodia. The mean annual rainfall is around 3.5m with 75% of this falling in the wet season. Mean minimum and maximum temperatures are around 25 and 30 degrees celcius.

3.2.3 Surface water

29. There is only one surface water source in Sihanoukville, Boeng Praek Tob lake behind Occheteul beach, which is used as the raw water source for the town. This is fed from the Andong Untac stream which comes from nearby mountains.

3.2.4 Groundwater

3.3 Population and Household Characteristics

30. The populations provided below are for the service area within Sihanoukville.

Table 3-1: Sihanoukville Population Characteristics

No	Core Villages	2013 Pop'n.	No. HH	Persons/ HH	M/F Ratio[1]
1	Sangkat 1	15,910	3,418	4.7	2.1
2	Sangkat 2	10,164	2,251	4.5	1.8
3	Sangkat 3	21,123	4,400	4.8	1.9
4	Sangkat 4	23,937	5,259	4.6	1.8
		71,134	**5,328**	**4.6**	**1.9**

[1] The Provincial Government authorities explained that this large imbalance in gender in Sihanoukville was due to many men from outlying areas moving into the town to work in fishing and at the Port.

3.4 Existing Water Supply and Sanitation

3.4.1 Water Supply

31. The water supply system was originally established between 1958 - 1962 under the French colonial time, with capacity of 8,000m3/day. This original system was made to feed raw water to the two main commercial customers, the Port and the Bayon Brewery, and was not intended as a domestic service.

32. Between 1980 and 1993, untreated water was served to citizens from the WTP. There was no mains power or treatment facility at this stage.

33. Some further improvements were made in 1994 under a WB/UNDP project, which provided some treatment and was able to supply approximately 15% of the population with treated water. A second WB project between1998-2003 expanded and rehabilitated the treatment plant and distribution further. The current demand capacity of the WTP is 8,000m3/day.

34. There is a private bulk treated water supply company called ANCO Brothers CO. Ltd which has a facility to supply up to 20,000m3/day, but this is currently split between supply to the Water Authority and private businesses. This is discussed further under Section 5.6.

35. The WTP is on the highest hill overlooking Sihanoukville and is supplied from the lake via three raw water pumps (two duty one standby) of 165m3/hr each[2]. The raw water rising main is 3.06km long up to the WTP on a hill overlooking the city. The WTP includes a circular flocculation and sedimentation tank with mechanical mixing, four filters and a 500m3 clear water tank. There is a disused sludge drying bed in the compound. Space for further development or extension is very limited as the land drops away steeply to one side and the other side is occupied.

36. The WTP is currently working at 100% design capacity.

3.5 Previous recent assistance from JICA

37. During 2012-13 JICA funded the “Project for Replacement and Expension of Water Distribution Systems in Provincial Capitals”, which included Pursat, Sihanoukville and Battambang. In Sihanoukville 7,640m of distribution pipelines were replaced, 22,450m of additional pipelines laid to expand the system, 6,440m of service pipe laid and one flow monitoring system installed. Materials for 1,300 reconnections and 700 new connections were purchased for the Provincial Waterworks. The water treatment plant capacity was not increased to complement and serve this increase in service area. The total costs for all three towns was 2.76 billion yen.

38. There is no additional pipelaying proposed for this subproject.

[2] Changsa pump works, type 150D30X5, Q=165m3/hr, TDH=135m, 1480RPM, 110kW.

4. POPULATION GROWTH AND WATER DEMAND FORECASTS

4.1 General

39. Sihanoukville is the capital city of the Province and acts as a market for the surrounding area.

40. There is significant industrial development in Sihanoukville consuming water, mainly the port and the brewery. The town has an increasing amount of tourism related businesses and continues to grow, but currently does not have the water supply infrastructure to support it sustainably.

4.2 Population Projections

41. The population projections3 are set out in Table 4-1. Within the core villages, total population is forecast to increase from about 71,134 in 2013 to about 116,223 in 2030.

Table 4-1: Population Projections for Sihanoukville's Core Villages

Year 2013 Population	Growth Rate %	Forecast Population 2014	Forecast Population 2020	Forecast Population 2025	Forecast Population 2030
71,134	2.93	73,218	87,071	100,596	116,223

4.3 Water Demand Forecasts

4.3.1 General Approach

42. Whilst the scope of proposed works under this project does not include increasing the production capacity of the Sihanoukville water supply system, demand forecasts have been produced to illustrate the shortfall of available treated water into the near future. Water demand forecasts for the Sihanoukville subproject were prepared by making separate projections of each component of demand, including:

- Demand for domestic use (based on per capita consumption, coverage targets and population projections);
- Demand for industry (based on a % of domestic use, and specific allowances for large industries);
- Demand for services (based on a % of domestic use, and specific allowances for large services areas);
- Physical losses as a % of total demand, excluding the demand of large industrial zones.
- Production losses in treatment plant (based % of total demands).

4.3.2 Domestic Consumption

43. Water demand and consumption data for other provincial and district towns in Cambodia show that domestic consumption accounts for about 90% of total demand. Per capita consumption figures for urban water supply systems in Cambodia can vary widely, particularly with strong reliance on rainwater collection during the wet season. Experience in other towns in Cambodia indicates that piped connections directly to the house will usually increase water consumption over time. The Feasibility Study has adopted a per capita consumption figure of 120 lpcd, plus 10% for non-domestic use which includes demand from industry and services, 15% for physical losses (leakage), and 50m3/day for backwashing filters in the WTP.

4.3.3 Water Demand Forecasts

44. Table 4-2 summarizes the demand forecasts and design criteria for the Sihanoukville subproject. By 2030, the average daily water demand is expected to be 27,000m3/day, comprising

[3] 2013 populations and growth rate provided by the Provincial Waterworks

62% domestic consumption, with the remaining 38% being for institutions, public use, services, handicraft and small industries, and allowances for physical losses and backwashing the filters.

Table 4-2: Water Demand Forecasts for Sihanoukville Subproject

Water Demand Forecasts for Sihanoukville Sub-project							
No.	Items	Unit	Forecasts				
			2013	2014	2020	2025	2030
A.	**Domestic Demand**						
1	Growth Rate	%	2.93	2.93	2.93	2.93	2.93
2	Population in Core Area		71,134	73,218	87,071	100,596	116,223
3	Coverage in Core Area	%	90	100	100	100	100
4	Population with Piped Water	No.	64,021	73,218	87,071	100,596	116,223
5	Per Capita Consumption	l/c/d	120	120	120	120	120
6	Total Domestic Demand	m3/d	7,682	8,786	10,449	12,072	13,947
B.	**Non-domestic demand**						
1	Services, Schools, Small Industry, Institutions, Hotels	%	40	40	40	40	40
2							
3	Total Non-domestic demand	m3/d	3,073	3,514	4,179	4,829	5,579
C.	**Subtotal Water Demand All Categories**	m3/d	10,755	12,301	14,628	16,900	19,525
D.	**Non Revenue Water (NRW) in Distribution system**						
1	NRW as % Average Daily Water Production	%	15	15	15	15	15
2	NRW (physical losses only-pipelines and WTP)	m3/d	1,613	1,845	2,194	2,535	2,929
E.	**Average Daily Water Production (C+D) rounded**	m3/d	12,370	14,150	16,820	19,440	22,450
F.	**Peak Annual Water Demand (Max day Max month)**						
1	Peak Annual Water Demand		1.20	1.20	1.20	1.20	1.20
2	Peak Annual Water Demand	m3/d	14,844	16,980	20,184	23,328	26,940
3	Peak Annual Water Demand	l/s	172	197	234	270	312
G.	**Required Treatment Plant Output (rounded)**	m3/d	14,840	16,980	20,180	23,330	26,940
H.	**Treatment Plant Backwashing**						
1	Treatment Plant Backwashing	m3/d	50	50	50	50	50
I.	**WTP Capacity**						
1	Required WTP Capacity	m3/d	14,890	17,030	20,230	23,380	26,990
2	Required WTP Capacity	l/s	172.34	197.11	234.14	270.60	312.38
	Total Required Source Capacity (Rounded)	**m3/d**					**27,000**
	Total Required Source Capacity	**l/s**					**315.00**

4.3.4 Future Demand Requirements

45. The table shows that the existing water treatment plant, last upgraded in 2003, at 8,000m3/day, is already insufficient to meet demand with 2014 demand projected at 17,030m3/day. A further 18,990m3/day of treated water will be required to meet projected 2030 demands.

46. This subproject is not intended to address future demands, but to rehabilitate the current existing WTP assets, improve water quality and improve security of supply. A new WTP is required urgently, as there is no space on the existing site for sufficient expansion to meet the required projected demand.

5. SUBPROJECT DESCRIPTION

5.1 Introduction

47. The proposed works are designed to improve operational improvements, increased water quality and security of supply. This improved water supply scheme is not designed to increase capacity of supply.

5.2 Output 2: Water Supply Development

48. Expected outputs of the overall Project include: (i) water treatment plants provided or improved in eight towns; (ii) water distribution systems improved and coverage increased in six towns; (iii) existing pumping stations rehabilitated in five towns; and (iv) institutional capacity of MIH and regulatory system strengthened, under a piggy-backed technical assistance.

5.2.1 Preliminary Designs

49. The proposed water supply scheme design improvements are based on limited topographical, hydrological and water quality data and are preliminary.

5.2.2 Description of Proposed Water Supply System

50. The Sihanoukville subproject aims to improve the provision of safe, affordable, reliable piped water supply to individual household connections to communities within the four core sangkats having Y2013 population of about 71,134. The improved water supply scheme will improve the quality of the treated water and improve the operation of the WTP. In the near future a second WTP will be required to meet the projected demand of about 116,223 people served with 120lpcd by 2030. There is insufficient space on the current WTP site.

51. The works proposed under the PPTA are summarised in Table 5.1 below;

Table 5.1: Proposed new infrastructure for Sihanoukville

Sihanoukville	Short FS	
		A- Rehabilitation of filters with introduction of mixed air/water stage
		B-Additional clearwater storage 500m^3 with necessary slope protection
		C-Install raw water flow meter
		D-Improve control panel for raw water pump security
		E-Replace intake pump gate valve (Dia 200mm)
		F-Re-route alum dosing pipe with ABS pipe

5.2.2.1 Rehabilitation of Filters

52. Currrently there are four filters with 3.6m x 7.55m internal dimensions. These filters have header and lateral pipe underdrains with nozzles for backwash and air scour, which have separate cycles. There are two sizes of gravel over the nozzles of 50mm thickness each, and 650mm sand on top.

53. The IA has requested that all four filters be rehabilitated, and that a new blower be provided as the existing one is no longer working. It is recommended that the rehabilitation be done one filter at a time, with the following measures;

- Filter inlet valve closed and tank drained.
- Sand removed and stored safely. Sand to be thoroughly washed before replacement.
- Gravel removed and stored.

- Main header pipe and lateral pipes examined for damage and leaks. Nozzles examined for damage. All pipework and nozzles tested under water using blower for leaks.
- Depending on the quantity of leaks found and the condition of the nozzles after 10 years of operation, some or all of them should be replaced. For the sake of cost estimating, we have assumed full replacement.
- Roughen internal wall of filter for heiht of media to prevent bypass of water during normal operation.
- Replacement of cleaned gravel and sand. If sand and gravel has mixed, it may be necessary to place new gravel.

5.2.2.2 Additional 500m^3 clear water tank

54. For the current 8,000m3/day WTP, there is only 1.5 hours of clear water storage (500m3). A second 500m3 tank will double this to 3 hours storage. There is limited space for a second tank, immediately adjacent to the existing one, but as this is on the edge of a steep slope, some geotechnical investigation and design will be required.

5.2.2.3 Install raw water flow meter

55. Raw water flow is not currently measured. The three raw water pumps at Boeng Praek Tob lake feed into a manifold and then the raw water rising main. An electromagnetic flowmeter should be installed in a chamber in the pump compound.

5.2.2.4 Improve raw water pump control panel

56. The current control panel is not functioning and requires replacing with a new one.

5.2.2.5 Replace raw water pump gate valve

57. Replacement of the existing valve is required as it is no longer functioning properly.

5.2.2.6 Replace and reroute alum dosing pipe and improve dosing facilities

58. The alum delivery pipe from the mixing building currently runs from the second storey down to ground level then back up the flocculation tank wall to the dosing point. This low point causes alum sludge to settle out and block the pipe. Additionally, the pipe is uPVC and is exposed to the elements and UV deterioration. The pipe is to be replaced with UV resistant ABS, and rerouted to pass directly from the mixing building to the top of the flocculation tank.

59. Inside the dosing building some of the alum and lime dosing pipelines are too small and need replacing. The dosing pumps are not working well and require replacement.

5.3 Consultation Activities during Preparation of Sihanoukville Feasibility Study

60. A series of community visits and consultations occurred during the finalization of the 2013 Feasibility Study to inform district and village authorities about the subproject and gather information and feedback from local authorities, people living in core villages and other stakeholders. Consultation activities during the project site visits in 2013 are detailed below:

(i) Initial reconnaissance visit March 2013: Team Leader and National water engineer visited the site for an initial inspection and discussion with the Provincial Waterworks.

(ii) Second engineering site visit 22nd April 2013: International and National water engineers visited Sihanoukville facility, collected data, and finalized scope following Inception workshop.

(iii) Socio-economic specialist visit: a visit for the purpose of carrying out the public consultation was undertaken on 18-27th June

(iv) Environmental and Resettlement specialist visit: This joint visit was carried out between June 3rd -11th to collect data to aid the finalization of the environmental and resettlement due diligence reports.

5.4 Operation and Maintenance of Project Facilities

5.4.1 Capacity to Operate and Maintain the Proposed Water Supply System

61. The Sihanoukville Provincial Waterworks have many years experience in operating and maintaining their treatment plant, and have full time Operator staff. There is a good understanding of how pumps work and the routine maintenance required. The works proposed under this project are minor with the exception of the addition of a 500m3 clear water tank. This will be a challenge to construct being in close proximity to a steep slope, but will not pose any operational difficulties once commissioned.

62. The renewal of the raw water pump control panel will make operation easier, and coupled with a new raw water bulk meter will enable more accurate monitoring and record keeping of WTP flows.

5.4.2 Management Arrangements

63. The PIAC will provide Project technical, safeguards, accounting and management assistance on a daily basis as well as support the PIUs with project implementation

64. At the start of Project implementation, the PMU and PIAC will (i) update the initial environment examinations and due diligence reports (IEEs and DDRs) and prepare EMPs submit to MOE for review and approval; (ii) clear potential unexploded ordnance (UXO) remain on site; and (iii) acquire necessary land before subproject bids are tendered.

5.4.3 Operation and Maintenance Plans

65. The Operation and Maintenance plan for each subproject can be divided into two types, those with a full conventional WTP and those with chlorinated groundwater being pumped to an elevated tank and fed into supply. For Sihanoukville, an Operation and Maintenance Plan reflecting the former has been developed and is presented in full in Appendix H.

5.5 Lessons learned in Cambodia and the SE Asia region

66. There are several “lessons learned” in both the region and inside the national water sector that would benefit the 9 project towns under this PPTA;

- As at PPWSA, use of standardized chlorination equipment that has a regional office that can offer technical support, spares and specialist staff when needed. PPWSA has selected equipment supplied by Severn Trent Services (STS), and equipment from this manufacturer has been recommended for the towns requiring replacement chlorination equipment under this study. STS have a main office in Singapore, but have local representation in Phnom Penh. However, final selection of equipment of equal or better specifications will be decided at tendering as specific brands cannot be specified in Contract documents.
- High density polyethylene pipe (HDPE) is favoured in Cambodia, even for larger diameters. As most of Cambodia is flat, as are all of the 9 towns under this study, system pressures are not higher than 60m head. As such, a PN6 rated pipe would be sufficient. However, experience has shown that for the pipes un to and including 90mm diameter, which may have domestic connections tapped from them, a PN8 minimum pipe is required, even for very low pressures. The reason for this is that the tapping saddles used can deform the thinner pipe wall thicknesses on PN6 pipe, which causes leakage.

- Automated valves linked to a central control panel were designed and installed under the 2006 Provincial Towns project. All of these have failed in the 6 towns where they were installed. The lesson here is to keep the WTPs simple and keep valves as manually operated. With the relatively smaller size of these WTPs (mostly under 6,000m^3/day), valve automation is not necessary and inappropriate.
- Alum and poly dosing lines under the previous Provincial Towns project used long lengths of uPVC pipe that followed buildings and structures, necessitating several 90 degree bends and causing significant headloss in the delivery pipe. This has caused the pipes to get blocked by sediment. In addition, the uPVC dosing pipes are exposed to direct sunlight. UV light will break down uPVC pipe over time. A better solution, as used in two recent projects in Laos, is to use ABS (acrylonitrile butadiene styrene) pipe, and select a more direct route for the pipe, minimizing bends and low points.
- For the water sector as a whole, a database of all water projects could be set up, to include design drawings, calculations, contract documents, demand calculations, feasibility reports, final design reports and other useful documentation, for each system. This would serve as an easily accessible online resource library for all Water Authority staff in the country. It is relatively easy and inexpensive (under US$40,000) to set up and populate, and solves the common problem of drawings and documents getting lost. Many of the available hard copy resources for Cambodian water supply systems are either misplaced, or are reportedly stacked in disorder in a storeroom so dirty that nobody is willing to enter. Such a database was set up and released in neighbouring Laos in 2012-13 with assistance from UNHabitat, and can be viewed at;

http//:laowtp.info
by pressing “login as guest”.

- Several of the project towns under this PPTA have had extensions added to serve areas that were outside of the original design core area, without considering required design pressures or treatment plant capacity. This often results in the WTP being operated above its design capacity, which can reduce water quality, and often has negative effects on service pressure to other parts of the reticulation network. Typically, to increase system pressure to serve these unplanned extensions, water is diverted around any elevated storage tank and pumped directly into the system in order to increase delivery pressure by a few metres head. This is bad operating practice as it eliminates the storage facility and increases leakage loss. Any pipeline extensions should be made in a planned way and carried out simultaneously with WTP capacity upgrades as required.

5.6 Public Private Partnerships

67. Options and viability for potential PPP for Sihanoukville subproject was discussed with the Director of the Department of Potable Water Supply4.

68. Sihanoukville is the only town of the 9 subproject towns under this PPTA that has an existing current PPP arrangement. The Water Authority has a contract with a private company ANCO Brothers Co Ltd (ANCO) to supply bulk treated water to the Water Authority, based on an MOU signed 7th December 2007, valid for 30 years. The water is treated reservoir water from above a waterfall. ANCO also supply the Anchor brewery and the Economic Zone with treated

[4] Mr Tan Sokchea

water, and the coal factory with untreated water. ANCO charge the Water Authority 1000riel/m3 and the Brewery and Economic Zone around 1500-2000riel/m3. These three entities lie within the concession area of the Water Authority, so the ANCO supply to these three customers is not strictly legal.

69. The water authority originally contracted ANCO to supply treated water into its distribution system to supplement the existing WTP, but as the brewery and Economic Zone were not receiving the security of supply they wanted, they also made an agreement with ANCO. This has had the result that the Water Authority is not receiving as much of this finite resource as it had originally wanted, as a share of it is redirected to the other three customers. There is some conflict over this arrangement particularly between the water needs of the Water Authority and the brewery.

70. Table 5.2 shows the volumes of water supplied by ANCO currently

Table 5.2: ANCO bulk treated water sales

	Units	From WS Utility	To Angkor brewery & surrounds	To Economic Zone	To Coal factory	Comment
Wet season	m^3/month	240,000				
Dry season	m^3/month	360,000				
Supplied by ANCO	m^3/month	150,000	150,000	30,000	60,000	Coal factory raw water only

71. In common with all towns in general, the urban water supply systems are seen as best managed by the government where possible. Installation and commissioning of the elements of work under this subproject require specialist contractors and involvement of public bodies is limited.

72. There are some peri-urban areas in Cambodia where whole water supply concessions have been granted to private companies to construct and manage water supply systems. This is not strictly PPP, as the private company needs only to acquire a license – there is no partnership as such. There are both good and bad examples of these private concessions throughout the country.

73. A possible additional area where a PPP could be utilized in the future is in the supply of bulk treated water to customers who are either just outside of the WTP service area or are inside the area but receive low pressure. Private water tankers could be used to fill up with (and pay for) treated water from the WTP and deliver and sell to customers with their own storage tanks.

5.7 Contract Packaging of Subproject

74. A number of packaging options were examined and discussed between the PPTA team, MIH and ADB. These options are presented below in Table 5.3.

Table 5.3: Subproject Contract Packaging Options

No. packages	Subproject Towns included	Advantages/disadvantages
2	Stung Treng Siem Reap plus 7 rehab towns	**Advantages:** • Small number of packages reduces tendering and contract management

		admin. • Larger packages makes them more attractive to international bidders. • Easier to standardise on equipment. **Disadvantages:** • Limited opportunity for NCB
3	Stung Treng Siem Reap 7 rehab towns	**Advantages:** • Three good sized packages attractive to ICB bidders • Small number of packages reduces tendering and contract management admin. • Easier to standardise on equipment **Disadvantages:** • Limited opportunity for NCB
4	Stung Treng Siem Reap 3 southern rehab towns (Svay Rieng, Kampot, Sihanoukville) 4 northern towns (Kampong Cham, Kampong Thom, Pursat, Stoung)	**Advantages:** • 2 larger and 2 smaller packages, the smaller of which could be NCB if an exception to the $1M limit relaxed **Disadvantages:** • More tender and contract management admin • More difficult to standardise on equipment with larger number of packages.
9	9 separate contracts	**Advantages:** • Each IA is responsibe for their own subproject and has direct ownership • 7 of the 9 subprojects could be let as NCB **Disadvantages:** • More tender and contract management admin • Some activities may not be suitable for many national contractors due to lack of specialist experience. • More difficult to standardise on equipment with larger number of packages.

75. During discussions, initially the option of two large contracts, one for Stung Treng and one for the other 8 towns, was favoured for the simplicity of the bidding process, contract administration, and the attractiveness of the larger packages to international bidders.

76. After further discussion, 9 separate contracts was favoured, as greater weight was put on having the contracts out to tender quickly, and having 7 of them of a size that would permit NCB would help achieve this. The procedures for approving and tendering NCB are far less time consuming compared to ICB. Additional benefits would be that each IA would have ownership of their own subproject, and that national contractors would benefit from both the experience and the business.

77. A perceived obstacle with having 7 of the subprojects as NCB is the technical nature of some of the rehabilitation work. Installation and commissioning of gas chlorination equipment, bladder tanks for surge protection, and proper construction of filter underdrains are all areas requiring a degree of specialist knowledge and experience. For this reason, coupled with the simplicity of having a lesser number of contract packages, a compromise of three packages was selected, being Stung Treng, Siem Reap, and the 7 rehabliitation subprojects.

78. These 3 packages will all need to be ICB due to their value, but this does not exclude national contractors from bidding, provided they meet the prequalification requirements. Additionally, if national contractors have difficulty meeting prequalification requirements, they can still benefit from these contracts by subcontracting.

6. COSTS AND FINANCING PLAN

6.1 Cost Estimates

79. The subproject cost is estimated at $0.340 million equivalent, including taxes. A summary of the cost estimates is given in Table 6-1.

Table 6-1 - Subproject Capital Cost

No	Description	Totals (inc tax) US$000
2	**Water Supply Development**	
2.1	Rehabilitation of filters with introduction of mixed air/water stage	55.0
2.2	Additional clearwater storage 500m^3 with necessary slope protection	200.0
2.3	Install raw water flow meter	10.0
2.4	Improve control panel for raw water pump security	10.0
2.5	Replace intake pump gate valve (Dia 200mm)	3.0
2.6	Re-route alum dosing pipe with ABS pipe	5.0
2.7	**Total for Water Supply Development**	
2.8	**TOTAL ESTIMATED BASE COST**[a]	283.0
	Contingencies 20%	56.6
	TOTAL ESTIMATED SUBPROJECT COST	**339.6**

Source: Consultant's estimate, 2013.

6.2 Least cost analysis

80. No least cost analysis was carried out for Sihanoukville as alternative solutions were not presented for consideration.

7. SUBPROJECT FINANCIAL AND ECONOMIC ASSESSMENT

7.1 Approach and Methodology: Financial Assessment

81. The financial analysis was done in three levels: (i) examination of the historical and current financial performance; (ii) evaluation of the feasibility of the proposed subproject under UWSP; and (iii) evaluation of the financial sustainability taking into account the impact of the proposed subproject to the future operation of PWWs and WSA.

82. Following the Asian Development Bank (ADB) guidelines5, four basic indicators for the financial viability of a water supply project have been identified. These are the following:

- Financial Internal Rate of Return (FIRR). It is the discount rate at which the revenues and costs generated by the project are equal to zero. A project is considered financially viable if the computed FIRR is equal to or higher than the weighted average cost of capital (WACC) that is used in financing the development of the proposed water supply project.

- Debt Service Coverage Ratio (DSCR). It measures the solvency of the PWWs/WSA and shows how many times debt service for a given period is covered by operations. DSCR should at least be 1.3 after project completion.

- Annual cash balance. Projected annual cash balances should be positive all throughout the projection period.

- Tariff affordability. Household monthly water bill should not be more than 5% of the average monthly household income of the low income group.

7.1.1 Financing Plan.

83. The project will be financed by ADB and the national government. Part of the ADB and national government funds will be on-lent to the PWWs/ WSA. Annual debt service was estimated based on preliminary discussions with MIH and MEF. The on-lending terms for the purpose of this study are as follow:

- Maturity period of 32 years, including 8 years grace period on principal payment while interest is capitalized during construction;

- Fixed interest rate[6] of 1.25% per annum for the first 8 years and 1.75% per annum for the next 24 years; and

- Foreign exchange risk to be borne by the national government.

7.1.2 Proposed Water Tariff.

84. Three scenarios were tested in the design of the water tariff based on the amount of loan, as a percent of project costs, passed on to the 8 PWWs. For Siem Reap WSA, 100% loan was assumed. For the 8 PWWs, the three scenarios tested were: (1) 0% loan-100% grant; (2) 50% loan-50% grant; and (3) 100% loan-0% grant.

7.1.3 Other Assumptions

85. The main assumptions used in the financial projections include:

- Estimates of annual water revenues are based on the total water billed for the year and the corresponding tariffs for the same year. Connection fees, for non-poor household customers

[5] ADB, *Financial Management and Analysis of Projects* (2005).

[6] ADB's interest rate to the national government is 1% and 1.5% respectively.

are included as other revenues and assumed to be paid by the customers in 24 equal installments.

- The investment cost of the proposed project and the O&M costs are prepared on an annual basis in August 2013 prices. Increases in costs due to inflation are covered through a provision for price contingencies both for the investment costs and the O&M costs.

- The incremental O&M costs, which is the difference between “with the project” and “without the project” scenario, were used in the evaluation. O&M costs include: 1) administration; 2) chemical; 3) power; 4) maintenance of facilities; 5) salaries and wages; and 6) other O&M items.

- Projected O&M costs “without the project” are based on actual O&M costs as presented in the historical revenue and expense statements. It is assumed that there will be minimal increases in the service connections as water supply demand approaches the maximum water supply capacity of the existing system, hence there will be no increases in the number of personnel. The unit cost of O&M is assumed to increase following the local inflation rate.

- Projected O&M costs “with the project”, except maintenance of facilities, are based on historical unit costs. Maintenance of facilities cost is based on engineering estimate of the required maintenance level of the facilities.

- Depreciation allowance is considered a non-cash item. However, for purposes of estimating the net income, it was included as expense in the projected income statement. Annual depreciation costs for the new facilities were calculated using the straight-line method based on the service life[7] of each type of asset.

- Water tariff “without the project”, is assumed to increase in the future to cover increases in O&M. For purposes of the projection, it is assumed that water tariffs will have to be increased by 5% starting 2015 and every four years thereafter until 2027 for Siem Reap, Stung Treng and Svay Rieng; for Kampong, because current tariff is low, the assumed increases are 10%.

- Water Revenue “without the project”. As mentioned earlier, since the existing facilities are already nearing its maximum operating capacities, it is assumed that there will be no further additional connections after the water supply capacities are reached in 2017. Volume of water sold after this period will remain constant. Any increase in projected revenue is then due to the assumed increase in water tariff.

- Water Revenue “with the project”. Based on the technical study, the proposed improvements in the water supply system can provide the water requirements of the projected beneficiaries up to year 2019 (Siem Reap) to 2023 (Kampong Cham, Stung Treng and Svay Rieng). The volume of water sold is therefore assumed to increase up to that year and is assumed to remain constant at the that level. Any increase in projected revenue after this period is then due to the assumed increase in water tariff.

7.2 Approach and Methodology: Economic Assessment

86. The economic analysis was undertaken in accordance with the procedures set out in the ADB Handbook for the Economic Analysis of Water Supply Projects (1999) and related ADB guidelines8. The period of analysis extends over 30 years from the start of project implementation in 2015 up until 2044. Costs and benefits were quantified at August 2013 prices and were converted to their economic

[7] Using PWWs/WSA asset life schedule.

[8] *Guidelines for the Economic Analysis of Projects (1997).*

cost equivalents using shadow prices. Both costs and benefits were treated as increments to a "without the project" situation.

87. The economic viability of the project was determined by computing the economic internal rate of return (EIRR) and comparing the result with the economic opportunity cost of capital (EOCC) of 12%. An EIRR exceeding the assumed EOCC indicates that the project is economically viable. The viability of the investments was then tested for changes in key variables such as capital costs, O&M costs and benefits through sensitivity analysis. Distribution of project benefits and poverty impact analysis were also undertaken to determine how much of the net economic benefits resulting from the investments will directly benefit the poor.

88. The economic viability of the proposed investments in water supply was determined considering the following benefits: (1) incremental gross revenue; (2) the value of time saved for not having to collect water from existing non-piped sources; (3) medical cost savings due to reduced morbidity from waterborne diseases; and (4) avoided income loss (productivity savings) because of reduced incidence of diseases. Economic costs were derived from the estimates of capital investments and O&M costs in financial terms, removing all duties and taxes and multiplying the net results by the conversion factors (CF). The following CFs were applied: 1.0 for traded goods and non-traded goods, and 0.7 for unskilled labor.

89. The proposed investments which aim to improve the population's access to piped water supply in the area, will form part of the Government's overall development plan for the water supply sector, which also aims to achieve the targets set under the Millennium Development Goal[9].

7.3 Sihanoukville Provincial Waterworks (SPWW)

90. A full financial and economic analysis report can be found in Appendix D.

7.3.1 Historical Financial Performance

91. From 2009 to 2012, SPWW's revenue was able to cover O&M except in 2010 where coverage is only 75%. Operating ratio ranged from 0.97 to 1.5 from 2009 to 2012. Current ratios were high for the four-year period while account receivable as of end 2012 was high at 51 days equivalent of annual water sales.

Table 7.1: SPWW Financial Indicators, 2009-2012

Financial Indicators	2009	2010	2011	2012
Cost Recovery:				
Total expenses	1.00	0.75	1.18	1.23
Total expenses & Depreciation	0.81	0.65	0.97	1.03
Current Ratio	8.64	4.55	4.09	5.87
Operating Ratio	1.23	1.54	1.03	0.97
Account Receivable (Days)	64	55	54	51

[9] MDG's Target No. 10, Goal No. 7: Halve, by 2015 the proportion of people without sustainable access to safe drinking water and sanitation. For urban water supply in Cambodia, people with access to safe drinking water is about 64% in 2004. Per MDG, this should reach 80% by 2015. Source: Key Indicators of Developing Asian and Pacific Countries, 2006, ADB.

7.3.2 Projected Financial Performance

7.3.2.1 Investment Costs.

92. The total investment cost for the water supply project is approximately KR 1587 million (assuming 50% loan), including price and physical contingencies and interest during construction. Table 7.2 presents a summary of the investment costs.

Table 7.2: SPWW Total Investment Cost (KR million)

Items	% Total	Total
Civil Works	58.4	927
Equipment and Materials	6.4	102
Total Base Cost	64.9	1,029
Physical Contingency	13.0	206
Price Contingency	12.3	196
Total Contingencies	25.3	402
Interest During Construction	0.8	13
Taxes and Duties	9.0	143
Total Cost	100.0	1,587

Source: Consultant's estimate

7.3.2.2. Financing Plan.

93. The project will be financed by ADB and the national government. ADB loan will finance KR 800 million while a grant of KR 787 million will finance the remaining cost. The grant will come from the government funds (KR 157 million) and from ADB funds (KR 630 million). The financing plan is shown in Table 7.3.

Table 7.3: SPWW Financing Plan (KR million)

Items	% Total	Total
ADB Loan (on-lending)	50.4	800
Disbursement	49.6	787
Interest During Construction	0.8	13
Government (grant)	49.6	787
Own Fund	9.9	157
ADB Fund	39.7	630
Total	100.0	1,587

Source: Consultant's estimate

7.3.2.3. Water Tariff.

94. SPWW needs the following tariff increases (average) to cover O&M costs and depreciation: 8% in 2015 and 2018, 9% in 2021 and 13% in 2023 (Table 7.4). It is recommended that the SPWW categorize its customer into household, government and commercial to facilitate the application of cross subsidy between different categories of customer. For a 50 or 100% loan, Table 7.5 shows the required tariffs. An average increase of 16% in 2023 is required such that revenues can cover O&M costs, depreciation and debt service.

Table 7.4: SPWW Proposed Tariff Rate - 0% Loan

Category		**2015**	**2018**	**2021**	**2023**
Household	0 to 7 m3	1,700	1,800	2,000	2,250
	8 to 15 m3	2,000	2,100	2,300	2,700
	>15 m3	2,250	2,500	2,750	3,150
Government		2,000	2,100	2,300	2,700
Commercial		2,250	2,500	2,750	3,150
Tariff Increase		8%	8%	9%	13%

Source: Consultant's estimate

Table 7.5: SPWW Proposed Tariff Rate - 50% and 100% Loan

Category		**2015**	**2018**	**2021**	**2023**
Household	0 to 7 m3	1,700	1,800	2,000	2,250
	8 to 15 m3	2,000	2,100	2,300	2,800
	>15 m3	2,250	2,500	2,750	3,250
Government		2,000	2,100	2,300	2,800
Commercial		2,250	2,500	2,750	3,250
Tariff Increase		8%	8%	9%	16%

Source: Consultant's estimate

7.3.2.4 Affordability of Water Rates.

95. A major consideration in the development of the tariff schedule is the ability of target beneficiaries to pay for their monthly water bill. For SPWW service area, the estimated monthly income belonging to the poor households for 2013 is KR 700000. Using the affordability criteria, the monthly water bill is about KR 11900 (KR 1700 x 7 m3) in 2015 is only 1.7% of the monthly income of poor households. In all subsequent years the monthly water bill is less than 5% of the estimated monthly income. Hence, the proposed level of water tariff is deemed affordable to the low income or poor households.

7.3.2.5 Impact of the Project on the SPWW's Financial Operation.

96. Selected financial ratios were computed to provide an indication of the SPWW's future financial performance (Table 7.6).

- Revenues can cover O&M costs and depreciation allowance from 2015 to 2025;
- Current ratio are high ranging from 4 to 6;
- Operating ratio are projected to be less than or equal to 1 from 2015 to 2025;
- Debt service coverage ratio is higher than 1.3 during the projection period; and
- Accounts receivable is 47 days equivalent of annual revenues.

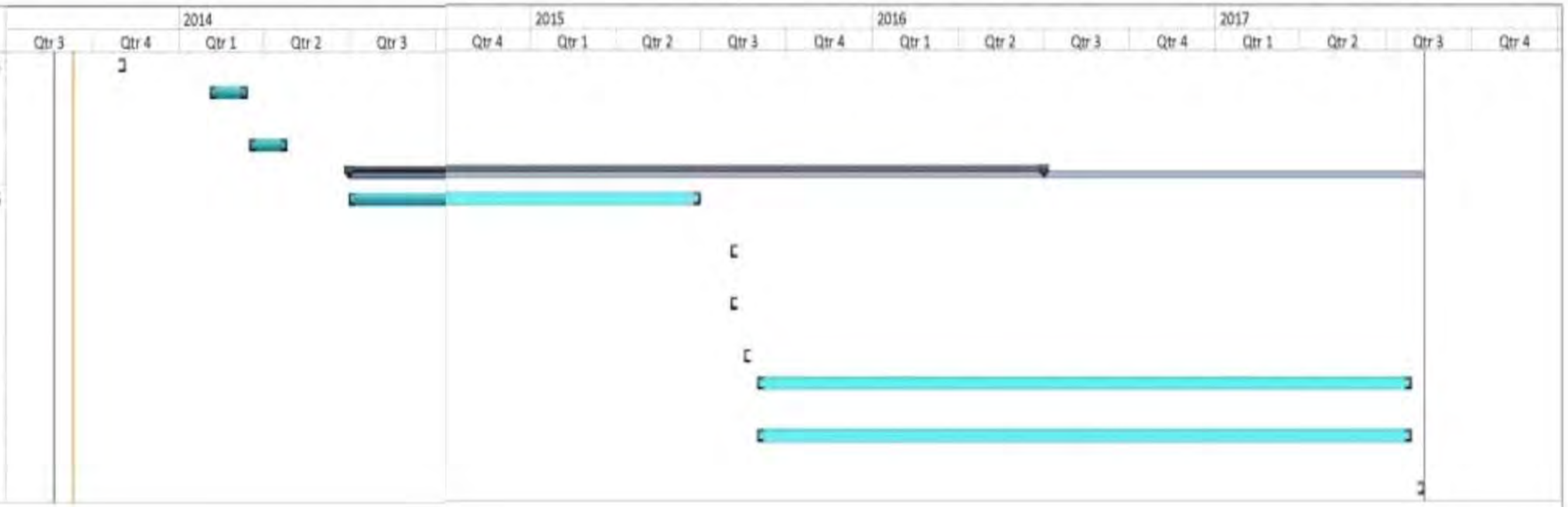
Table 7.6: SPWW Summary of Financial Indicators (50% Loan)

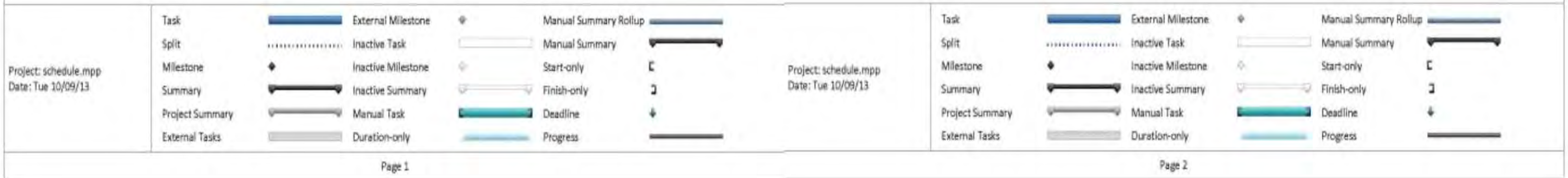
Financial Indicators	2015	2016	2017	2018	2019	2020	2025
Cost Recovery:							
O&M	1.2	1.2	1.1	1.2	1.2	1.1	1.3
O&M + Depreciation	1.0	1.0	1.0	1.0	1.0	1.0	1.1
Current Ratio	4.0	4.4	4.7	5.0	5.4	5.8	6.3
Operating Ratio	1.0	1.0	1.0	1.0	1.0	1.0	0.9
Debt Service Coverage Ratio	-	-	-	-	49.4	40.8	18.3
Account Receivable (Days)	47	47	47	47	47	47	47

Source: Consultant's estimate

Appendix A: Sihanoukville Subproject Implementation Schedule

ID	Task Mode	Task Name	Duration	Start	Finish
1		Completion of PPTA			Mon 4/11/13
2		Tendering of Implementation project	30 days	Mon 3/02/14	Fri 14/03/14
3		Tender evaluation	30 days	Mon 17/03/14	Fri 25/04/14
4		**Final design & contract management**	**524 days**	**Tue 1/07/14**	**Fri 1/07/16**
5		Final design & contract documentation	261 days	Tue 1/07/14	Tue 30/06/15
6		Tenders close - construction package 1		Mon 3/08/15	
7		Tenders close - construction package 2		Mon 3/08/15	
8		Tender award - package 1 & 2		Mon 17/08/15	
9		Construction Package 1 - Stung Treng	500 days	Mon 31/08/15	Fri 28/07/17
10		Construction Package 2 - Siem Reap plus 7 others	500 days	Mon 31/08/15	Fri 28/07/17
11		Commissioning			Fri 11/08/17





Appendix B: Cost Estimate Breakdowns for Sihanoukville Subproject

Appendix C: Water Quality Test Results for Sihanoukville Subproject

Month average	Temp (C)	Turbidity NTU	Res chlorine (mg/l)	pH	Colour TCU	Alkalinity (mg/l as $CaCO_3$	Conductivity (us/cm)
LIMIT		**<5**	**0.2-0.5 at end user**	**6.5-8.5**	**<5**		**1600**
Jan	28.8	0.6	1.28	6.9	-	14	52
Feb	30	0.8	1.34	6.8	-	14.6	58
Mar	31	1.8	1.4	6.9	-	14.4	80
Apr	31.6	2.3	0.86	6.9	-	13	104
May	31.6	2.2	0.97	6.81	2.5	15	129
Jun	30.1	1.7	0.88	6.92	2.1	19	96
Jul	29	1.2	0.99	6.85	1.6	23	77
Aug	28.3	2.2	1.19	6.7	2.2	18	63
Sept	29.1	1.8	1.06	6.67	2.0	22	68
Oct	28.1	2.2	0.93	6.78	2.3	24	73
Nov	27.9	1.4	1.06	6.76	1.7	21	79
Dec	28.3	0.9	1.09	6.83	0.9	21	74

Appendix D: 9 Subproject Towns Financial and Economic Analysis

Appendix E: deleted

Appendix F: Environmental Due Diligence report

Appendix G: Land acquisition due diligence report

Appendix H: Outline Operation and Maintenance Plan

Operational Procedures

WTP area	Procedure
Raw water pumps	Can be controlled (on/off) by level transducers in the main clear water tank, or manually by Operator.
Flocculation tank inlet weir	Set so that there is always a hydraulic break between water in the inlet channel and the first flocc channel.
Flocculation tank baffles	Baffle slot sizes on lower end of alternate baffles, which are calculated and specified during final design, should be adhered to. When baffles are moved during cleaning of the flocc tank, these slot sizes should be reset to the design dimensions. Failure to do this may result in incorrect velocity gradient across the flocc tank resulting in poor flocc formation.
Sed tank collection launders	The stainless steel collection launders should be set at a level that allows for the prescribed headloss across the flocc tank. If the launders are set too high it has the effect of "backing up" the flocc tank and reducing the hydraulic gradient across it. This is normally set during design by calculating the hydraulics across the full WTP, but is sometimes neglected.
Filters – bypass of water	For filters to operate properly, the plenum floor that holds up the gravel and sand layers needs to be sealed. No water should pass between the plenum floor and the vertical filter walls, or through the plenum floor except through the inserted filter nozzles. Additionally, water should not be allowed to take a "short cut" between the edge of the sand layer and the filter wall. This can be stopped by roughening the inside filter wall with a sand/cement mix.
Filters – backwashing	Filters should be backwashed when the sand becomes sufficiently blocked with debris and silt to slow the passage of water through the media. This can be judged by marking a dirty water level inside the filter, and when it is reached, a backwash is due. Similarly a low water level mark should be visible and this minimum water level in the filter kept by partially closing the clean water outlet valve to the clear water tank. The backwash cycle begins with air scour by itself to loosen the sand media and help release dirt. This should carry on for around 3-5 minutes. The air blower is then turned off and backwash valve opened partially at first and then gradually opened further, in order to maintain the design backwash flowrate as the head in the backwash tank decreases. The backwash valve should never be just opened fully for the backwash cycle.
Reticulation	
Washout valves	All washout valves on the system, installed at low points, should be opened every month to flush out the line as required.
Valves on the distribution system	Valves should be kept either fully open or fully closed.

KINGDOM OF CAMBODIA

MINISTRY OF INDUSTRY AND HANDICRAFT

URBAN WATER SUPPLY AND SANITATION PROJECT

(ADB PPTA: TA-8125-CAM)

SHORT FEASIBILITY STUDY FOR STOUNG SUBPROJECT

November 2013

Prepared by

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APPENDICES

ABBREVIATIONS AND EQUIVALENTS

ADB	Asian Development Bank
ADF	Asian Development Fund
AP	Affected persons
APs/AHs	Affected persons/affected households
ASR	ADB's Annual Sector Review
BOO	Build-Operate-Own
BOT	Build-Operate-Transfer
COBP	Country Operations Business Plan
CPP	Community Participation Plan
CPS	Country Partnership Strategy
DMC	Developing Member Countries
DMF	Design and Monitoring Framework
DPWS	Department of Potable Water Supply
EA	Executing Agency
EGM	Effective Gender Mainstreaming
EMP	Environmental Management Plan
FAR	Feasibility Assessment Report
FS	Feasibility Study
GAP	Gender Action Plan
HHs	Households
IAs	Implementing Agencies
IEEs	Initial Environmental Examinations
IOL/SES	Inventory of Losses and Socioeconomic Survey
IR	Inception Report
ISCD	Institutional Strengthening & Capacity Development
JICA	Japan International Cooperation Agency
LARP	Land Acquisition and Resettlement Plan
LARF/LARP	Land Acquisition and Resettlement Framework and Plan
MEF	Ministry of Economy and Finance
MIH	Ministry of Industry, Mines and Energy
MOU	Memorandum of Understanding
MOWRAM	Ministry of Water Resources Management and Meteorology
MPWT	Ministry of Public Work and Transport
MRD	Ministry of Rural Development
NCB	National Competitive Bidding
NRW	Non-revenue Water
O&M	Operation and Maintenance
PAM	Project Administration Manual
PDIH	Provincial Department of Industry and Handicraft
PDR	People Democratic Republic
pm	Person-months
PMU	Project Management Unit
PPP	Public Private Participation
PPPs	Public-Private Partnership
PPTA	Project Preparation Technical Assistance
PPWSA	Phnom Penh Water Supply Authority
REA	Rapid Environmental Assessment

RRP	
SCS	Stakeholder Communication Survey
SPS	Safeguards Policy Statement
SRWSA	Siem Reap Water Supply Authority
SR	Safeguards Requirements
TA	Technical Assistance
TOR	Terms of Reference
WOPs	Water Operators' Partnerships
WTP	Water Treatment Plant

UNITS

ha	Hectare
lpcd	Liters per capita per day
l/s	Liters per second
m	Meter
mg/l	Milligrams per Liter
mm	Millimeter
m^3/day	Cubic meters per day

Figure 1-1 - Location of Project Towns

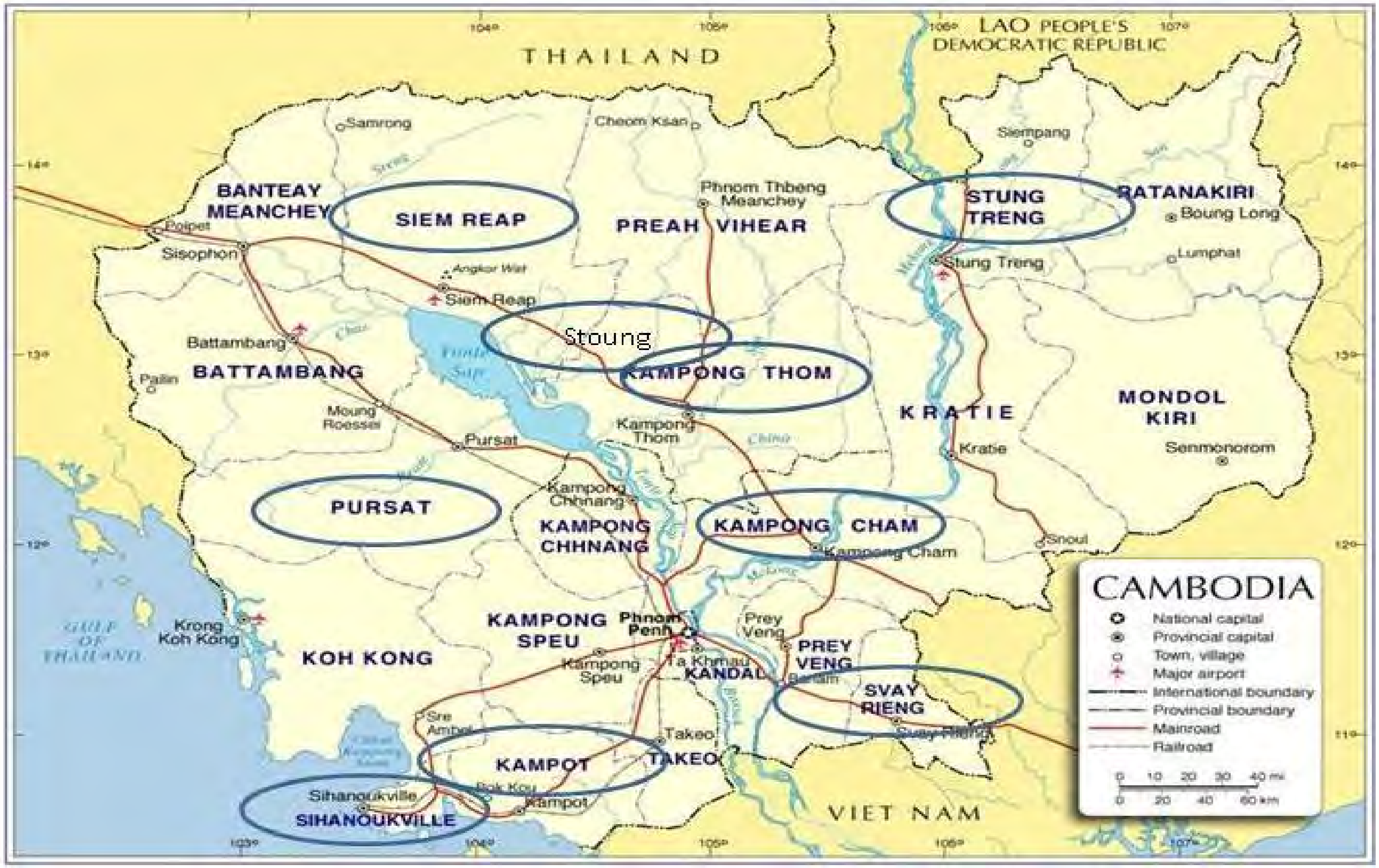
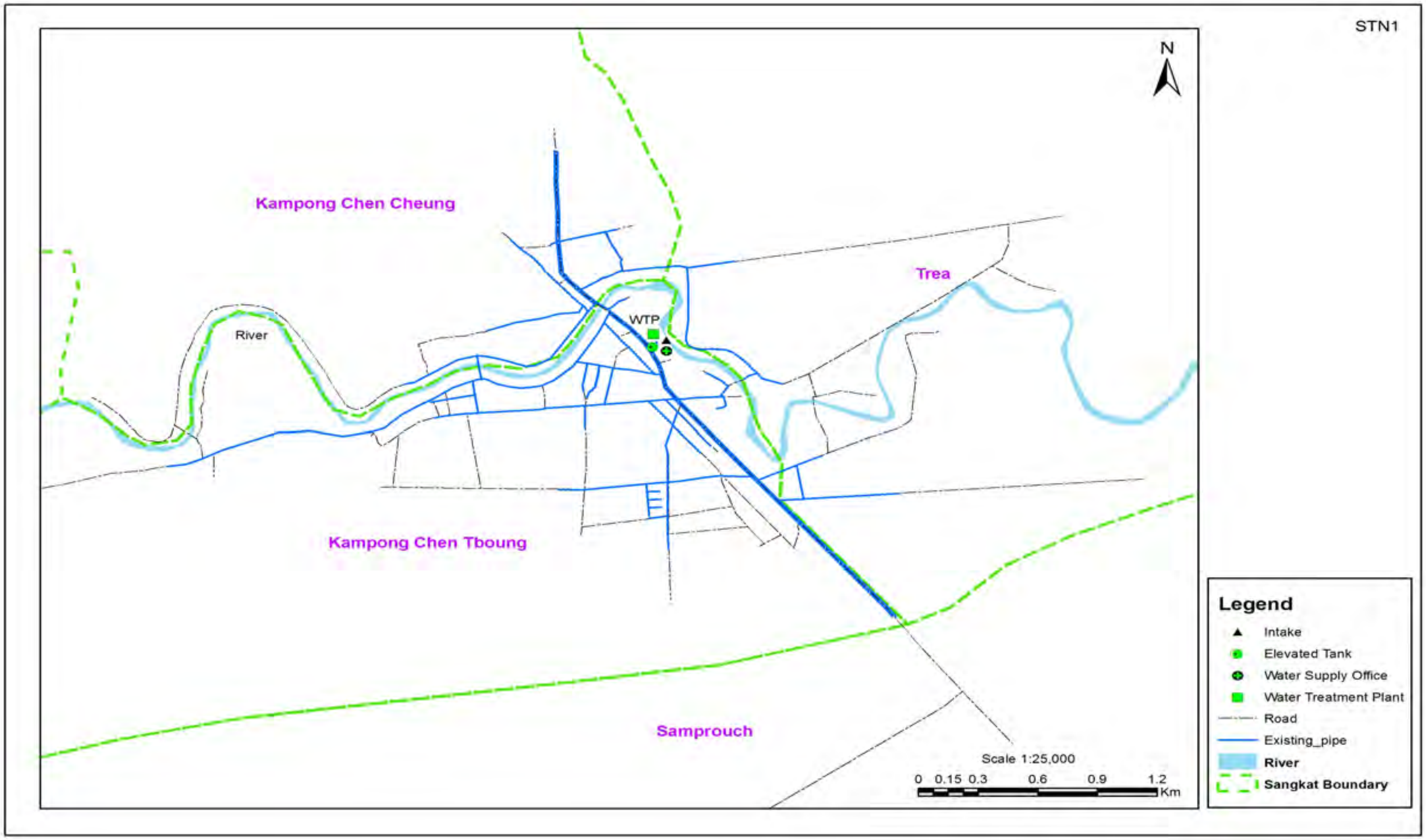


Figure 1-2 Location Plan of Proposed Stoung Subproject



1. EXECUTIVE SUMMARY

1.1 Project Description

1. Expected outputs of the overall Project include: (i) water treatment plants provided or improved in eight towns; (ii) water distribution systems improved and coverage increased in six towns; (iii) existing pumping stations rehabilitated in five towns; and (iv) institutional capacity of MIH and regulatory system strengthened, under a piggy-backed technical assistance.

1.2 Rationale

2. During 2011, through the ADB's Water Operators' Partnerships Program, ADB was able to re-engage in the urban water supply sector with MIH. Consequently ADB's Country Operations Business Plan 2010-2013 includes an Asian Development Fund loan for the Project for approval in 2014. The UWSP will assist the government to address the three core constraints identified in the ADB Country Partnership Strategy (2011-2013): (i) insufficient funds to expand coverage and improve services; (ii) weak sector planning and implementation capacity of responsible authorities at the central and sub-national levels; and (iii) inadequate (or sometimes weak) institutional and legal framework.

1.3 Background

3. The proposed Project "Urban Water Supply Project " (UWSP) will provide necessary facility improvements to the six provincial towns previously funded by ADB and to three provincial towns that have been funded by other bilateral or multilateral agencies, and expand public access to sustainable and safe water supply services for the urban population in Cambodia. In addition, the Project will address institutional weaknesses through the development of improved institutional structures, a regulatory framework, and appropriate capacity development.

1.4 Project Impact and Outcome

4. The impact of the proposed Project will be expanded access to sustainable and safe water supply services for the urban population in Cambodia and better functioning water treatment plants providing higher quality water. MIH targets are to increase the proportion of the urban population in the project area with access to safe water to 85% by 2018 and 90% by 2025, and the project will assist these aims. The outcome of the project will be improved water supply infrastructure and service provisions in selected provincial waterworks.

1.5 Candidate Towns

5. There are nine candidate towns: Kampong Cham, Kampong Thom, Kampot, Pursat, Siem Reap, Sihanoukville, Stoung, Stung Treng and Svay Rieng. Originally Battambang was to be included but this was removed at the request of the Provincial Waterworks.

1.6 Feasibility Study Context

6. The feasibility studies include: (i) needs assessment, supply and demand analysis, (ii) selection of technology, equipment, and facilities for the identified subprojects considering least cost and life cycle approach and the capacities of the local authorities to manage, operate, and maintain; (iii) assessment of economic and financial viability and sustainability for each of the subprojects; (iv) assessment of policy and legal capacity, including other institutional issues and mechanisms related to the financial management, procurement, and anticorruption; (v) poverty, social, and gender analysis and preparation of a poverty and social strategy, a gender action plan, stakeholder communication survey (SCS), and a Community Participation Plan (CPP), where required; and (vi) review of impacts on environment, involuntary resettlement, and indigenous peoples.

1.7 Subproject Description

1.7.1 Output 1 - Water Supply Development

7. The Stoung subproject aims to improve the provision of safe, affordable, reliable piped water supply to individual household connections to communities within the five core sangkats/communes having Y2012 population of about 51,152. The works proposed under the PPTA are summarised in Table 1.1 below and described in detail in Section 5.2.2.

1.7.2 Output 2 – Strengthening of Institutional capacity of MIH and Regulatory System

8. The Institutional Strengthening and Capacity Development is to (i) identify key stakeholders; (ii) assess institutional capacity constraints; (iii) develop institutional capacity building plan; and (iv) prepare terms of reference for strengthening sector regulation TA.

1.8 Cost Estimate

9. The subproject cost is estimated at $0.45 million equivalent, including taxes and duties. Table 1.1 provides a summary of the Stoung Subproject cost estimate.

Table 1.1: Stoung Subproject Cost Estimate ($'000's)

No	Description	Totals (inc tax) US$000
2	**Water Supply Development**	
2.1	Remove 2008 sed tank extension	5.0
2.2	Remove generator building and construct new one near carpark	5.0
2.3	New WTP between current WTP and office	80.0
2.4	Gate valve for backwash line	5.0
2.5	Acquire land next door	100.0
2.6	Build 500m3 storage tank	80.0
2.7	Following completion of A,B&C, demolish 2003 WTP and build second WTP train in its place	100.0
	Total for Water Supply Development	
	TOTAL ESTIMATED BASE COST[a]	**375.0**
	Contingencies 20%	75.0
	TOTAL ESTIMATED SUBPROJECT COST	**450.0**

1.9 Executing Agency and Implementation Arrangements

10. MIH will be the Executing Agency, and the existing project management unit (PMU) based in the Department of Potable Water Supply (DPWS) will be expanded to execute and manage the Project on behalf of MIH with the consulting service to be provided by the project implementation assistance consultants (PIAC). The Project implementing units (PIUs) are expected to be organized by the nine (9) implementation agencies (IAs) of the provincial waterworks. The nine (9) PIUs will be responsible for day-to-day coordination and supervision of subproject implementation in these provincial towns.

1.10 Implementation Period

11. The proposed Project is scheduled for implementation over five years from 2014 to 2018. The final design is proposed for a one year period between mid-2014 and mid-2015. Following this, a two year construction period would have the works commissioned in August 2017. A proposed Implementation schedule is included in Appendix A.

1.11 Procurement

12. The procurement shall be carried out under International Competetive Bidding (NCB) as three packages; one package Stung Treng; one package Siem Reap; and the remaining 7 subprojects as one package. The full Procurement Plan is contained in the Supplementary Appendices of the main PPTA report.

1.12 Consulting Services

13. The project implementation assistance consultants (PIAC) on the design and engineering review, tendering assistance, and construction management are provided under Bank financing will be selected in advance and engaged in accordance with the ADB's Guidelines on the Use of Consultants. An individual consultant will be engaged to prepare the PIAC terms of reference and to assist the EA on the preparation of the Request for Proposal. The PIAC consulting services will be signed once the loan becomes effective to provide under a single consulting package, by an association of international and domestic consulting firms. The lead consulting firm will provide the services of the Team Leader who will be responsible for managing the overall consulting services during the project implementation.

1.13 Subproject Benefits and Beneficiaries

14. The Stoung subproject aims to improve the provision of safe, affordable, reliable piped water supply to individual household connections to communities within the five core communes having Y2012 population of about 51,152.

1.14 Land Acquisition and Compensation

15. The overall project has Involuntary Resettlement Categorisation C because all of the improvement facilities are within the water treatment plant compound. The Resettlement Planning Document for Stoung is contained in Appendix H.

1.15 Environmental Impacts

16. An Environmental Due Diligence Report was done for Stoung and is contained in Appendix G. The subproject is classified as Category C.

1.16 Economic and Financial Analyses

17. Economic and Financial analyses for Stoung is contained in Section 7, and in full in Appendix D.

1.17 Tariff and Affordability

18. Due to limited water supply capacity, SGPWW's customer base is small compared to the other PWWs in the project. The required tariffs, therefore, to cover O&M cost and depreciation by year 2023, assuming 0 or 50% loan, are high (Table 1.2). For a 100% loan, the required tariffs are shown in Table 7.5. It is recommended that the SGPWW separate household and commercial customers and apply a different tariff rate for each category. It is also recommended that commercial customers will be charged higher than the household and government customers.

Table 1.2: SGPWW Proposed Tariff Rate – 0 or 50% Loan

Category		2015	2018	2021	2023
Household	0 to 7 m3	2,300	2,600	2,800	3,250
	> 7 m3	2,400	3,200	3,600	4,500
Government		2,400	3,200	3,600	4,500
Commercial		2,650	3,500	3,900	4,800
Tariff Increase (average)		30%	18%	9%	18%

Source: Consultant’s estimate

2. PROJECT RATIONALE, IMPACT AND OUTCOME

2.1 Rationale

19. During 2011, through the ADB's Water Operators' Partnerships Program, ADB was able to re-engage in the urban water supply sector with MIH. In January 2012, MIH signed a twinning agreement with the PPWSA, which is currently providing support to four provincial waterworks been included in the Project through direct peer-to-peer knowledge transfer. In February 2012, the Ministry of Economy and Finance (MEF) requested ADB to consider financing the Project in accordance with the strategy of Cambodia's Public Debt Management, to ensure sustainable economic growth. Consequently ADB's Country Operations Business Plan 2010-2013 includes an Asian Development Fund loan for the Project for approval in 2014. The project supports the ADB's annual sector review, country partnership strategy, and the water operational plan 2011–2020

20. The UWSP will assist the government to address the three core constraints identified in the ADB Country Partnership Strategy (2011-2013): (i) insufficient funds to expand coverage and improve services; (ii) weak sector planning and implementation capacity of responsible authorities at the central and sub-national levels; and (iii) inadequate (or sometimes weak) institutional and legal framework.

2.2 Background

21. The proposed Project "Urban Water Supply Project " (UWSP) will provide necessary facility improvements to the six provincial towns previously funded by ADB and to three provincial towns that have been funded by other bilateral or multilateral agencies, and expand public access to sustainable and safe water supply services for the urban population in Cambodia. In addition, the Project will address institutional weaknesses through the development of improved institutional structures, a regulatory framework, and appropriate capacity development.

22. This UWSP is in line with (i) Cambodian National Strategic Development Plan (2009-2013) and (ii) action plan of Ministry of Industry, Mines and Energy (MIH) to facilitate private sector partnerships, strengthening the management of public owned waterworks, and integration urban water supply with urban environmental management. The proportion of the urban population in the project area with access to safe water will be increased to 85% by 2018 and 90% by 2025 as targeted by MIH. In addition, a potential target date for 100% coverage could be assumed as 2030.

2.3 Project Outline

23. The feasibility studies include: (i) needs assessment, supply and demand analysis, (ii) selection of technology, equipment, and facilities for the identified subprojects considering least cost and life cycle approach and the capacities of the local authorities to manage, operate, and maintain; (iii) assessment of economic and financial viability and sustainability for each of the subprojects; (iv) assessment of policy and legal capacity, including other institutional issues and mechanisms related to the financial management, procurement, and anticorruption; (v) poverty, social, and gender analysis and preparation of a poverty and social strategy, a gender action plan, stakeholder communication survey (SCS), and a Community Participation Plan (CPP), where required; and (vi) review of impacts on environment, involuntary resettlement, and indigenous peoples.

2.4 Project Impact and Outcome

24. The impact of the proposed Project will be expanded access to sustainable and safe water supply services for the urban population in Cambodia and better functioning water treatment plants providing higher quality water. MIH targets are to increase the proportion of the urban population in the project area with access to safe water to 85% by 2018 and 90% by 2025, and the project will assist these aims. The outcome of the project will be improved water supply infrastructure and service provisions in selected provincial waterworks.

3. Profile of Stoung Area

3.1 Town Location and Profile

25. Stoung city is in Kampong Thom Province and is on National Road 6 between Phnom Penh and Siem Reap on the east side of the Tonle Sap lake, to the north of Kampong Thom city.

26. Agriculture is the primary industry in the Province along with fishing from the Tonle Sap.

3.2 Natural Features

3.2.1 Topography

27. Stoung is on a flat area on the flood plain of the Stoung river to the east of the Tonle Sap. There are no hills or mountains in the nearby area.

3.2.2 Climate

28. The climate, in common with other non-coastal areas of Cambodia, is hot all year with a distinct rain season May – October and a drier season November – February.

3.2.3 Surface water

29. There is only one surface water source in Stoung, the Stoung river. This is currently used by some private households and also by the Provincial Waterworks as the raw water source.

3.2.4 Groundwater

30. There is some domestic groundwater use in Stoung in the form of dug wells. Additionally a 210m deep borehole was drilled in mid 2013 to supplement the river water intake of the WTP during the dry season. This is discussed further in Section 3.4.1 below.

3.3 Population and Household Characteristics

31. The populations provided below are for the service area within Stoung.

Table 3-1: Stoung Population Characteristics

No	Core Commune	2012 Pop'n.	No. HH	Persons/ HH	M/F Ratio
1	Som Proch	12,204	2,443	5.00	1.05
2	Trial	12,378	2,639	4.69	0.93
3	Msa Krong	9,537	2,149	4.44	0.75
4	Kampong Chin Chheng	7,043	1,369	5.14	0.83
5	Kampong Chin Tbong	9,990	2,024	4.94	0.86
		51,152	**10,624**	**4.81**	**0.89**

3.3.1 Population Growth and Migration

32. Population growth from the 2008 National Survey1 shows an average national urban growth rate of 2.21%. For the purposes of this study we have used growth rates for individual towns, provided by each Provincial Waterworks2. For Stoung this is 0.15% showing a low growth rate.

[1] General Population Census 2008 National Report, August 2009

[2] Data collected by head of each commune

3.4 Existing Water Supply and Sanitation

3.4.1 Water Supply

33. The Stoung water treatment plant differs to all the others under the PPTA in that it was designed and built by a joint arrangement between twin towns in Italy and Belgium and the Stoung Provincial Waterworks. It was built 2003 so is fairly recent. Unfortunately, it does not appear to have been hydraulically designed, and as such does not operate as a WTP in the sense that water quality improves significantly as it flows through the WTP.

34. The inlet is from a stream adjacent to the WTP, with wet and dry season inlets. During the dry season this stream sometimes completely dries out and water is pumped from a reservoir dam 30km away to replenish the stream. Originally electric motors were used to run the pumps that deliver raw water from the adjacent stream, but these were changed to diesel generators to save money. Pumps are Jiangdong duty/standby with a capacity of approximately 100m3/hr. A new borehole was drilled in mid-2013 to supply raw water during the dry season instead of pumping 30km from the dam. It would make little sense to use this borehole to supplement the surface water source outside of the dry season, as the WTP is already over capacity, and the clean groundwater would be mixing with turbid stream water. The borehole is 210m deep with 400mm casing and DN200 PN13 rising main.

35. The inlet feeds to a flocculation tank which has no velocity gradient across it, with no visible flocc forming. The acting baffles are holes in bricks placed sideways for the first 3 short channels followed by 3 further channels with no baffles at all. The flocc tank outlet has not been constructed as per drawings, with outlet gate position making one channel redundant.

36. The original 2003 sedimentation tank is split into 3 channels, presumably to save space, but these channels have the effect of increasing the velocity of the water around the ends, and thus breaking any flocc that does manage to form. An extension to the sedimentation tank was made in 2008, with 4 further compartments, but the inlet to these later compartments is a narrow channel that again increases velocity, mixing up water that is meant to be settling at this stage, and disturbing flocc.

37. There is one filter, which is currently overloaded with the inlet channel submerged by 15cm. There is no backwash effluent channel, and in its place 2x150mm pipes through one wall of the filter tank for dirty backwash water to exit. These are completely ineffectual. Furthermore the pipes are just above sand level, so carry sand from the expansion layer out of the filter, caught by rice bags over the downstream end of the pipes which feed to a drain next to the filter. Backwash is by the clear water pumps with a pressure of around 30m, which is much too high and will have ruined the gravel/sand layers in the filters.

38. Clear water pumps work fine and there is one larger than the other. There is no need for larger capacity pumps as the WTP is already over capacity

39. One of the proposed improvements is a new 500m3 clear water tank and 150m3 elevated storage tank in the WTP grounds. There is no space for these currently. The option currently being explored is to purchase land from neighbours.

40. The Water Authority has reported only 54% utilisation of the WTP capacity. These figures can be misleading. This percentage was based on the average 2012 annual production and an assumed WTP capacity of 1,300m3/day. As there are no design calculations available we do not know the intended design capacity of this WTP, but the raw water pumps in use can supply 100m3/hour, which indicates that the practical capcity is 2,400m3/day. Secondly, the average annual production is estimated from pump running hours, as there are no working bulk meters at the WTP.

41. It is clear from observation at the WTP that the flowrate is equal to or exceeding the design capacity of 2,400m3/hr. The reasons for this are;

- The water levels in the sedimentation tanks are high with little freeboard, and the filter inlet channel is submerged even after a backwash. This indicates that the plant is being ran above its capacity.

- From observation the elevated tank never gets filled. The clear water pumps are pumping directly into supply with no excess water available for filling storage. This shows that the full 100m^3/hr (2,400m^3/day) is being consumed by customers and NRW.

42. In summary this is a very poor WTP, badly designed and with very little space in the grounds for further improvements as it stands. It is debateable whether it is worth spending more money on this WTP, or whether to look at a new properly designed WTP on a new site in the future.

4. POPULATION GROWTH AND WATER DEMAND FORECASTS

4.1 General

43. Stoung is the capital city of the Province and acts as a market for the surrounding area.

44. At present, there is no agro-processing or industrial development in Stoung consuming water or which could affect water quality, and nothing planned. There is no mine in the region.

4.2 Population Projections

45. The population projections3 are set out in Table 4-1. Within the core villages, total population is forecast to increase from about 51,152 in 2012 to about 52,472 in 2030.

Table 4-1: Population Projections for Stoung's Core Villages

Year 2012 Population	Growth Rate %	Forecast Population 2014	Forecast Population 2020	Forecast Population 2025	Forecast Population 2030
51,152	0.15	51,306	51,769	52,158	52,472

4.3 Water Demand Forecasts

4.3.1 General Approach

46. Whilst the scope of proposed works under this project does not include increasing the capacity of the Stoung water supply system, demand forecasts have been produced to illustrate the shortfall of available treated water into the near future. Water demand forecasts for the Stoung subproject were prepared by making separate projections of each component of demand, including:

- Demand for domestic use (based on per capita consumption, coverage targets and population projections);
- Demand for industry (based on a % of domestic use, and specific allowances for large industries);
- Demand for services (based on a % of domestic use, and specific allowances for large services areas);
- Physical losses as a % of total demand, excluding the demand of large industrial zones.
- Production losses in treatment plant (based % of total demands).

4.3.2 Domestic Consumption

47. Water demand and consumption data for other provincial and district towns in Cambodia show that domestic consumption accounts for about 90% of total demand. Per capita consumption figures for urban water supply systems in Cambodia can vary widely, particularly with strong reliance on rainwater collection during the wet season. Experience in other towns in Cambodia indicates that piped connections directly to the house will usually increase water consumption over time. The Feasibility Study has adopted a per capita consumption figure of 120 lpcd, plus 10% for non-domestic use which includes demand from industry and services, 15% for physical losses (leakage), and 50m3/day for backwashing filters in the WTP.

4.3.3 Water Demand Forecasts

48. Table 4-2 summarizes the demand forecasts and design criteria for the Stoung subproject. By 2030, the average daily water demand is expected to be 10,050m3/day, comprising 75% domestic consumption, with the remaining 25% being for institutions, public use, services, handicraft and small

[3] 2012 populations and growth rate provided by the Provincial Waterworks

industries, and allowances for physical losses and backwashing the filters. The proposed upgrades to the existing WTP will not meet this demand, given land area constraints of the current site, but will increase capacity to around 4,800m3/day.

Table 4-2: Water Demand Forecasts for Stoung Subproject

No.	Items	Unit	Forecasts				
			2012	2014	2020	2025	2030
A.	**Domestic Demand**						
1	Growth Rate	%	0.15	0.15	0.15	0.15	0.15
2	Population in Core Area		51,152	51,306	51,769	52,158	52,472
3	Coverage in Core Area	%	90	100	100	100	100
4	Population with Piped Water	No.	46,037	51,306	51,769	52,158	52,472
5	Per Capita Consumption	l/c/d	120	120	120	120	120
6	Total Domestic Demand	m3/d	5,524	6,157	6,212	6,259	6,297
B.	**Non-domestic demand**						
1	Services, Schools, Small Industry, Institutions, Hotels	%	15	15	15	15	15
2							
3	Total Non-domestic demand	m3/d	829	924	932	939	944
C.	**Subtotal Water Demand All Categories**	m3/d	6,353	7,080	7,144	7,198	7,241
D.	**Non Revenue Water (NRW) in Distribution system**						
1	NRW as % Average Daily Water Production	%	15	15	15	15	15
2	NRW (physical losses only-pipelines and WTP)	m3/d	953	1,062	1,072	1,080	1,086
E.	**Average Daily Water Production (C+D) rounded**	m3/d	7,310	8,140	8,220	8,280	8,330
F.	**Peak Annual Water Demand (Max day Max month)**						
1	Peak Annual Water Demand		1.20	1.20	1.20	1.20	1.20
2	Peak Annual Water Demand	m3/d	8,772	9,768	9,864	9,936	9,996
3	Peak Annual Water Demand	l/s	102	113	114	115	116
G.	**Required Treatment Plant Output (rounded)**	m3/d	8,770	9,770	9,860	9,940	10,000
H.	**Treatment Plant Backwashing**						
1	Treatment Plant Backwashing	m3/d	50	50	50	50	50
I.	**WTP Capacity**						
1	Required WTP Capacity	m3/d	8,820	9,820	9,910	9,990	10,050
2	Required WTP Capacity	l/s	102.08	113.66	114.70	115.63	116.32
	Total Required Source Capacity (Rounded)	**m3/d**					**10,050**
	Total Required Source Capacity	**l/s**					**120.00**

4.3.4 Future Demand Requirements

49. The table shows that the existing water treatment plant from 2003, at 2,400m3/day, is already insufficient to meet demand with 2014 demand projected at 9,820m3/day. This subproject is not intended to address future demands, but to rehabilitate the current existing WTP assets, improve water quality and improve security of supply.

50. A further 7,420m3/day of treated water will be required to meet projected 2030 demands. The current WTP grounds are not big enough for a WTP of this capacity, so a new larger capacity WTP will be required in the near future.

5. SUBPROJECT DESCRIPTION

5.1 Introduction

51. The proposed works are designed to improve operational improvements, increased water quality and security of supply. This improved water supply scheme is not designed to increase capacity of supply.

5.2 Output 2: Water Supply Development

52. Expected outputs of the overall Project include: (i) water treatment plants provided or improved in eight towns; (ii) water distribution systems improved and coverage increased in six towns; (iii) existing pumping stations rehabilitated in five towns; and (iv) institutional capacity of MIH and regulatory system strengthened, under a piggy-backed technical assistance.

5.2.1 Preliminary Designs

53. The proposed water supply scheme design improvements are based on limited topographical, hydrological and water quality data and are preliminary.

5.2.2 Description of Proposed Water Supply System

54. The Stoung subproject aims to improve the provision of safe, affordable, reliable piped water supply to individual household connections to communities within the five core communes having Y2012 population of about 51,152.

55. The works proposed under the PPTA are summarised in Table 5.1 below;

Table 5.1: Proposed new infrastructure for Stoung

Stoung	Short FS	
		A - Remove 2008 sed tank extension
		B - Remove generator building and construct new one near carpark
		C - New WTP between current WTP and office
		D - Gate valve for backwash line
		E - Acquire land next door
		F - Build 500m3 storage tank
		G - Following completion of A,B&C, demolish 2003 WTP and build second WTP train in its place

5.2.2.1 Remove 2008 sedimentation tank extension

56. The extra sedimentation tank constructed in 2008 which takes water from the original 3-chamber 2003 sedimentation tank and discharges to the single filter is proposed to be demolished. It serves little purpose as a sedimentation tank as flocc is broken up by the many changes in velocity and direction upstream of this tank. The original 2003 WTP should be left in operation initially to provide water. The removal of this 2008 sedimentation tank will not reduce capacity, and it is not thought to reduce quality either as, from observation, it has little effect on the intended treatment process.

57. The purpose of the removal is to make space for a new, properly designed WTP train of flocculation, sedimentation and rapid sand filtration in its place.

5.2.2.2 Remove generator building& construct new one elsewhere

58. The current generator building is between the 2008 sedimentation tank extension and the office building. By relocating the generator building there will be more space to construct a new WTP train. A location for a new generator building, out of the way of the main WTP process structures, has been identified in the current carpark area behind the elevated tank.

5.2.2.3 Build new WTP train between current WTP and office

59. A new single structure housing inlet chamber, dosing, flocculation, sedimentation and filtration is to be constructed between the 2003 WTP and the office. This must be hydraulically designed and checked by a qualified Engineer. The flocculation tank should be designed by specifying and creating a hydraulic gradient using baffles with calculated orifice spaces and weir depths, in addition to a retention time of between 15-30 minutes. The filter should be designed with a weir inlet, sealed plenum floor, durable nozzles, properly graded media, and one or two backwash effluent collection channels with lip set above the calculated sand expansion zone. Full design criteria are contained in Appendix I. The current capacity of the Stoung WTP is 2,400m3/day. A capacity of 10,050m3/day is required to serve the projected population to 2030. By building two WTP trains to replace the current one, we will be close to doubling the potential WTP capacity, but this capacity will still be less than 50% of that required to meet 2030 demand. Additionally, replacement of raw water pumps for larger models is not included in this subproject.

5.2.2.4 Gate valve to regulate backwash flow

60. The backwash water is currently supplied from the elevated tank in the WTP compound, which provides water at around 30m head. This is far too high for backwash, which should generally be approximately 3 to 6m above the lip level of the backwash effluent channel. A gate valve to be used for throttling flow is to be installed on the backwash water supply pipe at a convenient accessible location.

5.2.2.5 Acquisition of adjoining land

61. Adjoining land (225m2) to the WTP is needed if a new 500m3 storage tank is to be constructed. If this land cannot be acquired under the ADB loan the tank will have to be constructed at a later date under different funding.

5.2.2.6 New 500m^3 storage tank

62. The existing 100m3 ground storage tank and 56m3 elevated tank provide a maximum of 1.5 hours storage. Addition of a 500m3 ground storage tank will increase this to 6.5 hours storage, closer to the 8 hours usually recommended for urban water supplies. There is currently no space in the WTP grounds for construction of this tank, so it is dependent on whether or not the IA can purchase neighbouring land.

5.2.2.7 Construction of second WTP train

63. Once the new WTP train described in 2.5.5.3 has been constructed and is commissioned, the old 2003 WTP train can be demolished, and a new properly designed WTP constructed in its place. Full design criteria are contained in Appendix I.

5.3 Consultation Activities during Preparation of Stoung Feasibility Study

64. A series of community visits and consultations occurred during the finalization of the 2013 Feasibility Study to inform district and village authorities about the subproject and gather information and feedback from local authorities, people living in core villages and other stakeholders. Consultation activities during the project site visits in 2013 are detailed below:

(i) Initial reconnaissance visit March 2013: Team Leader and National water engineer visited the site for an initial inspection and discussion with the Provincial Waterworks.

(ii) Second engineering site visit 1st May 2013: International and National water engineers visited Stoung facility, collected data, and finalized scope following Inception workshop.

(iii) Socio-economic specialist visit: a visit for the purpose of carrying out the public consultation was undertaken on 18-27th June

(iv) Environmental and Resettlement specialist visit: This joint visit was carried out between June 3rd -11th to collect data to aid the finalization of the IEE and LACP.

5.4 Operation and Maintenance of Project Facilities

5.4.1 Capacity to Operate and Maintain the Proposed Water Supply System

65. As described in 3.4.1, the current WTP is not being operated correctly. This is mostly due to a poor design which inhibits the use of the WTP as an efficient facility, and not particularly because of staff capacity. The staff are familiar with pump maintenance but with the current WTP there has been little opportunity for staff to learn the correct operation of a functioning WTP – it has been more of "making the best of a bad job" with the existing plant.

66. Once the proposed WTP is completed, the flocculation, sedimentation, filtration and backwash processes will be improved and staff will require training on the objectives of each process, how to recognize good results, and corrective operational actions required at each stage. Some key points for each process where further training may be required are given here;

5.4.1.1 Flocculation

67. An improved flocculation tank will have adjustable vertical baffles with the water passing alternately over and underneath them. The "under" baffles will need the slot sizes through which the water passes hydraulically calculated by the designer, and these slots must be set on site during construction and checked. The Operator will need to understand the link between the slot size and the headloss this creates, and the mixing and flocc formation that the created velocity gradient across the flocc tank cause. The baffle slot sizes will be designed for the maximum design flow rate through the WTP. If a lower flow rate is set by the raw water pumps, then baffle slot sizes will need to be adjusted by the Operator to ensure proper flocc formation.

5.4.1.2 Sedimentation

68. The sedimentation tank should have no bends or weirs to increase the velocity of the water passing through the tank, as there are with the current arrangement. A detention time of around 4 hours is desirable but may not be possible with the space available at Stoung. Staff should become familiar with seeing the reduction in visible flocc along the length of the tank.

5.4.1.3 Filtration

69. The current filters are of a poor design and do not operate well. Operators will need to become familiar with the features of a correctly designed filter and how to recognize when they are operating correctly. The filter floor area should be sized to allow 5m3/m3/hr, and have a central effluent collection channel constructed sufficiently above the design sand level to avoid carrying away sand during the backwash cycle. If the plenum floor/nozzle type design is used (and this is recommended as they are simple and robust), then the nozzles should be sealed into concrete floor, and the concrete plenum floor slab sealed where it joins the vertical filter walls. A graded gravel bed of around 40cm depth is recommended and a clean graded sand bed of around 90cm placed on top.

70. Operators should be able to recognize when a filter needs backwashing by the backing-up of water above a pre-set height on the filter wall.

5.4.1.4 Backwashing

71. Currently backwashing is carried out using backwash water from the elevated clear water tank which can provide up to 30m head. This is far too much and results in filter sand being "blown out" of the filter. It is currently collected using sacks as filter material and replaced. The backwash line will have a controlling gate valve installed, and the backwash water should be throttled back to provide about 3-4m head over the lip of the backwash effluent channel to ensure an efficient backwash. The Operator will need to recognize, through adjusting the valve, when the backwash flow is enough to separate the sand layer but not so much that sand is being washed over into the backwash effluent channel with the dirt.

5.4.2 Management Arrangements

72. The PIAC will provide Project technical, safeguards, accounting and management assistance on a daily basis as well as support the PIUs with project implementation

73. At the start of Project implementation, the PMU and PIAC will (i) update the initial environment examinations and due diligence reports (IEEs and DDRs) and prepare EMPs submit to MOE for review and approval; (ii) clear potential unexploded ordnance (UXO) remain on site; and (iii) acquire necessary land before subproject bids are tendered.

5.4.3 Operation and Maintenance Plans

74. The Operation and Maintenance plan for each subproject can be divided into two types, those with a full conventional WTP and those with chlorinated groundwater being pumped to an elevated tank and fed into supply. For Stoung, an Operation and Maintenance Plan reflecting the former has been developed and is presented in full in Appendix F.

5.5 Lessons learned in Cambodia and the SE Asia region

75. There are several “lessons learned” in both the region and inside the national water sector that would benefit the 9 project towns under this PPTA;

- As at PPWSA, use of standardized chlorination equipment that has a regional office that can offer technical support, spares and specialist staff when needed. PPWSA has selected equipment supplied by Severn Trent Services (STS), and equipment from this manufacturer has been recommended for the towns requiring replacement chlorination equipment under this study. STS have a main office in Singapore, but have local representation in Phnom Penh. However, final selection of equipment of equal or better specifications will be decided at tendering as specific brands cannot be specified in Contract documents.
- High density polyethylene pipe (HDPE) is favoured in Cambodia, even for larger diameters. As most of Cambodia is flat, as are all of the 9 towns under this study, system pressures are not higher than 60m head. As such, a PN6 rated pipe would be sufficient. However, experience has shown that for the pipes un to and including 90mm diameter, which may have domestic connections tapped from them, a PN8 minimum pipe is required, even for very low pressures. The reason for this is that the tapping saddles used can deform the thinner pipe wall thicknesses on PN6 pipe, which causes leakage.
- Automated valves linked to a central control panel were designed and installed under the 2006 Provincial Towns project. All of these have failed in the 6 towns where they were installed. The lesson here is to keep the WTPs simple and keep valves as manually operated. With the relatively smaller size of these WTPs (mostly under 6,000m^3/day), valve automation is not necessary and inappropriate.
- Alum and poly dosing lines under the previous Provincial Towns project used long lengths of uPVC pipe that followed buildings and structures, necessitating several 90 degree bends and causing significant headloss in the delivery pipe. This has caused the pipes to get blocked by sediment. In addition, the uPVC dosing pipes are exposed to direct sunlight. UV light will break down uPVC pipe over time. A better solution, as used in two recent projects in Laos, is to use ABS (acrylonitrile butadiene styrene) pipe, and select a more direct route for the pipe, minimizing bends and low points.
- For the water sector as a whole, a database of all water projects could be set up, to include design drawings, calculations, contract documents, demand calculations, feasibility reports, final design reports and other useful documentation, for each system. This would serve as an easily accessible online resource library for all Water Authority

staff in the country. It is relatively easy and inexpensive (under US$40,000) to set up and populate, and solves the common problem of drawings and documents getting lost. Many of the available hard copy resources for Cambodian water supply systems are either misplaced, or are reportedly stacked in disorder in a storeroom so dirty that nobody is willing to enter. Such a database was set up and released in neighbouring Laos in 2012-13 with assistance from UNHabitat, and can be viewed at;

http//:laowtp.info
by pressing “login as guest”.

- Several of the project towns under this PPTA have had extensions added to serve areas that were outside of the original design core area, without considering required design pressures or treatment plant capacity. This often results in the WTP being operated above its design capacity, which can reduce water quality, and often has negative effects on service pressure to other parts of the reticulation network. Typically, to increase system pressure to serve these unplanned extensions, water is diverted around any elevated storage tank and pumped directly into the system in order to increase delivery pressure by a few metres head. This is bad operating practice as it eliminates the storage facility and increases leakage loss. Any pipeline extensions should be made in a planned way and carried out simultaneously with WTP capacity upgrades as required.

5.6 Public Private Partnerships

76. Options and viability for potential PPP for Stoung subproject was discussed with the Director of the Department of Potable Water Supply4.

77. In common with all towns in general, the urban water supply systems are seen as best managed by the government where possible. Installation and commissioning of the elements of work under this subproject require specialist contractors and involvement of public bodies is limited.

78. There are some peri-urban areas in Cambodia where whole water supply concessions have been granted to private companies to construct and manage water supply systems. This is not strictly PPP, as the private company needs only to acquire a license – there is no partnership as such. There are both good and bad examples of these private concessions throughout the country.

79. A possible area where a PPP could be utilized in the future is in the supply of bulk treated water to customers who are either just outside of the WTP service area or are inside the area but receive low pressure. Private water tankers could be used to fill up with (and pay for) treated water from the WTP and deliver and sell to customers with their own storage tanks.

5.7 Contract Packaging of Subproject

80. A number of packaging options were examined and discussed between the PPTA team, MIH and ADB. These options are presented below in Table 5.2.

[4] Mr Tan Sokchea

Table 5.2: Subproject Contract Packaging Options

No. packages	Subproject Towns included	Advantages/disadvantages
2	Stung Treng Siem Reap plus 7 rehab towns	**Advantages:** • Small number of packages reduces tendering and contract management admin. • Larger packages makes them more attractive to international bidders. • Easier to standardise on equipment. **Disadvantages:** • Limited opportunity for NCB
3	Stung Treng Siem Reap 7 rehab towns	**Advantages:** • Three good sized packages attractive to ICB bidders • Small number of packages reduces tendering and contract management admin. • Easier to standardise on equipment **Disadvantages:** • Limited opportunity for NCB
4	Stung Treng Siem Reap 3 southern rehab towns (Svay Rieng, Kampot, Sihanoukville) 4 northern towns (Kampong Cham, Kampong Thom, Pursat, Stoung)	**Advantages:** • 2 larger and 2 smaller packages, the smaller of which could be NCB if an exception to the $1M limit relaxed **Disadvantages:** • More tender and contract management admin • More difficult to standardise on equipment with larger number of packages.
9	9 separate contracts	**Advantages:** • Each IA is responsibe for their own subproject and has direct ownership • 7 of the 9 subprojects could be let as NCB **Disadvantages:** • More tender and contract management admin

		• Some activities may not be suitable for many national contractors due to lack of specialist experience. • More difficult to standardise on equipment with larger number of packages.

81. During discussions, initially the option of two large contracts, one for Stung Treng and one for the other 8 towns, was favoured for the simplicity of the bidding process, contract administration, and the attractiveness of the larger packages to international bidders.

82. After further discussion, 9 separate contracts was favoured, as greater weight was put on having the contracts out to tender quickly, and having 7 of them of a size that would permit NCB would help achieve this. The procedures for approving and tendering NCB are far less time consuming compared to ICB. Additional benefits would be that each IA would have ownership of their own subproject, and that national contractors would benefit from both the experience and the business.

83. A perceived obstacle with having 7 of the subprojects as NCB is the technical nature of some of the rehabilitation work. Installation and commissioning of gas chlorination equipment, bladder tanks for surge protection, and proper construction of filter underdrains are all areas requiring a degree of specialist knowledge and experience. For this reason, coupled with the simplicity of having a lesser number of contract packages, a compromise of three packages was selected, being Stung Treng, Siem Reap, and the 7 rehabliitation subprojects.

84. These 3 packages will all need to be ICB due to their value, but this does not exclude national contractors from bidding, provided they meet the prequalification requirements. Additionally, if national contractors have difficulty meeting prequalification requirements, they can still benefit from these contracts by subcontracting.

6. COSTS AND FINANCING PLAN

6.1 Cost Estimates

85. The subproject cost is estimated at $0.45 million equivalent, including taxes. A summary of the cost estimates is given in Table 6-1.

Table 6-1 - Subproject Capital Cost

No	Description	Totals (inc tax) US$000
2	**Water Supply Development**	
2.1	Remove 2008 sed tank extension	5.0
2.2	Remove generator building and construct new one near carpark	5.0
2.3	New WTP between current WTP and office	80.0
2.4	Gate valve for backwash line	5.0
2.5	Acquire land next door	100.0
2.6	Build 500m3 storage tank	80.0
2.7	Following completion of A,B&C, demolish 2003 WTP and build second WTP train in its place	100.0
	Total for Water Supply Development	
	TOTAL ESTIMATED BASE COST[a]	**375.0**
	Contingencies 20%	75.0
	TOTAL ESTIMATED SUBPROJECT COST	**450.0**

Source: Consultant's estimate, 2013.

6.2 Least cost analysis

86. No least cost analysis was carried out for Stoung as alternative solutions were not presented for consideration.

7. SUBPROJECT FINANCIAL AND ECONOMIC ASSESSMENT

7.1 Approach and Methodology: Financial Assessment

87. The financial analysis was done in three levels: (i) examination of the historical and current financial performance; (ii) evaluation of the feasibility of the proposed subproject under UWSP; and (iii) evaluation of the financial sustainability taking into account the impact of the proposed subproject to the future operation of PWWs and WSA.

88. Following the Asian Development Bank (ADB) guidelines5, four basic indicators for the financial viability of a water supply project have been identified. These are the following:

- Financial Internal Rate of Return (FIRR). It is the discount rate at which the revenues and costs generated by the project are equal to zero. A project is considered financially viable if the computed FIRR is equal to or higher than the weighted average cost of capital (WACC) that is used in financing the development of the proposed water supply project.

- Debt Service Coverage Ratio (DSCR). It measures the solvency of the PWWs/WSA and shows how many times debt service for a given period is covered by operations. DSCR should at least be 1.3 after project completion.

- Annual cash balance. Projected annual cash balances should be positive all throughout the projection period.

- Tariff affordability. Household monthly water bill should not be more than 5% of the average monthly household income of the low income group.

7.1.1 Financing Plan.

89. The project will be financed by ADB and the national government. Part of the ADB and national government funds will be on-lent to the PWWs/ WSA. Annual debt service was estimated based on preliminary discussions with MIH and MEF. The on-lending terms for the purpose of this study are as follow:

- Maturity period of 32 years, including 8 years grace period on principal payment while interest is capitalized during construction;

- Fixed interest rate[6] of 1.25% per annum for the first 8 years and 1.75% per annum for the next 24 years; and

- Foreign exchange risk to be borne by the national government.

7.1.2 Proposed Water Tariff.

90. Three scenarios were tested in the design of the water tariff based on the amount of loan, as a percent of project costs, passed on to the 8 PWWs. For Siem Reap WSA, 100% loan was assumed. For the 8 PWWs, the three scenarios tested were: (1) 0% loan-100% grant; (2) 50% loan-50% grant; and (3) 100% loan-0% grant.

7.1.3 Other Assumptions

91. The main assumptions used in the financial projections include:

[5] ADB, *Financial Management and Analysis of Projects* (2005).

[6] ADB's interest rate to the national government is 1% and 1.5% respectively.

- Estimates of annual water revenues are based on the total water billed for the year and the corresponding tariffs for the same year. Connection fees, for non-poor household customers are included as other revenues and assumed to be paid by the customers in 24 equal installments.

- The investment cost of the proposed project and the O&M costs are prepared on an annual basis in August 2013 prices. Increases in costs due to inflation are covered through a provision for price contingencies both for the investment costs and the O&M costs.

- The incremental O&M costs, which is the difference between “with the project” and “without the project” scenario, were used in the evaluation. O&M costs include: 1) administration; 2) chemical; 3) power; 4) maintenance of facilities; 5) salaries and wages; and 6) other O&M items.

- Projected O&M costs “without the project” are based on actual O&M costs as presented in the historical revenue and expense statements. It is assumed that there will be minimal increases in the service connections as water supply demand approaches the maximum water supply capacity of the existing system, hence there will be no increases in the number of personnel. The unit cost of O&M is assumed to increase following the local inflation rate.

- Projected O&M costs “with the project”, except maintenance of facilities, are based on historical unit costs. Maintenance of facilities cost is based on engineering estimate of the required maintenance level of the facilities.

- Depreciation allowance is considered a non-cash item. However, for purposes of estimating the net income, it was included as expense in the projected income statement. Annual depreciation costs for the new facilities were calculated using the straight-line method based on the service life[7] of each type of asset.

- Water tariff “without the project”, is assumed to increase in the future to cover increases in O&M. For purposes of the projection, it is assumed that water tariffs will have to be increased by 5% starting 2015 and every four years thereafter until 2027 for Siem Reap, Stung Treng and Svay Rieng; for Kampong, because current tariff is low, the assumed increases are 10%.

- Water Revenue “without the project”. As mentioned earlier, since the existing facilities are already nearing its maximum operating capacities, it is assumed that there will be no further additional connections after the water supply capacities are reached in 2017. Volume of water sold after this period will remain constant. Any increase in projected revenue is then due to the assumed increase in water tariff.

- Water Revenue “with the project”. Based on the technical study, the proposed improvements in the water supply system can provide the water requirements of the projected beneficiaries up to year 2019 (Siem Reap) to 2023 (Kampong Cham, Stung Treng and Svay Rieng). The volume of water sold is therefore assumed to increase up to that year and is assumed to remain constant at the that level. Any increase in projected revenue after this period is then due to the assumed increase in water tariff.

7.2 Approach and Methodology: Economic Assessment

92. The economic analysis was undertaken in accordance with the procedures set out in the ADB Handbook for the Economic Analysis of Water Supply Projects (1999) and related ADB guidelines8. The period of analysis extends over 30 years from the start of project implementation in 2015 up until 2044. Costs and benefits were quantified at August 2013 prices and were converted to their economic

[7] Using PWWs/WSA asset life schedule.

[8] *Guidelines for the Economic Analysis of Projects (1997).*

cost equivalents using shadow prices. Both costs and benefits were treated as increments to a "without the project" situation.

93. The economic viability of the project was determined by computing the economic internal rate of return (EIRR) and comparing the result with the economic opportunity cost of capital (EOCC) of 12%. An EIRR exceeding the assumed EOCC indicates that the project is economically viable. The viability of the investments was then tested for changes in key variables such as capital costs, O&M costs and benefits through sensitivity analysis. Distribution of project benefits and poverty impact analysis were also undertaken to determine how much of the net economic benefits resulting from the investments will directly benefit the poor.

94. The economic viability of the proposed investments in water supply was determined considering the following benefits: (1) incremental gross revenue; (2) the value of time saved for not having to collect water from existing non-piped sources; (3) medical cost savings due to reduced morbidity from waterborne diseases; and (4) avoided income loss (productivity savings) because of reduced incidence of diseases. Economic costs were derived from the estimates of capital investments and O&M costs in financial terms, removing all duties and taxes and multiplying the net results by the conversion factors (CF). The following CFs were applied: 1.0 for traded goods and non-traded goods, and 0.7 for unskilled labor.

95. The proposed investments which aim to improve the population's access to piped water supply in the area, will form part of the Government's overall development plan for the water supply sector, which also aims to achieve the targets set under the Millennium Development Goal[9].

7.3 Stoung Provincial Waterworks (SGPWW)

96. A full financial and economic analysis report can be found in Appendix D.

7.3.1 Historical Financial Performance

97. From 2009 to 2012, SGPWW was able to cover total expenses but not total expenses and depreciation. Current ratio was high in the five-year period. Operating ratio ranged from 1.0 to 1.35 from 2009 to 2012. Accounts receivable is zero since SGPWW operates on a cash basis.

Table 7.1: SGPWW Financial Indicators, 2009-2012

Financial Indicators	2009	2010	2011	2012
Cost Recovery:				
Total expenses	1.05	1.39	1.01	1.06
Total expenses & Depreciation	0.74	1.00	0.80	0.99
Current Ratio	5.81	32.93	19.31	13.80
Operating Ratio	1.35	1.00	1.25	1.01
Account Receivable (Days)	-	-	-	-

[9] MDG's Target No. 10, Goal No. 7: Halve, by 2015 the proportion of people without sustainable access to safe drinking water and sanitation. For urban water supply in Cambodia, people with access to safe drinking water is about 64% in 2004. Per MDG, this should reach 80% by 2015. Source: Key Indicators of Developing Asian and Pacific Countries, 2006, ADB.

7.3.2 Projected Financial Performance

7.3.2.1 Investment Costs.

98. The total investment cost for the water supply project is approximately KR 2086 million, including price and physical contingencies and interest during construction (assuming 50% loan). Table 7.2 presents a summary of the investment costs.

Table 7.2: SGPWW Total Investment Cost (KR million)

Items	% Total	Total
Civil Works	47.9	1,000
Equipment and Materials	0.0	-
Land Acquisition	19.2	400
Total Base Cost	67.1	1,400
Physical Contingency	13.1	273
Price Contingency	11.5	239
Total Contingencies	24.5	512
Interest During Construction	1.1	24
Taxes and Duties	7.2	151
Total Cost	100.0	2,086

Source: Consultant's estimate

7.3.2.2 Financing Plan.

99. The project will be financed by ADB and the national government. ADB loan will finance KR 1055 million (includes interest during construction) while the government grant will finance KR 1031 million. Grant funds will come from the national government (KR 206 million) and ADB funds (KR 825 million). The financing plan is shown in Table 7.3.

Table 7.3: SGPWW Financing Plan (KR million)

Items	% Total	Total
ADB Loan (on-lending)	50.6	1,055
Disbursement	49.4	1,031
Interest During Construction	1.1	24
Government (grant)	49.4	1,031
Own Fund	9.9	206
ADB Fund	39.5	825
Total	100.0	2,086

Source: Consultant's estimate

7.3.2.3 Water Tariff.

100. Due to limited water supply capacity, SGPWW's customer base is small compared to the other PWWs in the project. The required tariffs, therefore, to cover O&M cost and depreciation by year 2023, assuming 0 or 50% loan, are high (Table 7.4). For a 100% loan, the required tariffs are shown in Table 7.5. It is recommended that the SGPWW separate household and commercial customers and apply a different tariff rate for each category. It is also recommended that commercial customers will be charged higher than the household and government customers.

Table 7.4: SGPWW Proposed Tariff Rate – 0 or 50% Loan

Category		2015	2018	2021	2023
Household	0 to 7 m3	2,300	2,600	2,800	3,250
	> 7 m3	2,400	3,200	3,600	4,500
Government		2,400	3,200	3,600	4,500
Commercial		2,650	3,500	3,900	4,800
Tariff Increase (average)		30%	18%	9%	18%

Source: Consultant's estimate

Table 7.5: SGPWW Proposed Tariff Rate - 100% Loan

Category		2015	2018	2021	2023
Household	0 to 7 m3	2,300	2,600	2,800	3,250
	> 7 m3	2,400	3,200	3,600	4,750
Government		2,400	3,200	3,600	4,750
Commercial		2,650	3,520	3,900	5,100
Tariff Increase (average)		30%	18%	9%	21%

Source: Consultant's estimate

7.3.2.4 Affordability of Water Rates.

101. A major consideration in the development of the tariff schedule is the ability of target beneficiaries to pay for their monthly water bill. For SGPWW service area, the estimated monthly income belonging to the poor households for 2013 is KR 650,000. Using the affordability criteria, the monthly water bill is about KR 16100 (KR 2300 x 7 m3) in 2015 is only 2.5% of the monthly income of poor households. In all subsequent years the monthly water bill is less than 5% of the estimated monthly income. Hence, the proposed level of water tariff is deemed affordable to the low income or poor households.

7.3.2.5 Impact of the Project on the SGPWW's Financial Operation.

102. Selected financial ratios were computed to provide an indication of the SGPWW's future financial performance (Table 7.6).

- Despite the proposed high tariff rates, revenues can only cover O&M and depreciation starting in year 2023 (not shown in Table due to limited space);
- Current ratio are moderate ranging from 2 to 4;
- Operating ratio are projected to be less than 1 starting from 2023;
- Debt service coverage ratio is higher than 1.3 during the projection period; and
- Accounts receivable is 18 days equivalent of annual revenues.

Table 7.6: SGPWW Summary of Financial Indicators (50% Loan)

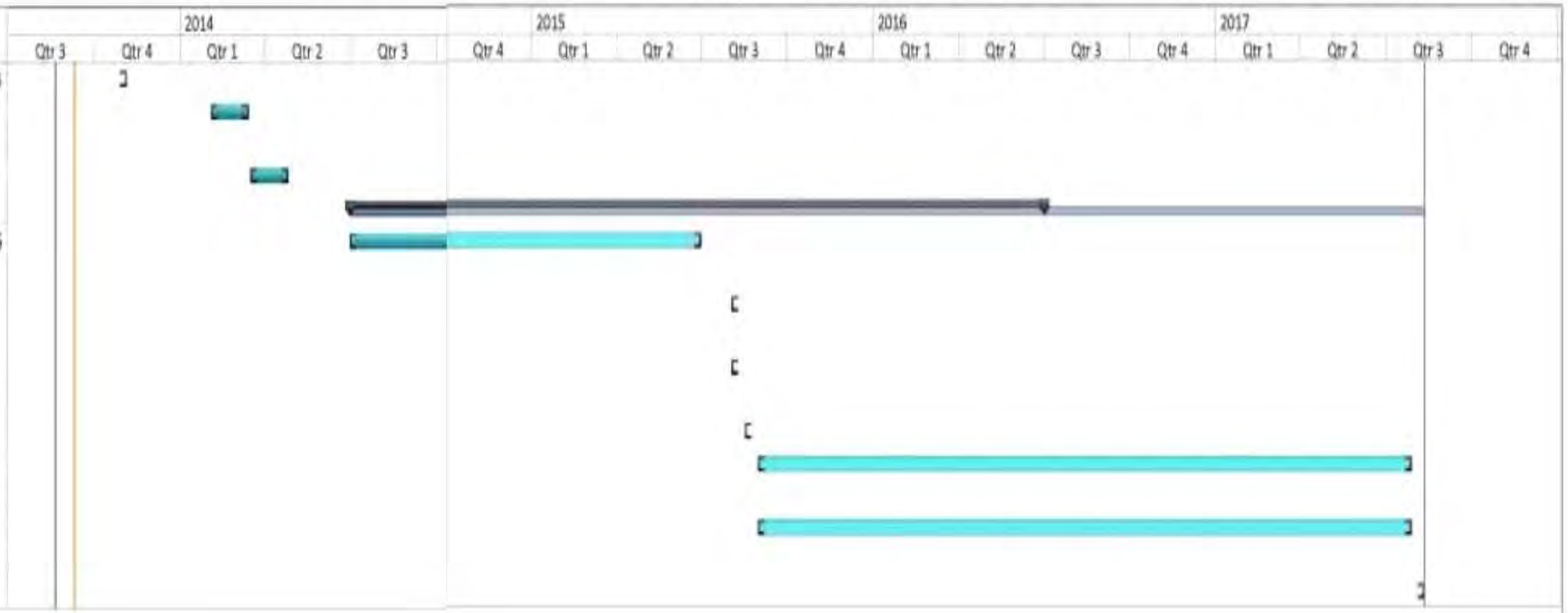
Financial Indicators	2015	2016	2017	2018	2019	2020	2025

Cost Recovery:							
O&M	1.1	1.1	1.0	1.1	1.0	1.0	1.2
O&M + Depreciation	1.0	0.9	0.8	0.9	0.9	0.9	1.0
Current Ratio	2.8	2.9	2.4	2.5	2.2	2.4	4.0
Operating Ratio	1.0	1.1	1.2	1.1	1.1	1.1	1.0
Debt Service Coverage Ratio	-	-	-	-	1.5	4.2	3.6
Account Receivable (Days)	18	18	18	18	18	18	18

Source: Consultant’s estimate

Appendix A: Stoung Subproject Implementation Schedule

ID	Task Mode	Task Name	Duration	Start	Finish
1		Completion of PPTA			Mon 4/11/13
2		Tendering of Implementation project	30 days	Mon 3/02/14	Fri 14/03/14
3		Tender evaluation	30 days	Mon 17/03/14	Fri 25/04/14
4		**Final design & contract management**	**524 days**	**Tue 1/07/14**	**Fri 1/07/16**
5		Final design & contract documentation	261 days	Tue 1/07/14	Tue 30/06/15
6		Tenders close - construction package 1		Mon 3/08/15	
7		Tenders close - construction package 2		Mon 3/08/15	
8		Tender award - package 1 & 2		Mon 17/08/15	
9		Construction Package 1 - Stung Treng	500 days	Mon 31/08/15	Fri 28/07/17
10		Construction Package 2 - Siem Reap plus 7 others	500 days	Mon 31/08/15	Fri 28/07/17
11		Commissioning			Fri 11/08/17



Project: schedule.mpp
Date: Tue 10/09/13

Task		External Milestone		Manual Summary Rollup	
Split		Inactive Task		Manual Summary	
Milestone		Inactive Milestone		Start-only	
Summary		Inactive Summary		Finish-only	
Project Summary		Manual Task		Deadline	
External Tasks		Duration-only		Progress	

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Project: schedule.mpp
Date: Tue 10/09/13

Task, External Milestone, Manual Summary Rollup, Split, Inactive Task, Manual Summary, Milestone, Inactive Milestone, Start-only, Summary, Inactive Summary, Finish-only, Project Summary, Manual Task, Deadline, External Tasks, Duration-only, Progress

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Appendix B: Cost Estimate Breakdowns for Stoung Subproject

Appendix C: Water Quality Test Results for Stoung Subproject

All samples taken at downstream end of WTP

e-coli tests:

Date of test	Permissible level	Result
27/3/13	10	0
28/9/12	10	0
5/7/12	10	0
22/4/09	10	0
20/2/06	10	0
22/12/04	10	0
11/8/03	10	0

Date	NO_3 (mg/l)	As (μg/l)	NO_2 (mg/l)	NH_3	Turb-idity NTU	Res Cl (mg/l)	pH	Color TCU	Iron (mg/l)	TDS (mg/l)
LIMIT	**<50**	**<50**	**<3**	**<0.5**	**<5**	**<250**	**6.5-8.5**	**<5**	**<0.3**	**800**
29/3/13	7.04	0	0.01	0.01		17.04				
1/10/12	4.84		3	0.19		435.94				
3/7/12	8.8		5	0.13		252.05				
4/4/12	6.6		0.9	0.09		284				
2/2/12		3			4	24.85	7.59		0.08	185
20/2/06	0.76		0.12	0	0	43	8.7		0	
11/6/04						19.88	4.7		0.14	20
14/8/03	0.84		0	0	0		7.8		0	

Appendix D: 9 Subproject Towns Financial and Economic Analysis

Appendix E: deleted

Appendix F: Outline Operation & Maintenance Plan

Operational Procedures

WTP area	Procedure
Raw water pumps	Can be controlled (on/off) by level transducers in the main clear water tank, or manually by Operator.
Flocculation tank inlet weir	Set so that there is always a hydraulic break between water in the inlet channel and the first flocc channel.
Flocculation tank baffles	Baffle slot sizes on lower end of alternate baffles, which are calculated and specified during final design, should be adhered to. When baffles are moved during cleaning of the flocc tank, these slot sizes should be reset to the design dimensions. Failure to do this may result in incorrect velocity gradient across the flocc tank resulting in poor flocc formation.
Sed tank collection launders	The stainless steel collection launders should be set at a level that allows for the prescribed headloss across the flocc tank. If the launders are set too high it has the effect of "backing up" the flocc tank and reducing the hydraulic gradient across it. This is normally set during design by calculating the hydraulics across the full WTP, but is sometimes neglected.
Filters – bypass of water	For filters to operate properly, the plenum floor that holds up the gravel and sand layers needs to be sealed. No water should pass between the plenum floor and the vertical filter walls, or through the plenum floor except through the inserted filter nozzles. Additionally, water should not be allowed to take a "short cut" between the edge of the sand layer and the filter wall. This can be stopped by roughening the inside filter wall with a sand/cement mix.
Filters – backwashing	Filters should be backwashed when the sand becomes sufficiently blocked with debris and silt to slow the passage of water through the media. This can be judged by marking a dirty water level inside the filter, and when it is reached, a backwash is due. Similarly a low water level mark should be visible and this minimum water level in the filter kept by partially closing the clean water outlet valve to the clear water tank. The backwash cycle begins with air scour by itself to loosen the sand media and help release dirt. This should carry on for around 3-5 minutes. The air blower is then turned off and backwash valve opened partially at first and then gradually opened further, in order to maintain the design backwash flowrate as the head in the backwash tank decreases. The backwash valve should never be just opened fully for the backwash cycle.
Reticulation	
Washout valves	All washout valves on the system, installed at low points, should be opened every month to flush out the line as required.
Valves on the distribution system	Valves should be kept either fully open or fully closed.

Maintenance Schedule

Raw water pumps	New submersible pumps should be raised using the auto-coupling & guiderails once per year to inspect the pumps and perform routine maintenance.
Flocculation tank	The flocc tank should be taken offline, one chamber at a time (there are 2 chambers), and cleaned out using shovels and a water blaster. Any repairs to baffles or replacement of rotten wooden baffles can take place at this time.
Sedimentation tank	The sedimentation tank should be taken offline, one at a time, and cleaned out annually.
Slide gates on all tanks	These should be inspected regularly and if not opening and closing easily, remedial action taken – either lubrication of threads or replacement of rubber seals.
Filters	Filter media will gradually become more blocked over time despite regular backwashing. Approximately every 5 years the sand and gravel media will need either removing and thoroughly washing before replacement, or new graded & washed sand placed. At this time, the nozzles and underdrains can also be inspected for damage.
Dosing pipelines	Check for leaks regularly and fix. Clean up spills and leaks.
Chemical mixing area	Keep floor clean
Chemical mixing tanks	When alum and poly tanks start to fill to the outlet pipe level with sediment they should be taken offline and cleaned out.
Pumps & blowers – general	Maintenance plan to follow manufacturers manual
Chlorination equipment - general	Maintenance plan to follow manufacturers manual
Reticulation	
Gate valves	All gate valves on the pipelines should be kept either fully shut or fully open as required.
Washout valves	Any washout valves, normally installed at low points, should be periodically (6 monthly) opened to flush out any debris.
Chambers	All valve chambers should be kept dry, clean and accessible.
Domestic connections	Any leaks on the upstream side of the meter should be recorded by meter readers and repaired promptly.
Physical leaks	All leaks reported or noticed by WA staff should be repaired promptly.

Appendix G: Environmental Due Dililgence Report

Appendix H: Land Acquisition Due Diligence Report

Appendix I: Design criteria & Proposed WTP Structure Dimensions

Maintenance Schedule

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