

Complete Economic and Financial Analysis

Kingdom of Cambodia
TA 8982-CAM: Provincial Water Supply and
Sanitation Project

Battambang Water Supply Subproject
Kampong Cham Water Supply Subproject
Battambang Wastewater and Sanitation Subproject
Sihanoukville Wastewater and Sanitation Subproject
Kampong Cham Sanitation Subproject
Siem Reap Wastewater Subproject

Table of Contents

A. Introduction	1
B. Methodology and Assumptions.....	1
C. Battambang Water Supply.....	3
1. Economic Evaluation	3
2. Financial Evaluation.....	6
D. Kampong Cham Water Supply	9
1. Economic Evaluation	9
2. Financial Evaluation.....	12
E. Battambang Wastewater and Sanitation.....	14
1. Economic Evaluation	14
2. Financial Evaluation.....	17
F. Sihanoukville Wastewater and Sanitation.....	19
1. Economic Evaluation	19
2. Financial Evaluation.....	22
G. Kampong Cham Sanitation.....	24
1. Economic Evaluation	24
2. Financial Evaluation.....	26
H. Siem Reap Wastewater.....	28
1. Economic Evaluation	28
2. Financial Evaluation.....	30

List of Tables

Table 1: Weighted Average Cost of Non-Piped Water - Battambang.....	4
Table 2: Economic Investment Cost – Battambang Water Supply	4
Table 3: Conversion of O&M Cost Financial Price into Economic Price.....	4
Table 4: EIRR and Sensitivity Analysis – Battambang Water Supply.....	5
Table 5: Distribution Analysis – Battambang Water Supply	5
Table 6: Poverty Impact Ratio – Battambang Water Supply	6
Table 7: Projected Tariffs – Battambang Water Supply	6
Table 8: Past Financial Performance – Battambang PWU.....	7
Table 9: Projected Financial Performance – Battambang PWU	7
Table 10: Weighted Average Cost of Non-Piped Water – Kampong Cham.....	10
Table 11: Economic Investment Cost – Kampong Cham Water Supply.....	10
Table 12: EIRR and Sensitivity Analysis – Kampong Cham Water Supply	10
Table 13: Distribution Analysis – Kampong Cham Water Supply.....	11
Table 14: Poverty Impact Ratio – Kampong Cham Water Supply.....	11
Table 15: Projected Tariffs – Kampong Cham Water Supply	12
Table 16: Past Financial Performance – Kampong Cham PWU	12
Table 17: Projected Financial Performance – Kampong Cham PWU.....	13
Table 18: Economic Investment Cost – Battambang Wastewater and Sanitation	15
Table 19: EIRR and Sensitivity Analysis – Battambang Wastewater and Sanitation.....	15
Table 20: Distribution Analysis – Battambang Wastewater and Sanitation	16
Table 21: Poverty Impact Ratio – Battambang Wastewater and Sanitation	16
Table 22: Projected Fees – Battambang Wastewater and Sanitation	17
Table 23: Past Financial Performance – Battambang PWU.....	17
Table 24: Projected Financial Performance – Battambang PWU.....	17

Table 25: Economic Investment Cost – Sihanoukville Wastewater and Sanitation20
Table 26: EIRR and Sensitivity Analysis – Sihanoukville Wastewater and Sanitation20
Table 27: Distribution Analysis – Sihanoukville Wastewater and Sanitation.....21
Table 28: Poverty Impact Ratio – Sihanoukville Wastewater and Sanitation.....21
Table 29: Projected Fees – Sihanoukville Wastewater and Sanitation.....22
Table 30: Past Financial Performance – Sihanoukville PWU22
Table 31: Projected Financial Performance – Sihanoukville PWU22
Table 32: Economic Investment Cost – Kampong Cham Sanitation25
Table 33: EIRR and Sensitivity Analysis – Kampong Cham Sanitation.....25
Table 34: Distribution Analysis – Kampong Cham Sanitation26
Table 35: Poverty Impact Ratio – Kampong Cham Sanitation26
Table 36: Projected Fees – Kampong Cham Sanitation27
Table 37: Projected Financial Performance – Kampong Cham PWU27
Table 38: Least Cost Analysis – Siem Reap Wastewater29
Table 39: EIRR and Sensitivity Analysis – Siem Reap Wastewater30

ABBREVIATIONS

ADB	Asian Development Bank
AFD	Agence Francaise de Development
BTB-WS	Battambang Water Supply
BTB-WW	Battambang Wastewater and Sanitation
CDIA	Cities Development Initiatives for Asia
DALY	Disability Adjusted Life Year
DPWT	Department of Public Works and Transport
DSCR	Debt Service Coverage Ratio
MEF	Ministry of Economy and Finance
EIRR	Economic Internal Rate of Return
EOCC	Economic Opportunity Cost of Capital
FIRR	Financial Internal Rate of Return
GNI	Gross National Income
HH	Households
km	Kilometer
KPC-WS	Kampong Cham Water Supply
KPC-SAN	Kampong Cham Sanitation
LIG	Low Income Group
lpcd	Liters Per Capita Per Day
m ³	Cubic meters
NPV	Net Present Value
O&M	Operation and Maintenance
PIR	Poverty Impact Ratio
PWW	Provincial Water Works
PWU	Provincial Wastewater Unit
SHV-WW	Sihanoukville Wastewater and Sanitation
SI	Sensitivity Indicator
SV	Switching Value
WACC	Weighted Average Cost of Capital
WHO	World Health Organization
WTP	Water Treatment Plant
WW	Wastewater
WWTP	Wastewater Treatment Plant

A. Introduction

1. Economic and financial analyses were carried out for the following subprojects: (i) Battambang water supply; (ii) Kampong Cham water supply; (iii) Battambang wastewater and sanitation; (iv) Sihanoukville wastewater and sanitation; (v) Kampong Cham sanitation; and (vi) Siem Reap wastewater. The analyses were undertaken in accordance with the ADB's *Framework for the Economic and Financial Appraisal of Urban Development Sector Projects*, *Guidelines for the Economic Analysis of Projects*, *Guidelines for the Economic Analysis of Water Supply Projects*, *Guidelines for the Financial Management and Analysis of Projects*, and the publication, *Financial Due Diligence, A Methodology Note*.¹

2. The objectives of the analyses were to: (i) determine the economic viability and financial sustainability of the subprojects; (ii) formulate appropriate tariffs that would achieve the financial objectives of the sector; (ii) ensure that tariffs formulated are affordable to domestic users, particularly those in the low-income group; and (iii) forecast the financial performance of the subprojects for ten years to determine their financial sustainability.

B. Methodology and Assumptions

3. The evaluation was conducted through a comparison of the without-project and with-project scenarios. The assumptions used in the evaluation were as follows:

- i. Economic and financial analyses and the calculation of the economic internal rate of return (EIRR) and financial internal rate of return (FIRR) were undertaken at constant 2017 prices; the domestic price numeraire was adopted in the analysis.
- ii. An exchange rate of KR4,000 per US\$1.00 was used.
- iii. The investment and O&M costs were based on reviewed estimates from the Cities Development Initiatives for Asia (CDIA) technical assistance study (TA-8556 REG: Pre-feasibility Studies and Preliminary Engineering – Provincial Water Supply and Sanitation Project).
- iv. In the economic analysis, the financial values were converted to their economic values using the appropriate conversion factors: tradable goods were converted using the shadow exchange rate factor (SERF) of 1.10; for non-tradable goods, a conversion factor of 1.00 was used; a shadow wage rate factor of 0.75 for rural unskilled labor was applied.² Transfer payments such as taxes, duties and subsidies were excluded in the economic analysis. Based on the distribution of costs as to traded and non-traded components, the overall conversion factor for capital costs and O&M costs is 0.93.
- v. Economic life of each subproject is assumed for 25 years; the subprojects' vehicle and equipment are assumed to be replaced every tenth year.

¹ ADB. 1994. *Framework for the Economic and Financial Appraisal of Urban Development Sector Projects*. Manila; ADB. 1997. *Guidelines for the Economic Analysis of Projects*. Manila; ADB. 1998. *Guidelines for the Economic Analysis of Water Supply Projects*. Manila; ADB. 2005. *Financial Management and Analysis of Projects*. Manila; ADB. 2009. *Financial Due Diligence A Methodology Note*. Manila.

² The economic conversion factors are identical to those used in the recent ADB-financed Cambodia project. ADB. 2014. *Report and Recommendation of the President to the Board, Proposed Loan, Kingdom of Cambodia, Urban Water Supply Project*. Manila

- vi. The economic opportunity cost of capital (EOCC) is assumed at 9%.
 - vii. The projected financial statements consisting of the income statement, cash flow statement and the balance sheet are stated at current prices; price escalation factor of 1.4% for 2017, 1.5% for 2018 and thereafter for foreign currency costs and 3.4% for 2017, 3.5% for 2018 and thereafter for local currency costs.
4. **Subprojects' financing plan.** The government will on-grant the ADB and AFD loan proceeds for output 1 (water supply) and output 2 (wastewater and sanitation) and government counterpart contribution to the implementing agencies.
5. **Connection policy.** Sewerage connections will be provided free of charge in order to ensure that all household (HHs) use the facilities. With regards to water supply, the project recommends that MIH and its provincial agents adapt and apply a policy similar to that of the Phnom Penh Water Supply Authority. Provincial agencies can use the P1 and P2 card system for initial identification of poor HHs to be considered for subsidy, and then use a "Subsidy Score Card" that has been adapted for provincial conditions, to determine the amount of subsidy for each applying HH. Where a HH claims to be poor but does not have a P1 or P2 card, the HH must obtain a letter from its Commune Council confirming its poor status, and submit this to the water supply agency for consideration. The agency will then use the score card system to determine what level of subsidy should be applied, if any. Where HHs are poor, but not deemed poor enough to be awarded a subsidy, that HH can apply to pay in installments. The repayment period would be determined by the agency's interviewing officer.
6. **Financial objectives.** The financial analysis was undertaken based on the following financial objectives of the water and sanitation sector:
- i. Water supply: a tariff road map for water will be implemented by 2020 with regular tariff reviews (e.g. every five years) to ensure sustainability of the water utility's operations. A socialized tariff scheme will be implemented to ensure affordability by LIHs (4% of monthly income). A 4-band tariff structure will likely be adopted similar to PPWSA and SRWSA's.
 - ii. Wastewater and sanitation: a regular tariff review (e.g. every five years) to ensure that at least O&M costs will be fully covered. A socialized tariff scheme will be implemented to ensure affordability by LIHs (1% of monthly income). MPWT will establish a semi-autonomous agency in Battambang and Kampong Cham to ring-fence fees. MPWT will ensure that should sanitation revenues be short to fully cover O&M costs, the shortfall will be covered under the DPWT annual budget. Licensing of private vacuum truck operators and regulations on septic tank cleaning and proper disposal of sludge shall be place by 2018 and enforced.

C. Battambang Water Supply

1. Economic Evaluation

7. **Without and with project situations.** The total combined capacity of the two existing water treatment plants is 33,520 m³/day. The existing distribution network is 374 km long with a coverage area of 5,603 ha. Present number of service connections is 14,249 with a served population of about 31%.

8. The subproject will provide the following facilities: (i) water treatment plant (WTP) with a capacity of 50,000 m³/day and 4 booster pumps; (ii) raw water intake with 4 pumps and a raw water pipeline of 6.6 km.; (iii) distribution pipeline of 120 km; and (iv) office, pump station and chemical building. The subproject is estimated to increase access to safe piped water within the subproject service area to about 98% by 2022.

9. Below are the parameters used in quantifying the economic benefits.

Item	2016	2021	2025	2030	2040
Average HH size (persons)	6	6	6	6	6
2017 Constant Price of Water (KR/m ³)					
Piped water		1,360	1,360	1,360	1,360
Non-piped water		11,688	11,688	11,688	11,688
Average HH usage (lcd)					
Piped water	108	127	140	140	140
Non-piped water	60	60	60	60	60
Without Project					
Water sold ('000 m ³)	4,528	6,876	8,835	10,400	10,400
Number of connections	14,249	18,029	21,053	24,337	24,337
With Project					
Water sold ('000 m ³)	4,528	7,652	12,713	18,156	25,912
Number of connections	14,249	20,097	30,464	42,827	61,317
Increments due to Project					
Water sold ('000 m ³)	0	776	3,878	7,756	15,513
Resource cost savings	0	258	1,175	2,308	4,616
Consumer surplus	0	518	2,703	5,448	10,896
Number of connections	0	2,068	9,411	18,490	36,980

Source: Consultant's calculation

10. **Economic benefits.** The quantifiable benefits of the subproject were measured based on the following:

- i. Resource cost savings associated with the replacement of non-incremental water consumed previously obtained from non-piped alternative water sources with those from the new piped water supply system. This is valued in terms of the weighted average supply price from existing non-piped water sources;
- ii. Consumer surplus, reflected in the incremental water consumed and billed, measured in terms of the difference between with and without project per capita consumption.³ This is valued at the average demand price of water (the average of the weighted average supply price from existing non-piped water sources and the average tariff)⁴.

11. Currently the residents in the subproject town use a variety of alternative water sources. Residents without piped water spend at least an hour a day to collect water from a variety of

³ Per capita consumption without project is assumed at 60 lpcd and with project at 140 lpcd.

⁴ ADB Handbook for the Economic Analysis of Water Supply Projects, page 146.

water sources (river, wells, etc.).⁵ Costs associated with the existing alternative water supply include source/treatment costs, collecting costs, and storage costs. Shown below is the calculation of the weighted average cost of non-piped water.

Table 1: Weighted Average Cost of Non-Piped Water - Battambang

Item	Proportion (%)	Financial Price KR/m ³	Traded	Non-traded		Economic Price KR/m ³
				Unskilled Labor	Others	
Conversion Factor			1.10	0.75	1.00	
Water Source						
Water vendor	22%	15,000	5%	90%	5%	11,700
River/stream	12%	26,250	1%	99%	0%	19,779
Rainwater	4%	406	20%	20%	60%	394
Dug well	40%	7,781	5%	95%	0%	5,972
Drilled well	22%	12,654	20%	20%	60%	12,274
Boiling		468	20%	20%	60%	454
Storage		1,218	20%	20%	60%	1,182
Total / Weighted Average	100%					11,688

Source: Socio-economic survey results, field visits and consultant's estimates

12. Health benefits, likely to occur provided that the adverse health impacts of an increased volume of wastewater can be minimized, have not been quantified to avoid double counting of benefits with the wastewater and sanitation subproject.

13. **Economic costs.** The financial price of the investment cost, net of taxes and duties and price contingencies, when converted to economic price is estimated at KR 131,334 million. The calculation is shown below.

Table 2: Economic Investment Cost – Battambang Water Supply

Item	Component Breakdown	Financial Price ^{1/}	Conversion Factor	Economic Price
Traded	40%	52,534	1.10	57,787
Non-traded	60%	78,801		
Unskilled Labor		15,760	0.75	11,820
Others		63,041	1.00	63,041
Total (KR million)		131,334		132,648

1/ In KR million; excludes taxes and duties and price contingencies

Source: Consultant's calculation

14. The conversion factor of the O&M cost financial price into economic price is 0.93. The calculation is shown below.

Table 3: Conversion of O&M Cost Financial Price into Economic Price

Item	Component Breakdown	Financial Price ^{1/}	Conversion Factor	Economic Price
Traded	30%	0.27	1.10	0.30
Non-traded				
Unskilled Labor	5%	0.05	0.75	0.03
Others	65%	0.59	1.00	0.59
Total	100%	0.91		0.93

1/ Excludes taxes and price contingencies

Source: Consultant's calculation

15. **Results of economic evaluation.** The results of the economic and sensitivity analysis are summarized in the table below. The subproject is economically viable in the base case scenario and robust against downside risks. The subproject economic performance is most

⁵ Cost of collection was valued based on the unskilled labor average daily wage rate of KR21,000.

sensitive to benefits delay and reduction, but the performance remains above the required threshold levels (KR 0 for NPV, 9% for EIRR).

Table 4: EIRR and Sensitivity Analysis – Battambang Water Supply

Year	Water Sold ('000 m ³)	Benefits	In KR million Capital Cost	O&M Cost	Net Inflow (Outflow)
2017	0	0	0	0	0
2018	0	0	53,059	0	(53,059)
2019	0	0	53,059	0	(53,059)
2020	0	0	26,530	0	(26,530)
2021	776	6,393	0	900	5,493
2022	1,551	12,707	0	1,792	10,915
2023	2,327	18,949	0	2,679	16,270
2024	3,103	25,125	0	3,559	21,566
2025	3,878	31,367	0	4,445	26,922
2026	4,654	37,598	0	5,331	32,267
2027	5,429	43,818	0	6,215	37,602
2028	6,205	50,029	0	7,099	42,930
2029	6,981	56,231	0	7,982	48,249
2030	7,756	62,520	0	8,872	53,648
2031	8,532	68,772	6,632	9,759	52,380
2032	9,308	75,024	0	10,647	64,377
2033	10,083	81,276	0	11,534	69,742
2034	10,859	87,528	0	12,421	75,107
2035	11,634	93,780	0	13,308	80,472
2036	12,410	100,032	0	14,196	85,836
2037	13,186	106,284	0	15,083	91,201
2038	13,961	112,536	0	15,970	96,566
2039	14,737	118,788	0	16,857	101,931
2040	15,513	125,040	0	17,745	107,295
2041	15,513	125,040	6,632	17,745	100,663
2042	15,513	125,040	0	17,745	107,295
2043	15,513	125,040	0	17,745	107,295
2044	15,513	125,040	0	17,745	107,295
2045	15,513	125,040	0	17,745	107,295

Scenario	Change	NPV ^{1/} (KR million)	EIRR (%)	SI ^{2/}	SV ^{3/}
Base Case		215,653	18.91%		
Increase in Capital Costs	+ 10%	204,952	17.91%	1.01	99%
Increase in O&M Costs	+ 10%	210,320	18.73%	0.18	561%
Decrease in Benefits	- 10%	178,053	17.62%	1.30	77%
Benefits Delay	1 year	175,183	16.88%	NPV lower by	19%

1/ NPV = Net Present Value discounted at EOCC of 9%

2/ SI = Sensitivity Indicator (ratio of % change in EIRR above the cut-off rate of 9% to % change in a variable)

3/ SV = Switching Value (% change in a variable to reduce the EIRR to the cut-off rate of 9%)

Source: Consultant's calculation

16. **Distribution and poverty impact analysis.** The costs and benefits of the subproject are shared among different groups. Based on the results from the financial and economic analysis, an assessment of the distribution of subproject benefits and costs were undertaken to show which participant will gain from the subproject or incur a loss. We evaluated which portion of the net gains of the project will ultimately benefit the poor. The distribution analysis and the calculation of the poverty impact ratio (PIR) are shown below.

Table 5: Distribution Analysis – Battambang Water Supply

Item	Financial Present Value / ¹	Economic Present Value / ¹	Economic minus Financial	PWW	Gov't. / Economy	Labor	Consumers
Benefits	42,276	280,278	238,001				238,001
Costs							
Traded	11,772	55,029	43,257		(43,257)		
Unskilled labor	1,962	15,057	13,095			(13,095)	
Non-traded	25,507	76,561	51,055		(51,055)		
Total Costs	39,241	146,648					
Net Benefits	3,035	133,630	130,595	3,035			

Benefits (Losses)				3,035	(94,312)	(13,095)	238,001
-------------------	--	--	--	-------	----------	----------	---------

1/ In KR million, discounted at 12%
Source: Consultant's calculation

Table 6: Poverty Impact Ratio – Battambang Water Supply

Particulars	Gov't. / Economy / ¹	Labor / ¹	Consumers / ¹	Total
Benefits (Losses)	(94,312)	(13,095)	238,001	130,595
Financial Return to PWW	3,035			3,035
Total Benefits (Losses)	(91,277)	(13,095)	238,001	133,630
Proportion of Poor (%)	13.5%	30.0%	25.0%	
Benefits to Poor	(12,322)	(3,928)	59,500	43,250
Poverty Impact Ratio (%) = 32.37%				

1/ In KR million, discounted at 12%
Source: Consultant's calculation

17. About 13.5% of population in Cambodia lives below the national poverty line.⁶ The proportion of poor among the labor force is estimated to be 30% while 25% of consumers are estimated to be poor. Poverty rate according to the 2015 updated commune database is 23.16%. With a subproject PIR of 32.37%, it can be concluded that the implementation of the proposed subproject will have a positive poverty reducing impact in the town.

18. **Project sustainability.** The subproject's sustainability is highly dependent on the implementation of the tariff and fee adjustments regularly and connection rate of prospective customers. Implementing an easy installment or subsidy scheme for water connections similar to that of the Phnom Penh Water Supply Authority will definitely ensure a high connection rate. The PWW must set aside an adequate maintenance fund out of the fees collected and ring-fence it for the subproject facilities. The depreciation charges component recovered from the fees collected must be used specifically for the replacement of depreciated equipment.

2. Financial Evaluation

19. **Investment cost and financing plan.** The subproject is estimated to cost KR 162,634 million, inclusive of taxes and duties, physical and price contingencies. The government will on-grant the subproject cost to the implementing agency.

20. **Tariff and affordability.** To meet the financial objectives of the sector (para 6), a 4-band tariff structure will likely be adopted similar to PPWSA and SRWSA's as presented below.

Table 7: Projected Tariffs – Battambang Water Supply

Customer	Current		Year 2020		Year 2025		Year 2030	
	Monthly m ³	KR/m ³	Monthly m ³	KR/m ³	Monthly m ³	KR/m ³	Monthly m ³	KR/m ³
Domestic	>0	1,500	0-7	1,500	0-7	1,650	0-7	1,815
			8-15	1,650	8-15	1,815	8-15	1,997
			16-50	1,800	16-50	1,980	16-50	2,178
			50+	2,000	50+	2,200	50+	2,420
Non-domestic	>0	1,500	0-100	1,750	0-100	1,925	0-100	2,118
			101-200	1,850	101-200	2,035	101-200	2,239
			201-500	1,950	201-500	2,145	201-500	2,360
			500+	2,100	500+	2,310	500+	2,541
Overall Average		1,500		1,718		1,891		2,083

Source: PWW and PPTA consultant's estimates

21. An affordability analysis was undertaken to ensure that domestic consumers, particularly those in the LIG, can afford the tariff levels that meet the financial objectives of the sector. The results of the analysis show that tariffs for the domestic customers, including the LIG, are considered affordable. The combined monthly water and sanitation charges are below the affordability threshold of 5% of average monthly household income.

⁶ ADB. 2016. Basic Statistics. Manila

22. **Past and projected financial performance.** The provincial water works (PWW) incurred losses in year 2013 and earned income in 2014 and 2015. Shown below is the past financial performance of the PWW for years 2013-2015.

Table 8: Past Financial Performance – Battambang PWW

KR million	2013	2014	2015
Revenue	4,249	4,990	6,078
O&M	3,570	3,560	3,893
Income before Depreciation	679	1,430	2,185
Depreciation	914	1,002	1,079
Net Income (Loss)	(236)	428	1,106

Source: Provincial Water Works

23. The projected financial performance of the PWW consisting of the income statement, sources and uses of funds statement and balance sheet for the period 2018 to 2027 are summarized and presented below together with the key performance indicators. The financial projections, which include the subproject, indicate that the PWW is estimated to earn positive net income each year over the forecast period. The PWW is also projected to generate positive net cash flow each year over the forecast period. As a result, the PWW will be able to fund all O&M expenses, major asset maintenance and generate an increasing cash surplus.

Table 9: Projected Financial Performance – Battambang PWW

In KR million	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
Income Statement										
Total Revenues	8,163	8,857	10,968	13,150	15,359	17,598	19,866	24,036	26,221	28,407
Expenses										
O&M	5,852	6,423	7,031	8,774	10,623	12,583	14,657	16,735	18,921	21,217
Depreciation	1,047	1,047	1,047	4,300	4,300	4,300	4,300	4,300	4,300	4,300
Finance & Other Charges	16	17	21	24	27	30	33	39	43	46
Total Expenses	6,915	7,487	8,099	13,098	14,951	16,913	18,990	21,074	23,263	25,563
Profit before Tax	1,248	1,370	2,869	52	409	684	875	2,962	2,958	2,844
Tax	250	274	574	10	82	137	175	592	592	569
Net Profit	998	1,096	2,295	41	327	547	700	2,370	2,366	2,275
Water Sold ('000 m ³)	5,442	5,905	6,382	7,652	8,938	10,242	11,565	12,713	13,861	15,009
Operating Ratio %	85%	84%	74%	99%	97%	96%	95%	88%	89%	90%
Increases in Tariffs %	0%	0%	14.6%	0.0%	0.0%	0.0%	0.0%	10.0%	0.0%	0.0%
Return on Assets %	9%	11%	2%	0%	0%	0%	1%	2%	2%	2%
% of Depreciation Recovered	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Sources & Uses of Funds										
Sources										
Internal Sources	2,295	2,417	3,916	4,351	4,708	4,984	5,175	7,262	7,258	7,144
External Sources	61,362	65,368	35,905	0	0	0	0	0	0	0
Total Sources	63,657	67,785	39,820	4,351	4,708	4,984	5,175	7,262	7,258	7,144
Uses										
Capital Expenditure	61,362	65,368	35,905	0	0	0	0	0	0	0
Debt Service	0	0	0	0	0	0	0	0	0	0
Other Uses	1,823	1,847	3,279	3,212	3,275	3,323	3,353	4,914	4,808	4,287
Total Uses	63,185	67,215	39,183	3,212	3,275	3,323	3,353	4,914	4,808	4,287
Cash Balance	3,227	3,797	4,434	5,573	7,006	8,668	10,490	12,838	15,288	18,144
Debt Service Ratio (times)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Balance Sheet										
Net Fixed Assets	74,722	139,043	173,900	169,601	165,301	161,001	156,701	152,401	148,102	143,802
Total Assets	81,899	148,416	186,671	186,772	187,161	187,773	188,542	190,983	193,425	195,780
Total Liabilities	1,072	1,125	1,182	1,241	1,303	1,368	1,436	1,508	1,583	1,663
Total Equity	80,827	147,290	185,490	185,531	185,858	186,405	187,106	189,475	191,842	194,117
Total Liabilities & Equity	81,899	148,416	186,671	186,772	187,161	187,773	188,542	190,983	193,425	195,780
% Debt on Debt plus Equity	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
# Days Accounts Receivable	37	36	35	34	33	32	31	30	30	30

Source: Consultant's calculation

24. **Financial sustainability.** The financial projections (income statement, cash flow statement and balance sheet) of the subproject for the period 2018-2027 show that the subproject is financially sustainable. Net cash inflows accumulated during the period are adequate to finance the replacement of equipment every tenth year.

25. The subproject's sustainability is highly dependent on the implementation of the tariff and fee adjustments regularly and connection rate of prospective customers. Implementing an easy installment or subsidy scheme for water connections similar to that of the Phnom Penh Water Supply Authority will definitely ensure a high connection rate. The PWW must set aside an adequate maintenance fund out of the fees collected and ring-fence it for the subproject facilities. The depreciation charges component recovered from the fees collected must be used specifically for the replacement of depreciated equipment.

D. Kampong Cham Water Supply

1. Economic Evaluation

26. **Without and with project situations.** The total combined capacity of the two existing water treatment plants is 19,500 m³/day. The existing distribution network is 166.5 km long with a coverage area of 4,311 ha. Present number of service connections is 7,371 with a served population of about 37%.

27. The subproject will provide the following facilities: (i) water treatment plant (WTP) with a capacity of 11,600 m³/day and 3 booster pumps; (ii) raw water intake with 3 pumps and a raw water pipeline of 4 km.; (iii) distribution pipeline of 80 km. with 3 booster pumps along the network; and (iv) service and workshop building. The subproject is estimated to increase access to safe piped water within the subproject service area to about 97% by 2022.

28. Below are the parameters used in quantifying the economic benefits.

Items	2016	2021	2025	2030	2040
Average HH size (persons)	5	5	5	5	5
2017 Constant Price of Water (KR/m ³)					
Piped water		1,147	1,147	1,147	1,147
Non-piped water		12,276	12,276	12,276	12,276
Average HH usage (lcd)					
Piped water	93	123	145	145	145
Non-piped water	60	60	60	60	60
Without Project					
Water sold ('000 m ³)	2,626	4,548	6,285	6,285	6,285
Number of connections	7,371	13,821	17,831	17,831	17,831
With Project					
Water sold ('000 m ³)	2,626	4,728	7,184	8,084	9,884
Number of connections	7,371	14,392	20,506	23,181	28,531
Increments due to Project					
Water sold ('000 m ³)	0	180	900	1,799	3,599
Resource cost savings	0	56	264	528	1,056
Consumer surplus	0	124	636	1,271	2,543
Number of connections	0	571	2,675	5,350	10,700

Source: Consultant's calculation

29. **Economic benefits.** The quantifiable benefits of the subproject were measured based on the following:

- i. Resource cost savings associated with the replacement of non-incremental water consumed previously obtained from non-piped alternative water sources with those from the new piped water supply system. This is valued in terms of the weighted average supply price from existing non-piped water sources;
- ii. Consumer surplus, reflected in the incremental water consumed, measured in terms of the difference between with and without project per capita consumption.⁷ This is valued at the average demand price of water (the average of the weighted average supply price from existing non-piped water sources and the average tariff)⁸.

30. Currently the residents in the subproject town use a variety of alternative water sources. Residents without piped water spend at least an hour a day to collect water from a variety of

⁷ Per capita consumption without project is assumed at 60 lpcd and with project at 145 lpcd.

⁸ ADB Handbook for the Economic Analysis of Water Supply Projects, page 146.

water sources (river, wells, etc.).⁹ Costs associated with the existing alternative water supply include source/treatment costs, collecting costs, and storage costs. Shown below is the calculation of the weighted average cost of non-piped water.

Table 10: Weighted Average Cost of Non-Piped Water – Kampong Cham

Item	Proportion (%)	Financial Price KR/m ³	Traded	Non-traded		Economic Price KR/m ³
				Unskilled Labor	Others	
Conversion Factor			1.10	0.75	1.00	
Water Source						
Water vendor	0%	0	5%	90%	5%	0
River/stream	0%	0	1%	99%	0%	0
Rainwater	3%	514	20%	20%	60%	498
Dug well	39%	8,103	5%	95%	0%	6,219
Drilled well	58%	13,805	20%	20%	60%	13,391
Boiling		592	20%	20%	60%	574
Storage		1,541	20%	20%	60%	1,495
Total / Weighted Average	100%					12,276

Source: Socio-economic survey results, field visits and consultant's estimates

31. Health benefits, likely to occur provided that the adverse health impacts of an increased volume of wastewater can be minimized, have not been quantified to avoid double counting of benefits with the wastewater and sanitation subproject.

32. **Economic costs.** The financial price of the investment cost, net of taxes and duties and price contingencies, when converted to economic price is estimated at KR 47,052 million. The calculation is shown below.

Table 11: Economic Investment Cost – Kampong Cham Water Supply

Item	Component Breakdown	Financial Price ^{1/}	Conversion Factor	Economic Price
Traded	40%	18,821	1.10	20,703
Non-traded	60%	28,231		
Unskilled Labor		5,646	0.75	4,235
Others		22,585	1.00	22,585
Total (KR million)		47,052		47,522

1/ In KR million; excludes taxes and duties and price contingencies

Source: Consultant's calculation

33. The conversion factor of the O&M cost financial price into economic price is 0.93. Please refer to para 13 for the details of the calculation.

34. **Results of economic evaluation.** The results of the economic and sensitivity analysis are summarized in the table below. The subproject is economically viable in the base case scenario and robust against downside risks. The subproject economic performance is most sensitive to benefits delay and reduction, but the performance remains above the required threshold levels (KR 0 for NPV, 9% for EIRR).

Table 12: EIRR and Sensitivity Analysis – Kampong Cham Water Supply

Year	Water		In KR million			Net Inflow (Outflow)
	Sold ('000 m3)	Benefits	Capital Cost	O&M Cost		
2017	0	0	0	0	0	0
2018	0	0	19,009	0	0	(19,009)
2019	0	0	19,009	0	0	(19,009)
2020	0	0	9,504	0	0	(9,504)
2021	180	1,521	0	192		1,330
2022	360	3,034	0	383		2,650
2023	540	4,534	0	575		3,959

⁹ Cost of collection was valued based on the unskilled labor average daily wage rate of KR21,000.

2024	720	6,019	0	765	5,254
2025	900	7,508	0	956	6,552
2026	1,080	9,009	0	1,147	7,862
2027	1,260	10,511	0	1,338	9,172
2028	1,440	12,012	0	1,530	10,483
2029	1,620	13,514	0	1,721	11,793
2030	1,799	15,015	0	1,912	13,103
2031	1,979	16,517	2,376	2,103	12,037
2032	2,159	18,018	0	2,295	15,724
2033	2,339	19,520	0	2,486	17,034
2034	2,519	21,021	0	2,677	18,344
2035	2,699	22,523	0	2,868	19,655
2036	2,879	24,024	0	3,059	20,965
2037	3,059	25,526	0	3,251	22,275
2038	3,239	27,027	0	3,442	23,586
2039	3,419	28,529	0	3,633	24,896
2040	3,599	30,031	0	3,824	26,206
2041	3,599	30,031	2,376	3,824	23,830
2042	3,599	30,031	0	3,824	26,206
2043	3,599	30,031	0	3,824	26,206
2044	3,599	30,031	0	3,824	26,206
2045	3,599	30,031	0	3,824	26,206

Scenario	Change	NPV ^{1/} (KR million)	EIRR (%)	SI ^{2/}	SV ^{3/}
Base Case		40,417	15.08%		
Increase in Capital Costs	+ 10%	36,584	14.20%	1.44	69%
Increase in O&M Costs	+ 10%	39,269	14.94%	0.23	444%
Decrease in Benefits	- 10%	31,393	13.96%	1.84	54%
Benefits Delay	1 year	30,703	13.56%	NPV lower by	24%

1/ NPV = Net Present Value discounted at EOCC of 9%

2/ SI = Sensitivity Indicator (ratio of % change in EIRR above the cut-off rate of 9% to % change in a variable)

3/ SV = Switching Value (% change in a variable to reduce the EIRR to the cut-off rate of 9%)

Source: Consultant's calculation

35. **Distribution and poverty impact analysis.** The costs and benefits of the subproject are shared among different groups. Based on the results from the financial and economic analysis, an assessment of the distribution of subproject benefits and costs were undertaken to show which participant will gain from the subproject or incur a loss. We evaluated which portion of the net gains of the project will ultimately benefit the poor. The distribution analysis and the calculation of the poverty impact ratio (PIR) are shown below.

Table 13: Distribution Analysis – Kampong Cham Water Supply

Item	Financial Present Value / ¹	Economic Present Value / ¹	Economic minus Financial	PWW	Gov't. / Economy	Labor	Consumers
Benefits	8,109	67,222	59,113				59,113
Costs							
Traded	2,535	18,158	15,623		(15,623)		
Unskilled labor	422	5,135	4,712			(4,712)	
Non-traded	5,492	24,057	18,564		(18,564)		
Total Costs	8,450	47,350					
Net Benefits	(341)	19,873	20,213	(341)			
Benefits (Losses)				(341)	(34,188)	(4,712)	59,113

1/ In KR million, discounted at 12%

Source: Consultant's calculation

Table 14: Poverty Impact Ratio – Kampong Cham Water Supply

Particulars	Gov't. / Economy / ¹	Labor / ¹	Consumers / ¹	Total
Benefits (Losses)	(34,188)	(4,712)	59,113	20,213
Financial Return to PWW	(341)			(341)
Total Benefits (Losses)	(34,528)	(4,712)	59,113	19,873
Proportion of Poor (%)	13.5%	30.0%	20.0%	
Benefits to Poor	(4,661)	(1,414)	11,823	5,748
Poverty Impact Ratio (%) = 28.92%				

1/ In KR million, discounted at 12%

Source: Consultant's calculation

36. About 13.5% of population in Cambodia lives below the national poverty line.¹⁰ The proportion of poor among the labor force is estimated to be 30% while 20% of consumers are estimated to be poor. Poverty rate according to the 2015 updated commune database is 17.32%. With a subproject PIR of 28.92%, it can be concluded that the implementation of the proposed subproject will have a positive poverty reducing impact in the town.

37. **Project sustainability.** The subproject's sustainability is highly dependent on the implementation of the tariff and fee adjustments regularly and connection rate of prospective customers. Implementing an easy installment or subsidy scheme for water connections similar to that of the Phnom Penh Water Supply Authority will definitely ensure a high connection rate. The PWW must set aside an adequate maintenance fund out of the fees collected and ring-fence it for the subproject facilities. The depreciation charges component recovered from the fees collected must be used specifically for the replacement of depreciated equipment.

2. Financial Evaluation

38. **Investment cost and financing plan.** The subproject is estimated to cost KR 58,265 million, inclusive of taxes and duties, physical and price contingencies. The government will on-grant the subproject cost to the implementing agency.

39. **Tariff and affordability.** To meet the financial objectives of the sector (para 6), a 4-band tariff structure will likely be adopted similar to PPWSA and SRWSA's as presented below.

Table 15: Projected Tariffs – Kampong Cham Water Supply

Customer	Current		Year 2020		Year 2025		Year 2030	
	Monthly m ³	KR/m ³	Monthly m ³	KR/m ³	Monthly m ³	KR/m ³	Monthly m ³	KR/m ³
Domestic ^{1/}	0-6	900	0-7	1,000	0-7	1,100	0-7	1,210
	>6-15	1,250	8-15	1,350	8-15	1,485	8-15	1,634
	15+	1,600	16-50	1,450	16-50	1,595	16-50	1,755
			50+	1,650	50+	1,815	50+	1,997
Non-domestic ^{2/}	>0	1,600	0-100	1,500	0-100	1,650	0-100	1,815
			101-200	1,700	101-200	1,870	101-200	2,057
			201-500	1,850	201-500	2,035	201-500	2,239
			500+	1,950	500+	2,145	500+	2,360
Overall Average		1,297		1,452		1,564		1,721

1/ Under current tariff, domestic refers to domestic and commercial since they have the same tariffs; in 2020, 2025 and 2030, domestic refers to residential customers only

2/ Under current tariff, non-domestic refers to government; in 2020, 2025 and 2030, non-domestic refers to commercial and government
Source: PWW and PPTA consultant's estimates

40. An affordability analysis was undertaken to ensure that domestic consumers, particularly those in the LIG, can afford the tariff levels that meet the financial objectives of the sector. The results of the analysis show that tariffs for the domestic customers, including the LIG, are considered affordable. The combined monthly water and sanitation charges are below the affordability threshold of 5% of average monthly household income.

41. **Past and projected financial performance.** The provincial water works (PWW) incurred losses in year 2013 and earned income in 2014 and 2015. Shown below is the past financial performance of the PWW for years 2013-2015.

Table 16: Past Financial Performance – Kampong Cham PWW

KR million	2013	2014	2015
Revenue	2,117	2,370	2,540
O&M	1,819	1,795	1,932
Income before Depreciation	298	576	608

¹⁰ ADB. 2016. Basic Statistics. Manila

Depreciation	481	398	416
Net Income (Loss)	(183)	178	191

Source: Provincial Water Works

42. The projected financial performance of the PWW consisting of the income statement, sources and uses of funds statement and balance sheet for the period 2018 to 2027 are summarized and presented below together with the key performance indicators. The financial projections, which include the subproject, indicate that the PWW is estimated to earn positive net income each year over the forecast period. The PWW is also projected to generate positive net cash flow each year over the forecast period. As a result, the PWW will be able to fund all O&M expenses, major asset maintenance and generate an increasing cash surplus.

Table 17: Projected Financial Performance – Kampong Cham PWW

In KR million	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
Income Statement										
Total Revenues	4,197	4,711	5,927	6,822	7,757	8,736	9,764	11,238	11,519	11,801
Expenses										
O&M	2,632	2,990	3,380	4,037	4,747	5,511	6,335	6,872	7,360	7,870
Depreciation	555	555	555	1,720	1,720	1,720	1,720	1,720	1,720	1,720
Finance & Other Charges	6	6	7	8	9	9	10	11	11	11
Total Expenses	3,193	3,551	3,942	5,766	6,476	7,241	8,065	8,603	9,092	9,602
Profit before Tax	1,004	1,160	1,985	1,056	1,281	1,495	1,699	2,635	2,427	2,199
Tax	201	232	397	211	256	299	340	527	485	440
Net Profit	803	928	1,588	845	1,025	1,196	1,359	2,108	1,942	1,759
Water Sold ('000 m ³)	3,242	3,647	4,082	4,728	5,408	6,125	6,883	7,184	7,364	7,544
Operating Ratio %	76%	75%	66%	84%	83%	83%	83%	76%	79%	81%
Increases in Tariffs %	0%	0%	12.4%	0.0%	0.0%	0.0%	0.0%	10.0%	0.0%	0.0%
Return on Assets %	13%	16%	3%	2%	2%	3%	3%	5%	4%	4%
% of Depreciation Recovered	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Sources & Uses of Funds										
Sources										
Internal Sources	1,559	1,715	2,540	2,776	3,001	3,216	3,419	4,355	4,148	3,920
External Sources	21,983	23,418	12,863	0	0	0	0	0	0	0
Total Sources	23,543	25,133	15,403	2,776	3,001	3,216	3,419	4,355	4,148	3,920
Uses										
Capital Expenditure	21,983	23,418	12,863	0	0	0	0	0	0	0
Debt Service	0	0	0	0	0	0	0	0	0	0
Other Uses	762	794	2,501	1,792	1,837	2,879	3,420	5,625	4,557	4,514
Total Uses	22,745	24,213	15,364	1,792	1,837	2,879	3,420	5,625	4,557	4,514
Cash Balance	2,475	3,396	3,435	3,419	4,583	4,919	1,919	(1,351)	(4,760)	(5,354)
Debt Service Ratio (times)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Balance Sheet										
Net Fixed Assets	30,018	52,882	65,189	63,469	61,748	60,028	58,308	56,587	54,867	53,146
Total Assets	34,113	58,461	72,913	73,758	74,784	75,981	77,341	79,450	81,393	83,154
Total Liabilities	16	17	18	19	20	21	22	23	24	25
Total Equity	34,097	58,443	72,895	73,739	74,764	75,960	77,319	79,427	81,369	83,129
Total Liabilities & Equity	34,113	58,461	72,913	73,758	74,784	75,981	77,341	79,450	81,393	83,154
% Debt on Debt plus Equity	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
# Days Accounts Receivable	24	23	22	21	20	19	18	17	17	17

Source: Consultant's calculation

43. **Financial sustainability.** The financial projections (income statement, cash flow statement and balance sheet) of the subproject for the period 2018-2027 show that the subproject is financially sustainable. Net cash inflows accumulated during the period are adequate to finance the replacement of equipment every tenth year.

44. The subproject's sustainability is highly dependent on the implementation of the tariff and fee adjustments regularly and connection rate of prospective customers. Implementing an easy installment or subsidy scheme for water connections similar to that of the Phnom Penh Water Supply Authority will definitely ensure a high connection rate. The PWW must set aside an adequate maintenance fund out of the fees collected and ring-fence it for the subproject facilities. The depreciation charges component recovered from the fees collected must be used specifically for the replacement of depreciated equipment.

E. Battambang Wastewater and Sanitation

1. Economic Evaluation

45. **Without and with project situations.** Existing wastewater treatment plant (WWTP) which was originally designed for 1,000 m³/day and to serve 3,125 households is now operating at 450 m³/day serving only 1,400 households. Sewerage/drainage network is a combined system. Currently, all other wastewater flows to several open canals that drain into the river and rice fields to the north of the town. DPWT does not have a vacuum truck for septage desludging. Seven private vacuum trucks are operating but septage is disposed to rice fields without treatment. There is limited awareness on sanitation. There are no regulations on septic tank cleaning and proper disposal of sludge.

46. The subproject will provide the following facilities: (i) WWTP with a total capacity of 11,645 m³/day in a new site; (ii) sludge drying beds; (iii) solar aerators with hoses; (iv) WW mains, pumping mains, trunk sewers for a separated system; (v) compact excavator, 6 m³ vacuum truck, sludge dewatering container, potable sludge pumps and water quality testing equipment; (vi) septage disposal bay with concrete apron and service water for cleaning; (vii) pumps and pump stations/pump wells (viii) household connections; and (ix) site office, storeroom and carpark. Free household connections will be provided to ensure that all households will use the facilities. Served population by 2040 is estimated at 57,803 persons. The existing WWTP lagoon site will be decommissioned. Intensive awareness campaign on sanitation will be undertaken. Licensing of private vacuum trucks and regulations on septic tank cleaning and proper disposal of sludge will be place.

47. Below are the parameters used in quantifying the economic benefits.

Item	2016	2021	2025	2030	2040
Population (persons)	38,186	41,615	44,665	48,966	59,512
Without Project					
Beneficiaries (persons)	6,720	6,720	6,720	6,720	6,720
Service coverage	18%	16%	15%	14%	11%
With Project					
Beneficiaries (persons)	0	41,053	44,119	48,276	57,803
Service coverage	0%	99%	99%	99%	97%

Source: Consultant's calculation

48. **Economic benefits.** The economic benefits for the subproject were quantified in terms of health benefits. The health benefits were measured using the disability-adjusted-life-year (DALY) approach.¹¹ The DALY approach measures overall disease burden and expresses it as the number of years lost due to ill-health, disability, or early death.¹² The World Health Organization (WHO) estimated the total DALYs in Cambodia at 38,451 per 100,000 population.¹³ The WHO also estimated that 10% of the total DALYs in Cambodia were related to water, sanitation and hygiene issues.¹⁴ Following the WHO approach, the analysis calculated the annual economic value of a DALY as equivalent to the country's per capita gross national income (GNI) in a given year.¹⁵ The country's estimated per capita GNI in 2015 was US\$3,300, based on purchasing

¹¹ The approach was developed by Harvard University for the World Bank in 1990 for a study that provided a comprehensive assessment of mortality and disability from diseases, injuries and risk factors. The World Health Organization (WHO) adopted the method in 1996. DALY determination is continually revised by the WHO.

¹² A DALY is an indicator of life expectancy combining mortality and morbidity into one summary measure of population health to account for the number of years lived in less than optimum health.

¹³ World Health Organization. 2004. World Health Report. Geneva.

¹⁴ WHO. 2007. Environmental Burden of Disease Series No. 15 (Water, Sanitation and Hygiene). Geneva.

¹⁵ The WHO Commission of Macroeconomics and Health assumes that each DALY can be valued at one year of per capita GNI to arrive at a conservative estimate of the economic value of a DALY.

power parity.¹⁶ Real GNI growth was assumed at 2% per annum. Savings in DALYs attributable to the subproject were assumed at 50% of the calculated economic value of DALYs.

49. Economic benefits will also accrue to the community as a whole, both rich and poor, and not only to the direct beneficiaries of the facilities as the subproject interventions are for public good.

50. **Economic costs.** The financial price of the investment cost, net of taxes and duties and price contingencies, when converted to economic price is estimated at KR 43,534 million. The calculation is shown below.

Table 18: Economic Investment Cost – Battambang Wastewater and Sanitation

Item	Component Breakdown	Financial Price ^{1/}	Conversion Factor	Economic Price
Traded	40%	17,414	1.10	19,155
Non-traded	60%	26,121		
Unskilled Labor		3,918	0.75	2,939
Others		20,699	1.00	20,699
Land		1,504		133
Total (KR million)	100%	43,534		42,926

1/ In KR million, excludes taxes and duties and price contingencies

Source: Consultant's calculation

51. **The** conversion factor of the O&M cost financial price into economic price is 0.93. Please refer to para 13 for the details of the calculation.

52. **Results of economic evaluation.** The results of the economic and sensitivity analysis are summarized in the table below. The subproject is economically viable in the base case scenario and robust against downside risks. The subproject economic performance is most sensitive to benefits delay and reduction, but the performance remains above the required threshold levels (KR 0 for NPV, 9% for EIRR).

Table 19: EIRR and Sensitivity Analysis – Battambang Wastewater and Sanitation

Year	Population		In KR million		Net Inflow (Outflow)
	Served	Benefits	Capital Cost	O&M Cost	
2017	0	0	0	0	0
2018	0	0	1,603	0	(1,603)
2019	0	0	4,622	0	(4,622)
2020	40,320	0	22,686	0	(22,686)
2021	41,053	5,866	14,015	217	(8,366)
2022	41,799	12,185	55	436	11,694
2023	42,558	12,654	56	438	12,160
2024	43,332	13,142	57	441	12,645
2025	44,119	13,648	58	443	13,148
2026	44,921	14,174	59	446	13,670
2027	45,737	14,721	60	448	14,213
2028	46,569	15,288	61	451	14,776
2029	47,415	15,877	62	454	15,361
2030	48,276	16,489	63	457	15,969
2031	49,154	17,124	2,160	460	14,505
2032	50,047	17,784	66	463	17,256
2033	50,957	18,469	67	466	17,936
2034	51,883	19,181	68	470	18,643
2035	52,825	19,920	69	474	19,378
2036	53,785	20,688	70	477	20,140
2037	54,763	21,485	72	482	20,932
2038	55,758	22,313	73	486	21,754
2039	56,771	23,173	74	490	22,608

¹⁶ World Bank. 2015. World Development Indicators. Washington D.C.

2040	57,803	24,066	76	495	23,495
2041	58,853	24,994	2,172	500	22,321
2042	59,923	25,957	78	505	25,373
2043	61,012	26,957	80	511	26,366
2044	62,121	27,996	81	516	27,398
2045	63,250	29,075	83	522	28,470
Scenario	Change	NPV ^{1/} (KR million)	EIRR (%)	SI ^{2/}	SV ^{3/}
Base Case		75,142	27.92%		
Increase in Capital Costs	+ 10%	72,011	25.81%	1.12	90%
Increase in O&M Costs	+ 10%	74,839	27.84%	0.04	2479%
Decrease in Benefits	- 10%	64,193	25.52%	1.27	79%
Benefits Delay	1 year	63,910	23.27%	NPV lower by	15%

1/ NPV = Net Present Value discounted at EOCC of 9%

2/ SI = Sensitivity Indicator (ratio of % change in EIRR above the cut-off rate of 9% to % change in a variable)

3/ SV = Switching Value (% change in a variable to reduce the EIRR to the cut-off rate of 9%)

Source: Consultant's calculation

53. **Distribution and poverty impact analysis.** The costs and benefits of the subproject are shared among different groups. Based on the results from the financial and economic analysis, an assessment of the distribution of subproject benefits and costs were undertaken to show which participant will gain from the subproject or incur a loss. We evaluated which portion of the net gains of the project will ultimately benefit the poor. The distribution analysis and the calculation of the poverty impact ratio (PIR) are shown below.

Table 20: Distribution Analysis – Battambang Wastewater and Sanitation

Item	Financial Present Value / ¹	Economic Present Value / ¹	Economic minus Financial	PWU	Gov't. / Economy	Labor	Consumers
Benefits	2,481	74,344	71,863				71,863
Costs							
Traded	13,285	11,727	(1,558)		1,558		
Unskilled labor	2,949	2,601	(348)			348	
Non-traded	16,468	14,565	(1,903)		1,903		
Total Costs	32,703	28,893					
Net Benefits	(30,221)	45,450	75,672	(30,221)			
Benefits (Losses)				(30,221)	3,461	348	71,863

1/ In KR million, discounted at 12%

Source: Consultant's calculation

Table 21: Poverty Impact Ratio – Battambang Wastewater and Sanitation

Particulars	Gov't. / Economy / ¹	Labor / ¹	Consumers / ¹	Total
Benefits (Losses)	3,461	348	71,863	75,672
Financial Return to PWU	(30,221)			(30,221)
Total Benefits (Losses)	(26,760)	348	71,863	45,450
Proportion of Poor (%)	13.5%	30%	25.0%	
Benefits to Poor	(3,613)	104	17,966	14,457
Poverty Impact Ratio (%) = 31.81%				

1/ In KR million, discounted at 12%

Source: Consultant's calculation

54. About 13.5% of population in Cambodia lives below the national poverty line.¹⁷ The proportion of poor among the labor force is estimated to be 30% while 25% of consumers are estimated to be poor. Poverty rate according to the 2015 updated commune database is 23.16%. With a subproject PIR of 31.81%, it can be concluded that the implementation of the proposed subproject will have a positive poverty reducing impact in the town.

55. **Project sustainability.** The subproject's sustainability is highly dependent on the implementation of the fee adjustments regularly and connection rate of prospective customers. Providing free connections for sewerage will definitely ensure a high connection rate. The PWU must set aside an adequate maintenance fund out of the fees collected and ring-fence it for the

¹⁷ ADB. 2016. Basic Statistics. Manila

subproject facilities. The depreciation charges component recovered from the fees collected must be used specifically for the replacement of depreciated equipment.

2. Financial Evaluation

56. **Investment cost and financing plan.** The subproject is estimated to cost KR 49,511 million, inclusive of taxes and duties, physical and price contingencies. The government will on-grant the subproject cost to the implementing agency.

57. **Fees and affordability.** To meet the financial objectives of the sector (para 6), the fees (sewer, disposal of sludge at treatment plant and desludging of septic tank) are presented below.

Table 22: Projected Fees – Battambang Wastewater and Sanitation

Item	Current	2020	2025	2030
Sewer Fee (KR/m ³ of water usage)	100	135	149	163
Disposal Fee (KR/per entry)	0	8,100	8,910	9,801
Desludging Fee (KR/per tank)				
Domestic	120,000	162,000	178,200	196,020
Non-domestic	200,000	270,000	297,000	326,700

Source: DPW and PPTA consultant's estimates

58. An affordability analysis was undertaken to ensure that domestic consumers, particularly those in the LIG, can afford the fee levels that meet the financial objectives of the sector. The results of the analysis show that the fees for the domestic customers, including the LIG, are considered affordable. The combined monthly water and sanitation charges are below the affordability threshold of 5% of average monthly household income.

59. **Past and projected financial performance.** The provincial wastewater unit (PWU) fully recovered the O&M costs in 2013 and 2015 but failed in 2014. The PWU does not calculate and record depreciation in the books of accounts similar to other wastewater units in the country. Shown below is the past financial performance of the PWU for years 2013-2015.

Table 23: Past Financial Performance – Battambang PWU

KR million	2013	2014	2015
Revenue	32	43	51
O&M	26	46	35
Income before Depreciation	6	(3)	16
Depreciation	0	0	0
Net Income (Loss)	6	(3)	16

Source: Provincial Wastewater Unit

60. The projected financial performance of the PWU for the period 2018 to 2027 are summarized and presented below. The financial projections indicate that the PWU is estimated to fully recover O&M costs each year over the forecast period. The PWU is also projected to generate positive cash balances each year over the forecast period. As a result, the PWU will be able to fund all O&M expenses, major asset maintenance and generate an increasing cash surplus.

Table 24: Projected Financial Performance – Battambang PWU

Item	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
Revenue	55	57	59	342	637	650	663	738	754	771
O&M Expenses	38	39	40	306	592	614	637	661	685	710
Income before Depreciation	17	18	18	36	45	36	26	77	69	61
Depreciation										
Net Income	17	18	18	36	45	36	26	77	69	61
Current Assets	0	0	0	1,084	1,180	1,201	1,211	1,273	1,326	1,369
Net Fixed Assets	1,853	7,381	35,452	52,886	51,967	51,049	50,135	49,222	48,312	47,405
Total Assets	1,853	7,381	35,452	53,969	53,147	52,250	51,346	50,495	49,638	48,774
Total Liabilities	0	0	0	66	137	142	148	153	159	165
Total Equity	1,853	7,381	35,452	53,903	53,009	52,108	51,198	50,342	49,479	48,609

Total Liabilities and Equity	1,853	7,381	35,452	53,969	53,147	52,250	51,346	50,495	49,638	48,774
------------------------------	-------	-------	--------	--------	--------	--------	--------	--------	--------	--------

Source: Consultant's calculation

61. **Financial sustainability.** The financial projections of the subproject for the period 2018-2027 show that the subproject is financially sustainable. Internal cash generated from operations is sufficient to finance the replacement of equipment every tenth year.

62. The subproject's sustainability is highly dependent on the implementation of the fee adjustments regularly and connection rate of prospective customers. Providing free connections for sewerage will definitely ensure a high connection rate. The PWU must set aside an adequate maintenance fund out of the fees collected and ring-fence it for the subproject facilities. The depreciation charges component recovered from the fees collected must be used specifically for the replacement of depreciated equipment.

F. Sihanoukville Wastewater and Sanitation

1. Economic Evaluation

64. **Without and with project situations.** Existing WWTP with a capacity of 6,900 m³/day was originally intended that 5,900 m³/day will serve 3,368 households and the balance of 1,000 m³/day will be for the effluent of Cambrew. In reality, an approximate of 3,000 m³/day is used for 1,767 households (52% of the original target of 3,368 households) and the balance of 3,900 m³/day is used for Cambrew. Forty-eight percent of the original targeted households did not want to connect to the system. There are no pump stations. One anaerobic pond is full of sludge and the other 3 ponds are half full. There is a limited number of vacuum trucks (one owned by the DPWT and one owned by a private operator) for a relatively large population and number of hotels. There is limited awareness on sanitation. There are no regulations on septic tank cleaning and proper disposal of sludge.

65. The subproject will undertake or provide the following: (i) upgrade the existing WWTP capacity to 20,500 m³/day through mixing / aeration; (ii) desludge 4 anaerobic lagoons; (iii) dispose the sludge to a landfill; (iii)) solar aerators with hoses; (iv) WW mains, pumping mains and trunk sewers; (v) compact excavator, 6 m³ vacuum truck, sludge dewatering container, potable sludge pumps and water quality testing equipment; (vi) septage disposal bay with concrete apron and service water for cleaning; (vii) pumps and pump stations/pump wells (viii) household connections; and (ix) shaded storage for sludge pumps, excavator and vacuum truck. Free household connections, including those not connected in the existing service area, will be provided to ensure that all households will use the facilities. Served population by 2040 is estimated at 42,858 persons. Intensive awareness campaign on sanitation will be undertaken. Licensing of private vacuum trucks and regulations on septic tank cleaning and proper disposal of sludge will be place.

66. Below are the parameters used in quantifying the economic benefits.

Item	2016	2021	2025	2030	2040
Population (persons)	42,674	45,582	48,072	51,420	59,020
Without Project					
Beneficiaries (persons)	7,156	7,156	7,156	7,156	7,156
Service coverage	17%	16%	15%	14%	12%
With Project					
Beneficiaries (persons)	0	37,344	38,443	39,862	42,858
Service coverage	0%	82%	80%	78%	73%

Source: Consultant's calculation

67. **Economic benefits.** The economic benefits for the subproject were quantified in terms of health benefits. The health benefits were measured using the disability-adjusted-life-year (DALY) approach.¹⁸ The DALY approach measures overall disease burden and expresses it as the number of years lost due to ill-health, disability, or early death.¹⁹ The World Health Organization (WHO) estimated the total DALYs in Cambodia at 38,451 per 100,000 population.²⁰ The WHO also estimated that 10% of the total DALYs in Cambodia were related to water, sanitation and hygiene issues.²¹ Following the WHO approach, the analysis calculated the annual economic

¹⁸ The approach was developed by Harvard University for the World Bank in 1990 for a study that provided a comprehensive assessment of mortality and disability from diseases, injuries and risk factors. The World Health Organization (WHO) adopted the method in 1996. DALY determination is continually revised by the WHO.

¹⁹ A DALY is an indicator of life expectancy combining mortality and morbidity into one summary measure of population health to account for the number of years lived in less than optimum health.

²⁰ World Health Organization. 2004. World Health Report. Geneva.

²¹ WHO. 2007. Environmental Burden of Disease Series No. 15 (Water, Sanitation and Hygiene). Geneva.

value of a DALY as equivalent to the country's per capita gross national income (GNI) in a given year.²² The country's estimated per capita GNI in 2015 was US\$3,300, based on purchasing power parity.²³ Real GNI growth was assumed at 2% per annum. Savings in DALYs attributable to the subproject were assumed at 50% of the calculated economic value of DALYs.

68. Economic benefits will also accrue to the community as a whole, both rich and poor, and not only to the direct beneficiaries of the facilities as the subproject interventions are for public good.

69. **Economic costs.** The financial price of the investment cost, net of taxes and duties and price contingencies, when converted to economic price is estimated at KR 51,566 million. The calculation is shown below.

Table 25: Economic Investment Cost – Sihanoukville Wastewater and Sanitation

Item	Component Breakdown	Financial Price ^{1/}	Conversion Factor	Economic Price
Traded	40%	20,626	1.10	22,689
Non-traded	60%	30,940		
Unskilled Labor		4,641	0.75	3,481
Others		26,299	1.00	26,299
Total (KR million)	100%	51,566		52,469

1/ In KR million, excludes taxes and duties and price contingencies

Source: Consultant's calculation

70. The conversion factor of the O&M cost financial price into economic price is 0.93. Please refer to para 13 for the details of the calculation.

71. **Results of economic evaluation.** The results of the economic and sensitivity analysis are summarized in the table below. The subproject is economically viable in the base case scenario and robust against downside risks. The subproject economic performance is most sensitive to benefits delay and reduction, but the performance remains above the required threshold levels (KR 0 for NPV, 9% for EIRR).

Table 26: EIRR and Sensitivity Analysis – Sihanoukville Wastewater and Sanitation

Year	Population Served	Benefits	In KR million Capital Cost	O&M Cost	Net Inflow (Outflow)
2017	0	0	0	0	0
2018	0	0	64	0	(64)
2019	0	0	4,045	0	(4,045)
2020	0	0	35,468	0	(35,468)
2021	37,344	5,336	12,891	291	(7,846)
2022	37,616	10,965	22	597	10,347
2023	37,890	11,266	22	612	10,632
2024	38,165	11,575	22	628	10,924
2025	38,443	11,892	23	645	11,225
2026	38,723	12,218	23	662	11,534
2027	39,004	12,554	23	679	11,851
2028	39,288	12,898	23	698	12,177
2029	39,574	13,251	23	717	12,512
2030	39,862	13,615	23	736	12,855
2031	40,152	13,988	2,913	753	10,322
2032	40,444	14,372	24	771	13,577
2033	40,738	14,766	24	789	13,952
2034	41,034	15,171	24	809	14,337
2035	41,333	15,587	24	829	14,733
2036	41,633	16,014	24	852	15,138

²² The WHO Commission of Macroeconomics and Health assumes that each DALY can be valued at one year of per capita GNI to arrive at a conservative estimate of the economic value of a DALY.

²³ World Bank. 2015. World Development Indicators. Washington D.C.

2037	41,936	16,453	25	875	15,554
2038	42,241	16,904	25	899	15,980
2039	42,549	17,368	25	925	16,418
2040	42,858	17,844	25	952	16,867
2041	43,170	18,333	2,914	980	14,439
2042	43,484	18,836	26	1,010	17,800
2043	43,800	19,352	26	1,042	18,285
2044	44,119	19,883	26	1,075	18,782
2045	44,440	20,428	26	1,110	19,292

Scenario	Change	NPV ^{1/} (KR million)	EIRR (%)	SI ^{2/}	SV ^{3/}
Base Case		46,998	20.48%		
Increase in Capital Costs	+ 10%	43,202	18.78%	1.48	68%
Increase in O&M Costs	+ 10%	46,514	20.38%	0.09	1086%
Decrease in Benefits	- 10%	38,018	18.50%	1.72	58%
Benefits Delay	1 year	38,044	17.42%	NPV lower by	19%

1/ NPV = Net Present Value discounted at EOCC of 9%

2/ SI = Sensitivity Indicator (ratio of % change in EIRR above the cut-off rate of 9% to % change in a variable)

3/ SV = Switching Value (% change in a variable to reduce the EIRR to the cut-off rate of 9%)

Source: Consultant's calculation

72. **Distribution and poverty impact analysis.** The costs and benefits of the subproject are shared among different groups. Based on the results from the financial and economic analysis, an assessment of the distribution of subproject benefits and costs were undertaken to show which participant will gain from the subproject or incur a loss. We evaluated which portion of the net gains of the project will ultimately benefit the poor. The distribution analysis and the calculation of the poverty impact ratio (PIR) are shown below.

Table 27: Distribution Analysis – Sihanoukville Wastewater and Sanitation

Item	Financial Present Value / ¹	Economic Present Value / ¹	Economic minus Financial	PWU	Gov't. / Economy	Labor	Consumers
Benefits	3,911	61,761	57,850				57,850
Costs							
Traded	15,869	14,435	(1,434)		1,434		
Unskilled labor	3,507	3,189	(318)			318	
Non-traded	21,197	19,296	(1,901)		1,901		
Total Costs	40,573	36,920					
Net Benefits	(36,663)	24,841	61,504	(36,663)			
Benefits (Losses)				(36,663)	3,336	318	57,850

1/ In KR million, discounted at 12%

Source: Consultant's calculation

Table 28: Poverty Impact Ratio – Sihanoukville Wastewater and Sanitation

Particulars	Gov't. / Economy / ¹	Labor / ¹	Consumers / ¹	Total
Benefits (Losses)	3,336	318	57,850	61,504
Financial Return to PWU	(36,663)			(36,663)
Total Benefits (Losses)	(33,327)	318	57,850	24,841
Proportion of Poor (%)	13.5%	30%	20.0%	
Benefits to Poor	(4,499)	95	11,570	7,166
Poverty Impact Ratio (%) = 28.85%				

1/ In KR million, discounted at 12%

Source: Consultant's calculation

73. About 13.5% of population in Cambodia lives below the national poverty line.²⁴ The proportion of poor among the labor force is estimated to be 30% while 20% of consumers are estimated to be poor. Poverty rate according to the 2015 updated commune database is 14.02%. With a subproject PIR of 28.85%, it can be concluded that the implementation of the proposed subproject will have a positive poverty reducing impact in the town.

²⁴ ADB. 2016. Basic Statistics. Manila

74. **Project sustainability.** The subproject's sustainability is highly dependent on the implementation of the fee adjustments regularly and connection rate of prospective customers. Providing free connections for sewerage will definitely ensure a high connection rate. The PWU must set aside an adequate maintenance fund out of the fees collected and ring-fence it for the subproject facilities. The depreciation charges component recovered from the fees collected must be used specifically for the replacement of depreciated equipment.

2. Financial Evaluation

75. **Investment cost and financing plan.** The subproject is estimated to cost KR 58,729 million, inclusive of taxes and duties, physical and price contingencies. The government will on-grant the subproject cost to the implementing agency.

76. **Fees and affordability.** To meet the financial objectives of the sector (para 6), the fees (sewer, disposal of sludge at treatment plant and desludging of septic tank) are presented below.

Table 29: Projected Fees – Sihanoukville Wastewater and Sanitation

Item	Current	2020	2025	2030
Sewer Fee (KR/per unit/month) ^{1/}				
Domestic (average)	5,200	6,500	7,475	8,596
Non-domestic (average)	25,000	31,250	35,938	41,328
Disposal Fee (KR/per entry)	0	7,500	8,625	9,919
Desludging Fee (KR/per tank)				
Domestic	120,000	150,000	172,500	198,375
Non-domestic	200,000	250,000	287,500	330,625

^{1/} Residential fees of KR3,500-KR12,500/unit; non-residential, KR13,500-KR210,000/unit depending on property classification
Source: DPWT and PPTA consultant's estimates

77. An affordability analysis was undertaken to ensure that domestic consumers, particularly those in the LIG, can afford the fee levels that meet the financial objectives of the sector. The results of the analysis show that the fees for the domestic customers, including the LIG, are considered affordable. The combined monthly water and sanitation charges are below the affordability threshold of 5% of average monthly household income.

78. **Past and projected financial performance.** The provincial wastewater unit (PWU) fully recovered the O&M costs in 2015 but failed in 2013 and 2014. The PWU does not calculate and record depreciation in the books of accounts similar to other wastewater units in the country. Shown below is the past financial performance of the PWU for years 2013-2015.

Table 30: Past Financial Performance – Sihanoukville PWU

KR million	2013	2014	2015
Revenue	241	352	385
O&M	266	372	284
Income before Depreciation	(25)	(20)	101
Depreciation	0	0	0
Net Income (Loss)	(25)	(20)	101

Source: Provincial Wastewater Unit

79. The projected financial performance of the PWU for the period 2018 to 2027 are summarized and presented below. The financial projections indicate that the PWU is estimated to fully recover O&M costs each year over the forecast period. The PWU is also projected to generate positive cash balances each year over the forecast period. As a result, the PWU will be able to fund all O&M expenses, major asset maintenance and generate an increasing cash surplus.

Table 31: Projected Financial Performance – Sihanoukville PWU

Item	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
Revenue	417	431	446	932	1,423	1,444	1,466	1,632	1,655	1,678

O&M Expenses	308	318	329	695	1,103	1,159	1,218	1,280	1,344	1,412
Income before Depreciation	109	113	117	237	321	286	248	352	311	266
Depreciation										
Net Income	109	113	117	237	321	286	248	352	311	266
Current Assets	0	0	0	1,205	1,500	1,669	1,795	2,023	2,205	2,339
Net Fixed Assets	72	4,761	47,290	62,684	61,537	60,391	59,245	58,100	56,955	55,811
Total Assets	72	4,761	47,290	63,889	63,037	62,059	61,040	60,122	59,160	58,150
Total Liabilities	0	0	0	89	188	199	211	223	236	250
Total Equity	72	4,761	47,290	63,800	62,850	61,860	60,830	59,899	58,924	57,900
Total Liabilities and Equity	72	4,761	47,290	63,889	63,037	62,059	61,040	60,122	59,160	58,150

Source: Consultant's calculation

80. **Financial sustainability.** The financial projections of the subproject for the period 2018-2027 show that the subproject is financially sustainable. Internal cash generated from operations is sufficient to finance the replacement of equipment every tenth year.

81. The subproject's sustainability is highly dependent on the implementation of the fee adjustments regularly and connection rate of prospective customers. Providing free connections for sewerage will definitely ensure a high connection rate. The PWU must set aside an adequate maintenance fund out of the fees collected and ring-fence it for the subproject facilities. The depreciation charges component recovered from the fees collected must be used specifically for the replacement of depreciated equipment.

G. Kampong Cham Sanitation

1. Economic Evaluation

83. **Without and with project situations.** There is no reticulated wastewater collection other than direct or indirect disposal to road drains by households and businesses. Wastewater runs to the Mekong through a series of combined road drains. There are an unknown number of working septic tanks in the city center, with a small number of private vacuum trucks which empty these tanks on demand and dispose of to surrounding agricultural land since there is no septage treatment facility. There is limited awareness on sanitation. There are no regulations on septic tank cleaning and proper disposal of sludge.

84. The subproject will provide the following: (i) septage treatment facility (ii) compact excavator; (iii) one 6 m³ vacuum truck; and (iv) sludge dewatering container. Intensive awareness campaign on sanitation will be undertaken. Licensing of private vacuum trucks and regulations on septic tank cleaning and proper disposal of sludge will be place.

85. Below are the parameters used in quantifying the economic benefits.

Item	2016	2021	2025	2030	2040
Population (persons)	43,470	46,677	49,413	58,798	76,672
Without Project					
Beneficiaries (persons)	0	0	0	0	0
Service coverage	0%	0%	0%	0%	0%
With Project					
Beneficiaries (persons) ^{/1}	0	5,400	5,400	5,400	5,400
Service coverage	0%	12%	11%	9%	7%

^{1/} Limited by vacuum truck capacity

Source: Consultant's calculation

86. **Economic benefits.** The economic benefits for the subproject were quantified in terms of health benefits. The health benefits were measured using the disability-adjusted-life-year (DALY) approach.²⁵ The DALY approach measures overall disease burden and expresses it as the number of years lost due to ill-health, disability, or early death.²⁶ The World Health Organization (WHO) estimated the total DALYs in Cambodia at 38,451 per 100,000 population.²⁷ The WHO also estimated that 10% of the total DALYs in Cambodia were related to water, sanitation and hygiene issues.²⁸ Following the WHO approach, the analysis calculated the annual economic value of a DALY as equivalent to the country's per capita gross national income (GNI) in a given year.²⁹ The country's estimated per capita GNI in 2015 was US\$3,300, based on purchasing power parity.³⁰ Real GNI growth was assumed at 2% per annum. Savings in DALYs attributable to the subproject were assumed at 20% of the calculated economic value of DALYs.

²⁵ The approach was developed by Harvard University for the World Bank in 1990 for a study that provided a comprehensive assessment of mortality and disability from diseases, injuries and risk factors. The World Health Organization (WHO) adopted the method in 1996. DALY determination is continually revised by the WHO.

²⁶ A DALY is an indicator of life expectancy combining mortality and morbidity into one summary measure of population health to account for the number of years lived in less than optimum health.

²⁷ World Health Organization. 2004. World Health Report. Geneva.

²⁸ WHO. 2007. Environmental Burden of Disease Series No. 15 (Water, Sanitation and Hygiene). Geneva.

²⁹ The WHO Commission of Macroeconomics and Health assumes that each DALY can be valued at one year of per capita GNI to arrive at a conservative estimate of the economic value of a DALY.

³⁰ World Bank. 2015. World Development Indicators. Washington D.C.

87. Economic benefits will also accrue to the community as a whole, both rich and poor, and not only to the direct beneficiaries of the facilities as the subproject interventions are for public good.

88. **Economic costs.** The financial price of the investment cost, net of taxes and duties and price contingencies, when converted to economic price is estimated at KR 2,675 million. The calculation is shown below.

Table 32: Economic Investment Cost – Kampong Cham Sanitation

Item	Component Breakdown	Financial Price ^{1/}	Conversion Factor	Economic Price
Traded	40%	1,052	1.10	1,157
Non-traded	60%	1,577		
Unskilled Labor		237	0.75	177
Others		1,341	1.00	1,341
Total (KR million)	100%	2,629		2,675

1/ In KR million, excludes taxes and duties and price contingencies

Source: Consultant's calculation

89. The conversion factor of the O&M cost financial price into economic price is 0.93. Please refer to para 13 for the details of the calculation.

90. **Results of economic evaluation.** The results of the economic and sensitivity analysis are summarized in the table below. The subproject is economically viable in the base case scenario and robust against downside risks. The subproject economic performance is most sensitive to benefits delay and reduction, but the performance remains above the required threshold levels (KR 0 for NPV, 9% for EIRR).

Table 33: EIRR and Sensitivity Analysis – Kampong Cham Sanitation

Year	Population Served	Benefits	In KR million Capital Cost	O&M Cost	Net Inflow (Outflow)
2017	0	0	0	0	0
2018	0	0	21	0	(21)
2019	0	0	986	0	(986)
2020	0	0	518	0	(518)
2021	5,400	309	1,149	48	(888)
2022	5,400	630	0	95	534
2023	5,400	642	0	95	547
2024	5,400	655	0	95	560
2025	5,400	668	0	95	573
2026	5,400	682	0	95	586
2027	5,400	695	0	95	600
2028	5,400	709	0	95	614
2029	5,400	723	0	95	628
2030	5,400	738	0	95	643
2031	5,400	753	836	95	(178)
2032	5,400	768	0	95	672
2033	5,400	783	0	95	688
2034	5,400	799	0	95	703
2035	5,400	815	0	95	719
2036	5,400	831	0	95	736
2037	5,400	847	0	95	752
2038	5,400	864	0	95	769
2039	5,400	882	0	95	787
2040	5,400	899	0	95	804
2041	5,400	917	836	95	(14)
2042	5,400	936	0	95	840
2043	5,400	954	0	95	859
2044	5,400	973	0	95	878
2045	5,400	993	0	95	898
Scenario	Change	NPV ^{1/}	EIRR (%)	SI ^{2/}	SV ^{3/}

(KR million)					
Base Case			2,007	19.05%	
Increase in Capital Costs	+ 10%		1,785	17.34%	1.71
Increase in O&M Costs	+ 10%		1,944	18.76%	0.30
Decrease in Benefits	- 10%		1,521	16.85%	2.19
Benefits Delay	1 year		1,531	15.89%	NPV lower by
					24%

1/ NPV = Net Present Value discounted at EOCC of 9%

2/ SI = Sensitivity Indicator (ratio of % change in EIRR above the cut-off rate of 9% to % change in a variable)

3/ SV = Switching Value (% change in a variable to reduce the EIRR to the cut-off rate of 9%)

Source: Consultant's calculation

91. **Distribution and poverty impact analysis.** The costs and benefits of the subproject are shared among different groups. Based on the results from the financial and economic analysis, an assessment of the distribution of subproject benefits and costs were undertaken to show which participant will gain from the subproject or incur a loss. We evaluated which portion of the net gains of the project will ultimately benefit the poor. The distribution analysis and the calculation of the poverty impact ratio (PIR) are shown below.

Table 34: Distribution Analysis – Kampong Cham Sanitation

Item	Financial Present Value / ¹	Economic Present Value / ¹	Economic minus Financial	PWU	Gov't. / Economy	Labor	Consumers
Benefits	518	3,369	2,851				2,851
Costs							
Traded	983	895	(88)		88		
Unskilled labor	213	194	(19)			19	
Non-traded	1,382	1,261	(121)		121		
Total Costs	2,577	2,349					
Net Benefits	(2,059)	1,020	3,079	(2,059)			
Benefits (Losses)				(2,059)	209	19	2,851

1/ In KR million, discounted at 12%

Source: Consultant's calculation

Table 35: Poverty Impact Ratio – Kampong Cham Sanitation

Particulars	Gov't. / Economy / ¹	Labor / ¹	Consumers / ¹	Total
Benefits (Losses)	209	19	2,851	3,079
Financial Return to PWU	(2,059)			(2,059)
Total Benefits (Losses)	(1,851)	19	2,851	1,020
Proportion of Poor (%)	13.5%	30%	20.0%	
Benefits to Poor	(250)	6	570	326
Poverty Impact Ratio (%) = 31.98%				

1/ In KR million, discounted at 12%

Source: Consultant's calculation

92. About 13.5% of population in Cambodia lives below the national poverty line.³¹ The proportion of poor among the labor force is estimated to be 30% while 20% of consumers are estimated to be poor. Poverty rate according to the 2015 updated commune database is 17.32%. With a subproject PIR of 31.98%, it can be concluded that the implementation of the proposed subproject will have a positive poverty reducing impact in the town.

93. **Project sustainability.** The subproject's sustainability is highly dependent on the implementation of the fee adjustments regularly. The PWU must set aside an adequate maintenance fund out of the fees collected and ring-fence it for the subproject facilities. The depreciation charges component recovered from the fees collected must be used specifically for the replacement of depreciated equipment.

2. Financial Evaluation

³¹ ADB. 2016. Basic Statistics. Manila

94. **Investment cost and financing plan.** The subproject is estimated to cost KR 3,002 million, inclusive of taxes and duties, physical and price contingencies. The government will on-grant the subproject cost to the implementing agency.

95. **Fees and affordability.** To meet the financial objectives of the sector (para 6), the fees (disposal of sludge at treatment plant and desludging of septic tank) are presented below.

Table 36: Projected Fees – Kampong Cham Sanitation

Item	Current	2020	2025	2030
Disposal Fee (KR/per entry)	0	9,900	11,385	13,093
Desludging Fee (KR/per tank)				
Domestic	0	198,000	227,700	261,855
Non-domestic	0	330,000	379,500	436,425

Source: DPWT and consultant's estimates

96. An affordability analysis was undertaken to ensure that domestic consumers, particularly those in the LIG, can afford the fee levels that meet the financial objectives of the sector. The results of the analysis show that the fees for the domestic customers, including the LIG, are considered affordable. The combined monthly water and sanitation charges are below the affordability threshold of 5% of average monthly household income.

97. **Projected financial performance.** The projected financial performance of the PWU for the period 2018 to 2027 are summarized and presented below. The financial projections indicate that the PWU is estimated to fully recover O&M costs each year over the forecast period. The PWU is also projected to generate positive cash balances each year over the forecast period. As a result, the PWU will be able to fund all O&M expenses, major asset maintenance and generate an increasing cash surplus.

Table 37: Projected Financial Performance – Kampong Cham PWU

Item	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
Revenue	0	0	0	65	130	130	130	150	150	150
O&M Expenses	0	0	0	58	120	124	128	132	136	140
Income before Depreciation	0	0	0	7	10	6	2	18	14	9
Depreciation										
Net Income	0	0	0	7	10	6	2	18	14	9
Current Assets	0	0	0	1,022	1,047	1,055	1,058	1,077	1,092	1,102
Net Fixed Assets	23	1,167	1,788	3,183	3,123	3,063	3,003	2,943	2,883	2,823
Total Assets	23	1,167	1,788	4,205	4,170	4,118	4,061	4,020	3,974	3,925
Total Liabilities	0	0	0	14	30	31	32	33	34	35
Total Equity	23	1,167	1,788	4,190	4,140	4,087	4,029	3,987	3,940	3,890
Total Liabilities and Equity	23	1,167	1,788	4,205	4,170	4,118	4,061	4,020	3,974	3,925

Source: Consultant's calculation

98. **Financial sustainability.** The financial projections of the subproject for the period 2018-2027 show that the subproject is financially sustainable. Internal cash generated from operations is sufficient to finance the replacement of equipment every tenth year.

99. The subproject's sustainability is highly dependent on the implementation of the fee adjustments regularly and connection rate of prospective customers. Providing free connections for sewerage will definitely ensure a high connection rate. The PWU must set aside an adequate maintenance fund out of the fees collected and ring-fence it for the subproject facilities. The depreciation charges component recovered from the fees collected must be used specifically for the replacement of depreciated equipment.

H. Siem Reap Wastewater

1. Economic Evaluation

100. **Without and with project situations.** The design and installation of the interceptor sewer was completed under the Siem Reap Wastewater Management (SRWM) subproject, one of the four outputs under the ADB Mekong Tourism Development Project³², with construction from 2007 to 2009 and commissioning in 2010.

101. The interceptor sewer consists of 632m of 600mm GRP pipe and 3,043m of 700mm GRP pipe, starting at the upstream end at National Road No. 6 running north to south down Sivatha St, then turning southwest onto Wat Chork St, crossing the Ring Road, and ending at a pump station. From this pump station wastewater is delivered to the WWTP, also constructed under the SRWM project.

102. The pipe invert at the upstream end was at 3m depth (600mm dia) and at the downstream end reached its maximum IL depth at 8.3m (700mm dia). The grade of the 632m of 600mm pipe was 0.237% and the downstream 3,043m of 700mm pipe 0.187%.

103. The original SRWM subproject, of which the interceptor sewer was a part, had the objective of collecting wastewater from central Siem Reap (2.4km² area), transporting it via the interceptor sewer to a pump station (ADB-PS) from which it was delivered to a new WWTP of capacity 2,776m³/day. This WWTP was intended to serve only the central area of Siem Reap. The 600mm interceptor portion has a capacity of 25,800m³/day and the 700mm interceptor 30,070m³/day. The capacity of the ADB pump station at the downstream end of the interceptor sewer was 20,750m³/day with 3 (Aurora brand) duty pumps.

104. Between 2011 and 2014, the pipeline collapsed in 5 locations. In the furthest upstream failure the top of the pipe deformed inwards at the top and developed a leak at the top, but did not break. In the four downstream cases the pipe failure was a typical compression failure with cracks at 3,6,9 and 12 o'clock and complete collapse at these 4 road failure locations. Three of these collapse locations have been fully repaired, the upstream deformity has had a temporary repair and backfill, and the fifth failure point around 500m upstream of the pump station has not been repaired due to lack of budget. The pipe remains blocked at this location. The interceptor sewer is therefore not functioning. Further failures could happen at any time, and there may be many more deformed areas of pipe that have not been detected yet as there is no road collapse evident. Failure along any part of this pipe means that there is no way for wastewater to reach the WWTP, and all of it is discharged via overflow weirs to the town drainage.

105. Following commissioning of the SRWM subproject in 2010, further work has been carried out under a Korean project. The WWTP was increased to 8,000m³/day under the Korean project, which currently serves the original (ADB) central area, western and eastern areas. Two new pump stations were installed, one east and one west, both pumping to the (now failed) ADB interceptor sewer before being pumped by the ADB pump station to the WWTP. Two further Grundfos pumps were added to supplement the ADB funded Aurora pumps in the Interceptor sewer pump station. The two pump stations constructed under the Korean project and the WWTP extension have not been able to be commissioned yet due to the failed interceptor sewer.

106. The subproject will replace the failed interceptor sewer with the least cost option.

³² ADB. 2002. *Report and Recommendation of the President to the Board of Directors, Proposed Loans to the Kingdom of Cambodia, Lao People's Democratic Republic and Socialist Republic of Vietnam for the Greater Mekong Subregion Mekong Tourism Development Project*. Manila.

107. Below are the parameters used in quantifying the economic benefits.

Item	2016	2021	2025	2030	2040
Population (persons)	25,428	29,478	33,178	38,462	51,690
Without Project					
Beneficiaries (persons)	0	0	0	0	0
Service coverage	0%	0%	0%	0%	0%
With Project					
Beneficiaries (persons)	0	16,326	18,374	21,301	28,627
Service coverage	0%	55%	55%	55%	55%

Source: Consultant's calculation

108. **Least cost option.** Under the CDIA final report, there are three main options for replacing the 3.7km length of interceptor sewer. All options will include increasing the capacity from the current 600/700mm and using a stronger pipe material such as ductile cast iron. The options are:

- i. Option 1: Same deep alignment as existing, using trenchless technology for one 1000mm diameter DCI pipe;
- ii. Option 2: Shallower alignment with multiple (3-4) in-line pump stations, using open cut trenching for one 1000mm diameter DCI pipe; and
- iii. Option 3: Same deep alignment as existing, using open cut trenching for one 1000mm diameter DCI pipe.

109. According to the CDIA final report, the pipe sizes above are suggested sizes only and will need to be confirmed during the detailed design. Please refer to the CDIA final report for the complete description and discussion of the options.

110. Under the CDIA final report, Option 3 has been discounted due to the problems experienced on the original project with dewatering, operating in a deep trench, necessary road closures, disruption and mess in the main tourist area.

111. Capital cost for option 1 is estimated at US\$16.05 million, inclusive of physical and price contingencies, while the capital cost for option 2 is estimated at US\$11.35 million, inclusive of physical and price contingencies. Construction period for both options is assumed to be 18 months. There is incremental annual power cost for option 2 over option 1 because of the multiple (3-4) in-line pump stations and is estimated at US\$0.18 million. Under option 2, disruption and mess in the main tourist area is anticipated with constant dewatering and necessary road closure. Under option 1, there is lesser disturbance to businesses, residents and traffic. Option 1 also involves smaller work footprint with lesser materials removed and replaced. Below are the details of the calculation for the least cost option analysis.

Table 38: Least Cost Analysis – Siem Reap Wastewater

Item	Option 1	Option 2
Capital cost (NPV, US\$ million) ^{/1}	14.21	10.06
Annual power cost (NPV, US\$ million) ^{/1}		1.36
Economic cost of disruption due to subproject (NPV, US\$ million) ^{/1}	2.88	11.53
Total Cost	17.09	22.94
Parameters Used for Economic Cost of Disruption:		
2015 international tourist arrivals (Cambodia) ^{/2}	4,775,231	4,775,231
2015 international tourist arrivals (Siem Reap international airport) ^{/2}	1,414,967	1,414,967
2015 tourism receipts (Cambodia) - million US\$ ^{/2}	3,012	3,012
Share of Siem Reap international airport in annual international tourist arrivals	30%	30%
Share of Siem Reap in annual tourism receipts - million US\$	892	892

Decline of Siem Reap annual international tourist arrivals due to subproject	0.25%	1%
Decline in Siem Reap annual tourism receipts due to subproject - million US\$	2.23	8.92

1/ Discounted at 12%

2/ 2015 Tourism Statistics Report, Statistics and Tourism Information Department, Ministry of Tourism

112. **Results of economic evaluation.** The results of the economic and sensitivity analysis are summarized in the table below. The subproject is economically viable in the base case scenario and robust against downside risks. The subproject economic performance is most sensitive to benefits delay and reduction, but the performance remains above the required threshold levels (KR 0 for NPV, 9% for EIRR).

Table 39: EIRR and Sensitivity Analysis – Siem Reap Wastewater

Year	Population Served	Benefits	In KR million Capital Cost	O&M Cost	Net Inflow (Outflow)
2017	0	0	0	0	0
2018	0	0	52,326	0	(52,326)
2019	0	0	4,125	0	(4,125)
2020	15,850	4,441	0	93	4,349
2021	16,326	4,666	0	93	4,573
2022	16,815	4,902	0	93	4,809
2023	17,320	5,150	0	93	5,057
2024	17,839	5,410	0	93	5,318
2025	18,374	5,684	0	93	5,592
2026	18,926	5,972	0	93	5,879
2027	19,494	6,274	0	93	6,181
2028	20,078	6,591	0	93	6,499
2029	20,681	6,925	0	93	6,832
2030	21,301	7,275	0	93	7,183
2031	21,940	7,644	0	93	7,551
2032	22,598	8,030	0	93	7,938
2033	23,276	8,437	0	93	8,344
2034	23,975	8,864	0	93	8,771
2035	24,694	9,312	0	93	9,219
2036	25,435	9,783	0	93	9,691
2037	26,198	10,278	0	93	10,186
2038	26,984	10,798	0	93	10,706
2039	27,793	11,345	0	93	11,252
2040	28,627	11,919	0	93	11,826
2041	29,486	12,522	0	93	12,429
2042	30,370	13,155	0	93	13,063
2043	31,281	13,821	0	93	13,729
2044	32,220	14,520	0	93	14,428
2045	33,186	15,255	0	93	15,163

Scenario	Change	NPV ^{1/} (KR million)	EIRR (%)	SI ^{2/}	SV ^{3/}
Base Case		5,682	10.02%		
Increase in Capital Costs	+ 10%	960	9.16%	8.42	12%
Increase in O&M Costs	+ 10%	5,611	10.01%	0.12	808%
Decrease in Benefits	- 10%	320	9.06%	9.42	11%
Benefits Delay	1 year	105	9.02%	NPV lower by	98%

1/ NPV = Net Present Value discounted at EOCC of 9%

2/ SI = Sensitivity Indicator (ratio of % change in EIRR above the cut-off rate of 9% to % change in a variable)

3/ SV = Switching Value (% change in a variable to reduce the EIRR to the cut-off rate of 9%)

Source: Consultant's calculation

2. Financial Evaluation

113. **Investment cost and financing plan.** The subproject is estimated to cost KR 64,183 million, inclusive of taxes and duties, physical and price contingencies. The government will on-grant the subproject cost to the implementing agency.