ECONOMIC ANALYSIS

A. Introduction

1. Investment in the urban water supply sector in Cambodia since 1993 has been primarily in Phnom Penh. The public waterworks (PWW) systems in the provinces across the country have suffered from slow and inadequate levels of investment in both physical infrastructure and institutional development. Rapid urbanization has exacerbated the situation. Typical problems include old pipework, insufficient coverage, inadequate operation and maintenance, intermittent supply, high levels of nonrevenue water, water quality issues, and the absence of tariff structures that recover the true costs of service provision. The Department of Potable Water Supply, under the Ministry of Industry and Handicraft (MIH),[1] is responsible for the countrywide coordination, policy, and regulation of urban water supply.

2. The proposed Urban Water Supply Project is aligned with (i) phase 3 of the government's rectangular strategy for growth, employment, equity, and efficiency;[2] (ii) Cambodia's national strategic development plan for 2014–2018; and (iii) the action plan of the MIH to facilitate private sector partnerships, strengthen the management of publicly owned waterworks, and integrate urban water supply with urban environmental management. The project supports ADB's water and sanitation sector assessment, strategy, and road map for Cambodia; as well as ADB's Water Operational Plan, 2011–2020 to improve the efficiency of water services.[3] It also aligns with the three pillars of the draft of ADB's country partnership strategy.[4]

B. Overall Approach to Economic Analysis

3. The economic analysis of the water supply investment under the proposed project was undertaken in accordance with the principles and procedures set out in the ADB guidelines.[5] The analysis period covered the 30 years from the scheduled start of project implementation in 2015. Costs and benefits were quantified at August 2014 prices and were converted to their economic cost equivalents using shadow prices. An exchange rate of $1 = KR4,000 was used when converting foreign exchange costs to the local currency equivalent. All costs were valued using the domestic price numeraire. The analysis derived the economic costs from its financial estimates of investment and recurrent costs, adjusted for transfer payments and other market distortions. Traded goods, net of taxes and duties, were adjusted by the shadow exchange rate factor of 1.1. The shadow wage rate factor of 0.75 was used for unskilled labor.[6] Both costs and benefits were treated as increments to a without-project situation.

4. The economic viability of the project was determined by computing the economic internal rate of return and comparing the result with the economic opportunity cost of capital of 12%.[7] The viability of the investments was then tested through sensitivity analysis under scenarios in which such key variables as capital costs, operations and maintenance (O&M) costs, and benefits changed from those anticipated. Distribution of project benefits and poverty impact

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1 This was the Ministry of Industry, Mines, and Energy until 2014.

2 Royal Government of Cambodia. 2013. *Rectangular Strategy for Growth, Employment, Equity, and Efficiency – Phase III*. Phnom Penh.

3 ADB. 2011. *Water Operational Plan, 2011–2020*. Manila.

4 ADB. Forthcoming. *Country Partnership Strategy: Cambodia, 2014–2018*. Manila.

5 ADB. 2013.*Cost-Benefit Analysis for Development – A Practical Guide;* ADB. 1997. Guidelines for the Economic Analysis of Projects; ADB. 1999. *Handbook for the Economic Analysis of Water Supply Projects;* and ADB. 1994. *Framework for the Economic and Financial Appraisal of Urban Development Sector Projects*.

6 ADB. 2012. *Report and Recommendation of the President to the Board of Directors: Cambodia Greater Mekong Subregion Economic Corridor Towns Development Project.* Manila.

7 An economic internal rate of return that exceeds the assumed economic opportunity cost of capital indicates that the project is economically viable.

analyses were also undertaken to determine how much of the net economic benefits resulting from the investments will directly benefit the poor.

5. Socioeconomic surveys were conducted in July 2013 for the four subproject towns with full feasibility study reports—Kampong Cham, Siem Reap, Stung Treng, and Svay Rieng. In accordance with the benefit transfer method of analysis, the results of the Kampong Cham survey were used for the other five subproject towns where no survey was conducted.[8]

C. With- and Without-Project Situations

6. **Kampong Cham**. Kampong Cham has two private water supply operators. One provides untreated water to about 105 customers. The inadequate and minimal investment being undertaken to improve existing services and the high connection fee of the Kampong Cham PWW continue to deprive an increasing number of people in the town's expanding population of this basic service.[9]

7. **Kampong Thom**. The existing water supply system in Kampong Thom was constructed in 1946 and rehabilitated in 1962. It has a capacity of 350 cubic meters per day (m^3/day). The current water treatment plant (WTP) was built under ADB's Provincial Towns Water Supply Project (PTWSP) in 2006, with a capacity of 5,760 m^3/day. The system serves eight communes with a total served population of 45,947. The Sen River is the main source of raw water.

8. **Kampot**. Kampot's water supply system was originally established in 1951. During 1993–1996, WTP capacity was increased to 2,800 m^3/day under a project financed by a nongovernment organization based in the Netherlands.[10] Through a system upgrade under ADB's PTWSP in 2002, a new WTP with a capacity of 5,760 m^3/day was built and pipelines were rehabilitated.

9. **Pursat**. Pursat's original water supply system was built in 1926 but was destroyed during the late 1970s. Rehabilitation work was carried out on the system during 1993–2002. The capacity of the WTP was increased through the assistance of SAWA. The current WTP was constructed in 2006 under ADB's PTWSP and has a design capacity of 5,760 m^3/day.

10. **Siem Reap.** The current water source used by the Siem Reap Water Supply Authority (SRWSA) is groundwater. SRWSA has boreholes throughout the town, but households, hotels, and private business establishments are also making use of unregulated boreholes to abstract water. This widespread and unregulated practice is believed to be lowering the water table to such an extent that the nearby temples at the Angkor UNESCO world heritage site have already been affected.

11. **Sihanoukville**. Sihanoukville is undergoing significant industrial development that includes expanding port activities and tourism businesses and a brewery operation. However, the town's water supply infrastructure cannot support this growth sustainably. Before improvements were made in 1994 under a World Bank project to provide a treatment facility, residents were supplied with untreated water. A second World Bank project in 1998 expanded and rehabilitated the WTP and the distribution system.

12. **Stoung**. The Stoung WTP was designed and built in 2003 through a joint agreement between a town in Belgium, another in Italy, and the Stoung PWW. The water source is a stream adjacent to the WTP, which is served through wet and dry season inlets. The stream

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[8] The benefit transfer method is used to estimate economic values for services by transferring available information from studies already completed in another location and/or context.

[9] The cost of KR440,000 per connection is equivalent to about 1 month's salary for the PWW personnel.

[10] Sanitation and Water Action, a Dutch nongovernment organization.

sometimes dries out during the dry season however, and water must be pumped from a dam reservoir 30 kilometers away to replenish it.

13. **Stung Treng**. The Stung Treng WTP was constructed in 1962, and its raw water source is located on the Sekong River upstream of the confluence with the Mekong River. The WTP is in poor condition and not operating as designed. It suffers from leaks in the structural concrete and has no filtration or flow measurement or control systems. In 2009, the Stung Treng PWW supplied 1,490 households, and this had not changed by 2013.

14. **Svey Rieng**. Built in 1948, the Svey Rieng PWW system uses the Vaiko River as its raw water source. A WTP was built in 2006 under ADB's PTWSP, uses raw water from three deep boreholes, and can process 5,760 m^3/day. Currently, however, it can run only one pump at a time due to limited power supply.

15. The project is designed to improve operation, increase water quality, and provide security of supply. It will also provide additional water supply for Stung Treng and Svay Rieng, but it is not designed to increase supply capacity at the other six PWWs. The subproject in Siem Reap is intended to complete the pipe network in zone 1 of the town and the APSARA zone.

D. Economic Benefits

16. The following economic benefits were considered in evaluating the economic viability of the proposed water supply investments:

(i) The economic value of incremental water due to increased supply was determined based on the increase in water consumption from the without-project situation to the with-project situation. The economic value was computed by multiplying the total additional volume consumed by the economic value of water users, represented by willingness to pay.

(ii) Resource cost savings on non-incremental water were computed by multiplying the volume of water consumed by those who are not currently connected by the economic value of non-piped water. The current economic value of non-piped water was based on the estimated costs of treating and storing water. These were based on information gathered through the household surveys conducted in each of the subproject towns.

(iii) The economic value of time saved by households not currently connected to water supply was represented by the income loss avoided by household members (usually adults) who will not need to collect water from wells and other sources after households have connections to the piped water system.

(iv) The value of non-technical water losses saved was computed by multiplying the amount of water that would have been lost due to non-technical reasons with the average of the willingness-to-pay and the supply price of water.

(v) The value of health benefits was quantified 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. In 2004, the World Health Organization (WHO) estimated DALYs in Cambodia to be 38,451 per 100,000 population.[12] WHO also estimated that 10% of the total DALYs were related to water, sanitation, and hygiene issues.[13] Following the WHO approach, the analysis calculated

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[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. WHO adopted the method in 1996. The method of determining a DALY is regularly revised by WHO.

[12] WHO. 2004. *World Health Report*. Geneva.

[13] WHO. 2007. Environmental Burden of Disease Series No. 15 (Water, Sanitation and Hygiene). Geneva. A conservative estimate of 5% was assumed for this water project.

the annual economic value of a DALY as equivalent to the country's per capita gross national income (GNI) in a given year.[14] The country's estimated GNI per capita in 2013 was $2,890, based on purchasing power parity. Real GNI growth was 2% per annum.[15] Savings in DALYs attributable to each subproject were assumed to vary and to be 1%–80% of the calculated economic value of DALYs, depending on the scope and nature of the proposed physical improvements to the water and sanitation facilities in the town.

17. The analysis made annual projections of served populations, total connections, and water consumption for the with- and without-project situations. Projected water usage for the with-project situation was broken down into incremental and non-incremental water.[16] Other parameters and values used in quantifying the economic benefits of water supply improvement are shown in Tables 1 and 2.

Table 1: Parameters for Economic Benefit Computation (with Socioeconomic Survey)

Item	Kampong Cham	Siem Reap	Stung Treng	Svay Rieng
Willingness to pay (KR/m^3)	1,263	1,500	1,829	1,741
Average water consumption (lpcd)	133	120	97	117
Economic cost of storage facility (KR/m^3)	342	310	495	626
Economic cost of treating water (KR/conn/day)	104	113	162	147
Economically active population (%)	45	46	44	46
Economic average wage rate (KR/day)	5,232	10,555	4,132	8,049
Time spent in water collection (min/day)	45	45	60	45
Improvement in nontechnical NRW	1%	3%	3%	2%
Total savings in DALY (KR billion)	36	188	198	22
Savings in DALY due to project (%)	10	60	60	10

Source: Socioeconomic survey, July 2013.

Table 2: Parameters for Economic Benefit Computation (without Socioeconomic Survey)

Item	Kampong Thom	Kampot	Pursat	Sihanouville	Stoung
Water consumption (lpcd)	108	76	100	104	70
Improvement in nontechnical NRW (%)	1	1	0.2	1	1
Total savings in DALY (KR billion)	22	3	10	10	15
Savings in DALY due to project (%)	10	1	3	3	10

[a] The SES result for Kampong Cham was assumed for subproject sites without SES. This Was warranted by the fact that (i) Pursat, Kampong Thom, and Stoung are all situated on Tonle Sap Lake; and (ii) Kampot and Sihanoukville have similar tourism-based local economies.

Source: Socioeconomic survey, July 2013.

E. Economic Costs

18. Economic costs were derived from the estimates of capital and non-capital investments (project management and training component), replacement costs, and O&M costs in financial terms, removing price contingencies, duties, and taxes and multiplying the net results by the conversion factors. Based on the distribution of costs as to traded and non-traded components, the overall conversion factor for capital costs and O&M costs are 0.96 and 0.92, respectively.

[14] The WHO commission of macroeconomics and health assumes that each DALY can be valued at 1 year of per capita GNI to arrive at a conservative estimate of the economic value of a DALY.

[15] World Bank. 2012. *World Development Indicators*. Washington D.C.

[16] Details are presented in the Supplemental Appendix on Economic Evaluation.

F. Economic Internal Rates of Return and Sensitivity Analysis

19. Based on the estimates of the stream of economic benefits and costs over the 30-year analysis period, the economic internal rates of return were computed, and sensitivity tests were undertaken.[17] Table 3 summarizes the results of the base case and the sensitivity tests for the nine subprojects and the overall project evaluation.

Table 3: Economic Internal Rates of Return and Sensitivity Test Results

Subproject Town	Base Case	Scenarios				
		Investment Rise 10%	O&M Rise 10%	RCS Down 10%	Incr. Water Down 10%	Cost rise 10% Benefits down 10%
Kampong Chan						
ENPV (KR million)	2,809	2,380	2,658	2,703	2,809	1,368
EIRR (%)	20.8	18.9	20.4	20.5	20.8	16.0
Kampong Thom						
ENPV (KR million)	1,416	1,127	1,332	1,361	1,416	530
EIRR (%)	19.6	17.5	19.2	19.3	19.6	14.7
Kampot						
ENPV (KR million)	552	507	461	484	552	222
EIRR (%)	36.4	32.4	32.4	33.3	36.4	20.9
Pursat						
ENPV (KR million)	1,277	1,144	1,184	1,182	1,277	698
EIRR (%)	28.1	25.2	27.0	26.9	28.1	20.1
Siem Reap						
ENPV (KR million)	3,439	-415	2,961	3,150	2,441	-5,570
EIRR (%)	13.0	11.9	12.8	12.9	12.7	10.5
Sihanoukville						
ENPV (KR million)	759	628	614	691	759	130
EIRR (%)	20.7	18.6	19.1	19.9	20.7	13.4
Stoung						
ENPV (KR million)	1,459	1,327	1,339	1,393	1,459	809
EIRR (%)	27.3	24.8	26.1	26.6	27.3	20.0
Stung Treng						
ENPV (KR million)	-5	-3,871	-478	-225	-872	-8,680
EIRR (%)	12.0	10.9	11.9	11.9	11.7	9.5
Svay Rieng						
ENPV (KR million)	3,378	2,935	3,141	3,197	3,108	1,681
EIRR (%)	20.8	19.1	20.2	20.4	20.2	16.2
Total Project						
ENPV (KR million)	15,084	5,763	13,211	13,963	12,949	8,813
EIRR (%)	13.9	12.7	13.6	13.7	13.6	10.9

EIRR = economic internal rate of return, ENPV = economic net present value, RCS = resource cost savings.
Source: ADB estimates.

a. Project Sustainability

20. Project sustainability is highly dependent on the implementation of the proposed water tariff increases, connection of prospective customers, and the ongoing sector reform by the MIH. A strategy to provide supply connections to poorer households with subsidies of up to 100% will be implemented under the project and are discussed under the financial analysis.[18]

b. Distribution of Net Economic Benefits and Poverty Impact

21. The nine subprojects are expected to generate total net economic benefits of KR987–KR7.7 billion. The computed poverty impact ratios for the water supply investments are 17%–23%. Poverty incidence in the service areas is about 20%.

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[17] Annual stream of benefits and costs are shown in the Supplementary Appendix on Economic Evaluation.
[18] Financial Analysis is accessible from the list of linked documents in Appendix 2