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Network on Water Technology in Asia and Pacific

Provincial Water Supply and Sanitation Project, Cambodia

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Summary

Cambodia is a strategically important country located in the southern portion of the Indochina peninsula in Southeast Asia. Though the country is one of the fastest growing economies in Asia, the low level of access to safe water in the rural areas still remains as a major concern. The Provincial Water Supply and Sanitation Project was intended for improved piped water supply, sanitation and institutional effectiveness in four selected towns of Cambodia. The total cost of the project is USD 119.17 million and is scheduled for completion by 2022. The project finances two water supply subprojects (in Battambang and Kampong Cham), including two new water treatment plants with a combined capacity of 61,600 m^3/day which will achieve 90% population coverage by reaching out to an additional 209,000 people by 2022. The project will also finance four sanitation subprojects which includes a new 10,625 m^3/day capacity WWTP at Battambang, a septage management system in Kampong Cham, expansion of the Sihanoukville WWTP to 20,500 m^3/day and 32.1 km of new sewers and a new 3.7 km trunk sewer in Siem Reap, constructed using trenchless technology. Finally, the project will also strengthen institutional effectiveness in Ministry of Industry and Handicraft (MIH), Ministry of Public Works and Transport (MPWT) and provincial waterworks.

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Acronyms and Abbreviations

ADB	Asian Development Bank
AFD	Agence Francaise de Developpement
AIF	Asia Investment Facility
ASEAN	Association of Southeast Asian Nations
DPWS	Department of Potable Water Supply
DRHC	Department of Rural Health Care
DRWS	Department of Rural Water Supply
EIRR	Economic Internal Rate of Return
FIRR	Financial Internal Rates of Return
JFJCM	Japan Fund for the Joint Crediting Mechanism
JICA	Japan International Cooperation Agency
km	kilometer
m^3/day	cubic meter per day
MIH	Ministry of Industry and Handicraft
MPWT	Ministry of Public Works and Transport
O&M	Operation and Maintenance
PPWSA	Phnom Penh Water Supply Authority
RGC	Royal Government of Cambodia
SRWSA	Siem Reap Water Supply Authority
TA	Technical Assistance
USD	United States Dollars
WSS	Water Supply and Sanitation
WTO	World Trade Organization
WTP	Water Treatment Plant
WWTP	Wastewater Treatment Plant

1 Introduction

Cambodia, officially the Kingdom of Cambodia, is a country located in the southern portion of the Indochina peninsula in Southeast Asia with a population of over 16 million. It is 181,035 square kilometres in area, bordered by Thailand to the northwest, Laos to the northeast, Vietnam to the east and the Gulf of Thailand to the southwest. The capital and largest city is Phnom Penh which is also the political, economic and cultural centre of Cambodia. Cambodia is a strategically important country being a member of the United Nations, ASEAN, East Asia Summit, WTO etc., The country still has widespread poverty, pervasive corruption, lack of political freedoms, low human development and a high rate of hunger. While per capita income remains low compared to most neighboring countries, Cambodia has emerged as one of the fastest growing economies in Asia, with growth averaging 7.6 percent over the last decade. Figure 1 presents the location of Cambodia in the world and the region, along with its provinces.

Water supply in Cambodia is characterized by a low level of access in rural areas compared to relatively high access to an improved water source in urban areas. In 2015, 76% of the population had access to improved water, 100% in urban areas and 76% in rural areas. Still, in 2015, around 9 million did not have access to improved water. Within the government, urban water supply policy is the responsibility of the Ministry of Industry, Mines and Energy. Service provision in urban areas is the responsibility of two water utilities in the largest cities, the Phnom Penh Water Supply Authority (PPWSA) and the Siem Reap Water Supply Authority (SRWSA), 11 Provincial Water Supply Authorities (known as PWWKs) as well as 147 smaller utilities. The Department of Rural Water Supply (DRWS) and Department of Rural Health Care (DRHC) of the Ministry of Rural Development are responsible for rural water supply for the smaller towns and villages with less than 1,000 households. The performance of the Provincial Water Supply Authorities, measured in terms of access, cost recovery through tariff revenues and non-revenue water, lags behind the performance of PPWSA which has improved its performance significantly in the late 1990s and early 2000s. In 2012 the government of Cambodia launched a plan to bring the performance of the provincial utilities to levels comparable to those achieved by PPWSA by 2015, including their financial autonomy. Many international organizations including ADB provide support for drinking water supply in Cambodia through local NGOs.

The Provincial Water Supply and Sanitation Project in Cambodia is within the scope of the government's rectangular strategy for growth, employment, equity, and efficiency, Cambodia's NSDP (2014-2018), and private sector partnerships, augmentation of the management of publicly owned waterworks, and integrate urban water supply with urban environmental management. The project supports ADB's Water Operational Plan (2011-2020) to improve the efficiency of water services. The project preparatory technical assistance (PPTA) prepares a strategy and road map for Cambodia's urban water and sanitation sector. It also aligns with two of the three pillars of ADB's country partnership strategy for Cambodia, namely pillar 1 to strengthen rural, urban, and regional linkages through investments in water supply and sanitation infrastructure and services; and pillar 3 to support public sector management by helping to decentralize and expand public financial management capacity for the water supply and sanitation sector.

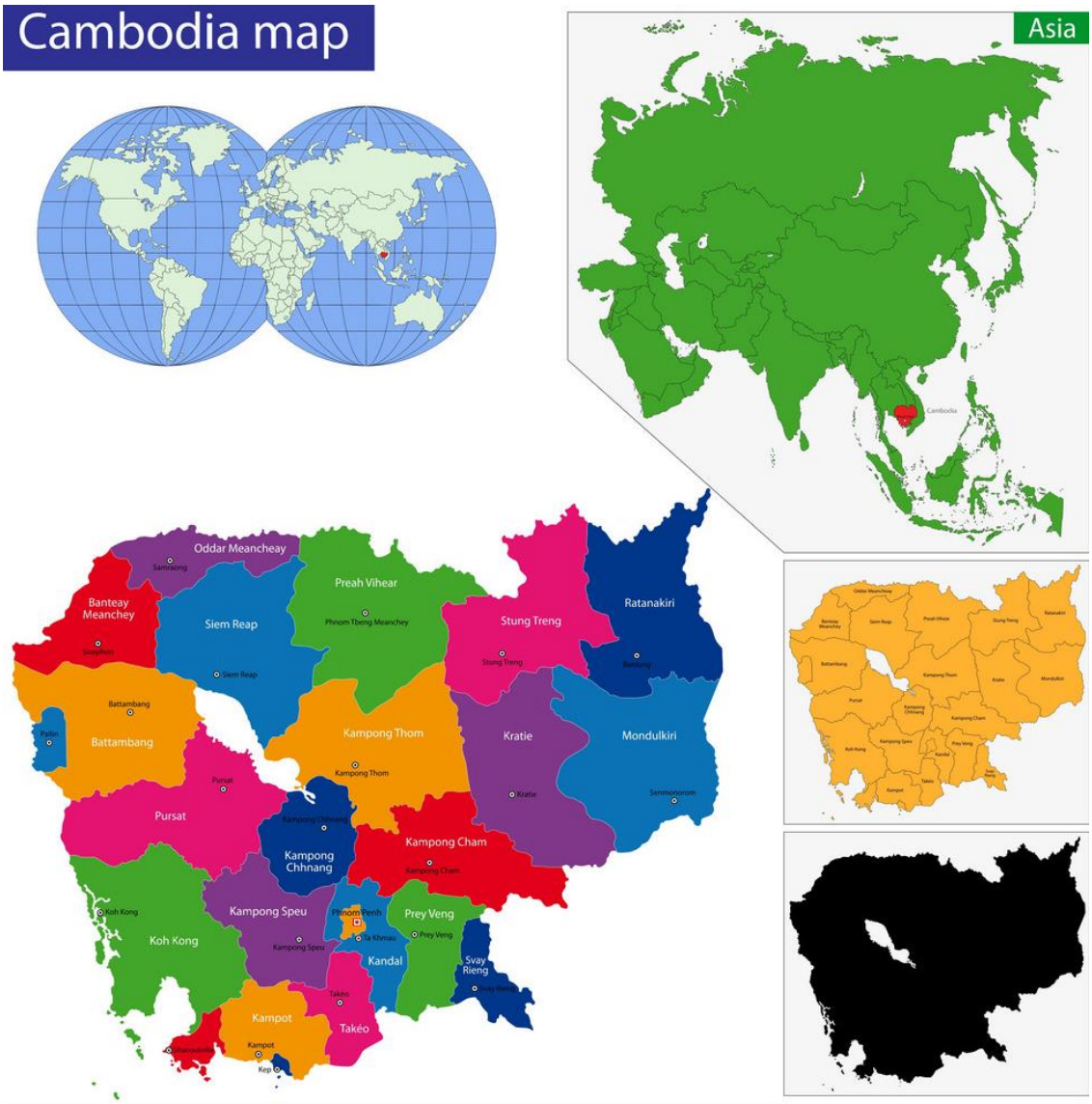

Figure 1: Location of Cambodia in the world and Asia along with the provincial map

Investment in the urban water and sanitation sector has centered primarily on Phnom Penh, the capital and largest city. Infrastructure and institutional development in provincial towns has suffered from inadequate levels of investment, relying mostly on official development assistance from numerous bilateral and multilateral development partners for financial support, including ADB. Inadequate urban water supply and sanitation infrastructure and services are highly visible throughout the country. The Department of Potable Water Supply (DPWS) under the Ministry of Industry and Handicraft (MIH) is responsible for the coordination, policy, and regulation of urban water supply in Cambodia. Urban sanitation is primarily the responsibility of the Ministry of Public Works and Transport (MPWT) through its provincial departments and includes coordination, policy, and regulation. Separation of responsibilities for urban water supply and urban sanitation has resulted in a lack of coordination and integration of services countrywide, and the financial sustainability of sanitation has been severely affected. The final PWSSP

comprises the four selected towns of Sihanoukville (sanitation), Battambang (water supply and sanitation), Siem Reap (sanitation), and Kampong Cham (water supply and sanitation).

Output 1: Improved piped water supply

The project finance two water supply subprojects (in Battambang and Kampong Cham), including two new water treatment plants with a combined capacity of 61,600 m^3/day and new distribution networks with a combined length of 161 km. The expanded systems will serve an additional 209,000 people (about 40,000 connections) by 2022 (achieving a population coverage of about 90%), increasing revenues and reducing unit costs through increased economies of scale. The project will assist the government to develop a subsidized connection policy, similar to the PPWSA approach, to encourage connection by poor and disadvantaged households (covering about 15% of connections). New laboratory equipment improves monitoring and water quality testing.

Output 2: Improved sanitation

The project finances four sanitation subprojects which includes a new 10,625 m^3/day capacity WWTP at Battambang and 15.4 km of new sewers, a septage management system (collection, treatment, and disposal) in Kampong Cham, expansion of the Sihanoukville WWTP from 6,900 m^3/day to 20,500 m^3/day and 32.1 km of new sewers and a new 3.7 km trunk sewer in Siem Reap, constructed using trenchless technology to limit disturbance to business and tourism activities.

Output 3: Improved institutional effectiveness

The project strengthens institutional effectiveness through improved coordination between MIH and MPWT, provide continued support to help provincial waterworks, and support the MIH to develop its regulatory role. It improves staff capacity in project implementation of urban WSS projects and O&M through on-the-job training. The project helps to develop a new master's program in water and wastewater engineering with the Institute of Technology of Cambodia to support future graduates in the sector.

Table 1: Overview of the water supply project (ADB, 2017)

Items		Description
Project Name	:	Cambodia: Provincial Water Supply and Sanitation Project
Type	:	Water and other urban infrastructure and services
Donor Name	:	i. Asian Development Bank ii. Agence Francaise de Developpement iii. Japan Fund for the Joint Crediting Mechanism iv. Cambodian Government v. European Union – Asia Investment Facility

Project rationale and objectives	:	i. water supply systems improved and service coverage increased through the development of new water supply intakes and treatment facilities, replacement of old water mains, and expansion of the distribution network ii. septage management and sewerage services provided through the provision of septage collection and treatment and the development of expanded sewerage systems iii. project implementation and operation and maintenance (O&M) developed to complement ongoing institutional development and capacity building in procurement, financial management, and governance.
Project Components		i. Battambang Water Supply ii. Kampong Cham Water Supply iii. Battambang Wastewater subproject iv. Sihanoukville Wastewater subproject v. Kampong Cham Septage subproject vi. Siem Reap Wastewater subproject
Project Fund	:	Total: USD 119.17 million Asian Development Bank: USD 50 million Agence Francaise de Developpement: USD 43.54 million Asia Investment Facility: USD 5.09 million Japan Fund for the Joint Crediting Mechanism: USD 10 million Cambodian Government: USD 8.50 million
Project Duration	:	March 2019 – June 2024

2 Technical and Technological Brief

Battambang Water Supply

This subproject is expected to expand the system to meet demand in growth areas within the city for 24-hour supply and improved water quality and to meet Cambodia's national drinking water standards. There are three components viz., the intake station, water treatment plant and water supply network. The service coverage is expected to improve towards 85-100% by 2025 and 95-100% by 2040. Noteworthy, water security will be ensured for an additional 27,861 households consisting of 143,861 people including 74,520 women by 2022. The existing Battambang water supply system serves 69,939 persons and the system was expanded with construction of a new water treatment plant (WTP) commissioned in 2016 with a total capacity of 33,520 m^3/day.

The new WTP will be located on public land belonging to the Department of Industry and Handicrafts (DIH) with an area of 2.4 ha and is approximately 4 km from the town center. The proposed WTP will use similar treatment processes to those used in existing plants. Water will be extracted from the Sangké River. WTP construction will initially meet production capacity of 50,000 m^3/day by 2025, which will be further increased for 30,000 m^3/d by 2040. The water supply network will comprise the main transmission pipelines, the secondary distribution pipelines, and house connections and will be made of high density polyethylene (HDPE) with ductile cast iron (DCI) used in higher pressure situations, such as pump station pressure pipes. Pumping system will also be improved in two phases for 2025 and 2040 for the total capacity of the intake as 28,896 m^3/d. The transmission main from the intake to WTP is 630 mm diameter HDPE pipe with a flow of 1.83 m/s.

Kampong Cham Water Supply

The Kampong Cham water supply is expected to ensure urban water supply in priority urban and suburban areas and will comprise three components: the intake station, WTP and water supply network. On completion of the subproject works in 2022 a further 15,775 households with a population of 65,194 people will have access to the extended water supply network, including 33,249 women (51%). In 2015 the Kampong Cham water system served 36,041 persons, about 79% of the total households (8,823) in the service area, with 6,931 connections. The existing WTP produces 8,000m^3/day and a new JICA funded WTP commissioned in July 2016, added an additional 11,500 m^3/day. Water is sourced from groundwater bores (for the previous supply system) and the Mekong River, for the new recently commissioned extensions. The WTPs operate 24 hours/day and have a total capacity of 19,500 m^3/day. The total piped network of 166.5 km serves an overall coverage area of 443 km^2. Figure 2 presents the water supply pipelines in Kampong Cham. The water intake for the planned improvements to be constructed under the subproject will be located at the river margin approximately 50m downstream from the recently commissioned JICA funded intake station, on land allocated by the provincial governor. The structure will have adequate space for the installation of additional pumps for the capacity beyond 2026 to year 2040 (Phase 2). In the meantime, the pump and electrical facilities will be installed with capacity for year 2025 (Phase 1) requirements. The new WTP to cover the demand of 11,600 m^3/day until 2025 is to be located in a public land some 3km from the present provincial waterworks office. A conventional treatment plant is proposed with processes similar to the existing plants. The reticulation pipelines will consist of distribution pipelines comprising transmission mains, secondary pipelines and house connections. All distribution pipes will be HDPE. Ductile cast iron (DCI) may be used for pressure pipelines such as the raw water transmission main from the water intake to the WTP. The proposed subproject components will supplement the existing system and support RGC's policy on water supply in providing safe water to all people by 2025. To cover the water demand for the next 20 years (2040), and to achieve a connection coverage of 90-100% in Kampong Cham and 85% of the three communities nearby the town, the subproject provides for: (i) additional WTP capacity of at least 17,000 m^3/day to provide sufficient capacity until 2040, (ii) 120km of reticulation network to extend the coverage area to 3,489 ha, (iii) provision in the medium term to serve a population (2025) of approximately 140,318 persons out of which 71,562 are

women (50.9%) in 31,182 families. An existing laboratory will be extended and equipped with further laboratory water quality testing equipment, basic tools, leak detection equipment and office equipment will be provided and training will be provided in water quality testing.

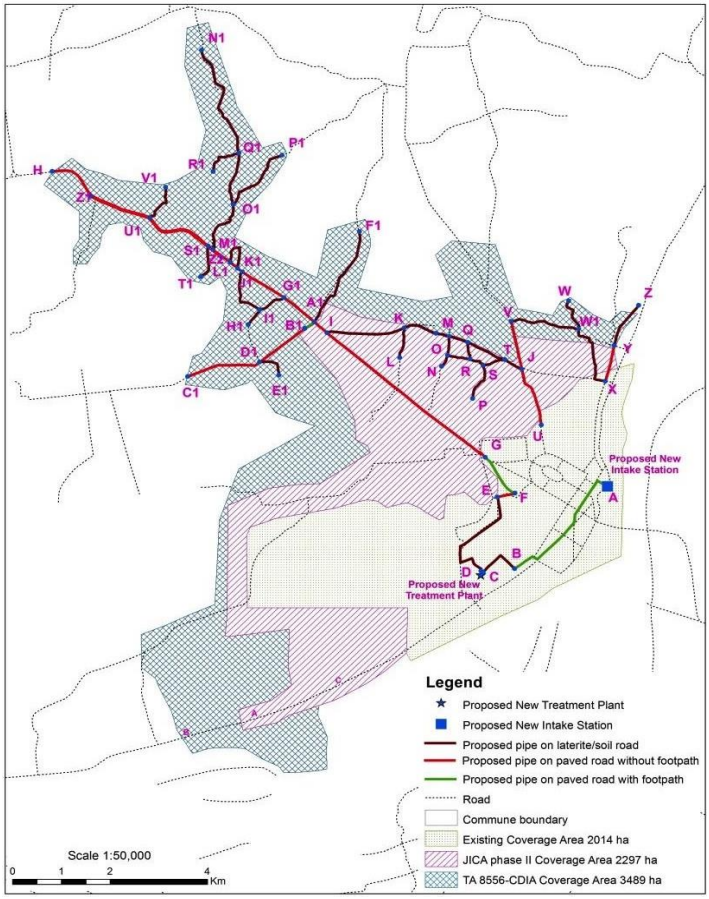

Figure 2: Water supply pipelines in Kampong Cham

Battambang Wastewater subproject

This subproject aims to extend and improve existing facilities in Battambang town to increase the capacities to handle projected sewerage loadings from the area for which service coverage is proposed up to 2025, containing the densely populated areas of the town centre to the west of the Sangké River, and most of the intermediately populated areas just outside the centre, to the year 2040. It is expected to directly benefit some 8,500 households (HHs), with 46,750 inhabitants who will be connected to the sewer. Battambang currently has a 1,000m^3/day lagoon-based wastewater treatment plant (WWTP) that was constructed in 1994 which was intended to serve 15,000 people over 89ha of the core city area on the west side of the Sangké River. The treatment plant is still operating but is now limited to a capacity of 450m^3/day because of general degradation of the system. The sewerage network in the town center is at present combined with the storm water system and consists of concrete pipes from 800mm to 1500mm in diameter, installed between the colonial period and recent years. The existing pipes flow in a north-westerly

direction to discharge into rice fields and a flood plain near the proposed new wastewater treatment plant. Figure 3 presents the existing WWTP in Battambang.

Figure 3: Existing WWTP in Battambang

The subproject is divided into two phases where Phase 1 covers an area of about 415 ha to the west of the river, designed to collect wastewater up to the year 2040, covering three densely populated sangkats. Phase 2 is designed to collect wastewater from an extended area of four suburban communes further westward from the river as these communes develop, beyond 2025, again to year 2040. The subproject will comprise decommissioning the existing 5.8 ha WWTP lagoon site, construction of a new WWTP at a new location, immediately outside the city, installation of trunk sewers, construction of pump stations and installation of smaller diameter collector pipelines in the secondary streets.

Sihanoukville wastewater subproject

This subproject significantly expands wastewater services in the city by increasing the capacity of the existing lagoon based WWTP on the same land footprint, tripling the existing wastewater treatment plant capacity. Over 10,000 HHs containing 46,217 people will be benefitted through this subproject. The existing lagoon wastewater treatment plant was constructed and commissioned in 2008 with a total capacity of 6,900 m^3/day. The sewerage system currently serves the central part of the town with total area 321 ha. The subproject aims to increase the capacity of the wastewater treatment plant, the coverage of the sewer network, including extension of trunk mains and local conveyance pipelines and the installation of pump stations in each sub-catchment of the extended service area. Improved septage disposal and treatment facilities will also be provided. it will comprise (i) trunk sewer expansion, (ii) increased capacity of the existing wastewater treatment plant (WWTP), (iii) sludge and septage management and (iv) installation of area pump stations. Unplasticized polyvinyl chloride (uPVC) pipe is proposed for trunk sewers with a diameter of 400 mm or less and for the conveyance pipes of 100mm diameter or less that are to be

installed along the roads within the proposed service areas. Glass reinforced plastic (GRP) or reinforced concrete pipe is proposed for all trunk sewers with a diameter greater than 400 mm. The upgraded wastewater treatment plant requires regular sampling of influent and effluent waters and periodical desludging of the anaerobic lagoons when they approach 50% depth of settled sludge. Concrete access ramps to the ponds, a compact mobile excavator and a dewatering container and sludge pumps will be provided for the purpose. A vacuum truck is also to be provided to Provincial Department of Public Works (DPWT). Dewatered sludge can be used as cover for the city's proposed landfill. Figure 4 depicts trunk sewers in Preah Sihanoukville whereas Figure 5 shows the existing facilities in the WWTP.

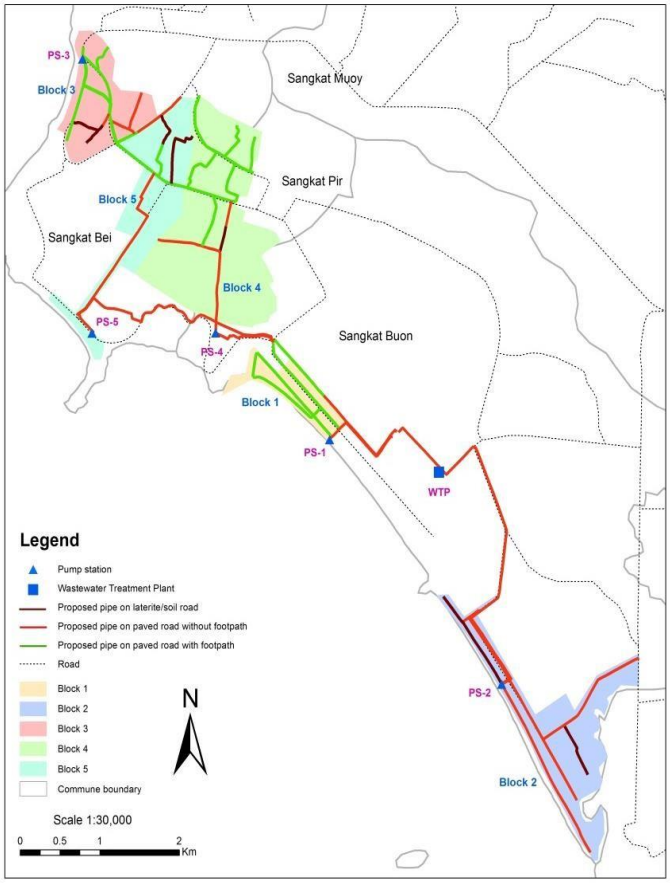

Figure 4: Trunk sewers in Preah Sihanoukville

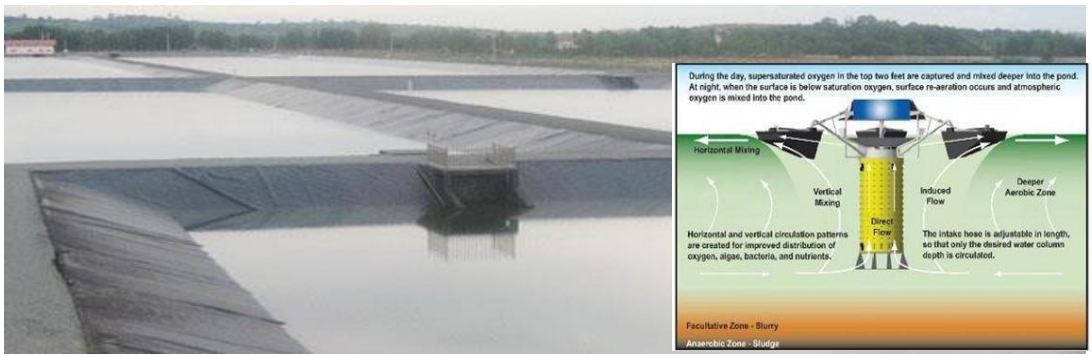

Figure 5: Existing WWTP and Proposed Solar Aerators in Sihanoukville

Kampong Cham Septage Subproject

The present combined sewer system serves only limited people in central area, handling both wastewater and stormwater and drains directly into the Mekong River. Very few toilets are connected to the sewer, since septic tanks are widely established. Figure 6 shows the proposed layout of septage area. A new separate and self- contained septage receiving and treatment facility and associated equipment will be accomplished through this subproject. The treatment units include receiving well, primary lagoons, maturation pond, dewatering container, sludge pumps and sludge drying bed as well as a mobile excavator. 36,031 people are expected to be benefited through this subproject.

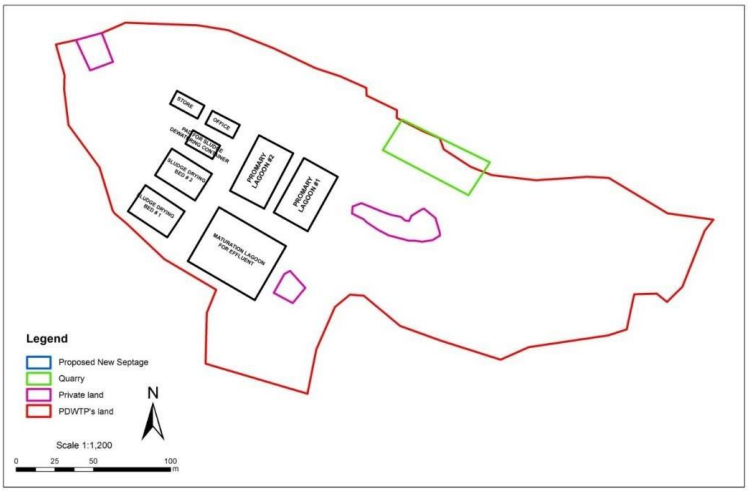

Figure 6: Proposed Layout of Septage Area

Kampong Cham currently has no wastewater collection system other than direct or indirect disposal to road drains by households and businesses or septage treatment facilities. Vacuum trucks dispose of the sludge from septic tanks in open fields, resulting in contamination of the fields. The proposed site of the septage facility is a 5.2 area of largely scrub land in Phkay Proek village area, about 18 km outside Kampong Cham. Existing land use is mainly degraded shrub land interspersed with some irrigated rice fields, and quarrying for building stone. However, the DPWT has expressed concerns about the distance of the site from the town and an effort is continuing to locate a suitable alternative site closer to Kampong Cham (ADB, 2017).

Siem Reap subproject

This subproject replaces and upgrade a 3.7km length of failed main trunk sewer. The opportunity is also being taken to upgrade the size of the pipe to accommodate increased future flows. The sewer was commissioned in 2010, is made of glass reinforced plastic (GRP) pipe and was designed and installed to collect wastewater from the center of Siem Reap over an area of 2.4 km2. At present the pipeline is not functioning, preventing wastewater in a central part of the town from reaching the wastewater treatment plant (WWTP) and causing it to back-up and be discharged over overflow weirs into the town drainage, until being finally released onto the lower lying land beyond the town. The sewer is to be replaced with a stronger pipe made of ductile iron, installed using trenchless technology. It connects to a WWTP of

capacity 2,776m3/day, intended to serve only the central area of Siem Reap. The use of trenchless technology (as shown in Figure 7) has been proposed following an examination of options and provides a cost-effective solution that entails less disruption to traffic and business and less spoil than open trenching would generate during the construction period.

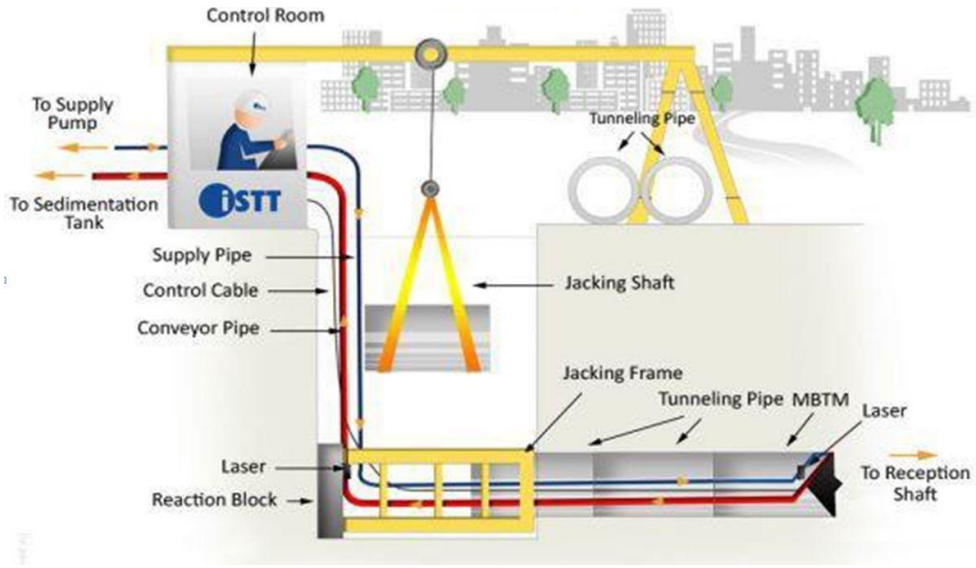

Figure 7: Trenchless Technology – Micro-tunneling

3 Financial brief

The total project cost, including contingencies and financing charges during implementation, was estimated at USD 119.17 million (100%). The ADB concessional loan was envisaged to be USD 50.00 million (41.96%) of the total project cost. The AFD loan was envisaged to finance USD 43.54 million (36.54%) of the total project cost. The JFJCM grant is expected to be USD 10 million (8.39%) of the total cost. The government finance the local currency costs of USD 10.54 million equivalent (8.84%). The EU-AIF grant was envisaged as USD 5.09 million (4.27%) of the total cost of the project. The project cost by different component is presented in Table 2. The plant and civil works is estimated to cost USD 92.109 million. The land acquisition and resettlement is estimated as USD 0.342 million. Vehciles and Equipment is estimated to cost USD 1.333 million. A cost of 1.110 million is earmarked for capacity building. The cost of USD 0.428 million is earmarked for community behaviour change communication. Consulting services are expected to cost USD 6,619 million, whereas PIM cost is estimated as USD 1.943 million.

Table 2 Project Investment Plan

Item	Project component	Amount (USD million)
A.	**Base Costs**	
	1. Improved piped water supply	45.70
	2. Improved sanitation	46.41
	3. Improved institutional effectiveness	11.77
	Subtotal (A)	**103.88**
B.	**Contingencies**	**13.91**

C.	**Financing Charges During Implementation**	**1.38**
	Total (A+B+C)	**119.17**

4 Project Features

4.1 Technical and technological features (ADB, 2017)

1	Battambang Water Supply	1) The subproject comprises three components: the intake station, water treatment plant and water supply network. 2) The capacity of the Water Treatment Plant (WTP) is 11,520 m^3/day, with an average production of 11,328 m^3/day with source from Sangké River. In 2016, a new WTP constructed under JICA funded project was brought into operation with a renewed capacity of 33,520 m^3/day. 3) The site for the new WTP to meet future demand is located on public land belonging to the DIH of Battambang at Chrabkrosaing at Battambang town. 4) The proposed WTP uses treatment plant processes similar to existing plants constructed with previous ADB and JICA financing. 5) Phase I has a production capacity of 50,000 m^3/day for demand to 2025. The second phase works have the capacity to produce a further 30,000 m^3/day for the period between 2026 and 2040. 6) The water supply reticulation network comprises the main transmission pipelines, the secondary distribution pipelines, and house connections. 7) All transmission and distribution pipes are to be of high density polyethylene (HDPE) with ductile cast iron (DCI) used in higher pressure situations, such as pump station pressure pipes. 8) The total capacity of the pumping intake is 28,896 m^3/d. There are 2 duty pumps with each pump having a capacity of 168 l/s. The diameter of suction pipe is 450 mm and the discharge pipe is 300 mm with a flow velocity of 2.38 m/sec. A packaged booster system is also used at the WTP. The raw water transmission main from the intake to the WTP is 630 mm diameter HDPE pipe with a flow velocity of 1.83 m/s.
2	Kampong Cham Water Supply	1) The subproject of Kampong Cham water supply comprises three components: the intake station, water treatment plant and water supply network. 2) The existing WTP produces 8,000 m^3/day with a new JICA WTP which was established in July 2016, resulting in total capacity of 19,500 m^3/day with ground water and Mekong river as source. The total piped network of 166.5km serves an overall coverage area of 43 km^2.

		3) The new WTP to cover the demand until 2025 is to be located in a public land belonging to the Kampong Cham DIH at Ta-Neng in Kampong Cham. 4) A conventional treatment plant is proposed with processes similar to the existing plants funded by ADB and JICA. 5) All distribution pipes are HDPE. Ductile cast iron (DCI) are used for pressure pipelines such as the raw water transmission main from the water intake to the WTP. 6) The subproject provides for additional WTP capacity of at least 17,000 m^3/day to provide sufficient capacity until 2040; 120km of reticulation network to extend the coverage area to 3,489 ha 7) A laboratory supported by the JICA water supply project will be extended .
3	Battambang Wastewater subproject	1) Battambang currently has a 1,000 m^3/day lagoon-based WWTP but is now limited to a capacity of 450 m^3/day because of general degradation of the system. 2) The existing pipe network are to be retained for stormwater only, with wastewater separated in the new system. 3) The subproject involving the initial Phase 1 activities has 5 main components viz., decommissioning the existing 5.8 ha WWTP lagoon site, construction of a new wastewater treatment plant (WWTP), installation of trunk sewers, construction of pump stations and installation of collector pipelines in the secondary streets. 4) The new WWTP is located on a 6.6 ha site in Chrey Kaong at Battambang town consisting of 4 anaerobic ponds, 4 trickling filters, a sludge drying bed and a septage receiving facility with a drying bed, dewatering container, and equipment for desludging and site cleansing. 5) There are in total 3 pump stations proposed for the Phase 1 service area, two pumps in the town and one at the WWTP. 6) Pipe diameters of the trunk sewer in the range from 100 mm to 450 mm with a total length of 15.39 km for the phase 1 area. Small diameter collection mains of 100mm diameter or less with a total length of 46km are also constructed along both sides of the roads in the service area for household and property connections. 7) The materials proposed for the trunk sewer pipes are glass reinforced plastic (GRP) or reinforced concrete for the largest pipes above 400mm diameter and unplasticized polyvinyl chloride (uPVC) for pipes with diameter of 400mm and under. 8) Free connections are provided to all existing residential properties in the proposed new Phase 1 service area with the

		provision of some 8,500 new connections by 2022 on completion of the proposed civil works.
4	Sihanoukville Wastewater subproject	1) The subproject has 4 components: Trunk sewer expansion, increased capacity of the existing wastewater treatment plant (WWTP), Sludge and septage management and installation of area pump stations. 2) The subproject extends the future service area to 5 new blocks. 3) The proposed trunk sewer development and the location of five proposed pump stations to be sited at the lowest point of each catchment 4) Unplasticized polyvinyl chloride (uPVC) pipe is proposed for trunk sewers with a diameter of 400 mm or less and for the conveyance pipes of 100mm diameter or less that are to be installed along the roads within the proposed service areas. 5) Glass reinforced plastic (GRP) or reinforced concrete pipe is proposed for all trunk sewers with a diameter greater than 400mm. 6) Trunk mains of 250mm to 1,200mm diameter of some 32.1 km total length and conveyance pipelines of 100mm diameter and 45.27 km length is constructed. 7) The connections are expected to rise to 5,075 by 2020. 8) The WWTP capacity is increased to 20,500 m^3/day, with all work accommodated within the existing land footprint of the WWTP site. 9) The dewatered and thickened sludge from the lagoon will be carried to the landfill for disposal.
5	Kampong Cham Septage subproject	1) An assessment of the septic tank situation is carried out. This study looks at a uniform septic tank design and guidelines for maintenance and desludging. 2) This subproject proposes a new separate and self-contained septage receiving and treatment facility with receiving well, primary lagoons, maturation pond and sludge drying bed. 3) Collection, cleansing and desludging equipment (vacuum truck, water blaster, small wheeled excavator, sludge pump and dewatering container) for improved septage management is expected. 4) Septage treatment facility for receiving waste collected is established. 5) The proposed site of the septage facility is a 5.2 ha area of land in Phkay Proek in Prey Chhor district, about 18 km outside Kampong Cham. 6) Treated and dried sludge is disposed of at approved land fill sites where it is suitable for use as a cover material. 7) Capacity building for DPWT and private vacuum truck operators and a public awareness campaign aimed at increased understanding of the operation of septic

		tanks and the need for maintenance and appropriate disposal.
6	Siem Reap Wastewater subproject	1) This subproject involves replacement of 3.7 km length of obsolete main trunk interceptor sewer. The size of the pipe is increased to meet higher flows in the future. The pipeline which was commissioned through Mekong Tourism Development project has failed and collapsed in five location points. 2) This 3.7 km interceptor sewer which was earlier made of glass reinforced plastic pipe, collecting wastewater from WWTP of 2,776 m3/day capacity at central Siem Reap, is replaced with ductile iron through trenchless technology. 3) A separate eastern WWTP is required to serve the eastern zone, considering the wastewater generated. 4) The study found that lifetime cost effectiveness was better for trenching up to a depth of 10 m without multiple in-line pumps. The use of an open trench is also problematic and therefore, the advanced trenchless technology using pipe thrusting, micro-tunneling, pipe bursting or pipe cutting and bursting are adopted.

4.2 Economic and financial features

The project is efficient in financial and economic terms. The economic internal rate of return (EIRR) and financial internal rates of return (FIRR) are found to be satisfactory, taking into account factors such as time savings and the economic benefits of improved water delivery, improved health, and increased revenue. The Ministry of Industry and Handicrafts (MIH), through its General Department of Potable Water Supply, oversees all public water utilities: Phnom Penh Water Supply Authority (PPWSA) and Siem Reap Water Supply Authority (SRWSA), both of which are autonomous, and 11 provincial waterworks (PWWs).

MIH's financial and technical support helped the other utilities become profitable and provide better services, replicating PPWSA's success. Financial projections indicate sustainability for every subcomponent of the project. The Ministry of Public Works and Transport (MPWT) through its General Department of Public Works and provincial departments (DPWTs) is responsible for urban sanitation. The subprojects are economically viable in the base case scenario and robust against downside risks. The subprojects' economic performances are most sensitive to benefits delay and reduction, but the performances remain above the required threshold levels (KR0 for net present value, 9% for economic internal rate of return) (ADB, 2017).

4.3 Social and environmental features

In Kampong Cham, the septage are mostly deposited onto agricultural land or at other locations where the practice is unmanaged and the suitability of the land to safely receive the septage has not been confirmed. This subproject ensures safe disposal of sludge. As a result, the people will

benefit from improved living environments and hygiene. The social impacts are overwhelmingly positive as the villages experience a better and reliable wastewater scheme and improved sanitation leading to an increase of their living quality. Free connections will be provided to all existing residential properties in the proposed new Phase 1 service area with the provision of some 8,500 new connections by 2022 on completion of the proposed civil works. The DPWTs with the assistance of the PIAC will convene meetings and arrange focus group discussions with project beneficiaries, including poor and vulnerable households, female headed households and affected peoples, to inform them of project purpose, scope, benefits and construction schedules and elicit views and feedback. Feedback will be recorded and used to input into design and implementation. Participants will be asked about their views on the severity of construction impacts and perceptions on environmental issues including the quality of effluent discharged at the WWTP. DPWT will record and implement appropriate actions with the support of the PIAC.

Piped water supplies shall be installed along the roads in priority locations with a potential for housing development and household connections. The main transmission network is designed to have sufficient capacity to handle projected supplies in the existing and extended areas up to year 2040. The water supply transmission and distribution pipes will be installed along road right-of-ways and where there is potential conflict with businesses occupying the road footpaths or squatter houses the pipes will be diverted and laid along the road edge or within the carriageway. The subproject will also include capacity building for DPWT and private vacuum truck operators and a public awareness campaign aimed at increased understanding of the operation of septic tanks and the need for maintenance and appropriate disposal. For the sustainability of the septage treatment facility it is vital to have both the support of the private vacuum truck operators through licensing and increased awareness of the owners of the septic tanks in proper upkeep, including regular emptying. Across Cambodia it is currently apparent that householders only empty their septic tanks as a last resort when there is an odor or drainage problem due to overflow of the septic tanks. The DPWT has expressed concerns about the distance of the site from the town and has questioned whether the facility will be used due to the time and cost of transporting the septage between the town and the facility. The operators mostly deposit the septage onto agricultural land or at other locations where the practice is unmanaged and the suitability of the land to safely receive the septage has not been confirmed (ADB, 2017).

5 Project Benefits

Around 302,022 people in 71,592 households are expected to have access to the extended water supply and wastewater systems provided under the Project by 2022. The project will expand and improve urban water supply and sanitation services in four of Cambodia's largest provincial cities, all of which are important commercial, industrial, and tourist centers in the country. A new energy efficient wastewater treatment plant will be established in Battambang. Currently, only 42.2% of the urban population, excluding the capital Phnom Penh have access to piped water supply, and while 80.2% have access to improved sanitation, only 10.7% have access to sewerage and wastewater treatment. The Provincial Water Supply and Sanitation Project will improve piped water supply in Battambang and Kampong Cham, benefitting an additional 209,000 people or about 40,000 connections by 2022, through the construction of two water treatment plants

with a combined capacity of 61,600 cubic meters per day and new distribution networks with a combined length of 161 km. This will increase coverage of piped water supply to about 90% of the population in the project cities, moving closer to the government's 100% target by 2025.

In Sihanoukville allowed for 3,368 connections in the existing service area which will rise to 5,075 connections by 2020. After completion in 2022, the wastewater subproject of Battambang is expected to directly benefit some 8,500 HHs who will have been connected to the sewer. The number of HHs accounts for 46,750 inhabitants of whom half are female. A new septage management system will also be constructed in Kampong Cham and a new 3.7 km trunk sewer will be built in Siem Reap to reduce pollution and improve the urban environment in this international tourist destination. Institutional capacity support will also be provided to relevant agencies and authorities (ADB, 2017).

Figure 8: Improved water supply in four of Cambodia's largest provincial cities

6 Implementation status of the project

It is envisaged that the project would be implemented over 5 years by December 2022. The ensuing loan was approved by ADB on December 2017 and advance actions for three major packages has commenced, with bidding commencing by February 2018. The TA was completed in December 2017. The tender was floated on March 2018 for Project Implementation Assistance Consultants. Bids were invited for water supply and sanitation project in April 2018. The tender for International Senior Sewerage/wastewater engineer was floated on May 2018. Tender for the recruitment of National Procurement Specialist and Executive Project Management Assistant was completed by August 2018. The tender for Executive Project Management Assistant was completed by March 2019. Figure 9 depicts the overall PWSSP Project Implementation Schedule. As shown in the figure, major part of the work is expected to be complete in next two years.

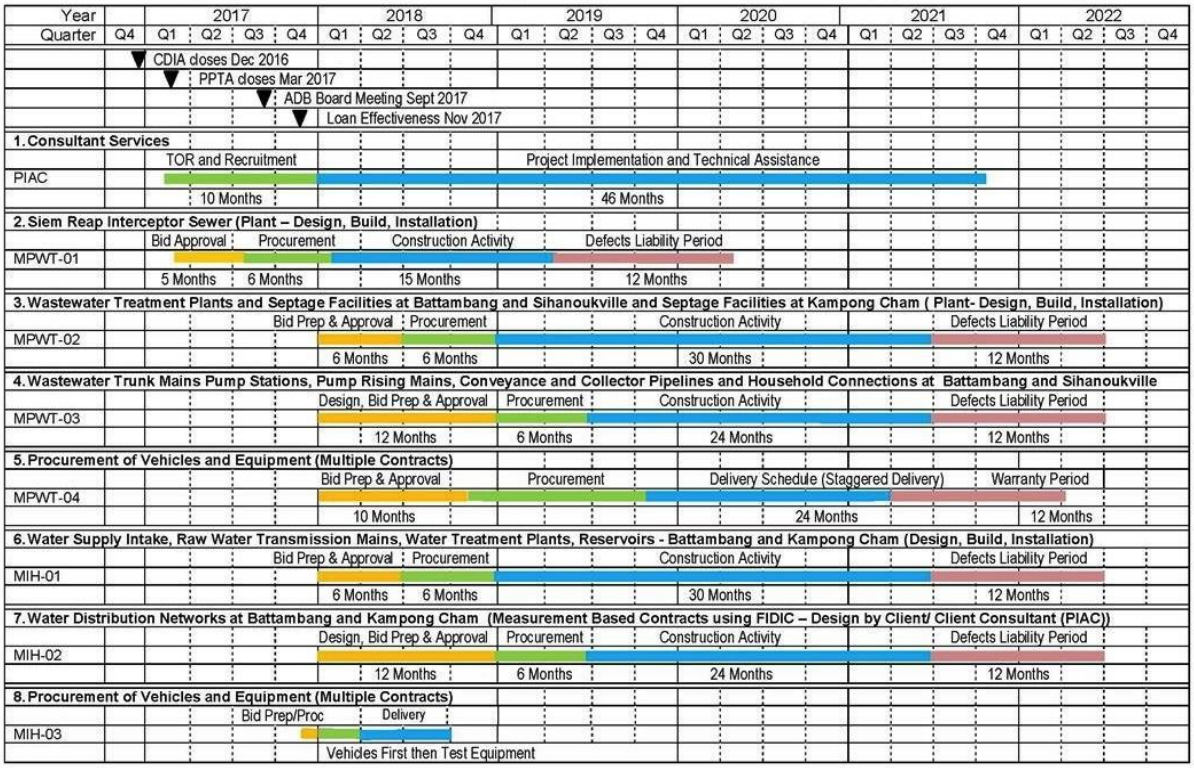

Figure 9: Overall PWSSP Project Implementation Schedule (ADB, 2017)

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