

# Detailed Economic Analysis

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Project Number: 53199-001  
July 2021

## Cambodia: Livable Cities Investment Project

## CURRENCY EQUIVALENTS

(as of 2 September 2021)

|               |   |           |
|---------------|---|-----------|
| Currency unit | – | riel (KR) |
| KR1.00        | = | \$0.00024 |
| \$1.00        | = | KR4,086   |

## ABBREVIATIONS

|       |   |  |
|-------|---|--|
| AAGR  | – | Average Annual Growth Rate   |
| ADB   | - | Asian Development Bank   |
| BOD   | - | biochemistry oxygen demand   |
| C&Is  | - | commercial and institutional entities  |
| CAPEX | - | Capital Expenditures   |
| CBA   | - | Cost-Benefit Analysis  |
| CCS   | - | Comprehensive City Survey of Households, Commercial Entities and Institutions  |
| CRVA  | - | Climate Change Risk and Vulnerability Assessment   |
| DALYs | - | Disability-adjusted life year. A measure of overall disease burden is expressed as the number of years lost due to ill-health, disability, or early death. |
| EIRR  | - | Economic Internal Rate of Return   |
| ENPV  | - | Economic Net Present Value   |
| EOCC  | - | Economic Opportunity Cost of Capital   |
| FCDI  | - | Financing Charges incurred during Implementation   |
| FIRR  | - | Financial Internal Rate of Return  |
| FNPV  | - | Financial Net Present Value  |
| GDP   | - | Gross domestic product   |
| GHG   | - | Greenhouse Gases   |
| HHs   | - | households   |
| LCIP  | - | Livable Cities Investment Project  |
| MA    | - | municipal administration   |
| MSW   | - | Municipal Solid Waste  |
| SCF   | - | Standard Conversion Factor   |
| SEZs  | - | Special Economic Zones   |
| SWM   | - | Solid waste management   |
| VAT   | - | Value Added Tax  |
| WHO   | - | World Health Organization  |
| WTP   | - | Willingness to Pay   |
| WWTP  | - | Wastewater Treatment Plant   |

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## SUMMARY OF ECONOMIC ANALYSIS

### A. Introduction

1. At the request of the Kingdom of Cambodia, the Asian Development Bank (ADB) is developing the Livable Cities Investment Project (LCIP) to facilitate long-term sustainable and economic growth in Bavet, Kampot and Poipet. The Project will focus on enhancing urban planning, building community resilience, and providing urban infrastructure (sanitation, solid waste management and drainage).

### B. Economic Outlook

2. Cambodia has made significant strides in economic development in recent years with economic growth averaging 7.7 % over the period between 1998 and 2019. Since that time, the opening of Cambodia's borders to international trade and investment has attracted foreign direct investment to support manufacturing, and tourism. As a result of Cambodia's sustained high growth and the percentage of Cambodians living under the national poverty line fell from 47.8% in 2007 to 13.5% in 2014. In the context of global health crisis, the economy is likely to contract by 3.1% (due to the impact of the COVID-19 pandemic) but is expected to increase to 4.0 % in 2021 and 5.5% in 2022.

### C. Sector Context

3. The pace of urbanization poses several challenges to cities with existing services no longer operating optimally and unable to meet demand. Many cities across Cambodia experience poor wastewater service, due largely to the absence of management along the sanitation chain and in particular, the lack of wastewater treatment plants (WWTP). Wastewater flows directly to the environment through combined sewers and road drains, or indirectly via open canals, into the open water. Most of the existing drainage lines are underdeveloped, filled with wastewater and raw black water. Similarly, solid waste services are also limited. Solid waste services are generally outsourced to the private sector, but a large proportion of municipal solid waste is left uncollected, dumped in stormwater channels or the open environment, or burned. The lack of a functioning drainage network and solid waste service exacerbates the impacts of flooding in many cities and towns.

4. The project aims to enhance urban planning, build community resilience and provide infrastructure that will facilitate long-term sustainable and economic growth. The project is aligned with the impact of improving the livability of secondary cities and will have the outcome of improving access to urban infrastructure and services in the participating cities. The project will comprise of three outputs:

- (i) **Output 1: Policy and regulatory environment improved.** The project will support the participating cities and stakeholders in developing resilient spatial planning and land use plans to inform and regulate future growth and development. Planning and service delivery guidelines on wastewater, stormwater drainage and municipal solid waste with climate resilient and gender responsive and inclusive measures will be prepared to provide guidance to the municipal administration in the operation, maintenance and delivery of sustainable and efficient services.
- (ii) **Output 2: Urban infrastructure improved.** The project will improve access to urban infrastructure through: (i) the construction of a WWTP and conveyance network in Bavet and Poipet, and the expansion of the sewerage network in Kampot; (ii) the

- rehabilitation of existing canals and construction of new stormwater drains in Bavet and Poipet; and (iii) the construction of landfills, including sorting and composting plants, in Bavet and Poipet. A behavior change campaign to promote awareness on pollution prevention and waste minimization measures will be developed.
- (iii) **Output 3: Institutional effectiveness and governance improved.** Institutional development road maps for each participating city will be developed that will guide the municipal administration to become self-sufficient service providers. It will include a tariff reform to cover operations and maintenance (O&M), and to reduce the risk of ineffective service delivery through poor maintenance of the infrastructure. A recruitment, mobility and training program will be developed to ensure regular skills development and women's participation in the sector will be encouraged through the promotion of women at technical and decision-making positions and scholarships for women in engineering or relevant disciplines.

## D. Demand Analysis

5. In the secondary cities of Bavet, Poipet and Kampot, existing urban services are no longer operating optimally and unable to meet demand. Although access to sanitation is high (90%-93% of the total population have access to pour/flush toilets), there are no WWTPs in operation and it is estimated that 74% - 91% of the excreta generated is unsafely managed. Only 14%-16% of the households have a solid waste collection service and it is estimated that 88%-90% of the solid waste generated is unsafely managed. In each city, the existing stormwater drainage systems are unable to cater to flows due to insufficient capacity and blockages caused by solid waste or building obstructions. As described previously, population growth in the targeted cities has highlighted that access to, and availability of, key public infrastructure are limited which restricts the city's development potential. Based on the adopted Average Annual Growth Rate (AAGR), the total population for each participating city, is projected as follows. By 2040,

- (i) Bavet is estimated to have 149,396 inhabitants or +33% in the next 20-years (i.e., 2020-2040);
- (ii) Kampot is estimated to have 76,707 inhabitants or +61% in the next 20-years (i.e., 2020-2040); and
- (iii) Poipet is estimated to have 226,118 inhabitants or +82% in the next 20-years (i.e., 2020-2040).

6. The rapid population growth and pace of urbanization is predicted to translate into increased demand for urban infrastructure and services. As such, the proposed WWTPs in Bavet and Poipet which have been designed to 2030 capacity.<sup>1</sup> The sorting and composting plants in Bavet will have a combined capacity of 56,420 tons/yr (against a projected SW generation of 51,744 tons/yr in 2025) and in Poipet a combined capacity of 72,195 tons/yr (against 67,513 tons/yr in 2025). The design of the controlled landfills in Bavet and Poipet have been based on a 20-year design life, with a total design capacity of 1,032,609m<sup>3</sup> and 1,265,568 m<sup>3</sup>, respectively.<sup>2</sup>

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<sup>1</sup> The capacity of the proposed WWTP for Bavet is 3,930m<sup>3</sup>/day, and will be sufficient to treat a projected wastewater flow of 3,376 m<sup>3</sup>/day by 2030. The capacity of the proposed WWTP for Poipet is 9,576 m<sup>3</sup>/day, which will be sufficient to treat the projected wastewater flow of 9,576m<sup>3</sup>/day by 2030. The project will however only service a priority catchment area in Poipet, and the projected flows are expected to be 2,037m<sup>3</sup>/day. For Kampot, no WWTP will be constructed under the project. A new 3,300m<sup>3</sup>/day WWTP is being built under the Second Greater Mekong Subregion Corridor Towns Development Project and will be sufficient to service a projected flow of 1,303m<sup>3</sup>/day.

<sup>2</sup> The delivery of the landfill will be staged, and the project will deliver a capacity of 516,305 m<sup>3</sup>/day for Bavet and 632,784 m<sup>3</sup>/day for Poipet.



## **E. Economic Analysis**

7. Least cost and cost - benefit analyses were completed for the project. Analyses have been conducted in accordance with Asian Development Bank's (ADB) *Guidelines for the Economic Analysis of Projects (2017)*.<sup>3</sup> Economic analysis was conducted separately for each of the three cities allowing for their share of the costs, and for the overall project. The principle used is comparing conditions future without project (fwop) - and future with-project (fwp) to quantify the net incremental benefits.

## **F. Least-Cost Analysis**

8. A qualitative comparative analysis was completed to compare the cost effectiveness of subproject design options. Selection of preferred options was based on cost, technical and environmental performance, and preference of Cambodian government.<sup>4</sup> As part of the master planning process, a detailed scenario analysis was carried out based on different infrastructure layouts, sizing and treatment options. For wastewater, the scenario analysis were based on adoption of different pipe layouts, treatment plant size and pump station requirements; for stormwater, the analysis looked at the use of different storm runoff rates and the implications this has on infrastructure sizing; and for solid waste, different collection and treatment options, ranging from the use of a controlled landfill only to the inclusion of pre-sorting and composting facilities were assessed. Estimated capital and operational expenditure were calculated for the different scenarios over a short term (2025), medium term (2030), and long term (2040) horizon. These options were presented to the Ministry of Public Works and Transport, Provincial Government and Municipal Administration in April 2020 where discussions were based on the affordable balance between the infrastructure costs, improved management of untreated sewage flows, reduced flood damage, and rate of diversion from landfilling.

## **G. Cost-Benefit Analysis**

9. Project costs. The total project costs are \$194.1 million and include (i) capital costs of civil works, mechanical and equipment, land acquisition and compensation, consultancy and training costs; (ii) recurrent cost associated with staff allowances, running costs for the project management and project implementation units, and financial auditing costs; and (iii) contingencies and financing charges during implementation (FCDI). Project investment costs including physical and price contingencies and FCDI are provided in Table 1. The overall conversion factor for the conversion of the financial costs excluding price contingency and FCDI of \$176.98 million (allowing for a shadow exchange rate factor (SERF) of 1.00 and shadow wage rate factor (SWRF) of 0.60) to economic costs is 0.84. Exchange rate used was US\$1=4,074 KHR (July 2021). The SERF of 1.00 was used to account for the high levels of dollarization in Cambodia. Cambodia runs a dual-currency system, with the US dollar widely circulating in its economy, gradually replacing the riel (KHR). The country's dollarization began in the 1980s and 90s, following years of civil war and unrest. Since 1992 the US dollar has become the largest currency in use and circulation in Cambodia, making Cambodia one of the typical countries with a currency

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<sup>3</sup> ADB. 2017. *Guidelines for the Economic Analysis of Projects*. Manila.

<sup>4</sup> Comparative analysis was prepared which assessed the various technical options including alternate treatment technologies, routing options, and estimated capital and operational expenditure. Findings of the assessment are documented in the sector master plans and feasibility studies, prepared under TA 9554-REG: Southeast Asia Urban Services Facility.

dollarization in today's world. (ADB, 2008; World Bank, 2019)<sup>5</sup>.

**Table 1: Summary of Investment Costs (\$ million)**

| <b>Outputs</b>  | <b>Financial<sup>a</sup></b> | <b>Economic<sup>b</sup></b> |
|---|------------------------------|-----------------------------|
| Output 1: Policy and Regulatory Environment Improved          | 2.1                          | 1.60                        |
| Output 2: Urban Infrastructure Improved                       | 189.3                        | 147.48                      |
| Output 3: Institutional Effectiveness and Governance Improved | 2.7                          | 2.12                        |
| <b>Total Project Cost</b>                                     | <b>194.1</b>                 | <b>151.2</b>                |

Note: Total values may not match exactly due to rounding.

a. Financial costs include price contingencies and FCDI.

b. Economic costs exclude price contingencies and financing costs and allow for the SERF and SWRF.

10. Project benefits. Project benefits are all incremental. The benefits considered in the economic analysis are:

11. Improved wastewater management systems:

- (i) Saved costs of new septic tank installations, and costs of maintenance, periodic desludging and cleaning costs of existing septic tanks through new connections to the new sewerage system;
- (ii) Saved cost of alternative wastewater collection and treatment for commercial and institutional connections through their connection to the new sewerage system;
- (iii) Saved health care costs for households connected the new sewerage system;
- (iv) Improved natural environment, rivers and wetlands through the net reduction in undesirable pollutants from unsafely managed excreta by the development of improved collection and treatment of wastewater and septage.<sup>6</sup>

12. Improved drainage systems:

- (i) Avoided flood damages to residential properties also considering the avoided productivity loss (unable to do the economic activity) due to flooding, and increased travel time/ costs;
- (ii) Avoided flood damages to commercial properties also considering the avoided productivity loss (unable to do the economic activity) due to flooding, and increased travel time/ costs.

13. Improved solid waste management systems:

- (i) Saved cost of alternative collection and disposal of rubbish;
- (ii) Reduced environmental impact from alternative disposal methods and reduction in greenhouse gases through a new controlled landfill;
- (iii) Reduced greenhouse gases (valued at the social cost of carbon)
- (iv) Increased value of reclaimed, recycled material and compost

<sup>5</sup> ADB. 2008. Cambodia's persistent dollarization: causes and policy options. Working Paper Series on Regional Economic Integration No. 19. Asian Development Bank, Manila; and Samreth, Sovannroeun; Sanchez-Martin, Miguel Eduardo; Ly, Sodeth. 2019. Dollarization Dilemma: Price Stability at the Cost of External Competitiveness in Cambodia. Policy Research Working Paper; No. 8893. World Bank, Washington, DC. <https://openknowledge.worldbank.org/handle/10986/31906> accessed 27 Aug 21

<sup>6</sup> The net reduction in undesirable pollutants – biological oxygen demand (BOD), chemical oxygen demand (COD), suspended solids (SS), nitrogen (N) and phosphorus (P) were valued at the estimated shadow for undesirable outputs from sewage and contaminated water, and is based on methodology from Economic Valuation of Wastewater - The cost of action and the cost of no action. United National Environment Programme, 2015.

- (v) Saved cost of expenditure on health, travel expenses and lost productivity through a reduction in days off sick for the resident population, Special Economic Zone (SEZ) workers and tourists.<sup>7</sup>

14. Increase in international tourists:

- (i) Increase of marginal income from international tourist spending estimated using historical tourist visits and expenditure.<sup>8</sup>

15. **Salvage value.** The economic analysis was conducted for a 20-year period 2021 – 2040 corresponding to the population projections. A salvage value was included for the remaining life of assets with a longer economic life, which ranges from 51% to 59% of the initial investment cost depending on the type of asset.

16. **Economic rates of return.** The net present values (NPVs) and economic internal rates of return (EIRRs) were calculated for each city using the methods and parameters discussed above. A summary of results is provided in 0. All of the EIRR values exceed 9%. The overall EIRR for the combined project is 12.07% indicating that the overall project is economically viable. Base case cash flows for the overall project are provided in Table 2.

**Table 2: Summary of the Economic Evaluation**

| Output          | EIRR (%) | NPV (\$ million) |
|-----------------|----------|------------------|
| Bavet city      | 15.5%    | 18.65            |
| Poipet city     | 9.7%     | 3.40             |
| Kampot city     | 15.2%    | 2.05             |
| Overall project | 12.07%   | 24.10            |

Source: ADB. 2021. *Feasibility Study Report for Cambodia: the Livable Cities Investment Project*. Manila (Prepared under TA 9554-REG: Southeast Asia Urban Services Facility).

17. **Sensitivity analysis.** Sensitivity analysis was undertaken to test the sensitivity of estimated EIRRs of the proposed outputs to adverse changes in key variables and to confirm their economic viability under unfavorable conditions. Four risks are considered: (i) an increase of 20% in capital cost; (ii) an increase of 20% in operating and maintenance costs; (iii) a 20% decrease in benefits and (iv) project delay of 1 year. A summary of sensitivity tests for the overall project are provided in Table 3. EIRR exceeds 9% for all tests except the reduction in the benefits.

**Table 3: Economic Internal Rate of Return and Switching Value**

| Sensitivity Test                 | EIRR (%) | NPV (\$ million) | Sensitivity Indicator | Switching Value (%) <sup>a</sup> |
|----------------------------------|----------|------------------|-----------------------|----------------------------------|
| BASE CASE                        | 12.07%   | 24.10            |                       |                                  |
| (i) Increase investment cost 20% | 9.6%     | 5.54             | 4.0                   | 25%                              |
| (ii) Increase operating cost 20% | 11.4%    | 18.84            | 1.1                   | 94%                              |
| (iii) Reduce benefits 20%        | 8.4%     | -4.54            | 6.0                   | -17%                             |
| (iv) Delay project 1 year        | 9.9%     | 7.62             | 7.4                   | 14%                              |

<sup>a</sup> The percentage increase/decrease in costs/benefits to maintain an EIRR equal to 9%.

Source: ADB. 2021. *Feasibility Study Report for Cambodia: the Livable Cities Investment Project*. Manila (Prepared under TA 9554-REG: Southeast Asia Urban Services Facility).

<sup>7</sup> Health benefits for the SEZ workers and tourists have a separate population projection and these two cohorts are not included in the health benefits for the general resident population. The health benefits is only a small contribution.

<sup>8</sup> No tourism benefits have been estimated for Kampot. Like the tourist health benefits, international tourism benefits is only a small contribution but was included for completeness. The recorded additional daily expenditure for international tourists in Bavet and Poipet is only \$33 per day and only 13% and 15% of this was used as the marginal economic benefit. Length of stay varies from 1.5 to 2.5 days.

18. **Benefit Distribution and Poverty Impact Analysis.** The analysis was prepared for each city. The economic benefits generated from the project will be allocated to stakeholders – government, consumers and the public and the distribution of costs and benefits among stakeholders relies on estimates of the net incremental benefits and costs generated by the main project outputs. All financial and economic benefits and costs are expressed in present value terms (9% discount rate). The difference in the present values (PV) of the capital expenditure (capex) and operational and maintenance expenditure (Opex) costs between economic and financial prices relate to the tax and the shadow value of unskilled labor. The higher future present value (FPV) for the unskilled labor is a gain to unskilled labor employed during construction as the SWRF is 0.6. The tax element in the Capex and Opex costs is a gain to the government.

19. The ADB's poverty assessment for Cambodia was 12.9% in 2018, having reduced from 47.8% in 2007 and 13.5% in 2014, although the Covid pandemic is expected to reverse this reducing trend. It is assumed that the cities incidence of poverty is similar to the national average and has been showing a progressive decline in tune with the rest of the country. Overall, the distribution impact will largely benefit the residents and the local communities including the workers employed in the SEZs.



## I. INTRODUCTION

1. At the request of the Kingdom of Cambodia, the Asian Development Bank (ADB) is developing the Livable Cities Investment Project (LCIP) to facilitate long-term sustainable and economic growth for key secondary cities in Cambodia. The project is aligned with the Government's policies and national strategies, in particular, the Government's Rectangular Strategy – Phase I<sup>1</sup> and ADB Strategy 2030.<sup>2</sup>
2. The project will concentrate on the three secondary cities of Bavet, Poipet, and Kampot, due to their economic potential and location at key trade and tourism zones. As a result of their high population growth, these cities have identified that limited urban infrastructure for water supply, sanitation, solid waste management and drainage is restricting their development potential. Existing services are inadequate and incapable of servicing current and future demand.
3. The project proposes to adopt a holistic methodology, comprising of an integrated urban development approach, to ensure interventions consider land use, long term city needs, asset management, and asset financing for sustainable operations. The project will focus on enhancing urban planning, building community resilience, and providing urban infrastructure. Project outputs include (i) Output 1: policy and regulatory environment improved, (ii) Output 2: urban infrastructure improved, and (iii) Output 3: institutional effectiveness and governance improved.
4. This report provides an economic evaluation of LCIP. The economic analysis is conducted from the national perspective of the overall economy and is prepared in accordance with ADB's *Guidelines for the Economic Analysis of Projects (2017)*. This report is a combined report of the economic evaluation for each city.

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<sup>1</sup> Kingdom of Cambodia. 2018. Rectangular Strategy for Growth, Employment, Equity and Efficiency: Building the Foundation Toward Realizing the Cambodia Vision 2050 Phase IV. Phnom Penh.

<sup>2</sup> ADB. 2018. Strategy 2030: Achieving a Prosperous, Inclusive, Resilient and Sustainable Asian and the Pacific. Manila.

## II. MACRO-ECONOMIC ENVIRONMENT

5. Cambodia has made significant strides in economic development. Cambodia's growth averaged 7.9 % over the period 1997-2019. Since that time, the opening of Cambodia's borders to international trade and investment has attracted foreign direct investment to support manufacturing, and tourism. As a result of Cambodia's sustained high growth, the percentage of Cambodians living under the national poverty line fell from 47.8% in 2007 to 13.5% in 2014.<sup>3</sup> In the context of global health crisis, the economy contracted by 3.1% and poverty levels will increase. However, the economy is forecasted to have a positive growth of 4.0 % in 2021 and 5.5% in 2022.

6. Key macroeconomic indicators in recent years are presented in Table 1 below.

**Table 1: Cambodia Key Macro-economic Indicators**

| Item   | 2016       | 2017       | 2018       | 2019       |
|--|------------|------------|------------|------------|
| Population, total  | 15,766,293 | 16,009,414 | 16,249,798 | 16,486,542 |
| Population growth (annual %)   | 1.6        | 1.5        | 1.5        | 1.4        |
| Life expectancy at birth, total (years)  | 69.0       | 69.3       | 69.6       | ..         |
| Mortality rate, under-5 (per 1,000 live births)                                | 30.1       | 28.8       | 27.6       | 26.6       |
| Urban population growth (annual %)   | 3.3        | 3.3        | 3.3        | 3.2        |
| GDP (current US\$ million)   | 20,016.748 | 22,177.201 | 24,571.754 | 27,089.390 |
| GDP growth (annual %)  | 7.0        | 6.8        | 7.5        | 7.1        |
| Inflation, GDP deflator (annual %)   | 3.4        | 3.5        | 3.1        | 3.2        |
| Agriculture, forestry, and fishing, value added (% of GDP)                     | 24.7       | 23.4       | 22.0       | 20.7       |
| Industry (including construction), value added (% of GDP)                      | 29.5       | 30.8       | 32.3       | 34.2       |
| Exports of goods and services (% of GDP)                                       | 61.3       | 60.7       | 61.6       | 61.1       |
| Imports of goods and services (% of GDP)                                       | 65.7       | 64.1       | 63.3       | 62.5       |
| Gross capital formation (% of GDP)   | 22.7       | 22.9       | 23.4       | 24.2       |
| Revenue, excluding grants (% of GDP)   | 17.4       | 18.6       | 19.9       | ..         |
| Merchandise trade (% of GDP)   | 119.6      | 118.7      | 126.5      | 133.6      |
| External debt stocks, total (DOD, current US\$ million)                        | 9,874.767  | 11,238.064 | 13,346.669 | ..         |
| Total debt service (% of exports of goods, services, and primary income)       | 5.1        | 6.2        | 6.7        | ..         |
| Personal remittances, received (current US\$ m)                                | 1,199.734  | 1,294.718  | 1,433.191  | 1,575.077  |
| Foreign direct investment, net inflows (BoP, current US\$ m)                   | 2,475.916  | 2,788.084  | 3,212.633  | 3,706.033  |
| Net official development assistance and official aid received (current US\$ m) | 728.410    | 855.760    | 768.560    | ..         |

Source: World Development Indicators.

<sup>3</sup> ADB. 2021. *Basic 2021 Statistics*. Manila.

### III. SECTOR CONTEXT

7. **Urbanization.** In 2019, the recorded total population of the country was approximately 15.5 million. The population increased by approximately 2.6 million persons (i.e., 16.1 %) over the 11-year period from 2008 to 2019. In the same period, the urban population recorded an increase, from 2.6 million in 2008 (approximately 19.5% of the total population) to 6.1 million in 2019 (39.4 % of the total population). In the last 11 years, the urban population has grown at an average annual growth rate of 8.1%.

8. **Infrastructure needs.** The pace of urbanization poses several challenges to cities. In terms of access to basic infrastructure, across the country, the 2019 general population census reported that for urban households, 46.7% have access to piped water into dwellings with 10.6% reliant on piped water into a compound or public tap/standpipe and 44.8% have access to a pour flush (or flush) toilet, connected to sewerage, and 34.7% have access to a pour flush toilet that is connected to a septic tank or pit.

9. Many cities across Cambodia experience poor wastewater service, due largely to the absence of management along the sanitation chain and in particular to the lack of wastewater treatment plants. Wastewater flows directly to the environment through combined sewers and road drains, or indirectly via open canals, into the open water. Most of the existing drainage lines are underdeveloped, filled with wastewater and raw black water.

10. Similarly, solid waste services are also limited. Solid waste services are generally outsourced to the private sector, but a large proportion of municipal solid waste is left uncollected, dumped in stormwater channels or the open environment, or burned. The lack of a functioning drainage network and solid waste service exacerbates the impacts of flooding in many cities and towns.

11. **National priorities.** The Political Platform of the Royal Government of the Sixth Legislature of the National Assembly sets key strategic goals and policies to expedite development and drive greater reforms throughout the country. It outlines a clear focus in the areas of social-economic development, good governance, strengthening public institution and administration and improving public service operations. Supporting the political platform is the government's RSIV, which consolidates the reforms and efforts made over the last twenty years to transform and rehabilitate the country and provides the goals to progress the future vision of Cambodia. The RSIV serves as the socio-economic policy agenda and comprises of four priority areas: (i) Human Resource Development; (ii) Economic Diversification; (iii) Private Sector and Job Development, and (iv) Inclusive and Sustainable Development.

12. As part of the fourth priority area, Inclusive and Sustainable Development, the Government has identified a need to: (a) accelerate the development of master plans and land use plans to facilitate urban planning and construction at national and subnational levels; (b) promote digitization to improve the management of urbanization; (c) develop infrastructure master plans to support the provision of basic essential infrastructure, such as roads, water, and sewerage, and (d) promote development in core cities, and urban areas including the incorporation of smart city principles, conservation of buildings, and green and beautifying cities. In addition, the government has also set a goal to minimize environmental impacts and improve its capacity to adapt to climate change and promote sustainable development.

13. **Sectoral challenges.** As a result of the rapid urbanization, cities are experiencing limitations with respect to access to basic and essential infrastructure. The government has



recognized the growing trends and demands of urbanization and has identified a need to invest in long term land use and urban planning.

14. **Urban infrastructure and services.** The recent population growth in the targeted cities has highlighted that access to, and availability of key public infrastructure are limited which restricts the city's development potential. Existing services are no longer operating optimally and unable to meet demand. Although access to sanitation is high (90%-93% of the total population have access to latrines), there are no wastewater treatment plants (WWTP) in operation, and it is estimated that 74% - 91% of the excreta generated is unsafely managed. Only 14%-16% of the households have a solid waste collection service. It is estimated that 88%-90% of the solid waste generated is unsafely managed. In each city, the existing stormwater drainage systems are also unable to cater to flows due to insufficient capacity (poorly sized and/or built) and blockages caused by solid waste or building obstructions.

15. The current limitations of the cities' basic service impinge on their ability to achieve their overall vision and to support anticipated future growth and demand.

#### IV. RATIONALE FOR PUBLIC INTERVENTION

16. The project aims to enhance urban planning, build community resilience and provide infrastructure that will facilitate long-term sustainable and economic growth. The project is aligned with the following impact: livability of secondary cities improved. The project will have the following outcome: access to urban infrastructure and services in participating cities improved.

17. **Output 1: Policy and regulatory environment improved.** The project will support the participating cities and stakeholders in developing resilient spatial planning and land use plans to inform and regulate future growth. Planning and service delivery guidelines on wastewater, stormwater drainage and municipal solid waste with climate resilient and gender responsive and inclusive measures will be prepared to provide guidance to the municipal administration in the operation, maintenance and delivery of sustainable and efficient services.

18. **Output 2: Urban infrastructure improved.** The project will improve access to urban infrastructure through: (i) the construction of a WWTP and conveyance network in Bavet and Poipet, and the expansion of the sewerage network in Kampot; (ii) the rehabilitation of existing canals and construction of new stormwater drains in Bavet and Poipet; and (iii) the construction of landfills, including sorting and composting plants, in Bavet and Poipet.

19. **Output 3: Institutional effectiveness and governance improved.** Institutional development road maps for each participating city will be developed that will guide the municipal administration to become self-sufficient service providers. It will include a tariff reform to cover operations and maintenance (O&M) and to reduce the risk of ineffective service delivery through poor maintenance of the infrastructure. A recruitment, mobility and training program will be developed to ensure regular skills development and women's participation in the sector will be encouraged through the promotion of women at technical and decision-making positions and scholarships for women in engineering or relevant disciplines.

## V. DEMAND ANALYSIS

20. Bavet and Poipet are important border entry points to Cambodia, from Vietnam and Thailand respectively. Kampot is a unique historical city and an important tourist destination. Recent economic expansion stimulated by the SEZs and casinos catering for overseas visitors coupled with high population growth has exacerbated the situation where the limited and inadequate urban infrastructure for water supply, sanitation, solid waste management and drainage is restricting their development potential. Existing services are inadequate and incapable of servicing current and future demand. Publicly-funded infrastructure and urban assets are needed to underpin their economic development.

21. **Projected growth.** Based on the adopted Average Annual Growth Rate (AAGR), the total population in Poipet is projected to increase to 226,118 inhabitants by 2040 from 124,244 in 2020, an increase of 82% over 20 years. For Bavet the total population in 2040 is estimated to be 149,396, an increase of 33% from the residential population of 109,584 in 2020. Kampot is projected to have a 61% increase 2020-2040 from 47,624 in 2020 to 76,707 in 2040.

22. **Project costs.** The total project costs are \$194.1 million and include (i) capital costs of civil works, mechanical and equipment, land acquisition and compensation, consultancy and training costs; (ii) recurrent cost associated with staff allowances, running costs for the project management and project implementation units, and financial auditing costs; and (iii) contingencies and financing charges during implementation (FCDI). Project investment costs including physical and price contingencies and financing charges during implementation (FCDI) are provided in Table 2. Project financial costs excluding price contingencies and FCDI were converted to economic costs resulting in an overall conversion factor of 0.84.<sup>4</sup>

**Table 2: Summary of Investment Costs (\$ million)**

| Outputs   | Financial    | Economic <sup>a</sup> |
|---|--------------|-----------------------|
| Output 1: Policy and Regulatory Environment Improved          | 2.1          | 1.6                   |
| Output 2: Urban Infrastructure Improved                       | 189.3        | 147.48                |
| Output 3: Institutional Effectiveness and Governance Improved | 2.7          | 2.12                  |
| <b>Total Project Cost</b>                                     | <b>194.1</b> | <b>151.2</b>          |

Note: Total values may not match exactly due to rounding.

a. Financial costs include price contingencies and FCDI.

b. Economic costs exclude tax, price contingencies and financing costs and allow for the SERF and SWRF.

Source: ADB. 2021. Feasibility Study Report for Cambodia: the Livable Cities Investment Project. Manila (Prepared under TA 9554-REG: Southeast Asia Urban Services Facility).

<sup>4</sup> The conversion factor is based on the financial costs excluding price contingency and FCDI of \$176.98 m, allowing for a shadow exchange rate factor (SERF) of 1.00 and shadow wage rate factor (SWRF) of 0.60.

## VI. BACKGROUND OF ECONOMIC ANALYSIS

### 1. Approach and Methodology

23. The economic analysis is conducted from the national perspective of the overall economy and is prepared in accordance with ADB's *Guidelines for the Economic Analysis of Projects (2017)*. Cost-Benefit Analysis (CBA) is applied, whereby the future benefits are weighed against the investment costs with the economic performance measured by the internal economic rate of return (EIRR) and the economic net present value (ENPV), at the economic opportunity cost of capital (EOCC) of 9%. The principle of "future with project minus future without project" to estimate the incremental benefits and costs attributable to the project.

24. An overall economic analysis is shown for the total project, and separate economic analyses were prepared for Bavet, Kampot, and Poipet. Where appropriate, separate economic analyses are shown for the revenue-generating urban infrastructure that will be developed by the project (solid waste management and wastewater/ sanitation). Given the strong linkages between economic development, ecosystems, and urban development, these are consolidated into aggregate analyses for each city. The primary economic benefits resulting from the project are related to the enhanced and sustainable economic development for each city, including tourism, especially through the development of the urban infrastructure for the benefit of the resident population and the business and industrial sectors. Additional quantified benefits accrue to the development of improved sanitation, solid waste management, and drainage and the reduction in undesirable pollutants due to improved collection and treatment of wastewater and septage.

25. The analysis describes the economic rationale, the rationale for public intervention, and the setting of the with-project and without-project situations. The economic analysis uses a standard cost-benefit methodology with shadow pricing and conversion factors to convert the financial cost and benefits into economic terms. The analysis is undertaken in constant 2020 prices based on the project costs estimated in early 2020 and evaluated over a 20-year time period from 2021 to 2040. The results are expressed as the internal economic rate of return (EIRR), which can be compared with the economic opportunity cost of capital (EOCC) at the ADB hurdle rate of 9%. Sensitivity and risk analyses are undertaken to assess the robustness of the project's economic performance under changes in the main parameters for cost and benefits.

#### 1.1. Key Assumptions

26. The following assumptions are applied to economic analysis:
- (i) Costs are expressed in Cambodian Riels (KHR) and \$ at an exchange rate of KHR4,074 = \$1.00 applied in July 2021.
  - (ii) Where necessary physical contingencies are applied based on realistic rates and price contingencies at the international and domestic inflation rates as indicated by ADB for Cambodia.<sup>5</sup>
  - (iii) Value Added Tax (VAT) of 10% is included in all costs except for land acquisition and compensation and replanting/ afforestation.
  - (iv) The conversion of foreign costs to local costs uses constant purchasing parity (CPP), which automatically adjusts the exchange rate for the difference in inflation

<sup>5</sup> Physical contingency were calculated based on 17% for civil works and 15% for all other components. Price contingency based on ADB's SERD-DCEF inflation forecast 2020-2024 of October 2020 for domestic costs of and the international MUV index of 22 October 2020 for the period 2020–2026 which projects an annual average of 2.67% and 1.41% for domestic and international inflation respectively over the life of the project 2020 - 2026

for domestic and international costs resulting in a progressive depreciation of the KHR against the \$.

- (v) Costs are assumed to be free of customs and excise duty.
- (vi) Costs are divided between foreign exchange and local costs according to the source of the cost item and its breakdown.
- (vii) The project implementation period of six years 2022 to 2027 starting in the first quarter of 2022.
- (viii) A Project life of 20 years from 2021 to 2040 is assumed, including the implementation period of six years. The basis for this period is that the population projections on which the benefit streams are based are limited to the period 2020 to 2040.
- (ix) Salvage values are included for those assets that have an economic life of more than the 20-years project analysis period as a benefit at the end of the project life.
- (x) FCDI is financed by the Cambodian Government
- (xi) Tax is financed by the government for consultancy services and by the loan for civil works and equipment.
- (xii) Cost and benefits in financial terms are converted to their economic value allowing for tax, transfer payments, shadow value of unskilled labor, and a standard conversion factor for foreign exchange as appropriate to indicate the standard conversion factor for converting financial prices to economic value.
- (xiii) Internationally trade inputs and outputs are valued at border parity.

## 1.2. Summary of Benefits

27. The economic benefits emanate from an interlinked impact of the project on the resident population, business sector, and the environment through investment in urban infrastructure and institutional strengthening for governance and capacity building. The table below presents a summary of the main economic benefits that have been identified, the method of quantifying benefits in monetary terms, and a description of the unquantified benefits that are also important.

**Table 3: Summary of Identification and Quantification of Economic Benefits**

| Benefit  | Means of Identification and Quantification  | Data Source   |
|--|---|---|
| <b>QUANTIFIABLE AND MONETIZED BENEFITS</b>   |   |   |
| <b>Sanitation</b>  |   |   |
| Saved costs of new septic tank installations, maintenance of existing septic tanks, and periodic desludging and cleaning costs | <ul style="list-style-type: none"> <li>• Number of new sewer connections</li> <li>• Cost of a septic tank installation</li> <li>• Cost of septic tank maintenance</li> <li>• Cost of periodic septic tank septage cleaning</li> </ul> | <ul style="list-style-type: none"> <li>• Technical team's estimate of new sewer connections</li> <li>• Prevailing cost of installing a septic tank by a septic tank contractor</li> <li>• Prevailing cost of septic tank cleaning by a desludging service contractor</li> <li>• Comprehensive city survey (CCS) for frequency and cost of septic tank cleaning</li> </ul> |
| Avoided healthcare cost from wastewater and sanitation improvement   | <ul style="list-style-type: none"> <li>• % of households with household members experiencing typical health problems due to the poor wastewater and sanitation system</li> </ul>  | <ul style="list-style-type: none"> <li>• CCS</li> <li>• Prevailing cost of household including medicines of typical health problems with the poor wastewater and sanitation</li> </ul>  |

| Benefit  | Means of Identification and Quantification   | Data Source   |
|--|--|---|
|  | <ul style="list-style-type: none"> <li>• Average healthcare cost per household</li> <li>• The average loss of productivity due to health problems</li> <li>• Estimated annual expenditure on health costs for illness related to water-borne disease</li> <li>• % of DALYs in Cambodia related to water, sanitation, and hygiene issues</li> <li>• Number of new water supply and sewer connections and beneficiaries in the service area</li> </ul> | <ul style="list-style-type: none"> <li>• Loss of workdays due to sickness of family members</li> <li>• WHO latest statistics on DALYs</li> </ul>            |
| Saved cost of wastewater collection and treatment for commercial and institutional connections                   | <ul style="list-style-type: none"> <li>• Cost of alternative wastewater treatment for commercial enterprises – hotels, restaurants, etc.</li> <li>• Cost of Wastewater Treatment Plant for the domestic water of the Special Economic Zones (SEZs)</li> </ul>  | <ul style="list-style-type: none"> <li>• Institutional &amp; Commercial survey</li> <li>• Technical team's estimation</li> </ul>                            |
| Connections to the sewer network   | <ul style="list-style-type: none"> <li>• Cost of alternative wastewater treatment for commercial enterprises – hotels, restaurants, etc.</li> </ul>  | <ul style="list-style-type: none"> <li>• Planned connections to the sewer network and CCS for Willingness to Pay for connection and monthly fees</li> </ul> |
| <b>Reduced Flood Damage</b>  |  |   |
| Avoided flood damages to residential and commercial properties   | <ul style="list-style-type: none"> <li>• % of households with flood damages of properties</li> <li>• The average cost of flood damages of properties in a year per household</li> </ul>  | <ul style="list-style-type: none"> <li>• CCS</li> <li>• Flood prediction events and level of inundation</li> </ul>  |
| Avoided productivity loss (unable to do the economic activity) due to flooding, and increased travel time/ costs | <ul style="list-style-type: none"> <li>• % of households with household members unable to do economic activity due to flooding</li> <li>• The average number of days household members were unable to do economic activity due to flooding</li> <li>• Minimum daily wage rate (for conservative benefit estimate)</li> </ul>   | <ul style="list-style-type: none"> <li>• CCS</li> <li>• Current minimum wage law</li> </ul>   |
| Avoided flood damage to public infrastructure and facilities   | <ul style="list-style-type: none"> <li>• The average annual cost of damage and repair to public infrastructure</li> </ul>  | <ul style="list-style-type: none"> <li>• Technical experts</li> <li>• Expenditure on maintenance</li> </ul>   |
| <b>Solid Waste Management</b>  |  |   |
| Saved cost of alternative collection and disposal  | <ul style="list-style-type: none"> <li>• Alternative disposal methods and cost</li> </ul>  | <ul style="list-style-type: none"> <li>• CCS and technical experts</li> </ul>   |
| Environmental impact from alternative disposal methods   | <ul style="list-style-type: none"> <li>• Negative environmental impact through illegal dumping and disposal, pollution through fires,</li> </ul>   | <ul style="list-style-type: none"> <li>• Technical experts</li> </ul>   |

| Benefit  | Means of Identification and Quantification   | Data Source  |
|--|--|--|
|  | contamination of waterways and groundwater   |  |
| Greenhouse gases   | <ul style="list-style-type: none"> <li>Reduction in Greenhouse Gases (GHG) through reduction of the burning of rubbish and methane capture in a controlled landfill</li> </ul>   | <ul style="list-style-type: none"> <li>Technical experts and international best practice</li> <li>ADB guidelines for the social value of carbon</li> </ul>   |
| Value of reclaimed, recycled material  | <ul style="list-style-type: none"> <li>Quantity of recycled material PET, aluminum, etc., and economic value</li> </ul>  | <ul style="list-style-type: none"> <li>Waste categorization survey</li> <li>Technical experts</li> <li>International practice</li> </ul>   |
| Value of compost   | <ul style="list-style-type: none"> <li>Quantity of compost made from sorted biowaste and green waste</li> </ul>  | <ul style="list-style-type: none"> <li>Technical experts and international best practice</li> </ul>  |
| <b>Tourism development</b>   |  |  |
| <p>Increase of income from tourist spending</p> <p>*Ultimately, protection of the environment and development of tourism enterprises will result in an increase in tourists and their daily expenditure in a sustainable manner</p>                        | <ul style="list-style-type: none"> <li>Number of foreign and domestic travelers</li> <li>The average length of stay of tourists</li> <li>Average daily travel expenditures</li> </ul> <p>* The economic benefits can be calculated as the marginal added value for tourism expenditure based on the average expenditure per day, and length of stay allowing for the costs of inputs</p> | <ul style="list-style-type: none"> <li>Local Tourism Office</li> <li>Department of Tourism</li> <li>Technical experts and tourism statistics</li> <li>Survey of tourist visits, tourism statistics and Willingness to Pay</li> </ul> |
| <b>Environmental Impact</b>  |  |  |
| Improved natural environment, rivers and wetlands through the net reduction in undesirable pollutants from unsafely managed excreta by the development of improved collection and treatment of wastewater and septage                                      | <ul style="list-style-type: none"> <li>Reduction in annual amount of undesirable pollutants (BOD, COD, SS, N and P) and valuation according to methodology from the economic valuation of wastewater from the UN Environmental Programme</li> </ul>  | <ul style="list-style-type: none"> <li>Technical experts calculation in the annual reduction of undesirable pollutants</li> </ul>  |
| <b>UNQUANTIFIED ECONOMIC BENEFITS</b>  |  |  |
| <p>Increase in economic activity due to improved urban infrastructure and improved municipal governance and creation of a livable city</p> <p>Improved natural environment through reduction in pollution and, flooding and containment of stormwater.</p> | <ul style="list-style-type: none"> <li>Growth of GDP attributed to the improved commercial environment and urban infrastructure</li> <li>Growth in commercial activity and an increase in taxes and property values</li> </ul>   | <ul style="list-style-type: none"> <li>GDP statistics</li> <li>Local information on the growth of commercial activity</li> <li>Property valuation</li> </ul>   |



| Benefit                               | Means of Identification and Quantification   | Data Source   |
|---------------------------------------|--|---|
| Resource use value<br>Existence value | <ul style="list-style-type: none"> <li>Improved local environment – reduced pollution of groundwater, flooding, bad smells, and the more attractive environment through a reduction in pollution from drainage runoff and flooding</li> <li>Preservation of local assets for future enjoyment</li> </ul> | <ul style="list-style-type: none"> <li>Willingness to Pay (WTP) for the project location of from studies in similar locations</li> </ul>  |
| Employment impact                     | <ul style="list-style-type: none"> <li>Increase in employment and incomes linked to increased commercial activity and tourism</li> </ul>   | <ul style="list-style-type: none"> <li>Projected employment in the commercial and tourism sectors, using conversion factors for the number of jobs per tourist arrival</li> </ul> |
| Training and capacity building        | <ul style="list-style-type: none"> <li>Support to the cities for the management of urban infrastructure and provision of technical services, e.g., for tariff setting</li> </ul>   | <ul style="list-style-type: none"> <li>Number and types of jobs</li> <li>Number of people trained</li> </ul>  |

## 2. Project Costs and Implementation

### 2.1. Least Cost Analysis

20. A qualitative comparative analysis was completed on sub-projects to compare the cost effectiveness of subproject design options. Selection of preferred options was based on cost and technical and environmental performance and preference of Cambodian government.<sup>6</sup> As part of the master planning process, a detailed scenario analysis was carried out based on different infrastructure layouts, sizing and treatment options. For wastewater, the scenario analysis were based on adoption of different pipe layouts, treatment plant size and pump station requirements; for stormwater, the analysis looked at the use of different storm runoff rates and the implications this has on infrastructure sizing; and for solid waste, different collection and treatment options, ranging from the use of a controlled landfill only to the inclusion of pre-sorting and composting facilities were assessed. Estimated capital and operational expenditure were calculated for the different scenarios over a short term (2025), medium term (2030), and long term (2040) horizon. These options were presented to the Ministry of Public Works and Transport, Provincial Government and Municipal Administration in April 2020 where discussions were based on the affordable balance between the infrastructure costs, improved management of untreated sewage flows, reduced flood damage, and rate of diversion from landfilling. Table 4 summarizes the main technical options studied for each component:

**Table 4: Summary of Technical Options**

| Component                   | Option | Preferred |
|-----------------------------|--------|-----------|
| <b>Wastewater</b>           |        |           |
| Maximal depth – pipe layout | 4m     | No        |
|                             | 6m     | Yes       |

<sup>6</sup> Comparative analysis was prepared which assessed the various technical options including alternate treatment technologies, routing options, and estimated capital and operational expenditure. Findings of the assessment are documented in the sector master plans and feasibility studies, prepared under TA 9554-REG: Southeast Asia Urban Services Facility.



| Component                     | Option  | Preferred   |
|-------------------------------|---|-------------|
| Maximal length – force main   | 3km   | Yes         |
|                               | 5km   | No          |
| Material for gravity pipes    | Concrete pipes  | No          |
|                               | PVC pipes   | Yes         |
| Material for force mains      | Concrete pipes  | No          |
|                               | HDPE pipes  | Yes         |
| Base Treatment Process        | Waste Stabilization Pond                                  | Yes         |
|                               | Conventional Activated Sludge Process - Extended Aeration | No          |
| Septage treatment             | A specific treatment: septage treatment plan              | No          |
|                               | A co-treatment at the wastewater treatment plant          | Yes         |
| <b>Solid Waste Management</b> |   |             |
| Household collection service  | Door-to-door collection                                   | Yes         |
|                               | Centralized collection points                             | (urban)     |
| Source-sorted (biowaste)      | from markets  | Yes (rural) |
|                               | from households   | Yes         |
| Transfer stations             |   | No          |
|                               |   | No          |
| Treatment                     | Incineration  | No          |
|                               | Pre-Sorting Plant (Dry Recyclables)                       | Yes         |
| Options for Composting        | Composting Plant (Biowaste)                               | Yes         |
|                               | Anaerobic Digestion                                       | No          |
| Options for Landfill          | Mechanical Biological Treatment (MBT)                     | No          |
|                               | Windrow Composting Process                                | Yes         |
| Basal lining system           | Silo Composting Process                                   | No          |
|                               | Controlled landfill                                       | Yes         |
| Leachate treatment system     | Sanitary landfill   | No          |
|                               | Geomembrane liner   | Yes         |
| Landfill gas treatment system | Mineral liner   | No          |
|                               | On-site leachate treatment plant                          | No          |
|                               | Off-site treatment at WWTP                                | Yes         |
|                               | Leachate recirculation                                    | Yes         |
|                               | Passive venting   | No          |
|                               | Active venting, with a flare stack                        | Yes         |
|                               | Active venting with electricity generation                | No          |
| <b>Stormwater drainage</b>    |   |             |
| Recurrence interval           | 1 in 2  | No          |
|                               | 1 in 5  | Yes         |
|                               | 1 in 10   | No          |
| Drainage line section         | Circular pipes  | No          |
|                               | U-Drains  | Yes         |
|                               | Box culverts  | Yes         |
|                               | Open-channels   | Yes (rural) |
| Retention ponds               |   | No          |

Source: ADB. 2021. *Feasibility Study Report for Cambodia: the Livable Cities Investment Project*. Manila (Prepared under TA 9554-REG: Southeast Asia Urban Services Facility).

29. When cost data are available, the least cost analysis uses a life-cycle cost approach to compare costs of design options over a 20-year period of operations. Costs included in the analysis are base costs and operation and maintenance costs. PVs are used as summary measures of cost effectiveness. A discount rate of 9% is the assumed social opportunity cost.

## 2.2. Capital Costs

30. Cost estimates for the proposed seven-year project 2021 – 2027 have been prepared in Excel according to the ADB guidelines. The designs and civil works components are based upon conceptual designs developed through the feasibility study with the cost estimates reflecting current prices for materials, equipment, and civil works in Cambodia and comparable international

standards. Cost estimates for all training, technical assistance, and support activities are also based on current costs prevailing in mid-2020.

### 2.2.1. Inflation and Exchange Rates

31. A summary of the inflation rates and the exchange rates applied under constant purchasing parity is provided below.

**Table 5: Summary of Inflation and Exchange Rates**

| Inflation rates           |     | 2020   | 2021  | 2022  | 2023   | 2024   | 2025   | 2026   | 2027   |
|---------------------------|-----|--------|-------|-------|--------|--------|--------|--------|--------|
| Foreign currency (USD)    | USD | -0.50% | 1.60% | 1.70% | 1.70%  | 1.80%  | 1.80%  | 1.80%  | 1.80%  |
| Local currency (KHR)      | KHR | 2.10%  | 1.80% | 2.80% | 3.00%  | 3.00%  | 3.00%  | 3.00%  | 3.00%  |
| Cumulative Inflation      |     | 2020   | 2021  | 2022  | 2023   | 2024   | 2025   | 2026   | 2027   |
| Foreign currency (USD)    | %   | 1.76%  | 2.32% | 4.01% | 5.77%  | 7.62%  | 9.56%  | 11.53% | 13.54% |
| Local currency (KHR)      | %   | 3.07%  | 5.08% | 7.50% | 10.61% | 13.93% | 17.35% | 20.87% | 24.50% |
| Price index               |     |        |       |       |        |        |        |        |        |
| Foreign currency (USD)    | #   | 1.02   | 1.02  | 1.04  | 1.06   | 1.08   | 1.10   | 1.12   | 1.14   |
| Local currency (KHR)      | #   | 1.031  | 1.05  | 1.07  | 1.11   | 1.14   | 1.17   | 1.21   | 1.24   |
| Relative (KHR/USD)        | #   | 1.01   | 1.03  | 1.03  | 1.05   | 1.06   | 1.07   | 1.08   | 1.10   |
| Exchange rate (July 2021) |     |        |       |       |        |        |        |        |        |
| Real (KHR/USD)            |     | 4,074  | 4,074 | 4,074 | 4,074  | 4,074  | 4,074  | 4,074  | 4,074  |
| Nominal (KHR/USD)         |     | 4,074  | 4,131 | 4,157 | 4,206  | 4,258  | 4,308  | 4,359  | 4,410  |

Source: Egis, 2021

### 2.2.2. LCIP Capital Costs

32. The project investment cost is \$194.1 million (KHR786,774 million), including taxes and duties, physical and price contingencies, and financing charges during implementation (FCDI). The project will be funded by an ADB concessional (COL) of \$180 million. The government will contribute \$13.5 million to finance expenditures in relation to land acquisition and compensation, recurrent costs (staff allowances and financial auditing services) and interest during construction. A summary of the Project costs is presented in the table below.

**Table 6: Summary of Project Costs (Financial)**

| Item                                | KIP Million      |                  |                  | \$ Million  |             |              | % of Total Base Costs |
|-------------------------------------|------------------|------------------|------------------|-------------|-------------|--------------|-----------------------|
|                                     | Foreign          | Local            | Total            | Foreign     | Local       | Total        |                       |
| <b>A</b>                            |                  |                  |                  |             |             |              |                       |
| <b>Investment Costs</b>             |                  |                  |                  |             |             |              |                       |
| 1 Civil Works                       | 190,068.0        | 332,619.1        | 522,687.1        | 46.7        | 81.6        | 128.3        | 84.9%                 |
| 2 Mechanical and Equipment          | 13,476.0         | 9,722.0          | 23,197.9         | 3.3         | 2.4         | 5.7          | 3.8%                  |
| 3 Land acquisition and compensation | -                | 20,187.2         | 20,187.2         | -           | 5.0         | 5.0          | 3.3%                  |
| 4 Consultancy and Training          |                  |                  |                  |             |             |              |                       |
| a. Project Consultants              | 23,334.4         | 19,445.3         | 42,779.8         | 5.7         | 4.8         | 10.5         | 6.9%                  |
| b. Capacity Development             | -                | 1,539.4          | 1,539.4          | -           | 0.4         | 0.4          | 0.2%                  |
| <b>Subtotal (A)</b>                 | <b>226,878.4</b> | <b>383,512.9</b> | <b>610,391.3</b> | <b>55.7</b> | <b>94.1</b> | <b>149.8</b> | <b>99.1%</b>          |
| <b>B</b>                            |                  |                  |                  |             |             |              |                       |
| <b>Recurrent Costs</b>              |                  |                  |                  |             |             |              |                       |
| 1 Staff Allowances                  | -                | 1,574.2          | 1,574.2          | -           | 0.4         | 0.4          | 0.3%                  |
| 2 Equipment, Vehicles, Furniture    | -                | -                | -                | -           | -           | -            | 0.0%                  |
| 3 Running Costs                     | 897.8            | 2,693.5          | 3,591.4          | 0.2         | 0.7         | 0.9          | 0.6%                  |
| 4 Financial audit costs             | 40.7             | 407.4            | 448.1            | 0.0         | 0.1         | 0.1          | 0.1%                  |
| <b>Subtotal (B)</b>                 | <b>938.6</b>     | <b>4,675.1</b>   | <b>5,613.7</b>   | <b>0.2</b>  | <b>1.1</b>  | <b>1.4</b>   | <b>0.9%</b>           |

|          |   |                  |                  |                  |             |              |              |               |
|----------|---|------------------|------------------|------------------|-------------|--------------|--------------|---------------|
|          | <b>Total Base Cost (A+B)</b>                          | <b>227,817.0</b> | <b>388,188.0</b> | <b>616,005.0</b> | <b>55.9</b> | <b>95.3</b>  | <b>151.2</b> | <b>100.0%</b> |
| <b>C</b> | <b>Contingencies</b>                                  |                  |                  |                  |             |              |              |               |
| 1        | Physical  | 39,341.7         | 67,036.1         | 106,377.8        | 9.7         | 16.5         | 26.1         | 17.3%         |
| 2        | Price   | 16,536.4         | 28,177.2         | 44,713.6         | 4.1         | 6.9          | 11.0         | 7.3%          |
|          | <b>Subtotal (C)</b>                                   | <b>55,878.1</b>  | <b>95,213.3</b>  | <b>151,091.4</b> | <b>13.7</b> | <b>23.4</b>  | <b>37.1</b>  | <b>24.5%</b>  |
| <b>D</b> | <b>Financing Charges During Implementation (FCDI)</b> |                  |                  |                  |             |              |              |               |
| 1        | Interest during construction                          | 23,624.1         | -                | 23,624.1         | 5.8         | -            | 5.8          | 3.8%          |
|          | <b>Subtotal (D)</b>                                   | <b>23,624.1</b>  | <b>-</b>         | <b>23,624.1</b>  | <b>5.8</b>  | <b>-</b>     | <b>5.8</b>   | <b>3.8%</b>   |
|          | <b>Total Project Costs (A+B+C+D)</b>                  | <b>307,319.2</b> | <b>483,401.3</b> | <b>790,720.5</b> | <b>75.4</b> | <b>118.7</b> | <b>194.1</b> | <b>128.4%</b> |

### 2.2.3. Climate Change adaptation

28. Allowance for climate change adaptation is included in the design criteria and the Capex costs based on projected sea-level rise, increasing incidence and severity of extreme climatic events.<sup>7</sup>

### 2.2.4. Implementation Schedule

29. The project will be implemented over a six-year period from 2022 to 2027. The construction of most facilities will be completed by 2026, the expenditure scheduled for 2027 relates to the commissioning and handover of the facilities including operator training. A summary showing the scheduling by the main outputs, including contingencies, is shown below.

**Table 7: Project Implementation Schedule**

| Item  | 2022        | 2023         | 2024         | 2025         | 2026        | 2027        | Total Cost    |
|---|-------------|--------------|--------------|--------------|-------------|-------------|---------------|
| <b>A</b>  |             |              |              |              |             |             |               |
| <b>Investment Costs</b>                               |             |              |              |              |             |             |               |
| 1 Civil Works   | -           | 19.2         | 44.9         | 57.7         | 6.4         | -           | 128.3         |
| 2 Mechanical and Equipment                            | 0.9         | 1.7          | 1.4          | 1.1          | 0.6         | -           | 5.7           |
| 3 Land acquisition and compensation                   | -           | 5.0          | -            | -            | -           | -           | 5.0           |
| 4 Consultancy and Training                            |             |              |              |              |             |             |               |
| a. Project Consultants                                | 1.1         | 5.3          | 2.1          | 1.1          | 0.5         | 0.5         | 10.5          |
| b. Capacity Development                               | 0.0         | 0.2          | 0.1          | 0.0          | 0.0         | 0.0         | 0.4           |
| <b>Subtotal (A)</b>                                   | <b>1.9</b>  | <b>31.3</b>  | <b>48.5</b>  | <b>60.0</b>  | <b>7.5</b>  | <b>0.5</b>  | <b>149.8</b>  |
| <b>B</b>  |             |              |              |              |             |             |               |
| <b>Recurrent Costs</b>                                |             |              |              |              |             |             |               |
| 1 Staff Allowances                                    | 0.1         | 0.1          | 0.1          | 0.1          | 0.1         | 0.1         | 0.4           |
| 3 Running Costs                                       | 0.1         | 0.1          | 0.1          | 0.1          | 0.1         | 0.1         | 0.9           |
| 4 Financial audit costs                               | 0.0         | 0.0          | 0.0          | 0.0          | 0.0         | 0.0         | 0.1           |
| <b>Subtotal (B)</b>                                   | <b>0.2</b>  | <b>0.2</b>   | <b>0.2</b>   | <b>0.2</b>   | <b>0.2</b>  | <b>0.2</b>  | <b>1.4</b>    |
| <b>Total Base Cost (A+B)</b>                          | <b>2.2</b>  | <b>31.6</b>  | <b>48.7</b>  | <b>60.2</b>  | <b>7.8</b>  | <b>0.8</b>  | <b>151.2</b>  |
| <b>C</b>  |             |              |              |              |             |             |               |
| <b>Contingencies</b>                                  |             |              |              |              |             |             |               |
| 1 Physical  | 0.3         | 5.3          | 8.5          | 10.6         | 1.3         | 0.1         | 26.1          |
| 2 Price   | 0.1         | 1.4          | 3.2          | 5.3          | 0.9         | 0.1         | 11.0          |
| <b>Subtotal (C)</b>                                   | <b>0.4</b>  | <b>6.7</b>   | <b>11.7</b>  | <b>15.9</b>  | <b>2.2</b>  | <b>0.2</b>  | <b>37.1</b>   |
| <b>D</b>  |             |              |              |              |             |             |               |
| <b>Financing Charges During Implementation (FCDI)</b> |             |              |              |              |             |             |               |
| 1 Interest during construction                        | 0.0         | 0.2          | 0.7          | 1.3          | 1.7         | 1.8         | 5.8           |
| <b>Subtotal (D)</b>                                   | <b>0.0</b>  | <b>0.2</b>   | <b>0.7</b>   | <b>1.3</b>   | <b>1.7</b>  | <b>1.8</b>  | <b>5.8</b>    |
| <b>Total Project Costs (A+B+C+D)</b>                  | <b>2.6</b>  | <b>38.4</b>  | <b>61.2</b>  | <b>77.4</b>  | <b>11.7</b> | <b>2.8</b>  | <b>194.1</b>  |
| <b>% of cost category</b>                             | <b>1.3%</b> | <b>19.8%</b> | <b>31.5%</b> | <b>39.9%</b> | <b>6.0%</b> | <b>1.4%</b> | <b>100.0%</b> |

<sup>7</sup> Details of the CRVA measures are included in the Climate Change and Vulnerability Assessment Reports.

## 2.3. Operation and Maintenance Costs

30. The operation and maintenance (Opex) costs associated with the new capital investment in the three cities for the urban infrastructure are estimated for when the new facilities of WWTP, septage, storm water drainage and the controlled landfill are fully operational in 2026. Opex costs are divided into fixed costs and variable costs, and the annual costs from 2026 to 2040 are adjusted accordingly to relate to the volume of solid waste, wastewater and stormwater handled. A summary of the Opex costs is provided in the table below as a snapshot in 2026 when the new facilities are fully operational.

31. The total annual Opex for the three cities is estimated at \$4.195 million (KHR17,178 m) per year in 2026.

**Table 8: Project Opex Costs**

|                  | KHR'000           | \$'000         |
|------------------|-------------------|----------------|
| <b>Kampot</b>    |                   |                |
| Wastewater       | 82,089            | 20.0           |
| <b>Total</b>     | <b>82,089</b>     | <b>20.0</b>    |
| <b>Poipet</b>    |                   |                |
| Wastewater       | 2,297,651         | 561.1          |
| Stormwater       | 180,757           | 44.1           |
| SWM              | 6,994,181         | 1,708.0        |
| <b>Total</b>     | <b>9,472,589</b>  | <b>2,313.2</b> |
| <b>Bavet</b>     |                   |                |
| Wastewater       | 1,005,146         | 245.5          |
| Stormwater       | 179,215           | 43.8           |
| SWM              | 6,439,344         | 1,572.5        |
| <b>Total</b>     | <b>7,623,704</b>  | <b>1,861.7</b> |
| <b>Total All</b> | <b>17,178,382</b> | <b>4,195.0</b> |

Note: assumes exchange rate of \$1:KR4,074.

Source: Egis, 2021

## 2.4. Conversion to Economic Costs

32. For the conversion of financial costs to economic costs, taxes and duties, interest and price contingencies are excluded, costs are broken down into their foreign costs, domestic added value costs (locally traded), skilled and unskilled labor components. In recognition of the high rate of unemployment and underemployment in Cambodia, the shadow value of unskilled labor is taken as 0.60. Table 9 summarizes the conversion factors used for each expenditure category. Individual conversion factors were calculated for the conversion of financial costs to economic costs for each of the main items of expenditure and their associated O&M costs (civil works, machinery and equipment, project management, etc.). The breakdown of the financial costs for the cost components used for the conversion to economic costs is shown in Table 10. This shows that overall for the total project base costs before contingency of \$151.2 million, the foreign costs make up 41%, locally traded costs 30%, skilled labor 3% and unskilled labor 17%. Total project capital investment costs (Capex) in economic terms are \$127.31 million while total project investment costs in economic terms is US\$149.3 million

**Table 9: Summary of Conversion factors used for each Expenditure Category**

| Category          | Foreign<br>SERF | Local traded<br>CF | Skilled labor<br>CF | Unskilled labor<br>SWRF | Tax<br>CF |
|-------------------|-----------------|--------------------|---------------------|-------------------------|-----------|
| Conversion factor | 1.00            | 1.00               | 1.00                | 0.60                    | -         |

Source: Egis, 2021.

Table 10: Summary of Economic Costs for Expenditure Categories

| Expenditure categories  |                                    | Breakdown & Economic Cost Conversion |         |              |               |                 |     |       |                   |
|-------------------------|------------------------------------|--------------------------------------|---------|--------------|---------------|-----------------|-----|-------|-------------------|
| Ref                     | Description                        | Local                                | Foreign | Local traded | Skilled labor | Unskilled labor | Tax | Total | Conversion Factor |
| <b>Expenditure Code</b> |                                    |                                      |         |              |               |                 |     |       |                   |
| CW-BA_WW                | Civil works- Bavet- Wastewater     | 60%                                  | 40%     | 27%          | 4%            | 20%             | 9%  | 100%  | 0.83              |
| CW-BA_DR                | Civil works- Bavet- Stormwater     | 60%                                  | 40%     | 27%          | 4%            | 20%             | 9%  | 100%  | 0.83              |
| CW-BA_SW                | Civil works- Bavet- Solid waste    | 60%                                  | 40%     | 27%          | 4%            | 20%             | 9%  | 100%  | 0.83              |
| CW-PP_WW                | Civil works- Poipet- Wastewater    | 60%                                  | 40%     | 27%          | 4%            | 20%             | 9%  | 100%  | 0.83              |
| CW-PP_DR                | Civil works- Poipet- Stormwater    | 60%                                  | 40%     | 27%          | 4%            | 20%             | 9%  | 100%  | 0.83              |
| CW-PP_SW                | Civil works- Poipet- Solid waste   | 60%                                  | 40%     | 27%          | 4%            | 20%             | 9%  | 100%  | 0.83              |
| CW-KA_WW                | Civil works- Kampot- Wastewater    | 60%                                  | 40%     | 27%          | 4%            | 20%             | 9%  | 100%  | 0.83              |
| CW-ALL-EMP              | Civil works                        | 60%                                  | 40%     | 27%          | 4%            | 20%             | 9%  | 100%  | 0.83              |
| D&S-ALL                 | a. Project Consultant (DCS+TA)     | 40%                                  | 60%     | 31%          | 0%            | 0%              | 9%  | 100%  | 0.91              |
| SA                      | Staff Allowance                    | 40%                                  | 60%     | 40%          | 0%            | 0%              | 0%  | 100%  | 1.00              |
| TAC                     | Technical Assistant                | 40%                                  | 60%     | 31%          | 0%            | 0%              | 9%  | 100%  | 0.91              |
| NGO-ALL                 | NGO (awareness campaign, training) | 40%                                  | 60%     | 31%          | 0%            | 0%              | 9%  | 100%  | 0.91              |
| OFF                     | Office Equipment and Furniture     | 40%                                  | 60%     | 31%          | 0%            | 0%              | 9%  | 100%  | 0.91              |
| MAC                     | Mechanical and Equipment           | 30%                                  | 70%     | 10%          | 0%            | 0%              | 20% | 100%  | 0.80              |
| LND                     | Land Acquisition & Compensation    | 100%                                 | 0%      | 100%         | 0%            | 0%              | 0%  | 100%  | 1.00              |
| TAS                     | b. Capacity Development (PMU)      | 95%                                  | 5%      | 86%          | 0%            | 0%              | 9%  | 100%  | 0.91              |
| ENV                     | Replanting/ afforestation          | 15%                                  | 85%     | 15%          | 0%            | 0%              | 0%  | 100%  | 1.00              |
| REC                     | Running Costs                      | 75%                                  | 25%     | 75%          | 0%            | 0%              | 0%  | 100%  | 1.00              |
| AUD                     | Financial Audit                    | 90%                                  | 10%     | 81%          | 0%            | 0%              | 9%  | 100%  | 0.91              |

Note. VAT rate is 10% VAT

Table 11: Breakdown of Costs by Expenditure Category and Cost Component

| LCIP COMBINED CAPEX COST           |  |                        |            |              |               |                 |           |                        |
|------------------------------------|--|------------------------|------------|--------------|---------------|-----------------|-----------|------------------------|
|                                    |  | Financial cost         | Foreign    | Local        |               |                 |           |                        |
| Expenditure Category               |  | Cost (\$'000) excl Tax | Foreign    | Local Traded | Skilled labor | Unskilled labor | Tax       | Economic Cost (\$'000) |
|                                    |  | \$                     | %          | %            | %             | %               | %         |                        |
| <b>Investment&amp;Runnig Costs</b> |  |                        |            |              |               |                 |           |                        |
| Civil Works                        |  | 116,635                | 40%        | 27%          | 4%            | 20%             | 9%        | 106,370.9              |
| Mechanical and Equipment           |  | 4,725                  | 70%        | 13%          | 0%            | 0%              | 17%       | 4,725.4                |
| Land acquisition and compensation  |  | 4,955                  |            | 100%         | 0%            | 0%              | 0%        | 4,955.1                |
| Consulting Costs                   |  |                        |            |              |               |                 |           | -                      |
| a. Project Consultants (DCS + TAS) |  | 9,546                  | 60%        | 31%          | 0%            | 0%              | 9%        | 9,546.1                |
| b. Capacity Development (PMU)      |  | 344                    | 0%         | 91%          | 0%            | 0%              | 9%        | 343.5                  |
| Equipment, Vehicles, Furniture     |  |                        |            |              |               |                 |           |                        |
| Staff Allowances                   |  | 386                    | 0%         | 100%         | 0%            | 0%              | 0%        | 386.4                  |
| Running Costs                      |  | 882                    | 25%        | 75%          | 0%            | 0%              | 0%        | 881.5                  |
| Financial audit costs              |  | 100                    | 10%        | 81%          | 0%            | 0%              | 9%        | 100.0                  |
| <b>Total</b>                       |  | <b>137,573</b>         | <b>41%</b> | <b>30%</b>   | <b>3%</b>     | <b>17%</b>      | <b>9%</b> | <b>127,309.0</b>       |

Note. This table shows the breakdown of the financial base costs excluding tax into the costs categories used for conversion to economic values.

Table 12: Summary of Project Costs in Economic Values

| LCIP COMBINED CAPEX COST           |                        | Financial cost        |                                  |         | Foreign      | Local         |                 |     |                   |                        |  |
|------------------------------------|------------------------|-----------------------|----------------------------------|---------|--------------|---------------|-----------------|-----|-------------------|------------------------|--|
| Expenditure Category               | Cost (\$'000) excl Tax | TAX and Duty (\$'000) | Total Base Cost icd Tax (\$'000) | Foreign | Local Traded | Skilled labor | Unskilled labor | Tax | Conversion factor | Economic Cost (\$'000) |  |
|                                    | \$                     |                       |                                  | %       | %            | %             | %               | %   |                   |                        |  |
| Investment&Runnig Costs            |                        |                       |                                  |         |              |               |                 |     |                   |                        |  |
| Civil Works                        | 116,635                | 11,663                | 128,298                          | 40%     | 27%          | 4%            | 20%             | 9%  | 0.83              | 106,370.9              |  |
| Mechanical and Equipment           | 4,725                  | 969                   | 5,694                            | 70%     | 13%          | 0%            | 0%              | 17% | 0.83              | 4,725.4                |  |
| Land acquisition and compensation  | 4,955                  | -                     | 4,955                            |         | 100%         | 0%            | 0%              | 0%  | 1.00              | 4,955.1                |  |
| Consulting Costs                   |                        |                       |                                  |         |              |               |                 |     |                   | -                      |  |
| a. Project Consultants (DCS + TAS) | 9,546                  | 955                   | 10,501                           | 60%     | 31%          | 0%            | 0%              | 9%  | 0.91              | 9,546.1                |  |
| b. Capacity Development (PMU)      | 344                    | 34                    | 378                              | 0%      | 91%          | 0%            | 0%              | 9%  | 0.91              | 343.5                  |  |
| Equipment, Vehicles, Furniture     |                        |                       |                                  |         |              |               |                 |     |                   |                        |  |
| Staff Allowances                   | 386                    | -                     | 386                              | 0%      | 100%         | 0%            | 0%              | 0%  | 1.00              | 386.4                  |  |
| Running Costs                      | 882                    | -                     | 882                              | 25%     | 75%          | 0%            | 0%              | 0%  | 1.00              | 881.5                  |  |
| Financial audit costs              | 100                    | 10                    | 110                              | 10%     | 81%          | 0%            | 0%              | 9%  | 0.909             | 100.0                  |  |
|                                    |                        |                       |                                  |         |              |               |                 |     | -                 |                        |  |
| Total                              | 137,573                | 13,631                | 151,204                          | 41%     | 30%          | 3%            | 17%             | 9%  | 0.842             | 127,309.0              |  |
| Contingency                        |                        |                       |                                  |         |              |               |                 |     |                   |                        |  |
| Physical                           |                        |                       | 26,111                           |         |              |               |                 |     | 0.842             | 21,985                 |  |
| Price                              |                        |                       | 10,975                           |         |              |               |                 |     |                   |                        |  |
| IDC                                |                        |                       |                                  |         |              |               |                 |     |                   |                        |  |
| Interest during construction       |                        |                       | 5,799                            |         |              |               |                 |     |                   |                        |  |
| Total                              |                        |                       |                                  |         |              |               |                 |     |                   |                        |  |
|                                    |                        |                       | 194,089                          |         |              |               |                 |     |                   | 149,294                |  |

Note. This table presents the economic cost for the outputs by applying the economic conversion factors to the expenditure categories making up each output.  
Source: Egis, 2021.

33. The overall Standard Conversion Factor (SCF) for the capital costs derived from the conversion to economic prices for the project Capex is 0.84. The conversion factor for the Opex costs is calculated separately.

34. The scheduling of project expenditure over the six years 2022–2027 has been allocated on the basis of the expected disbursement for the different outputs, as shown in Table 12 above.

## 2.5. Opex Costs Economic Conversion

35. The conversion of the Opex costs to economic costs used the same approach as the conversion of Capex costs, allowing for the percentage of the cost expenditure items made up of local, foreign exchange, locally traded, skilled labor and unskilled labor. The details of the economic cost conversion for Bavet's sanitation infrastructure (network, pump stations and WWTP), is shown in Table 14 below. The overall conversion factor is 0.99. A similar approach was used for the economic cost conversion for WW, SWM and storm water sub-projects for the Kampot and Poipet, which produced a similar conversion factor.

## 2.6. Salvage Values

36. The salvage value of assets that have an economic life longer than the 20-year project analysis period is included as a benefit in year 2040 in the cashflows. The assumed economic life of the various assets is summarised below. The table also shows the maintenance rate as a percentage of the original capital cost used for estimating the O&M costs. For those assets with an economic life of less than 20 years, for example pumps and vehicles, allowance is made for the cost of their periodic replacement costs in the cashflows.

37. Applying the asset life to the various capital costs results in a range from 51% to 59% depending on the type of asset of the original capital cost.

**Table 13: Economic Life of New Assets**

| Equipment macro-categories | Equipment categories         | Maintenance rate<br>(% of initial CAPEX/year) | Asset life duration<br>(years) |
|----------------------------|------------------------------|---|--------------------------------|
| Trucks and vehicles        |                              | 3%  | 10                             |
| Pumping station            | Electric/hydraulic equipment | 3%  | 10                             |
|                            | Concrete structures          | -   | 50                             |
| Wastewater treatment plant | Electric/hydraulic equipment | 3%  | 10                             |
|                            | Concrete structures          | -   | 50                             |
| Pipe network               | PVC gravity pipes            | 0.10%   | 40                             |
|                            | HDPE force mains             | 0.10%   | 40                             |

Source: Egis, 2021.



**Table 14: Conversion of Opex Costs to Economic Prices**

| <b>Bavet Sewer Network, Pump Stations &amp; WWTP Opex</b> |                    |              | <b>Economic Pricing Conversion Factors</b> |                       |                      |                         |            |                  |             |
|---|--------------------|--------------|--|-----------------------|----------------------|-------------------------|------------|------------------|-------------|
|   |                    |              | <b>SERF</b>                                | <b>CF</b>             | <b>CF</b>            | <b>SWRF</b>             | <b>CF</b>  |                  |             |
| <b>Summary</b>  |                    |              | 1.00                                       | 1.00                  | 1.00                 | 0.60                    | -          |                  |             |
|   | Financial costs \$ |              |  |                       |                      |                         |            |                  |             |
| <b>Network &amp; PS</b>                                   |                    | <b>Loc %</b> | <b>FE %</b>                                | <b>Locally traded</b> | <b>Skilled labor</b> | <b>Unskilled labour</b> | <b>Tax</b> | <b>Total</b>     | <b>CF</b>   |
| 1. Personnel  | 90,000             | 100%         | 0%   | 0%                    | 95%                  | 5%                      | 0%         | 100%             | 100%        |
| 2. Energy   | 16,838             | 85%          | 15%  | 85%                   | 0%                   | 0%                      | 0%         | 100%             | 100%        |
| 3. Operation & Maintenance                                | 32,398             | 80%          | <b>20%</b>                                 | 80%                   | 0%                   | 0%                      | 0%         | 100%             | 100%        |
| <b>Total</b>  | <b>139,236</b>     |              | <b>9,005</b>                               | <b>40,230</b>         | <b>85,500</b>        | <b>2,700</b>            | <b>-</b>   | <b>\$137,436</b> | <b>0.99</b> |
| <b>WWTP</b>   |                    |              |  |                       |                      |                         |            |                  |             |
| 1. Personnel  | 45,600             | 100%         | 0%   | 0%                    | 95%                  | 5%                      | 0%         | 100%             | 100%        |
| 2. Energy   | 6,014              | 85%          | 15%  | 85%                   | 0%                   | 0%                      | 0%         | 100%             | 100%        |
| 3. Operation & Maintenance                                | 54,231             | 80%          | <b>20%</b>                                 | 80%                   | 0%                   | 0%                      | 0%         | 100%             | 100%        |
| <b>Total</b>  | <b>105,862</b>     |              | <b>11,751</b>                              | <b>48,511</b>         | <b>43,320</b>        | <b>1,368</b>            | <b>-</b>   | <b>\$104,950</b> | <b>0.99</b> |
| <b>TOTAL ALL</b>  | <b>245,457</b>     |              | <b>20,756</b>                              | <b>88,741</b>         | <b>128,820</b>       | <b>4,068</b>            | <b>-</b>   | <b>\$242,385</b> | <b>0.99</b> |

Source: Egis, 2021

### 3. Economic Impact of Subproject Outputs

38. Urban infrastructure developed by the project will contribute to improved environment and living conditions in the three cities and support the sustainable management of the residential and commercial built-up areas through providing improved public utilities and protection of the natural environment and groundwater through improved sanitation, drainage, and solid waste management. The urban infrastructure developed by the project includes revenue-generating utilities (sanitation, septage, and SWM) where user fees (tariffs) are collected and contribute directly to the Opex, and non-revenue generating services (drainage) where there are no direct service charges and Opex is covered by the MA's general revenue (including transfers from central government) and property and business taxes.

39. The three cities (Bavet, Kampot and Poipet) have experienced rapid population growth, urbanization, and commercial and tourism development relative to the available urban infrastructure services in recent years. Largely due to their location as an international border crossing point with Vietnam (Bavet) and Thailand (Poipet) with the creation of Special Economic Zones (SEZs), access to casinos for gambling, and Kampot as a favored tourist destination, the expansion of the resident population, SEZ workers, and tourism has caused pollution of the local environment which threatens the long-term potential of commercial development and tourism to contribute to the vision of the municipalities.

#### 3.1. Physical Environment and Health Problems

40. The Comprehensive Cities Survey (CCS) of household and commercial/institutional entities conducted in December 2019 and January 2020 as part of the project planning recorded the respondents' perception of the main problems with the local environments. The results are presented below. Air pollution was regarded as the main problem with flooding and water pollution identified as an issue by over 50% of the surveyed households.

**Table 15: Households Physical Environment Problems**

| Physical Impacts | Frequency  |            |            |
|------------------|------------|------------|------------|
|                  | Bavet      | Kampot     | Poipet     |
| Air Pollution    | 327        | 288        | 503        |
| Flooding         | 253        | 266        | 393        |
| Water pollution  | 234        | 230        | 417        |
| <b>Total</b>     | <b>444</b> | <b>413</b> | <b>609</b> |
|                  | Percentage |            |            |
|                  | Bavet      | Kampot     | Poipet     |
| Air Pollution    | 74%        | 70%        | 83%        |
| Flooding         | 57%        | 64%        | 65%        |
| Water pollution  | 53%        | 56%        | 68%        |

Source: Egis, 2021

41. The CCS also recorded people's perception of the impact of their current environment on their family's health and wellbeing. The results are shown in Table 16. Respiratory illness was the most common making up over half with infections and disease. The disease of the digestive system, which is closely associated with the incidence of water-borne disease affected between 10% and 23% of the surveyed households. The incidence of "bad smells" was recorded by over 90% of the households. This was associated with the indiscriminate dumping of waste in all locations, with households aware of the problems of solid waste dumping on the environment and their health.

**Table 16: Impact of the environment on family health and wellbeing**

| Impact  | Frequency  |            |            |
|---|------------|------------|------------|
|   | Bavet      | Kampot     | Poipet     |
| Bad smell                                       | 412        | 345        | 565        |
| Diseases associated with the digestive system   | 45         | 56         | 139        |
| Diseases associated with the Respiratory system | 243        | 209        | 342        |
| Infections and Diseases                         | 179        | 204        | 285        |
| Wounds scabies                                  | 157        | 84         | 298        |
| <b>Total</b>                                    | <b>444</b> | <b>413</b> | <b>609</b> |
| Impact  | Percentage |            |            |
|   | Bavet      | Kampot     | Poipet     |
| Bad smell                                       | 93%        | 84%        | 93%        |
| Diseases associated with the digestive system   | 10%        | 14%        | 23%        |
| Diseases associated with the Respiratory system | 55%        | 51%        | 56%        |
| Infections and Diseases                         | 40%        | 49%        | 47%        |
| Wounds scabies                                  | 35%        | 20%        | 49%        |

Source: Egis, 2021.

### 3.2. Benefits to Public Health

42. As the associated health benefits of improved sanitation, solid waste management, and drainage are common to all components, as a first step, the overall public health benefits from improved urban infrastructure are quantified. At present, the population living in Bavet, Kampot, and Poipet do not have access to sewerage services and have to rely on septic tanks and cesspits with varying standards of effectiveness and cleanliness. Off-site pollution through the discharge of wastewater into the local inadequate drainage system is significant, and ultimately leading to more pollution of the local urban and rural environment. Untreated or partially treated wastewater not only affects the immediate residents but also contaminates the groundwater aquifer and the local watershed. Many residents also do not have access to a clean reticulated water supply and rely on groundwater and other sources. The negative health implications of an unimproved water supply are important as drinking contaminated water can also lead to illness, increased costs, lost productivity, and a subsequent decrease in the quality of life.

43. The benefits of improved sanitation and drainage services are closely linked to reticulated water supply, and to an extent, the full benefits of one cannot be gained without the other. For an effective supply of clean potable water, it is important to prevent contamination from raw sewerage, for example, contamination of groundwater sources from unlined pit latrines or broken pipes, and to ensure the effective functioning of the sewerage network a reliable and adequate water supply is needed for flushing, and for personal cleanliness and hygiene. To a lesser extent, improved solid waste management also has health benefits through a reduction in indiscriminate dumping and burning of rubbish resulting in contamination of the local environment, the spread of vermin, bad smells, unsightliness, etc.

44. Various international studies have attempted to detail and quantify the impact of poor water supply and sanitation services on the population. A useful summary compiled by the World Health Organization (WHO) is presented in Table 22, which can be used to help quantify the impact of the Project.

45. **Incidence of disease in Bavet, Kampot and Poipet.** The CCS conducted as part of the project planning recorded the incidence of illness and disease for the last 12 months for the sampled households in the three cities. The results are presented in Table 18. Mild diarrhea affected the majority of households with a relatively high incidence of other diseases commonly associated with poor sanitation, water supply, and a polluted environment, such as eye infections, skin infections, and more serious dysentery, typhoid, cholera, and dengue fever (mosquito-borne

associated with stagnant water). The main source of these diseases were considered to be from wastewater and garbage (Bavet 34%, Kampot 29%, and Poipet 63%).

46. **Source of medical treatment.** Health centers or clinics, private doctors, and pharmacies or shop are the default facilities where household members seek advice or treatment when a family member is ill, with around 50% of seeking help from these health providers. Around 38% also seek help from a referral hospital when a family member is ill. Traditional healer practitioners are relatively insignificant.

**Table 17: Source of Medical Treatment**

| Source of Medical Treatment            | Frequency  |            |            |
|--|------------|------------|------------|
|  | Bavet      | Kampot     | Poipet     |
| Health center or clinic                | 298        | 356        | 339        |
| Private doctor                         | 334        | 281        | 303        |
| Pharmacy or shop                       | 378        | 318        | 172        |
| Referral hospital                      | 256        | 255        | 267        |
| Friends relatives or neighbors         | 86         | 15         | 20         |
| Traditional doctor healer practitioner | 15         | 4          | 39         |
| Other                                  | 22         | 16         | 5          |
| <b>Total</b>                           | <b>704</b> | <b>669</b> | <b>692</b> |
|  | Percentage |            |            |
|  | Bavet      | Kampot     | Poipet     |
| Health center or clinic                | 42%        | 53%        | 49%        |
| Private doctor                         | 47%        | 42%        | 44%        |
| Pharmacy or shop                       | 54%        | 48%        | 25%        |
| Referral hospital                      | 36%        | 38%        | 39%        |
| Friends relatives or neighbors         | 12%        | 2%         | 3%         |
| Traditional doctor healer practitioner | 2%         | 1%         | 6%         |
| Other                                  | 3%         | 2%         | 1%         |

Source: Egis, 2020

**Table 18: Frequency of Illnesses in last 12 Months**

| City (age group & sex) | Percentage of Respondents |                 |                         |  |                                    |                                  |                          |
|------------------------|---------------------------|-----------------|-------------------------|--|------------------------------------|----------------------------------|--------------------------|
|                        | Mild diarrhea             | Severe diarrhea | Eye irritation/diseases | Skin diseases (e.g. scabies, ringworm) | Colds, cough, respiratory ailments | Typhoid fever, cholera/dysentery | Hemorrhagic dengue fever |
| <b>Bavet</b>           |                           |                 |                         |  |                                    |                                  |                          |
| Nobody                 | 57%                       | 94%             | 59%                     | 66%                                    | 8%                                 | 86%                              | 94%                      |
| Adults Female          | 32%                       | 3%              | 25%                     | 19%                                    | 80%                                | 9%                               | 2%                       |
| Adults Male            | 27%                       | 3%              | 20%                     | 14%                                    | 71%                                | 7%                               | 2%                       |
| Children under 5Ys     | 19%                       | 2%              | 6%                      | 14%                                    | 52%                                | 3%                               | 3%                       |
| <b>Kampot</b>          |                           |                 |                         |  |                                    |                                  |                          |
| Nobody                 | 44%                       | 91%             | 68%                     | 64%                                    | 13%                                | 82%                              | 83%                      |
| Adults Female          | 42%                       | 4%              | 22%                     | 18%                                    | 75%                                | 11%                              | 5%                       |
| Adults Male            | 35%                       | 4%              | 14%                     | 13%                                    | 72%                                | 6%                               | 4%                       |
| Children under 5Ys     | 29%                       | 2%              | 7%                      | 18%                                    | 47%                                | 4%                               | 10%                      |
| <b>Poipet</b>          |                           |                 |                         |  |                                    |                                  |                          |
| Nobody                 | 44%                       | 64%             | 41%                     | 45%                                    | 9%                                 | 58%                              | 62%                      |
| Adults Female          | 38%                       | 21%             | 42%                     | 39%                                    | 75%                                | 30%                              | 19%                      |
| Adults Male            | 33%                       | 20%             | 38%                     | 31%                                    | 70%                                | 26%                              | 17%                      |
| Children under 5Ys     | 33%                       | 21%             | 26%                     | 30%                                    | 56%                                | 17%                              | 23%                      |

Source: Egis, 2020.

47. It is highly likely that the incidence of diarrheal disease may be under-reported in these data. International studies have shown that in developing countries such as Cambodia, the incidence of diarrhea is likely to be much higher than the results indicated by the survey. For example, a World Bank report in 2006 for Vietnam noted that a recent survey showed 1.5 cases

of diarrhea per person per year, one-fifth of which required medical attention. It was also noted that this rate is five times the incidence in developed countries of 0.3 cases per person. The financial implications of this are serious. A 2005 World Bank study of the economic impact of Cambodia's lack of sanitation coverage estimated that \$448 m, or about 7% of the country's GDP, is lost each year to health problems resulting from poor sanitation.

48. **Infant mortality.** Overall, the infant mortality rate for Cambodia for 2019 was 22.8 per 1,000 live births, and the under-5 mortality rate was 26.6 deaths per 1,000 live births. These statistics have improved markedly from historical levels: in 2000, the under-5 mortality rate was 106 per 1,000 live births. No information is available for the infant mortality in the three cities.

49. **Incidence of dengue fever.** Dengue fever, which is spread by mosquitoes that breed in stagnant waters found around residential areas, is endemic in Cambodia and is also a significant health hazard in the three cities, as evident from the CCS.

50. **Cholera and typhoid.** Cholera is endemic in Cambodia, with periodic outbreaks being recorded. The disease particularly affects communities with poor water and sanitation infrastructure leading to outbreaks, which, if not managed properly, have deadly consequences, especially for children. Clean water and sanitation are fundamental to the reduction of cholera. Typhoid is also endemic in Cambodia and is spread by eating or drinking food or water contaminated by an infected person. Like cholera, the risk factors include poor sanitation and poor hygiene. While inadequate urban infrastructure remains in the three cities, an outbreak brought about by poor sanitation and contaminated water supply would be disastrous to the local economy and the tourist industry. Although the CCS recorded an incidence of typhoid/cholera/dysentery in each city, it is not known what the actual incidence of the more serious diseases is.

### 3.3. Household Healthcare Expenditure

51. The average monthly household expenditure is shown below, which includes expenditure on healthcare. On average, annual healthcare expenditure was recorded as Bavet KHR1.824 m (\$445.42), Poipet KHR2.244 m (\$548), Kampot KHR4.008 m (\$978.75), representing from 6% to 12% of total annual household expenditure. This is a relatively high percentage of household expenditure indicative of the unhealthy environment

**Table 19: Average Monthly Household Expenditure**

| Item   | Average expense/month |                   |                   |
|--|-----------------------|-------------------|-------------------|
|  | Bavet<br>KHR'000      | Poipet<br>KHR'000 | Kampot<br>KHR'000 |
| 1. Food consumption                              | 491                   | 571               | 630               |
| 2. Appliances and amenities                      | 46                    | 465               | 203               |
| 3. Electricity                                   | 92                    | 125               | 83                |
| 4. Energy/fuel for cooking                       | 33                    | 31                | 36                |
| 5. Water consumption                             | 8                     | 186               | 31                |
| 6. Solid waste collection                        | 2                     | 3                 | 4                 |
| 7. Toilet facility                               | 14                    | 15                | 22                |
| 8. Drainage                                      | 0                     | 0                 | 0                 |
| 9. Transport including fuel                      | 108                   | 92                | 141               |
| 10. Clothing                                     | 67                    | 61                | 99                |
| 11. Housing i.e. rental, maintenance, decoration | 33                    | 329               | 255               |
| 12. Healthcare                                   | 152                   | 187               | 334               |
| 13. Education                                    | 116                   | 187               | 216               |
| 14. Telephone, internet etc.                     | 49                    | 68                | 49                |

| Item                                  | Average expense/month |                   |                   |
|---------------------------------------|-----------------------|-------------------|-------------------|
|                                       | Bavet<br>KHR'000      | Poipet<br>KHR'000 | Kampot<br>KHR'000 |
| 15. Entertainment/Leisure             | 62                    | 77                | 96                |
| 16. Social event and ceremony         | 291                   | 297               | 325               |
| 17. Other                             | 330                   | 575               | 269               |
| <b>Total KHR'000/mth</b>              | <b>1,894</b>          | <b>3,269</b>      | <b>2,793</b>      |
| Total KHR'000/year                    | 22,728                | 39,228            | 33,516            |
| \$ per year                           | 5,550                 | 9,579             | 8,185             |
| <b>Healthcare expenditure</b>         |                       |                   |                   |
| KHR'000/mth                           | 152                   | 187               | 334               |
| KHR'000 per year                      | 1,824                 | 2,244             | 4,008             |
| <b>\$ per year</b>                    | <b>445.42</b>         | <b>547.99</b>     | <b>978.75</b>     |
| <b>Healthcare % of total expenses</b> | <b>8%</b>             | <b>6%</b>         | <b>12%</b>        |

Source: Egis, 2020

52. The CCS also questioned households on the expenditure on healthcare with the results shown for the three cities in Table 20 below. The calculated average spending on healthcare per household in the last year was: Bavet KHR 433,700 (\$105.91); Kampot KHR280,200 (\$68.43); and Poipet KHR 551,900 (\$134.77), which is somewhat less than the healthcare expenditure recorded as part of the total monthly household expenditure noted in the table above. At an average household size of 4.7 persons, this is equivalent to expenditure per capita per year of: Bavet KHR92,277 (\$22.53); Kampot KHR59,617 (\$14.56); and Poipet KHR 117,426, (\$28.68 for health expenditure).

**Table 20: Expenditure on Healthcare in last year**

| Expenditure            | Frequency  |            |            |
|------------------------|------------|------------|------------|
|                        | Bavet      | Kampot     | Poipet     |
| Less than 20,000 KHR   | 72         | 50         | 68         |
| 20,000 to 40,000 KHR   | 116        | 99         | 148        |
| 40,001 to 80,000 KHR   | 63         | 85         | 87         |
| 80,001 to 120,000 KHR  | 103        | 120        | 113        |
| 120,001 to 200,000 KHR | 142        | 84         | 82         |
| More than 200,000 KHR  | 207        | 158        | 145        |
| Don't Know             | 1          | 73         | 49         |
| <b>Total</b>           | <b>704</b> | <b>669</b> | <b>692</b> |
| Expenditure            | Percentage |            |            |
|                        | Bavet      | Kampot     | Poipet     |
| Less than 20,000 KHR   | 10%        | 7%         | 10%        |
| 20,000 to 40,000 KHR   | 16%        | 15%        | 21%        |
| 40,001 to 80,000 KHR   | 9%         | 13%        | 13%        |
| 80,001 to 120,000 KHR  | 15%        | 18%        | 16%        |
| 120,001 to 200,000 KHR | 20%        | 13%        | 12%        |
| More than 200,000 KHR  | 29%        | 24%        | 21%        |
| Don't Know             | 0%         | 11%        | 7%         |

53. **Avoided health costs.** For the purpose of the analysis, it is assumed that the average annual saving of household expenditure and opportunity costs relating to poor sanitation and water-borne illness is related to the recorded household annual expenditure on healthcare in each city as noted above – KHR433,700, KHR551,900 and KHR280,200 for Bavet, Poipet and Kampot respectively. It is assumed that benefit as a result of the improved urban infrastructure built by the project for Bavet and Poipet is 35% of this amount, and for Kampot 20% as LCIP is only supporting sanitation in Kampot. This allows for some level of subsidy of the health sector and other government expenditure for additional costs for hospitalization and treatment for severe cases of 25%.<sup>8</sup>

<sup>8</sup> Although the Cambodia has initiatives to provide financial protection to particular populations groups, the country does not have a national system that provides universal health protection to the entire population.

54. The annual transport costs per household of visiting the health clinic etc. is assumed to be KHR20,000 (\$5), and lost productivity in taking time off for sickness and caring for sick children is assumed to be 15 days a year at 50% of the minimum wage of \$7.38/d.<sup>9</sup> No allowance is included for any reduction in under-5 mortality and the economic costs relating to the incidence of hepatitis, dengue, etc., and other respiratory and digestive diseases that can be attributed to poor sanitation and hygiene and pollution from burning rubbish. The table below shows the avoided healthcare costs for each city assumed for the economic analysis.

**Table 21: Avoided Healthcare Costs**

| Item                      | Bavet          | Kampot         | Poipet         |
|---------------------------|----------------|----------------|----------------|
| Annual HH health exp      | 433,700        | 280,200        | 551,900        |
| LCIP %                    | 35%            | 20%            | 35%            |
| Total for project         | 151,795        | 56,040         | 193,165        |
| Saved transport costs     | 20,000         | 12,500         | 20,000         |
| Lost productivity         | 215,000        | 215,000        | 215,000        |
| <b>Total KHR/HH /year</b> | <b>386,795</b> | <b>283,540</b> | <b>428,165</b> |
| \$/HH/year                | 94.46          | 69.24          | 104.56         |

Source: Egis, 2021

55. It is not possible to attribute the health benefits to the individual components of sanitation, SWM, and drainage and if the benefit is considered to be related to all of these. Healthcare benefits attributed to the project used for the economic analysis are as follow:

- Bavet \$94.46 per HH per year
- Kampot \$69.24 per HH per year
- Poipet \$104.37 per HH per year

56. Health benefits to SEZ workers and tourists. In addition to the saving in healthcare costs for the resident households, it is expected that the SEZ workers and tourists would also receive an economic benefit through the reduction in disease caused by poor sanitation and pollution. An allowance of \$30.00 per person per year is allowed for the SEZ workers to allow for their saved healthcare expenditure and lost productivity through sick days. A nominal benefit of \$2.0 for tourists is included as a benefit to allow for an assumed saving in their healthcare related to the environment. Although tourists generally stay in superior accommodation, they are still exposed to the environment outside in the three cities.

<sup>9</sup> In September 2020 the minimum wage for garment workers was \$192 per month.

Table 22: Impact of Poor Water Supply and Sanitation

| Benefit by sector   | Variable   | Data source                 | Data values (+ range)  |
|---|--|-----------------------------|--|
| <b>1. Health sector</b>   |  |                             |  |
| Direct expenditures avoided, due to less illness from diarrhoeal disease        | Unit cost per treatment  | WHO regional unit cost data | US\$4.3-US\$9.7 (cost per visit) US\$16.1-US\$39.7 (cost per day) <i>Varying by WHO region</i> |
|   | Number of cases  | WHO BoD data                | Variable by region   |
|   | Visits or days per case  | Expert opinion              | 1 outpatient visit per case (0.5-1.5) 5 days for hospitalised cases (3-7)                      |
|   | Hospitalisation rate   | WHO data                    | 91.8% of cases ambulatory 8.2% of cases hospitalised   |
| <b>2. Patients</b>  |  |                             |  |
| Direct expenditures avoided, due to less illness from diarrhoeal disease        | Transport cost per visit   | Assumptions                 | US\$0.50 per visit   |
|   | % patients use transport   | Assumptions                 | 50% of patients use transport (0-100%)   |
|   | Non-health care patient costs  | Assumptions                 | US\$0.50 ambulatory (US\$0.25-1.00) US\$2.00 hospitalisation (US\$1.0-3.0)                     |
|   | Number of cases  | WHO BoD data                | Variable by region   |
|   | Visits or days per case  | Expert opinion              | 1 outpatient visit per case (0.5-1.5) 5 days for hospitalised cases (3-7)                      |
|   | Hospitalisation rate   | WHO data                    | 91.8% of cases ambulatory 8.2% of cases hospitalised   |
| Income gained, due to days lost from work avoided                               | Days off work/ episode   | Expert opinion              | 2 days (1-4)   |
|   | Number of people of working age  | WHO population data 2002    | Variable by region   |
|   | Opportunity cost of time   | World Bank data             | Minimum wage rate (GNP per capita – value added in manufacturing)                              |
| Days of school absenteeism avoided  | Absent days / episode  | Expert opinion              | 3 (1-5)  |
|   | Number of school age children (5-14)   | WHO population data 2002    | Variable by region   |
|   | Opportunity cost of time   | World Bank data             | Minimum wage rate (GNP per capita – value added in manufacturing)                              |
| Productive parent days lost avoided, due to less child illness                  | Days sick  | Expert opinion              | 5 (3-7)  |
|   | Number of babies (0-4)   | WHO population data 2002    | Variable by region   |
|   | Opportunity cost of time   | World Bank data             | 50% minimum wage rate (50% GNP per capita – 50% value added in manufacturing)                  |
| Value of loss-of-life avoided (life expectancy, discounting future years at 3%) | Discounted productive years lost (0 – 4 years)                               | WASH study [16]             | 16.2 years (9.5 – 29.1)  |
|   | Discounted productive years lost (5 – 14 years)                              | WASH study [16]             | 21.9 years (15.2 – 33.8)   |
|   | Discounted productive years lost (15+ years)                                 | WASH study [16]             | 19.0 years (16.3 – 22.7)   |
|   | Opportunity cost per year of life lost                                       | World Bank data             | Minimum wage rate  |
| <b>3. Consumers</b>   |  |                             |  |
| 'Convenience' – time savings  | Water collection time saved per household per day for better external access | Expert opinion              | 0.5 hours (0.25-1.0)   |
|   | Water collection time saved per household per day for piped water            | Expert opinion              | 1.5 hours (1.0-2.0)  |
|   | Sanitation access time saved per person                                      | Expert opinion              | 0.5 hours (0.25-0.75)  |
|   | Average household size   | WHO population data 2002    | 6 people (4-8)   |
|   | Opportunity cost of time   | World Bank data             | Minimum wage rate (GNP per capita – value added in manufacturing)                              |

Source: "Evaluation of the Costs and Benefits of Water and Sanitation Improvements at the Global Level", Guy Hutton and Laurence Haller, Water, Sanitation and Health Protection of the Human Environment, World Health Organisation, Geneva, 2004.



### 3.4. Solid Waste Management

57. The development of a more efficient and comprehensive rubbish collection system, recycling of waste, and the construction of a new controlled landfill has several economic benefits. In the current and without project situation, Bavet and Poipet are only partially served by a solid waste collection system with disposal to the underdeveloped dumpsite with its attendant disadvantages. In the absence of a rubbish collection system, households resort to their own means of disposal, including indiscriminate dumping, burning, and other unhygienic practices contributing to urban disfiguration and pollution. The economic benefits from the improved SWM include:

- (i) Saving in the cost in material and time for households and commercial enterprises having to dispose of their waste through other means
- (ii) Reduction in pollution through bad smells, burning of waste, contamination of the environment through indiscriminate disposal, and a reduction in vermin
- (iii) Reduction in health impact and saving indirect health costs through the reduction in the above
- (iv) Value of recycled materials that otherwise would end up in the dumpsite or be disposed of indiscriminately
- (v) Reduction of Green House Gases (GHG) through a reduction of the burning and rotting of municipal waste and disposal in a controlled landfill instead of an open dumpsite

58. The benefits of recycling include:

- (i) Reduces the amount of waste sent to landfills and incinerators
- (ii) Conserves natural resources such as timber, water, and minerals
- (iii) Increases economic security by tapping a domestic source of materials
- (iv) Prevents pollution by reducing the need to collect new raw materials
- (v) Saves energy
- (vi) Supports local manufacturing and conserves valuable resources
- (vii) Helps create jobs in the recycling and manufacturing industries

59. **Saved alternative collection and disposal.** The introduction of an improved SWM system will benefit households and commercial entities through the saving in the alternative costs of rubbish collection and disposal where they do not currently have access to a rubbish collection service in the future without project situation (FWOP). It is difficult to quantify the economic impact of all the benefits in monetary terms, but it is possible to generalize the amount of time and money saved by households through not having to resort to alternative means of waste disposal, including dumping on wasteland and drains, burning and transporting to the collection center.

60. **Environmental benefits.** Indiscriminate dumping and burning of municipal waste contribute to CO<sub>2</sub> and GHG production from burning and decomposition of the waste. Sorting, recycling, the conversion of green waste and bio waste to compost, and the disposal of waste in a controlled landfill will reduce the production of GHG. Incineration of 1 ton of municipal waste is associated with the release of about 0.7 to 1.7 tons of carbon dioxide (CO<sub>2</sub>) into the atmosphere, depending on its composition.<sup>10</sup>

Uncontrolled decomposition leads to the production of methane, an important GHG. The value of the CO<sub>2</sub> saved is included in the capture of GHG from the new controlled landfill.

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<sup>10</sup> The Impact of Waste-to-Energy incineration on climate. Zero Waste Europe, Policy Briefing September 2019.

61. **Capture of greenhouse gases.** The operation of the new controlled landfill proposed for Bavet and Poipet is designed to cover the waste and capture landfill gases, which will be flared off, converting the more harmful methane CO<sub>4</sub> portion to less harmful CO<sub>2</sub>. The production of the landfill gas resulting from the consolidation of waste in the new landfill under anerobic conditions is projected to progressively increase as the landfill is built up with waste as landfill gets bigger. Landfill gas is composed of 50% methane and 50% CO<sub>2</sub> by volume. Methane is a potent greenhouse gas 28 to 36 times more effective than CO<sub>2</sub> at trapping heat in the atmosphere over a 100-year period (IPPC AR5). The conversion of methane to the less harmful CO<sub>2</sub> through burning that otherwise would escape to the atmosphere can be included as an economic benefit and valued at the price of carbon saved. Burning methane produces 2.75 the weight of CO<sub>2</sub>, but as CO<sub>4</sub> is 25 times more harmful than CO<sub>2</sub>, there will be a net gain on GHG emissions of 9 for every unit of CO<sub>4</sub> that is flared off at the landfill. It is assumed that 60% of landfill gases are captured and converted to CO<sub>2</sub>. The value of the CO<sub>2</sub> is taken as \$43.2/t in 2020 prices and inflating at 2% in real terms per year over the life of the project, according to the ADB guidelines.<sup>11</sup>

62. **Health benefits.** As discussed in the preceding section, the current situation where municipal waste that is not collected and disposed of in the dumpsite is dumped and, in some cases, burnt by households themselves constitutes a health hazard and contributes to healthcare costs associated with vermin, flies, smoke and unhygienic practices. A portion of the saving in healthcare costs that will result from the urban infrastructure investment can be attributed to improved SWM. The increase in solid waste collection resulting from the project can also have a general impact on all the residents, the commercial sector, and tourists through the reduction in the negative aspects, as noted above.

63. **Recycled material and compost.** The improved SWM system proposed for Bavet and Poipet will have a greater degree of waste separation and recycling and marketing of material with value and composting of organic biowaste for sale as compost. The CCS indicated that practically all households and commercial establishments are willing to separate materials into separate bags for collection purposes if a recycling program is put in place, and in fact, a high degree of separation and recycling is already taking place in Bavet and Poipet. The income received from recycling and from the sale of compost can be included as a benefit to the project, after allowing for the degree of recycling and use of biowaste that already occurs in the twop situation.

### 3.5. Sanitation

64. It is proposed that three cities will each have a sub-project to develop wastewater collection and treatment for the urban population as an alternative to septic tanks and cesspits that are widely used by resident households and commercial enterprises.<sup>12</sup> In conjunction with the development of sewer network and the new WWTP in Bavet and Poipet the project also include support to septage through the rehabilitation of existing cesspits and septic tanks for those who cannot be connected in the service area, the installation of new septic tanks, and the connection of households and commercial enterprises to the new sewer network and the decommissioning of the existing septic tanks and the procurement of septage vacuum trucks.

65. **Economic benefits.** In a similar way to the introduction of SWM, providing a sanitation system and improved drainage will contribute to an improved environment, and less pollution in

<sup>11</sup> According to the ADB guidelines for Economic Evaluation of Projects 2017 based on a value of GHG of \$36.30/t in 2016 price terms inflated by 2% per year in real terms to allow for potential of increasing marginal damage of global warming over time.

<sup>12</sup> For Kampot, the LCIP will fund the expansion of the sewer network and connections only.

the area served through reducing wastewater and result in a more favorable environment for the local community and for the local economy. The direct economic benefits that result from improved sanitation include:

- (i) Saving in the costs of maintaining septic tanks and latrines and the costs of periodic desludging of septic tanks
- (ii) Saving in time and convenience in having better access to an in-house house toilet and not having to use alternative and inadequate sanitation facilities
- (iii) Reduction in health costs associated with unsanitary sanitation, particularly for households without the septic tank,
- (iv) Reduction of pollution of groundwater, waterways, the general environment, and the coastal environment.

66. **Benefits to public health.** The population of the cities will have access to improved sanitary facilities, which will significantly reduce the incidence of disease related to poor sanitation and drainage, particularly of acute intestinal infectious diseases, hepatitis, dengue fever, malaria, etc. thereby reducing production time lost and money spent on dealing with illnesses and impacting on the health of infants and the very young who are most susceptible to disease related to poor sanitation.

67. As discussed in the section above, the impact of the new urban infrastructure on healthcare costs for the cities has been quantified. Although it is likely that the impact of improved sanitation and drainage represents the bulk of the healthcare benefits, it is not possible to realistically allocate an actual amount to individual components. Consequently, health benefits are assumed to relate to the overall project impact.

68. **Saved desludging costs.** The progressive connection of households and commercial establishments to the sewerage system will result in the decommissioning of septic tanks and saving in the costs of their maintenance and periodic desludging. Some households that make use of permeable septic tanks or cesspits periodically construct a new structure when the old one is full, rather than desludging. The saved cost of not having to construct a new one can also be included as an economic benefit. The saved costs of septage cleaning is assumed to be \$8.50 per HH per year, and the saved costs of septic tank and cesspit maintenance, including their periodic cost of building a new facility is taken as \$5.00 per HH per year, and for non-residential establishments \$25.0 per year in each city.

### 3.6. Drainage

69. The LCIP will support a new stormwater drainage system for Bavet and Poipet, which will allow the separation of wastewater from stormwater. The existing drainage systems in the cities are a combined system collecting wastewater, sewerage, septic tank outflows, and stormwater, thereby functioning as sewers for most of the time. Thus, a significant level of organic material and coliforms is present in the drainage water and is discharged into the local environment. Residents also dispose of solid waste into the drains contributing to the accumulation of debris, forming blockages, and the generation of bad smells and polluted groundwater.

70. The benefits of improved drainage are similar to the benefits of sanitation, with the added impact of a reduction in surface flooding and inundation of land and property associated with heavy rainfall and the reduction in the costs of flood damage through the flooding of property and houses. Overall, the benefits of improved drainage can be summarized as:

- (i) Saving in the costs of flood damage to property through a reduction in flooding and inundation

- (ii) Saving in loss of productive time in having to clean up flood damage and having to take time off work
- (iii) Reduction in disease and health costs associated with unsanitary sanitation, and flooding and the contamination of floodwater with sewerage
- (iv) Reduction of pollution of groundwater, waterways, the general environment and reduction of BOD loadings.

71. As drainage is a non-revenue generating infrastructure, it is not possible to directly quantify the economic benefits for households and commercial entities through the willingness to pay (WTP) for improved drainage infrastructure, as is the case for the other urban infrastructure, SWM, sanitation, and water supply where the user pays applies. The cost of maintaining drainage infrastructure is indirectly funded through the contribution of property rates and business tax to the MA.

72. For the economic analysis, the environmental and health benefits of improved drainage are considered to be bundled with benefits of the expanded sanitation system and a dedicated sewer network that separates wastewater from the stormwater and drainage system and reduces the BOD level and pollutants that currently are discharged to the local environment.<sup>13</sup> The SWM service for Bavet and Poipet will also alleviate some of the problems associated with the illegal dumping of waste into the drains.

73. **Flood damage.** The economic benefits of reduced flooding can be quantified separately. The CCS recorded the value and incidence of flooding and the cost of damage to households, as shown in the tables below.

**Table 23: Incidence of Flooding in Ward**

|                                | Frequency   |             |             |
|--------------------------------|-------------|-------------|-------------|
|                                | Bavet       | Kampot      | Poipet      |
| Every time it rains            | 17          | 13          | 64          |
| Only when it rains heavily     | 200         | 306         | 344         |
| at least once a year           | 23          | 104         | 78          |
| at least once every two years  | 11          | 9           | 19          |
| at least once every five years | 4           | 12          | 12          |
| at least once every ten years  | 1           | 17          | 9           |
| Never                          | 448         | 208         | 166         |
| <b>Total</b>                   | <b>704</b>  | <b>669</b>  | <b>692</b>  |
|                                | Percentage  |             |             |
|                                | Bavet       | Kampot      | Poipet      |
| Every time it rains            | 2.4%        | 1.9%        | 9.2%        |
| Only when it rains heavily     | 28.4%       | 45.7%       | 49.7%       |
| at least once a year           | 3.3%        | 15.5%       | 11.3%       |
| at least once every two years  | 1.6%        | 1.3%        | 2.7%        |
| at least once every five years | 0.6%        | 1.8%        | 1.7%        |
| at least once every ten years  | 0.1%        | 2.5%        | 1.3%        |
| Never                          | 63.6%       | 31.1%       | 24.0%       |
| <b>Total</b>                   | <b>100%</b> | <b>100%</b> | <b>100%</b> |

Source: Egis 2020.

74.. Of those households that responded to this question, it is apparent the flooding is worse in Kampot and Poipet, where 31% and 24% of households said that they had never experienced

<sup>13</sup> **Biochemical oxygen demand (BOD)**, the amount of dissolved oxygen used by microorganisms in the biological process of metabolizing organic matter in water. The more organic matter there is (e.g., in sewage and polluted bodies of water), the greater the BOD; and the greater the BOD, the lower the amount of dissolved oxygen available for higher animals such as fishes. The BOD is therefore a reliable gauge of the organic pollution of a body of water.

flooding, compared to 64% in Bavet. The majority of households said that it only floods when it rains heavily, but this is expected to occur regularly during the rainy monsoon season May to October.

75. The respondents considered that skin diseases were the highest health problem that occurred in the flood season. Households also considered that effluent contamination causing diarrhea affected children with an average incidence of Bavet 29%, Kampot 19%, and Poipet by 34%.

76. In Bavet, 36% of households had experienced flooding in their ward. And among those, 84% of them had encountered flooding in their yard, and 48% of them had flooding in their house. Most flooding was less than 20 cm in-depth, and more than 50% of the floods last for at least one day. Mosquito breeding is the main problem (74%) caused by floods, followed by a proliferation of trash rubbish (50%) and stagnant water for days/weeks (40%).

77. There are 69% of households in Kampot that experienced flooding in their ward. Among those, 91% of them encountered flooding in their yard, and 64% of them experienced a flood in their house. The flood depth level is 30cm or less (66%), and 75% of the floods last for at least one day. Mosquito breeding is the main problem (72%) caused by flood and follow by stagnant water for days/weeks (46%) and the proliferation of trash rubbish (42%).

78. For Poipet, 76% of households had experienced flooding in their ward. Among those, 93% of them encountered flooding in their yard, and 72% of them experienced the flood in their house. The flood depth level is 30cm or less (73%), and 61% of the flood lasts for at least one day. Mosquito breeding is the main problem.

79. **Cost of flood damage.** Only 9% of Bavet households said that they had experienced serious flood damage to their house or property, 12% in Kampot, and 16% in Poipet. However, most affected households said that they were not able to repair or build a new house (Bavet 67%, Kampot 75%, and Poipet 79%), which implies that the cost of flooding is more significant than indicated. Of those households that said that they were affected by flooding, two-thirds of the 24 Bavet households said they did not know what the cost of flood damage was, while 33% and 44% of Kampot and Poipet households respectively said they did not know the cost.

**Table 24: Cost of Flood Damage**

|                        | Frequency   |             |             |
|------------------------|-------------|-------------|-------------|
|                        | Bavet       | Kampot      | Poipet      |
| Less than 20,000 KHR   | 3           | 13          | 14          |
| 20,000 to 40,000 KHR   | 3           | 12          | 17          |
| 40,001 to 80,000 KHR   | 0           | 7           | 9           |
| 80,001 to 120,000 KHR  | 2           | 0           | 3           |
| 120,001 to 200,000 KHR | 0           | 1           | 2           |
| More than 200,000 KHR  | 0           | 3           | 1           |
| Don't Know             | 16          | 18          | 36          |
| <b>Total</b>           | <b>24</b>   | <b>54</b>   | <b>82</b>   |
|                        | Percentage  |             |             |
|                        | Bavet       | Kampot      | Poipet      |
| Less than 20,000 KHR   | 12.5%       | 24.1%       | 17.1%       |
| 20,000 to 40,000 KHR   | 12.5%       | 22.2%       | 20.7%       |
| 40,001 to 80,000 KHR   | 0.0%        | 13.0%       | 11.0%       |
| 80,001 to 120,000 KHR  | 8.3%        | 0.0%        | 3.7%        |
| 120,001 to 200,000 KHR | 0.0%        | 1.9%        | 2.4%        |
| More than 200,000 KHR  | 0.0%        | 5.6%        | 1.2%        |
| Don't Know             | 66.7%       | 33.3%       | 43.9%       |
| <b>Total</b>           | <b>100%</b> | <b>100%</b> | <b>100%</b> |

Source: Egis, 2020.

80. The existing drainage systems in the three cities do provide some measure of protection against flooding. The proposed drainage in LCIP will provide a greater degree of protection but will not alleviate flooding entirely but is expected to reduce the costs associated with flooding significantly in the areas served by the new drainage infrastructure. However, because of the high percentage of the respondents that were not able to provide this information, these survey results are likely to be lower than the average cost. Commercial and institutional properties also suffer from periodic flood damage with its associated cost. Based on the response in this table and other information from Cambodia, the average cost of flood damage repair per year is estimated to be \$150 (KHR614,250) for households within the drainage area in Bavet and Poipet, and for the commercial and institutional establishments protected by the new infrastructure \$250 per year.

### 3.7. Impact on Tourism

81. The development of improved urban infrastructure in the three cities is anticipated to have a positive impact on tourism with an increase in the number of tourists, their average length of stay and daily expenditure. The increase in expenditure over the frop situation can be included as an economic benefit. The latest available data of the number of domestic and international tourists visiting the three cities for the years 2016 to 2018 is summarized in the table below. Kampot with over 1.5 million tourist visits per year is the most important as a tourist destination followed by Poipet. Poipet has experienced the biggest growth in tourist over the three years with an average annual growth of 21.2 %, predominantly for domestic tourist. The average length of stay varies from less than one day for domestic visitors to Kampot to 2.5 days for international tourists, who are recorded as having a longer visit. In terms of the number of days stay at each location international tourist to Bavet and Kampot are the more significant, attached by the casinos while in Kampot domestic tourist are more important. The average expenditure per day, based on the available data for Kampot is \$33 per day.

**Table 25: Tourist for Bavet, Kampot and Poipet 2016 - 2018**

| City          |               | 2016             | 2017             | 2018             | Ave growth %/y | Average length of stay Days | Ave days stay /yr (3 years) |
|---------------|---------------|------------------|------------------|------------------|----------------|-----------------------------|-----------------------------|
| <b>Bavet</b>  | <b>Total</b>  | <b>713,177</b>   | <b>705,798</b>   | <b>736,633</b>   | 1.1%           |                             |                             |
|               | Domestic      | 188,676          | 188,101          | 201,973          | 2.3%           | 1.5                         | 289,375                     |
|               | International | 524,501          | 517,697          | 534,660          | 0.6%           | 1.5                         | 788,429                     |
| <b>Kampot</b> | <b>Total</b>  | <b>1,577,439</b> | <b>1,600,699</b> | <b>1,629,530</b> | 1.1%           |                             |                             |
|               | Domestic      | 1,417,191        | 1,438,449        | 1,461,795        | 1.1%           | <1                          | 863,487                     |
|               | International | 160,248          | 162,250          | 167,735          | 1.7%           | 2.5                         | 408,528                     |
| <b>Poipet</b> | <b>Total</b>  | <b>931,119</b>   | <b>1,330,915</b> | <b>1,522,917</b> | 21.2%          |                             |                             |
|               | Domestic      | 487,571          | 812,857          | 1,066,476        | 39.6%          | 1                           | 788,968                     |
|               | International | 443,548          | 518,058          | 456,441          | 1.0%           | 2                           | 945,365                     |

Source: Egis and PD of Tourism.

82. The economic benefit from tourism has been valued at the marginal increase in expenditure by international tourists to Poipet and Bavet. A 20% increase in the average growth of international tourist over the historical growth 2016 – 2018 has been assumed with 15% of their increased expenditure counted as the marginal benefits allowing for the input costs associated with their expenditure. For Bavet this amounts to an additional growth due to the project of 0.13% per year and for Poipet 0.15%. The growth in tourism is assumed to persist for 10 years. No tourism benefit is assumed for Kampot. This results in a net annual benefit of \$5,040 and \$6,926



for Bavet and Poipet respectively in 2025, inflating at 0.13% per year. No economic benefit is allowed for an increase in domestic tourists resulting from the project as it is assumed that any increase in domestic tourism expenditure only contributes to the regional economy and has no benefit to the national economy.

### 3.8. Reduction in Undesirable Pollutants

83. The positive environmental impact of reducing the amount of untreated wastewater and septic tank outflow to the environment is a major benefit of wastewater and septage treatment. The improvement in the collection and treatment of MSW also contributes to a reduction in pollution of ground water, especially through the containment of leachate from a dumpsite as a result of the controlled landfill. Because the negative environmental effects due to the degradation of the water bodies and ecosystems where untreated, or inadequately treated wastewater is discharged cannot not be easily valued through market prices they are not fully accounted for in a conventional economic analysis.

84. For the economic analysis of the environment impact of LCIP the methodology described in the report UNEP *Economic Valuation of Wastewater: The cost of action and the cost of no action* has been applied for valuing the reduction in undesirable pollutants due to improved sanitation in the three cities.<sup>14</sup> This approach values the impact of untreated wastewater to the environment by ascribing values to the undesirable pollutants of which are removed through the treatment process of sewage and septage through the new WWTP. Following a methodology developed by Hernández-Sancho et al., 2010, shadow values for undesirable outputs that are equivalent to their benefits were determined for different situations for the discharge of wastewater. This study used a sample of wastewater treatment plants in Spain to estimate the shadow values of five indicators: nitrogen (N); phosphorus (P); suspended solids (SS); biological oxygen demand (BOD); and chemical oxygen demand (COD). The economic values so derived differ depending on the type of receiving water body and difference reference water prices used. The main environment benefits are for the elimination of P followed by N. The summary of the values determined by this study is shown in Table 26 below. Values in Euro are converted to \$ at the exchange rate prevailing in 2010 and inflated to 2020 values by a factor of 1.14 through applying the MUV index.<sup>15</sup>

**Table 26: Estimated Shadow Prices for Undesirable Outputs**

| Effluent destination                            | Reference price of water (€/m3)  | Nitrogen (N) (€/kg)  | Phosphorus (P) (€/kg)   | Suspended solids (SS) (€/kg)   | Biological oxygen demand (BOD) (€/kg)  | Chemical oxygen demand (COD) (€/kg)  |
|---|----------------------------------|----------------------|-------------------------|--------------------------------|--|--------------------------------------|
| River   | 0.7                              | 16.3                 | 30.9                    | 0.005                          | 0.03                                   | 0.1                                  |
| Sea   | 0.1                              | 4.6                  | 7.5                     | 0.001                          | 0.005                                  | 0.01                                 |
| Wetlands  | 0.9                              | 65.2                 | 103.4                   | 0.01                           | 0.12                                   | 0.12                                 |
| Reuse   | 1.5                              | 26.2                 | 79.3                    | 0.01                           | 0.06                                   | 0.14                                 |
| Source: Hernández-Sancho et al. (2010).         |                                  |                      |                         |                                |  |                                      |
| Convert to US\$/kg                              |                                  |                      | Euro: US\$              | 1.2                            | (Exchange rate 2010)                   |                                      |
| Inflate to 2020 values by MUV index 2010 - 2020 |                                  |                      |                         | 1.1477                         |  |                                      |
| Effluent destination                            | Reference price of water (\$/m3) | Nitrogen (N) (\$/kg) | Phospho-rus (P) (\$/kg) | Suspen-ded solids (SS) (\$/kg) | Biological oxygen demand (BOD) (\$/kg) | Chemical oxygen demand (COD) (\$/kg) |

<sup>14</sup> Economic Valuation of Wastewater - The cost of action and the cost of no action. United National Environment Programme, 2015

<sup>15</sup> The manufactures unit value (MUV) index, produced twice-yearly by the World Bank, is a composite index of prices for manufactured exports from the five major (G-5) industrial countries (France, Germany, Japan, the United Kingdom, and the United States) to low- and middle-income economies, valued in U.S. dollar.

|                 |       |       |        |      |      |      |
|-----------------|-------|-------|--------|------|------|------|
| <b>River</b>    | 0.964 | 22.45 | 42.56  | 0.01 | 0.04 | 0.14 |
| <b>Sea</b>      | 0.138 | 6.34  | 10.33  | 0.00 | 0.01 | 0.01 |
| <b>Wetlands</b> | 1.240 | 89.80 | 142.41 | 0.01 | 0.17 | 0.17 |
| <b>Reuse</b>    | 2.066 | 36.08 | 109.22 | 0.01 | 0.08 | 0.19 |

Source: Egis, 2021.

85. For the LCIP economic analysis the values relating to discharge into combination of a river and wetland are regarded as being appropriate for Bavet and Poipet, while for Kampot the value of pollutants discharged to a river are used for quantifying the economic benefit.

### 3.9. Impact on GDP

86. The project is expected to result in a more livable cities for the residents and the commercial sector. As a result of the improved urban infrastructure through investment in sanitation, SWM, and drainage, the environment will be more conducive to business and growth of the local economy, than would be the case in the future without project situation. The local economic performance is measured by the contribution to Gross Domestic Product (GDP), which is a measure of all economic activity goods and services contributing to the economy during a period of time (usually a year). It follows, therefore, that the establishment of a more livable city that has improved public utilities will be more attractive to business development and tourism and have a high GDP than would be the case without the project. A change in the growth of GDP in the future between the future with the project and the future without the project situation can be included as an economic benefit that encompasses the totality of all the impacts that are not quantified in the direct economic impact and benefit.

87. GDP for Cambodia in 2019 was \$27.09 billion, according to official data from the World Bank, and the country achieved a growth rate of 7.10% in 2019 and has maintained an average growth rate of 7.9% since 1997. GDP per capita in 2019 was \$1,643. Cambodia's open borders to international trade and investment have helped attract foreign direct investment to support manufacturing, construction, and tourism. ADB projections for 2020 and 2021 indicated negative GDP growth of -4.0% for 2020 due to Covid-19 and improving to 5.9% for 2020. Summary statistics for Cambodia for the last four years and the projections for 2020 to 2022 are shown in the table below.

**Table 27: Cambodia GDP**

| Item                               | 2016       | 2017       | 2018       | 2019       | 2020       | 2021       | 2022          |
|------------------------------------|------------|------------|------------|------------|------------|------------|---------------|
| <b>Cambodia</b>                    |            |            |            |            |            |            |               |
| Population, total                  | 15,766,293 | 16,009,414 | 16,249,798 | 16,486,542 | 16,717,354 | 16,951,397 | 17,188,716.09 |
| Population growth (annual %)       | 1.6%       | 1.5%       | 1.5%       | 1.4%       | 1.4%       | 1.4%       | 1.4%          |
| Urban population growth (annual %) | 3.3%       | 3.3%       | 3.3%       | 3.2%       |            |            |               |
| GDP (current US\$ m)               | 20,016.748 | 22,177.201 | 24,571.754 | 27,089.390 | 26,005.814 | 27,540.157 | 29,192.567    |
| GDP growth (annual %)              | 7.0%       | 6.8%       | 7.5%       | 7%         | -4%        | 5.9%       | 6.0%          |
| GDP per capita \$                  | 1269.59    | 1385.26    | 1512.13    | 1643.12    | 1,555.62   | 1,624.65   | 1,698.36      |
| GDP growth per capita              |            | 9%         | 9%         | 9%         | -5%        | 4%         | 4%            |
| <b>Provincial GDP \$m)</b>         |            |            |            |            |            |            |               |



| Item                                  | 2016     | 2017     | 2018     | 2019     | 2020     | 2021     | 2022     |
|---------------------------------------|----------|----------|----------|----------|----------|----------|----------|
| Svay Rieng (Bavet) (\$m)              | 750.50   | 828.10   | 900.60   | 963.64   | 925.10   | 979.68   | 1,028.66 |
| Kampot (Kampot) (\$m)                 | 1,252.00 | 1,357.00 | 1,451.99 | 1,553.63 | 1,491.48 | 1,579.48 | 1,658.46 |
| Banteay Meanchey (Poipet) (\$m)       | 881.70   | 966.90   | 1,043.80 | 1,111.65 | 1,067.18 | 1,130.14 | 1,186.65 |
| <b>Provincial GDP growth (%/y)</b>    |          |          |          |          |          |          |          |
| Svay Rieng (Bavet)                    | 5.1%     | 6.7%     | 7.4%     | 7.0%     | -4%      | 5.9%     | 5%       |
| Kampot (Kampot)                       | 6.1%     | 6.7%     | 7.0%     | 7.0%     | -4%      | 5.9%     | 5%       |
| Banteay Meanchey (Poipet) (\$m)       | 8.4%     | 6.0%     | 6.5%     | 6.5%     | -4%      | 5.9%     | 5%       |
| <b>Provincial GDP per capita (\$)</b> |          |          |          |          |          |          |          |
| Svay Rieng (Bavet)                    | 1,215    | 1,327    | 1,426    | 1,837    | 1,739    | 1,816    | 1,881    |
| Kampot (Kampot)                       | n.a.     | n.a.     | n.a.     | 2,621    | 2,481    | 2,591    | 2,683    |
| Banteay Meanchey (Poipet)             | 1,166    | 1,243    | 1,363    | 1,293    | 1,224    | 1,279    | 1,371    |
| <b>Provincial Population</b>          |          |          |          |          |          |          |          |
| <b>2019 census</b>                    |          |          |          |          |          |          |          |
| Svay Rieng (Bavet)                    | 617,695  | 624,039  | 631,557  | 524,554  | 531,898  | 539,344  | 546,895  |
| Kampot (Kampot)                       | n.a.     | n.a.     | n.a.     | 592,849  | 601,149  | 609,565  | 618,099  |
| Banteay Meanchey (Poipet)             | 765,175  | 777,876  | 765,811  | 859,545  | 871,579  | 883,781  | 896,154  |

Source: World Bank, ADB projections for 2020 and 2021.

88. **Provincial GDP.** The data for the province where the three cities are located provided a more location-specific indication of their contribution to GDP and historical growth of GDP. Overall GDP per capita and GDP growth per year for the three cities is less than the national average. The values from 2019 to 2022 (in italics) are projected based on the growth rates shown in the table.

89. The projected population for the three cities from 2020 to 2022 is shown in the following table. The percentage of the provincial population contributed by the three cities is quite low and varies from 7% for Kampot, 8% for Bavet, and 13% for Poipet. Combined with the GDP per capita for the province, these data are used to estimate the contribution that each city makes to GDP, which is an indication of the level of economic activity in each city. (The temporary population, tourist, and SEZ workers are not included). This indicates that in 2020 Bavet contributed \$69.332 m, Kampot \$62.965 m, and Poipet \$171.911 m. These data could be used as the basis of estimating the impact of the project and the increase in GDP due to the project.

**Table 28: Projected population and GDP for Bavet, Kampot, and Poipet**

|                               | 2020   | 2021   | 2022   |
|-------------------------------|--------|--------|--------|
| <b>LCIP Cities Population</b> |        |        |        |
| Bavet                         | 44,569 | 45,694 | 46,820 |
| Kampot                        | 40,476 | 41,513 | 42,550 |

|                              |         |         |         |
|------------------------------|---------|---------|---------|
| Poipet                       | 110,510 | 114,075 | 117,640 |
| <b>LCIP Cities GDP (\$m)</b> |         |         |         |
| Bavet                        | 77.516  | 83.000  | 88.063  |
| Kampot                       | 100.423 | 107.566 | 114.167 |
| Poipet                       | 135.311 | 145.874 | 155.774 |

Source: Egis, 2021.

90. However, the impact of the project on GDP for the three cities was not used for the estimation of the economic benefits for the economic analysis, as it is not possible to apportion the impact of the project on future GDP growth with the degree of necessary to quantify this benefit.

## VII. BAVET ECONOMIC ANALYSIS

### 1. Introduction

91. This section presents the economic evaluation for Bavet City. The proposed investment for Bavet include improvements to sanitation, wastewater, and solid waste management, and stormwater drainage. The proposed project will support the short-term time horizon 2020 – 2025, as defined in the Master Plan. The costs and benefits for the three components are estimated and combined into an overall economic analysis for the project for the city. Because the economic benefits of the different components - sanitation, SWM, and drainage - are interrelated, it is not realistic to apportion all of the benefits to the individual components.

92. **Economic Condition.** Bavet city went through major changes since 2008, with the establishment of SEZs and continuous development of transborder tourism and trade. By 2019, 10 SEZs have been established and are in operation. The local authorities are expecting additional industry locators to expand the existing and develop new SEZs. Main jobs are in the industrial sector (SEZs employ 57,042 workers) and small-scale business (5% in service). 14% of the population is still engaged in agriculture.<sup>16</sup>

93. **Population.** Being in a strategic location at the Cambodia-Vietnam border, the population of Bavet City grew by a large extent based on a 1998 to 2018 population census<sup>17</sup> The permanent population increased from 30,759 in 1998 to 37,123 in 2008 and 42,546 in 2018. Over 20 years since 1998 the population increased by 38%. In 2018 the population of Bavet represented 8.1% of the Svay Rieng province's population. Based on the adopted Average Annual Growth Rate (AAGR), the total population in Bavet in 2040 is estimated to be 149,396 inhabitants or plus 33% in the next 20-years (2020-2040).

94. The population of Bavet is projected to increase from 109,583 to 149,396 in 2040, made up of the permanent population, temporary population SEZ workers, and tourists, as shown in the table below.

**Table 29: Bavet Population 2020 - 2040**

| Category                          | 2020           | 2025           | 2030           | 2040           |
|-----------------------------------|----------------|----------------|----------------|----------------|
| Permanent Population              | 44,569         | 50,196         | 56,765         | 73,514         |
| Temporary Population <sup>1</sup> | 387            | 411            | 436            | 490            |
| SEZ workers                       | 57,042         | 61,042         | 63,042         | 63,042         |
| Tourists International population | 3,733          | 3,916          | 4,109          | 4,522          |
| Tourists Domestic population      | 3,853          | 4,600          | 5,491          | 7,827          |
| <b>Total population</b>           | <b>109,583</b> | <b>120,164</b> | <b>129,842</b> | <b>149,396</b> |

<sup>1</sup> The temporary population includes residents who are not officially recognised as living in the city. For the purpose the analysis they are regarded as permanent residents.

Source: Egis, 2021.

### 2. Bavet Proposed Subprojects

95. Following the Urban Development Strategy (UDS), the sector Master plan (MP), and the Comprehensive Technical Options Study (CTOP). The following sections provide a brief overview of the proposed infrastructure in Bavet to service the priority area up to 2025 horizon.

<sup>16</sup> City Socio-Economic Status report.

<sup>17</sup> National Institute of Statistics of Ministry of Planning.

## 2.1. Wastewater Management Subproject

96. There is at present no public wastewater system functioning in the municipality. It was assessed that currently, approximately 74% of fecal waste is not safely managed. Wastewater is not adequately evacuated, ponds along roadsides and remains stagnant in urban areas. Part of the effluent is also discharged directly to open waters without any form of treatment.

97. To cater to the city's future growth and development, a wastewater system comprising a new WWTP, sewers, pumping stations (PS), and force mains is proposed. The following table summarizes the proposed wastewater investments to be delivered under this project to improve sanitation services, as agreed by the national and sub-national administrations.

**Table 30: Proposed Investments in Sanitation in Bavet Municipality**

| Investment Area            | Components  |
|----------------------------|---|
| Pumping stations           | 6 PS  |
| Networks                   | 66 km of gravity lines, 9.5 km of force mains         |
| Wastewater Treatment Plant | Waste Stabilization Ponds (3,930 m <sup>3</sup> /day) |

Source: Egis, 2020

## 2.2. Stormwater Drainage Subproject

98.. Bavet has more than 20km of open channel network, which is considered the main drainage infrastructure for the city. This network acts as a combined sewer/drainage network and therefore acts as a conveyance network for sewage effluent and stormwater. The construction of the drainage network has been carried out ad-hoc, with minimal planning. As such, the capacity of the main stormwater channels is not sufficient to ensure proper drainage of the city center, and residents and local authorities have reported recurrent flooding. In addition, the network is blocked by an accumulation of the garbage, or by new construction near the drains.

99. The increasing growth and development within the city is likely to exacerbate the flooding situation. Construction of new buildings, such as hotels, shopping malls, casinos, will increase the natural land cover with concrete, steel, and asphalt structures. Runoff rates will increase from the impermeable surfaces, which will likely increase flooding on streets and around buildings in low-lying areas.

100. Following the completion of the technical feasibility study, the following stormwater drainage infrastructure is proposed to be delivered as part of this project and as agreed by the national and sub-national administrations.

**Table 31: Investments in Drainage**

| Investment Area | Components |
|-----------------|------------|
| Box culvert     | 1.8 km     |
| Open channel    | 6.8 km     |
| U-drain         | 1.0 km     |

Source: Egis, 2020

## 2.3. Solid Waste Management Subproject

101. Several external private service providers provide the current waste collection services. Although an estimated 84% of municipal solid waste (MSW) generated across the city is collected, only 14% of households are covered by this service. The current collection area covers Bavet *sangkat*, part of Chrak Mtes, Balti and Prey Angkunh. Wastes that are collected are taken to a dumpsite operated by the service provider outside the city. The proportion that is left uncollected usually is burnt or dumped into the nearby environment or open drains.

102. The anticipated growing urban population for the city and the establishment of new commercial facilities will require improved SWM services to be provided. The following table summarizes the proposed solid waste investments to be delivered as part of LCIP, as agreed by the national and sub-national administrations.

**Table 32: Investments in Solid Waste**

| Investment Area | Components  |
|-----------------|---|
| Collection      | 16 compacting trucks  |
| Treatment       | One sorting plant (capacity 53,041 tpy) and one composting plant (capacity 3,379 tpy) |
| Disposal        | One controlled landfill (capacity 516,305m3 )   |

Source: Egis, 2020

### 3. Bavet Capex Costs

103. The total Capex cost of the proposed urban infrastructure for Bavet city is \$74.1 million. The total cost is shown below.

**Table 33: Bavet Capital Investment Costs**

| Expenditure Category                  | Financial cost            |                          |  |
|---------------------------------------|---------------------------|--------------------------|--|
|                                       | Cost (\$'000)<br>excl Tax | TAX and Duty<br>(\$'000) | Total<br>Base Cost<br>inc Tax (\$'000) |
| <b>Investment &amp; Running Costs</b> |                           |                          |  |
| Civil Works                           | 44,923                    | 4,492                    | 49,415                                 |
| Mechanical and Equipment              | 2,257                     | 463                      | 2,720                                  |
| Land acquisition and compensation     | 1,177                     | -                        | 1,177                                  |
| Consulting Costs                      |                           |                          |  |
| a. Project Consultants                | 3,717                     | 372                      | 4,088                                  |
| b. Capacity Development               | 115                       | 11                       | 126                                    |
| Staff Allowances                      | 129                       | -                        | 129                                    |
| Running Costs                         | 294                       | -                        | 294                                    |
| Financial audit costs                 | 33                        | 3                        | 37                                     |
| <b>Total</b>                          | <b>52,644</b>             | <b>5,341</b>             | <b>57,986</b>                          |
| <b>Contingency</b>                    |                           |                          |  |
| Physical                              |                           |                          | 9,664                                  |
| Price                                 |                           |                          | 4,187                                  |
| <b>IDC</b>                            |                           |                          |  |
| Interest during construction          |                           |                          | 2,224                                  |
| <b>Total</b>                          |                           |                          | <b>74,060</b>                          |

Source: Egis, 2021

#### 3.1. Economic Costs

104. The capital investment costs in economic terms allowing for the conversion of financial costs to economic costs and allowing for the shadow price of unskilled labor is \$56.81 m, with a conversion factor of 0.84, as shown below.

**Table 34: Bavet Capital Costs Economic Terms**

| Expenditure Category                  | Financial cost                            | Foreign      |                     | Local                 |                         | Tax | Conversion factor | Economic Cost (\$'000) |
|---------------------------------------|---|--------------|---------------------|-----------------------|-------------------------|-----|-------------------|------------------------|
|                                       | Total<br>Base Cost<br>inc Tax<br>(\$'000) | Foreign<br>% | Local<br>Trade<br>% | Skilled<br>labor<br>% | Unskilled<br>labor<br>% |     |                   |                        |
| <b>Investment &amp; Running Costs</b> |   |              |                     |                       |                         |     |                   |                        |

|                                   |               |           |           |          |           |          |              |                 |
|-----------------------------------|---------------|-----------|-----------|----------|-----------|----------|--------------|-----------------|
| Civil Works                       | 49,415        | 40        | 27        | 4        | 20        | 9        | 0.83         | 40,969.7        |
| Mechanical and Equipment          | 2,720         | 70        | 13        | 0        | 0         | 17       | 0.83         | 2,257.4         |
| Land acquisition and compensation | 1,177         |           | 100       | 0        | 0         | 0        | 1.00         | 1,176.7         |
| Consulting Costs                  |               |           |           |          |           |          |              |                 |
| a. Project Consultants            | 4,088         | 60        | 31        | 0        | 0         | 9        | 0.91         | 3,716.6         |
| b. Capacity                       |               |           |           |          |           |          |              |                 |
| Development                       | 126           | 0         | 91        | 0        | 0         | 9        | 0.91         | 114.5           |
| Staff Allowances                  | 129           | 0         | 100       | 0        | 0         | 0        | 1.00         | 128.8           |
| Running Costs                     | 294           | 25        | 75        | 0        | 0         | 0        | 1.00         | 293.8           |
| Financial audit costs             | 37            | 10        | 81        | 0        | 0         | 9        | 0.909        | 33.3            |
|                                   |               |           |           |          |           |          | -            |                 |
| <b>Total</b>                      | <b>57,986</b> | <b>42</b> | <b>29</b> | <b>3</b> | <b>17</b> | <b>9</b> | <b>0.840</b> | <b>48,690.8</b> |
| <b>Contingency</b>                |               |           |           |          |           |          |              |                 |
| Physical                          | 9,664         |           |           |          |           |          | 0.840        | 8,115           |
| Price                             | 4,187         |           |           |          |           |          |              |                 |
| <b>IDC</b>                        |               |           |           |          |           |          |              |                 |
| Interest during construction      | 2,224         |           |           |          |           |          |              |                 |
| <b>Total</b>                      |               |           |           |          |           |          |              |                 |
|                                   | <b>74,060</b> |           |           |          |           |          |              | <b>56,805</b>   |

Source: Egis, 2021.

## 4. Wastewater and Sanitation

### 4.1. Introduction

105. At present, Bavet does not have a WWTP or sewer system. The assessment of the waste disposal chain, both in rural and urban areas, suggests that 74% of fecal waste is not managed safely. Within the town center, wastewater is not being adequately evacuated from urban areas and remains stagnant and subject to flooding.

106. Based on the selected short-term scenario for the Bavet Master Plan, a centralized WWTP will serve the built-up area of Bavet in the short term and its extension in the medium- and long-term horizon. Under LCIP, providing sewerage and connections to the existing population will be the priority but with the expected capacity required for the long term. It is proposed to start the implementation with:

- (i) Development of a sewer network to serve the short-term time horizon to 2025 with a design capacity to 2040.
- (ii) Six service areas with force mains and pump stations to serve the short-term priority area with 2030 design capacity for equipment and 2040 for civil works;
- (iii) New Wastewater Treatment Plant (WWTP) with a daily capacity of 3,930 m<sup>3</sup>/day to design capacity meet the projected wastewater in 2030;
- (iv) Septage treatment facility;
- (v) Septage vacuum trucks for collection and disposal of septage and maintenance of the sewer system.

107. The following table shows the volume of wastewater and septage collected by the new sewer system considering the infrastructure proposed in the LCIP investment, which is designed to serve the priority core urban area only in 2025. This shows the overall population of residents and SEZ workers connected to the sewerage system and located within the short-term service areas and allows for a connection rate of 75% of the potential connections in the service area.

The total volume of wastewater generated is projected to remain at 2,909 m<sup>3</sup>/d in 2025 to 2040, based on a generation of 153.6 lpcd for the domestic population and 59.8 lpcd for SEZ workers.

**Table 35: Bavet Wastewater Projections**

|  | Population                                   | Unit                   | 2025          | 2030          | 2040          |
|--|--|------------------------|---------------|---------------|---------------|
| <i>Overall population connected to the sewerage system and located within the short-term service areas</i> | Domestic population                          | No.                    | 9,948         | 9,948         | 9,948         |
|  | SEZ population                               | No.                    | 39,306        | 39,306        | 39,306        |
|  | <b>TOTAL potential population connected</b>  | <b>No.</b>             | <b>49,254</b> | <b>52,439</b> | <b>93,085</b> |
|  | <b>Total actual population connected 75%</b> |                        | <b>36,941</b> | <b>36,941</b> | <b>36,941</b> |
|  | <b>TOTAL wastewater volume generated</b>     | <b>m<sup>3</sup>/d</b> | <b>2,909</b>  | <b>2,909</b>  | <b>2,909</b>  |
|  | <b>TOTAL Septage volume generated</b>        | <b>m<sup>3</sup>/d</b> | <b>21.1</b>   | <b>21.8</b>   | <b>24.3</b>   |

Source: Egis, 2021.

108. The connection rate represents 16.8% of the resident population including tourists in 2025, equivalent to 1,523 households, based on an average HH size of 4.9 people. In terms of the number of commercial entities, hotels, casinos, and institutions and SEZ establishments connected, it is assumed that 67% of commercial entities are connected in 2025, 64% of hotels/casinos, and 10% of institutions. Of the 10 SEZ in Bavet, only two will be connected (Manhattan and Tay Seng), but they employ 64% of the SEZ workers. The area served by the new sanitation infrastructure is estimated to cover 16% of the total wastewater generated in Bavet. The remainder will continue to be served by the existing septic tanks and on-site containment systems. A summary of the key parameters for the sanitation project serving the short-term planning horizon is shown in the table that follows.

## 4.2. Wastewater Projections

109. The projected wastewater handled by the area served by the project is shown in the table below. The throughput of the WWTP is limited to 3,930 m<sup>3</sup>/d, but it will not reach full capacity during the phase 1 project.

**Table 36: Bavet Sanitation Parameters**

| Item   | Unit                   | 2025           | 2030           | 2040           |
|--|------------------------|----------------|----------------|----------------|
| <b>Population</b>  |                        |                |                |                |
| Domestic population  | no.                    | 50,196         | 56,765         | 73,514         |
| Temporary population                                       |                        | 411            | 436            | 490            |
| SEZ workers  |                        | 61,042         | 63,042         | 63,042         |
| Tourists International population                          |                        | 3,916          | 4,109          | 4,522          |
| Tourists Domestic population                               |                        | 4,600          | 5,491          | 7,827          |
| <b>Total Population</b>                                    |                        | <b>120,165</b> | <b>129,843</b> | <b>149,395</b> |
| <b>1. Population Connected to Sewer System</b>             |                        |                |                |                |
| % popn potential connected (incl temp & tourist exclg SEZ) |                        | 17%            | 15%            | 9%             |
| Population Connected (75% short term/ priority area)       |                        | 7,461          | 7,461          | 7,461          |
| No. of HH connections                                      | no. hh                 | 1,523          | 4,523          | 1,523          |
| Wastewater generation (lpcd)                               | m <sup>3</sup> /d      | 1,146          | 1,146          | 1,146          |
| <b>2. SEZ Population Connected</b>                         | no.                    | 29,480         | 29,480         | 29,480         |
| Percent of SEZ population connected                        | % tot                  | 48%            | 48%            | 48%            |
| Wastewater generation (lpcd)                               | m <sup>3</sup> /d      | 1,763          | 1,763          | 1,763          |
| <b>Total Waste Generation from Popn &amp; SEZ</b>          | <b>m<sup>3</sup>/d</b> | <b>2,909</b>   | <b>2,909</b>   | <b>2,909</b>   |
| <b>2. Commercial, Hotels, Institutions &amp; SEZ</b>       | No.                    | 94             | 94             | 94             |
| <b>a. Commercial</b>                                       |                        |                |                |                |

| Item   | Unit   | 2025  | 2030      | 2040      |           |
|--|--------|-------|-----------|-----------|-----------|
| Total number   |        | 3     | 3         | 3         |           |
| Percent connected                                    |        | 67%   | 67%       | 67%       |           |
| Number of connections                                | unit   | 2.01  | 2         | 2.01      |           |
| Number not connected                                 |        | 1     | 1         | 1         |           |
| b. Hotels  |        |       |           |           |           |
| Total number   |        | 28    | 28        | 28        |           |
| Percent connected                                    |        | 64%   | 64%       | 64%       |           |
| Number of connections                                | unit   | 17.92 | 17.92     | 17.92     |           |
| Number not connected                                 |        | 10    | 10        | 10        |           |
| c. Institutions                                      |        |       |           |           |           |
| Total number   | No.    | 63    | 63        | 63        |           |
| Percent connected                                    | %      | 10%   | 10%       | 10%       |           |
| Number of connections                                | unit   | 6.3   | 6.3       | 6.3       |           |
| Number not connected                                 | unit   | 56.7  | 57        | 57        |           |
| Summary of C&Is                                      |        |       |           |           |           |
| Total number   |        | 94    | 94        | 94        |           |
| Number connected to sewer system                     |        | 26    | 26        | 26        |           |
| Number not connected (septic tanks)                  |        | 68    | 68        | 68        |           |
| d. SEZs  |        |       |           |           |           |
| Total number   | No.    | 10    | 10        | 10        |           |
| Percent connected                                    | %      | 20%   | 20%       | 20%       |           |
| Number of connection (Manhattan and Tay Seng)        | unit   | 2     | 2         | 2         |           |
| Number not connected                                 | unit   | 8     | 8         | 8         |           |
| 3. Wastewater Generation                             |        |       |           |           |           |
|  | lpcd   |       |           |           |           |
| Total WW generated Population, Tourist, SEZ          | 153.64 | m3/d  | 12,740    | 14,040    | 17,043    |
| Wastewater in sewerage system (Population FWP)       | 153.64 | m3/d  | 1,146     | 1,146     | 1,146     |
| SEZ workers (Future with project)                    | 59.9   | m3/d  | 1,763     | 1,763     | 1,763     |
| Total Wastewater from Population & SEZ workers (FWP) |        | m3/d  | 2,909     | 2,909     | 2,909     |
|  |        | m3/y  | 1,061,851 | 1,195,809 | 1,379,239 |
| Percent of Total WW generated in Sewerage System     |        |       | 23%       | 21%       | 17%       |

Source: Egis, 2021.

### 4.3. Economic Costs

110. **Capex.** The estimated cost for civil works and mechanical and equipment for the sanitation component in Bavet is \$29.08 million (excluding consulting services, VAT, physical contingency and price contingency). The total economic capital costs is \$31.9 million (allowing for costs associated with design and supervision and physical contingency but excluding tax and price contingency), with implementation scheduled from 2022 to 2027 with the majority of the works completed by 2026.

111.. The cost of equipment that will require replacement after 10 years' service totals \$1 million.

112. Because the project period is only 20 years limited by the population projections cutoff at 2040, a salvage value is included to allow for the remaining value of the new assets created by the project. The asset life assumed for the various components is shown in the table below.

**Table 37: Economic Life of Urban Infrastructure Assets**

| Equipment macro-categories | Component                | Equipment categories | Asset life duration (years) |
|----------------------------|--------------------------|----------------------|-----------------------------|
| Trucks and vehicles        | - Sewerage<br>- Drainage | Trucks and vehicles  | 10                          |



|                         |                          |                                   |    |
|-------------------------|--------------------------|-----------------------------------|----|
|                         | - Solid waste management |                                   |    |
| <b>Pumping station</b>  | - Sewerage               | Electric/hydraulic equipment      | 10 |
|                         |                          | Concrete structures               | 50 |
| <b>Treatment plants</b> | - WWTP                   | Electric/hydraulic equipment      | 10 |
|                         | - Solid waste management | Concrete structures and buildings | 50 |
| <b>Pipe network</b>     | - Sewerage               | PVC gravity pipes                 | 40 |
|                         | - Drainage               | HDPE force mains                  | 40 |
|                         |                          | Box culverts                      | 50 |

Source: Egis, 2021.

113. Applying these values to the sanitation assets for a 20-year project life indicates that the end of project salvage value is 51% of the original cost. This value is included as a benefit for the project in 2040.

114. **Opex.** The annual O&M costs vary according to the increasing volume of wastewater collected each year that is handled through the pump stations and the WWTP. The Opex costs in financial terms excluding tax are estimated to be \$245,457 in 2026. Applying the same SERF and SWRF factors as for the conversion of Capex to economic prices generates an CF for the Opex of 0.99, as shown below. The economic Opex cost is projected to be \$242,745 in 2026 and to remain at this level through the cashflow as the volume of wastewater treated remains constant at 2,909 m<sup>3</sup>/d throughout the period of analysis.

**Table 38: Sanitation Opex Economic Conversion**

| Total Sewer Network, PSs & WWTP Opex |         | Economic Pricing Conversion Factors |        |                |               |                 |      |         |      |
|--------------------------------------|---------|-------------------------------------|--------|----------------|---------------|-----------------|------|---------|------|
|                                      |         |                                     |        |                |               |                 |      |         |      |
|                                      |         | SERF                                | CF     |                | CF            | SWR F           | CF   |         |      |
| Summary                              |         |                                     | 1.00   | 1.00           |               | 1.00            | 0.60 | -       |      |
| \$                                   |         |                                     |        |                |               |                 |      |         |      |
| Network & PS                         |         | Loc %                               | FE %   | Locally traded | Skilled labor | Unskilled labor | Tax  | Total   | CF   |
|                                      | 90,000  | 100                                 |        |                |               |                 |      |         |      |
| 1. Personnel                         |         | %                                   | 0%     | 0%             | 95%           | 5%              | 0%   | 100%    | 100% |
| 2. Energy                            | 16,838  | 85%                                 | 15%    | 85%            | 0%            | 0%              | 0%   | 100%    | 100% |
| 3. Operation & Maintenance           | 32,398  |                                     |        |                |               |                 |      |         |      |
| Total                                | 139,236 | 80%                                 | 20%    | 80%            | 0%            | 0%              | 0%   | 100%    | 100% |
| WWTP                                 |         |                                     | 9,005  | 40,230         | 85,500        | 2,700           | -    | 137,436 | 0.99 |
|                                      | 45,600  | 100                                 |        |                |               |                 |      |         |      |
| 1. Personnel                         |         | %                                   | 0%     | 0%             | 95%           | 5%              | 0%   | 100%    | 100% |
| 2. Energy                            | 6,030   | 85%                                 | 15%    | 85%            | 0%            | 0%              | 0%   | 100%    | 100% |
| 3. O&M                               | 54,231  | 80%                                 | 20%    | 80%            | 0%            | 0%              | 0%   | 100%    | 100% |
| Total                                | 105,862 |                                     | 11,751 | 48,511         | 43,320        | 1,368           | -    | 104,950 | 0.99 |
| TOTAL ALL                            |         | 245,457                             |        |                |               |                 |      | 242,745 | 0.99 |

Source: Egis, 2021.

#### 4.4. Economic Benefits

115. **Saved septic tanks costs.** The progressive connection of households and commercial establishments to the sewerage system will result in the decommissioning of septic tanks and saving in the costs of their maintenance and periodic desludging. For those households that have to periodically build a new containment tank when the old tank is full, the cost of the new tank will also be saved. However, most of the households served by the project in the core urban area are assumed to use a non-permeable septic tank that is periodically cleaned out of septage. The economic O&M costs of the existing septic tanks are assumed to be \$5.00 per year for households and \$25 per year for commercial and institutions (C&I). The capital value of the septic tanks that will become redundant is assumed to be a sunk cost and is not included as a loss to the owners.

116. **Saved septage costs.** Residential households are assumed to have to empty their septic tanks of septage every three years on average (1m<sup>3</sup>/year) and C&Is once a year for 10m<sup>3</sup>/y. This represents a total saving in septage cleaning of 262 m<sup>3</sup>/y for C&Is and an average volume for households that are connected to the sewerage system of 1,523 m<sup>3</sup>/y from 2026. A total of 1,785 m<sup>3</sup>. The economic cost per m<sup>3</sup> for septage is taken as \$8.50 /m<sup>3</sup> (HH rate times the SCF of 0.84).

117. **Health benefits.** As discussed earlier, it is not possible to easily apportion the overall health benefits from improved sanitation, SWM, and drainage to the individual components as they are interlinked, and an overall health benefit of \$94.46 per years for all HH served by the SWM, sanitation and drainage is assumed. However, for the purpose of the analysis of sanitation an additional specific health benefit is also allocated to those households in Bavet that are connected to the new sewer system of \$15 per HH per year, representing 16% of the total health benefits for Bavet, to allow for the assumed extra benefits they receive through improved hygiene and convenience. For the SEZ workers an annual benefit of \$30.0 per person is also included to allow for lost three days of lost productivity at a rate of \$10 per day resulting from ill-health through poor sanitation. For tourists, an annual benefit of \$2.0per person is also included to allow for their

reduction in ill health. The direct health benefits of those HHs that are connected to the sewer system are capped at the level of 1,523 new HHs connected for phase 1 in 2026 and remaining at that level.

## **5. Bavet – Solid Waste Management**

### **5.1. Introduction**

118. The proposed LCIP investment focuses on municipal solid waste (MSW), including household solid waste (hazardous and non-hazardous) and similar waste from commercial and institutional waste. Other solid waste is not considered, such as industrial waste.

119. Currently, it is estimated that 85% of the municipal solid waste generated in Bavet is unsafely managed with the household collection coverage of only approximately 14%, while most commercial and industrial (C&I) waste is collected. A large portion of the MSW is left uncollected and is dumped directly in the nearby natural environment and/or burnt, making it necessary to improve the collection and treatment for the whole city following the three Rs of SWM of reduce, use, recycle.

120.. In terms of collection, door to door collection is preferred in the urban city center while centralized collection is suggested in rural areas until these areas are sufficiently developed to allow for door-to-door collection. Source segregation at markets, with a dedicated centralized collection point is an opportunity to increase the sorting of bio-waste and, therefore, the potential for compost production.

121. In terms of treatment, a sorting plant and a composting plant have been identified as the most appropriate technologies to reduce the amount of waste to be deposited in the landfill; to control part of the market for recyclables to increase revenue potential, and to contribute to the climate change mitigation. A controlled landfill is proposed as the most appropriate disposal system for the city to avoid the harmful dumping and burning of waste, to reduce pollution of the groundwater, and to reduce harmful greenhouse gasses (GHG).

122. The proposed short-term horizon investments include:
- (i) Construction of a new controlled landfill with leachate management and landfill gas collection and flare-off design to a 2030 capacity
  - (ii) Sorting plant designed to 2040 capacity
  - (iii) Compositing plant designed to 2040 capacity
  - (iv) Collection: provision of 16 collection trucks and collection bins with centralized collection points for rural areas, door to door collection for urban areas.

### **5.2. Bavet SWM Projections**

123. The table below summarizes the projected MSW production and the collection percentage and volume for the different categories – households, commercial establishments, hotels and casino, markets, and the SEZs. Currently, average daily waste production is estimated to be 131t/d (47,693 t/y), of which 96t/d is handled by official collection, 13t/d is unofficially collected and handled by waste pickers, while 24tpd is not collected. The table below provides a summary in 2020.

**Table 39: Breakdown of Current Waste Generation and Collection**

| <b>Waste generation</b>               | <b>Ton per day</b> | <b>Percent</b> |
|---------------------------------------|--------------------|----------------|
| Official collection                   | 96                 | 73%            |
| Unofficial collection (waste pickers) | 13                 | 10%            |
| Not collected                         | 24                 | 18%            |
| <b>Total</b>                          | <b>131</b>         | <b>100%</b>    |

Source: Egis, 2021

124. Table 40 provides a summary of the SWM generation and collection assumption for Bavet for the years 220 to 2040. Only 14% of household waste is currently collected increasing to 85% by 2040. Of the other categories, all have 100% collection currently except for institutions and commercial entities at less than 100%.

**Table 40: Bavet MSW Generation and Collection Projections**

| <b>Items</b>   | <b>Unit</b>   | <b>2020</b>    | <b>2025</b>    | <b>2030</b>    | <b>2040</b>    |
|--|---------------|----------------|----------------|----------------|----------------|
| <b>Population</b>  |               |                |                |                |                |
| <i>Total permanent population</i>  | <i>inhab.</i> | <i>44,569</i>  | <i>50,196</i>  | <i>56,765</i>  | <i>73,514</i>  |
| <i>Total SEZ population</i>  | <i>inhab.</i> | <i>57,042</i>  | <i>61,042</i>  | <i>63,042</i>  | <i>63,042</i>  |
| <i>Total tourist and non permanent</i>                                   | <i>inhab.</i> | <i>7,972</i>   | <i>8,926</i>   | <i>10,035</i>  | <i>12,840</i>  |
| <b>Total Population in Bavet</b>   | <b>inhab.</b> | <b>109,583</b> | <b>120,164</b> | <b>129,842</b> | <b>149,396</b> |
| <b>Waste generation</b>  |               |                |                |                |                |
|  | <b>AAGR</b>   |                |                |                |                |
| Households, Institutional & Commercial                                   | 0.50%         | 59.0           | 60.49          | 62.02          | 63.58          |
| SEZ  | 1.50%         | 44             | 47.40          | 51.06          | 55.01          |
| Market   | 0.50%         | 8              | 8.20           | 8.41           | 8.62           |
| Casinos  | 0.50%         | 20             | 20.51          | 21.02          | 21.55          |
| <b>Total</b>   | <b>t/d</b>    | <b>131</b>     | <b>137</b>     | <b>143</b>     | <b>149</b>     |
|  | <b>t/y</b>    | <b>47,815</b>  | <b>49,858</b>  | <b>52,017</b>  | <b>54,301</b>  |
| <b>Households, institutional, and commercial (collected)</b>             | <b>tpd</b>    | <b>8</b>       | <b>30</b>      | <b>47</b>      | <b>54</b>      |
| <i>Waste production (AAGR)</i>   | %             |                | 0.50%          | 0.50%          | 0.50%          |
| <i>Collection rate (households)</i>                                      | %             | 14%            | 50%            | 75%            | 85%            |
| <b>SEZ (collected)</b>   | <b>tpd</b>    | <b>44</b>      | <b>47</b>      | <b>51</b>      | <b>55</b>      |
| <i>Waste production (AAGR)</i>   | %             |                | 1.50%          | 1.50%          | 1.00%          |
| <i>Collection rate</i>   | %             | 100%           | 100%           | 100%           | 100%           |
| <b>Market (collected)</b>  | <b>tpd</b>    | <b>8</b>       | <b>8</b>       | <b>8</b>       | <b>9</b>       |
| <i>Waste production (AAGR)</i>   | %             |                | 0.50%          | 0.50%          | 0.50%          |
| <i>Collection rate</i>   | %             | 100%           | 100%           | 100%           | 100%           |
| <b>Casinos (collected)</b>   | <b>tpd</b>    | <b>20</b>      | <b>21</b>      | <b>21</b>      | <b>22</b>      |
| <i>Waste production (AAGR)</i>   | %             |                | 0.50%          | 0.50%          | 0.50%          |
| <i>Collection rate</i>   | %             | 100%           | 100%           | 100%           | 100%           |
| <b>Total collection (FWP)</b>  | <b>t/d</b>    | <b>80</b>      | <b>106</b>     | <b>127</b>     | <b>139</b>     |
| Sub-Total collected waste flow   | tpy           | 29,295         | 38,819         | 46,358         | 50,819         |
| Sub-Total not collected waste flow                                       | tpy           | 13,739         | 6,054          | 457            | 766            |
| <b>Total waste flow</b>  | <b>tpy</b>    | <b>43,034</b>  | <b>44,872</b>  | <b>46,816</b>  | <b>51,586</b>  |
| Sub total waste flow collected before official collection (10% or total) | tpy           | 4,782          | 4,986          | 5,202          | 2,715          |
| <b>Total waste generation</b>  | <b>tpy</b>    | <b>47,815</b>  | <b>49,858</b>  | <b>52,017</b>  | <b>54,301</b>  |
| <b>Total collection (FWOP)</b>   | <b>t/d</b>    | <b>80</b>      | <b>85</b>      | <b>89</b>      | <b>94</b>      |
| Sub-Total collected waste flow   | tpy           | 29,295         | 30,870         | 32,550         | 34,342         |

| Items  | Unit       | 2020          | 2025          | 2030          | 2040          |
|--|------------|---------------|---------------|---------------|---------------|
| Sub-Total not collected waste flow                                       | tpy        | 13,739        | 14,002        | 14,265        | 14,529        |
| <b>Total waste flow</b>  | <b>tpy</b> | <b>43,034</b> | <b>44,872</b> | <b>46,816</b> | <b>48,870</b> |
| Sub total waste flow collected before official collection (10% or total) | tpy        | 4,782         | 4,986         | 5,202         | 5,430         |
| <b>Total waste generation</b>  | <b>tpy</b> | <b>47,815</b> | <b>49,858</b> | <b>52,017</b> | <b>54,301</b> |
| <b>Increase in Waste Collected (FWP-FWOP)</b>                            | <b>t/y</b> | <b>0</b>      | <b>7,948</b>  | <b>13,808</b> | <b>16,478</b> |

Source: Egis, 2021

### 5.3. Bavet SWM Capex

125. The total base cost for the proposed SWM investment for Bavet is \$12.27 million, including civil works, equipment, but excluding consulting services, VAT, physical contingency and price contingency.

126. **Replacement equipment.** The cost of equipment and vehicles that will require replacement after 10 years' service totals \$1.9 million.

127. **Salvage value.** Because the project period is only 20 years limited by the population projections cutoff at 2040, a salvage value is included to allow for the remaining value of the new assets created by the project. The asset life assumed for the various components is shown in the table below.

**Table 41: Economic Life of Urban Infrastructure Assets**

| Equipment macro-categories | Component                | Equipment categories              | Asset life duration (years) |
|----------------------------|--------------------------|-----------------------------------|-----------------------------|
|                            |                          |                                   |                             |
| <b>Trucks and vehicles</b> | - Sewerage               | Trucks and vehicles               | 10                          |
|                            | - Drainage               |                                   |                             |
|                            | - Solid waste management |                                   |                             |
| <b>Pumping station</b>     | - Sewerage               | Electric/hydraulic equipment      | 10                          |
|                            |                          | Concrete structures               | 50                          |
| <b>Treatment plants</b>    | - WWTP                   | Electric/hydraulic equipment      | 10                          |
|                            | - Solid waste management | Concrete structures and buildings | 50                          |
| <b>Pipe network</b>        | - Sewerage               | PVC gravity pipes                 | 40                          |
|                            | - Drainage               | HDPE force mains                  | 40                          |
|                            |                          | Box culverts                      | 50                          |

Source: Egis, 2021.

128. Applying these values to the sanitation assets for a 20-year project life indicates that the end of project salvage value is 51% or the original cost. This value is included as a benefit for the project in 2040.

129. **Economic costs.** The conversion of the financial costs to their economic value (allowing for costs associated with design and supervision and physical contingency but excluding tax and price contingency) results in a total costs of \$15.2 million.

### 5.4. Bavet SWM Opex

130. Opex costs in 2026 are \$1.572m made up of 52% fixed costs and 48% variable costs, as shown below. Opex costs increase in line with the volume of solid waste collected and processed. Opex costs are converted to economic costs with the overall Opex conversion factor for Bavet of 0.99.

**Table 42: Bavet SWM Opex Costs**

| Component        | Fixed \$       | Variable \$    | Total \$         | % of Total  |
|------------------|----------------|----------------|------------------|-------------|
| Landfill         | 106,816        | 66,981         | 173,797          | 11%         |
| Sorting plant    | 327,156        | 118,497        | 445,652          | 28%         |
| Composting plant | 60,778         | 26,082         | 86,860           | 6%          |
| Collection       | 317,423        | 548,757        | 866,180          | 55%         |
| <b>TOTAL</b>     | <b>812,172</b> | <b>760,317</b> | <b>1,572,489</b> | <b>100%</b> |
| % of Total       | 52%            | 48%            | 100%             |             |

Source: Egis, 2021

## 5.5. SWM Benefits

131. **Saved cost of uncollected waste.** Currently, only 14% of the solid waste generated by households is collected, and households have to make their own arrangements for disposing of their waste – in open land, drains, and discarded on the roadside -, and provide their own containers and bags for disposal. These costs will be saved with the introduction of collection services with the project. The average cost per m<sup>3</sup> for this saving is assumed to be \$5.00/m<sup>3</sup> representing 25% of the estimated cost of the existing rubbish collection service, allowing for the HHs time and direct costs involved with disposing of household rubbish.

132. **Saved collection costs FWOP.** The project will introduce a rubbish collection service which will replace the existing collection service that currently collects an estimated 73% of the solid waste. The cost of the existing service can be offset against the Opex costs of the project-funded services. An average collection cost of \$20/m<sup>3</sup> based on the estimated collection cost for the new system introduced by the project based on the calculated representative cost of waste collection introduced by the LCIP.

133. **Value of recyclables.** The project will fund a sorting plant that will allow the recovery of valuable recyclable material that otherwise would be deposited in the landfill. The volume of recyclable material in at the start of the project in 2025/26 and the increase over the project life and the assumed prices are shown in the table below. The assumed price of recyclables I based on current quoted prices and the international market for the recycled material. The amount of recyclable material increases in line with the volume of solid waste collected. The volume of waste that can be recycled allows for the material that is already be sorted and recycled. A 5% reduction in economic benefits is allowed to account for an increase in the amount of the recyclable material assumed to be sorted and sold in the FWOP situation.

**Table 43: Bavet Volume of Recyclables**

|                        | Unit | 2025  | 2030  | 2035  | 2040  | Value \$/t |
|------------------------|------|-------|-------|-------|-------|------------|
| <b>Recyclables</b>     |      |       |       |       |       |            |
| PET bottle             | t/y  | 1,387 | 1,573 | 1,700 | 1,827 | 225        |
| HDPE (shampoo bottles) | t/y  | 225   | 255   | 276   | 296   | 207        |
| Plastic bags and films | t/y  | 3,962 | 4,496 | 4,858 | 5,220 | 120        |
| Plastic glass          | t/y  | 254   | 289   | 312   | 335   | 250        |

|                          |            |              |              |              |              |       |
|--------------------------|------------|--------------|--------------|--------------|--------------|-------|
| Cans                     | t/y        | 109          | 124          | 134          | 144          | 1,000 |
| Iron metals              | t/y        | 103          | 117          | 127          | 136          | 250   |
| <b>Total Tonnage</b>     | <b>t/y</b> | <b>6,040</b> | <b>6,854</b> | <b>7,406</b> | <b>7,958</b> |       |
| Biowaste/ green waste    | t/y        | <b>2,572</b> | <b>3,380</b> | <b>3,576</b> | <b>3,772</b> |       |
| <b>Waste to Landfill</b> | <b>t/y</b> | 32,074       | 36,463       | 39,750       | 43,248       |       |
| Compost                  | t/y        | 772          | 1,014        | 1,073        | 1,132        |       |

Source: Egis, 2021

134. **Value of compost.** Biowaste and green waste collected from the markets and from households and C&Is will be converted to compost for sale to the local agricultural sector. The conversion rate of biowaste to compost is 30%, and the price of compost is assumed to be \$100/t. The economic benefit from compost is reduced by 5% to allow for the current use of biowaste for animal feed and compost in the FWOP situation.

135. **Carbon credit for GHGs.** The operation of the new landfill is designed to cover the waste and capture landfill gases, which will be flared off, converting the more harmful methane CO<sub>4</sub> portion to less harmful CO<sub>2</sub>. The production of the landfill gas resulting from the consolidation of waste in the new landfill under anerobic conditions is projected to progressively increase from 18m<sup>3</sup>/h in 2025 to 150m<sup>3</sup>/h by 2040 as the landfill gets bigger. Landfill gas is composed of 50% methane and 50% CO<sub>2</sub> by volume. Methane is a potent greenhouse gas 28 to 36 times more effective than CO<sub>2</sub> at trapping heat in the atmosphere over a 100-year period (IPPC AR5). The conversion of methane to the less harmful CO<sub>2</sub> through burning that otherwise would escape to the atmosphere can be included as an economic benefit and valued at the price of carbon saved.<sup>18</sup> Burning methane produces 2.75 the weight of CO<sub>2</sub>, but as CO<sub>4</sub> is 25 times more harmful than CO<sub>2</sub>, there will be a net gain on GHG emissions of 9 for every unit of CO<sub>4</sub> that is flared off at the landfill. It is assumed that 70% of landfill gases are captured and converted to CO<sub>2</sub>. Based on a price of carbon of \$43.20/t in 2020 and inflating in real terms by 2% per year this results in a saving of carbon valued at \$49,800 per year in 2025, progressively rising to \$551,720 per year by 2040. The table below shows the calculation of the economic benefit of capturing landfill gasses and reducing the amount of methane that is released.

**Table 44: Landfill Greenhouse Gases Capture**

| Item                  | Unit                         | 2025    | 2030    | 2035    | 2040      |
|-----------------------|------------------------------|---------|---------|---------|-----------|
| Landfill gas (theory) | m3/h                         | 26      | 91      | 154     | 214       |
| Landfill gas (design) | m3/h                         | 18      | 64      | 108     | 150       |
| Landfill gas (actual) | m3/y                         | 159,432 | 558,012 | 944,328 | 1,312,248 |
| Weight of LFG         |                              |         |         |         |           |
| CO <sub>4</sub>       | t/y                          | 52      | 181     | 307     | 426       |
| CO <sub>2</sub>       | t/y                          | 146     | 512     | 867     | 1,205     |
| GHG - CO <sub>4</sub> | t CO <sub>2</sub> equivalent | 1,295   | 4,534   | 7,673   | 10,662    |
| - CO <sub>2</sub>     | t CO <sub>2</sub> equivalent | 146     | 512     | 867     | 1,205     |
| Total GHG             | t CO <sub>2</sub> equivalent | 1,442   | 5,046   | 8,540   | 11,867    |
| GHG after burning     |                              |         |         |         |           |
| CO <sub>4</sub>       | t CO <sub>2</sub>            | 142     | 499     | 844     | 1,173     |
| CO <sub>2</sub>       | t CO <sub>2</sub>            | 146     | 512     | 867     | 1,205     |
| Total CO <sub>2</sub> | t CO <sub>2</sub>            | 289     | 1,011   | 1,711   | 2,377     |

<sup>18</sup> According to the ADB guidelines for Economic Evaluation of Projects 2017 based on a value of GHG of \$36.30/t in 2016 price terms and \$43.20 in 2020 and inflated by 2% per year in real terms to allow for potential of increasing marginal damage of global warming over time.



| Item                       | Unit        | 2025          | 2030           | 2035           | 2040           |
|----------------------------|-------------|---------------|----------------|----------------|----------------|
| GHG/CO2 saving             | t CO2       | 1,153         | 4,035          | 6,829          | 9,489          |
| <b>Value carbon credit</b> | <b>\$/y</b> | <b>49,805</b> | <b>174,317</b> | <b>294,999</b> | <b>409,933</b> |

| Item                     | CO4  | CO2                                   |
|--------------------------|------|---------------------------------------|
| kg/m <sup>3</sup>        | 0.65 | 1.836                                 |
| LFG composition          | 50%  | 50%                                   |
| LFG capture efficiency   | 70%  | 70% (range from 60% to 90%)           |
| GHG ratio                | 25   | 1                                     |
| CO2 from burning CO4     |      | 2.75                                  |
| Carbon credit price      |      | \$43.20 (GHG value in 2020 per tonne) |
| Inflating by 2% per year |      |                                       |

Source: Egis, 2021.

## 6. Bavet – Stormwater Drainage

### 6.1. Introduction

136. Currently, Bavet has more than 20 km of the open channel network that is now considered as the main drainage infrastructure. This network is the outfall of some drainage/sewerage pipes and so receives brown and greywater from the inhabitants and commercial and institutional entities. Recurrent floods are reported by inhabitants and local authorities. Main stormwater channels are operating properly, but their capacity is not sufficient to ensure proper drainage of the city center.

### 6.2. Proposed Drainage Network

137. The proposed drainage network is planned to accommodate a 1 in 5 flood event. The new system relies on gravity, with no pumping, and follows the natural topography and discharges at low points of the road. As much as possible, the few existing cross-drains will be reused to limit the cost of road cutting and reinstatement.

138. In urban areas, in order to minimize the risk of blockage by solid waste, problems related to resettlement, and to limit future urban development constraints, an underground drainage network (box-culvert) will be prioritized.

139. In rural areas, as the irrigation canal system is well developed in Bavet, it is proposed to enlarge the existing earthen open-channels as this drainage solution fits with the actual land use. In the future, as the urban development grows, it might be needed to replace the open channels with box culvert lines. In which care maintenance will have to be increased to clean mud deposits and ensure the drainages lines operate to their capacity. The existing hydraulic crossing structures will be enlarged with box culverts. Further studies will have to be done to refine the dimension of those new structures.

140. With the proposed sewerage project, all illegal connections of the sewers to the drainage network shall be removed to ensure the separation of stormwater and sewage. A prevention campaign shall also be carried out with local companies to avoid any discharge of industrial waste into the drainage system, particularly from petrol stations, hotels, and restaurants. The proposed coverage and the number of households and C&Is that will be served by the new drainage system are shown in the following table. Overall, 17% of the city's population will be covered by the drainage system.



**Table 45: Bavet - Drainage System Coverage**

| Item   | Unit | 2025<br>Priority<br>Area | 2025<br>Short<br>term | 2030           | 2040           |
|--|------|--------------------------|-----------------------|----------------|----------------|
| <b>Population covered by the Drainage System</b> |      |                          |                       |                |                |
| <b>Total Population of the City</b>              | no.  |                          | <b>120,165</b>        | <b>129,843</b> | <b>149,395</b> |
| Population covered by the drainage system        |      |                          | 10,051                | 11,356         | 14,680         |
| Percent  |      | 0                        | 17%                   | 17%            | 17%            |
| <b>Number of HHs covered</b>                     | 4.9  |                          | <b>2,051</b>          | <b>2,318</b>   | <b>2,996</b>   |
| <b>Commercial &amp; Institutional covered</b>    |      |                          |                       |                |                |
| 1. Commercial number covered                     |      | 2                        | 2                     | 2              | 2              |
| 2. Hotels Number covered                         | No.  | 18                       | 22                    | 22             | 22             |
| 3. Institutions number covered                   | No.  | 6                        | 9                     | 9              | 9              |
| 4. SEZ number covered                            |      | 2                        | 2                     | 2              | 2              |
| Total covered                                    |      | 28                       | 35                    | 35             | 35             |

Source: Egis, 2021

### 6.3. Bavet Stormwater Drainage Capex

141. The total base cost of the proposed drainage works is \$5.8 million, including civil works and equipment, excluding consulting services, VAT, physical contingency and price contingency.

142. The cost of equipment that will require replacement after 10 years' service totals \$0.3 million.

143. **Salvage value.** Because the project period is only 20 years limited by the population projections cutoff at 2040, a salvage value is included to allow for the remaining value of the new assets created by the project. The asset life assumed for the various components is shown in the Table 41 above. Applying these values to the sanitation assets for a 20-year project life indicates that the end of project salvage value is 51% of the original cost. This value is included as a benefit for the project in 2040.

144. **Economic cost.** The conversion of the financial costs to their economic value allowing for design and supervision, and physical contingency and excluding tax and price contingency results in a total costs of \$7.69 m.

### 6.4. Bavet Stormwater Opex

145. The annual O&M costs for the new drainage system is estimated to be \$43,643 per year, as summarized below. The annual costs are assumed to be constant over the project life and include the O&M costs for the existing drainage system. The cost are converted to economic prices with a CF of 0.99.

**Table 46: Bavet Stormwater Opex**

| <b>Item</b>                     | <b>Cost<br/>(\$/year)</b> |
|---------------------------------|---------------------------|
| 1. Personnel                    | 27,600                    |
| 2. Fuel and energy              | 6,959                     |
| 2. Maintenance                  | 9,084                     |
| <b>Total Stormwater network</b> | <b>43,643</b>             |

Source: Egis, 2021

## 6.5. Stormwater Economic Benefits

146. The development of an efficient stormwater and drainage system will contribute to the improvement of the living conditions in the city by reducing the negative impact and costs of flooding during heavy rain and reducing the associated health risks. Overall making the city more conducive for continuing economic development and more attractive to tourists.

147. The direct cost to households through flooding incidents was investigated in the CCS, as discussed in the preceding section. For Bavet, it is estimated the average annual cost per household due to flooding is \$150 per year, allowing for property damage and the loss of productivity. An average annual economic cost of \$250 per C&I is also allowed for those C&Is that will benefit directly from the coverage of the new drainage system to allow for their damage to property and cost of repairs.

148. The stormwater drainage infrastructure is non-revenue generating as there are no direct tariffs or user-pays fees for the drainage network. The O&M cost will be borne by the municipal administration or the line agency responsible for maintaining the system. including the O&M cost of the drainage system constructed under the Greater Mekong Subregion Southern Economic Corridor Towns Development Project (GMS 1) project. This cost will be funded indirectly through the funds provided to the municipal administration by central government, or potentially by local property taxes and business fees.

149. **FWOP cost saving.** The expenditure for O&M of the current drainage system is very low and is not quantified. However, for the purpose of the analysis, a nominal cost of \$5,000 per year of the saved costs for the FWOP situation is included to allow for clearing of drains and irregular maintenance by the city and local residents. This included the O&M costs of the drainage works under construction through GMS 1.

## 7. Tourism Benefit

150. Section VI, Chapter 3.7 discussed the impact of the project on tourism and how the economic benefits of the increase in international tourists to Bavet as a result of the project are quantified. The economic benefit from tourism has been valued at the marginal increase in expenditure by international tourists Bavet assuming a 20% increase in the average growth of international tourists over the historical growth 2016 – 2018. Based on an average length of stay of 1.5 days and daily expenditure of \$33 per day 15 of their increased expenditure is counted as the marginal economic benefit allowing for the input costs associated with their expenditure. For Bavet, this amounts to an additional growth due to the project of 0.13% per year and net annual benefit of \$5,040 per years. It is assumed that this growth persists for 10 years after project completion. No economic benefit is allowed for an increase in domestic tourists resulting from the

project as it is assumed that any increase in domestic tourism expenditure only contributes to the regional economy and has no benefit to the national economy.

## 8. Reduction in Undesirable Pollutants

151. As discussed in Section 3.8, the positive environmental impact of reducing the amount of untreated wastewater and septic tank outflow to the environment is a major benefit of wastewater and septage treatment to be developed by the project. The improvement in the collection and treatment of MSW also contributes to a reduction in pollution of ground water, especially through the containment of leachate from a dumpsite as a result of a controlled landfill.

152. For Bavet the reduction in the volume of undesirable pollutants (BOD, COD, SS N and P) that is attributed to the project is estimated to the 2,015 t/y by comparing the fwp and fwop situations. A summary is shown below. The reduction represents 36% of the amount of pollutants produced in the without project situation.

**Table 47: Bavet Reduction in Undesirable Pollutants**

| Pollutant          | 2020         | 2025 (fwp)   | 2025 (fwop)  | 2025 (fwop-fwp) | Reduction % |
|--------------------|--------------|--------------|--------------|-----------------|-------------|
|                    | t/y          | t/y          | t/y          | t/y             |             |
| BOD                | 1,389        | 1,161        | 1,545        | -384            | -33%        |
| COD                | 3,198        | 2,643        | 3,556        | -913            | -35%        |
| TSS                | 1,900        | 1,501        | 2,112        | -611            | -41%        |
| TN                 | 315          | 259          | 350          | -91             | -35%        |
| TP                 | 56           | 46           | 62           | -17             | -36%        |
| <b>Total (t/y)</b> | <b>6,858</b> | <b>5,610</b> | <b>7,625</b> | <b>-2,015</b>   | <b>-36%</b> |

Source: Egis, 2021

153. The value of the undesirable pollutants depends on the type of water body they will be discharged to. For Bavet, this is assumed to be a combination of wetland and river resulting in the value per kg is shown below.

**Table 48: Bavet Value of Undesirable Pollutants**

| Effluent destination | Nitrogen (N) | Phosphorus (P) | Suspended solids (SS) | Biological oxygen demand (BOD) | Chemical oxygen demand (COD) |
|----------------------|--------------|----------------|-----------------------|--------------------------------|------------------------------|
| River/ wetland 50%   | 56.12        | 92.48          | 0.01                  | 0.10                           | 0.15                         |

Note: \$/kg; constant 2020 prices

Source: Egis, 2021.

154. The total economic benefit from the reduction of pollutants is \$6.819 m per year, which is assumed to remain constant over the project life. The biggest contribution is from the reduction in N and P.

## 9. Impact on GDP

155. The project is expected to result in a more livable city for the residents and the commercial sector, and as a result of the improved urban infrastructure through investment in sanitation, SWM, and drainage, the local environment will be more conducive to business and growth of the local economy, than would be the case in the future without project situation. Local economic performance is measured by the contribution to Gross Domestic Product (GDP), which is a

measure of all economic activity goods and services contributing to the economy during a period of time (usually a year).

156. It is expected that the establishment of a more livable city that has improved public utilities will be more attractive to business development and have a high GDP than would be the case without the project so that the change in the growth of GDP in the future between the fwp and fwp situation is an economic benefit that encompasses the totality of all the impacts of the project.

157. However, because of the difficulty of quantifying the impact of the project on GDP and in separating GDP from the other quantified benefits, the impact on GDP has not been included in the economic analysis as a benefit. The direct economic benefits of the project are captured through the benefits resulting through the reduction in expenditure on health, lost productivity, the increased value of recycled material, reduction in flooding, etc.

## 10. Results of Overall Economic Analysis

158. As discussed in the earlier section, economic analysis has been conducted from the perspective of the overall combined project for Bavet.

159. The results of the overall economic analysis including the city's share of Output 2 and 3 indicates an EIRR of 15.5% with an NPV at an OCC of 9% of \$18.65 m. This result comfortably meets ADB's hurdle of a 9% EIRR.

160. Summary tables of the CBA for the Bavet are presented in the following tables.

161. The main project parameters – capital costs, Opex costs, and the benefits have been tested to show the sensitivity of the analysis to changes in these items and to indicate their switching values, the percentage change needed to increase the EIRR to 9%. The table below shows the results.

**Table 49: Bavet Results of Sensitivity Analysis**

|                  | Change | EIRR         | PV 9%\$ m    | EIRR % SV |
|------------------|--------|--------------|--------------|-----------|
| <b>Base case</b> |        | <b>15.5%</b> | <b>18.64</b> |           |
| <b>Capital</b>   | 20%    | 12.4%        | 11.53        | 42%       |
| <b>O&amp;M</b>   | 20%    | 14.8%        | 16.48        | 181%      |
| <b>Benefits</b>  | -20%   | 11.0%        | 5.64         | -29%      |

SV = switching value.  
Source: Egis, 2021.

162. Capex would have to increase by 42%, O&M costs by 181%, and the benefits to decrease by 29% to reduce the EIRR to 9%.

163. The economic performance is relatively high on account of the anticipated reduction in undesirable pollutants for the city as a result of the improved urban infrastructure is a catalyst for the expansion of economic activity and tourism attracted to the casinos.

**Table 50: Bavet Economic Analysis Summary****ECONOMIC ANALYSIS RESULTS****Feasibility Study of Livable Cities Investment Project - Bavet**

|      |        |               |             | Net Benefit (Cost) |                            | Sensitivity |          |          |            |
|------|--------|---------------|-------------|--------------------|----------------------------|-------------|----------|----------|------------|
|      |        | Economic Cost |             |                    | Base                       | Investmt    | O&M      | Benefit  | 1-yr Delay |
| Year | Capex  | Opex          | Total Costs | Benefits           | Case                       | 20%         | 20%      | -20%     | in Benefit |
|      | \$'000 | \$'000        | \$'000      | \$'000             | \$'000                     | \$'000      | \$'000   | \$'000   | \$'000     |
| 1    | 2021   | -             | 0           | 0                  | 0                          | 0           | 0        | 0        | 0          |
| 2    | 2022   | 935           | 0           | 935                | 0                          | (935)       | (1,123)  | (935)    | (935)      |
| 3    | 2023   | 11,716        | 0           | 11,716             | 0                          | (11,716)    | (14,060) | (11,716) | (11,716)   |
| 4    | 2024   | 18,465        | 0           | 18,465             | 0                          | (18,465)    | (22,158) | (18,465) | (18,465)   |
| 5    | 2025   | 22,688        | 825         | 23,512             | 8,800                      | (14,712)    | (19,250) | (14,877) | (23,512)   |
| 6    | 2026   | 2,981         | 1,859       | 4,840              | 11,259                     | 6,419       | 5,823    | 6,048    | 4,168      |
| 7    | 2027   | 314           | 1,881       | 2,195              | 11,363                     | 9,168       | 9,105    | 8,791    | 6,895      |
| 8    | 2028   | -             | 1,904       | 1,904              | 11,466                     | 9,562       | 9,562    | 9,181    | 7,269      |
| 9    | 2029   | -             | 1,927       | 1,927              | 11,571                     | 9,644       | 9,644    | 9,258    | 7,329      |
| 10   | 2030   | -             | 1,951       | 1,951              | 11,681                     | 9,731       | 9,731    | 9,341    | 7,394      |
| 11   | 2031   | -             | 1,965       | 1,965              | 10,806                     | 8,841       | 8,841    | 8,448    | 6,679      |
| 12   | 2032   | -             | 1,980       | 1,980              | 10,908                     | 8,928       | 8,928    | 8,532    | 6,746      |
| 13   | 2033   | -             | 1,994       | 1,994              | 11,011                     | 9,016       | 9,016    | 8,617    | 6,814      |
| 14   | 2034   | 2,257         | 2,009       | 4,267              | 11,115                     | 6,848       | 6,397    | 6,447    | 4,625      |
| 15   | 2035   | -             | 2,024       | 2,024              | 11,220                     | 9,196       | 9,196    | 8,791    | 6,952      |
| 16   | 2036   | -             | 2,039       | 2,039              | 11,326                     | 9,287       | 9,287    | 8,879    | 7,022      |
| 17   | 2037   | -             | 2,055       | 2,055              | 11,433                     | 9,379       | 9,379    | 8,968    | 7,092      |
| 18   | 2038   | -             | 2,070       | 2,070              | 11,542                     | 9,472       | 9,472    | 9,058    | 7,163      |
| 19   | 2039   | -             | 2,085       | 2,085              | 11,651                     | 9,566       | 9,566    | 9,149    | 7,236      |
| 20   | 2040   | -             | 26,435      | 2,101              | (24,334)                   | 11,763      | 36,096   | 41,383   | 35,676     |
|      |        |               |             | 0                  |                            |             |          |          |            |
|      |        |               |             | 0                  |                            |             |          |          |            |
| 1    | 1      | 32,922        | 30,669      | 63,591             | 178,914                    | 115,323     | 108,739  | 109,189  | 79,540     |
|      |        |               |             |                    | Discount Rate @ 9% EIRR    | 15.5%       | 12.4%    | 14.8%    | 11.0%      |
|      |        |               |             |                    | ENPV 9%                    | 18,645      | 11,531   | 16,481   | 5,638      |
|      |        |               |             |                    | Sensitivity Indicator EIRR |             | 2.4      | 0.6      | 3.4        |
|      |        |               |             |                    | ENPV                       |             | 1.9      | 0.6      | 3.5        |
|      |        |               |             |                    | Switching Value EIRR       |             | 42%      | 181%     | 29%        |
|      |        |               |             |                    | Switching Value ENPV       |             | 52%      | 172%     | 29%        |

Table 51: Bavet Economic Analysis Cash Flows

| LCIP ECONOMIC ANALYSIS - BAVET                         |        | US\$'000 in constant 2020 economic prices           |        |          |           | Exchange Rate KHR: \$ |           | 4095     |          |          |          |                                    |          |          |          |          |          |          |          |          |             |               |
|--|--------|---|--------|----------|-----------|-----------------------|-----------|----------|----------|----------|----------|------------------------------------|----------|----------|----------|----------|----------|----------|----------|----------|-------------|---------------|
|  |        | 2021  | 2022   | 2023     | 2024      | 2025                  | 2026      | 2027     | 2028     | 2029     | 2030     | 2031                               | 2032     | 2033     | 2034     | 2035     | 2036     | 2037     | 2038     | 2039     | 2040        |               |
| CAPEX COSTS (economic)                                 |        |   |        |          |           |                       |           |          |          |          |          |                                    |          |          |          |          |          |          |          |          |             |               |
| BAVET ECONOMIC COSTS                                   |        | Total \$'000  |        |          |           |                       |           |          |          |          |          | Septage truck and Pump replacement |          |          |          |          |          |          |          |          |             | Salvage value |
|  |        | Landfill machinery and collection truck replacement |        |          |           |                       |           |          |          |          |          |                                    |          |          |          |          |          |          |          |          |             |               |
| Bavet Wastewater                                       | 31,904 | 31,904.29   | 167.86 | 5,836.21 | 10,684.07 | 13,590.86             | 1,586.04  | 39.25    |          |          |          |                                    |          |          | 1,063    |          |          |          |          |          | - 16,271.19 |               |
| Bavet Stormwater                                       | 7,695  | 7,694.57  | 134.76 | 2,161.93 | 2,265.50  | 2,772.96              | 353.28    | 6.15     |          |          |          |                                    |          |          | 304      |          |          |          |          |          | - 3,924.23  |               |
| Bavet Solid Waste Management                           | 15,240 | 15,239.89   | 139.63 | 4,838.04 | 4,268.04  | 5,345.91              | 642.13    | 6.15     |          |          |          |                                    |          |          | 1,930.07 |          |          |          |          |          | - 7,772.35  |               |
| Total Bavet Urban Infra                                | 54,839 | 54,838.76   | -      | 442.24   | 12,836.18 | 17,217.61             | 21,709.74 | 2,581.45 | 51.54    | -        | -        | -                                  | -        | -        | 3,297.12 | -        | -        | -        | -        | -        | - 27,967.77 |               |
| 1. Policy and Regulatory Environment Improved          |        |   |        |          |           |                       |           |          |          |          |          |                                    |          |          |          |          |          |          |          |          |             |               |
| Bavet Urban Planning                                   | 849    | 848.94  | 80.67  | 353.86   | 181.63    | 149.42                | 54.13     | 29.23    |          |          |          |                                    |          |          |          |          |          |          |          |          |             |               |
| 3. Institutional Effectiveness and Governance Improved |        |   |        |          |           |                       |           |          |          |          |          |                                    |          |          |          |          |          |          |          |          |             |               |
| Bavet's share  | 988    | 988.44  | 30.48  | 421.46   | 244.69    | 236.42                | 28.62     | 26.77    |          |          |          |                                    |          |          |          |          |          |          |          |          |             |               |
| Total Output 1 & 3                                     |        | 1,837.38  | -      | 111.15   | 775.32    | 426.32                | 385.84    | 82.76    | 55.99    |          |          |                                    |          |          |          |          |          |          |          |          |             |               |
| Total Capex  | \$'000 | 56,676.13   | -      | 553.39   | 13,611.50 | 17,643.93             | 22,095.57 | 2,664.21 | 107.54   | -        | -        | -                                  | -        | -        | 3,297.12 | -        | -        | -        | -        | -        | - 27,967.77 |               |
| OPEX   | SCF    | 32,005.48   |        |          |           |                       |           |          |          |          |          |                                    |          |          |          |          |          |          |          |          |             |               |
| BAVET  |        | 0.99 Economic Price                                 |        |          |           | 1                     |           |          |          |          |          |                                    |          |          |          |          |          |          |          |          |             |               |
| Sanitation   |        |   |        |          |           | -                     | 230.79    | 230.79   | 230.79   | 230.79   | 230.79   | 230.79                             | 230.79   | 230.79   | 230.79   | 230.79   | 230.79   | 230.79   | 230.79   | 230.79   | 230.79      |               |
| SWM  |        |   |        |          |           | 777.56                | 1,576.89  | 1,599.09 | 1,621.72 | 1,644.78 | 1,668.25 | 1,682.64                           | 1,697.17 | 1,711.83 | 1,726.61 | 1,741.53 | 1,756.58 | 1,771.75 | 1,787.05 | 1,802.48 | 1,818.06    |               |
| Drainage   |        |   |        |          |           | 43.16                 | 43.16     | 43.16    | 43.16    | 43.16    | 43.16    | 43.16                              | 43.16    | 43.16    | 43.16    | 43.16    | 43.16    | 43.16    | 43.16    | 43.16    | 43.16       |               |
| Total OPEX   | \$'000 | -   | -      |          |           | 820.72                | 1,850.84  | 1,873.05 | 1,895.68 | 1,918.73 | 1,942.20 | 1,956.60                           | 1,971.12 | 1,985.78 | 2,000.57 | 2,015.48 | 2,030.53 | 2,045.70 | 2,061.01 | 2,076.43 | 2,092.01    |               |
| TOTAL COSTS  |        | \$'000  | -      | 553.39   | 13,611.50 | 17,643.93             | 22,916.29 | 4,515.05 | 1,980.58 | 1,895.68 | 1,918.73 | 1,942.20                           | 1,956.60 | 1,971.12 | 1,985.78 | 5,297.68 | 2,015.48 | 2,030.53 | 2,045.70 | 2,061.01 | 2,076.43    | - 25,875.75   |

Table 52 continued..

|                                       |                         | 2021   | 2022    | 2023                    | 2024                    | 2025       | 2026     | 2027     | 2028     | 2029     | 2030     | 2031     | 2032     | 2033     | 2034     | 2035     | 2036     | 2037     | 2038     | 2039     | 2040     |
|---------------------------------------|-------------------------|--------|---------|-------------------------|-------------------------|------------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|
| BENEFITS                              |                         |        |         |                         |                         |            |          |          |          |          |          |          |          |          |          |          |          |          |          |          |          |
| GDP                                   |                         |        |         |                         |                         |            |          |          |          |          |          |          |          |          |          |          |          |          |          |          |          |
| Bavet GDP (projected FWOP)            | \$'000/y                | 82,802 | 86,942  | 91,290                  | 95,854                  | 100,647    | 105,679  | 110,963  | 116,511  | 122,337  | 128,454  | 134,876  | 141,620  | 148,701  | 156,136  | 163,943  | 172,140  | 180,747  | 189,784  | 199,274  | 209,237  |
| GDP growth FWP                        | \$'000/y                | 82,802 | 86,942  | 91,290                  | 95,854                  | 100,647    | 107,692  | 115,230  | 123,297  | 131,927  | 141,162  | 148,220  | 155,631  | 163,413  | 171,584  | 180,163  | 189,171  | 198,629  | 208,561  | 218,989  | 229,938  |
| Marginal GDP growth due to project    | \$'000/y                | -      | -       | -                       | -                       | -          | 2,013    | 4,267    | 6,785    | 9,591    | 12,709   | 13,344   | 14,011   | 14,712   | 15,447   | 16,220   | 17,031   | 17,882   | 18,777   | 19,715   | 20,701   |
| Total GDP Benefit                     | \$0.00 \$'000/y         |        |         |                         |                         |            |          |          |          |          |          |          |          |          |          |          |          |          |          |          |          |
| SANITATION                            |                         |        |         |                         |                         |            |          |          |          |          |          |          |          |          |          |          |          |          |          |          |          |
| Septage saving                        | 8.5 \$'000/y            |        |         |                         |                         | 15.17      | 15.17    | 15.17    | 15.17    | 15.17    | 15.17    | 15.17    | 15.17    | 15.17    | 15.17    | 15.17    | 15.17    | 15.17    | 15.17    | 15.17    | 15.17    |
| Healthcare saving (connected HHs)     | 15.0 \$'000/y           |        |         |                         |                         | 22.84      | 22.84    | 22.84    | 22.84    | 22.84    | 22.84    | 22.84    | 22.84    | 22.84    | 22.84    | 22.84    | 22.84    | 22.84    | 22.84    | 22.84    | 22.84    |
| Septic tank & cesspit maintenance     | 5.0 \$'000/y            |        |         |                         |                         | 8.32       | 8.32     | 8.32     | 8.32     | 8.32     | 8.32     | 8.32     | 8.32     | 8.32     | 8.32     | 8.32     | 8.32     | 8.32     | 8.32     | 8.32     | 8.32     |
| Total Bavet sanitation                | \$324.15 \$'000/y       | -      | -       |                         |                         | 46.33      | 46.33    | 46.33    | 46.33    | 46.33    | 46.33    | 46.33    | 46.33    | 46.33    | 46.33    | 46.33    | 46.33    | 46.33    | 46.33    | 46.33    | 46.33    |
| SWM                                   |                         |        |         |                         |                         |            |          |          |          |          |          |          |          |          |          |          |          |          |          |          |          |
| Uncollected HH waste saved cost fwop  | t/yr                    |        |         |                         |                         | 3,298      | 3,854    | 4,435    | 4,742    | 5,060    | 6,319    | 6,612    | 6,912    | 7,217    | 7,528    | 7,787    | 8,109    | 8,437    | 8,771    | 9,112    | 9,526    |
| Saved HH disposal costs FWOP          | 5.0 \$'000/y            |        |         |                         |                         | 16.49      | 19.27    | 22.17    | 23.71    | 25.30    | 31.60    | 33.06    | 34.56    | 36.09    | 37.64    | 38.93    | 40.54    | 42.19    | 43.86    | 45.56    | 47.63    |
| Saved collection costs FWOP           | t/yr                    |        |         |                         |                         | 30,870     | 31,199   | 31,531   | 31,867   | 32,206   | 32,549   | 32,788   | 33,028   | 33,270   | 33,514   | 33,760   | 34,008   | 34,258   | 34,509   | 34,763   | 35,005   |
| Saved collection costs FWOP           | 20.0 \$'000/y           |        |         |                         |                         | 617.40     | 623.97   | 630.62   | 637.33   | 644.12   | 650.99   | 655.76   | 660.56   | 665.41   | 670.29   | 675.20   | 680.16   | 685.16   | 690.19   | 695.26   | 700.10   |
| Value of recyclables                  | 100% \$'000/y           |        |         | -                       | -                       | -          | 1,060.22 | 1,088.10 | 1,115.97 | 1,143.85 | 1,171.73 | 1,190.61 | 1,209.48 | 1,228.36 | 1,247.24 | 1,266.11 | 1,284.99 | 1,303.87 | 1,322.74 | 1,341.62 | 1,360.50 |
| Value of compost                      | 100% \$'000/y           |        |         |                         |                         | -          | 82.01    | 86.86    | 91.70    | 96.55    | 101.40   | 102.58   | 103.75   | 104.93   | 106.10   | 107.28   | 108.46   | 109.63   | 110.81   | 111.98   | 113.16   |
| Value of carbon credit saving SLF     | constant \$'000/y       |        |         | -                       | -                       | 49.80      | 74.71    | 99.61    | 124.51   | 149.41   | 174.32   | 198.45   | 222.59   | 246.73   | 270.86   | 295.00   | 317.99   | 340.97   | 363.96   | 386.95   | 409.93   |
| - Carbon saving at growth 2% /y       | 2% \$'000/y             |        |         |                         |                         | 1.00       | 1.02     | 1.04     | 1.06     | 1.08     | 1.10     | 1.13     | 1.15     | 1.17     | 1.20     | 1.22     | 1.24     | 1.27     | 1.29     | 1.32     | 1.35     |
| Value of carbon credit saving SLF     | inflated \$'000/y       |        |         |                         |                         | 49.80      | 76.20    | 103.63   | 132.13   | 161.73   | 192.46   | 223.49   | 255.69   | 289.08   | 323.71   | 359.60   | 395.38   | 432.44   | 470.82   | 510.57   | 551.72   |
| Total Bavet SWM                       | \$14,359.84             | -      | -       |                         |                         | 683.69     | 1,861.67 | 1,931.37 | 2,000.86 | 2,071.56 | 2,148.17 | 2,205.49 | 2,264.04 | 2,323.86 | 2,384.98 | 2,447.13 | 2,509.53 | 2,573.27 | 2,638.42 | 2,704.99 | 2,773.10 |
| DRAINAGE                              |                         |        |         |                         |                         |            |          |          |          |          |          |          |          |          |          |          |          |          |          |          |          |
| Number HHs served                     | HHs                     |        |         | -                       | -                       | 1,026      | 2,104    | 2,158    | 2,211    | 2,264    | 2,318    | 2,385    | 2,453    | 2,521    | 2,589    | 2,657    | 2,725    | 2,792    | 2,860    | 2,928    | 2,996    |
| Number C&Is & SEZ served              | C&Is                    |        |         |                         |                         | 35         | 35       | 35       | 35       | 35       | 35       | 35       | 35       | 35       | 35       | 35       | 35       | 35       | 35       | 35       | 35       |
| Value of saved damage HHs             | \$150.00 \$'000/y       |        |         | -                       | -                       | 153.84     | 315.67   | 323.66   | 331.66   | 339.65   | 347.64   | 357.81   | 367.99   | 378.16   | 388.34   | 398.51   | 408.69   | 418.86   | 429.04   | 439.21   | 449.39   |
| Value of saved damage C&Is            | \$250.00 \$'000/y       |        |         | -                       | -                       | 4.37       | 8.74     | 8.74     | 8.74     | 8.74     | 8.74     | 8.74     | 8.74     | 8.74     | 8.74     | 8.74     | 8.74     | 8.74     | 8.74     | 8.74     | 8.74     |
| Total Bavet Drainage                  | \$2,445.47 \$'000/y     | -      | -       |                         |                         | 158.21     | 324.41   | 332.40   | 340.39   | 348.38   | 356.38   | 366.55   | 376.73   | 386.90   | 397.08   | 407.25   | 417.43   | 427.60   | 437.78   | 447.95   | 458.13   |
| HEALTH BENEFITS                       |                         |        |         |                         |                         |            |          |          |          |          |          |          |          |          |          |          |          |          |          |          |          |
| Sanitation area (HHs connected)       | No. HH                  |        |         |                         |                         | 761        | 1,523    | 1,523    | 1,523    | 1,523    | 1,523    | 1,523    | 1,523    | 1,523    | 1,523    | 1,523    | 1,523    | 1,523    | 1,523    | 1,523    | 1,523    |
| SWM served area (HHs affected)        | No. HH                  |        |         |                         |                         | 5,164      | 10,597   | 10,866   | 11,135   | 11,405   | 11,674   | 12,017   | 12,360   | 12,702   | 13,045   | 13,388   | 13,731   | 14,074   | 14,417   | 14,760   | 15,103   |
| Drainage area                         | No. HH                  |        |         | -                       | -                       | 1,378      | 2,051    | 2,104    | 2,158    | 2,211    | 2,264    | 2,318    | 2,385    | 2,453    | 2,521    | 2,589    | 2,657    | 2,725    | 2,792    | 2,860    | 2,928    |
| Resident popn health benefit (SWM are | \$94.46 \$'000/y        |        |         |                         |                         | 488        | 1,001    | 1,026    | 1,052    | 1,077    | 1,103    | 1,135    | 1,167    | 1,200    | 1,232    | 1,265    | 1,297    | 1,329    | 1,362    | 1,394    | 1,427    |
| SEZ population                        | \$30.00 \$'000/y        |        |         |                         |                         | 590        | 1,179    | 1,179    | 1,179    | 1,179    | 1,179    | 203      | 203      | 203      | 203      | 203      | 203      | 203      | 203      | 203      | 203      |
| Tourist population                    | \$2.00 \$'000/y         |        |         |                         |                         | 9          | 17       | 18       | 18       | 19       | 19       | 20       | 20       | 21       | 21       | 22       | 22       | 23       | 24       | 24       | 25       |
| Total Health Benefits                 | \$12,357.35 60 \$'000/y | -      | -       |                         |                         | 1,085.90   | 2,197.65 | 2,223.50 | 2,249.36 | 2,275.22 | 2,301.08 | 1,357.81 | 1,390.75 | 1,423.69 | 1,456.63 | 1,489.57 | 1,522.52 | 1,555.46 | 1,588.40 | 1,621.34 | 1,654.28 |
| UNDESIRABLE POLLUTANTS BENI           |                         |        |         |                         |                         |            |          |          |          |          |          |          |          |          |          |          |          |          |          |          |          |
| Biological Oxygen Demand (BOD)        | \$/kg 0.10 \$'000/y     |        |         | Reduction t/y from 2025 |                         | 39.6       |          |          |          |          |          |          |          |          |          |          |          |          |          |          |          |
| Chemical oxygen demand (COD)          | 0.15 \$'000/y           |        |         | -                       | 913.1                   | 138.3      |          |          |          |          |          |          |          |          |          |          |          |          |          |          |          |
| Suspended solids (SS)                 | 0.01 \$'000/y           |        |         | -                       | 611.1                   | 6.3        |          |          |          |          |          |          |          |          |          |          |          |          |          |          |          |
| Nitrogen (N)                          | 56.12 \$'000/y          |        |         | -                       | 90.8                    | 5,097.4    |          |          |          |          |          |          |          |          |          |          |          |          |          |          |          |
| Phosphorus (P)                        | 92.48 \$'000/y          |        |         | -                       | 16.6                    | 1,537.0    |          |          |          |          |          |          |          |          |          |          |          |          |          |          |          |
| Total Undesirable Elements Benefit    | \$56,680.40             | -      | 2,015.2 |                         |                         | 6,818.6    | 6,818.6  | 6,818.6  | 6,818.6  | 6,818.6  | 6,818.6  | 6,818.6  | 6,818.6  | 6,818.6  | 6,818.6  | 6,818.6  | 6,818.6  | 6,818.6  | 6,818.6  | 6,818.6  | 6,818.6  |
| INTERNATIONAL TOURIST BENEFIT         |                         |        |         |                         |                         |            |          |          |          |          |          |          |          |          |          |          |          |          |          |          |          |
| Marginal increase in revenue          | \$42.18 \$'000/y        |        |         | growth per year         |                         | 5.0        | 5.0      | 5.1      | 5.1      | 5.1      | 5.1      | 5.1      | 5.1      | 5.1      | 5.1      | 5.1      | 5.1      | 5.1      | 5.1      | 5.1      | 5.1      |
| TOTAL BENEFITS                        | \$70,852 \$'000/y       | -      | -       |                         |                         | 8,797.8    | 11,253.8 | 11,357.3 | 11,460.6 | 11,565.2 | 11,675.7 | 10,799.9 | 10,901.6 | 11,004.5 | 11,108.8 | 11,214.0 | 11,319.6 | 11,426.4 | 11,534.7 | 11,644.4 | 11,755.6 |
| NET CASH FLOW                         | \$'000/y                | -      | -       | 553.39                  | - 13,611.50 - 17,643.93 | - 14,118.5 | 6,738.7  | 9,376.7  | 9,565.0  | 9,646.5  | 9,733.5  | 8,843.3  | 8,930.5  | 9,018.7  | 5,811.1  | 9,198.6  | 9,289.0  | 9,380.7  | 9,473.7  | 9,567.9  | 37,631.3 |
| EIRR                                  | 15.5%                   |        |         |                         |                         | 8,797.8    | 11,253.8 | 11,357.3 | 11,460.6 | 11,565.2 | 11,675.7 | 10,799.9 | 10,901.6 | 11,004.5 | 11,108.8 | 11,214.0 | 11,319.6 | 11,426.4 | 11,534.7 | 11,644.4 | 11,755.6 |
| ENPV 9%                               | \$18,748.28             |        |         |                         |                         |            |          |          |          |          |          |          |          |          |          |          |          |          |          |          |          |

## 11. Distribution Analysis and Poverty Impact

164. The distributional analysis is shown below. The distribution of the difference between the ENPV and the FNPV for benefits relates to GDP economic benefit which is allocated as a gain to the Government and consumers and the public. The difference in the PVs of the Capex and Opex costs relate to the tax and the shadow value of unskilled labour and are allocated as a gain to the community and unskilled labor. The higher FNPV for the unskilled labor is a gain to the government and to unskilled labor employed during construction as the SWRF is 0.6. The tax element in the Capex and Opex costs is a gain to the government.

165. **Poverty impact.** The ADB's poverty assessment for Cambodia was 12.9% in 2018, having reduced from 47.8% in 2007 and 13.5% in 2014, although the Covid pandemic is expected to reverse this reducing trend. It is assumed that Bavet's incidence of poverty is similar to the national average and has been showing a progressive decline in tune with the rest of the country. Overall, the distribution impact will largely benefit the residents and the local communities of Bavet including the SEZ workers.

**Table 52: Distributional Analysis and Poverty Impact**

| A. Distribution of Benefits |                      |             |                               |                      |             |        |           | KHR billion<br>(100xmillion) |
|-----------------------------|----------------------|-------------|-------------------------------|----------------------|-------------|--------|-----------|------------------------------|
| Particulars                 | Financial PV         | Economic PV | Economic PV LESS Financial PV | Government / Economy | Labor       | Public | Consumers | Total                        |
| Revenue / Benefits          | 44.6                 | 266         | 221.1                         | 110.6                |             | 55.3   | 55.3      | 221.1                        |
| Costs                       |                      |             |                               |                      |             |        |           |                              |
| Civil works                 | 122.7                | 112.1       | (15.5)                        | 15.5                 |             |        |           | 15.5                         |
| Equipment & materials       | 6.5                  | 5.7         | (0.8)                         | 0.8                  |             |        |           | 0.8                          |
| Labour                      | 38.9                 | 34.2        | (4.7)                         |                      | 4.5         |        |           |                              |
| Other                       | 42.3                 | 38.0        | (5.2)                         | 5.2                  |             |        |           | 5.2                          |
| Net Benefits                | - 171.6              | 75.7        | 247.3                         | (171.6)              |             |        |           | (171.6)                      |
| Gains and Losses            |                      |             |                               | (39.6)               | 4.7         | 55.3   | 55.3      | 75.7                         |
| PV=present value            |                      |             |                               |                      |             |        |           |                              |
| B. Poverty Impact Ratio     |                      |             |                               |                      |             |        |           | KHR billion<br>(100xmillion) |
| Items                       | Government / Economy | Labor       | Public                        | Consumer s           | Total       |        |           |                              |
| Gains and losses            |                      | 4.7         | 55.3                          | 55.3                 | 115.3       |        |           |                              |
| Financial return            | (39.6)               |             |                               |                      | (39.6)      |        |           |                              |
| Benefits (Losses)           | (39.6)               | 4.7         | 55.3                          | 55.3                 | 75.7        |        |           |                              |
| Proportion of poor          | 0.35                 | 0.50        | 0.30                          | 0.40                 |             |        |           |                              |
| Benefits to poor            | (13.9)               | 2.4         | 16.6                          | 22.1                 | 27.2        |        |           |                              |
| <b>Poverty Impact Ratio</b> |                      |             |                               |                      | <b>0.36</b> |        |           |                              |

Source: Egis, 2021



## VIII. POIPET ECONOMIC ANALYSIS

### 1. Introduction

166. This section presents the economic evaluation for Poipet City. The proposed investment for Poipet will support sanitation wastewater, solid waste management, and stormwater drainage for the short-term time horizon 2020 – 2025. The costs and benefits for the three components are estimated and combined into an overall economic analysis for the project for the city. Because the economic benefits of the different components - sanitation, SWM, and drainage - are interrelated, it is not realistic to apportion some of the benefits to the individual components.

167. **Poipet Economic Condition.** Poipet City is a flourishing border city strategically located in the Province of Banteay Meanchey in the northwest of Cambodia. It shares borders with the provinces of Oddar Meanchey and Siem Reap to the east, Battambang to the south, and an international border with Thailand to the west. The provincial capital is Serei Saophoan (also called Sisophon).

168. Poipet city has experienced major changes and expansion since 2008, with the establishment of Special Economic Zones (SEZs) and development of the transborder tourism and trade with Thailand. In 2020, three SEZs have been established and are in operation. The local authorities are expecting additional industry locators to expand the existing and develop new SEZs. Significant land-use conversion from agriculture to residential is anticipated after 2030. The main economic activities and employment are: service sector 71%; industry 13%; and agriculture 18%. The SEZs employ 5,000 workers.<sup>19</sup>

169. Given the competitive labor costs, the cheap and stable electricity supply from Thailand (\$0.16 per kilowatt), the proximity to Bangkok, and the favorable investment policy providing incentives, Poipet is seen as a major future industrial city of the northwestern part of Cambodia. The opening of the cross-border trade with Thailand in 1991 enabled growth in trade activities and a growing influx of worker migrants and tourist into the area. Service-oriented activities are estimated to employ 71% of the population. Major accommodation in the city consists of hotels and guesthouses along with casinos - the main form of recreation.

170. **Population.** Based on the 2018 population census,<sup>20</sup> in 2018 Poipet's population of 104,156 represented 12.1% of the province's population and having increased from 43,366 in 1998 to 89,549 in 2008 and 104,156 in 2018 and making it the fourth most populous city in Cambodia and larger than its provincial capital Serei Saophoan. In 2020 its population is estimated to be 124,244 inhabitants including the temporary population, SEZ workers and tourists.<sup>21</sup> Based on the adopted Average Annual Growth Rate (AAGR) the population is expected to grow to 226,118 by 2040, an 82% increase from 2020. The projected population and the contribution of the various groups is shown in the following table.

<sup>19</sup> Poipet City Socio-Economic Status report.

<sup>20</sup> National Institute of Statistics of Ministry of Planning.

<sup>21</sup> The temporary population are residents who do not have formal resident status but are considered as permanent residents.

**Table 53: Poipet Projected population 2020-2040**

| Category                          | 2020           | 2025           | 2030           | 2040           |
|-----------------------------------|----------------|----------------|----------------|----------------|
| Permanent Population              | 110,510        | 128,335        | 149,354        | 203,561        |
| Temporary Population              | 3,070          | 3,729          | 4,531          | 6,687          |
| SEZ workers                       | 5,000          | 7,000          | 8,000          | 8,000          |
| Tourists International population | 2,555          | 2,696          | 2,845          | 3,167          |
| Tourists Domestic population      | 3,109          | 3,448          | 3,824          | 4,703          |
| <b>Total population</b>           | <b>124,244</b> | <b>145,209</b> | <b>168,554</b> | <b>226,118</b> |

Source: Egis, 2021

## 2. Poipet Proposed Subprojects

171. Following the Urban Development Strategy (UDS), the sector Master plan (MP), and the Comprehensive Technical Options Study (CTOP). The following sections provide a brief overview of the proposed infrastructure for LCIP in Poipet to service the priority area to 2025 horizon.

### 2.1. Wastewater Management Subproject

172. There is at present no public wastewater system functioning in the municipality. It was assessed that currently, approximately 91% of fecal waste is not safely managed. The wastewater is not adequately evacuated, ponds along roadsides and remains stagnant in urban areas, and part of the effluent is also discharged directly to open waters without any form of treatment.

173. To cater to the city's future growth and development, a wastewater system comprising treatment plants, sewers, pumping stations, and force-mains has been proposed. The following table summarizes the proposed wastewater investments to be delivered under this project to improve sanitation services, as agreed by the national and sub-national administrations.

**Table 54: Investments in wastewater infrastructure in Poipet Municipality**

| Investment Area            | Components  |
|----------------------------|---|
| Pumping stations           | 6 PS  |
| Networks                   | 56 km of gravity lines, 11 km of force mains  |
| Wastewater Treatment Plant | Conventional Activated Sludge process (9,576m <sup>3</sup> /day)<br>Extended Aeration (ASP-EA) with solar panel field |

Source: Egis, 2020

### 2.2. Stormwater Drainage Subproject

174. Poipet has more than 3.3 km of open channel network, which is considered the main drainage infrastructure for the city. This network acts as a combined sewer/drainage network and therefore acts as a conveyance network for sewage effluent and stormwater. The construction of the network has been carried out ad-hoc, with minimal planning. As such, the capacity of the main stormwater channels is not sufficient to ensure proper drainage of the city center, and residents and local authorities have reported recurrent flooding. In addition, the network is blocked by an accumulation of garbage or by new construction.

175. The increasing growth and development within the city are likely to exacerbate the flooding situation. Construction of new buildings, such as hotels, shopping malls, casinos, will increase the natural land covered with concrete, steel, and asphalt structures. Runoff rates will increase

from the impermeable surfaces, which will likely increase flooding on streets and around buildings in low-lying areas.

176. After completing the technical feasibility study, the following stormwater drainage infrastructure is proposed to be delivered as part of this project and as agreed by the national and sub-national administrations.

**Table 55: Investments in Drainage**

| Investment Area | Components |
|-----------------|------------|
| Box culvert     | 7.13 km    |

Source: Egis, 2020

### 2.3. Solid Waste Management Subproject

177. Several external service providers provide current waste collection services. An estimated 69% of solid waste generated across the city is collected. However, only 16% of households are covered by this service.<sup>22</sup> The current collection area covers Poipet *sangkat* (i.e., 85%) and part of Phsar Kandal *sangkat* (i.e., 5%).<sup>23</sup> Nimitt rural *sangkat* is not covered. Wastes that are collected are taken to a dumpsite operated by the service provider. The proportion that is left uncollected is usually burnt or dumped into the nearby environment or open drains.

178. The anticipated growing urban population for the city and the establishment of new commercial facilities will require improved solid waste management services to be provided. The following table summarizes the proposed solid waste investments to be delivered as part of LCIP, as agreed by the national and sub-national administrations.

**Table 56: Investments in Solid Waste Management**

| Investment Area | Components  |
|-----------------|---|
| Collection      | 18 compacting trucks  |
| Treatment       | One sorting plant (capacity 66,709 tpy) and one composting plant (capacity 5,486 tpy) |
| Disposal        | One controlled landfill (capacity 632,784m <sup>3</sup> )                             |

Source: Egis, 2020.

## 3. Poipet Capex Costs

179. The total Capex cost of the proposed investment for Poipet city is \$111.81 million. The total costs including physical and price contingencies and tax and duties are shown in the following table.

**Table 57: Poipet Capex Costs**

| Expenditure Category                  | Cost (\$'000)<br>excl Tax | Financial cost<br>TAX and Duty<br>(\$'000) | Total<br>Base Cost<br>icd Tax (\$'000) |
|---------------------------------------|---------------------------|--|--|
| <b>Investment &amp; Running Costs</b> |                           |  |  |
| Civil Works                           | 67,915                    | 6,792                                      | 74,707                                 |
| Mechanical and Equipment              | 2,138                     | 438  | 2,576                                  |
| Land acquisition and compensation     | 3,613                     | -  | 3,613                                  |
| Consulting Costs                      |                           |  |  |
| a. Project Consultants                | 5,508                     | 551  | 6,059                                  |
| b. Capacity Development               | 115                       | 11   | 126                                    |
| Staff Allowances                      | 129                       | -  | 129                                    |

<sup>22</sup> According to the Feasibility Study, 2021.

<sup>23</sup> Ibid.

|                    |                              |               |              |                |
|--------------------|------------------------------|---------------|--------------|----------------|
|                    | Running Costs                | 294           | -            | 294            |
|                    | Financial audit costs        | 33            | 3            | 37             |
|                    | <b>Total</b>                 | <b>79,745</b> | <b>7,795</b> | <b>87,540</b>  |
| <b>Contingency</b> |                              |               |              |                |
|                    | Physical                     |               |              | 14,589         |
|                    | Price                        |               |              | 6,322          |
| <b>IDC</b>         |                              |               |              |                |
|                    | Interest during construction |               |              | 3,357          |
| <b>Total</b>       |                              |               |              | <b>111,808</b> |

Source: Egis, 2021

### 3.1. Economic Costs

180. The capital investment costs for Poipet allowing for the conversion of financial costs to economic costs and the shadow price of unskilled labor is \$86.10 million, with an overall conversion factor of 0.84, as shown below.

**Table 58: Poipet Urban Infrastructure Capex in Economic Terms**

US\$ millions

| Expenditure Category                  | Financial cost Cost (\$'000) inc Tax | Foreign    |               | Local         |                 | Tax       | Conversion factor | Economic Cost (\$'000) |
|---------------------------------------|--------------------------------------|------------|---------------|---------------|-----------------|-----------|-------------------|------------------------|
|                                       |                                      | Foreign    | Local Trade d | Skilled labor | Unskilled labor |           |                   |                        |
|                                       | \$                                   | %          | %             | %             | %               | %         |                   |                        |
| <b>Investment &amp; Running Costs</b> |                                      |            |               |               |                 |           |                   |                        |
| Civil Works                           | 74,707                               | 40%        | 27%           | 4%            | 20%             | 9%        | 0.83              | 61,938.6               |
| Mechanical and Equipment              | 2,576                                | 70%        | 13%           | 0%            | 0%              | 17%       | 0.83              | 2,137.6                |
| Land acquisition and compensation     | 3,613                                |            | 100%          | 0%            | 0%              | 0%        | 1.00              | 3,613.1                |
| Consulting Costs                      |                                      |            |               |               |                 |           |                   |                        |
| a. Project                            |                                      |            |               |               |                 |           |                   |                        |
| Consultants                           | 6,059                                | 60%        | 31%           | 0%            | 0%              | 9%        | 0.91              | 5,508.3                |
| b. Capacity                           |                                      |            |               |               |                 |           |                   |                        |
| Development                           | 126                                  | 0%         | 91%           | 0%            | 0%              | 9%        | 0.91              | 114.5                  |
| Staff Allowances                      | 129                                  | 0%         | 100%          | 0%            | 0%              | 0%        | 1.00              | 128.8                  |
| Running Costs                         | 294                                  | 25%        | 75%           | 0%            | 0%              | 0%        | 1.00              | 293.8                  |
| Financial audit costs                 | 37                                   | 10%        | 81%           | 0%            | 0%              | 9%        | 0.909             | 33.3                   |
| <b>Total</b>                          | <b>87,540</b>                        | <b>40%</b> | <b>30%</b>    | <b>3%</b>     | <b>17%</b>      | <b>9%</b> | <b>0.843</b>      | <b>73,768.2</b>        |
| <b>Contingency</b>                    |                                      |            |               |               |                 |           |                   |                        |
| Physical                              | 14,589                               |            |               |               |                 |           | 0.843             | 12,294                 |
| Price                                 | 6,322                                |            |               |               |                 |           |                   |                        |
| Interest during construction          | 3,357                                |            |               |               |                 |           |                   |                        |
| <b>Total</b>                          | <b>118,808</b>                       |            |               |               |                 |           |                   | <b>86,062</b>          |

Source: Egis, 2021.

## 4. Wastewater and Sanitation

### 4.1. Introduction

181. At present, Poipet does not have a sewer system or WWTP but part of the existing sewerage flow is conveyed through the current stormwater drainage system into open water. In 2020, 90% of the population had access to a toilet, mostly pour-flush toilets,<sup>24</sup> 2% of the population use public toilets, 2% are still practicing open defecation, and 6% share a neighbor's toilet. Two septage emptying services providers currently operate in Poipet (six vacuum trucks in total). The assessment of the fecal and non-fecal waste disposal chain, both in rural and urban areas, suggests that 91% of fecal waste is not being managed safely.

182. Based on the selected short-term scenario for the Poipet Master Plan, a centralized WWTP will serve the existing built-up area of Poipet in the short term and its extension in the medium- and long-term horizon. Under LCIP, providing sewerage and connections to the existing population will be the priority but with the expected capacity required for the long term. It is proposed to start the implementation with:

- (i) A separate sewerage system will be constructed with 55.6 km of gravity sewerage lines. A 75% connection rate is targeted inside the built-up area served by the phase 1 project. The wastewater will flow by gravity out of the existing urbanized area.
- (ii) A transfer chain of six pumping stations and 11km of force mains will collect the flow and pipe it to the WWTP when gravity flows cannot be achieved because of distance and topography
- (iii) New Activated Sludge treatment (ASP-EA) WWTP with a solar panel field with a daily capacity of 9,576 m<sup>3</sup>/day to design capacity meet the projected wastewater in 2030;
- (iv) In rural areas and urban areas where the connection sewerage system would have been too expensive, on-site collection is proposed. The collected fecal sludge will be transferred by vacuum-truck to the WWTP Septage treatment facility;
- (v) Septage vacuum trucks for collection and disposal of septage and maintenance of the sewer system.

183. A summary of the investment horizon and design capacity is shown below.

**Table 59: Poipet Wastewater Design Horizon and Capacity**

| Item                           | LCIP – investment horizon                 | Design Capacity                    |
|--------------------------------|---|------------------------------------|
| Sewer Network                  |   | 2040                               |
| Pumping Stations & Force mains | 2025<br>short term<br>or<br>priority area | Equipment 2030<br>Civil works 2040 |
| WWTP                           |   | 2030                               |

### 4.2. Wastewater Projections

184. The following table shows the volume of wastewater and septage collected by the new sewer system considering the infrastructure proposed in the LCIP investment (designed to serve the priority core urban area) and the increase in population until 2040 in the collection service area. This shows an overall population of 16,425 residents are located within the short-term service areas with the potential to be connected to the sewerage system. Based on a maximum 75% connection rate the population connected in 2025/26 is 12,318, and assumed to remain at

<sup>24</sup> Department of Planning, 2018. Socio-Economic Situation Report.

this level until 2040. The total volume of wastewater collected is projected to be 1,892 m<sup>3</sup>/d, based on a generation of 153.6 lpcd for the domestic population.

**Table 60: Poipet Wastewater Projections Phase 1**

| Ref. | Parameter  | Unit                   | Short-term 2025 | Mid-term 2030 | Long-term 2040 |
|------|--|------------------------|-----------------|---------------|----------------|
| A    | Population - including temporary & tourists population, in priority areas targeted by FS | Inhab.                 | 16,425          | 17,679        | 20,992         |
| B    | SEZ population, in priority areas targeted by FS   | Inhab.                 | 0               | 0             | 0              |
| C    | Daily wastewater production ratio considered for domestic workers                        | L/day/capita           |                 | 153.6         |                |
| D    | Connection rates   | %                      | 75%             | 75%           | 75%            |
| E    | <b>TOTAL population connected (F = A * D)</b>  | <b>Inhab.</b>          | <b>12,318</b>   | <b>12,318</b> | <b>12,318</b>  |
| F    | <b>TOTAL wastewater volume collected (F = E * C)</b>                                     | <b>m<sup>3</sup>/d</b> | <b>1,862</b>    | <b>1,892</b>  | <b>1,892</b>   |

Source: Egis, 2021

185. The parameters for the number of connections for the residential and commercial sectors is shown in Table 61. The connection rate represents 12% of the resident population in 2025, equivalent to 2,415 households, based on an average HH size of 5.1 people. In terms of the number of commercial entities, hotels, casinos, and institutions and SEZ establishments connected, it is assumed that 57% of commercial entities are connected in 2025, 54% of hotels/casinos, and 80% of institutions. Of the 3 SEZ in Poipet, none will be connected (not included in the priority areas for service coverage). The area served by the new sanitation infrastructure is estimated to cover around 8% of the total wastewater generated in Poipet in 2025/6 and reducing to 5% by 2040. The remainder will continue to be served by the existing septic tanks and on-site containment systems.

186. **Septage.** The CCS reported that 30% of the population emptied its sanitation containment at least once. 26% of them hired a pump truck to empty and transport the fecal sludge, while 4% did it manually. When emptied manually, the sludge is most of the time dumped onto paddy fields or to the water body. It requires between 3 to 5 years to fill up the semi-permeable containments with fecal sludge.

187. Two emptying companies are providing emptying services in Poipet City. According to the CCS survey, approximately one-third of the fecal sludge is sold to farmers. The remaining part is dumped in unknown locations.

188. The estimated septage quantity would be 19.8 m<sup>3</sup>/d in 2025 and for design, 20 m<sup>3</sup>/d is considered for septage co-treatment at the WWTP. The septage collection service and treatment will be designed for:

- (i) Households in urban areas that are not connected to the sewer system (25% of the urban population);
- (ii) New households in rural areas that follow the construction permit standards; and
- (iii) Institutions and commercial complexes that are not connected to the sewer system.

189. A receiving septage station is included with the WWTP site capable of handling the 2040 design horizon. The saving in septage cleaning from septic tanks due to the project is estimated to be 757 m<sup>3</sup>/year.

**Table 61: Poipet Sanitation Parameters**

| Table 61: Toilet Sanitation Parameters                          |                    |                    |                  |                   |
|---|--------------------|--------------------|------------------|-------------------|
| Item  | Unit               | 2025<br>Short term | 2030<br>Med Term | 2040<br>Long Term |
| <b>Residential</b> ( <i>Domestic + Temporary/Tourist</i> )      |                    |                    |                  |                   |
| Domestic popn   | no.                | 128,335            | 149,354          | 203,561           |
| Temporary Population  |                    | 3,729              | 4,531            | 6,687             |
| SEZ workers   |                    | 7,000              | 8,000            | 8,000             |
| Tourists International population                               |                    | 2,696              | 2,845            | 3,167             |
| Tourists Domestic population                                    |                    | 3,448              | 3,824            | 4,703             |
| <b>Total Residential Population</b>                             |                    | <b>145,208</b>     | <b>168,554</b>   | <b>226,118</b>    |
| <b>1. Population connected to sewer system</b>                  |                    |                    |                  |                   |
| % popn connected  |                    | 12%                | 10%              | 8%                |
| Potential population Connected (domestic, temporary & tourists) | inhab.             | 16,425             | 16,425           | 16,425            |
| Actual popn. Connected  | 75%                | 12,318             | 12,318           | 12,318            |
| No. of connections (pax per hh 5.1)                             | 5.1 no. hh         | 2,415              | 2,415            | 2,415             |
| <b>Total wastewater from Population connected</b>               | <b>153.63 m3/d</b> | <b>1,892</b>       | <b>1,892</b>     | <b>1,892</b>      |
| Flow rate per connection (HH)                                   | m3/d/              | 0.78               | 0.78             | 0.78              |
| <b>2. Commercial, Hotels, Institutions &amp; SEZ</b>            |                    | Tot. No.           | 68               | 68                |
| <b>a. Commercial</b>  |                    |                    |                  |                   |
| Total number  |                    | 7                  | 7                | 7                 |
| Percent connected   |                    | 57%                | 57%              | 57%               |
| Number of connections   | unit               | 4                  | 4                | 4                 |
| Number not connected  |                    | 3                  | 3                | 3                 |
| <b>b. Hotels</b>  |                    |                    |                  |                   |
| Total number  |                    | 26                 | 26               | 26                |
| Percent connected   |                    | 54%                | 54%              | 54%               |
| Number of connections   | unit               | 14                 | 14               | 14                |
| Number not connected  |                    | 12                 | 12               | 12                |
| <b>c. Institutions</b>  |                    |                    |                  |                   |
| Total number  | No.                | 35                 | 35               | 35                |
| Percent connected   | %                  | 80%                | 80%              | 80%               |
| Number of connections   | unit               | 28                 | 28               | 28                |
| Number not connected  | unit               | 7                  | 7                | 7                 |
| <b>d. SEZs</b>  |                    |                    |                  |                   |
| Total number  | No.                | 3                  | 3                | 3                 |
| Percent connected   | %                  | 0%                 | 0%               | 0%                |
| Number of connections   | unit               | 0                  | 0                | 0                 |
| Number not connected  | unit               | 3                  | 3                | 3                 |
| <b>3. Wastewater Generation</b>                                 |                    |                    |                  |                   |



| Item   |        | Unit | 2025       | 2030     | 2040      |
|--|--------|------|------------|----------|-----------|
|  |        |      | Short term | Med Term | Long Term |
| Total WW generated FWOP (for all popn)           | 115    | m3/d | 22,310     | 25,897   | 34,741    |
| Wastewater in sewerage system (fwp)              | 153.64 | m3/d | 1,892      | 1,892    | 1,892     |
|  | lpcd   | m3/y | 690,755    | 690,755  | 690,755   |
| Percent of Total WW generated in Sewerage System |        |      | 8%         | 7%       | 5%        |

Source: Egis, 2021

### 4.3. Economic Costs

190. **Capex.** The estimated cost for civil works and mechanical and equipment for the sanitation component in Poipet is \$40.16 million (including civil works, equipment, but excluding consulting services, VAT, physical contingency and price contingency). Total direct economic capital costs for the wastewater sanitation subproject are \$46.34 million (allowing for costs associated with design and supervision and physical contingency but excluding tax and price contingency), with implementation scheduled from 2022 to 2027 (expenditure in 2026 and 2027 is minimal are mostly relates to the handover and commissioning of the new facilities). Allowance is included in the capex cost for the periodic replacement of assets with a shorter economic life – trucks, pumps and electrical equipment.

191.. **Equipment replacement.** The cost of equipment that will require replacement after 10 years' service totals \$0.622 million.

192.. **Salvage value.** Because the project period is only 20 years limited by the population projections cutoff at 2040, a salvage value is included to allow for the remaining value of the new assets created by the project. The asset life assumed for the various components is shown in the table below.

**Table 62: Economic Life of Urban Infrastructure Assets**

| Equipment macro-categories | Component                | Equipment categories              | Asset life duration (years) |
|----------------------------|--------------------------|-----------------------------------|-----------------------------|
| Trucks and vehicles        | - Sewerage               | Trucks and vehicles               | 10                          |
|                            | - Drainage               |                                   |                             |
|                            | - Solid waste management |                                   |                             |
| Pumping station            | - Sewerage               | Electric/hydraulic equipment      | 10                          |
|                            |                          | Concrete structures               | 50                          |
| Treatment plants           | - WWTP                   | Electric/hydraulic equipment      | 10                          |
|                            | - Solid waste management | Concrete structures and buildings | 50                          |
| Pipe network               | - Sewerage               | PVC gravity pipes                 | 40                          |
|                            | - Drainage               | HDPE force mains                  | 40                          |
|                            |                          | Box culverts                      | 50                          |

Source: Egis, 2021

193. Applying these values to the sanitation assets for a 20-year project life indicates that the end of project salvage value is 55% or the original cost. This value is included as a benefit for the project in 2040.

194. **Opex.** The annual O&M costs vary according to the increasing volume of wastewater collected each year that is handled through the pump stations and the WWTW. Applying the



same SERF and SWRF factors as for the conversion of Capex to economic prices generates an CF for the Opex of 0.99, as shown below with an economic cost of \$558,231 per year.

Table 63: Sanitation Opex Economic Price Conversion

| Total Sewer Network, PSs & WWTP<br>OPEX     |                | Economic Pricing Conversion Factors |               |                   |                  |                     |          |                |             |
|---|----------------|-------------------------------------|---------------|-------------------|------------------|---------------------|----------|----------------|-------------|
|   |                | SERF                                | CF            | CF                | SWRF             | CF                  |          |                |             |
|   |                | 1.00                                | 1.00          | 1.00              | 0.60             | -                   |          |                |             |
| Item  | Total          | Loc %                               | FE %          | Locally<br>traded | Skilled<br>labor | Unskilled<br>labour | Tax      | Total          | CF          |
| <b>Sewer Network &amp; Pumping Stations</b> |                |                                     |               |                   |                  |                     |          |                |             |
| 1. Personnel                                | 82,800         | 100%                                | 0%            | 0%                | 95%              | 5%                  | 0%       | 100%           | 100%        |
| 2. Energy                                   | 90,443         | 85%                                 | 15%           | 85%               | 0%               | 0%                  | 0%       | 100%           | 100%        |
| 3. Operation & Maintenance                  | 44,281         | 80%                                 | 20%           | 80%               | 0%               | 0%                  | 0%       | 100%           | 100%        |
| <b>Total</b>                                | <b>217,525</b> |                                     | <b>22,347</b> | <b>112,001</b>    | <b>78,660</b>    | <b>2,484</b>        | <b>-</b> | <b>215,869</b> | <b>0.99</b> |
| <b>2.1 WWTP</b>                             |                |                                     |               |                   |                  |                     |          |                |             |
| 1. Personnel                                | 52,800         | 100%                                | 0%            | 0%                | 95%              | 5%                  | 0%       | 100%           | 100%        |
| 2. Energy                                   | 162,409        | 85%                                 | 15%           | 85%               | 0%               | 0%                  | 0%       | 100%           | 100%        |
| 3. Operation & Maintenance                  | 112,650        | 80%                                 | 20%           | 80%               | 0%               | 0%                  | 0%       | 100%           | 100%        |
| <b>Total</b>                                | <b>327,859</b> |                                     | <b>46,891</b> | <b>228,168</b>    | <b>50,160</b>    | <b>1,584</b>        | <b>-</b> | <b>326,803</b> | <b>1.00</b> |
| <b>Total All Sewer, PSs &amp; WWTP</b>      | <b>545,384</b> |                                     |               |                   |                  |                     |          |                |             |
| <b>SEPTAGE</b>                              |                |                                     |               |                   |                  |                     |          |                |             |
| 1. Personnel                                | 7,200          | 100%                                | 0%            | 0%                | 95%              | 5%                  | 0%       | 100%           | 100%        |
| 2. Energy (2 vacuum trucks)                 | 5,280          | 85%                                 | 15%           | 85%               | 0%               | 0%                  | 0%       | 100%           | 100%        |
| 3. Operation & Maintenance (2 trucks)       | 3,223          | 80%                                 | 20%           | 80%               | 0%               | 0%                  | 0%       | 100%           | 100%        |
| <b>Total</b>                                | <b>15,703</b>  |                                     | <b>1,437</b>  | <b>7,067</b>      | <b>6,840</b>     | <b>216</b>          | <b>-</b> | <b>15,559</b>  | <b>0.99</b> |
| <b>Total All</b>                            | <b>561,097</b> |                                     |               |                   |                  |                     |          | <b>558,231</b> | <b>0.99</b> |

Source: Egis, 2021

#### 4.4. Economic Benefits

195. **Saved septic tanks costs.** The progressive connection of households, institutions and commercial establishments to the sewerage system will result in the decommissioning of septic tanks and saving in the future costs of their maintenance and periodic desludging. For those households that have to periodically build a new containment tank when the old tank is full, the cost of the new tank will also be saved. However, most of the households served by the project in the core urban area are assumed to use a non-permeable septic tank that is periodically cleaned out of septage. The economic O&M costs of the existing septic tanks are assumed to be \$5.00 per year for households and \$25 per year for C&Is. The capital value of the septic tanks that will become redundant is assumed to be a sunk cost and is not included as a loss to the owners.

196. **Saved septage costs.** Residential households are assumed to have to empty their septic tanks of septage every three years ( $1\text{m}^3/\text{year}$ ) and C&Is once a year for  $10\text{m}^3/\text{y}$ . This represents a total net saving in septage cleaning of  $250\text{m}^3/\text{y}$  for C&Is and for households  $507\text{m}^3/\text{y}$  remaining constant. The economic cost per  $\text{m}^3$  for septage is taken as \$8.50 / $\text{m}^3$  (HH rate times the SCF of 0.84).

197. **Health benefits.** As discussed earlier in Section 5.7, it is not possible to apportion the overall health benefits from improved sanitation, SWM, and drainage to the individual components as they are interlinked, and an overall health benefit of \$104.56/HH/year is estimated. However, for the purpose of the analysis, a specific health benefit is also allocated to those households that are connected to the new sewer system of \$15.00 per HH per year to allow for the assumed extra benefits they receive through improved hygiene and convenience. For the SEZ workers and tourists, an annual benefit of \$30 and \$2 per person respectively is also included to account for the impact of the improved environment resulting from the project.

### 5. Poipet – Solid Waste Management

#### 5.1. Introduction

198. The proposed LCIP investment focuses on MSW, including household solid waste (hazardous and non-hazardous) and C&I waste. Other solid waste is not considered.

199. The current generation of MSW in Poipet is estimated<sup>25</sup> at 1712 ton per day (tpd) equivalent to 62,416 ton per year (tpy), of which 99 tpd is collected by the official collection operator, 21 tpd is collected by waste pickers and 51 tpd (30%) is not collected.

200. Currently, it is estimated that 84% of the solid waste generated in Poipet is unsafely managed with the household collection coverage of only approximately 16%. Currently, most C&Is waste is collected. A large portion of the MSW is also left uncollected and is dumped directly in the nearby natural environment and/or burnt, making it necessary to improve the collection for the whole city.

201. In terms of collection, door to door collection is preferred in the city center while the centralized collection is suggested in rural areas until these areas are sufficiently developed to allow for door-to-door collection. Source segregation at markets, with a dedicated centralized

<sup>25</sup> Solid Waste Characterization Survey, Egis 2020.

collection point, is an opportunity to increase the sorting of bio-waste and, therefore, the potential for compost production.

202. In terms of treatment, a sorting plant and a composting plant have been identified as the most appropriate technologies to reduce the amount of waste to be deposited in the landfill; to control part of the market for recyclables to increase revenue potential, and to contribute to the climate change mitigation. A controlled landfill is proposed as the most appropriate disposal system for the city to avoid the harmful dumping and burning of waste, to reduce pollution of the groundwater, and to reduce harmful greenhouse gasses (GHG).

203. The proposed short-term horizon investments include:

- (i) Construction of a new controlled landfill with leachate management and landfill gas collection and flare-off design to a 2030 capacity
- (ii) Sorting plant designed to 2040 capacity
- (iii) Compositing plant designed to 2040 capacity
- (iv) Collection: provision of 18 collection trucks for door-to-door collection for urban areas and centralized collection points for rural areas.

## 5.2. Poipet SWM Projections

204. The MSW volumes projected are based on the current collected volume and collection rates estimated during the field assessment. To this baseline is added the estimated new collected households (based on the population projection), as well as the impact of increased tourist arrivals and the creation of new SEZs.

205. Collection rates for hazardous and non-hazardous domestic solid waste and AAGR are noted below:

- (i) Households, institutional and commercial premise:
  - a. Baseline: 64 tpy
  - a. For HHs the collection rate: 16% in 2020, 50% in 2025, 75% in 2030, and 85% in 2040. Increases in the collection rate are applied linearly.
  - b. For the new households the waste production ratio applied is 0.5 kg/cap/day. An average annual growth rate of 1% is applied on this ratio to integrate an increase in purchasing power associated with dynamic local economic growth.
- (ii) SEZs:
  - a. Baseline: 2 tpy
  - b. Collection rate: 30% in 2020 and 100% in 2025.
  - c. An average annual growth rate of 1.5% is proposed until 2030 due to high sector dynamism. The AAGR is applied on the baseline from 2020 and then decreases with an AAGR of 1% between 2030 and 2040.
- (iii) Markets:
  - a. Baseline: 17 tpy
  - b. An average annual growth rate of 0.5% is applied due to the increase in purchasing power associated with dynamic local economic growth.
- (iv) Casinos:
  - a. Baseline: 16 tpy
  - b. An average annual growth rate of 0.5% is applied due to the increase in purchasing power associated with dynamic local economic growth.

206.. It is assumed that the waste flow collected by the waste pickers in the streets before the official collection is equivalent to 12% of the total waste generation flow.

207.. Table 65 below summarizes the projected MSW production and the collection percentage and volume for the different categories – households, commercial establishments, hotels and casino, markets, and the SEZs. Currently, average daily waste production is estimated to be 171/d (62,216 t/y). Of the other categories, all have 100% collection currently except for institutions at 85% and the SEZs at 30%.

**Table 64: Poipet MSW Generation and Collection Projections**

| Items   | Unit/year     | 2020           | 2025           | 2030           | 2040           |
|---|---------------|----------------|----------------|----------------|----------------|
| <b>Total Population in Poipet</b>                               | <b>inhab.</b> | <b>124,244</b> | <b>145,209</b> | <b>168,554</b> | <b>226,118</b> |
| <i>Permanent population</i>                                     | <i>inhab.</i> | <i>110,510</i> | <i>128,335</i> | <i>149,354</i> | <i>203,561</i> |
| <i>SEZ's workers</i>  | <i>inhab.</i> | <i>5,000</i>   | <i>7,000</i>   | <i>8,000</i>   | <i>8,000</i>   |
| <i>Tourists</i>   | <i>inhab.</i> | <i>8,734</i>   | <i>9,874</i>   | <i>11,200</i>  | <i>14,557</i>  |
| <b>Households, institutional, and commercial (collected)</b>    | <b>tpd</b>    | <b>64</b>      | <b>89</b>      | <b>115</b>     | <b>148</b>     |
| <b>Household collection rate</b>                                |               | 16%            | 50%            | 75%            | 85%            |
| <b>Household collected</b>                                      | <b>tpd</b>    | <b>9.09</b>    | <b>33.02</b>   | <b>57.71</b>   | <b>89.36</b>   |
| <b>Commercial collected (10% balance)</b>                       |               | <b>27.46</b>   | <b>27.99</b>   | <b>28.65</b>   | <b>29.32</b>   |
| <b>Institutional collected (90% balance)</b>                    |               | <b>27.46</b>   | <b>27.99</b>   | <b>28.65</b>   | <b>29.32</b>   |
| <i>Waste production (AAGR)</i>                                  | %             |                | 0.50%          | 0.50%          | 0.50%          |
| <b>SEZ (collected)</b>  | <b>tpd</b>    | <b>2</b>       | <b>5</b>       | <b>6</b>       | <b>6</b>       |
| <i>Waste production (AAGR)</i>                                  | %             |                | 1.50%          | 1.50%          | 1.00%          |
| <i>Collection rate</i>  | %             | 30%            | 100%           | 100%           | 100%           |
| <b>Market (collected)</b>                                       | <b>tpd</b>    | <b>17</b>      | <b>17</b>      | <b>18</b>      | <b>19</b>      |
| <i>Waste production (AAGR)</i>                                  | %             |                | 0.50%          | 0.50%          | 0.50%          |
| <i>Collection rate</i>  | %             | 100%           | 100%           | 100%           | 100%           |
| <b>Casinos (collected)</b>                                      | <b>tpd</b>    | <b>16</b>      | <b>17</b>      | <b>18</b>      | <b>21</b>      |
| <i>Waste production (AAGR)</i>                                  | %             |                | 0.50%          | 0.50%          | 0.50%          |
| <i>Collection rate</i>  | %             | 100%           | 100%           | 100%           | 100%           |
| <b>Sub-Total collected waste flow</b>                           | <b>tpd</b>    | <b>99</b>      | <b>128</b>     | <b>157</b>     | <b>194</b>     |
| <b>Sub-Total collected waste flow</b>                           | <b>tpy</b>    | <b>36,135</b>  | <b>46,800</b>  | <b>57,089</b>  | <b>70,517</b>  |
| <b>Sub-Total not collected waste flow</b>                       | <b>tpy</b>    | <b>18,791</b>  | <b>12,612</b>  | <b>7,325</b>   | <b>5,971</b>   |
|   | <b>tpd</b>    | <b>51</b>      | <b>35</b>      | <b>20</b>      | <b>16</b>      |
| <b>Total waste flow</b>   | <b>tpy</b>    | <b>54,926</b>  | <b>59,412</b>  | <b>64,414</b>  | <b>76,488</b>  |
| <b>Sub-Total collected before the official collection (12%)</b> | <b>tpy</b>    | <b>7,490</b>   | <b>8,102</b>   | <b>8,784</b>   | <b>10,430</b>  |
|   | <b>t/d</b>    | <b>21</b>      | <b>22</b>      | <b>24</b>      | <b>29</b>      |
| <b>Total waste generation</b>                                   | <b>tpy</b>    | <b>62,416</b>  | <b>67,513</b>  | <b>73,198</b>  | <b>86,919</b>  |
|   | <b>t/d</b>    | <b>171</b>     | <b>185</b>     | <b>201</b>     | <b>238</b>     |

Source: Egis, 2021

### 5.3. Poipet SWM Capex

208. The total capex base cost for the proposed SWM investment for Poipet is \$12.25 million. Costs include civil works, equipment but excludes consulting services VAT, physical contingency and price contingency.

209. The cost of equipment that will require replacement after 10 years' service totals \$3.3 million.

210. **Economic costs.** The conversion of the financial cost to their economic value is \$17.11 million after allowing for design and supervision and physical contingency but excluding tax and price contingency.

211. **Salvage values.** Because the project period is only 20 years limited by the population projections cutoff at 2040, a salvage value is included to allow for the remaining value of the new assets created by the project. The asset life assumed for the various components is shown in the table below.

**Table 65: Economic Life of Urban Infrastructure Assets**

| Equipment macro-categories | Component                | Equipment categories              | Asset life duration (years) |
|----------------------------|--------------------------|-----------------------------------|-----------------------------|
| <b>Trucks and vehicles</b> | - Sewerage               | Trucks and vehicles               | 10                          |
|                            | - Drainage               |                                   |                             |
|                            | - Solid waste management |                                   |                             |
| <b>Pumping station</b>     | - Sewerage               | Electric/hydraulic equipment      | 10                          |
|                            |                          | Concrete structures               | 50                          |
| <b>Treatment plants</b>    | - WWTP                   | Electric/hydraulic equipment      | 10                          |
|                            | - Solid waste management | Concrete structures and buildings | 50                          |
| <b>Pipe network</b>        | - Sewerage               | PVC gravity pipes                 | 40                          |
|                            | - Drainage               | HDPE force mains                  | 40                          |
|                            |                          | Box culverts                      | 50                          |

Source: Egis, 2021

212. Applying these values to the sanitation assets for a 20-year project life indicates that the end of project salvage value is 55% or the original cost. This value is included as a benefit for the project in 2040.

### 5.4. Poipet SWM Opex

213. Opex costs in 2025/6 are \$1.707 m, as shown below. Collection costs are the biggest component accounting for 52% followed by the sorting plant at 31%. Fixed costs make up 64%. Opex costs increase in line with the volume of solid waste collected and processed. Opex costs are in economic values are similar.

**Table 66: Poipet SWM Opex Costs**

| Component         | Fixed \$         | Variable \$    | Total \$         | % of tot    |
|-------------------|------------------|----------------|------------------|-------------|
| Landfill          | 131,562          | 43,200         | 174,762          | 10%         |
| Sorting plant     | 299,689          | 228,000        | 527,689          | 31%         |
| Composting plant  | 87,720           | 24,000         | 111,720          | 7%          |
| Collection        | 572,339          | 320,400        | 892,739          | 52%         |
| <b>TOTAL</b>      | <b>1,091,311</b> | <b>615,600</b> | <b>1,706,911</b> | <b>100%</b> |
| <b>% of Total</b> | <b>64%</b>       | <b>36%</b>     | <b>100%</b>      | <b>0%</b>   |

Source: Egis, 2021

## 5.5. SWM Benefits

214. **Saved cost of uncollected waste.** Currently, only 16% of the solid waste generated by households is collected, and households have to make their own arrangements for disposing of their waste – in open land, drains, and discarded on the roadside -, and provide their own containers and bags for disposal. These costs will be saved with the introduction of collection services with the project. The average cost per m<sup>3</sup> for this saving is assumed to be \$5.00/m<sup>3</sup>.

215. **Saved collection costs FWOP.** The project will introduce a rubbish collection service which will replace the existing collection service that currently collects an estimated 58% of the solid waste. The cost of the existing service can be offset against the Opex costs of the project-funded services. An average collection cost of \$14.85/m<sup>3</sup> based on the estimated collection cost for the new system introduced by the project is allowed for this item.

216. **Value of recyclables.** The project will fund a sorting plant that will allow the recovery of valuable recyclable material that otherwise would be deposited in the landfill. The volume of recyclable material in 2025 and the assumed prices are shown below. The price is based on the current stated values as indicated by a survey conducted in January 2020 in Poipet and are related to international prices. The amount of recyclable material increases in line with the volume of solid waste collected. The volume of waste that can be recycled allows for the material that is already be sorted and recycled. A 5% reduction in economic benefits is allowed for an increase in the amount of the recyclable material assumed to be sorted and sold in the FWOP situation.

**Table 67: Poipet Volume of Recyclables**

| Recyclables              | unit | 2025         | 2030         | 2040         | Value \$/t |
|--------------------------|------|--------------|--------------|--------------|------------|
| PET bottle               | t/y  | 1,413        | 1,695        | 2,114        | 150        |
| HDPE (shampoo bottles)   | t/y  | 332          | 399          | 497          | 150        |
| Plastic bags and films   | t/y  | 3,257        | 3,906        | 4,873        | 0          |
| Plastic glass            | t/y  | 403          | 483          | 603          | 200        |
| Cans                     | t/y  | 161          | 193          | 241          | 1000       |
| Iron metals              | t/y  | 305          | 366          | 457          | 200        |
| <b>Total Tonnage</b>     | t/y  | <b>5,871</b> | <b>7,042</b> | <b>8,785</b> |            |
| Biowaste/ green waste    | t/y  | <b>3,792</b> | <b>5,486</b> | <b>6,183</b> |            |
| <b>Waste to Landfill</b> | t/y  | 36,996       | 44,781       | 55,543       |            |
| Compost                  | t/y  | 758          | 1,646        | 1,855        | 175        |

Source: Egis, 2021

217. **Value of compost.** Biowaste and green waste collected from the markets and from households and C&Is will be converted to compost for sale to the local agricultural sector. The conversion rate of biowaste to compost is 30%, and the price of compost is assumed to be \$175/t based on the current market in Thailand. The economic benefit from compost is reduced by 5% to allow for the current use of biowaste for animal feed and compost in the FWOP situation.

218. **Carbon credit for GHGs.** The operation of the new landfill is designed to cover the waste and capture landfill gases, which will be flared off, converting the more harmful methane CO<sub>4</sub> portion to less harmful CO<sub>2</sub>. The production of the landfill gas resulting from the consolidation of waste in the new landfill under anerobic conditions is projected to progressively increase from 21m<sup>3</sup>/h in 2025 to 184m<sup>3</sup>/h by 2040 as the landfill gets bigger. Landfill gas is composed of 50% methane and 50% CO<sub>2</sub> by volume. Methane is a potent greenhouse gas 28 to 36 times more effective than CO<sub>2</sub> at trapping heat in the atmosphere over a 100-year period (IPPC AR5). The

conversion of methane to the less harmful CO<sub>2</sub> through burning that otherwise would escape to the atmosphere can be included as an economic benefit and valued at the price of carbon saved.<sup>26</sup> Burning methane produces 2.75 the weight of CO<sub>2</sub>, but as CO<sub>4</sub> is 25 times more harmful than CO<sub>2</sub>, there will be a net gain on GHG emissions of 9 for every unit of CO<sub>4</sub> that is flared off at the landfill.

219. It is assumed that 70% of landfill gases are captured and converted to CO<sub>2</sub>. This results in a saving of carbon valued at \$59,380 per year in 2025, progressively rising to \$680,620 per year by 2040 allowing for a social value of carbon of \$43.20/t in 2020 and a 2% inflation of the price of carbon per year in real terms thereafter. The table below shows the calculation of the economic benefit of capturing landfill gasses and reducing the amount of methane that is released into the atmosphere.

**Table 68: Poipet Landfill Green House Gasses Capture**

| Item                       | Unit                         | 2025          | 2030           | 2040           |
|----------------------------|------------------------------|---------------|----------------|----------------|
| Landfill gas (theory)      | m3/h                         | 31            | 108            | 264            |
| Landfill gas (design)      | m3/h                         | 21            | 76             | 184            |
| Landfill gas (actual)      | m3/y                         | 190,092       | 662,256        | 1,618,848      |
| Weight of LFG              |                              |               |                |                |
| CO <sub>4</sub>            | t/y                          | 62            | 215            | 526            |
| CO <sub>2</sub>            | t/y                          | 175           | 608            | 1,486          |
| GHG - CO <sub>4</sub>      | t CO <sub>2</sub> equivalent | 1,544         | 5,381          | 13,153         |
| - CO <sub>2</sub>          | t CO <sub>2</sub> equivalent | 175           | 608            | 1,486          |
| Total GHG                  | t CO <sub>2</sub> equivalent | 1,719         | 5,989          | 14,639         |
| GHG after burning          |                              |               |                |                |
| CO <sub>4</sub>            | t CO <sub>2</sub>            | 170           | 592            | 1,447          |
| CO <sub>2</sub>            | t CO <sub>2</sub>            | 175           | 608            | 1,486          |
| Total CO <sub>2</sub>      | t CO <sub>2</sub>            | 344           | 1,200          | 2,933          |
| GHG/CO <sub>2</sub> saving | t CO <sub>2</sub>            | 1,375         | 4,789          | 11,706         |
| <b>Value carbon credit</b> | <b>\$/y 2020 real terms</b>  | <b>59,383</b> | <b>206,882</b> | <b>505,712</b> |

| Item   | CO <sub>4</sub> | CO <sub>2</sub>                |
|--|-----------------|--------------------------------|
| kg/m3  | 0.65            | 1.836                          |
| LFG composition                              | 50%             | 50%                            |
|  |                 | <b>70%</b>                     |
| LFG capture efficiency                       | 70%             | <b>(range from 60% to 90%)</b> |
| GHG ratio                                    | 25              | 1                              |
| CO <sub>2</sub> from burning CO <sub>4</sub> |                 | 2.75                           |
| Carbon credit value 2020                     |                 | 43.20                          |

Source: Egis, 2021

## 6. Poipet – Stormwater Drainage

### 6.1. Introduction

220. Currently urban flooding is a recurring problem for the city center of Poipet and surrounding the market because of the inadequate existing urban drainage. However, some relief

<sup>26</sup> According to the ADB guidelines for Economic Evaluation of Projects 2017 based on a value of GHG of \$36.30/t in 2016 price terms and \$43.20/t in 2020, inflated by 2% per year in real terms to allow for potential of increasing marginal damage of global warming over time.



will be provided by the new box-culverts lines being constructed as part of the ADB GMS1 program. Other streets and upstream areas (northeast of the city center) in the built-up area will continue to experience floods.

221. Construction of new buildings such as hotels, shopping malls, casinos, and parking areas resulting from economic expansion of the city will continue to exacerbate the situation through the increase in impermeable hard surfaces with the result that runoff rates will increase and cause more localized flooding on streets and around buildings in low-lying areas.

## 6.2. Proposed Drainage Network

222. The proposed drainage network is planned to accommodate a 1 in 5 flood event. The proposed short-term works is to extend street drainage to cover all of the existing built-up areas near the Thai border and integrating coverage with the GMS1 drainage construction. This will include approximately 41 km of primary drainage.

223. The new system relies on gravity, with no pumping, and follows the natural topography and discharges at low points of the road. As much as possible, the few existing cross-drains will be reused to limit the cost of road cutting and reinstatement.

224. In urban areas, in order to minimize the risk of blockage by solid waste, problems related to resettlement, and to limit future urban development constraints, an underground drainage network (box-culvert) will be prioritized.

225. With the proposed sewerage project, all illegal connections of the sewer to the drainage network shall be removed to ensure the separation of stormwater and sewerage. A prevention campaign shall also be carried out with local companies to avoid any discharge of industrial waste in the drainage system, particularly petrol stations, hotels, and restaurants.

226. The proposed coverage and the number of households and C&Is that will be served by the new drainage system are shown below.

**Table 69: Poipet - Drainage System Coverage**

| Item  | Unit       | 2025<br>Priority<br>Area | 2025<br>Short<br>term | 2030<br>Medium<br>term | 2040<br>Long<br>term |
|---|------------|--------------------------|-----------------------|------------------------|----------------------|
| <b>Population covered by Drainage System</b>  |            |                          |                       |                        |                      |
| <b>Total Population of the City</b>           | no.        | <b>145,208</b>           | <b>145,208</b>        | <b>168,554</b>         | <b>226,118</b>       |
| Population covered by drainage system         |            | 13,916                   | 14,521                | 32,025                 | 42,962               |
| Percent covered                               |            | 10%                      | 10%                   | 19%                    | 19%                  |
| <b>Number of HHs covered</b>                  | <b>5.1</b> | <b>2,729</b>             | <b>2,847</b>          | <b>6,279</b>           | <b>8,424</b>         |
| <b>Commercial &amp; Institutional covered</b> |            |                          |                       |                        |                      |
| 1. Commercial number covered                  |            | 4                        | 5                     | 6                      | 7                    |
| 2. Hotels Number covered                      | no.        | 14                       | 23                    | 25                     | 26                   |
| 3. Institutions number covered                | no.        | 28                       | 27                    | 29                     | 31                   |
| 4. SEZ number covered                         |            | 0                        | 2                     | 3                      | 3                    |
| <b>Total covered</b>                          |            | <b>46</b>                | <b>57</b>             | <b>63</b>              | <b>67</b>            |

Source: Egis, 2021

### 6.3. Poipet Stormwater Drainage Capex

227. **Economic costs.** The total cost of the proposed drainage works is \$17.6 million, including civil works, equipment, but excluding consulting services, VAT, physical and price contingency. Implementation would be over four years, starting in 2022. Capex are converted to economic prices at the SCF of 0.84. In economic terms after the conversion from financial prices the cost is \$20.50 million.

228. **Equipment replacement costs.** The cost of equipment that will require replacement after 10 years' service totals \$0.302 million.

229. **Salvage value.** Because the project period is only 20 years limited by the population projections cutoff at 2040, a salvage value is included to allow for the remaining value of the new assets created by the project. The asset life assumed for the various components is shown in the table below.

**Table 70: Economic Life of Urban Infrastructure Assets**

| Equipment macro-categories | Component                | Equipment categories              | Asset life duration (years) |
|----------------------------|--------------------------|-----------------------------------|-----------------------------|
| <b>Trucks and vehicles</b> | - Sewerage               | Trucks and vehicles               | 10                          |
|                            | - Drainage               |                                   |                             |
|                            | - Solid waste management |                                   |                             |
| <b>Pumping station</b>     | - Sewerage               | Electric/hydraulic equipment      | 10                          |
|                            |                          | Concrete structures               | 50                          |
| <b>Treatment plants</b>    | - WWTP                   | Electric/hydraulic equipment      | 10                          |
|                            | - Solid waste management | Concrete structures and buildings | 50                          |
| <b>Pipe network</b>        | - Sewerage               | PVC gravity pipes                 | 40                          |
|                            | - Drainage               | HDPE force mains                  | 40                          |
|                            |                          | Box culverts                      | 50                          |

Source: Egis, 2021.

230. Applying these values to the sanitation assets for a 20-year project life indicates that the end of project salvage value is 59% of the original cost. This value is included as a benefit for the project in 2040.

### 6.4. Poipet Stormwater Opex

231. The annual O&M costs for the new drainage system is estimated to be \$44,020 per year in 2025, as summarized below. The annual costs are assumed to be constant over the project life. These costs also allow for the Opex of the drainage works constructed by the GSM project.

232. The annual O&M costs are converted to their economic values by applying the SCF for Opex of 0.99.

**Table 71: Poipet Stormwater Opex**

| Item                      | Unit     | Unit rate  | Quantity | Cost (KHR/year)    | Cost (\$/year) |
|---------------------------|----------|------------|----------|--------------------|----------------|
| <b>1. Personnel</b>       |          |            |          |                    |                |
| Technician                | KHR/year | 24,570,000 | 3        | 73,710,000         | 18,000         |
| Team leader               | KHR/year | 39,312,000 | 1        | 39,312,000         | 9,600          |
|                           |          |            |          | <b>113,022,000</b> | <b>27,600</b>  |
| <b>2. Fuel and energy</b> |          |            |          |                    |                |

|                                 |          |            |   |                    |               |
|---------------------------------|----------|------------|---|--------------------|---------------|
| Fuel for pick-up trucks         | KHR/year | 2,576,000  | 2 | 5,152,000          | 1,258         |
| Fuel for Shovel/Excavator       | KHR/year | 20,125,000 | 1 | 20,125,000         | 4,915         |
| Fuel for Utility truck          | KHR/year | 3,220,000  | 1 | 3,220,000          | 786           |
|                                 |          |            |   | <b>28,497,000</b>  | <b>6,959</b>  |
| <b>3. Maintenance</b>           |          |            |   |                    |               |
| General maintenance             | KHR/year | 38,741,976 | 1 | 38,741,976         | 9,761         |
| <b>Total Stormwater network</b> |          |            |   | <b>180,260,976</b> | <b>44,020</b> |

Source: Egis, 2021.

## 6.5. Stormwater Economic Benefits

233. The development of an efficient stormwater and drainage system will contribute to the improvement of the living conditions in the city by reducing the negative impact and costs of flooding during heavy rain and reducing the associated health risks. Overall making the city more conducive for continuing economic development and more attractive to tourists.

234. The direct cost to households through flooding incidents was investigated in the CCS, as discussed in the preceding section. For Poipet, it is estimated the average annual cost per household caused by flooding and the associated loss of productivity is \$150 per year. An economical cost of \$250 per C&I is also allowed for those C&Is that will benefit directly from the coverage of the new drainage system.

235. The stormwater drainage infrastructure is non-revenue generating as there are no direct tariffs or user-pays fees for the drainage network. The O&M cost will be borne by the municipal administration or the line agency (MPWT) responsible for maintaining the system. This cost will be funded indirectly through the funds provided to the municipal administration by central government, or potentially by local property taxes and business fees.

236. **FWOP cost saving.** The expenditure for O&M of the current drainage system is very low and is not quantified. However, for the purpose of the analysis, a nominal cost of \$5,000 per year of the saved costs for the FWPO situation is included to allow for clearing of drains and irregular maintenance by the city and local residents.

## 7. Tourism Benefit

237. Section VI, Chapter 3.7 above discussed the impact of the project on tourism and how the economic benefits of the increase in international tourists to Poipet as a result of the project are quantified. The economic benefit from tourism has been valued at the marginal increase in expenditure by international tourists to Poipet assuming a 20% increase in the average growth of international tourists over the historical growth 2016 – 2018. Based on an average length of stay of 2.0 days and daily expenditure of \$33 per day 15% of their increased expenditure is counted as the marginal economic benefit allowing for the input costs associated with their expenditure. For Poipet this amounts to an additional growth due to the project of 0.15% per year and net annual benefit of \$6,926 per year. It is assumed that this growth persists for 10 years after project completion. No economic benefit is allowed for an increase in domestic tourists resulting from the project as it is assumed that any increase in domestic tourism expenditure only contributes to the regional economy and has no benefit to the national economy.

## 8. Reduction in Undesirable Pollutants

238. As discussed in Section 3.8 above, the positive environmental impact of reducing the amount of untreated wastewater and septic tank outflow to the environment is a major benefit of wastewater and septage treatment to be developed by the project. The improvement in the collection and treatment of MSW also contributes to a reduction in pollution of ground water, especially through the containment of leachate from a dumpsite as a result of a controlled landfill.

239. For Poipet the reduction in the volume of undesirable pollutants (BOD, COD, SS, N and P) that is attributed to the project is estimated to the 2,207 t/y by comparing the fwp and fwop situations. A summary is shown in the table below. The reduction represents 18% of the amount of pollutants produced in the without project situation.

**Table 72: Poipet Reduction in Undesirable Pollutants**

| Pollutant        | 2020          | 2025 (fwp)    | 2025 (fwop)   | 2025 (fwop-fwp) | Reduction % |
|------------------|---------------|---------------|---------------|-----------------|-------------|
|                  | t/y           | t/y           | t/y           | t/y             |             |
| <b>BOD</b>       | 2,493         | 2,562         | 2,914         | -351            | -14%        |
| <b>COD</b>       | 5,774         | 5,706         | 6,749         | -1,043          | -18%        |
| <b>TSS</b>       | 3,440         | 3,320         | 4,021         | -701            | -21%        |
| <b>TN</b>        | 566           | 572           | 662           | -90             | -16%        |
| <b>TP</b>        | 102           | 96            | 119           | -23             | -23%        |
| <b>Total t/y</b> | <b>12,376</b> | <b>12,257</b> | <b>14,465</b> | <b>-2,207</b>   | <b>-18%</b> |

Source: Egis, 2021

240. The value of the undesirable pollutants depends on the type of water body they will be discharged to. For Poipet this is assumed to be a combination of wetland and river resulting in the value per kg as shown below.

**Table 73: Poipet Value of Undesirable Pollutants**

| Effluent destination | Nitrogen (N) | Phosphorus (P) | Suspended solids (SS) | Biological oxygen demand (BOD) | Chemical oxygen demand (COD) |
|----------------------|--------------|----------------|-----------------------|--------------------------------|------------------------------|
| River/ wetland 50%   | 56.12        | 92.48          | 0.01                  | 0.10                           | 0.15                         |

Note: \$/kg; constant 2020 prices

Source: Egis, 2021

241. The total economic benefit from the reduction of pollutants is \$7.312 m per year, which is assumed to remain constant over the project life. The biggest contribution is from the reduction in N and P.

## 9. Impact on GDP

242. The project is expected to result in a more livable city for the residents and the commercial sector, and as a result of the improved urban infrastructure through investment in sanitation, SWM, and drainage, the local environment will be more conducive to business and growth of the local economy, than would be the case in the future without project situation. Local economic performance is measured by the contribution to Gross Domestic Product (GDP), which is a

measure of all economic activity goods and services contributing to the economy during a period of time (usually a year).

243. It is expected that the establishment of a more livable city that has improved public utilities will be more attractive to business development and have a high GDP than would be the case without the project so that the change in the growth of GDP in the future between the fwp and fwop situation is an economic benefit that encompasses the totality of all the impacts of the project.

244. However, because of the difficulty of quantifying the impact of the project on GDP and in separating GDP from the other quantified benefits, the impact on GDP has not been included in the economic analysis as a benefit. The direct economic benefits of the project are captured through the benefits resulting through the reduction in expenditure on health, lost productivity, the increased value of recycled material, reduction in flooding, etc.

## 10. Results of Overall Economic Analysis

245. As discussed in the earlier section, economic analysis has been conducted from the perspective of the overall combined project for Poipet.

246. The results of the overall economic analysis including the share of Output 1 and 3 indicates an EIRR of 9.7% with an NPV at an OCC of 9% of \$3.40 m. This result meets ADB's hurdle of a 9% EIRR.

247. Summary tables of the CBA for the overall Poipet LCIP and for the urban infrastructure alone are presented in the following tables. The main project parameters – capital costs, Opex costs, and the benefits have been tested to show the sensitivity of the analysis to changes in these items and to indicate their switching values, the percentage change needed to increase the EIRR to 9%.

**Table 74: Poipet Results of Sensitivity Analysis**

|                  | Change | EIRR | \$ mil | EIRR % SV |
|------------------|--------|------|--------|-----------|
| <b>Base case</b> |        | 9.7% | 3.40   |           |
| <b>Capital</b>   | 20%    | 7.7% | -7.31  | 7%        |
| <b>O&amp;M</b>   | 20%    | 9.2% | 0.82   | 26%       |
| <b>Benefits</b>  | -20%   | 6.6% | -10.58 | 5%        |

SV = switching value

Source: Egis, 2021

248. The sensitivity analysis indicates that Capex would have to increase by 7%, O&M costs by 26%, and the benefits to decrease by 5% to reduce the EIRR to 9%. The project is sensitive to changes in these parameters. The economic value of the reduction of undesirable pollutants is the main economic benefit and has the biggest impact on the economic return. A 50% reduction in the value of the pollutants reduces the EIRR to 5.7%.

**Table 75: Poipet LCIP Economic Analysis Summary****ECONOMIC ANALYSIS RESULTS****Feasibility Study of Livable Cities Investment Project - Poipet**

|                            |          |                  |             | Net Benefit<br>(Cost) |          | Sensitivity |          |          |            |
|----------------------------|----------|------------------|-------------|-----------------------|----------|-------------|----------|----------|------------|
|                            |          | Economic<br>Cost |             |                       | Base     | Investmt    | O&M      | Benefit  | 1-yr Delay |
| Year                       | Capex    | Opex             | Total Costs | Benefits              | Case     | 20%         | 20%      | -20%     | in Benefit |
|                            | \$'000   | \$'000           | \$'000      | \$'000                | \$'000   | \$'000      | \$'000   | \$'000   | \$'000     |
| 1 2021                     | -        | 0                | 0           | 0                     | 0        | 0           | 0        | 0        | 0          |
| 2 2022                     | 1,125    | 0                | 1,125       | 0                     | (1,125)  | (1,349)     | (1,125)  | (1,125)  | (1,125)    |
| 3 2023                     | 19,270   | 0                | 19,270      | 0                     | (19,270) | (23,124)    | (19,270) | (19,270) | (19,270)   |
| 4 2024                     | 27,457   | 0                | 27,457      | 0                     | (27,457) | (32,948)    | (27,457) | (27,457) | (27,457)   |
| 5 2025                     | 33,936   | 0                | 33,936      | 3,723                 | (30,213) | (37,000)    | (30,213) | (30,957) | (33,936)   |
| 6 2026                     | 4,301    | 2,342            | 6,643       | 11,116                | 4,474    | 3,613       | 4,005    | 2,250    | (2,920)    |
| 7 2027                     | 419      | 2,368            | 2,787       | 11,499                | 8,712    | 8,628       | 8,238    | 6,412    | 8,329      |
| 8 2028                     | -        | 2,396            | 2,396       | 11,898                | 9,502    | 9,502       | 9,023    | 7,123    | 9,104      |
| 9 2029                     | -        | 2,424            | 2,424       | 12,312                | 9,888    | 9,888       | 9,403    | 7,426    | 9,474      |
| 10 2030                    | -        | 2,453            | 2,453       | 12,742                | 10,289   | 10,289      | 9,799    | 7,741    | 9,859      |
| 11 2031                    | -        | 2,471            | 2,471       | 12,963                | 10,492   | 10,492      | 9,998    | 7,900    | 10,272     |
| 12 2032                    | -        | 2,488            | 2,488       | 13,187                | 10,698   | 10,698      | 10,201   | 8,061    | 10,474     |
| 13 2033                    | -        | 2,507            | 2,507       | 13,415                | 10,908   | 10,908      | 10,407   | 8,225    | 10,680     |
| 14 2034                    | 2,138    | 2,525            | 4,662       | 13,647                | 8,985    | 8,557       | 8,480    | 6,255    | 8,753      |
| 15 2035                    | -        | 2,543            | 2,543       | 13,883                | 11,340   | 11,340      | 10,831   | 8,563    | 11,104     |
| 16 2036                    | -        | 2,562            | 2,562       | 14,123                | 11,561   | 11,561      | 11,049   | 8,737    | 11,321     |
| 17 2037                    | -        | 2,581            | 2,581       | 14,367                | 11,787   | 11,787      | 11,271   | 8,913    | 11,543     |
| 18 2038                    | -        | 2,600            | 2,600       | 14,616                | 12,016   | 12,016      | 11,496   | 9,093    | 11,768     |
| 19 2039                    | -        | 2,619            | 2,619       | 14,868                | 12,250   | 12,250      | 11,726   | 9,276    | 11,997     |
| 20 2040                    | - 40,307 | 2,638            | (37,669)    | 15,125                | 52,794   | 60,855      | 52,266   | 49,769   | 52,537     |
|                            |          |                  |             | 0                     |          |             |          |          |            |
|                            |          |                  |             | 0                     |          |             |          |          |            |
| 1 1                        | 53,575   | 12,933           | 66,508      | 69,910                | (16,335) | (28,452)    | (39,167) | (36,580) | (69,910)   |
| Discount Rate @ 9% EIRR    |          |                  |             |                       | 9.7%     | 7.7%        | 9.2%     | 6.6%     | 8.0%       |
| ENPV 9%                    |          |                  |             |                       | 3,402    | -7,313      | 816      | -10,580  | -4,846     |
| Sensitivity Indicator EIRR |          |                  |             |                       |          | 14.2        | 3.8      | 21.1     | 57.8       |
| ENPV                       |          |                  |             |                       |          | 15.7        | 3.8      | 20.5     | 59.7       |
| Switching Value EIRR       |          |                  |             |                       |          | 7%          | 26%      | 5%       | 2%         |
| ENPV                       |          |                  |             |                       |          | 6%          | 26%      | 5%       | 2%         |

Source: Egis, 2021

Table 76: Poipet Economic Analysis Cash Flows

| LCIP ECONOMIC ANALYSIS - POIPET                               |                     | US\$'000 in constant 2020 economic prices |               |                  |                  | Exchange Rate KHR: \$ |                  | 4095            |                 |                 |                 |   |                 |                 |                 |                 |                 |                 |                 |                 |                    |               |
|---|---------------------|---|---------------|------------------|------------------|-----------------------|------------------|-----------------|-----------------|-----------------|-----------------|---|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|--------------------|---------------|
|   |                     | 2021                                      | 2022          | 2023             | 2024             | 2025                  | 2026             | 2027            | 2028            | 2029            | 2030            | 2031  | 2032            | 2033            | 2034            | 2035            | 2036            | 2037            | 2038            | 2039            | 2040               |               |
| <b>CAPEX COSTS (economic)</b>                                 |                     |   |               |                  |                  |                       |                  |                 |                 |                 |                 |   |                 |                 |                 |                 |                 |                 |                 |                 |                    |               |
| <b>2. Poipet Improved Urban Services</b>                      |                     | <b>Total \$'000</b>                       |               |                  |                  |                       |                  |                 |                 |                 |                 | Septage truck and Pump replacement                  |                 |                 |                 |                 |                 |                 |                 |                 |                    | Salvage Value |
|   |                     |   |               |                  |                  |                       |                  |                 |                 |                 |                 | Landfill machinery and collection truck replacement |                 |                 |                 |                 |                 |                 |                 |                 |                    |               |
| Wastewater  | 46,339              | 46,338.66                                 | -             | 249.89           | 9,803.62         | 14,985.38             | 19,037.66        | 2,219.47        | 42.65           |                 |                 |   |                 |                 |                 | 621.91          |                 |                 |                 |                 | - 25,074.57        |               |
| Stormwater  | 20,497              | 20,497.14                                 | -             | 216.79           | 4,106.22         | 6,725.79              | 8,427.64         | 1,011.16        | 9.54            |                 |                 |   |                 |                 |                 | 355.92          |                 |                 |                 |                 | - 12,097.13        |               |
| Solid Waste Management  | 17,105              | 17,105.36                                 | -             | 216.79           | 6,463.85         | 4,358.39              | 5,383.84         | 672.96          | 9.54            |                 |                 |   |                 |                 |                 | 3,297.58        |                 |                 |                 |                 | - 9,255.98         |               |
| <b>Total Poipet Urban Infra</b>                               |                     | <b>83,941.15</b>                          | <b>-</b>      | <b>683.47</b>    | <b>20,373.68</b> | <b>26,069.55</b>      | <b>32,849.14</b> | <b>3,903.58</b> | <b>61.73</b>    | <b>-</b>        | <b>-</b>        | <b>-</b>  | <b>-</b>        | <b>-</b>        | <b>-</b>        | <b>4,275.41</b> | <b>-</b>        | <b>-</b>        | <b>-</b>        | <b>-</b>        | <b>- 46,427.67</b> |               |
| <b>1. Policy and Regulatory Environment Improved</b>          |                     |   |               |                  |                  |                       |                  |                 |                 |                 |                 |   |                 |                 |                 |                 |                 |                 |                 |                 |                    |               |
| Poipet Urban Planning   | 1,217               | 1,216.73                                  | -             | 107.41           | 532.20           | 267.47                | 215.80           | 67.09           | 26.77           |                 |                 |   |                 |                 |                 |                 |                 |                 |                 |                 |                    |               |
| <b>3. Institutional Effectiveness and Governance Improved</b> |                     |   |               |                  |                  |                       |                  |                 |                 |                 |                 |   |                 |                 |                 |                 |                 |                 |                 |                 |                    |               |
| Poipet' share (33.33%)  | 988                 | 988.45                                    | -             | 30.48            | 421.46           | 244.69                | 236.42           | 28.62           | 26.77           |                 |                 |   |                 |                 |                 |                 |                 |                 |                 |                 |                    |               |
| <b>Total Output 1 &amp; 3</b>                                 |                     | <b>2,205.18</b>                           | <b>-</b>      | <b>137.89</b>    | <b>953.66</b>    | <b>512.16</b>         | <b>452.22</b>    | <b>95.71</b>    | <b>53.54</b>    | <b>-</b>        | <b>-</b>        |   |                 |                 |                 |                 |                 |                 |                 |                 |                    |               |
| <b>Total Capex</b>  | <b>\$'000</b>       | <b>86,146.33</b>                          | <b>-</b>      | <b>821.36</b>    | <b>21,327.34</b> | <b>26,581.71</b>      | <b>33,301.36</b> | <b>3,999.29</b> | <b>115.27</b>   | <b>-</b>        | <b>-</b>        | <b>-</b>  | <b>-</b>        | <b>-</b>        | <b>-</b>        | <b>4,275.41</b> | <b>-</b>        | <b>-</b>        | <b>-</b>        | <b>-</b>        | <b>- 46,427.67</b> |               |
| <b>OPEX</b>   | <b>SCF</b>          | 43,994.07                                 |               |                  |                  |                       |                  |                 |                 |                 |                 |   |                 |                 |                 |                 |                 |                 |                 |                 |                    |               |
| <b>POIPET</b>   | 0.99 Economic Price |   |               |                  |                  |                       |                  |                 |                 |                 |                 |   |                 |                 |                 |                 |                 |                 |                 |                 |                    |               |
| Sanitation  |                     |   |               |                  |                  |                       | 1                |                 |                 |                 |                 |   |                 |                 |                 |                 |                 |                 |                 |                 |                    |               |
|   |                     |   |               |                  |                  |                       |                  | 539.93          | 539.93          | 539.93          | 539.93          | 539.93  | 539.93          | 539.93          | 539.93          | 539.93          | 539.93          | 539.93          | 539.93          | 539.93          | 539.93             |               |
| SWM   |                     |   |               |                  |                  |                       |                  | 1,716.03        | 1,742.86        | 1,770.34        | 1,798.46        | 1,827.23  | 1,844.97        | 1,862.88        | 1,880.96        | 1,899.22        | 1,917.65        | 1,936.25        | 1,955.02        | 1,973.96        | 1,993.08           |               |
| Drainage  |                     |   |               |                  |                  |                       |                  | 43.58           | 43.58           | 43.58           | 43.58           | 43.58   | 43.58           | 43.58           | 43.58           | 43.58           | 43.58           | 43.58           | 43.58           | 43.58           | 43.58              |               |
| <b>Total OPEX</b>   | <b>\$'000</b>       | <b>-</b>                                  | <b>-</b>      | <b>-</b>         | <b>-</b>         | <b>-</b>              | <b>2,299.54</b>  | <b>2,326.37</b> | <b>2,353.85</b> | <b>2,381.97</b> | <b>2,410.74</b> | <b>2,428.48</b>                                     | <b>2,446.39</b> | <b>2,464.47</b> | <b>2,482.73</b> | <b>2,501.16</b> | <b>2,519.76</b> | <b>2,538.53</b> | <b>2,557.47</b> | <b>2,576.59</b> | <b>2,595.88</b>    |               |
| <b>TOTAL COSTS</b>  | <b>\$'000</b>       | <b>-</b>                                  | <b>821.36</b> | <b>21,327.34</b> | <b>26,581.71</b> | <b>33,301.36</b>      | <b>6,298.83</b>  | <b>2,441.64</b> | <b>2,353.85</b> | <b>2,381.97</b> | <b>2,410.74</b> | <b>2,428.48</b>                                     | <b>2,446.39</b> | <b>2,464.47</b> | <b>2,482.73</b> | <b>6,776.56</b> | <b>2,519.76</b> | <b>2,538.53</b> | <b>2,557.47</b> | <b>2,576.59</b> | <b>- 43,831.80</b> |               |

Source: Egis, 2021

Table 78 continued..

| LCIP ECONOMIC ANALYSIS - POIPET         |                      | US\$'000 in constant 2020 economic prices |                 |          |             | Exchange Rate KHR: \$ |             |           |           | 4095       |           |           |           |           |           |           |           |           |           |           |           |
|---|----------------------|---|-----------------|----------|-------------|-----------------------|-------------|-----------|-----------|------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
|   |                      | 2021                                      | 2022            | 2023     | 2024        | 2025                  | 2026        | 2027      | 2028      | 2029       | 2030      | 2031      | 2032      | 2033      | 2034      | 2035      | 2036      | 2037      | 2038      | 2039      | 2040      |
| BENEFITS                                |                      |   |                 |          |             |                       |             |           |           |            |           |           |           |           |           |           |           |           |           |           |           |
| GDP                                     |                      |   |                 |          |             |                       |             |           |           |            |           |           |           |           |           |           |           |           |           |           |           |
| Poipet GDP (projected FWOP)             | \$'000/y             | 143,294                                   | 150,459         | 157,982  | 165,881     | 174,175               | 182,884     | 192,028   | 201,630   | 157,982.03 | 222,297   | 233,411   | 245,082   | 257,336   | 270,203   | 283,713   | 297,899   | 312,794   | 328,433   | 344,855   | 362,098   |
| GDP growth FWP                          | \$'000/y             | 143,294                                   | 150,459         | 157,982  | 165,881     | 174,175               | 186,367     | 199,413   | 213,372   | 7,899.10   | 239,724   | 251,710   | 264,295   | 277,510   | 291,385   | 305,955   | 321,252   | 337,315   | 354,181   | 371,890   | 390,484   |
| Marginal GDP growth due to project      | \$'000/y             | -   | -               | -        | -           | -                     | 3,484       | 7,385     | 11,743    | 165,881.13 | 17,427    | 18,298    | 19,213    | 20,174    | 21,183    | 22,242    | 23,354    | 24,521    | 25,748    | 27,035    | 28,387    |
| Total GDP Benefit                       | \$0.00 \$'000/y      |   |                 |          |             |                       |             |           |           |            |           |           |           |           |           |           |           |           |           |           |           |
| SANITATION                              |                      |   |                 |          |             |                       |             |           |           |            |           |           |           |           |           |           |           |           |           |           |           |
| Septage saving                          | 8.5 \$'000/y         |   |                 |          |             | -                     | 7.87        | 7.87      | 7.87      | 7.87       | 7.87      | 7.87      | 7.87      | 7.87      | 7.87      | 7.87      | 7.87      | 7.87      | 7.87      | 7.87      | 7.87      |
| Healthcare saving (connected HHs)       | 15.0 \$'000/y        |   |                 |          |             | -                     | 36.23       | 36.23     | 36.23     | 36.23      | 36.23     | 36.23     | 36.23     | 36.23     | 36.23     | 36.23     | 36.23     | 36.23     | 36.23     | 36.23     | 36.23     |
| Septic tank & cesspit maintenance (HHs) | 5.0 \$'000/y         |   |                 |          |             | -                     | 12.08       | 12.08     | 12.08     | 12.08      | 12.08     | 12.08     | 12.08     | 12.08     | 12.08     | 12.08     | 12.08     | 12.08     | 12.08     | 12.08     | 12.08     |
| Non residential                         | 25.0 \$'000/y        |   |                 |          |             | -                     | 1.15        | 1.15      | 1.15      | 1.15       | 1.15      | 1.15      | 1.15      | 1.15      | 1.15      | 1.15      | 1.15      | 1.15      | 1.15      | 1.15      | 1.15      |
| Total Poipet sanitation                 | \$356.85 \$'000/y    | -   | -               |          |             | -                     | 57.33       | 57.33     | 57.33     | 57.33      | 57.33     | 57.33     | 57.33     | 57.33     | 57.33     | 57.33     | 57.33     | 57.33     | 57.33     | 57.33     | 57.33     |
| SWM                                     |                      |   |                 |          |             |                       |             |           |           |            |           |           |           |           |           |           |           |           |           |           |           |
| Uncollected HH waste saved cost fwop    | t/yr                 |   |                 |          |             |                       | 9,710       | 11,306    | 12,981    | 14,735     | 16,570    | 17,468    | 18,386    | 19,325    | 20,285    | 21,265    | 22,266    | 23,288    | 24,330    | 25,392    | 26,475    |
| Saved HH disposal costs FWOP            | 5.0 \$'000/y         |   |                 |          |             |                       | 48.55       | 56.53     | 64.90     | 73.68      | 82.85     | 87.34     | 91.93     | 96.63     | 101.43    | 106.33    | 111.33    | 116.44    | 121.65    | 126.96    | 132.38    |
| Saved collection costs FWOP             | t/yr                 |   |                 |          |             |                       | 32,798      | 33,012    | 33,225    | 33,437     | 33,648    | 33,967    | 34,285    | 34,603    | 34,920    | 35,238    | 35,554    | 35,871    | 36,187    | 36,503    | 36,813    |
| Saved collection costs FWOP             | 14.85 \$'000/y       |   |                 |          |             |                       | 487.06      | 490.23    | 493.39    | 496.54     | 499.68    | 504.41    | 509.13    | 513.85    | 518.57    | 523.28    | 527.98    | 532.68    | 537.37    | 542.06    | 546.68    |
| Value of recyclables                    | 100% \$'000/y        |   |                 |          |             |                       | 586.86      | 609.37    | 631.88    | 654.39     | 676.90    | 693.68    | 710.45    | 727.23    | 744.00    | 760.78    | 777.55    | 794.33    | 811.10    | 827.88    | 844.65    |
| Value of compost                        | 100% \$'000/y        |   |                 |          |             |                       | 216.87      | 234.65    | 252.44    | 270.23     | 288.02    | 291.67    | 295.33    | 298.99    | 302.65    | 306.31    | 309.97    | 313.63    | 317.29    | 320.95    | 324.61    |
| Value of carbon credit saving SLF       | \$'000/y             |   |                 | -        | -           | 59.38                 | 88.88       | 118.38    | 147.88    | 177.38     | 206.88    | 236.77    | 266.65    | 296.53    | 326.41    | 356.30    | 386.18    | 416.06    | 445.95    | 475.83    | 505.71    |
| - Carbon saving at growth 2% /y         | 2%                   |   |                 |          |             | 1.00                  | 1.02        | 1.04      | 1.06      | 1.08       | 1.10      | 1.13      | 1.15      | 1.17      | 1.20      | 1.22      | 1.24      | 1.27      | 1.29      | 1.32      | 1.35      |
| Value of carbon credit saving SLF       | \$'000/y             |   |                 |          |             | 59.38                 | 90.66       | 123.17    | 156.93    | 192.00     | 228.41    | 266.64    | 306.29    | 347.43    | 390.10    | 434.32    | 480.17    | 527.67    | 576.88    | 627.85    | 680.62    |
| Total Poipet SWM                        | \$11,647.34          | -   | -               |          |             | 59.38                 | 1,430.00    | 1,513.95  | 1,599.55  | 1,686.84   | 1,775.85  | 1,843.73  | 1,913.14  | 1,984.13  | 2,056.74  | 2,131.01  | 2,207.00  | 2,284.74  | 2,364.29  | 2,445.69  | 2,528.93  |
| DRAINAGE                                |                      |   |                 |          |             |                       |             |           |           |            |           |           |           |           |           |           |           |           |           |           |           |
| Number HHs served                       | HHs                  |   |                 | 1,423.61 | 2,135.41    | 2,847                 | 3,468       | 4,121     | 4,808     | 5,527      | 6,279     | 6,494     | 6,708     | 6,923     | 7,137     | 7,352     | 7,566     | 7,781     | 7,995     | 8,210     | 8,424     |
| Number C&Is & SEZ served                | C&Is                 |   |                 |          |             | 57                    | 58          | 59        | 61        | 62         | 63        | 63        | 64        | 64        | 65        | 65        | 65        | 66        | 66        | 67        | 67        |
| Value of saved damage HHs               | \$150.00 \$'000/y    |   |                 |          |             |                       | 520.16      | 618.19    | 721.15    | 829.06     | 941.92    | 974.09    | 1,006.26  | 1,038.42  | 1,070.59  | 1,102.76  | 1,134.93  | 1,167.10  | 1,199.26  | 1,231.43  | 1,263.60  |
| Value of saved damage C&Is              | \$250.00 \$'000/y    |   |                 |          |             |                       | 14.55       | 14.85     | 15.15     | 15.45      | 15.75     | 15.85     | 15.95     | 16.05     | 16.15     | 16.25     | 16.35     | 16.45     | 16.55     | 16.65     | 16.75     |
| Total Poipet Drainage                   | \$5,754.96 \$'000/y  | -   | -               |          |             | -                     | 534.71      | 633.04    | 736.30    | 844.51     | 957.67    | 989.94    | 1,022.21  | 1,054.47  | 1,086.74  | 1,119.01  | 1,151.28  | 1,183.55  | 1,215.81  | 1,248.08  | 1,280.35  |
| HEALTH BENEFITS                         |                      |   |                 |          |             |                       |             |           |           |            |           |           |           |           |           |           |           |           |           |           |           |
| Sanitation area (HHs connected)         | No. HH               |   |                 | 1,208    | 1,812       | 2,415                 | 2,415       | 2,415     | 2,415     | 2,415      | 2,415     | 2,415     | 2,415     | 2,415     | 2,415     | 2,415     | 2,415     | 2,415     | 2,415     | 2,415     | 2,415     |
| SWM served area (HHs affected)          | No. HH               |   |                 | 6,473.73 | 9,710.59    | 12,947                | 14,713      | 16,564    | 18,500    | 20,522     | 22,630    | 23,772    | 24,936    | 26,121    | 27,329    | 28,559    | 29,812    | 31,086    | 32,382    | 33,701    | 35,041    |
| Drainage area                           | No. HH               |   |                 | 1,364.31 | 2,046.47    | 2,729                 | 2,847       | 3,468     | 4,121     | 4,808      | 5,527     | 6,279     | 6,494     | 6,708     | 6,923     | 7,137     | 7,352     | 7,566     | 7,781     | 7,995     | 8,210     |
| Resident popn health benefit (SWM area) | \$104.56 \$'000/y    |   |                 |          |             |                       | 1,538       | 1,732     | 1,934     | 2,146      | 2,366     | 2,486     | 2,607     | 2,731     | 2,858     | 2,986     | 3,117     | 3,250     | 3,386     | 3,524     | 3,664     |
| SEZ population                          | \$30.00 \$'000/y     |   |                 |          |             |                       | 216         | 222       | 228       | 234        | 240       | 240       | 240       | 240       | 240       | 240       | 240       | 240       | 240       | 240       | 240       |
| Tourist population                      | \$2.00 \$'000/y      |   |                 |          |             |                       | 12          | 13        | 13        | 13         | 13        | 14        | 14        | 14        | 14        | 15        | 15        | 15        | 15        | 15        | 16        |
| Total Health Benefits                   | \$16,833.40 \$'000/y | -   | -               |          |             | -                     | 1,766.87    | 1,966.62  | 2,175.31  | 2,392.96   | 2,619.55  | 2,739.16  | 2,861.08  | 2,985.31  | 3,111.86  | 3,240.72  | 3,371.88  | 3,505.36  | 3,641.15  | 3,779.25  | 3,919.66  |
| UNDESIRABLE POLLUTANTS BENEFIT          |                      |   |                 |          |             |                       |             |           |           |            |           |           |           |           |           |           |           |           |           |           |           |
|   | \$/kg                | 1.00                                      | 1.00            | 1.00     | 1.00        | 1.00                  | 1.00        | 1.00      | 1.00      | 1.00       | 1.00      | 1.00      | 1.00      | 1.00      | 1.00      | 1.00      | 1.00      | 1.00      | 1.00      | 1.00      | 1.00      |
| Biological Oxygen Demand (BOD)          | 0.10 \$'000/y        | -   | 351.5           | BOD      |             | 36.3                  |             |           |           |            |           |           |           |           |           |           |           |           |           |           |           |
| Chemical oxygen demand (COD)            | 0.15 \$'000/y        | -   | 1,042.9         | COD      |             | 158.0                 |             |           |           |            |           |           |           |           |           |           |           |           |           |           |           |
| Suspended solids (SS)                   | 0.01 \$'000/y        | -   | 700.7           | TSS      |             | 7.2                   |             |           |           |            |           |           |           |           |           |           |           |           |           |           |           |
| Nitrogen (N)                            | 56.12 \$'000/y       | -   | 89.6            | TN       |             | 5,028.2               |             |           |           |            |           |           |           |           |           |           |           |           |           |           |           |
| Phosphorus (P)                          | 92.48 \$'000/y       | -   | 22.5            | TP       |             | 2,082.8               |             |           |           |            |           |           |           |           |           |           |           |           |           |           |           |
| Total Undesirable Elements Benefits     | \$57,432.00          | -   | 2,207.3         |          |             | 3,656.3               | 7,312.6     | 7,312.6   | 7,312.6   | 7,312.6    | 7,312.6   | 7,312.6   | 7,312.6   | 7,312.6   | 7,312.6   | 7,312.6   | 7,312.6   | 7,312.6   | 7,312.6   | 7,312.6   | 7,312.6   |
| INTERNATIONAL TOURIST BENEFIT           |                      |   |                 |          |             |                       |             |           |           |            |           |           |           |           |           |           |           |           |           |           |           |
|   |                      |   | growth per year |          |             | 6.9                   |             |           |           |            |           |           |           |           |           |           |           |           |           |           |           |
| Marginal increase in revenue            | \$53.27 \$'000/y     |   | 0.15%           |          |             | 6.9                   | 6.9         | 6.9       | 7.0       | 7.0        | 7.0       | 7.0       | 7.0       | 7.0       | 7.0       | 7.0       | 7.0       | 7.0       | 7.1       | 7.1       | 7.1       |
| TOTAL BENEFITS                          | \$69,843.27 \$'000/y | -   | -               | -        | -           | 3,722.61              | 11,108.45   | 11,490.48 | 11,888.05 | 12,301.21  | 12,729.98 | 12,949.74 | 13,173.36 | 13,400.86 | 13,632.29 | 13,867.70 | 14,107.13 | 14,350.63 | 14,598.25 | 14,850.03 | 15,105.96 |
| NET CASH FLOW                           | \$'000/y             | -   | -               | 821.36   | - 21,327.34 | - 26,581.71           | - 29,578.75 | 4,809.61  | 9,048.84  | 9,534.20   | 9,919.23  | 10,319.24 | 10,521.27 | 10,726.97 | 10,936.39 | 11,149.56 | 7,091.14  | 11,587.37 | 11,812.10 | 12,040.77 | 12,273.44 |
| EIRR                                    | 9.9%                 |   |                 |          |             |                       |             |           |           |            |           |           |           |           |           |           |           |           |           |           |           |
| NPV                                     | \$4,159.06           | 9%  | KHR 17,031.34   | million  |             |                       |             |           |           |            |           |           |           |           |           |           |           |           |           |           |           |

Source: Egis, 2021



## 11. Distribution Analysis and Poverty Impact

249. The distributional analysis for Poipet is shown below. The distribution of the difference between the economic and financial PVs for benefits relates to the GDP economic benefits which is allocated as a gain to the Government, consumers and the public. The difference in the PVs of the Capex and Opex costs relate to the tax and the shadow value of unskilled labor. The higher FPV for the unskilled labor is a gain to unskilled labor employed during construction as the SWRF is 0.6. The tax element in the Capex and Opex costs is a gain to the government.

250. **Poverty impact.** The ADB's poverty assessment for Cambodia was 12.9% in 2018, having reduced from 47.8% in 2007 and 13.5% in 2014, although the Covid pandemic is expected to reverse this reducing trend. It is assumed that Poipet's incidence of poverty is similar to the national average and has been showing a progressive decline in tune with the rest of the country. Overall, the distribution impact will largely benefit the residents and the local communities of Poipet including the workers employed in the SEZs.

**Table 77: Poipet Distributional Analysis and Poverty Impact**

| A. Distribution of Benefits |                      |             |                               |                      |             |             |           | KHR billion |
|-----------------------------|----------------------|-------------|-------------------------------|----------------------|-------------|-------------|-----------|-------------|
| Particulars                 | Financial PV         | Economic PV | Economic PV LESS Financial PV | Government / Economy | Labor       | Public      | Consumers | Total       |
| Revenue / Benefits          | 45.1                 | 285         | 240                           | 120                  |             | 60          | 60        | 240         |
| Costs                       |                      |             |                               |                      |             |             |           |             |
| Civil works                 | 186.7                | 163.0       | (23.7)                        | 23.7                 |             |             |           | 23.7        |
| Equipment & materials       | 935                  | 8.3         | (1.2)                         | 1.2                  |             |             |           | 1.2         |
| Labour                      | 57.0                 | 49.7        | (7.2)                         |                      | 7.2         |             |           |             |
| Other                       | 63.3                 | 55.3        | (8.0)                         | 8.0                  |             |             |           | 8.0         |
| Net Benefits                | -271.3               | 8.8         | 280.1                         | 271.3                |             |             |           | (271.3)     |
| Gains and Losses            |                      |             |                               | (118.4)              | 7.2         | 60.0        | 60.0      | 8.8         |
| PV=present value            |                      |             |                               |                      |             |             |           |             |
| B. Poverty Impact Ratio     |                      |             |                               |                      |             | KHR billion |           |             |
| Items                       | Government / Economy | Labor       | Public                        | Consumers            | Total       |             |           |             |
| Gains and losses            |                      | 7.2         | 60.0                          | 60.0                 | 127.2       |             |           |             |
| Financial return            | (118.4)              |             |                               |                      | (118.4)     |             |           |             |
| Benefits (Losses)           | (118.4)              | 7.2         | 60                            | 60.0                 | 8.8         |             |           |             |
| Proportion of poor          | 0.35                 | 0.50        | 0.30                          | 0.40                 |             |             |           |             |
| Benefits to poor            | (41.4)               | 3.6         | 18.0                          | 24.0                 | 4.2         |             |           |             |
| <b>Poverty Impact Ratio</b> |                      |             |                               |                      | <b>0.47</b> |             |           |             |

Source: Egis, 2021

## IX. KAMPOT ECONOMIC ANALYSIS

### 1. Introduction

251. This section presents the economic evaluation for Kampot City. The proposed investment for Kampot will support sanitation wastewater for the short-term time horizon 2020 – 2025, as defined in the Master Plan. The costs and benefits for wastewater are estimated and combined into an overall economic analysis for the project for the city.

252. **Kampot Economic Condition.** Kampot is the provincial capital of Kampot Province located in the southern coastal region of Cambodia. Kampot City is surrounded by the District Tuek Chhu at the west-north-eastern side and by the sea at the southern side and comprises of 5 *Sangkats*, and a total of 15 villages.

253. Kampot benefits from a strategic position where the economic drivers identified are tourism and the service sector, with agriculture as a support sector. As the provincial capital, Kampot serves as the gateway to the province's four historical/cultural areas, including wildlife sanctuaries and protected areas. Provincial tourist arrival statistics showed an increasing trend from 1.27 m in 2014 to 1.63 m in 2019. Although the majority of the land uses are non-agricultural and only 652 ha or 0.45% of the city's total land area remains for cultivation, Kampot still receives a significant contribution from agriculture to boost its local economy. There are currently no Special Economic Zones (SEZ) within the city's administrative boundary.

254. **Population projections.** Since 1998, Kampot City experimented with steady growth from 33,126 inhabitants in 1998 to 36,367 in 2008 and 38,595 in 2018. The population grew by 16.51% based on a 20-year comparison from 1998 to the 2018 population census with an average annual growth rate (AAGR) of 0.8%.

255. **Permanent population contribution.** Using the historical census<sup>27</sup> data as a base, the permanent population is projected to 2040, based on the AAGR 2015-2018 at the Village administrative level (range of 0.45%-5.01% AAGR per village). As the city also accommodates temporary migrant workers, the temporary population of the city is computed based on the AAGR of the official temporary population from 2014 to 2018 at the village administrative level (range of 0.40%-6.10% AAGR). Tourism contribution is computed using the AAGR from 2014 to 2018 of the foreign tourists and local tourists (1% each).

256. There are currently no SEZ within the city's administrative boundary. Kampot is seen as a future industrial city in this part of Cambodia, but this will be possible if Koh Toc, where Kampot SEZ is located, will be integrated into Kampot City. No additional SEZ' workers contribution is assumed in the population projection.

257. Based on the adopted AAGR, the total population in Kampot in 2040 is estimated to be 76,707. A summary is shown in the table below.

**Table 78: Kampot Projected Population 2020-2040**

| Category             | 2020   | 2025   | 2030   | 2040   |
|----------------------|--------|--------|--------|--------|
| Permanent Population | 40,476 | 45,660 | 51,619 | 66,403 |
| Temporary Population | 2,125  | 2,494  | 2,944  | 4,175  |
| Tourism              | 5,023  | 5,279  | 5,549  | 6,129  |
| SEZ' workers         | -      | -      | -      | -      |

<sup>27</sup> City Socio-Economic Status, 2014, 2015, 2016, 2017, 2018.

|                         |               |               |               |               |
|-------------------------|---------------|---------------|---------------|---------------|
| <b>Total Population</b> | <b>47,624</b> | <b>53,432</b> | <b>60,111</b> | <b>76,707</b> |
| Source : Egis, 2021     |               |               |               |               |

## 2. Kampot Proposed Subprojects

258. Following the Urban Development Strategy (UDS), the sector Master plan (MP), and the Comprehensive Technical Options Study (CTOP). The following sections provide a brief overview of the proposed infrastructure for LCIP in Kampot.

### 2.1. Wastewater Management Subproject

259. **Current situation.** In 2018, 86% of the total population of Kampot had access to a toilet,<sup>28</sup> reached 93% in 2020, mostly pour-flush toilets. It is estimated that 2% of the population are still practicing open defecation, and 5% share a neighbor's toilet, in particular in specific villages such as Traeuy Kaoh Sangkat (south island). In the urban areas, it is assumed that 100% of the septic tank containments will have to be emptied due to the lack of available space; and in a rural areas, the percentage of emptying septic tanks is as indicated by the CCS and FGDs, of 20%.

260. Currently two septage emptying services companies operate in Kampot. One truck comes from Takeo Province and has a volume of 8.5 m<sup>3</sup>. The price for a single empty is around \$200. The service could be shared between households to decrease the cost (e.g., for 4 HH it will cost \$50 for each HH). The second service (located near Kampot city) has also adopted a similar price, and it is independent of the number of tanks to empty. The truck's capacity is 5 m<sup>3</sup> volume. This company started at the end of 2019 and since then has had about 20 clients in Kampot city.

261. There is currently no central wastewater treatment plant (WWTP) operating in Kampot. Wastewater flows directly to the *Preaek Tuek Chhu* River through combined sewers and road drains, or indirectly via a canal into the open water.

262. **GMS2 Project.** A new sewerage system will be delivered as part of the Second Greater Mekong Subregion Corridor Towns Project (GMS 2) which includes a new WWTP to be constructed and commissioned. This treatment plant, which will be located approximately 6km from the Kampot city center, will service about 30% of the city center area in Kampong Kandal, Krang Ampil, and Kampong Bay districts. Construction of the wastewater system is currently underway and is expected to be completed and commissioned by 2021.

263. The new 3,300m<sup>3</sup>/day WWTP comprising of waste stabilization ponds has been designed to cater for a domestic waste generation of 1,474m<sup>3</sup>/day in 2020, increasing to 2,056m<sup>3</sup>/day (source: PISCB DED Report 2018). The plant will include a septage receiving chamber for the treatment of septage from household septic tanks.

264. **Short-term (2020 – 2025).** Providing sewerage and connections to the existing population will be the priority but with the expected capacity required for the long term horizon. For the short-term 2020-2025, it is proposed that the LCIP Kampot wastewater investment will involve extensions of the sewerage system in the current built-up areas adjacent to the GMS 2 works, and then on the west side of the river with a cross-river pipeline, with one pumping station, pipes, house connections, and street repair. This involves: (i) Use of the GMS 2 pumping stations to deliver wastewater to the new WWTP; (ii) Construction of sewer pipes designed primarily for the selected existing built-up areas but with extra capacity to allow for extensions of the service areas and for future population growth in accordance with the medium term (2025 – 2030) and long-

<sup>28</sup> Department of Planning, 2018. Socio-Economic Situation Report.

term (2030 – 2040) planning horizons. Recent modifications to the scope and design of the sewer network propose that:

- (i) Pumping station C3 will be taken over by the GMS 2 project. In the GMS2 scope amendment document, the technical assistance team did not specify the capacity of the pumping station. Therefore, the electrical and hydraulic equipment has been retained in the final LCIP CAPEX (provision of \$51,000) in anticipation of an expansion of the GMS2 pumping capacity.
- (ii) Force main (1.6 km) of the pumping station C3 will also be taken over by the GMS2 project
- (iii) Of the 16 km of sewerage network proposed and studied during the LCIP feasibility phase, 8.5 km will be undertaken by the GMS2 project. Therefore, 7.5 km remain under LCIP for DED.
- (iv) Household connections remain under LCIP scope.

### 3. Kampot Capex Costs

265. The total Capex cost of the proposed investment for Kampot city is \$7.25 million. Table 81 presents a breakdown of the cost.

**Table 79: Kampot Capex Costs**

| Expenditure Category                  | Financial cost            |                          |  |
|---------------------------------------|---------------------------|--------------------------|--|
|                                       | Cost (\$'000)<br>excl Tax | TAX and Duty<br>(\$'000) | Total<br>Base Cost<br>inc Tax (\$'000) |
| <b>Investment &amp; Running Costs</b> |                           |                          |  |
| Civil Works                           | 3,797                     | 380                      | 4,176                                  |
| Mechanical and Equipment              | 330                       | 68                       | 398                                    |
| Land acquisition and compensation     | 165                       | -                        | 165                                    |
| Consulting Costs                      |                           |                          |  |
| a. Project Consultants                | 321                       | 32                       | 353                                    |
| b. Capacity Development               | 115                       | 11                       | 126                                    |
| Equipment, Vehicles, Furniture        |                           |                          |  |
| Staff Allowances                      | 129                       | -                        | 129                                    |
| Running Costs                         | 294                       | -                        | 294                                    |
| Financial audit costs                 | 33                        | 3                        | 37                                     |
| <b>Total</b>                          | <b>5,184</b>              | <b>494</b>               | <b>5,678</b>                           |
| <b>Contingency</b>                    |                           |                          |  |
| Physical                              |                           |                          | 946                                    |
| Price                                 |                           |                          | 410                                    |
| <b>IDC</b>                            |                           |                          |  |
| Interest during construction          |                           |                          | 218                                    |
|                                       |                           |                          | <b>7,253</b>                           |

Source: Egis, 2021

#### 3.1. Economic Costs

266. The capital investment costs in economic terms allowing for the conversion of financial costs to economic costs and shadow price of unskilled labor is \$5.66 million, with an overall conversion factor of 0.85, as shown below.

**Table 80: Kampot Capital Costs Economic Terms**

| Financial<br>cost | Forei<br>gn | Local |
|-------------------|-------------|-------|
|-------------------|-------------|-------|

| Expenditure Category                  | Cost (\$'000) inc Tax | Foreign    | Local Traded | Skilled labor | Unskilled labor | Tax       | Conversion factor | Economic Cost (\$'000) |
|---------------------------------------|-----------------------|------------|--------------|---------------|-----------------|-----------|-------------------|------------------------|
|                                       | \$                    | %          | %            | %             | %               | %         |                   |                        |
| <b>Investment &amp; Running Costs</b> |                       |            |              |               |                 |           |                   |                        |
| Civil Works                           | 4,176                 | 40%        | 27%          | 4%            | 20%             | 9%        | 0.83              | 3,462.7                |
| Mechanical and Equipment              | 398                   | 70%        | 13%          | 0%            | 0%              | 17%       | 0.83              | 330.4                  |
| Land acquisition and compensation     | 165                   |            | 100%         | 0%            | 0%              | 0%        | 1.00              | 165.3                  |
| Consulting Costs                      |                       |            |              |               |                 |           |                   |                        |
| a. Project Consultants                | 353                   | 60%        | 31%          | 0%            | 0%              | 9%        | 0.91              | 321.1                  |
| b. Capacity                           |                       |            |              |               |                 |           |                   |                        |
| Development                           | 126                   | 0%         | 91%          | 0%            | 0%              | 9%        | 0.91              | 114.5                  |
| Equipment, Vehicles, Furniture        |                       |            |              |               |                 |           |                   |                        |
| Staff Allowances                      | 129                   | 0%         | 100%         | 0%            | 0%              | 0%        | 1.00              | 128.8                  |
| Running Costs                         | 294                   | 25%        | 75%          | 0%            | 0%              | 0%        | 1.00              | 293.8                  |
| Financial audit costs                 | 37                    | 10%        | 81%          | 0%            | 0%              | 9%        | 0.909             | 33.3                   |
| <b>Total</b>                          | <b>5,678</b>          | <b>39%</b> | <b>34%</b>   | <b>3%</b>     | <b>15%</b>      | <b>9%</b> | <b>0.854</b>      | <b>4,850.0</b>         |
| <b>Contingency</b>                    |                       |            |              |               |                 |           |                   |                        |
| Physical                              | 946                   |            |              |               |                 |           | 0.854             | 808                    |
| Price                                 | 410                   |            |              |               |                 |           |                   |                        |
| <b>IDC</b>                            |                       |            |              |               |                 |           |                   |                        |
| Interest during construction          | 218                   |            |              |               |                 |           |                   |                        |
| <b>Total</b>                          | <b>7,253</b>          |            |              |               |                 |           |                   | <b>5,658</b>           |

Source: Egis, 2021.

## 4. Wastewater and Sanitation

### 4.1. Introduction

267. At present, Kampot does not have a sewer system or a WWTP but part of the existing sewerage flow is conveyed through the current stormwater drainage system into open water. In 2020, 90% of the population had access to a toilet, mostly pour-flush toilets,<sup>29</sup> 2% of the population use public toilets, 2% are still practicing open defecation, and 6% share a neighbor's toilet. Two septage emptying services providers currently operate in Kampot (6 vacuum trucks in total). The assessment of the fecal and non-fecal waste disposal chain, both in rural and urban areas, suggests that 91% of fecal waste is not being managed safely.

268. Based on the selected short-term scenario for the Kampot Master Plan, a wastewater works will serve the existing built-up area of Kampot in the short term and its extension in the medium- and long-term horizon. Under LCIP, providing sewerage and connections to the existing population will be the priority but with the expected capacity required for the long term. It is proposed to start the implementation with:

- (i) Construct sewer pipes to service the south part of the city, which includes provisions to extend for future growth.
- (ii) Provide households connection in the center of Kampot and south part of the city.

269. The project will support the construction of public toilets available for use in all public places such as markets and major public buildings in areas serviced by the sewer system.

<sup>29</sup> Department of Planning, 2018. Socio-Economic Situation Report.

270. Because GMS2 is already addressing a major part of the city centre, only an extension of the GMS2 proposed network is considered for the LCIP. These extensions will connect directly to the main pumping station being implemented under GMS2.

271. The investment horizon and design capacity are shown below.

**Table 81: Investment Horizon and Design Capacity**

| Item          | LCIP – investment horizon          | Design Capacity |
|---------------|------------------------------------|-----------------|
| Sewer Network | 2025 – short term or priority area | 2040            |

Source: Egis, 2021.

## 4.2. Wastewater Projections

272. The following table shows the volume of wastewater and septage collected by the new sewer system considering the infrastructure proposed in the LCIP investment (designed to serve the priority core urban area) and the increase in population until 2040 in the collection service area. This shows the overall population of residents, temporary population and tourists connected to the sewerage system and located within the short-term service areas. This assumes that 75% of the potential connections in the service area are actually connected to the new sewer system. The total volume of wastewater generated is projected to increase from 1,086 m<sup>3</sup>/d in 2025 to 1,303 m<sup>3</sup>/d in 2040, based on a generation of 153.6 lpcd for the domestic population and tourists. Total faecal sludge production increases from 10.4 m<sup>3</sup>/d in 2025 to 30.2 m<sup>3</sup>/d in 2040.

**Table 82: Kampot Wastewater Projections**

| Ref. |  | Unit          | Short-term<br>2025 | Mid-term<br>2030 | Long-term<br>2040 |
|------|--|---------------|--------------------|------------------|-------------------|
| A    | Domestic population (including temporary and tourist population) | Inhab.        | 9,430              | 11,312           | 13,987            |
| B    | Daily wastewater production ratio for domestic population        | L/day/ca pita | 153.6              | 153.6            | 153.6             |
| C    | Connection rates   | %             | 75%                | 75%              | 75%               |
| D    | <b>TOTAL population connected</b><br><b>D = A * C</b>            | <b>Inhab.</b> | <b>7,073</b>       | <b>8,484</b>     | <b>10,490</b>     |
| E    | <b>TOTAL wastewater volume</b><br><b>E = D * B</b>               | <b>m³/d</b>   | <b>1,086</b>       | <b>1,303</b>     | <b>1,611</b>      |

Source: Egis 2021

273. The parameters for the number of connections for the residential and commercial sectors in the phase 1 service area is shown in Table 85. The connection rate in represents 13% of the resident population in 2025, equivalent to 1,415 households, based on an average HH size of 5.0 people. In terms of the number of commercial entities, hotels, casinos, and institutions connected, it is assumed that 80% of commercial entities are connected in 2025, 73% of hotels/casinos, and 81% of institutions. The area served by the new sanitation infrastructure is estimated to cover around 20% of the total wastewater generated in Kampot and will remain at this level throughout the project period with the volume of sewage conveyed to the WWTP remaining at 1,087 m<sup>3</sup>/d. The remainder will continue to be served by the existing septic tanks and on-site containment systems.

274. **Septage.** The CCS reported that 30% of the population emptied its sanitation containment at least once. 26% of them hired a pump truck to empty and transport the fecal sludge, while 4% did it manually. When emptied manually, the sludge is most of the time dumped onto agricultural fields or to the water body. It requires between 3 to 5 years to fill up the semi-permeable containments with fecal sludge. Two sludge emptying companies are providing septage services in Kampot City.

275. The estimated septage quantity would be 19.8 m<sup>3</sup>/d in 2025 and for design, 20 m<sup>3</sup>/d is considered for septage co-treatment at the WWTP. The septage collection service and treatment will be designed for:

- (i) Households in urban areas that are not connected to the sewer system (25% of the urban population);
- (ii) New households in rural areas that follow the construction permit standards; and
- (iii) Institutions and commercial complexes that are not connected to the sewer system.

276. A receiving septage station is included with the WWTP site capable of handling the 2040 design horizon.

**Table 83: Kampot Sanitation Parameters**

| Item  | Unit             | 2020        | 2025       | 2030     | 2035    | 2040      |     |
|---|------------------|-------------|------------|----------|---------|-----------|-----|
|   |                  |             | Short term | Med Term |         | Long Term |     |
| Residential (Domestic + Temporary/Tourist)            |                  |             |            |          |         |           |     |
| Domestic population                                   | no.              | 40,476      | 45,660     | 51,619   | 59,011  | 66,403    |     |
| Temporary Population                                  |                  | 2,125       | 2,494      | 2,944    | 3,560   | 4,175     |     |
| Tourists  |                  | 5,023       | 5,279      | 5,549    | 5,839   | 6,129     |     |
| Total Population                                      |                  | 47,624      | 53,433     | 60,112   | 68,410  | 76,707    |     |
| 1. Population connected to sewer system               |                  |             |            |          |         |           |     |
| % popn connected                                      |                  | 0%          | 13%        | 12%      | 10%     | 9%        |     |
| Population Connected (domestic, temporary & tourists) | inhab.           | 0           | 7,073      | 7,073    | 7,073   | 7,073     |     |
| No. of connections (pax per hh 5)                     | 5.00 no. hh      |             | 1,415      | 1,415    | 1,415   | 1,415     |     |
| Total wastewater from Population connected            |                  | 153.63 m3/d | 1,087      | 1,087    | 1,087   | 1,087     |     |
| Flow rate per connection (HH)                         | m3/d/cnctn       |             | 0.768      | 0.77     | 0.77    | 0.77      |     |
| 2. Commercial, Hoteks, Institutions & SEZ             |                  | Total No.   | 202        | 202      | 202     |           |     |
| a. Commercial   |                  |             |            |          |         |           |     |
| Total number  |                  | 7           | 4          | 4        | 4       | 4         |     |
| Percent connected                                     |                  | 0           | 80%        | 80%      | 80%     | 80%       |     |
| Number of connection                                  |                  | unit        | -          | 3        | 3       | 3         |     |
| Number not connected                                  |                  |             | 7          | 1        | 1       | 1         |     |
| b. Hotels   |                  |             |            |          |         |           |     |
| Total number  |                  | 121         | 121        | 121      | 121     | 121       |     |
| Percent connected                                     |                  | 0           | 23%        | 23%      | 23%     | 23%       |     |
| Number of connection                                  |                  | unit        | -          | 28       | 28      | 28        |     |
| Number not connected                                  |                  |             | 121        | 93       | 93      | 93        |     |
| c. Institutions                                       |                  |             |            |          |         |           |     |
| Total number  | No.              | 77          | 77         | 77       | 77      | 77        |     |
| Percent connected                                     | %                | 0%          | 43%        | 43%      | 43%     | 43%       |     |
| Number of connection                                  |                  | unit        | -          | 33       | 33      | 33        |     |
| Number not connected                                  |                  | unit        | 77         | 44       | 44      | 44        |     |
| d. SEZs   |                  |             |            |          |         |           |     |
| Total number  | No.              | 0           | 0          | 0        | 0       | 0         |     |
| Percent connected                                     | %                | 0%          | 0%         | 0%       | 0%      | 0%        |     |
| Number of connection                                  |                  | unit        | -          | -        | -       | -         |     |
| Number not connected                                  |                  | unit        | 0          | 0        | -       | 0         |     |
| 3. Wastewater Generation                              |                  |             | 64         | 64       |         |           |     |
| Total WW generated FWOP (for all popn)                | 115 m3/d         | 5,477       | 8,209      | 6,913    | 7,273   | 7,633     |     |
| Wastewater in sewerage system (fwp)                   | 153.64 lpcd m3/d | -           | 1,087      | 1,087    | 1,087   | 1,087     |     |
|   | m3/y             | -           | 396,620    | 396,620  | 396,620 | 396,620   |     |
| Percent of Total WW generated in Sewerage System      |                  |             | 0%         | 13%      | 16%     | 15%       | 14% |

Source: Egis, 2021



### 4.3. Economic Benefits

277. **Saved septic tanks costs.** The progressive connection of households, institutions and commercial establishments to the sewerage system will result in the decommissioning of septic tanks and saving in the future costs of their maintenance and periodic desludging. For those households that have to periodically build a new containment tank when the old tank is full, the cost of the new tank will also be saved. However, most of the households served by the project in the core urban area are assumed to use a non-permeable septic tank that is periodically cleaned out of septage. The economic O&M costs of the existing septic tanks are assumed to be \$5.00 per year for households and \$25 per year for C&Is.

278. **Saved septage costs.** Residential households are assumed to have to empty their septic tanks of septage every three years ( $1\text{m}^3/\text{year}$ ) and C&Is once a year for  $10\text{m}^3/\text{y}$ . This represents a total saving in septage cleaning of  $1,378\text{ m}^3/\text{y}$  for C&Is and  $396\text{ m}^3/\text{y}$  for residential HHs. A total of  $1,774\text{ m}^3/\text{y}$  per year from 2025. The economic cost per  $\text{m}^3$  for septage is taken as \$8.50/ $\text{m}^3$ . The capital value of the septic tanks that will become redundant is assumed to be a sunk cost and is not included as a loss to the owners.

279. **Health benefits.** As discussed earlier, it is not possible to apportion the overall health benefits from improved sanitation, the WWTP, and improved drainage to the individual components as they are interlinked. Based on the data gained from the CCS an overall health benefit of \$28.95/HH/year is estimated for Kampot. However, for the purpose of the analysis for Kampot where the LCIP investment is only for wastewater, a specific health benefit is only allocated to those households that are connected to the new sewer system of \$15.00 per HH per year to allow for the direct benefits they receive through improved hygiene and convenience. For tourists an annual benefit of \$2.0 per person is also included.

### 4.4. Economic Costs

280. **Capex.** The total cost of the proposed drainage works is \$4.1 million, including civil works, equipment, but excluding consulting services, VAT, physical and price contingency. The total economic costs for the subproject is \$5.0 million, allowing for consulting services and price contingency. Implementation is scheduled from 2022 to 2025/6, with the bulk of the Capex investment completed by 2025. Allowance is included in the capex cost for the replacement of assets with a shorter economic life – trucks, pumps and electrical equipment.

281. The cost of equipment that will require replacement after 10 years' service totals \$0.306 million.

282. **Salvage value.** Because the project period is only 20 years limited by the population projections cutoff at 2040, a salvage value is included to allow for the remaining value of the new assets created by the project. The asset life assumed for the various components is shown in the table below.

**Table 84: Economic Life of Urban Infrastructure Assets**

| Equipment macro-categories | Component  | Equipment categories | Asset life duration (years) |
|----------------------------|------------|----------------------|-----------------------------|
| Trucks and vehicles        | - Sewerage | Trucks and vehicles  | 10                          |



|                         |            |                                   |    |
|-------------------------|------------|-----------------------------------|----|
| <b>Pumping station</b>  | - Sewerage | Electric/hydraulic equipment      | 10 |
|                         |            | Concrete structures               | 50 |
| <b>Treatment plants</b> | - WWTP     | Electric/hydraulic equipment      | 10 |
|                         |            | Concrete structures and buildings | 50 |
| <b>Pipe network</b>     | - Sewerage | PVC gravity pipes                 | 40 |
|                         | - Drainage | HDPE force mains                  | 40 |

Source: Egis, 2021.

283. Applying these values to the sanitation assets for Kampot a 20-year project life indicates that the end of project salvage value is 54% of the original cost. This value is included as a benefit for the project in 2040.

284. **GMS2 Project CAPEX.** The investment costs of the associated GMS2 project that is also developing sanitation infrastructure for Kampot has not been included in the economic analysis and is regarded as a sunk cost.

285. **Opex.** The annual O&M costs vary according to the volume of wastewater collected each year that is handled through the pump stations and the WWTP. In this case as the volume of wastewater remains constant the Opex costs remain the same each year. The Opex cost for the LCIP investment is projected to be \$20,046 in 2026 and remain the same until 2040. The Opex cost of the associated GMS2 project sanitation investment for the WWTP, PSs and sewer network are estimated to be an additional \$420,000 per year, making a total of \$440,000 per year for the sewerage system. These costs are converted to economic prices using the CF of 0.99 calculated to the Opex costs excluding tax. Total Opex costs in economic terms are projected to be \$435,470 in 2026. The conversion of financial Opex to economic prices is shown in the following table.

**Table 85: Conversion of Opex to Economic Prices**

| Kampot Sewer Network Opex |                   |               | Economic Pricing Conversion Factors |              |                |               |                  |          |               |             |
|---------------------------|-------------------|---------------|-------------------------------------|--------------|----------------|---------------|------------------|----------|---------------|-------------|
|                           |                   |               | SERF                                | CF           | CF             | SWRF          | CF               |          |               |             |
|                           |                   |               | 1.00                                | 1.00         | 1.00           | 0.60          | -                |          |               |             |
|                           | KHR               | \$            | Loc %                               | FE %         | Locally traded | Skilled labor | Unskilled labour | Tax      | Total         | CF          |
| 1. Personnel              | -                 | -             | 100%                                | 0%           | 0%             | 95%           | 5%               | 0%       | 100%          | 100%        |
| 2. Energy                 | 36,166,567        | 8,832         | 85%                                 | 15%          | 85%            | 0%            | 0%               | 0%       | 100%          | 100%        |
| 3. Maintenance            | 45,921,961        | 11,214        | 80%                                 | 20%          | 60%            | 15%           | 5%               | 0%       | 100%          | 100%        |
| <b>Total Opex</b>         | <b>82,088,527</b> | <b>20,046</b> |                                     | <b>3,568</b> | <b>14,236</b>  | <b>1,682</b>  | <b>336</b>       | <b>-</b> | <b>19,822</b> | <b>0.99</b> |

Source: Egis, 2021.

## 5. Reduction in Undesirable Pollutants

286. As discussed above, the positive environmental impact of reducing the amount of untreated wastewater and septic tank outflow to the environment is a major benefit of wastewater and septage treatment to be developed by the project.

287. For Kampot the reduction in the volume of undesirable pollutants (BOD, COD, SS, N and P) that is attributed to the project is estimated to the 1,068 t/y by comparing the fwp and fwop

situations. A summary is shown in Table 88. The reduction represents 16% of the amount of pollutants produced in the without project situation.

**Table 86: Poipet Reduction in Undesirable Pollutants**

| Pollutant        | 2020         | 2025 (fwp)   | 2025 (fwop)  | 2025 (fwop-fwop) | Reduction % |
|------------------|--------------|--------------|--------------|------------------|-------------|
|                  | t/y          | t/y          | t/y          | t/y              |             |
| <b>BOD</b>       | 953          | 1,349        | 1,536        | -176             | -13%        |
| <b>COD</b>       | 2,196        | 3,042        | 3,537        | -495             | -16%        |
| <b>TSS</b>       | 1,305        | 1,761        | 2,102        | -341             | -19%        |
| <b>TN</b>        | 213          | 302          | 348          | -45              | -15%        |
| <b>TP</b>        | 38           | 51           | 62           | -11              | -21%        |
| <b>Total t/y</b> | <b>4,708</b> | <b>6,516</b> | <b>7,584</b> | <b>-1068</b>     | <b>-16%</b> |

Source: Egis, 2021.

288. The value of the undesirable pollutants depends on the type of water body they will be discharged to. For Kampot is assumed that pollutants are discharged to the river resulting in the value per kg as shown below.

**Table 87: Poipet Value of Undesirable Pollutants**

| Effluent destination | Nitrogen (N) | Phosphorus (P) | Suspended solids (SS) | Biological oxygen demand (BOD) | Chemical oxygen demand (COD) |
|----------------------|--------------|----------------|-----------------------|--------------------------------|------------------------------|
| River                | 22.45        | 42.56          | 0.01                  | 0.04                           | 0.14                         |

Note: \$/kg; constant 2020 prices.

Source: Egis, 2021.

289. The total economic benefit from the reduction of pollutants is \$1.435 m per year, which is assumed to remain constant over the project life. The biggest contribution is from the reduction in N and P.

## 6. Impact on GDP

290. The project is expected to result in a more livable city for the residents and the commercial sector, and as a result of the improved urban infrastructure through investment in sanitation, the local environment will be more conducive to business and growth of the local economy and tourism, than would be the case in the future without project situation. Local economic performance is measured by the contribution to GDP which is a measure of all economic activity goods and services contributing to the economy during a period of time (usually a year).

291. It is expected that the establishment of a more livable city that has improved public utilities will be more attractive to business development and have a high GDP than would be the case without the project so that the change in the growth of GDP in the future between the fwp and fwop situation is an economic benefit that encompasses the totality of all the impacts of the project.

292. However, because of the difficulty of quantifying the impact of the project on GDP and in separating GDP from the other quantified benefits, the impact on GDP on Kampot has not been included in the economic analysis as a benefit. The direct economic benefits of the project are captured through the benefits resulting through the reduction in expenditure on health, lost productivity, saved costs of septage and septic tanks, and the reduction in the volume of undesirable pollutants.

## 7. Results of Overall Economic Analysis

293. As discussed in the earlier section, economic analysis has been conducted from the perspective of the overall combined project for Kampot.

294. The results of the overall economic analysis indicate an EIRR of 15.2% with an NPV at an OCC of 9% of \$2.05 m. This result comfortably meets ADB's hurdle of a 9% EIRR.

295. Summary tables of the CBA for the Kampot are presented in the following tables.

296. The main project parameters – capital costs, Opex costs, and the benefits have been tested to show the sensitivity of the analysis to changes in these items and to indicate their switching values, the percentage change needed to increase the EIRR to 9%.

**Table 88: Kampot Results of Sensitivity Analysis**

|                  | Change | EIRR         | \$ mill     | EIRR % SV |
|------------------|--------|--------------|-------------|-----------|
| <b>Base case</b> |        | <b>15.2%</b> | <b>2.05</b> |           |
| <b>Capital</b>   | 20%    | 12.5%        | 1.32        | 45%       |
| <b>O&amp;M</b>   | 20%    | 13.7%        | 1.54        | 82%       |
| <b>Benefits</b>  | -20%   | 10.3%        | 0.41        | 25%       |

SV = switching value.

Source: Egis, 2021.

297. The sensitivity analysis indicates that Capex would have to increase by 45%, O&M costs by 82%, and the benefits to decrease by 25% to reduce the EIRR to 9%.

298. The economic performance is relatively high on account of the assumption that the capital investment costs of the GMS2 for expansion of the sanitation system are treated as a sunk cost. The additional Capex investment to complete the sewer network and the connections funded by the LCIP is relatively minor compared with the original investment and so has a high marginal impact. The economic value of the reduction in undesirable pollutants is the major economic benefit. The value of this benefit would have to reduce by 35% to reduce the EIRR to 9%.

**Table 89: Kampot Economic Analysis Summary****ECONOMIC ANALYSIS RESULTS****Feasibility Study of Livable Cities Investment Project - KAMPOK**

|                            |        |               |             | Net Benefit |         | Sensitivity |         |         |            |
|----------------------------|--------|---------------|-------------|-------------|---------|-------------|---------|---------|------------|
|                            |        | Economic Cost |             |             | Base    | Investmt    | O&M     | Benefit | 1-yr Delay |
| Year                       | Capex  | Opex          | Total Costs | Benefits    | Case    | 20%         | 20%     | -20%    | in Benefit |
|                            | \$'000 | \$'000        | \$'000      | \$'000      | \$'000  | \$'000      | \$'000  | \$'000  | \$'000     |
| 1 2021                     | -      | 0             | 0           | 0           | 0       | 0           | 0       | 0       | 0          |
| 2 2022                     | 198    | 0             | 198         | 0           | (198)   | (238)       | (198)   | (198)   | (198)      |
| 3 2023                     | 1,264  | 0             | 1,264       | 0           | (1,264) | (1,516)     | (1,264) | (1,264) | (1,264)    |
| 4 2024                     | 1,709  | 0             | 1,709       | 0           | (1,709) | (2,051)     | (1,709) | (1,709) | (1,709)    |
| 5 2025                     | 2,045  | 415           | 2,460       | 61          | (2,399) | (2,808)     | (2,482) | (2,411) | (2,460)    |
| 6 2026                     | 356    | 435           | 792         | 1,565       | 774     | 702         | 686     | 460     | (731)      |
| 7 2027                     | 115    | 435           | 550         | 1,565       | 1,015   | 992         | 928     | 702     | 1,015      |
| 8 2028                     | -      | 435           | 435         | 1,565       | 1,130   | 1,130       | 1,043   | 817     | 1,130      |
| 9 2029                     | -      | 435           | 435         | 1,565       | 1,130   | 1,130       | 1,043   | 817     | 1,130      |
| 10 2030                    | -      | 435           | 435         | 1,565       | 1,130   | 1,130       | 1,043   | 817     | 1,130      |
| 11 2031                    | -      | 435           | 435         | 1,565       | 1,130   | 1,130       | 1,043   | 817     | 1,130      |
| 12 2032                    | -      | 435           | 435         | 1,565       | 1,130   | 1,130       | 1,043   | 817     | 1,130      |
| 13 2033                    | -      | 435           | 435         | 1,565       | 1,130   | 1,130       | 1,043   | 817     | 1,130      |
| 14 2034                    | 330    | 435           | 766         | 1,565       | 800     | 733         | 712     | 487     | 800        |
| 15 2035                    | -      | 435           | 435         | 1,565       | 1,130   | 1,130       | 1,043   | 817     | 1,130      |
| 16 2036                    | -      | 435           | 435         | 1,565       | 1,130   | 1,130       | 1,043   | 817     | 1,130      |
| 17 2037                    | -      | 435           | 435         | 1,565       | 1,130   | 1,130       | 1,043   | 817     | 1,130      |
| 18 2038                    | -      | 435           | 435         | 1,565       | 1,130   | 1,130       | 1,043   | 817     | 1,130      |
| 19 2039                    | -      | 435           | 435         | 1,565       | 1,130   | 1,130       | 1,043   | 817     | 1,130      |
| 20 2040                    | -      | 2,353         | 435         | (1,918)     | 1,565   | 3,483       | 3,954   | 3,396   | 3,170      |
|                            |        |               |             | 0           |         |             |         |         |            |
|                            |        |               |             | 0           |         |             |         |         |            |
| 1 NPV                      | 3,637  | 2,550         | 6,187       | 8,240       | 2,053   | 1,325       | 1,543   | 405     | 1,116      |
| Discount Rate @ 9% EIRR    |        |               |             |             | 15.2%   | 12.5%       | 13.7%   | 10.3%   | 12.0%      |
| ENPV 9%                    |        |               |             |             | 2,053   | 1,325       | 1,543   | 405     | 1,116      |
| Sensitivity Indicator EIRR |        |               |             |             |         | 2.2         | 1.2     | 4.0     | 4.2        |
| ENPV                       |        |               |             |             |         | 1.8         | 1.2     | 4.0     | 3.8        |
| Switching Value EIRR       |        |               |             |             |         | 45%         | 82%     | 25%     | 24%        |
| Switching Value ENPV       |        |               |             |             |         | 56%         | 80%     | 25%     | 26%        |

Source: Egis, 2021.

Table 90: Kampot Economic Analysis Cash Flows

| LCIP ECONOMIC ANALYSIS - KAMPOT         |                  |                         | US\$'000 in constant 2020 economic prices |          |          |          | Exchange Rate KHR: \$ |          | 4095     |          |          |          |          |          |          |          |          |          |          |          |          |          |
|---|------------------|-------------------------|---|----------|----------|----------|-----------------------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|
|   |                  |                         | 2021                                      | 2022     | 2023     | 2024     | 2025                  | 2026     | 2027     | 2028     | 2029     | 2030     | 2031     | 2032     | 2033     | 2034     | 2035     | 2036     | 2037     | 2038     | 2039     | 2040     |
| CAPEX COSTS (economic)                  |                  |                         |   |          |          |          |                       |          |          |          |          |          |          |          |          |          |          |          |          |          |          |          |
| Item                                    | Total \$'000     |                         |   |          |          |          |                       |          |          |          |          |          |          |          |          |          |          |          |          |          | Salvage  |          |
| Kampot Wastewater                       | 5,017            | 5,017.29                | -   | 66.17    | 1,310.95 | 1,487.52 | 1,869.54              | 248.55   | 34.56    |          |          |          |          |          |          |          | 45.84    | -        |          |          | -        | 2,646.81 |
| Kampot Urban Planning                   | 236              | 235.95                  | -   | 30.87    | 74.11    | 39.01    | 36.38                 | 28.82    | 26.77    |          |          |          |          |          |          |          | 260.79   | -        |          |          |          |          |
| Institutional Development Roadmap and   | 988              | 988.44                  | -   | 30.48    | 421.46   | 244.69   | 236.42                | 28.62    | 26.77    |          |          |          |          |          |          |          |          |          |          |          |          |          |
|   | 6,242            |                         |   |          |          |          |                       |          |          |          |          |          |          |          |          |          |          |          |          |          |          |          |
| Total Capex                             | \$'000           | 6,241.67                | -   | 127.52   | 1,806.52 | 1,771.21 | 2,142.34              | 305.99   | 88.09    | -        | -        | -        | -        | -        | -        | -        | 306.62   | -        | -        | -        | -        | 2,646.81 |
| OPEX                                    | Opex SCF         | 0.85                    | Economic                                  | Price CF |          |          |                       |          |          |          |          |          |          |          |          |          |          |          |          |          |          |          |
| KAMPOT                                  | 0.99             |                         |   |          |          |          | 1                     |          |          |          |          |          |          |          |          |          |          |          |          |          |          |          |
| Sanitation                              |                  |                         |   |          |          |          | 415.30                | 435.12   | 435.12   | 435.12   | 435.12   | 435.12   | 435.12   | 435.12   | 435.12   | 435.12   | 435.12   | 435.12   | 435.12   | 435.12   | 435.12   | 435.12   |
| Total OPEX                              | \$'000           | -                       | -   |          |          |          | 415.30                | 435.12   | 435.12   | 435.12   | 435.12   | 435.12   | 435.12   | 435.12   | 435.12   | 435.12   | 435.12   | 435.12   | 435.12   | 435.12   | 435.12   | 435.12   |
| TOTAL COSTS                             | \$'000           | -                       | 127.52                                    | 1,806.52 | 1,771.21 | 2,557.64 | 741.12                | 523.21   | 435.12   | 435.12   | 435.12   | 435.12   | 435.12   | 435.12   | 435.12   | 741.75   | 435.12   | 435.12   | 435.12   | 435.12   | -        | 2,211.69 |
| BENEFITS                                |                  |                         |   |          |          |          |                       |          |          |          |          |          |          |          |          |          |          |          |          |          |          |          |
| SANITATION                              |                  |                         |   |          |          |          |                       |          |          |          |          |          |          |          |          |          |          |          |          |          |          |          |
| Septage saving (m3/y)                   | \$8.50 \$'000/y  |                         |   |          |          |          | 7.54                  | 15.08    | 15.08    | 15.08    | 15.08    | 15.08    | 15.08    | 15.08    | 15.08    | 15.08    | 15.08    | 15.08    | 15.08    | 15.08    | 15.08    | 15.08    |
| Healthcare saving (connected HHs)       | \$69.24 \$'000/y |                         |   |          |          |          | 48.97                 | 97.95    | 97.95    | 97.95    | 97.95    | 97.95    | 97.95    | 97.95    | 97.95    | 97.95    | 97.95    | 97.95    | 97.95    | 97.95    | 97.95    | 97.95    |
| Septic tank & cesspit maintenance (HHs) | \$5.00 \$'000/y  |                         |   |          |          |          | 3.54                  | 7.07     | 7.07     | 7.07     | 7.07     | 7.07     | 7.07     | 7.07     | 7.07     | 7.07     | 7.07     | 7.07     | 7.07     | 7.07     | 7.07     | 7.07     |
| Non residential                         | \$25.00 \$'000/y |                         |   |          |          |          | 0.80                  | 1.61     | 1.61     | 1.61     | 1.61     | 1.61     | 1.61     | 1.61     | 1.61     | 1.61     | 1.61     | 1.61     | 1.61     | 1.61     | 1.61     | 1.61     |
| Total KAMPOT sanitation                 | \$805 \$'000/y   | -                       | -   |          |          |          | 60.85                 | 121.70   | 121.70   | 121.70   | 121.70   | 121.70   | 121.70   | 121.70   | 121.70   | 121.70   | 121.70   | 121.70   | 121.70   | 121.70   | 121.70   | 121.70   |
| UNDESIRABLE POLLUTANTS BENEFIT          |                  |                         |   |          |          |          |                       |          |          |          |          |          |          |          |          |          |          |          |          |          |          |          |
| \$/kg                                   | 1.00             | Reduction t/y from 2025 | \$/y                                      |          |          |          |                       |          |          |          |          |          |          |          |          |          |          |          |          |          |          |          |
| Biological Oxygen Demand (BOD)          | 0.041 \$'000/y   | -                       | 176.2                                     | BOD      | 7.3      |          |                       |          |          |          |          |          |          |          |          |          |          |          |          |          |          |          |
| Chemical oxygen demand (COD)            | 0.138 \$'000/y   | -                       | 494.8                                     | COD      | 68.1     |          |                       |          |          |          |          |          |          |          |          |          |          |          |          |          |          |          |
| Suspended solids (SS)                   | 0.007 \$'000/y   | -                       | 341.0                                     | TSS      | 2.3      |          |                       |          |          |          |          |          |          |          |          |          |          |          |          |          |          |          |
| Nitrogen (N)                            | 22.449 \$'000/y  | -                       | 45.4                                      | TN       | 1,019.5  |          |                       |          |          |          |          |          |          |          |          |          |          |          |          |          |          |          |
| Phosphorus (P)                          | 42.557 \$'000/y  | -                       | 10.7                                      | TP       | 454.4    |          |                       |          |          |          |          |          |          |          |          |          |          |          |          |          |          |          |
| Total Undesirable Elements Benefits     | \$10,671         |                         |   |          |          |          | -                     | 1,443.0  | 1,443.0  | 1,443.0  | 1,443.0  | 1,443.0  | 1,443.0  | 1,443.0  | 1,443.0  | 1,443.0  | 1,443.0  | 1,443.0  | 1,443.0  | 1,443.0  | 1,443.0  | 1,443.0  |
| TOTAL BENEFITS                          | \$8,237 \$'000/y | -                       | -   | -        | -        | 60.85    | 1,564.70              | 1,564.70 | 1,564.70 | 1,564.70 | 1,564.70 | 1,564.70 | 1,564.70 | 1,564.70 | 1,564.70 | 1,564.70 | 1,564.70 | 1,564.70 | 1,564.70 | 1,564.70 | 1,564.70 | 1,564.70 |
| NET CASH FLOW                           | \$1,695 \$'000/y | -                       | 127.52                                    | 1,806.52 | 1,771.21 | 2,496.78 | 823.58                | 1,041.49 | 1,129.58 | 1,129.58 | 1,129.58 | 1,129.58 | 1,129.58 | 1,129.58 | 1,129.58 | 822.96   | 1,129.58 | 1,129.58 | 1,129.58 | 1,129.58 | 1,129.58 | 3,776.39 |
| EIRR                                    | 13.6%            |                         |   |          |          | 8.86     | 11.80                 | 13.12    | 14.50    | 15.94    | 19.26    | 24.57    | 26.84    | 29.20    | 31.64    | 42.11    | 45.50    | 49.04    | 52.71    | 56.54    | 73.25    |          |
| ENPV 9%                                 | \$1,695.38       | 9% KHR 6,942.59         | million                                   |          |          | 52.00    | 1,552.90              | 1,551.58 | 1,550.20 | 1,548.76 | 1,545.44 | 1,540.13 | 1,537.86 | 1,535.50 | 1,533.06 | 1,522.59 | 1,519.20 | 1,515.66 | 1,511.99 | 1,508.16 | 1,491.45 |          |

Source: Egis, 2021

## 8. Distribution Analysis and Poverty Impact

299. The distributional analysis is shown below. The distribution of the difference between the economic and financial PVs for benefits relates to the GDP economic benefits which is allocated as a gain to the Government, consumers and the public. The difference in the PVs of the Capex and Opex costs relate to the tax and the shadow value of unskilled labor. The higher FPV for the unskilled labor is a gain to unskilled labor employed during construction as the SWRF is 0.6. The tax element in the Capex and Opex costs is a gain to the government.

300. **Poverty impact.** The ADB's poverty assessment for Cambodia was 12.9% in 2018, having reduced from 47.8% in 2007 and 13.5% in 2014, although the Covid pandemic is expected to reverse this reducing trend. It is assumed that Poipet's incidence of poverty is similar to the national average and has been showing a progressive decline in tune with the rest of the country. Overall, the distribution impact will largely benefit the residents and the local communities of Kampot including tourists visiting the city.

**Table 91: Distributional and Poverty Analysis**

| <b>A. Distribution of Benefits</b> |                      |             |                               |                      |             |        |           | KHR billion |
|------------------------------------|----------------------|-------------|-------------------------------|----------------------|-------------|--------|-----------|-------------|
| Particulars                        | Financial PV         | Economic PV | Economic PV LESS Financial PV | Government / Economy | Labor       | Public | Consumers | Total       |
| Revenue / Benefits                 | 5.2                  | 67          | 61.3                          | 30.7                 |             | 15.3   | 15.3      | 61.3        |
| Costs                              |                      |             |                               |                      |             |        |           |             |
| Civil works                        | 18.7                 | 16.8        | (1.9)                         | 1.9                  |             |        |           | 1.9         |
| Equipment & materials              | 1.0                  | 0.9         | (0.1)                         | 0.1                  |             |        |           | 0.1         |
| Labour                             | 5.7                  | 5.1         | (0.6)                         |                      | 0.6         |        |           |             |
| Other                              | 6.4                  | 5.7         | (0.7)                         | 0.7                  |             |        |           | 0.7         |
| Net Benefits                       | -                    | 22.4        | 37.9                          | 60.3                 | (26.6)      |        |           | (26.6)      |
| Gains and Losses                   |                      |             |                               | 6.8                  | 0.6         | 15.3   | 15.3      | 38.0        |
| PV=present value                   |                      |             |                               |                      |             |        |           |             |
| <b>B. Poverty Impact Ratio</b>     |                      |             |                               |                      |             |        |           | KHR billion |
| Items                              | Government / Economy | Labor       | Public                        | Consumers            | Total       |        |           |             |
| Gains and losses                   |                      | 0.6         | 15.3                          | 15.3                 | 31.3        |        |           |             |
| Financial return                   | 6.8                  |             |                               |                      | 6.8         |        |           |             |
| Benefits (Losses)                  | 6.8                  | 0.6         | 15.3                          | 15.3                 | 38.0        |        |           |             |
| Proportion of poor                 | 0.35                 | 0.50        | 0.30                          | 0.40                 |             |        |           |             |
| Benefits to poor                   | 2.4                  | 0.3         | 4.6                           | 6.1                  | 13.4        |        |           |             |
| <b>Poverty Impact Ratio</b>        |                      |             |                               |                      | <b>0.35</b> |        |           |             |

Source: Egis, 2021.