CLIMATE CHANGE ASSESSMENT

I. BASIC PROJECT INFORMATION

Project Title:	Livable Cities Investment Project
Project Cost ($ million)**:**	$194.1 million
Location:	Cambodia: Bavet, Poipet and, Kampot
Sector:	Water and other urban infrastructure and services
Theme:	Climate change mitigation and adaptation
Brief Description:	The project will focus on improving access to basic infrastructure and services in the participating cities. The project will provide: (i) 26,850 people with access to improved wastewater services; (ii) 91,130 people with benefits from improved solid waste management services, and (iii) 23,960 people with benefits from reduced flooding through improved urban stormwater and drainage systems.

II. SUMMARY OF CLIMATE CHANGE FINANCE

Project Financing		**Climate Finance**	
Source	**Amount** ($ million)	**Adaptation** ($ million)	**Mitigation** ($ million)
Asian Development Bank			
Ordinary capital resources (regular loan)	180.00	30.86	5.46
Cambodian Government	14.1		
Total	**194.1**	**30.86**	**5.46**

III. SUMMARY OF CLIMATE RISK SCREENING AND ASSESSMENT

A. Sensitivity of Project Component(s) to Climate or Weather Conditions and the Sea Level

Drainage (Bavet and Poipet)

1. Rehabilitated or installed drainage lines could be overwhelmed by increased flood magnitude due to an increase in the size of extreme rainfall events.

Wastewater (Bavet, Poipet and, Kampot)

1. An increase in rainfall, particularly the size of extreme events, will increase the extent of flood events. Where the route of the proposed sewage mains and collection lines cross streams and drainage lines, more infrastructure will be exposed to erosion or damage by floodwaters.
2. Increased rainfall will increase the amount of runoff around and within components of the wastewater treatment plants (WWTP).

Solid Waste (Bavet and Poipet)

1. An increase in rainfall, particularly the size of extreme events, will increase the amount of runoff that will need to be managed at treatment sites during large rainfall events.

B. Climate Risk Screening

Rainfall Increase. Flood protection measures calculated with current climate statistics may be insufficient given the projected increase in rainfall intensity.

Sea Level Rise. Higher sea level will raise the baseflow height of the Kampot River, increasing flooding beyond current levels.

Storm Surge. Storm surge will contribute to increasing flooding beyond current levels.

Climate Risk Classification: Medium

Climate risk and vulnerability assessment prepared (refer to linked documents).

C. Climate Risk and Adaptation Assessment

The risk assessment considered project components that are vulnerable to extreme weather and future climate change. Hazard mapping based on previously published flood maps was used to identify the relevant hazards. A review of climate-related studies in Cambodia, climate simulation models and GIS models were also conducted to identify hazard exposure under future conditions. National vulnerability assessment and assessment of local government capacity was also used as input into risk assessment. Risk assessment was based on likelihood and consequence of hazard impacts on the elements of each component. Adaptation options were explored for each element (e.g. km of pipe, number of pumping stations) identified as vulnerable. Climate proofing was incorporated in the project design and corresponding additional costs were calculated. The main factors that will trigger the climate risks that will impact the project are extreme rainfall events above current events, which will increase the magnitude of flood events. The adaptation activities are summarized below:

Bavet

1. The larger extreme event size means that localized flooding will continue to occur and will increase in extent in areas not serviced by drainage lines. Therefore, the wastewater treatment plant will need to be isolated from the surrounding area that is currently flood prone and will require higher embankments to ensure protection from external flood waters and internal water management designed to manage rainfall events 5% higher than at present.
2. The landfill site will also require flood water management designed to manage rainfall events 5% higher than at present.

Poipet

1. The larger extreme event size means that localized flooding will continue to occur and will increase in extent in areas not serviced by drainage lines. Therefor the wastewater treatment plant will require an onsite rainwater management plan designed for extreme rainfall 5% above current events.
2. The landfill site will also require flood water management designed to manage rainfall events 5% higher than at present.

Kampot (Sewage lines only)

1. The pipes will be laid along road corridors and protection from flooding will be provided by the impervious surfaces such as the road and pavement surfaces. There are no major crossings that will require protection from floods.

D. Climate Risk Screening Tool and/or Procedure Used

Information and data on historic climate from the Ministry of Water Resources and Meteorology and climate change projections from the Royal Netherlands Meteorological Institute (KNMI) Climate Explorer Website, and climate change downscaling carried out by the Climate Futures program of the Commonwealth Scientific and Industrial Research Organization funded by Australia aid were used to determine the extent of potential climate change impacts. The risk from climate change to each project component was calculated as a combination of the likelihood of a hazard impacting an infrastructure element and the consequences of that impact. Likelihood was determined based on the current likelihood and the projected climate change. The assessment of consequence is formed from a combination of inputs; the GIS analysis showing the number of km or the number of components that are exposed, an analysis of the sensitivity of components to flood damage, and an assessment of the adaptive capacity of the municipal government.

IV. CLIMATE ADAPTATION PLANS WITHIN THE PROJECT

Adaptation Activity	Target Climate Risk	Estimated Adaptation Costs ($ million)	Adaptation Finance Justification
Bavet			
Increase size of drainage network	Increase of size if extreme rainfall event	$0.60	A climate risk study recommended a higher rainfall event size to be used in design of network in anticipation of the impact of higher flooding expected under projected climate change in the project area. Cost based on 11% increase in capital expenditure.

Adaptation Activity	Target Climate Risk	Estimated Adaptation Costs ($ million)	Adaptation Finance Justification
1 m added to height of dykes used within the WWTP	Extreme rainfall 5% larger Increased depth of flooding	$0.42	Extra material and construction costs to increase size of embankment and local drains to ensure no release of effluent in anticipation of the impact of higher flooding expected under projected climate change in the project area. Cost based on 8% increase in CAPEX for the construction of the dykes, and 11% increase to increase the capacity of the stormwater system.
Increase capacity of stormwater management system for the solid waste facilities.		$0.013	
Climate Change proof; wastewater system, functioning drainage system and efficient waste management	Increase of size if extreme rainfall event	$10.53	Contribution to improving the capacity of Bavet to adapt to climate change estimated at 30% of costs[a] for: WWTP, pumping stations, and sewer network; drainage network and outfalls; and the landfill, (excluding above specific adaptation costs and mitigation costs outlined below).
Poipet			
Increase size of drainage network	Increase of size if extreme rainfall event	$0.345	A climate risk study recommended a higher rainfall event size to be used in design of network in anticipation of the impact of higher flooding expected under projected climate change in the project area. Cost based on 2% increase in capital expenditure.
Increase capacity of stormwater management system at WWTP	Extreme rainfall 5% larger Increased depth of flooding	$0.002 + $0.001	Extra material and construction costs to increase size of embankment and local drains to ensure no release of effluent in anticipation of the impact of higher flooding expected under projected climate change in the project area Cost based on 5% increase in size for the stormwater lagoon and 2% increase for the stormwater system at the WWTP and landfill site.
Increase capacity of stormwater management system for the solid waste facilities.		$0.001	
Climate Change proof; wastewater system, functioning drainage system and efficient waste management	Increase of size if extreme rainfall event	$17.73	Contribution to improving the capacity of Poipet to adapt to climate change estimated at 30% of costs[a] for: WWTP, pumping stations, sewer network and connection points: box culverts: and the landfill (excluding above specific adaptation costs and mitigation costs).
Kampot			
Climate Change proof; wastewater system	Extreme rainfall events 10% larger, combined with Sea level rise	$1.23	Contribution to increasing the resilience of the population of Kampot estimated at 30% of costs[a] (excluding above specific adaptation cost).
	Total	**$30.86**	

[a] Based on ADB 2016. Guidance Note on Counting Climate Finance in Urban and Water, Type 2: Project or Activities predicated on climate change adaptation.

V. CLIMATE MITIGATION PLANS WITHIN THE PROJECT

Mitigation Activity	Estimated GHG Emissions Reduction (tCO_2e/year)	Estimated Mitigation Costs ($ million)	Mitigation Finance Justification
Bavet			
Use of solar power thru Photovoltaic modules at WWTP: 180 kWp system with a capacity to produce a total of 157,680 kWh annually[f]	37.4[a]	0.30	The project will allow increased penetration of renewable energy generation into the grid, allowing greater displacement of fossil-generated electricity.
Solid Waste Treatment Plant LFG collection and flue Composting Plant Use of solar power thru Photovoltaic modules; 110 kWp system with a capacity to produce a total of 100,200 kWh annually[g]	25.8[b] 4.6[c] 8.4[a]	0.21 1.84 0.18	Emissions of the more potent greenhouse gases (CH_4) and (N_2O) from anaerobic decomposition will be reduced. Increased penetration of renewable energy generation into the grid.
Poipet			
Use of solar power thru Photovoltaic modules at WWTP: 90 kWp system with a capacity to produce a total of 77,015 kWh annually[h]	46.0[a]	0.15	The project will allow increased penetration of renewable energy generation into the grid, allowing greater displacement of fossil-generated electricity.
Solid Waste Treatment Plant LFG collection and flue Composting Plant Use of solar power thru Photovoltaic modules; 130 kWp system with a capacity to produce a total of 118,420 kWh annually[j]	31.7[d] 6.8[e] 10.7[a]	0.20 2.37 0.21	Emissions of the more potent greenhouse gases (CH_4) and (N_2O) from anaerobic decomposition will be reduced. Increased penetration of renewable energy generation into the grid.
Total	**171.4**	**5.46**	

GHG = greenhouse gas, WWTP = wastewater treatment plant, LFG = land fill gas, kW = kilowatt, tCO_2e = tons of carbon dioxide equivalent, kWh = kilowatt-hour, EDC = Electricité du Cambodge, CH_4 = Methane, N_2O = Nitrous Oxide.

[a] Based on Energy CO_2 emissions of 0.09 Kg CO_2 per kWh (In 2014). From Ritchie and Roser (2017) - "CO_2 and Greenhouse Gas Emissions". Published online at OurWorldInData.org. Retrieved from: 'https://ourworldindata.org/co2-and-other-greenhouse-gas-emissions' [Online Resource].

[b] It is estimated that by 2040 up to 150 m^3 of methane will be captured from the landfill per hour. In the initial stage of the project, it is recommended that active venting with a flare stack be used for ease of operation with a view to installing electricity installation in the future. Both of these options will convert methane into CO2. As methane produces 28 times more greenhouse warming than CO_2, the conversion of the estimated N_2O emissions to CO_2 equates to a reduction in greenhouse potential of 25,811 kg CO_2e.

[c] It is difficult to calculate the CO_2 emission reductions until the exact design and size of the composting plant and the makeup and moisture content of the feedstock is determined but it is estimated that 2572 t/y of material will be composted by 2025 saving conservatively the equivalent amount of CO_2e.

[d] It is estimated that by 2040 up to 184 m^3 of methane will be captured from the landfill per hour. In the initial stage of the project, it is recommended that active venting with a flare stack be used for ease of operation with a view to installing electricity installation in the future. Both options will convert methane into CO_2. As methane produces 28 times more greenhouse warming than CO_2, the conversion of the estimated N_2O emissions to CO_2 equates to a reduction in greenhouse potential of 31,661 kg CO_2e.

[e] It is difficult to calculate the CO_2 emission reductions until the exact design and size of the composting plant and the makeup and moisture content of the feedstock is determined but it is estimated that 2572 t/y of material will be composted by 2025 saving conservatively the equivalent amount of CO_2e.

[f] Only 61% of the power needs of the WWTP will be met by local solar production with the rest to be purchased from the electric grid. At this stage, the surplus photovoltaic electricity is not considered to be resold to Electricité Du Cambodge (EDC).

[g] Only 69% of the power needs of the landfill non-process equipment and 77% of Leachate disposal will be met by local solar production with the rest to be purchased from the electric grid. At this stage, the surplus photovoltaic electricity is not considered to be resold to Electricité Du Cambodge (EDC).

[h] Only 54% of the power needs of the WWTP non-process equipment will be met by local solar production with the rest to be purchased from the electric grid. At this stage, the surplus photovoltaic electricity is not considered to be resold to Electricité Du Cambodge (EDC).

[j] Only 69% of the power needs of the landfill non-process equipment and 77% of Leachate disposal will be met by local solar production with the rest to be purchased from the electric grid. At this stage, the surplus photovoltaic electricity is not considered to be resold to Electricité Du Cambodge (EDC).