Initial Environmental Examination

Project No.: 50099-003
June 2018

REG: Fourth Greater Mekong Subregion Corridor Towns Development

Thakhek Subproject

Prepared by the Ministry of Public Works and Transport for the Asian Development Bank.

CURRENCY EQUIVALENTS

(as of 20 June 2018)

Currency unit	–	Kip (LAK)
LAK1.00	=	$0.000119
$1.00	=	LAK 8,412

ABBREVIATIONS

ADB	–	Asian Development Bank
AP	–	affected person
CEMP	–	contractor environmental management plan
CSO	–	combined sewer overflow
DHUP	–	Department of Housing and Urban Planning
DONRE	–	Department of Natural Resources and Environment
DPWT	–	Department of Public Works and Transport
EIA	–	environmental impact assessment
EHS	–	environmental, health, and safety guidelines
EMP	–	environmental management plan
EMR	–	environmental monitoring report
EO	–	environment officer (of implementing agency)
ESO	–	environmental safeguard officer (of executing agency)
ES	–	environmental specialist
GHG	–	greenhouse gas
GMS	–	Greater Mekong Subregion
GMS-CTDP-4	–	Fourth Greater Mekong Subregion Corridor Towns Development Project
GRM	–	grievance redress mechanism
HDPE	–	high-density polyethylene
IEC	–	information, education and communication
IEE	–	initial environmental examination
MONRE	–	Ministry of Natural Resources and Environment
MPWT	–	Ministry of Public Works and Transport
PIU	–	project implementation unit
PIC	–	project implementation consultant
PCU	–	project management unit
PPE	–	personal protective equipment
PPTA	–	project preparatory technical assistance
PTRI	–	Public Works Transport Research Institute
SES	–	socio-economic survey
SPS	–	Safeguard Policy Statement
SWTP	–	small-scale wastewater treatment plant
UDAA	–	Urban Development Administrative Authority
USD	–	United States dollar
UXO	–	unexploded ordinance
WWTP	–	wastewater treatment plant

UNITS OF MEASURE

ha	–	hectare
km	–	kilometer
m	–	meter
m^3	–	cubic meter
tpy	–	tonne per year

NOTES

(i) The fiscal year (FY) 2018 of the Government of the Lao People's Democratic Republic and its agencies ends on 31 December 2018.

(ii) In this report, "$" refers to United States dollars.

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EXECUTIVE SUMMARY

A. Introduction

1. The Fourth Greater Mekong Subregion Corridor Towns Development Project (GMS-CTDP-4, or Project) will support the governments of Cambodia and the Lao People's Democratic Republic (Lao PDR) in enhancing the competitiveness of towns located along the Central Mekong Economic Corridor in the GMS. The Project will support at least three of the seven strategies of the ten-year Socio-economic Development Strategy (2016–2025),[1] and also contribute to one of the five key government directions of the 8th Five-Year National Socio-Economic Development Plan (2016–2010).[2]

2. In Lao PDR, the Project will cover the districts of Pakxan and Thakhek in the provinces of Borikhamxay and Khammouane, respectively (Figure 1). Both districts lie along National Road 13 (NR 13) and are located on the banks of the Mekong River. The districts have significant economic potential given the strategic road network that provide access to Thailand and Vietnam. However, the districts suffer from perennial flooding due to lack of adequate drainage system. There are also problems on solid waste management, environmental sanitation, and wastewater disposal that need to be addressed to sustain socio-economic competitiveness.

3. This report is the draft initial environmental examination (IEE) and environmental management report (EMP) for the proposed CTDP-4 – Thakhek Subproject. The IEE and EMP were prepared following the Safeguard Policy Statement (June 2009) of the Asian Development Bank (ADB) and Environmental Protection Law 2012 (No. 29/NA) of Lao PDR and its implementing guidelines.

B. Description of the Subproject

4. The proposed infrastructure components in Thakhek are as follows:

Component	Description
1. Storm water drainage improvement	• Extension of five sections of open channels with total length of 9.85 km to serve a total drainage area of 650.6 ha • Rivergate for Houay[3] Simang • Four pumping stations
2. Small-scale wastewater treatment plants (SWTPs) for treatment of black water only	• Four medium-sized SWTP systems of 200m^3/d capacity located at: A. Close to Old town area; sewer length 2267m with 150mm diameter B. Hospital grounds; sewer length 1585m with 150mm diameter C. Local bus station and market; sewer length 2139m with 150mm diameter D. Provincial bus station; sewer length 833m with 150mm diameter • Free household connections to 2,240 HHs in 2020

[1] Namely (i) strategy on quality, inclusive, stable, sustainable and green economic growth, (ii) strategy on 'least developed country' graduation by 2020 and progress on the sustainable development goals, and (iii) strategy on sustainable and green environment with effective and efficient use of the natural resources.

[2] Ensuring sustainable development with harmonization between economic development, socio-cultural development and environmental protection.

[3] Houay refers to river or stream.

Component	Description
3. Thakhek municipal solid waste-controlled landfill	• Controlled landfill with 307,751 m3 capacity of compacted wastes over 14-15 years (to Year 2035), with 3 cells and associated site roads and drains and septage treatment plant. • Six waste collection and compaction vehicles • One crane for handling recyclables.
4. Riverbank protection along Mekong River	• Four sections along Mekong River: o Inside Thakhek center, 850m o To the north of the aforementioned section up to further 1000m o South of the town, from end of existing riverbank protection o Continue to 2384m further from previous section with a 300m break at the That Sikhotttabong temple area
5. Heritage conservation	• Renovation of. central town square • Renovation of old post office building • Signage and wayfinding hardware.

5. The subproject will also enhance institutional capacities of the Executing Agency and Implementing Agency officials through the following interventions:

- Training on SWTP, solid waste management (SWM), and urban asset operation and maintenance (O&M)
- Support to project management, construction supervision, and social and environment safeguards monitoring
- Awareness raising campaign
- Formulating the provincial town master plan.

C. Key Findings

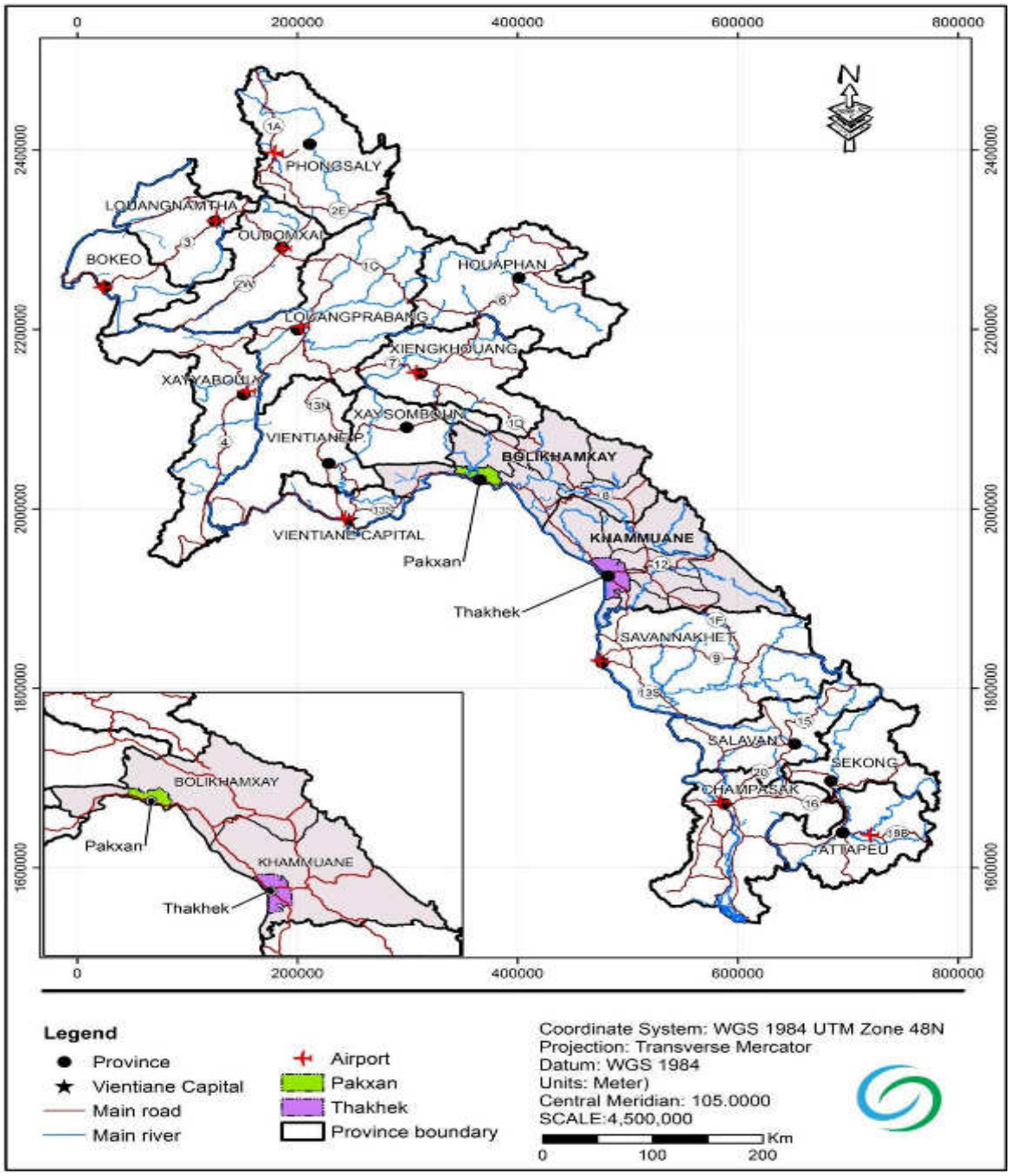
6. **Environmental benefits, positive impacts and results.** The Thakhek subproject will provide the town with improved stormwater, small-scale wastewater treatment plants and solid waste management, better protection of the banks of the Mekong River and architectural heritage, strengthened institutional capacities, and a 5-year provincial development strategy. The positive impacts include: reduced flood risk and incidence of diseases; reduced pollution to the Mekong River; improved water quality and environmental sanitation; controlled greenhouse gas (GHG) emissions from solid waste disposal; reduced air, water and land pollution; improved social equity from access by all to recreational amenity; and urban growth in a more sustainable direction. The subproject will also lead to: (i) improved climate resilience; (ii) reduced vulnerability to climate risks; and (iii) enhanced quality of life and livability.

7. **Stormwater Drainage Improvement.** The proposed drainage improvement works will follow the natural drainage pattern, hence, impacts on diversion of flow is not foreseen. The assimilative capacity of the receiving water bodies will be assessed further during detailed design to ensure that flooding in the downstream areas due to the extension of the current road drains is avoided. There are also some structures, shops, and agricultural land that may be affected during the implementation of the project. Potential impacts on irrigation systems (if any) will have to be assessed during detailed design.

8. There are four pumping stations to be provided as part of the stormwater drainage component. Temporary nuisance to the surrounding areas due to noise during operation of the pumping stations may occur. To minimize noise, the pumps will be placed in an enclosed

building/room and regular maintenance will be undertaken on the pump units.

Figure 1: Location Map



9. **Small-scale Wastewater Treatment Plants (SWTPs).** This component will include the construction of the four SWTP units and the laying of sewer lines along road easements to channel and treat black water from the service area.

10. The sewer lines will be laid along road easements and will affect drainage lines, sidewalks,

driveways, electric poles and water lines during pipe laying. Coordination with affected agencies, utility companies and stakeholders will be undertaken during detailed design. Restoration of damaged road easement, sidewalks, and driveways will be undertaken after the laying of the sewer lines.

11. The impacts of the SWTPs will be generally positive because treatment of domestic sewage will avoid pollution of waterbodies and reduce incidences of water-borne and water-related diseases caused by unsanitary practices and exposure of the people to untreated wastewater. The operation of the four SWTPs is expected to reduce the BOD concentration being discharged into receiving bodies of water by >300mg/l or about 90% reduction in BOD concentration.[4] By treating wastewater, the project will avoid water pollution and contribute to the clean-up of the receiving water bodies. Table 6 presents the resulting effluent quality before and after treatment.

12. Effluent from all the SWTP units should conform to the allowable effluent standards to avoid impacts on the uses of the receiving stream and Mekong River. Regular monitoring of effluent quality should form part of the operational monitoring parameters to ensure that discharges are complying with the prescribed standards as embodied in the Mekong River Commission Guidelines for the Protection of Aquatic Life and the National Environmental Standards No. 81/NA (21 February 2017).

13. The SWTP at the Old Town Area will be near the confluence of two streams and a drainage canal. The site is about 2 -3 meters below the street level and is prone to flooding, with flood waters reaching up to 1.5 – 2 meters above the current ground level. The location of the site will be evaluated further during detailed design to determine flood risk and if flood retaining walls will be necessary to avoid scouring of land. Soil tests will also be undertaken to confirm the foundation to be designed for the structures. In terms of hydrology, the discharge of 200m^3/day from the SWTP A will not have an impact on Mekong River since it is large enough to accommodate the flow from the SWTP.

14. The SWTP within the Khammoune Provincial Hospital compound will drain into an intermittent creek that is about 200m away from the Mekong River. There is no foreseen impact on the capacity of the receiving stream since it can accommodate the small flow from the SWTP. The site is not prone to flooding.

15. The SWTP at the local bus station and market in Ban Nongboukham will drain into an open canal leading to a creek that eventually discharges into the Mekong River. The capacity of the open drainage canal to receive the daily effluent discharge from the SWTP will be evaluated further during detailed design.

16. The SWTP in Ban Souksavanh will be located in an open area behind the inter-provincial bus station. The effluent outfall of this SWTP will be the nearby a natural drainage retention area or wetland. The said drainage retention area is also the receiving point of runoff from the surrounding areas. There are no known uses of the retention area except as recipient of runoff from the catchment area. The SWTP site is not prone to flooding but the hydrology of the catchment area and capacity of the natural drainage retention area or wetland will be evaluated further during detailed design to ensure that the discharge from the service area of Ban Souksavanh through the outfall of the SWTP will not induce flooding in the surrounding areas.

[4] Based on BOD inflow concentration of 333 mg/l and effluent concentration of 29 mg/l following treatment. See Table 6.

17. The operation of the SWTPs may result to changes to natural surface hydrology and drainage pathways and risk of pollution if facilities are flooded. These impacts will be addressed at final design phase through (i) detailed hydrological assessment to ensure that the final designs fully accommodate and mitigate impacts on natural hydrology, and (ii) the bunds and raised elevations of the SWTP units above potential flood levels are incorporated in the design.

18. **Controlled Landfill.** The controlled landfill will be located in a secondary forest area near the site of the existing dumpsite. The landfill site is within a 95-hectare land that is owned by the province. Access to the site is through National Road 13 (NR13) South in Ban Nabuok.

19. There are waste pickers at the existing dumpsite. Four of the waste pickers have constructed temporary huts inside the dumpsite and allow family members, including children to help in waste picking. The waste pickers salvage reusable or recyclable materials such as metal (copper, aluminum, iron, etc.), water bottles, plastic items, and paper from the dumpsite and sell these to the guard at the dumpsite. Except for the waste picker households who are staying at the dumpsite, there are no residential communities within 500-meter radius from the landfill site. The nearest establishments to the site are two concrete batching plants located more than 200 meters away from the site. The closure plan of the existing dumpsite will involve the transfer of existing wastes to the new lined waste cell of the proposed landfill. The plan also includes the relocation of the households and measure to enhance occupational safety and livelihood security for existing waste pickers. The waste pickers will be allowed to continue their livelihood activities at the site, however, they will be trained and will be required to abide by the guidelines set out by the management of the landfill to ensure their safety. All waste pickers should be required to wear protective gear such as rubber gloves, rubber boots, and crush helmets. Minors will not be allowed to enter the landfill site.

20. There are no nearby water bodies that may be affected in the immediate vicinity of the landfill but groundwater quality sampling from the existing well at the dumpsite indicated exceedances with the Lao PDR drinking water quality standards in terms of Pb, As, Cd, NO3, total coliform, E. coli, and fecal coliform. The results of the groundwater sampling were disclosed during the meeting with the Provincial Governor in April 2018. The households inside the existing dumpsite were advised during site surveys that groundwater is contaminated and is not safe for drinking. Groundwater monitoring will continue during project implementation with additional monitoring stations at the downgradient and upgradient of the landfill site. Persons living in the project area of influence will be kept informed on the monitoring results.

21. The identified potential impacts of the controlled landfill include the clearing of vegetation, accidental discovery of mine/UXO, soil runoff, and odor during mining or transfer of existing wastes to the new waste cells due to ongoing decomposition of wastes. The concerns and potential impacts during controlled landfill operation include: (i) generation of dust, gas, fumes and odor; (ii) greenhouse gas emissions; (iii) potential groundwater and soil contamination from leachate and landfill gas migration; (vi) pests/rodents/vermin, bird and stray animal attraction; (vii) wind-blown litter; (viii) fire/explosion; (ix) community health and safety; and (x) workers' health and safety hazards.

22. The design of the controlled landfill will prioritize key mitigation features that includes (i) surface grading and covering of exposed waste cell surfaces to improve controlled runoff and reduce erosion, and (ii) site perimeter drains to control surface water run-on and runoff. An Environmental Compliance Audit (ECA) will be undertaken on the existing dumpsite during the detailed engineering phase to determine areas for improvement in the operation of the proposed

landfill.

23. During the construction and operational phases, the impacts of the controlled landfill on groundwater, air quality and soil quality will be monitored by establishing monitoring stations at the landfill site and surrounding areas. Workers will also be trained on waste handling and recording, and wearing of personnel protective equipment while working at the site. A fire protection system to manage occasional landfill fires during the dry season will be provided and a materials recovery facility (MRF) at the landfill site will be established to temporarily store collected recyclables to be sold to buyers.

24. **Riverbank Protection.** The riverside embankment protection works are proposed in four sections along the Mekong River. These riverbank sections have experienced flooding and bank erosion in the past, hence, require protection against potential future flooding. The proposed riverbank protection will strengthen and raise the riverbank. There are sections where some fruit trees may be affected. There are about 26 households that will be relocated in one section of the riverbank protection works, these impacts are addressed in a resettlement plan. Cutting of trees will be avoided to the extent possible. Should there be a need to cut trees, the DPWT will coordinate with the Forest Department on the removal of affected trees and any required compensatory planting.

25. During the construction of the riverbank embankments, possible blocking of one lane of adjacent roads may occur particularly during delivery of construction materials to the site. Vehicle movement is not heavy at the adjacent roads but a traffic management system will be implemented to guide motorists during temporary lane blocking. Construction activities may also cause erosion and pollution impacts on the Mekong River, hence, erosion control and water quality protection measures are specified in the EMP.

26. **Heritage Conservation.** The impacts of the heritage conservation component will be largely positive. Adverse impacts will primarily occur during the construction phase which are site-specific and can be easily mitigated through best construction practices.

27. Prior to construction, there will be a need to obtain UXO clearance, conduct baseline environmental studies that includes ecological survey and hydrological assessment of the natural drainage retention area near the provincial bus station, environmental sampling (ambient air, noise, groundwater quality, soil quality, as presented in the EMP), operationalize a grievance redress mechanism, update the IEE and EMP based on detailed engineering design, obtain relevant DONRE/MONRE approval of IEE/ESIA, and incorporate the EMP in procurement documents. During detailed design phase, the environmental issues associated with the existing dumpsite such as groundwater pollution, will be reviewed and addressed in the design of the controlled landfill. The update of the IEE/EMP for ADB will include supplementary baseline assessments,[5] public consultations and conduct of ECA on the existing dumpsite facility.

28. **Air Quality.** The controlled landfill will generate landfill gas.[6] These gases are formed through organic decomposition processes within waste masses, with decomposition being accelerated through saturation due to the ingress of precipitation and surface waters. The transition from uncontrolled open dumping to controlled landfilling will however reduce the impacts of LFG generation and emission to some extent, due to (i) surface covering (capping) system,

[5] These include for example, the sampling and analysis of biodiversity, air quality, surface waters, groundwater, soils (vadose zone), noise, wastewater effluents.

[6] LFG includes the primary greenhouse gases (GHGs) of carbon dioxide, methane and nitrous oxide.

thus reducing surface water inundation, and (ii) through the controlled venting of LFG from the facility, which will reduce fire and explosion risks.[7]

29. Using the IGES tool, the estimated GHG emission from the controlled landfill operation, as designed, is 982,409.93 kg of CO_2/monthly managed waste. A simulation was made to see how much emission would be saved if the following measures would be implemented by the project:

- Waste to be collected is reduced by 15% due to active recycling at source.
- Waste collection frequency is every other day except for market waste.
- Composting of about 20% of the waste collected at the landfill site.

30. The simulation revealed a reduction of greenhouse gas by 74.05% as compared to the current open dumping of wastes.

31. **Odor**. The handling of organic wastes at the SWTPs and controlled landfill will generate odor. The SWTPs will be sited away from major receptors and the sites will have berms and tree lines to act as buffer against odor. The controlled landfill in Thakhek is not located near community areas (except for the 6 households inside the dumpsite who will be relocated). Odor is expected to be minimized with the operation of the controlled landfill as compared to the current open dumping activities. The odor control measures include the soil covering of wastes to significantly reduce odor and planting of trees around the landfill site to act as buffer against odor.

32. **Hydrology.** The consolidated flows from the stormwater road drains and sewer network would have an impact on the receiving water bodies in terms of effects on assimilative capacity of the receiving water, uses, and water quality. The assimilative capacity of the receiving water bodies will be further assessed during detailed design to ensure that flooding will not be induced in the downstream areas. Climate risk mitigation options will be considered during detailed design such as the detailed analysis of historical and projected future flood levels taking into account climate change, increasing rainfall intensities, and land use changes.

33. There is no anticipated problem in terms of the hydrological capacity of the Mekong River to accommodate the effluent discharges from the SWTPs because the river is very large as compared to the minimal volume of effluent to be discharged from the SWTP units.

34. The locations of the SWTP at the Old town square in Thakhek Khang village and the SWTP near the provincial bus station in Souksavanh village are in areas that are prone to flooding. The SWTP units will be raised to an elevation that is above conventional flood levels to protect the units against potential overflowing of adjacent water bodies. Factor of safety will be incorporated based on detailed analysis of the flood situation. Bunds around the SWTP units will be provided.

35. The SWTP facilities will be designed to meet national standards for effluent discharge. These include (i) specifying maintenance procedures in SWTP operations manuals, (ii) ensuring adequate budget and equipment for routine maintenance activities, (iii) removing flow obstructions in the sewer system, (iv) conducting operator training for SWTP operations and maintenance (O&M), and (v) monitoring water quality of the effluent to receiving water bodies following an overflow event.

[7] In the future, it may be feasible to install LFG flaring systems at the controlled landfill, however at the present time, such installation would be difficult due to the challenges in capture such small quantities of generated LFG, and the excessive cost of the system.

36. **Water Quality.** The subproject components that will cause impacts on water quality are the SWTPs and the controlled landfill. The SWTP impacts on water quality are generally positive since it will avoid pollution of receiving water bodies. Regular maintenance of the SWTPs should be undertaken to ensure that effluents conform with the prescribed discharge standards.

37. Surface water quality impacts at the controlled landfill (during operations) include: (i) surface water run-on,[8] (ii) waste water runoff, (iii) waste mass inundation, and (iv) discharge of leachate. Surface water run-on and runoff will be mitigated through the provision of perimeter drains. The potential for waste mass inundation from precipitation will be mitigated through the provision of cover materials over waste mass surfaces, and drainage of these areas through the contouring of surfaces and installation of surface drains to encourage flow. Completed waste mass surfaces can also be vegetated to reduce cover material erosion.

38. Leachate may impact surface waters by its migration through the sidewalls and bases of the landfill. This will be mitigated through provision of base liners to capture leachate which will be collected in a leachate pond for landfill reticulation.

39. **Groundwater.** A failure of the integrity of the sewer systems, the SWTPs and the controlled landfill could result in leakage of untreated or partially treated wastewater effluents, which in turn could percolate into and contaminate soil and the underlying groundwater. These impacts will be mitigated however by ensuring system design and operation integrity through both the facility designs (that provide for system sustainability) and facility O&M procedures, which are supported by training, monitoring and evaluation.

40. **Disposal of sludge from SWTPs**. The SWTPs will be designed with anaerobic tanks to treat wastewater delivered from the sewer lines. Based on the conceptual plan of the wastewater treatment plant, sludge will be removed annually or every two years. Using the anaerobic system and with the low volume of wastewater to be treated in each SWTP unit, sludge generation is expected to be minimal at about 4.48 m3/year[9] (total) for all the four SWTPs. Sludge from anaerobic treatment is largely inert, can be dried and landfilled or applied to agricultural land. During the first two years of operation of the SWTPs, sludge that will be collected will be analyzed in terms of bacterial content before these are applied to agricultural land. If the results show consistent absence of bacterial contamination, only then can this be applied to agricultural land, otherwise, sludge will only be dried and landfilled.

41. **Health and Safety Aspects**. Operations and maintenance (O&M) activities of the SWTPs and controlled landfill pose risks to the health and safety of workers. These risks will be mitigated through preparation of an operations manual for the SWTP and controlled landfill, which shall include an occupational health and safety plan (OHSP) and capacity building program.[10]

D. Environmental Management Plan

42. The EMP will serve as the framework for the environmental management of the subproject, commencing from the detailed design phase through to operation and if applicable, decommissioning. The EMP addresses the potential impacts and risks identified in the IEE. It includes: (i) mitigation measures; (ii) monitoring measures; (iii) implementation arrangements and

[8] Surface water run-on is the movement of surface water onto the site.
[9] Sludge generation rate is estimated at 0.0056 m^3 per m^3 of wastewater per year.
[10] Based on the Environmental, Health and Safety Guidelines for Water and Sanitation of the International Finance Corporation, dated 10 December 2007.

responsibilities; and (iv) preliminary costs for EMP implementation. The EMP will be updated by the Project Management Unit (PMU) based on the detailed design, with technical assistance from the Environmental Specialists of the Project Management and Construction Supervision (PMCS) Consultant.

43. The EA will ensure that the subproject complies with the environmental requirements and standards as stipulated in the Law on Environmental Protection No. 29/NA and other Ministerial Instructions and directives. An Environmental and Social Impact Assessment (ESI) report for the controlled landfill component will be submitted to MONRE to secure the Environmental Compliance Certificate (ECC) prior to project implementation while IEE reports will be prepared for the components on drainage improvement, riverbank protection and SWTPs. The IEE reports are to be reviewed by the DONRE in securing approval of the ECC for the subproject components prior to implementation.

44. A Project Implementation Consultant (PIC) with Environment Specialists (1 international and 1 national) will be commissioned to provide support to MPWT and DPWT. Sufficient budget through the PIC will be allocated for the conduct of baseline studies and ECA, updating of the IEE, preparation of IEIA and EIA for DONRE/MONRE, implementation of the EMP and environmental monitoring plan and post-closure monitoring of existing dumpsite. The PIC will work in close coordination with the Public Works and Transport Research Institute (PTRI) of the MPWT in ensuring the project's compliance with environmental safeguards identified in the EMP. An Environment Safeguards Officer under the PTRI will be engaged and assigned to the project to sustain the environmental management and monitoring activities of MPWT. Capacity building program on environment safeguards will be undertaken by the PIC through hand-on training for the PTRI, Project Coordinating Units (PCUs), Project Implementation Units (PIUs), and other relevant units and agencies.

E. Conclusion

45. The IEE concludes that the proposed subproject components in Thakhek are not environmentally critical and not located in an environmentally sensitive area. Overall, the subproject components in Thakhek are not expected to have long-term permanent, irreversible adverse impacts. Any adverse impacts can be mitigated through design and engineering interventions. There are no significant adverse environmental impacts resulting from the subproject that cannot be mitigated if implemented effectively and efficiently. The subproject is expected to improve the urban environment in Thakhek, reduce pollution impacts, reduce vulnerability to environmental and climate risks, improve health and support a more sustainable development path for the future.

46. The proposed EMP will mitigate impacts on the natural environment and affected people to an acceptable level. The adverse impacts during construction will be temporary and short-term (i.e. most likely to occur only during peak construction period) and can be readily mitigated with effective implementation of mitigation and monitoring measures. The SWTPs and landfill operations will be guided by respective operations manuals. Institutional capacities will be strengthened through continued capacity development.

47. In terms of climate risk, given their nature, the proposed components will be vulnerable to climate change particularly the SWTP for the Old town square which experience flooding annually, either partly or fully at the SWTP site near the provincial bus station and a wetland. Hence, it is important that the components are designed to ensure flood resilience. The proposed components will be optimally engineered to avoid and/or minimize adverse impacts to surrounding

communities and to ensure resilience to climate risks. Detailed analysis of historical and future flood levels, rainfall intensities taking into account climate change to determine appropriate factors of safety, will be considered in the design.

48. Mitigation measures that have been integrated in the preliminary design to address climate risks are: (i) raising of banks of the open channels by 1 m above ground and enlargement of channel; (ii) provision of larger pumps for the four flood gates; (iii) concreting of roads and installation of larger drains at the controlled landfill; (iv) leachate recirculation; (v) raising of river embankment by 1 m; and (vi) use of geotextile layers under gabion blankets for the river bank protection. Additional measures to improve flood resilience will be considered during detailed engineering design, as set out in the Climate Risk and Vulnerability Assessment report and as presented in summary in this IEE.

49. Based on the above conclusions, the classification of GMS-CTDP-4 Thakhek Subproject as Category B for environment is confirmed. This IEE and EMP will be updated and finalized during detailed engineering design. Baseline environmental studies that includes assessment of impacts on hydrology, groundwater, surface water, air quality, noise, ecology, and soil quality will be conducted as part of the updated IEE. Information disclosure and follow-up public consultations will be undertaken with affected stakeholders during detailed design in accordance with ADB's Public Communications Policy. As required by ADB SPS (2009) for existing facilities, an environmental compliance audit (ECA) will be undertaken on the existing dumpsite to determine existence of areas which may cause or is causing environmental risks or impacts and to identify corrective actions to address the environmental issues and ensure that these are avoided or addressed during subproject implementation.

I. INTRODUCTION

A. Background

1. The GMS-CTDP-4 or Project will support the governments of Cambodia and the Lao People's Democratic Republic (Lao PDR) in enhancing the competitiveness of towns located along the Central Mekong Economic Corridor in the GMS.

2. The Project will improve urban services and competitiveness in the participating towns, namely, Pakxan and Thakhek in Lao PDR. Both towns lie along National Road 13 (NR 13) and are located on the banks of the Mekong River. In Thakhek, the Project will include urban infrastructure improvements, particularly (i) storm water drainage, (ii) small-scale wastewater treatment plants, (iii) municipal solid waste-controlled landfill, (iv) riverbank protection along the Mekong River, and (v) heritage conservation. It will also support the development of institutional capacities for enhanced regional economic connectivity, particularly through the formulation of the next provincial 5-year strategic development plans.

3. The Project will support at least three of the seven strategies in the Ten-Year Socio-economic Development Strategy (2016–2025) of Lao PDR, namely: (i) quality, inclusive, stable, sustainable and green economic growth; (ii) "least developed country" graduation by 2020 and progress on the sustainable development goals; and (iii) sustainable and green environment with effective and efficient use of the natural resources. The Project also contributes to one of the five key government directions of the 8th Five-Year National Socio-Economic Development Plan (2016-2010) to ensure sustainable development in harmony with economic development, sociocultural development and environmental protection.

4. This report is the IEE and EMP for the proposed GMS-CTDP4 – Thakhek Subproject.

B. Purpose of the Report

5. This IEE and EMP have been prepared according to the Safeguard Policy Statement (June 2009) of the Asian Development Bank (ADB), and the Environmental Protection Law 2012 (No. 29/NA) of Lao PDR and its implementing guidelines. This IEE and EMP: (i) identify and assess potential impacts and risks arising from the implementation of the proposed subproject on the physical, biological, physical cultural and socioeconomic environment and (ii) recommend measures to avoid, mitigate, and compensate for adverse impacts and enhance positive impacts.

6. The IEE is based on relevant reports/documents, site reconnaissance, consultations with communities, and meetings and discussions with the government agencies.

II. POLICY, LEGAL, AND ADMINISTRATIVE FRAMEWORK

A. Lao PDR Safeguard Systems

7. **Policy Framework.** The Government of Lao PDR has enacted policies and legislation that provide the framework to manage its natural and physical cultural resources; protect the environment for the health and well-being of its people; and achieve its international, regional and sub-regional commitments. This is contained in the following key policy documents:

(i) The 8th Five-Year National Socio-Economic Development Plan (2016-2020) is Lao PDR's guiding strategic document which ensures sustainable development in harmony with economic development, socio-cultural development and environmental protection.
(ii) National Vision 2030, which targets effective environmental protection and sustainable natural resources management by 2030, among others;
(iii) National Socio-Economic Development Strategy 2016–2025, comprising seven strategies including quality, inclusive, stable, sustainable and green economic growth, and sustainable and green environment with efficient use of the natural resources.
(iv) The 2030 Agenda for Sustainable Development which are mainstreamed into all three aforementioned policies.

8. The Strategy on Climate Change of the Lao PDR, March 2010 outlines the approach for mainstreaming climate change in the 7th Five-Year National Socio-Economic Development Plan (2011–2015). Furthermore, sector level policies that seek to preserve and expand cultural and national heritage resources; protect natural resources and biodiversity; and develop and promote environmental and social assessment are contained in the National Urban Sector Strategy (2012), and in the National Environment Strategy to the Year 2020.

9. **Legal Framework.** The principal legislation on environmental safeguard is the Environmental Protection Law 2012 (No. 29/NA). This law requires every private and public investment project to undergo either an initial environmental examination (IEE) or an environmental impact assessment (EIA) and prepare the corresponding report for MONRE clearance prior to consideration and approval by the Government of Lao PDR. The law is supported by the:

(i) Ministerial Agreement on the Endorsement and Promulgation of List of Investment Projects and Activities Requiring the Conduct of Initial Environmental Examination or Environmental and Social Impact Assessment (No. 8056/MONRE), 2013, which categorized projects and activities into two groups based on type and scale.[11] Table 1 screens the proposed activities under the Project following the provisions of this Agreement.
(ii) Ministerial Instruction on the Process of Initial Environmental Examination of Investment Projects and Activities (No. 8029/MONRE), 2013, provides the guidelines on the preparation, review and approval process for IEEs.[12]
(iii) Ministerial Instruction on the Process of Environmental and Social Impact Assessment of Investment Projects and Activities (No. 8030/MONRE), 2013, provides the guidelines on the preparation, review and approval process for ESIAs.[13]

[11] Group 1 projects and activities are required IEEs; Group 2, ESIAs. The Agreement stipulates that investment projects involving compensation and resettlement of people as specified in the Decree on Compensation and Resettlement of People Affected by Development Projects (No. 192/PM), dated 07 July 2005, or in any superseding legislation, will require ESIA.

[12] An approved IEE is granted an environmental compliance certificate (ECC), a required document prior to construction.

[13] An approved ESIA is granted an environmental compliance certificate (ECC), a required document prior to construction.

Table 1: Screening of Proposed Activities Using Ministerial Agreement No. 8056/MONRE

TOWN/Proposed Activities [a]		Required Assessment	
		IEE	ESIA
THAKHEK			
Drainage improvement			
5 open channels	9.85 km	Not in the Agreement's list of activities. MONRE will assess based on the designs and PPTA's IEE to determine the appropriate EA requirement.	
Riverbank protection			
4 stretches	3.16 km	Not in the Agreement's list of activities. MONRE will assess based on the designs and PPTA's IEE to determine the appropriate EA requirement.	
Solid waste management			
Controlled solid waste disposal facility	Includes medical waste incinerator and separate cells for medical waste		√
Wastewater management			
SWTP in Old Town Square	200 m^3/d	Not in the Agreement's list of activities. MONRE will assess based on the designs and PPTA's IEE to determine the appropriate EA requirement.	
SWTP at Hospital compound	200 m^3/d		
SWTP at local bus station and market	200 m^3/d		
SWTP at provincial bus station	200 m^3/d		

* Proposed scopes/lengths/numbers were obtained from Final Report - Technical Annex v9. May 2018. PPTA Engineering Team.

10. Other laws, regulations and guidelines that will apply to the activities under the Project include: (i) the Law on Water and Water Resources 1996, (ii) Law on National Heritage 2005, (iii) Labor Law 2013, (iv) Law on Hygiene, Disease Prevention and Health Promotion 2011, (v) Land Law 2003, (vi) The revised Law on Public Roads 2016, (vii) Decree on the Compensation and Resettlement Management in Development Projects 2016, and (viii) Decree on Disposal Site Management 207. A summary description of these legal issuances and their relevance to the project activities is presented in **Appendix B**. The IEE applies the environmental quality standards presented in **Table 2**. **Appendix C** compares the limits set in the national standards against those of international standards featured in the Environmental, Health, and Safety Guidelines (EHSG)[14]. The more stringent limit will apply.

[14] Environmental, Health and Safety General Guidelines, 30 April 2007; Environmental, Health and Safety Guidelines for Water and Sanitation, 10 December 2007; and Environmental, Health and Safety Guidelines for Waste Management Facilities, 10 December 2007. IFC. WBG. These are currently being updated.

Table 2: Key Standards to Apply in the IEE

Particular	National Environmental Standard (No. 81/NA) 21 February 2017		International Standard
Ambient air quality	Table 5	General Ambient Air Quality Standard	WHO Air Quality Guidelines, global update 2005
Noise	Table 15	General Noise Standard	WHO Guidelines for Community Noise, 1999
Surface water quality	Table 10	Standard for Surface Water Quality	US EPA National Recommended Water Quality Criteria
			MRC Technical Guidelines for the Protection of Aquatic Life
			MRC Technical Guidelines for the Protection of Human Health
Groundwater quality	Table 11.1	Groundwater Standard for Domestic Consumption	WHO Guidelines for Drinking-water Quality, Fourth Edition, 2011
Soil quality	Table 8.2	Soil Quality Standard for Other Purposes	-
Wastewater discharge	Table 14.4	Standard of Pollution Control to River from Toilet	EHSG for Water and Sanitation, 2007
	Table 14.5	Standard of Pollution Control to River from Public Drainage	EHSG for Waste Management Facilities, 2007

11. Lao PDR is committed to the Sustainable Development Goals 2030 and has adopted the Sendai Framework for Disaster Risk Reduction 2015-2030. At the regional level, it is party to the ASEAN Agreement on Transboundary Haze Pollution, while at a sub-regional level, to the Mekong Agreement.[15] The country is also party to relevant international environmental agreements, namely:

(i) UNESCO World Heritage Convention
(ii) UN Framework Convention on Climate Change and its associated Kyoto Protocol and Paris Agreement
(iii) Basel Convention on the Control of Transboundary Movements of the Hazardous Wastes and Their Disposal; and
(iv) Vienna Convention for the Protection of the Ozone Layer and its Montreal Protocol on Substances that Deplete the Ozone Layer and all Amendments.

12. **Administrative Framework.** The Ministry of Natural Resources and Environment (MONRE) is the national environmental management agency. It reviews and approves Environmental and Social Impact Assessment (ESIA) reports which are handled and processed by its ESIA Department. The supporting agencies are as follows:

(i) Provincial or Capital DONRE, which reviews and approves IEE reports.
(ii) District or Municipality Offices of Natural Resources and Environment; and
(iii) Village Units of Natural Resources and Environment.

13. **MONRE Prescriptive Periods for IEE and ESIA Reports.** The MONRE has issued the

[15] Agreement for sustainable development, utilization, management and conservation of water and related resources of the Mekong River Basin, and to the minimization of harmful effects that might result from natural occurrences and man-made activities.

following prescriptive periods for both reports:

(i) Ministerial Instructions No. 8029 prescribes: (a) 10 business days to review the accuracy and comprehensiveness of an IEE Report from the date of receipt, and (b) should revision not be required, another 40 business days from the date of receipt of 15 or more hard and electronic copies of the report for review, incorporation of comments from relevant institutions, and decision making.
(ii) The Ministerial Instructions No. 8030 prescribes: (a) 10 business days to review the accuracy and comprehensiveness of an ESIA Report from the date of receipt; (b) should revision not be required, another 55 business days from receipt of 15 or more hard and electronic copies of the report for compiling reviews, forwarding comments to the Project Proponent for reference in finalizing the report, and (c) another 40 business days from receipt of Final ESIA Report for decision making.

B. ADB Safeguard Policy Statement (SPS)

14. All projects funded by ADB must comply with SPS 2009 to ensure that these are environmentally sound, are designed to operate in compliance with applicable regulatory requirements, and are not likely to cause significant environmental, health, or safety hazard. Depending on the type, location, scale and sensitivity and magnitude of its potential environmental impacts, projects are categorized as either, Category A, B, or C which dictates whether and IEE or EIA is required.

15. This Project is classified as environment Category B as impacts are site-specific, few, if any of them are irreversible, and in most cases mitigation measures can be readily designed. This requires an IEE and EMP. The IEE is based on primary and secondary information and data, including from published reports. Public consultations with government stakeholders, key stakeholders and affected persons was undertaken and site reconnaissance was conducted to determine community perceptions on the subproject and to obtain relevant information.

16. The report structure follows the format outlined in Appendix 1 of the SPS. In line with ADB's Public Communications Policy, ADB will post the IEE reports and environmental monitoring reports submitted by the borrowers/clients during project implementation on ADB website. Translations of the EMPs will be made available at PIU offices.

III. DESCRIPTION OF THE PROJECT

A. Rationale

17. The GMS-CTDP-4 focuses on the eastern branch of the Central GMS Corridor where Thakhek town, the capital and most populated town of Khammouane Province is located. Lying approximately half way between Vientiane and Savannakhet along National Road 13, it acts as the key transport hub for southern Lao PDR. Thakhek also sits at an important junction between National Roads 12 (to Vietnam) and 13 (to Cambodia) with the Third Thai–Lao Friendship Bridge to Nakhon Phanom in Thailand just north of the town.

18. Recent development in the area has focused on the new Mekong bridge crossing, in association with the recently formed special economic zone (SEZ) (14 km north of town) as well as general expansion of the town along existing routes to the north, east and south. An upcoming

feasibility study[16] on a railway from Vientiane to Thakhek and then to Vietnam, if it develops into a project, could attract more trade and visitors to the town.

19. Thakhek's economy is underpinned by the development of government services and associated construction, trade, transport, and tourism. There is little in the way of endogenous growth industries, since most goods and services are imported. The development of the town is significantly affected by the ability to generate economies of scale with a limited number of firms, and to specialize in the agriculture, tourism, and education services industries.

20. Thakhek has significant potential to be a tourist center given its surrounding attractions, cultural heritage, architectural character, and strategic location along the Mekong adjacent to Thailand. Urban renewal and heritage conservation initiatives in the old town area can further enhance tourism. From 2010–2014, there has been increased tourist arrivals to the country, from 2.7 million to 4.1 million.[17]

21. Despite the significant development prospects potentially available to Thakhek, it faces significant challenges brought about by deficiencies in urban infrastructure and services. Inadequacies in drainage, wastewater treatment, sanitation, solid waste management, and riverbank protection are threatening the environment and creating environmental risks for the public. Thakhek experiences regular typhoons with continuing strong rains for many days that cause flooding. This is aggravated by blocked drains caused by solid waste. Riverbank erosion occurs because the bank embankment is limited and inadequate to hold the strong flow of water. Only 18% of HHs have access to sewerage or drainage and 8% to open canal drains based on the household survey. Some households dispose toilet waste directly to drains causing water pollution and foul smell. Solid waste collection problems in their area are considered serious by 57% of households.

22. In line with ADB's country partnership strategy (CPS) for the Lao PDR, 2017–2020 and its geographic focus along the GMS economic corridors, a project roadmap framework has been prepared which entailed analyses on the degree of competitiveness and connectivity of the towns and cities along the Central Mekong Economic Development Corridor (CMEDC).[18] This determined the scope and priorities of the subproject, which include the following:

(i) storm water drainage, to mitigate against flooding and improve public health;
(ii) small-scale wastewater treatment systems for improved sanitation in the town;
(iii) municipal solid waste management, to improve collection coverage and treatment of waste in managed landfills, which will also mitigate against flooding and improve public health;
(iv) river bank protection for Mekong River which will also address flooding which could potentially be worse due to projected climate change risks;
(v) heritage conservation to renovate the central town square, old post office building, and improve the town's accessibility;
(vi) improve the efficiency of local government services and connectivity between the

[16] MoU signed between Lao PDR and Vietnam governments in April 2017. Feasibility study of $3 million for 550 km length from Vientiane-Thakhek-Muya in Vietnam to be financed by Korean Government. Linked to development of Vung Ang seaport to provide Lao PDR with sea access. Souksakhone Vaenkeo, Vientiane Times, 18th May 2017.

[17] Government of the Lao PDR, Ministry of Planning and Investment. 2016. *Eighth Five-Year National Socio-Economic Development Plan, 2016–2020*. Vientiane.

[18] As part of the fact-finding mission undertaken to prepare the concept paper for the GMS-CTDP-4 by ADB in September 2016, an evaluation was carried out to determine which towns should be selected for inclusion in the Project. One of the criteria for town selection was location along the Central Mekong Economic Development Corridor (CMEDC).

towns; and

(vii) assistance to the provincial governments for strategic planning, including addressing climate change and disaster risk management as well as identifying opportunities for the marketing of agricultural products, and the improvement of tourism and research and knowledge-based facilities.

B. Description of Thakhek Subproject

23. The components of the Thakhek subproject under GMS-CTDP-4 are described as follows:

24. **Component 1: Stormwater drainage improvement.** The town drainage improvement will comprise of five sections of existing open channel that will be extended. The drainage extension will follow the natural streams. This will be supplemented by a river gate at Houay Simang and four flood protection pump stations at each of four streams namely, Nam Sot, Nam Li, Houay Sakham, Houay Simang.

25. The existing main open canals that were constructed in 2003 under the Secondary Towns Urban Development Project (STUDP)[19] will be rehabilitated by dredging sediments and cutting and removal of vegetation. Overall, the drainage extension will cover a total length of 9.85 km and is expected to serve a drainage area of 950.6 ha. The locations of the drainage channels are shown in Figure 2 while Table 3 summarizes the proposed drain cross sectional dimensions.

Table 3: Proposed Trunk Drainage Channels

Canal	Drainage Area (ha)	Channel length (m)	Start point	End point
4A	60.1	1,746	B. Thakhek Nua	Nangly creek
1A	39.6	1,437	B. Viengvilay	B. Viengvilay
1B	66.7	1,540	B.Phonsa-at	B. Santisouk
3	144.0	2,041	B. Syvilay	B. Phonsanham
5	340.6	3,086	B. Phonphim	Confluence of Simang creek
Total	650.6	9,850		

26. **Component 2: Small-scale wastewater treatment plants.** Four units of SWTPs, 200 m^3/d capacity each, will be built to serve most of the central urban area. These would be located at: (i) Thakhek Kang village, close to the old town square; (ii) the compound of Khammouane Provincial Hospital to serve the hospital and its immediate surroundings; (iii) Nongbouakham village at the market and local bus station; and (iv) Souksavanh village, beside the provincial bus station. These four service areas will have a coverage of 100% since all households are close to the respective treatment plants (**Table 4**). Figure 3 presents the coverage areas and the proposed locations of the SWTPs.

Table 4: Proposed SWTP Locations

SWTP	Location	Point of Discharge	Service Area
A – Old Town Area	Ban Thakhek Kang	Mekong River	Ban Nabo
B – Hospital	Ban Done Kheuanexang	Mekong River	Ban Done Kheuanexang Ban Nongbouakham

[19] ADB Secondary Towns Urban Development Project, final design report 1999.

SWTP	Location	Point of Discharge	Service Area
C – Local Bus Station and Market	Ban Nongbouakham	Open drainage canal to creek leading to Mekong River	Ban Santisouk Ban Nongbouakham
D – Provincial Bus Station	Ban Souksavanh	Wetland	Ban Souksavanh

27. Based on the preliminary design, only black water will be accommodated at the SWTPs. The subproject will include the laying of sewer lines along road easements, consisting of the 150mm diameter sewer pipes. Wastewater will be channeled to the SWTPs by gravity to avoid use of pumps to operate the systems. The treated effluent will be discharged to one of the open drainage canals/creeks, draining ultimately to the Mekong River. It is also proposed to install free connections to 2,240 households by 2020 in the proposed service areas.

28. Following the guidelines set by BORDA[20] and adopted by the Ministry of Public Works and Transport (MPWT), the SWTPs will comprise of the following units:

(i) Primary treatment module—sedimentation and flotation;
(ii) Secondary anaerobic treatment in fixed-bed reactors: baffled upstream; reactors or anaerobic filters;
(iii) Tertiary aerobic treatment in sub-surface flow filters; and
(iv) Tertiary aerobic treatment in polishing ponds or gravel beds, or release to river, wetland or open drainage canals.

29. The sizes of the SWTP units are presented in Table 5.

Table 5: SWTP Module Sizes for Thakhek

SWTP Location	Module	Capacity (m^3/d)	Length (m)	Width (m)	WW Depth (m)	Height (m)
Thakhek	Settling /flotation tank	200	12	18	3.0	3.5
	ABR	200	8.5	18	2.9	3.5
	Aerobic filiter	200	19	10	2.9	3.5

[20] Stands for Bremen Overseas Research and Development Association. BORDA's Project Office is in the capital city of Vientiane since 2013. BORDA Laos aims to uplift the living situation of disadvantaged demographic groups by improving their sanitation. Their work also focuses on environmental protection by reducing pollution of ecosystems and clearing untreated wastewater.

Figure 2: Location of Drains for Extension

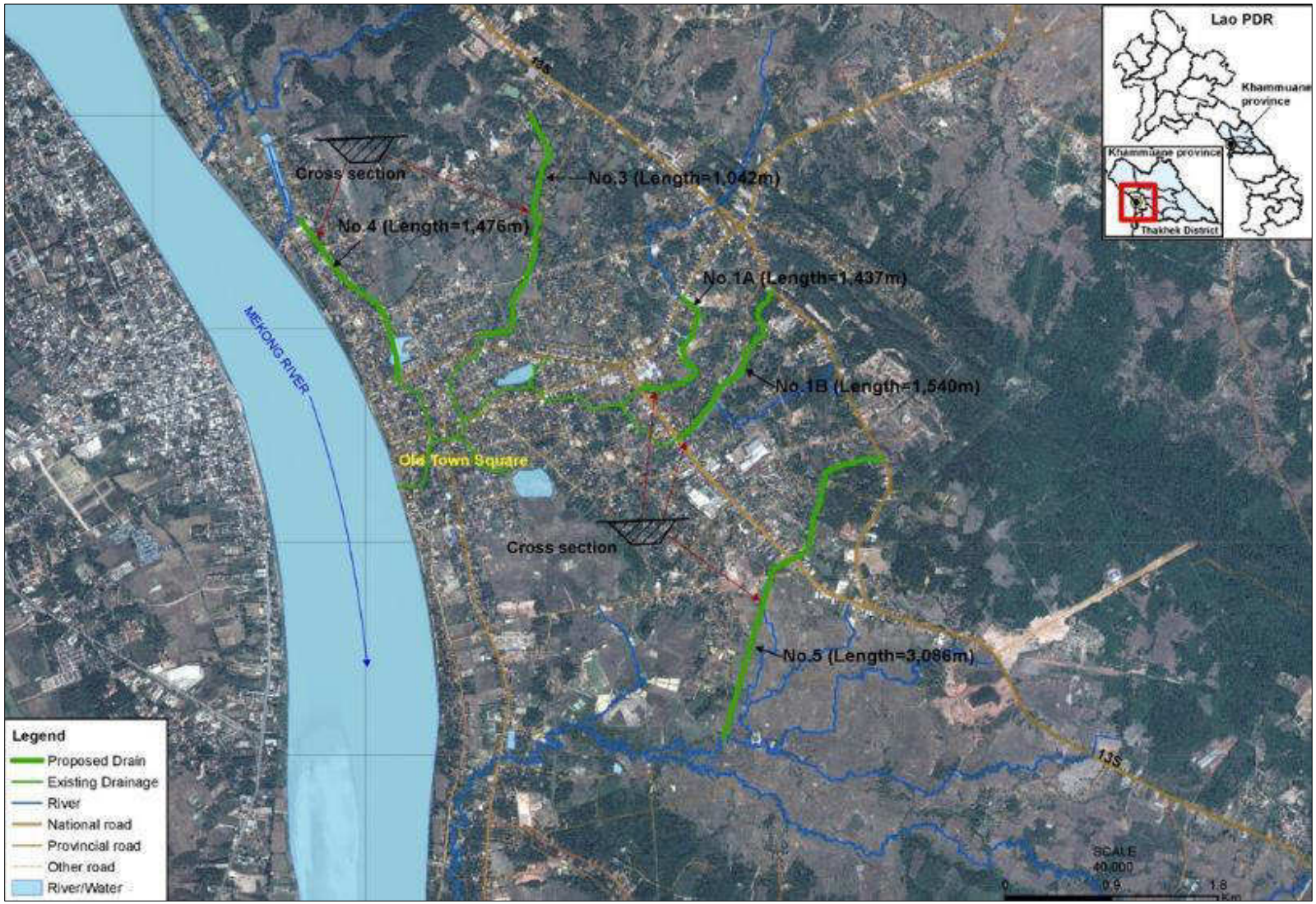


Figure 3: Proposed Sewer Service Area and SWTP Location in Old Town area

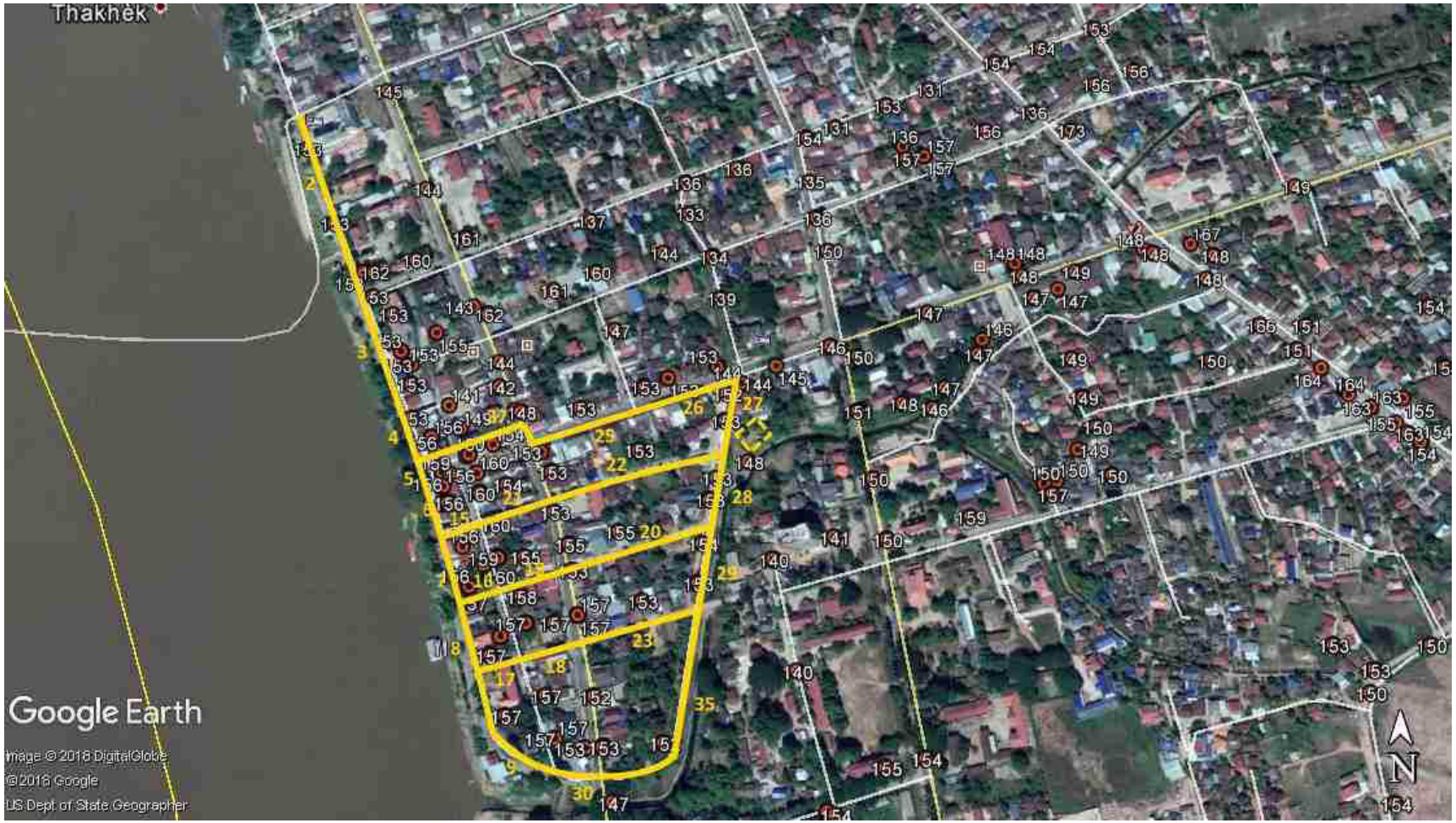


Figure 4: Proposed Sewer Service Area and SWTP Location at Khammouane Provincial Hospital

Figure 5: Proposed Sewer Service Area and SWTP Location at Local Bus Station and Market

Figure 6: Proposed Sewer Service Area and SWTP Location Near Provincial Bus Station

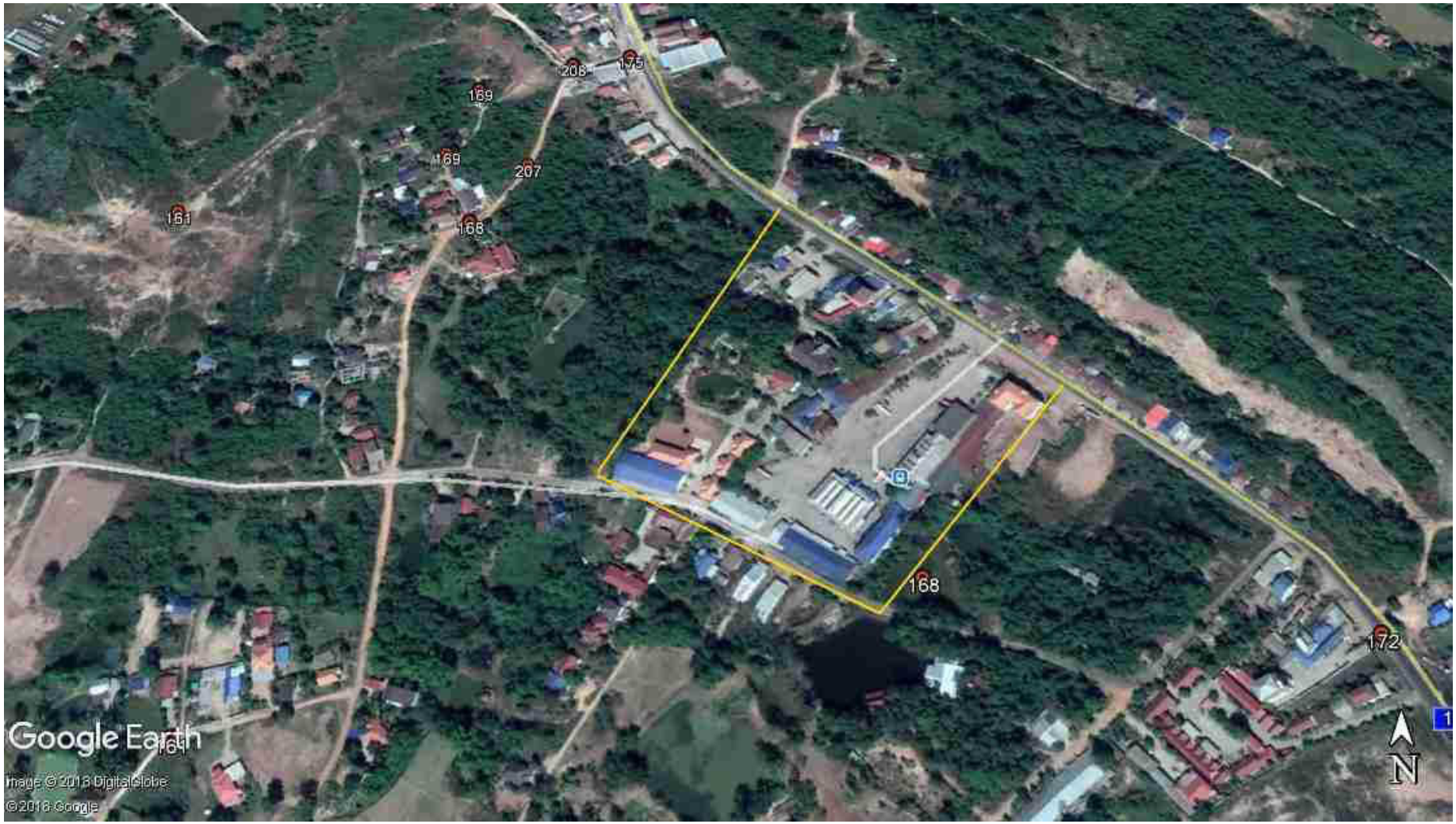
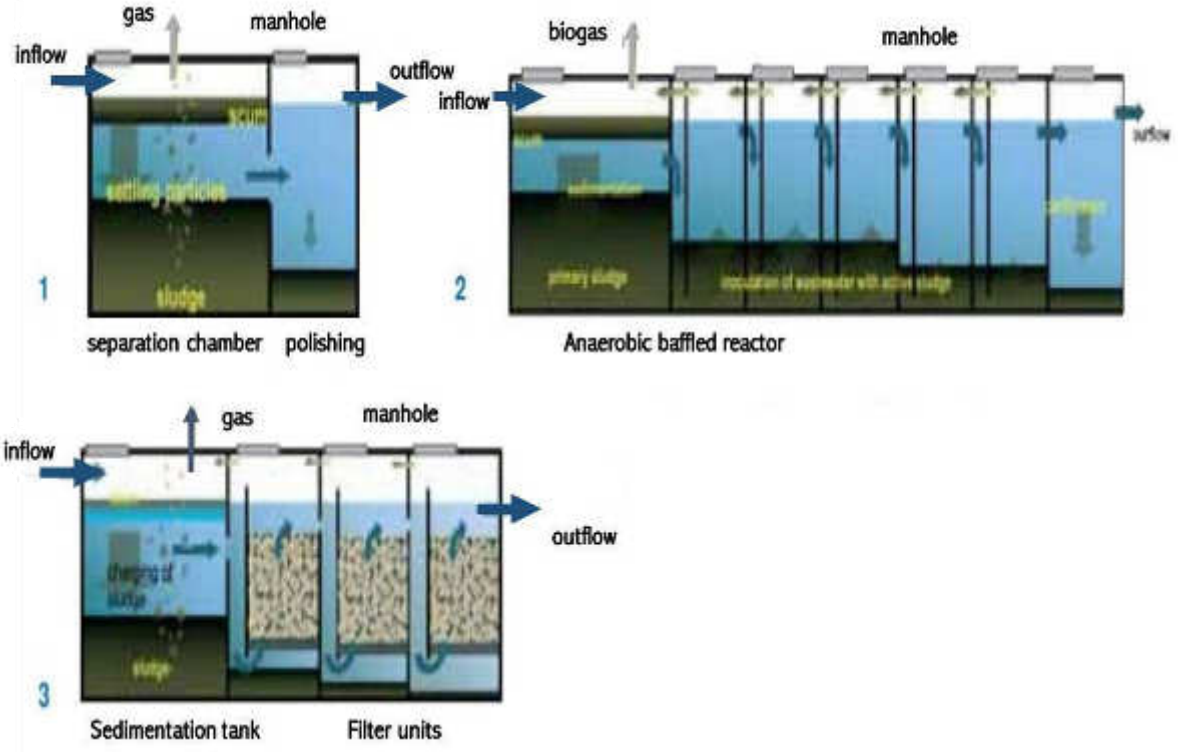


Figure 7: SWTP Treatment Process



Source: Decentralized Wastewater Treatment Solutions, BORDA & BORDA BNS Network

30. The effluent from the SWTPs is expected to comply with the effluent quality standards as outlined in the National Environmental Standard No. 81/NA (21 February 2017). Table 6 presents the material balance of the SWTP.

Table 6: Summary of Material Balance of SWTP for Thakhek

	Unit	Inflow	After Settler/Septic tank	After ABR	After AF	Lao PDR Effluent Standards
BOD5	mg/l	333	171	36	29	30
COD	mg/l	633	343	93	123	125
TSS	mg/l	350	300	250	20	50

31. **Component 3: Municipal solid waste controlled landfill**. A controlled solid waste landfill facility is proposed on the current 95-hectare site which is approximately 9 km southeast of the town center. The existing dumpsite operates within the property and close to National Road 13 (NR13). The proposed site of the controlled landfill is located on the northern section of the property which comprises scattered secondary growth forest. The location of the controlled landfill is shown in Figure 5.

32. The proposed new controlled landfill will accommodate wastes collected from 22 villages in the current urban area. The new landfill will have six lined waste cells (about 100 m x 100m and with 10 m final depth) and leachate underdrains. Three cells will be proposed for construction under the subproject which provides a waste capacity of 294,295m^3 until 2035. Wastes at the

existing dumpsite will be managed and covered in a retirement cell. The proposed controlled landfill will consist of the following:

(i) site office for full time operators,
(ii) lined cells of sufficient total volume to take all waste from all 22 villages up to 2040
(iii) "retirement" cell for all existing waste to be buried, compacted and covered
(iv) all season access roads
(v) capping soil storage
(vi) site drainage
(vii) leachate collection, storage and recirculation
(viii) monitoring boreholes
(ix) covered sorting and recycling area
(x) separate medical/hazardous waste area
(xi) full site fencing
(xii) water and power services at the site
(xiii) collection trucks and a bulldozer.

33. Figure 6 presents the proposed layout of the Thakhek controlled landfill site.

34. At this stage, a composite lining of geomembrane HDPE liner with clay/earth cover is recommended. The selection of the liner should be taken during the final design stage based on source and availability of clay and transport costs. Geotechnical investigations will also better inform the preferred liner type to ensure protection from leakage.

35. **Component 4: Riverbank protection.** The subproject proposes four separate lengths of riverbank protection along Mekong River. The locations of the river bank protection are described below and shown in Figure 7:

(i) Inside Thakhek center, from 850m south of the Old Town Square to 500m north. This will be a combination of riverbank protection and recreational enhancement by providing a 2-level embankment similar to the one in place in Luang Prabang. The lower level, still above normal flood level, will serve as a platform for restaurants to lay out tables and be accessed by concrete steps from the upper road level. The road level itself will be widened where possible and enhanced with landscaping and planting, seating, durable footpath paving and outdoor exercise equipment.
(ii) To the north of the above section, the riverbank protection is proposed to continue up to the location of the intake for the town water supply, a further 1000m, without the 2-level design but retaining the improved upper level footpath.
(iii) To the south of the town, there is a 1,500m of existing riverbank protection supporting a riverside road. From where the existing riverbank protection ends, the proposed project will continue further 2,384m towards That Sikhottabong temple area.
(iv) A further 276m from That Sikhottabong temple area, 300m of existing riverbank protection will be improved. The proposed riverbank protection will comprise of basic embankment with no associated recreational facilities. These areas are not densely populated but there is significant erosion and houses all along the riverbank are affected.

Figure 8: Location of the Existing Dumpsite and the Controlled Landfill

Figure 9: Layout of Proposed Thakhek Contolled Landfill

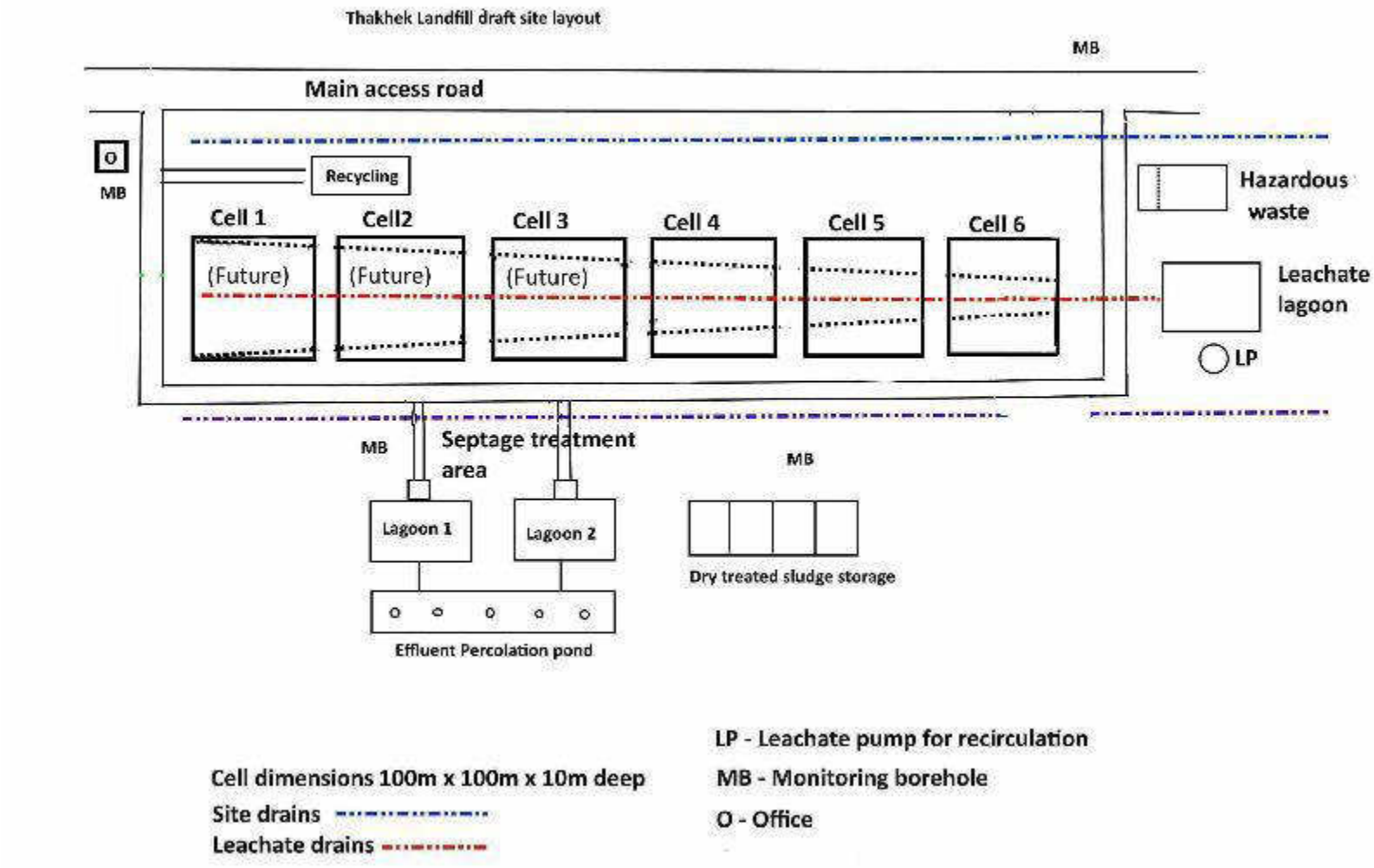


Figure 10: Location of proposed riverbank protection

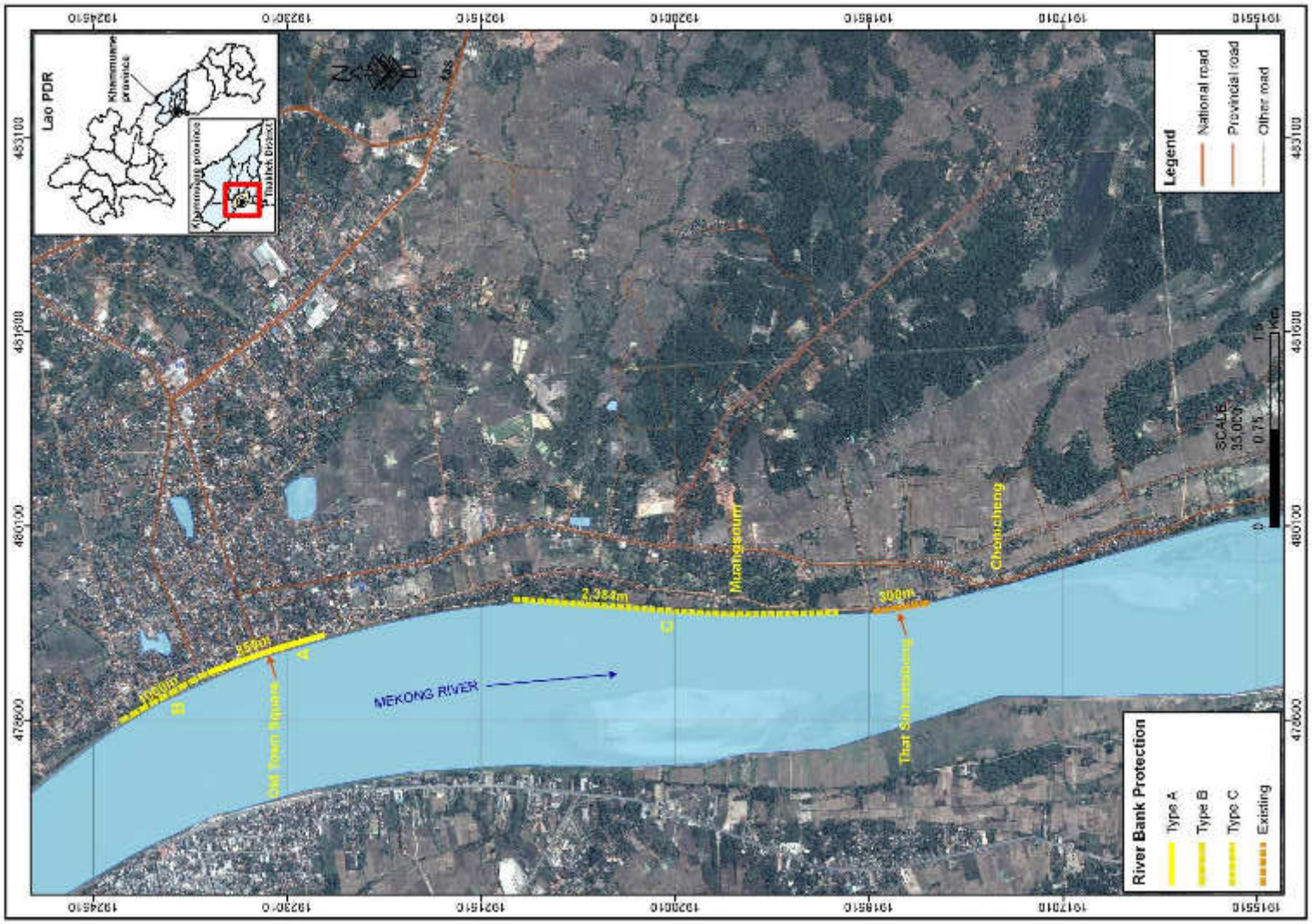
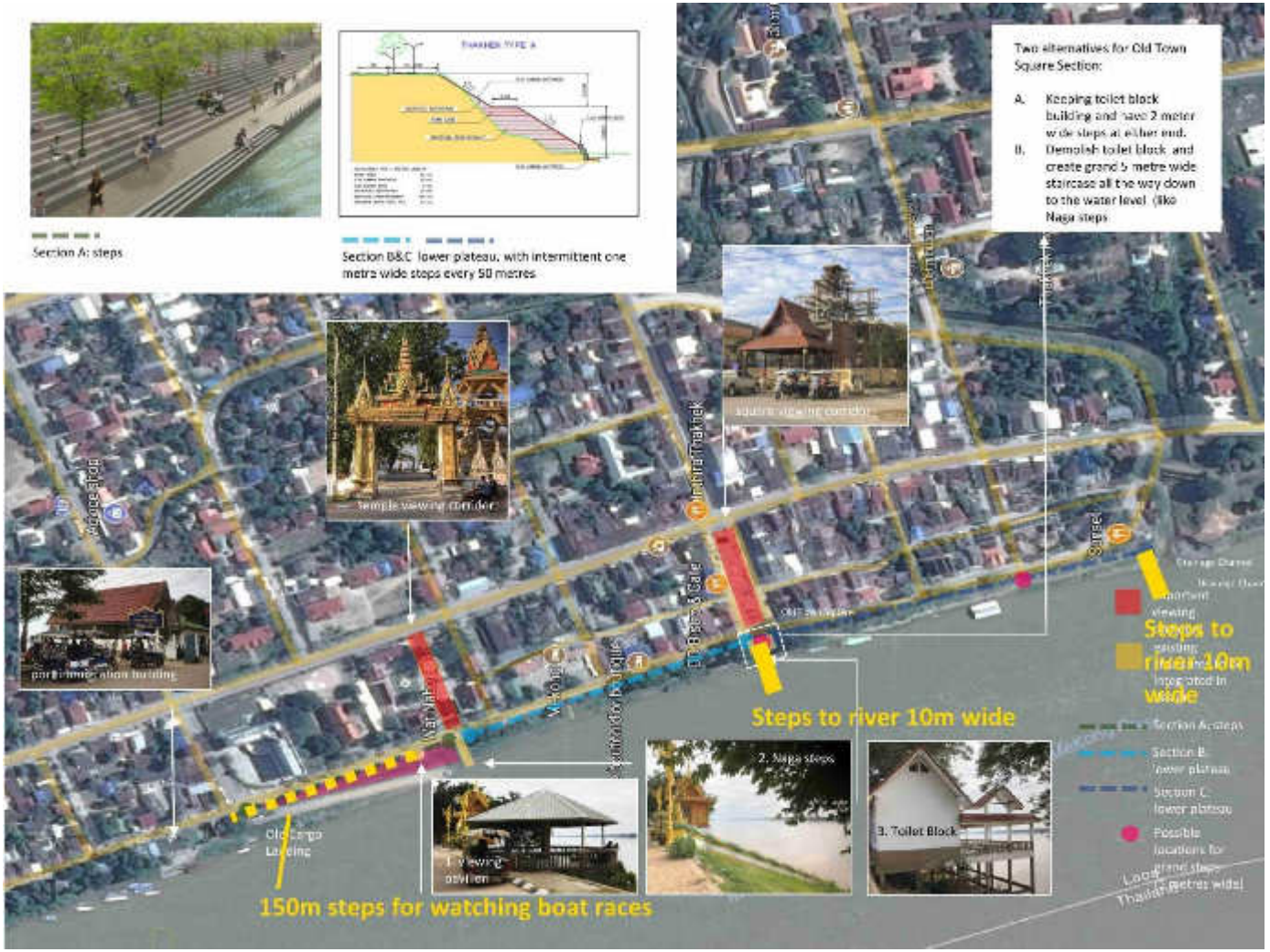


Figure 11: Proposal for riverbank protection around Old Town Square



36. **Component 5: Heritage-led urban regeneration of the Thakhek Old Town**. This Component aims to enhance the old city center as a leisure and tourism destination by creating an appealing, lively riverside promenade, respectful upgrading of the old square and adaptive reuse of the old post office into a tourism information center. Proposal for the riverbank protection around old town square area is shown in **Figure 8**. This consists of:

(i) Upgrading of public square integrated with waterfront promenade to create uniform public space with look and feel that is respectful to the historic character of the Old Town. This will include: (i) upgrading of current tourism information structure to allow viewing corridor, (ii) uniform design for benches, street lights and trash receptacles, (iii) tree planting with indigenous tree species to provide shade (i.e. dok champa), and (iv) traffic flow, (night time) pedestrian zones and assigned parking facilities.
(ii) Renovating and re-purposing 5,000-sqft historic Old Post & Telecommunication Office into a multipurpose Tourism Information Centre, including tourism information counter and displays/old town heritage center/coffee shop/pop-up exhibition and retail space.
(iii) Place branding, way finding and interpretive signage system of heritage trails in Thakhek Old Town for specific target groups (adventure, cultural, English/Thai/ Japanese/Korean/Chinese) that depict the different historic layers and unique multicultural history of old town. This should include a hardware (interpretative signage, way finding) and software (maps, apps, leaflets and website) component.

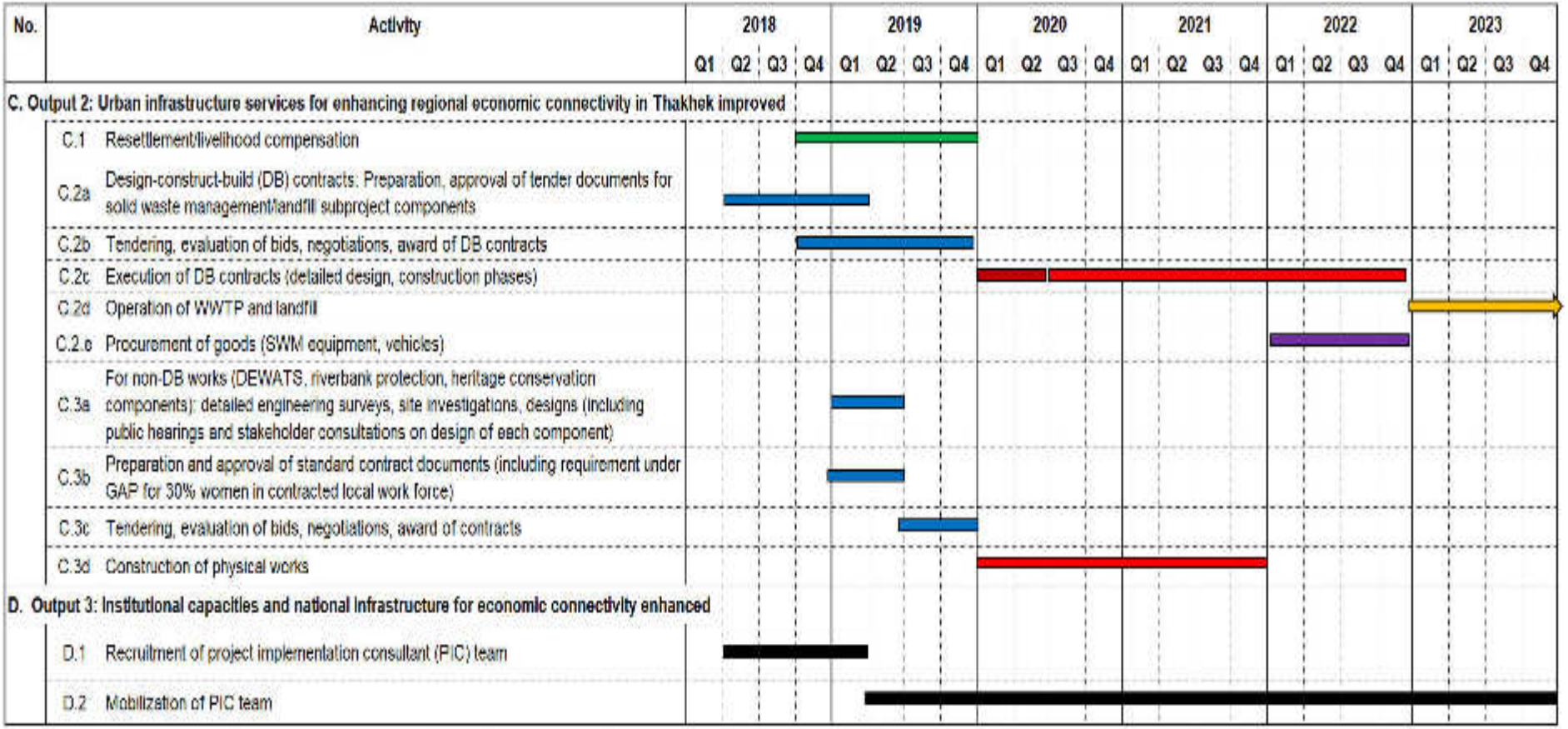
37. This component will also include a zoning plan and management structure for the promenade, survey/update/documentation of heritage building, and public awareness campaign.

38. **Component 6: Institutional capacity for regional economic connectivity enhanced**. This component will strengthen the institutional capacity of the provincial government by: (ii) supporting project management, construction supervision and social and safeguards monitoring; (ii) training on resilience town planning that incorporates economic, climate change and disaster risks; and (iii) formulating the next provincial 5-year strategic development plans through the regional economic corridor development analysis on commodity value-chains, tourism, and human resources.

C. Implementation Period

39. The physical components of the subproject will be implemented under standard (non-DB) contract. The standard contracts are expected to involve: (i) 6 months of detailed design and preparation and approval of tender documents starting 2019; (ii) 6 months of procurement for construction works; and (iii) 24 months of construction activities, starting 2020. Completed works under standard contracts are expected to commence operation by beginning of 2022. The subproject implementation schedule is in **Figure 9**.

Figure 12: Implementation Schedule



Key: ADB = Asian Development Bank; DB = design-build; DEWATS = decentralized wastewater treatment solutions

Source: PPTA Consultant.

IV. DESCRIPTION OF THE ENVIRONMENT

A. Geographic Location

40. Thakhek is situated along the National Road 13 (NR13) and along the east bank of the Mekong River. It is about 337 km east of Vientiane. Based on altitude, Thakhek is in the central plains region of Lao PDR, which includes the alluvial basin of the Mekong River. It lies in the Mekong Plain physiographic unit of Lao PDR. The Mekong Plain has flat upper levees with recent alluvial deposits that are acidic and shallow. The younger alluvial soils of the floodplain are fertile but are often subject to wet season inundation (ICEM 2003).[21]

B. Description of Subproject Areas of Influence

41. The subproject impact areas include: i) the directly impacted areas or main areas of influence, covering the subproject construction footprints and areas within 200m from their edges, considering the potential reach of noise, dust, impact or water quality, impact on biodiversity and socio-economic impacts; and (ii) indirect or extended areas of influence which include waste disposal site/s, sources of water for construction use, workers' campsites, and sources of labor. Potentially affected resources within the main areas of influence are presented in Table 7.

42. **Component 1: Stormwater drainage.** Main open canals for each of these sub-catchments were constructed in 2003.[22] These canals drain to the Mekong River. The drainage system follows natural streams but has been improved, with the three main canals built in concrete and with access roads alongside. The drainage system works moderately well but there is some annual flooding in the lower areas of town. Residents further up the natural creeks and away from the Mekong have poor drainage as these channels are silted up and used for solid waste disposal.

43. Of the four creeks (Nam Sot, Nam Li, Houay Sakham, Houay Simang) bounding the three sub-catchments, three have flood gates installed and one, Houay Simang, does not yet. None of the creeks have pump stations for wet season floodwater release to the Mekong River. There are structures that are directly encroaching on the natural drainage courses which may be affected during implementation of the stormwater drainage extensions and declogging of existing drains such as houses, shops, water supply pipes, and cell tower. **Figure 10** shows photos of locations of proposed drain extensions, floodgate, and pump stations.

44. **Component 2: Small-scale wastewater treatment plants.** All four sites of the SWTP have access roads: about 4m-5m wide paved roads for A, B and C; while SWTP D is along NR13. Only the access road of SWTP A is flooded when Mekong River water level is high, and the drainage system cannot drain properly. NR13 sometimes floods during the rainy season. It has drainage only on one side.

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[21] Profile on Environmental and Social Considerations in Lao P.D.R. December 2013 Japan International Cooperation Agency.

[22] ADB Secondary Towns Urban Development Project, final design report 1999.

Table 7: Identified Environmentally Sensitive Receptors in the Main Areas of Influence[a]

Component/ Sub-component	GPS	Surface Water Receptors	Socio-Economic & Cultural Receptors	Land Cover/ Ecological Receptors	Protected Area Status
○ Drainage No. 4 (1,746m)			• Residents/residences, workers, business and/or other establishments in the main urban area • At least 1 school • At least 1 church • Existing utility lines within or adjacent to the channels	• Urban area • Agricultural lands • Trees and vegetation	None
No.3 (2,041m)			• Residents/residences, workers, business establishments • Utility lines	• Urban area • Trees and vegetation • Pond	None
No.1A (1,437m)			• Residents/residences, workers, business and other establishments • At least 1 school and 1 temple	• Urban area • Some trees	None
No. 1B (1,540m)			• Residents/residences, workers, business and other establishments • At least 1 school and 1 temple	• Urban area • Some trees	None
No. 5 (3,085m)			• Agricultural lands • Some houses, domestic structures • Utility lines	• Trees and vegetation • Aquatic and riverine flora and fauna	None
○ SWTP (Old Town Square) and sewer lines	17.394904 104.806618	Mekong River	• Residents, workers, business and/or other establishments and social institutions in the old town . • At least 1 temple. • Existing utility line	• Main urban area • Agricultural lands • Few treed areas	None
○ SWTP at hospital compound) and sewer lines	17.389719 104.806874	Mekong River	• Residents, workers, business and/or other establishments and social institutions in the old town. • Hospital • patients and workers • At least 2 schools • 1 church • Existing utility lines	• Main urban area	None
○ SWTP at local bus station and market and sewer lines	17.404171 104.834828	Wetland	• Residents, workers, businesses and/or other establishments • Existing utility lines	• Urban area • agricultural lands	None
○ SWTP near provincial bus station and sewer lines	17.390420 104.828557	Open drainage canal to creek leading to	• Residents, workers, business and/or other establishments and social institutions • market • Existing utility lines	• Urban area • agricultural lands	None

Component/ Sub-component	**GPS**	**Surface Water Receptors**	**Socio-Economic & Cultural Receptors**	**Land Cover/ Ecological Receptors**	**Protected Area Status**
		Mekong River			
○ Controlled landfill	17.352284 104.889477	No river nearby	• Waste pickers and their households • Users of NR13.	• largely secondary forest land • NR13 on one side • Across NR 13 is a farmland	None
○ Riverbank protection	Northern segment (north of old town center) From 17.406552 104.796860 To: 17.398664 104801299	Mekong River	• Residents and houses, workers, restaurants and other establishments • Drinking Water Factory • Water supply intake • Nabo High School • Boat landings • informal settlers	• Riverine strip with trees and vegetation • urban development	None
	Old Town Center segment From 17.398664 104801299 To 17.391787 104803979	Mekong River	• Residents and houses, workers • Informal settlers • Wat Nabo • hotels and restaurants • boat landing operations • riverside road and road users	• Main urban area (old town) • Trees and vegetation • Stream ending at Mekong River	None
	Southern segment 1 From 17.378011 104.807134 To 17.351673 104.806368	Mekong River	• Residents and houses • agricultural lands • trees and vegetation • boat landings • 2 temples	• residential lands • agricultural lands • few riverbank gardens • forested/treed lands • temple and park grounds • stream ending at Mekong River	Noe
	Southern segment 2 From 17.349125 104.806828 To 17.333643 104811118	Mekong River	• Residents and houses • 1 temple • quarry landing/access • boat landings	• temple and park grounds • residential lands • agricultural lands • riverbank gardens • forested/treed lands • Trees and vegetation	None

[a] 200 m from the edges of construction footprints.

Figure 13: Photos of Proposed Locations of Drains, River Gate, and Pump Stations

Drain 1B — Drain 1A

Stuctures immediately adjacent and encroaching water pipes within natural drainage courses

Drain 1B — Small hut over the drainage channel

Drain 1B — Structure adjacent to the drainage channel

Drain C

Structure over and utility lines adjacent to the drainage courses

Drain 4 Drain 5

Structures immediately adjacent or encroaching and water pipes within natural drainage courses

Cell tower within Drain 5

Drain 5

Water supply pipe

45. The SWTP for the old town area will be located in Ban Thakhek Khang near the confluence of two streams and a drainage canal. The site is about 2 m–3 m below the street level and is reportedly prone to flooding. It is currently used as a vegetable garden by a villager living near the site, who also claims that the site gets submerged during heavy rains. According to the villager, flood waters can reach up to 1.5 m–2 m above the current ground level at the site.

Figure 14: Location of SWTP (old town area) near Houay Sakham

The site is currently being used as a vegetable garden. The site is adjacent to Houay Sakham.

The receiving Hoauy Sakham of SWTP leading to Mekong River.

46. The planned location of the SWTP within the Khammouane Provincial Hospital compound is near the waste storage building and incinerator area of the hospital. Further to the south is the Thakhek Secondary High School. Adjacent to the SWTP site is an intermittent creek leading to the Mekong River which will serve as the discharge point of the SWTP. In the immediate vicinity are the hospital storage, the hospital morgue and the" patients' bed building" of the hospital.

Figure 15: Location of SWTP at Khammoune Provincial Hospital compound

Location of SWTP at Khammoune Provincial Hospital Compound near the waste storage building and incinerator.

The receiving creek of SWTP near hospital. The creek has intermittent flow.

47. The proposed location of third SWTP in Thakhek is at the parking area of Lak Sam Market. There is a local bus station next to the market. The market operates daily through a concessionaire of the province. It consists of wet and dry market sections. There are residential houses across the fence of the proposed location of SWTP. Effluent from the SWTP will drain through the open canal of the market leading to a creek which eventually discharges into the Mekong River.

Figure 16: Location of SWTP (local bus station and market)

The proposed site of SWTP at the open parking area of the market.

The Lak-Sam Market

48. The proposed location of SWTP in Souksavanh village is behind the inter-provincial bus station. The site is a vacant area with vegetation consisting of banana trees, bamboo, and shrubs. The site is also adjacent to a series of wetland areas which is the effluent outfall of the SWTP. The wetlands are natural drainage retention areas which are the receiving point of runoff from the surrounding areas. There is no reported use of the wetlands except as retention area. The SWTP site is reportedly prone to flooding as a resulting of overflowing of the adjacent wetlands.

Figure 17: Location of SWTP near the provincial bus station

Proposed site of SWTP behind is the Provincial Bus station.

The second wetland across the road as discharge point of SWTP.

49. **Component 3: Municipal solid waste-controlled landfill.** The existing dumpsite operates within the same property where the proposed controlled landfill will be located in Ban Nabouk. The dumpsite is accessible through NR13. At the site is a small office building, a water tower tank, a shed for compacting wastes, a small garage for equipment, and shanties of waste pickers and their households. There are a number of waste pickers at the existing dumpsite but information is unclear as to their actual numbers. Four of the waste pickers have constructed temporary huts and stay inside the dumpsite compound with their families who help (including children) with waste picking activities. According to the waste pickers who were interviewed at the dumpsite, each household earns about K1,200,000 per month by segregating glass, plastic bottles, cartons, copper wires, metals and other recyclable materials through manual picking from the dump. Majority of the wastes that can be found at the dumpsite consists of plastic wastes. The waste pickers do not have any personal protection and children can be found roaming around the dumpsite.

50. Except for the households staying inside the existing dumpsite compound, there are no residential houses in the surrounding areas outside the dumpsite and landfill site. The residential communities can be found about 500-meters away from the landfill site. The nearest establishments to the site are two concrete batching plants located more than 200 meters away from the site.

Figure 18: Photos of existing dumpsite and proposed controlled landfill site

Entrance to dumpsite from NR13

Guardhouse/office and waste weighing and baling area

Houses of waste pickers inside the dumpsite

Waste pickers at the dumpsite

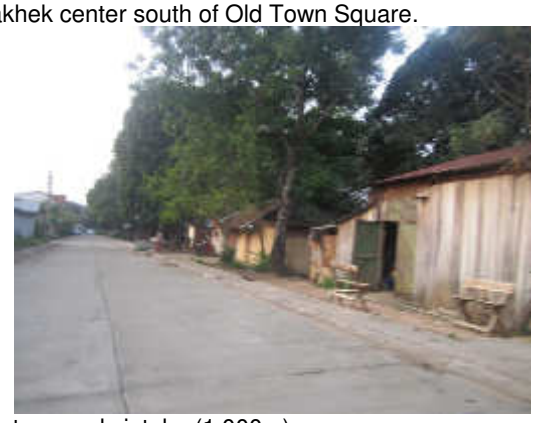
The existing waste dump. The vegetated area behind is the proposed location of the controlled landfill.

51. **Component 4: Riverbank protection.** There are some houses, shops, and restaurants at the riverside embankment A in Thakhek Neua village. The villagers said that they have not experienced flooding but the banks are prone to scouring and erosion. Some trees are in danger of getting uprooted because of river bank erosion. The highest flood was experienced in 1993 but flood waters only reached the banks of the river.

52. There are sections where some fruit trees may be affected. There are about 26 households that will be relocated in one section of the riverbank protection works. The impacts on resettlement of households will be addressed in a resettlement plan.

Figure 19: Location of riverbank improvement


Line A: Riverbank protection area at Thakhek center south of Old Town Square.

Line B: Old town center to water supply intake (1,000m)


Riverbank section C

Restaurant located along section C.

Line C: Riverbank protection from south to north at That Sikhottabong temple area (2,660m)

Line D: Riverbank protection from south at That Sikhottabong to north (1770m)

53. **Component 5: Heritage Conservation.** The heritage conservation component will be undertaken at the Old Town Square. The old post office building will be renovated along with the adjacent Old Town Square. Construction works will be limited within this area.

Figure 20: Current condition of Old Post Office Building

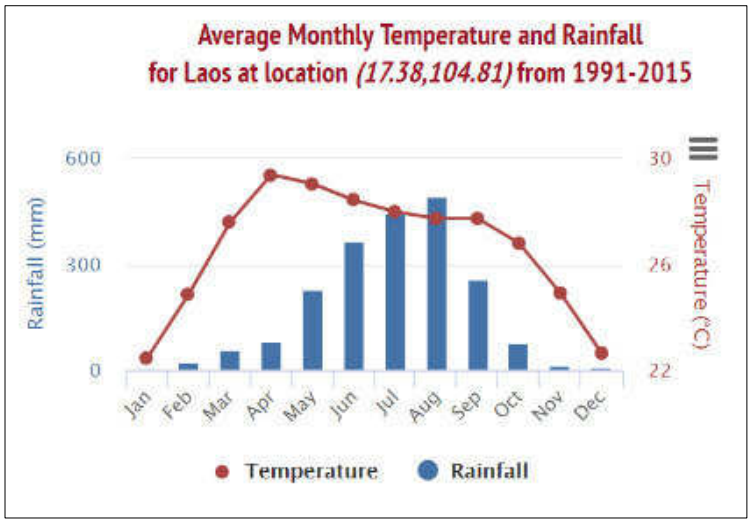
C. Climate

54. Lao PDR's tropical climate is influenced by the southeast monsoon which causes significant rainfall and high humidity. The climate is divided into two distinct seasons: rainy season, or monsoon, from May to mid-October, followed by a dry season from mid-October to April. Considering its altitude, Lao PDR is divided into three different climatic zones, and Thakhek belongs to the "tropical lowland plain and floodplains along the Mekong River", where more than 50% of the Lao population resides. Average temperatures in the plains are 25°C–27°C; average rainfall is 1,500 mm to 2,000 mm.[23]

55. Mean monthly temperature in Thakhek for the period 1991–2015 ranged from a minimum 22.48 ^{O}C in January to a maximum of 29.38 ^{O}C in April. Mean monthly rainfall was a minimum of 0.0 mm in January and a maximum 494.56 mm in August.

[23] National Adaptation Programme of Action to Climate Change. WREA UNDP. GEF. April 2009.

Figure 21: Average Monthly Temperature and Rainfall (1901-2015)[24] – Thakhek



Climate Change and Natural Disaster

56. The Project was screened using the AWARE for Projects tool, an online tool used by ADB to screen projects for climate risks. The result of the screening indicated that the Project is at "high" risk for flood, landslide and onshore category 1 storm; at medium risk for precipitation increase; and low risk for other variables, such as temperature increase, precipitation decrease, water availability, and wind speed increase.

57. Initial findings of the Climate Risk and Vulnerability Assessment conducted show that the probable range of mean annual temperature by 2050 for Thakhek would be 27.3°C to 28.6°C. The mean annual rainfall ranges from 2,158 mm to 2,315 mm. Thakhek experiences regular typhoons, with continuing strong rains for many days that result in flooding. This is aggravated by blocked drainages caused partly by illicit solid waste disposal. Trapped water in low-lying areas also stagnates and causes water pollution. Deforestation caused by logging also exacerbates the flooding condition. The town's drainage system drains to the Mekong, but only about 30% of the town has road drains, and many of these are blocked due to poor maintenance, indiscriminate waste dumping, and development activities. Flood levels and duration data for the Project towns, other than anecdotal data, was not available from the municipalities or provincial authorities.

58. Thakhek lies across Nakhon Phanom and upstream of Mukdahan in Thailand. According to the MRC Working Paper 2011-2015:[25]

(i) Over the period 1985-2000 to 2042-2050, the mean annual high flow season discharge along the entire length of the Mekong River is projected to increase by 10%-15%. This would potentially increase the mean annual "flood days" in the project towns.[26]
(ii) In Nakhon Phanom (Thailand), at the mean high flow season discharge of 11,601

[24] Source: Climate Change Knowledge Portal. The World Bank Group. http://sdwebx.worldbank.org/climateportal/
[25] Working Paper 2011-2015. The Impact and Management of Floods and Drought in the Lower Mekong Basin and Implications of Possible Climate Change. Flood Management and Mitigation Programme. Mekong River Commission. March 2012.
[26] Flood days are days with discharges greater that mean annual high flow season discharge.

m^3/s, the mean annual number of flood days would increase to 94 days in 2042-2050 (from 87 days in 1985–2000).

(iii) In Mukdahan (Thailand), at the mean high flow season discharge of 12,522 m^3/s, the mean annual number of flood days would increase to 93 days in 2042–2050 (from 86 days in 1985–2000).

(iv) A comparison of the extent of flooding between that in the 2000 flood event and that of a large flood event in 2048 under a projected climate change state revealed an 8.8% increase in the extent of flooding (that is, flood depths above 0.0 m) in the 2048 event. This will increase with greater depths. For depths over 1.5 m, the projected increase would be 30%–60%.

D. Air Quality

59. Data on ambient air quality in Thakhek are not available. Emissions from moving vehicles are considered as the major sources of air pollution in Thakhek although traffic volume is low when compared with major urban centers like Vientiane. Resuspended dust also occurs when vehicles pass over dry unpaved roads or from wind action of unpaved or exposed surfaces.

60. Air quality at the proposed landfill site and immediate vicinity is largely affected spontaneous landfill fires at the existing dumpsite which occur during the dry season[27] as well as by emissions from moving vehicles along NR13. Ambient air quality data is not available at the dumpsite area.

61. In general, air quality at the sites of the SWTP sites, riverside embankment, Old Town Square, and drainage improvement areas is good because of the low volume of vehicles plying roads adjacent to the project sites. There are drainage improvement areas where ongoing road construction activities are contributing to dust emission.

E. Noise

62. Ambient noise in the main urban area is brought about by vehicles, construction activities, small-scale industry involving metal forming and equipment maintenance and repairs. Drainage, riverbank protection and SWTP works will be implemented in the main urban area, where population concentration is high and where there are sensitive receptors, such as hospitals, schools and temples.

F. Surface Water

63. The drainage system works moderately well but there is some annual flooding in the lower areas of the town. Residents further up the natural creeks and away from the Mekong River experience poor drainage as these channels are silted up and are clogged with solid wastes. Residents use the channels as disposal area of solid wastes.

64. Fourteen (14) villages out of the 35 villages in Thakhek have no drainage at all. The households reported various problems with drainage, such as too small canals or lack of culverts. Households interviewed during the survey added that flooding occurred in their private residential areas over the last 5 years. The depth of water is ankle deep or knee level in most cases, lasting from 3 hours to 7 days. (Source: Household survey).

[27] Based on information provided by waste pickers at the existing dumpsite during the site visit on April 3, 2018.

65. It was observed that there are access roads without drainage canals and some drainage canals that are not connected. Some households dispose toilet wastes directly into drainage canals causing water pollution and odor. There are also establishments which are backfilling and elevating land resulting to clogging of the natural drainage lines and flooding of lowlying areas.

66. Of the four creeks (Nam Sot, Nam Li, Houay Sakham, and Houay Simang), three have flood gates installed and one Houay Simang is not yet installed. None of the creeks have pump stations for wet season floodwater release to the Mekong River. The creeks serve as drainage channels of catchments areas. No fishing activities were observed in the creeks.

67. Houay Nam Sot is a small natural stream that discharges to Mekong River. It is located in the southeast of Thakhel District. This natural stream is nearly dry in the dry season but has high water level during the wet season. Along Nam Sot are open land and rice fields, with some houses mostly located along the road.

Figure 22: Location of Houay Nam Sot

The existing floodgate at Houay Nam Sot.

View of the road where Houay Nam Sot and the floodgate are located.

68. Houay Nam Li is a natural stream that discharges to the Mekong River. It is located in the southeast of Thakhek District, close to a large lake. Along this stream is low-lying land with trees. There are also some houses along Nam Li.

Figure 23: Location of Houay Nam Li

The upstream of the existing flood gate at Houay Nam Li.

Downstream section of Houay Nam Li

69. Houay Simang is a large stream which contains water all year round. A proposed pump station will be located at this stream.

Figure 24: Location of pump station at Houay Simang

70. Houay Sakham is near the mouth of Mekong River. The stream receives the upstream waters from Houay Nam Li and Nam Sot. There is an existing flood gate at this stream.

Figure 25: Location of Houay Sakham

The location of the proposed pump station at Houay Sakham, near mouth of Mekong River.

The existing floodgate at Houay Sakham.

G. Water quality

71. Data on the water quality of Mekong River and the four streams (Nam Sot, Nam Li, Houay Sakham, Houay Simang) are not available. Baseline water quality of these waterbodies will be established during detailed engineering design.

72. According to the 2014 Lower Mekong Regional Water Quality Monitoring Report of the Mekong River Commission, water samples taken at the Vientiane station had rating scores of: (i) "B" or "good quality" for the protection of human health; (ii) "B" or "good quality" for the protection of aquatic life; and (iii) "A" for agricultural use. Water samples taken at Nakhon Phanom station had rating scores of: (i) "B" for the protection of human health; (ii) "A" for the protection of aquatic life; and "A" for agricultural use.[28]

H. Groundwater

73. The PPTA team engaged the DONRE Borikhamxay Province to conduct a study of the groundwater quality in the vicinity of the dumpsite in December 2017. The study revealed exceedances in Pb, As, Cd, NO_3, total coliform and E coli, Faecal coliform with the Lao PDR drinking water quality standards and with the Guidelines for Drinking Water Quality of the WHO. (Table 8 and Appendix D). Considering that the groundwater sample was taken directly from the well at the dumpsite and that there are no other industrial activities in the surrounding areas that would contribute to contamination, it is most probable that the contamination of the groundwater is attributed to the open dumping of wastes. The heavy metals (Pb, As, and Cd) and coliform were results of leaching from the unprotected waste mass.

Table 8: Parameters That Exceeded Standard Limits – Groundwater Study – Thakhek[a]

Parameter	Unit	Results	Lao PDR [b]	WHO [c]
Pb	mg/L	0.49	0.01	0.01
Cd	mg/L	0.025	0.003	0.003
As	mg/L	0.063	0.01	0.01
NO_3	mg/L	66	45	50
Total Coliform	MPN/100ml	59	2.2	Must not be detectable in any 100 ml sample
E.Coli (Faecal Coliform – T44)	-	6	None	

[a] Conducted by DONRE Pakxan for the PPTA of GMS-CTDP-4. December 2017. Samples were taken from the well inside the Thakhek Dumpsite.
[b] Table 11.1 Standard for Groundwater Quality for Domestic Consumption. National Environmental Standards (No. 81/NA), 21 February 2017. LPDR.
[c] Guidelines for Drinking Water Quality. Fourth Edition incorporating the first addendum. Geneva. WHO. 2017.

I. Biological Environment

74. Thakhek lies to the west of Phou Hi Poun National Bio-Diversity Conservation Area. The nearest point of Thakhek district to the protected area is about 5 km. There is no RAMSAR site and international bird area in Khammouane Province. The natural drainage retention area near the SWTP behind the provincial bus station in Souksavanh village are not considered as wetlands of ecological importance. These are functioning as areas where urban drainage and floodwaters

[28] "A" for "high quality" class indicates all measurements as within objectives virtually all of the time. "B" for "good quality" class indicates conditions rarely depart from desirable values.

accumulate during the rainy season.

J. Physical Cultural Environment

75. There is no UNESCO world heritage site in Khammouane Province or in adjacent province and close to Thakhek. At the local level, there could be temples or religious structures in the areas of influence of the trunk and road drains, SWTPs and riverbank protection works.

K. Socioeconomic Environment[29]

76. **Population.** Thakhek has an urban population of 38,388 people and is considered as 6th largest urban population in Lao PDR. Over the period 2005–2015, the urban population of Thakhek grew by 1%. In 2005, the Thakhek greater urban area had a total population of 26,000. This rose to 38,388 in 2015, giving an average growth rate of 3.9%. The PPTA Team projected the population to reach 99,900 by 2040 on population growth rate.

77. **Water Supply**. The household survey indicated that 62% of the households had access to piped water, while 34% had wells.

78. **Sanitation.** There is no reticulated wastewater collection and treatment in Thakhek. There are no records of numbers, volume or condition of septic tanks in the town. Private septage trucks and septage disposal are unregulated, nor is there a building code that stipulates requirements for urban on-site sanitation. Wastewater treatment is limited to septic tanks in the more modern houses, hotels and restaurants. The majority of households use an unsealed soakaway pit formed with locally available concrete ring sections. A UDAA-owned vacuum truck, and three privately owned small tankers modified for use as septage trucks operate in Thakhek.[30] Septage is typically being sold as fertilizer and discharged directly to agricultural land without treatment. There is no current working facility at Thakhek landfill or anywhere else for septage disposal.

79. **Drainage.** The town drainage system comprises three main sub-catchments, and main open canals for each of these sub-catchments was constructed in 2003.[31] These drain to the Mekong River. The drainage system follows natural streams but has been improved, with the main three canals formed in concrete with access roads alongside. Only around 30% of the town has road drains and many of these are reported to be blocked. Development has infilled many key open drains, and closed drains have become blocked due to lack of maintenance. The drainage system works moderately well but there is some annual flooding in the lower areas of town. Residents further up the natural creeks, away from the Mekong, have poor drainage as these channels are silted up and used for solid waste disposal. The town is affected by the periodical large floods, such as the 2009 Mekong flood.

80. **Wastewater Management.** There is no current reticulated wastewater collection and treatment in Thakhek. There are no records kept of numbers, volumes or condition of septic tanks in the city, private septage trucks and septage disposal are unregulated, and there is no building code that stipulates requirements for urban on-site sanitation. Wastewater treatment is limited to septic tanks in the more modern houses, hotels and restaurants. The majority of households use an unsealed soakaway pit formed with locally available concrete ring sections. These do not allow

[29] Sources: (i) Commune Database 2009-2013. Ministry of Planning. (ii) PPTA SES of September 2017.
[30] Confirmed during UDAA interview 23/2/18 by the PPTA Engineering Team.
[31] ADB Secondary Towns Urban Development Project, final design report 1999.

for any significant treatment: liquid waste soaks into the ground if the water table is low enough, and solids remain in the pit. Detailed septic tank surveys as part of the socio-economic survey in 2017 showed the average incidence of true septic tanks to be under 20%. A far greater percentage is often reported as most people (the public and DHUP/District staff) do not differentiate between septic tanks and unsealed soakaway "ring" tanks.

81. There is one vacuum truck owned by UDAA and three privately-owned small tankers modified for use as septage trucks operating in Thakhek.[32] Septage is typically being sold as fertilizer and discharged directly to agricultural land without treatment. There is no current working facility at the Thakhek dumpsite or anywhere else for septage disposal.

82. **Solid Waste Management.** Of the 35 villages in urban Thakhek, 26 have at least a partial waste collection service, with coverage generally over 90%. Of the 272 respondent HHs, 57% said they were covered by the solid waste collection services. The existing solid waste landfill was constructed under an ADB project[33] in 1997. The last remaining government owned vehicle lasted until 2011. From 2014 a private company, Shinawat, was contracted to collect waste and manage the landfill which has now reverted to an uncontrolled dumpsite. Shinawat utilizes 5 small collection trucks and 1 tractor. The dump site occupies around 10 ha of a larger 95-ha site, and currently only 4 ha are being used. Approximately 50 tonnes of waste is generated daily and around 30 tonnes of this are collected, while the remainder are either burned or disposed to vacant land or drains. Domestic collection is once per week at about 2 – 4 truck trips. The septic sludge disposal facility constructed at the landfill has fallen into disuse.

83. **Power Supply.** All households in Thakhek are connected to the power supply. Of the 272 respondent households, 98% are connected.

84. **Health**. Health care centers are provided in 8 villages. The Khammouane Provincial Hospital has a bed capacity of 150. A new hospital building is currently being built. The Provincial Public Health Department reported that dengue fever is normally widespread and with high incidence in the province in the rainy season, but now there are cases all year. It is not epidemic but showing signs of becoming endemic. In 2017, up to August there have been 637 cases of dengue fever in the province. The most are in Thakhek District with 136 cases, and in Houaxay District with 177 cases.

85. In Thakhek, there are 3,069 cases of acute diarrhea that were reported in 2015-2016 by Khammoune Province. The Department of Health implements clean water and sanitation campaign programs in cooperation with World Vision covering the whole province, also other urban areas, twice-thrice per year. The program started in 2005 and will end in 2018.

86. The number of road traffic accidents is high in the province, also in Thakhek town.

Table 9: Water-borne, Water Related and Most Common Diseases in Khammouane Province 2015–2016

Disease	Cases 2015-2016 (2 years)
Water borne diseases	
Acute Watery Diarrhea	3,069
Acute Bloody Diarrhea	302

[32] Confirmed during UDAA interview 23/2/18
[33] ADB Secondary Towns Urban Development Project, final design report 1999.

Disease	Cases 2015-2016 (2 years)
Typhoid Fewer	134
Most common diseases	
Dengue without warning signs	581
Severe Acute Respiratory Infection	409
Food Poisoning	68
Dengue with warning signs	29
Meningitis	17
Diphtheria	14
Fever and Rash	13
Acute Flaccid Paralysis	7
Acute Jaundice Syndrome	7
Neonatal tetanus	1
Tetanus of all ages	1
Acute Encephalitis Syndrome	1
HIV/AIDS (accumulate)	405
HIV/AIDS	45 - all get treatment

Source: Khammouane Public Health Department report, June 2017.

87. **Education**. From the survey of schools in Thakhek which was conducted by the District Office of the Ministry of Education, there are 95 primary schools, of which 7 are private and 88 are government-owned. The students to teacher ratio is 27. There are 18 secondary schools, of which 1 is private, 1 is run by the monks, and 16 are government-owned. The students to teacher ratio is 17.

88. Of the 272 respondent households in the socioeconomic survey conducted under the PPTA, the highest educational attainments of any female member of the household are as follows: primary, 15%; secondary, 20%; high school, 21%; vocational, 18%; university, 20%; others, 3% and no formal education, 3%. For any male member of the household, they are as follows: primary, 7%; secondary, 21%; high school, 26%; vocational, 16%; university, 23%; others, 5% and no formal education, 2%.

89. **UXO Contamination in Thakhek.** Khammouane Province is one of the nine province beneficiaries of the Lao National Unexploded Ordnance Programme that clears land for agriculture and community purposes (e.g. schools, hospitals, temples and water supply) and other development activities. From the start of the said programme in January 1996 until December 2017, a total of 48,984 UXOs were destroyed/removed from Khammouane Province during its clearance operations of a total 2,578.79 ha of land.[34] The Hazard Assessment Report of the Developing a National Risk Profile of Lao PDR reported that "*several districts of Khamouane Province have a very high density of UXOs ranging from 2–4 UXOs per square kilometer*".[35]

[34] Lao National Unexploded Ordnance Programme (UXO Lao). https://www.uxolao.org

[35] Developing a National Risk Profile of Laos PDR. Part 1: Hazard Assessment. 2010. National Disaster Management Committee. Government of Lao PDR. United Nations Development Programme (UNDP) Lao PDR.

V. ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

A. Environmental Benefits, Positive Impacts and Results

90. The subproject is expected to improve the urban environment in Thakhek, reduce the town's vulnerability to environmental and climate risks, and improve its climate resilience level and quality of life. It will provide Thakhek with improved stormwater, wastewater and solid waste management services, enhance flood protection from river overflows, formulate a provincial development strategy, and strengthen institutional capacities in resilience town planning. Cumulatively, the positive impacts of such benefits are: (i) reduced flood risk, (ii) reduced risk of human contact with raw sewage during flooding, (iii) reduced health risks from diseases caused by inadequate stormwater management, (iv) improved environmental sanitation, (v) controlled GHG emissions from solid waste disposal, (vi) reduced pollution discharges and improved water quality, (vii) reduced air and land pollution, and (viii) improved social equity from access by all to recreational amenity. Table 10 presents the positive impacts and expected results from each component of the subproject.

Table 10: Benefits, Positive Impacts and Outcomes

Subproject Component	Benefits, Positive Impacts and Outcomes	
Stormwater drainage	Benefit	Improved stormwater management
	Positive impacts	Reduced flood risks Reduced health risks and incidence of diseases
SWTP systems	Benefit	Improved wastewater management
	Positive impacts	Reduced pollution discharges Improved water quality Reduced health risks and incidence of diseases Improved environmental sanitation Reduced risks of human contact with sewage from drainage during flooding
Controlled landfill, equipment and septage facility	Benefit	Improved solid waste management
	Positive impacts	Improved environmental sanitation Improved groundwater quality Reduced air and land pollution Controlled and managed GHG emissions from solid waste disposal operations Improved living and working conditions for informal waste pickers currently at the disposal site
Riverbank protection	Benefit	Improved flood protection Provision of a public recreational amenity
	Positive impacts	Reduced flood risks Improved public safety Reduced health risks and incidence of diseases from flooding Improved public health Improved social equity, ensuring access by all to recreational amenity
Heritage Conservation	Benefits	Preserved cultural heritage
	Positive Impacts	Stabilized waterfront Improved visual environment Improved pedestrian environment Improved public health Improved social equity, ensuring access by all to recreational amenity

Subproject Component	Benefits, Positive Impacts and Outcomes	
Institutional support	Benefit	Strengthened institutional capacities 5-year Provincial Development Strategy
	Positive impacts	Sustainable urban growth Reduced infilling of wetlands

91. A significant, positive impact from the subproject will be the improvement in the living and working conditions of informal waste pickers currently operating at the existing dumpsite. Currently, these workers endure significant occupational health and safety risks,[36] working and living under difficult and often dangerous conditions in order to segregate wastes and sell higher value waste fractions from the dumpsite.[37] The waste pickers will be allowed to continue their livelihood activities at the site, however, they will be trained and will be required to abide by the guidelines set out by the management of the landfill to ensure their safety. A sorting area will be constructed to facilitate the recovery of recyclable materials brought to the landfill. All waste pickers should be required to wear protective gear such as rubber gloves, rubber boots and crush helmets. Waste picking will only be allowed during regular operating hours and minors will be prohibited from doing waste picking activity at the landfill.

B. Anticipated Impacts/Issues/Concerns of Each Subproject Component

92. The proposed location and conceptual design of each of the infrastructure components of the subproject was assessed to identify issues and concerns that need to be evaluated further during detailed design and to design mitigation measures to address adverse impacts that will affect the operation. The general pre-construction and construction impacts and mitigation measures that apply to all subproject components are discussed in sections C and D of this chapter.

1. Stormwater Drainage Improvement

93. **Impacts on hydrology.** The proposed drainage improvement works will follow the natural drainage pattern, hence, impacts on diversion of flow is not foreseen. The impacts of stormwater drainage improvement will be largely positive for communities since it will abate perennial flooding in certain areas of the town. Likewise, the declogging of existing drains will ease flow and help mitigate localized flooding.

94. Based on the assessment, the receiving water bodies are large enough to accommodate the additional flows from the extension of five sections of the current road drains. Downstream impacts on flooding and water quality due to increased runoff will be mitigated through the provision of four pump stations to serve the four major streams of Nam Sot, Nam Li, Houay Sakham, and Houay Simang and regular declogging and drain cleaning operations of the DPWT. Climate risk mitigation options will be considered during detailed design that includes detailed analysis of historical and projected future flood levels taking into account climate change, increasing rainfall intensities, and land use changes.

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[36] Waste picker health complaints include diarrhoea, fever, chronic coughs and phlegm, colds, shortness of breath, skin infections, skin ulcers, respiratory and gastrointestinal ailments and visual problems. Other afflictions include dysentery and bronchitis, asthma and pneumonia, as well as the prevalence of parasites and malnutrition.

[37] Particulate and dust levels can be high at dumpsites, and can include asbestos and other dangerous dusts. Decomposing wastes also produce gases, including methane, carbon monoxide, and volatile organics potentially containing toxic and carcinogenic compounds. Waste burning releases hazardous compounds into the atmosphere, including dioxins and polycyclic aromatic hydrocarbons, which are known mutagens and teratogens (causing fetal defects), and are suspected human carcinogens (causing cancer).

95. Further study will be undertaken during detailed design to evaluate the assimilative capacity and users of the receiving water bodies to take into consideration the ongoing land development and future land use plan of Thakhek. The downstream impacts at Ban Viengvilay, Ban Santisouk, Ban Phonsanham, and at Houay Simang will be evaluated further.

96. **Impact on structures and land.** There are some structures, shops, agricultural land and utilities (water supply lines and cell tower) that may be affected during the implementation of the stormwater drainage component. Some structures and shops that are directly located on top of existing drains and natural drainage flows will have to be removed. Potential impacts on irrigation systems (if any) will have to be assessed during detailed design.

97. **Disposal of debris.** The drains are being used by communities as disposal site of garbage. There are also sections of existing drains that are clogged with shrubs. In order to enhance the drainage capacity declogging activities on existing drains will be undertaken as part of the regular program of DPWT. This activity will result to the generation of debris, shrubs and garbage. These debris are mostly organic and can be disposed at the controlled landfill. During declogging, the contractor will be instructed to avoid leaving the debris at the site and to immediately transport debris and wastes to the controlled landfill site.

98. **Noise due to pump stations.** There are four pumping stations to be provided as part of the stormwater drainage component. There are houses located about 100–200 meters away from the locations of the pump stations which could experience nuisance due to noise during operation of the pumping stations. In order to minimize noise from pump operation, the units will be placed in an enclosed building/room and that regular preventive maintenance will be undertaken on the units.

2. Small-scale Wastewater Treatment Plants

99. **Positive impacts.** The wastewater treatment component will include the construction of four SWTPs and the laying of sewer lines along road easements to channel and treat black water from the service area. The component will avoid the current practice of uncontrolled disposal of sewage by households into canals and rivers. This issue was raised during the household survey wherein 17.7% of respondents think that wastewater disposal is a serious problem of the town. With properly designed and effective wastewater treatment systems, microbial contamination of receiving water will be controlled and spread of disease, odors, and contamination of land and ground will be avoided. The operation of the four SWTPs is expected to reduce the BOD concentration being discharged into receiving bodies of water by >300mg/l or about 90% reduction in BOD concentration. By treating wastewater, the project will avoid water pollution and contribute to the clean-up of the receiving water bodies. Table 6 presents the effluent quality before and after SWTP treatment.

100. **Impact of sewer pipe laying.** The sewer lines will be laid along road easements and will affect drainage lines, sidewalks, driveways, electric poles and water lines during pipe laying. Coordination with affected agencies, utility companies and stakeholders will be undertaken during detailed design and prior to construction. Restoration of damaged road easement, sidewalks, and driveways should be undertaken after the laying of the sewer lines.

101. **Leaks from the sewer lines.** Once the sewer lines are operational, there may be instances when black water would leak and cause contamination of soil, groundwater and surface water. Overflow of blackwater may occur when the system cannot manage the volume of wastewater due to blockages. Overflow due to storm water runoff is not anticipated from the sewer

lines since the pipes will accommodate black water only and the design will employ the closed pipe system using HDPE circular pipes. In order to prevent, minimize and control leaks, sufficient hydraulic capacity will be designed to accommodate peak flows with adequate slope in the main trunk to prevent buildup of solids. Routine maintenance and inspection program will be undertaken to identify areas needing repair, cracked or deteriorated pipes, leaking joints or seals, and any suspected infiltration or exfiltration.

102. **Waterlogging at SWTP sites.** Of the four SWTP locations, the proposed location of SWTP (Old Town Area), near the confluence of two streams and a drainage canal and SWTP (provincial bus station) near the wetland are the ones that have been identified as prone to flooding. SWTP (old town area) is about 2–3 meters below the street level and flood waters reach up to 1.5–2 meters above the current ground level. The SWTP behind the Provincial Bus Station and near wetland areas have no reports of flooding but changes in land uses and land development in the surrounding areas may increase runoff into the wetlands and cause flooding in the future.

103. The location of the SWTP sites will be evaluated during detailed design to determine buffer against flooding and if flood retaining walls will be necessary to avoid scouring of land. Soil tests will also be undertaken during detailed design to confirm the foundation to be designed for the structures considering that the site may be prone to liquefaction since it is adjacent to water bodies. Detailed hydrological assessments will be undertaken to determine appropriate measures that can counter the effects of flooding on the operation of the SWTPs such as through aboveground design of tanks, reinforcement or riprapping of banks of rivers and wetland, among others.

104. During the operational phase, an emergency response plan will be designed to ensure that the SWTP will not impact on the surrounding areas in case of emergency. Flood risk areas will be identified along with location of designated evacuation sites and routes. Community-based flood warning system, information dissemination campaign of the community evacuation plan, and drills will be identified through consultation with communities.

105. **Impact on receiving stream capacity and uses.** Hydrologically, the potential environmental impacts to surface water resources from SWTP construction are: (i) changes to natural surface hydrology and drainage pathways and (ii) potential flooding of the facilities by elevated surface waters. These impacts will be addressed at final design phase through (i) detailed hydrological assessment to ensure that the final designs fully accommodate and mitigate impacts on natural hydrology, and (ii) incorporating bunds and raising the elevations of the SWTP units above potential flood levels. The capacity and impacts on other uses/users will be evaluated further during detailed design.

106. The conceptual design of the SWTPs for Thakhek calls for four small-scale treatment plants with capacity of 200m^3/day each to be placed in major central urban areas. This is due to the lack of available large land that could allow larger SWTPs that could serve a larger portion of the town in one system. In terms of hydrology, the discharge of 200m^3/day from the SWTP will not have an impact on the receiving stream. There are no other uses of the stream except as a channel of runoff into the Mekong River.

107. The SWTP location at the open area within the Khammoune Provincial Hospital compound also do not have an impact on the capacity of the receiving stream since it can accommodate the flow of 200 m^3/day. The stream has intermittent flow and there are no beneficial uses except as a drainage channel. The site is not prone to flooding. Although the receiving stream is unlined,

the potential of 200m^3/day to cause bank scouring is considered low.

108. The effluent outfall of the SWTP (provincial bus station) will be the nearby wetland which is also the receiving point of runoff from the surrounding areas. The area is reportedly prone to flooding, hence, the need to evaluate further the hydrology of the catchment area and capacity of the natural drainage retention area during detailed design to ensure that the discharge from the service area of Ban Souksavanh through the outfall of the SWTP will not cause flooding.

109. The SWTP located at the parking area of the market will discharge through an open drainage canal. The current open canal may not be enough to accommodate the effluent flow from the SWTP leading to the creek. The size of the receiving canal needs to be evaluated further during detailed design.

110. **Impacts of effluent on surface water quality.** During the final design phase, the SWTP facilities will be designed to ensure that appropriate effluent discharge standards are adhered to (**Appendix C**). This is important, as the SWTP facilities will discharge directly into nearby surface waters. Measures will therefore be implemented to strengthen the operations and maintenance of these facilities to ensure that they continue comply with the Effluent Standards as embodied in the National Environmental Standards 81/NA.[38] These measures include:

(i) Specifying specific maintenance procedures in the SWTP operations manuals.
(ii) Ensuring adequate budget and equipment for routine maintenance activities.
(iii) Conducting operator training for SWTP operations and maintenance.
(iv) Monitoring effluent quality and implementing corrective actions for non-compliance.

111. **Air quality and Odor from SWTPs**. The SWTPs would be able to reduce the biodegradable organics in wastewater. The SWTP units are expected to generate biogas at each stage of the process units which could release odor to the surrounding area. Based on information provided by the PPTA engineering team, the septic tank or the first process unit will produce about 14.5m^3/day; the anaerobic baffled reactor will produce 27 m^3/day and the aerobic filter will produce 29m^3/day. This is based on the SWTP capacity of 200m^3/day. The biogas is composed of 70% methane (CH_4) which has a global warning potential of 21. Using these information, the estimated GHG emission from all units was computed as 496.29 tons CO_2 eq/year.

112. Based on the 2006 IPCC guidelines for national GHG inventories, direct emissions from nitrification and denitrification at wastewater treatment plants may be considered as minor sources. Typically, these emissions are much smaller than those from effluent and may only be of interest for advanced centralized wastewater treatment plants with significant volume and with nitrification and denitrification steps.

113. To mitigate odors from the operation of the SWTP, berms and tree lines can be incorporated into the design of the SWTPs.

114. **Disposal of sludge from SWTP.** Based on the conceptual plan of the SWTPs, sludge will be removed annually or every two years. Sludge from anaerobic treatment is largely inert, can be dried and landfilled or applied to agricultural land. Using the anaerobic system and with the low volume of wastewater to be treated in each unit, sludge generation is expected to be minimal

[38] Appendix C compares the Lao PDR and IFC EHS effluent discharge standards. The standards are the same for pH, BOD, COD, TSS and TKN. The Lao PDR standard is stricter in terms of oil/grease (5mg/l as compared to the EHS guideline of 10mg/l). The Lao PDR standard also includes more parameters including heavy metals.

at about 4.48 m^3/year (total) for all the four SWTPs. During the first two years of operation of the SWTPs, sludge that will be collected will be analyzed in terms of bacterial content before these are applied to agricultural land. If the results show consistent absence of bacterial contamination, only then can this be applied to agricultural land, otherwise sludge will only be dried and landfilled.

115. **Health and Safety Aspects.** Damage of or failure to wastewater pipelines could result in leaks, and the outflow of untreated wastewater. This could potentially lead to both human contact with raw wastewater, and the contamination of the water supply system if nearby water supply pipelines are also damaged, both of which can endanger community health. Routine inspections for the early detection of leaks, together with close and ongoing collaboration with communities in leak monitoring and reporting will help to mitigate this impact.

116. Operation and maintenance activities pose risks to the health and safety of workers of SWTPs and the controlled landfill. These risks will be mitigated through the preparation of an operations manual for the controlled landfill and the SWTP facilities, which shall include an occupational health and safety plan (OHSP) and capacity building program.[39]

3. Controlled Landfill

117. The identified potential impacts of the controlled landfill include the clearing of vegetation, accidental discovery of mine/UXO, soil runoff, and odor during mining or transfer of existing wastes to the new waste cells due to ongoing decomposition of wastes. The concerns and potential impacts during controlled landfill operations include: (i) generated dust, gas, fumes and odor; (ii) greenhouse gas emissions; (iii) potential groundwater and soil contamination from leachate and landfill gas migration; (vi) pests/rodents/vermin, bird and stray animal attraction; (vii) wind-blown litter; (viii) fire/explosion; (ix) community health and safety; and (x) workers' health and safety hazards.

118. The closure plan of the existing dumpsite includes the transfer of the existing wastes into a new lined waste cell at the landfill. An Environmental Compliance Audit (ECA) will be undertaken on the existing dumpsite during the detailed engineering phase to determine issues affecting environmental performance and to plan corrective actions during implementation of the controlled landfill (see Appendix G for Terms of Reference). The plan will prioritize key mitigation features, including (i) surface grading and covering of exposed waste cell surfaces to improve controlled runoff and reduce erosion, and (ii) site perimeter drains to control surface water run-on and runoff.

119. During the construction and operational phases, the impacts of the controlled landfill on groundwater, air quality and soil quality will be monitored by establishing monitoring stations at the landsite site and at the upgradient and downgradient of the site for groundwater and soil quality. Workers will also be trained on waste handling, recording, including wearing of personnel protective equipment while working at the site. Fire protection system to manage occasional landfill fires during the dry season will be provided and a materials recovery facility (MRF) at the landfill site will be established to temporarily store collected recyclables.

120. **Impact on waste pickers.** There are a number of waste pickers at the existing dumpsite but information is unclear on their actual numbers. There are about four waste pickers who have constructed temporary huts inside the dumpsite and were allowed to stay with their families at the site. The waste pickers will be allowed to continue their livelihood activities at the site, however,

[39] Based on the Environmental, Health and Safety Guidelines for Water and Sanitation of the International Finance Corporation, dated 10 December 2007.

they will be trained and will be required to abide by the guidelines set out by the management of the landfill to ensure their safety. A sorting area will be constructed to facilitate the recovery of recyclable materials brought to the landfill. All waste pickers should be required to wear protective gear such as rubber gloves, rubber boots and crush helmets. Waste picking will only be allowed during regular operating hours and persons below 18 years of age will be prevented from waste picking activity at the landfill.

121. **Impact of landfill on air quality.** During its operation, the controlled landfill will generate landfill gas (LFG), which includes the primary greenhouse gases (GHGs) of carbon dioxide, methane and nitrous oxide. These gases are formed through organic waste decomposition process, with decomposition being accelerated through the saturation of waste due to the ingress of precipitation and surface waters into the waste. The subproject transition from uncontrolled open dumping to controlled landfilling will however reduce the impacts of landfill gas generation and emission to some extent. This is due to a reduction of landfill gas generation within the waste as a result of reducing precipitation and surface water inundation due to its surface cover (capping) system.

122. As indicated in a recent ADB preliminary report,[40] as the landfill will receive only a relatively small waste volume (less than 100 tons per day), the facility will only generate limited amounts of landfill gas. Given the technical complexity and excessive cost in capturing and treating such small amounts of landfill gas, available capture and treatment systems, such as a flaring system or energy conversion system, are not considered to be appropriate or affordable at this time by the technical team, as indeed, it would likely take a number of years anyway for LFG generation to reach a point of viable capture. It is therefore considered that the LFG be vented over the medium term, with the potential to evaluate more sophisticated LFG management systems at a later date, once the landfill reaches critical mass.

123. A simulation to estimate GHG emissions of the dumpsite was made using IGES tool and using information provided by the UDAA. The simulation revealed net GHG emission of 982,410 kg of CO2-eq/monthly managed waste or 11,789 tonnes CO_2-eq/yearly managed waste. This was compared with the GHG emission from the current open dumping of wastes. The simulation revealed that with the proposed controlled landfill, GHG emission will be reduced by 74.05% as compared to open dumping of wastes. (See **Appendix F**)**.**

124. **Odor.** Odor will be produced during waste dumping as well as during waste mining or transfer of existing wastes at the open dumpsite to the new waste cell. Odor can be mitigated through structural design and non-structural measures. This includes (i) enforcing waste encapsulation in waste trucks while in transit, (ii) constructing perimeter fences and berms around the facility, (iii) minimizing exposed tipping areas, (iv) covering all exposed waste daily, and (v) washing vehicles on facility exit.

125. The impacts of the controlled landfill on air quality will be monitored by establishing monitoring stations at the existing dumpsite and at the new landfill site. Ambient air quality sampling will be undertaken during detailed design (as part of baseline), during the construction phase, and will be continue throughout the operational phase. Post-closure monitoring of the existing dumpsite will also continue one year after the existing dumpsite has been decommissioned.

[40] Preliminary Report on GMS and CTDP Projects – Solid Waste, March 2018, prepared by an independent SWM expert assigned by the ADB.

126. As part of operational control, workers of the controlled landfill will be trained on waste handling, recording, including wearing of personnel protective equipment while working at the site. Fire protection system to manage occasional landfill fires during the dry season will be provided and a materials recovery facility (MRF) at the landfill site will be established to temporarily store collected recyclables.

127. **Impact on surface water quality.** Surface water impacts relating to controlled landfill operations include: (i) surface water run-on,[41] (ii) site water runoff, (iii) waste mass inundation, and (iv) leachate emissions. Surface water run-on and runoff will be mitigated through the provision of perimeter drains and additional collector drains within the site area. As discussed earlier, the potential for waste mass inundation from precipitation will be mitigated through the provision of cover materials over waste mass surfaces, coupled with the drainage of these covered areas through the contouring of surfaces and installation of surface drains. Completed waste mass surfaces can also be vegetated to reduce cover material erosion.

128. A leachate collection pond will be constructed as part of the features of the controlled landfill. Leachate will not be disposed to a body of water but will be recirculated into the landfill mass.

129. **Impact on groundwater.** Leachate generated within the waste mass of the landfill can migrate through the sidewalls and base and cause contamination of groundwater. Monitoring of the deepwell at the existing dumpsite already reveals that the groundwater quality is contaminated with Pb, As, Cd, NO_3, total coliform and E coli, Faecal coliform with concentration above the allowable standards for drinking water. Groundwater contamination will be mitigated to some extent through (i) a reduction in leachate generation, (ii) the provision of a base liner to capture leachate, and (iii) a rudimentary leachate collection and disposal system that will allow leachate to be collected and stored, for disposal back onto and into the controlled landfill.

130. During the operational phase, damage to the liner could result to failure in the integrity of the leachate collection system of the controlled landfill resulting in subsurface contamination. These impacts will be mitigated through measures to strengthen facility O&M procedures to ensure that the facilities operate as intended over the long term, coupled with continuous monitoring of groundwater quality to detect and mitigate any future subsurface emissions should they occur. The impacts of the controlled landfill on groundwater quality will be monitored by establishing monitoring stations at the upgradient and downgradient of the site.

131. **Impacts on Access Roads due to Waste Transportation.** The collection and transport of solid wastes will become regular activities that will use existing roads and infrastructure within the community areas and to the controlled landfill site. On the average, there will be about 24 truck trips per day to the landfill site during the operational phase. Frequent movement of waste haulers will cause nuisance to villagers living along the access road to the landfill. The lack of proper maintenance of roads being traversed by waste collection vehicles may lead to damage, unnecessary delays in solid waste collection and disposal, and community hazards. NR13 will be utilized as the direct haul route to the landfill. Traffic along this national road is light but large trucks transporting goods to and from Cambodia also ply NR13. On a continuous basis, the DPWT should ensure a program and budget for the maintenance of NR13 as well as other access roads to be used as haul route of waste collectors in community areas. Typical repairs include cleaning, adding or grading of soil and gravel, filling holes, and cleaning of drainage ditches.

[41] Surface water run-on is the movement of surface water onto the site.

132. Another impact on access road is on the management of vehicle movement in and out of the controlled landfill site. From the town center, waste haulers will traverse the right lane and may need to stop upon reaching the entrance gate of the landfill to turn left and enter the site. This may cause traffic accidents along NR13 with large trucks also passing by NR13. A traffic signal and warning signs should be installed at this intersection to warn vehicles about frequent waste hauler movement. Drivers of waste haulers should also undergo training on traffic rules and regulations. Likewise, measures to manage and regulate vehicle movement in and out of the controlled landfill site should be implemented by assigning security and traffic aides.

4. Riverbank Protection

133. The riverside embankment will be located in four sections along the Mekong River. There are 26 households that will be affected in one section. There are also sections where some fruit trees may be affected. During the construction of the riverbank embankment, possible blocking of one lane of adjacent roads may occur particularly during delivery of construction materials to the site. Vehicle movement is not heavy at the adjacent roads but a traffic management system will be implemented to guide motorists during temporary lane blocking. Construction activities may also cause runoff of sediments to the Mekong River, hence, erosion control measures will be necessary.

5. Heritage Conservation

134. The impacts of the heritage conservation component will be largely positive. Adverse impacts will primarily occur during the construction phase which are site-specific and can be easily mitigated through good construction practices.

C. Anticipated Impacts/Issues/Concerns – Pre-Construction Phase

135. Pre-construction issues and concerns primarily relate to (i) ensuring that subproject component designs fully incorporate environmental protection, sustainability and climate resilience measures, and (ii) promoting the preparation and readiness of key subproject stakeholders and affected communities. Mitigation of impacts from these issues includes the following:

(i) **Engaging Qualified Environmental Specialists.** These include the engagement of (i) an international Environmental Specialist (4 months,) and national Environmental Specialist (20 months), based in the PIC, (ii) an Environmental Safeguard Officer in the PCU, and (iii) an environmental focal point in the PIU.

(ii) **Environmental Training and Capacity Building:** The PIC will provide training for environmental personnel of the PCU, PIU, contractors and the DOE. Training modules will include environmental management and technical strengthening in EMP implementation, grievance redress mechanism (GRM) implementation, climate adaptation, disaster risk resilience, public consultation, and monitoring and reporting. Funds for environmental seminars, workshops and training are also allocated.

(iii) **Mine and Unexploded Ordnance Clearances.** Working closely with relevant agencies, these impacts will be mitigated as follows: (i) all subproject sites and their areas of influence will have been cleared by the National Regulatory Authority for UXO/Mine Action Sector in Lao PDR (UXO-NRA) at least two weeks prior to construction

mobilization,[42] (ii) In collaboration with the UXO-NRA, PCU and PIU, a workers' preconstruction workshop will be held to orientate workers on health and safety requirements, and particularly the procedures to follow when mines or unexploded ordnances are encountered during construction, and (iii) information and key contacts will be incorporated in an emergency response plan.

(iv) **Preparing the National IEE/ESIA and Obtaining Clearances.** The MPWT will engage a registered environmental assessment entity to prepare the national IEE/ESIA and secure clearances prior to contract awards.

(v) **Grievance Redress Mechanism:** Established by the MPWT and with oversight from the PCU, the PIU will ensure implementation of the GRM at the subproject level. The GRM provides the mechanism to receive and facilitate the resolution of affected peoples' environmental and other concerns and grievances at the subproject level, accommodating informally and formally lodged grievances. The PCU and PIU will ensure that information about the GRM is posted at the offices of the PIU, town and affected villages prior to construction mobilization. Section VIII describes the GRM.

(vi) **IEE and EMP Updates.** Mitigation measures defined in this IEE and associated EMP will be modified and updated as necessary, based on the final design of subproject components. The detailed design of the subproject components on stormwater drainage, SWTPs, and road drains and the updated IEE will consider the assimilative capacity of receiving water bodies, intended use of receiving water bodies, presence of sensitive receptors, and impacts on ecology. Further site assessment, ecological surveys, environmental sampling (surface and groundwater quality noise and leachate quality), geological survey, hydrological and hydrogeological assessment and environmental compliance audit of existing dumpsite will be conducted. These activities will be conducted during detailed engineering design as part of the domestic IEE/ESIAs and in the updating of the IEE and EMP. In accordance with ADB and government protocol, the revised IEE and EMP will be submitted to ADB and government for review and approval, for subsequent disclosure on the ADB's website.

(vii) **Inclusion of the EMP in Bidding Documents.** The updated EMP will be included in the respective bidding and contract documents. Civil works contracts will include provisions to ensure that contractors prepare site-specific contractor EMPs (CEMPs) that fully respond to the EMPs.

(viii) **Consultations and Disclosures.** Consultations and disclosure activities will be maintained with affected people and other involved stakeholders to ensure continued communication, including for example, overall subproject implementation schedule, details of construction activities and particularly activities that result in nuisances and disturbances, the status of claims and compensation, and other aspects.

(ix) **Environmental Site Parameter Evaluation.** Supplementary baseline assessments will be conducted during the final design phase to further refine component designs and inform any necessary IEE and EMP modifications.[43] Further baseline studies will also be required as part of national IEE/ESIA preparation; hence, will be carried out as part of that work and then also used to inform the detailed engineering design and updates to this IEE/EMP. These include for example, the sampling and analysis of air quality, surface waters, groundwater, soils, noise, wastewater influents, and existing dumpsite effluent and leachate quality. The PCU will ensure the results of these baseline studies are provided to the design team.

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[42] According to the UXO-NRA: "*Despite huge advancements in the human and institutional capacity within the UXO Sector, and much investment from the international community, Laos still has a very significant UXO problem*". http://www.nra.gov.la/uxoproblem.html

[43] For example, an inventory of affected trees will be conducted and mitigation finalized, in accordance with forestry and other regulations.

(x) **Environmental Compliance Audit (ECA) of existing dumpsite.** In accordance with SPS 2009, ECA will be completed for the existing dumpsite in order to assess compliance with existing environmental requirements, identify deficiencies, evaluate impacts, and propose remedial recommendations for dumpsite closure and post closure monitoring and maintenance. They will also provide additional technical and operational information in order to guide the final dumpsite closure designs and corrective actions will be integrated in the updated IEE/EMP. Post-closure monitoring plan will also be designed to ensure effectiveness of the dumpsite closure. The monitoring plan will include monitoring of surface and groundwater, landfill gas, erosion control, and leachate collection. The post-closure monitoring plan will be included in the updated IEE. **Appendix G** provides a draft terms of reference template for the conduct of the ECA of the existing dumpsite.

D. Anticipated Impacts/Issues/Concerns – Construction Phase

136. **Air Quality.** Temporary, moderate air quality impacts are anticipated during the construction phase, due to both fugitive dust generation associated with earthworks and construction works, and to the movement and disturbance of solid wastes at the existing dumpsite.[44] The receptors of these air quality impacts are residents, businesses, and other affected persons residing nearby, and particularly downwind of construction activities, as well as formal and informal waste workers at the dumpsite. Dust will also be generated during the construction of the riverbank protection works, and also the pipeline network installation excavations in urban areas which are by their nature, densely populated. Sources of air quality impacts during construction therefore include the following:

(i) Construction machinery and equipment leading to minor increases in levels of nitrogen oxides (NOx) and sulfur oxides (SOx).
(ii) Asphalt for any road pavement reinstatement for pipelines and other excavations that will generate emissions containing small quantities of toxic and hazardous chemicals such as volatile organic compounds (VOC) and poly-aromatic hydrocarbons (PAH).
(iii) Fugitive dust from (i) the loading, unloading and haulage of construction materials. (ii) borrow pits and other excavations, (iii) batching plants and (iv) movements of construction trucks over unpaved access roads.
(iv) Fugitive dust, bioaerosols and potentially hazardous chemicals from the movement or disturbance of waste within the existing dumpsite.
(v) Fugitive dust from wind action on stockpiles of cement, fine natural aggregates and dry residual wastes.

137. The following mitigation measures are proposed to protect sensitive receptors from air quality issues:

(i) The spraying of water at borrow pits, construction sites, material handling areas and access roads where fugitive dust is generated.
(ii) Ensuring dust suppression systems are included in asphalt and concrete batching facilities, and that they are located at least 500 m downwind from the nearest receptors.
(iii) Covering trucks to encapsulate dry construction materials.
(iv) Ensuring that vehicles and machinery are maintained to a high standard to minimize emissions.

[44] The existing dumped wastes at the Thakhek dumpsite will be carefully transferred to one of the cells of the controlled landfill.

(v) Ensuring suitable advance notice is provided for pipeline and other excavation works.
(vi) Ensuring that formal and informal waste workers at the dumpsites, and receptors within 500 m of these facilities, are suitably informed in advance of when these activities are planned.
(vii) Ensuring that appropriate environmental protection and occupational health and safety provisions are followed during the disturbances and movement of solid wastes at the dumpsite, as to be defined in the controlled landfill final design.

138. **Noise.** Noise impacts will be caused by the operation and movement of construction vehicles as well as works involving the use of excavators, electric saws, pumps, generators, drilling rigs, and other equipment. These noise impacts will however be temporary and localized, as the machinery and vehicles only generate noise as they operate. It is anticipated that construction machinery may generate noise levels of up 90 dB(A), and also, that receptors within an approximate 250 m influence area could be affected temporarily by intermittent noise impacts above the WHO limit of One Hour LAeq 55 dBA. Although noise will therefore be periodically endured by nearby receptors, particularly during pipeline laying activities, it is anticipated that only construction site workers will be subjected to noise impacts for an extended period of time.

139. Potential noise impacts will be mitigated through the following measures:

(i) Utilizing low-noise, well maintained vehicles and equipment, and ensuring that exhaust systems are in good working order.
(ii) Establishing noise barriers such as temporary fences around active work areas, and barriers to be as close to the source or to the receptor location as possible.
(iii) Installing sound-absorbing enclosures around generators and other equipment.
(iv) Restricting heavy and noisy machinery operations to between 8am-5pm.
(v) Providing construction workers with and enforcing the use of personnel protective equipment (PPE).
(vi) Enforcing the non-use of vehicle horns unless absolutely necessary.
(vii) Maintaining close coordination with affected persons and communities, to ensure that advanced warning is provided, considerations are given, and the GRM is widely understood so that grievances and complaints are handled expeditiously.
(viii) Monitoring noise levels, particularly of nearby sensitive receptors.

140. **Surface Water**. Regarding controlled landfill development, the final design of this facility will incorporate surface drainage features, including perimeter drains, to mitigate any adverse run-on or runoff drainage impacts during construction.

141. The proposed sites of the SWTP facilities are, by their very nature, at low elevations to allow gravity flow (without pumping) of wastewater to the units. Due to their relatively low elevations, these sites are however subject to flooding. Any potential flooding impact will therefore be evaluated and mitigated at the final design phase by for example, incorporating bunds or other protection features, elevating the facilities, and/or through the actual design of the SWTP facilities, which can be sealed, partly underground units. The hydrology of receiving waters from each SWTP facility will also be re-evaluated and verified during detailed engineering design.

142. Other mitigation measures to be adopted that are common to the construction of the SWTP facilities, controlled landfill and riverbank improvements include the following:

(i) Adequate management of sediments, soils, stockpiles and aggregate materials

utilized in facility construction.
(ii) Monitoring of upgradient and downgradient surface water quality.
(iii) Monitoring of river water quality in relation to riverbank protection works.
(iv) Management of solid and hazardous wastes.[45]
(v) Siltation and sedimentation runoff control by (i) minimizing excavation exposure, (ii) stockpiling soils away from water bodies and flood-prone areas, (iii) utilizing sediment detention basins and other control features, and (iv) avoiding rainy season excavation where possible.
(vi) Avoidance of vegetation removal or damage beyond site boundaries.

143. For works that will be close to the river such as the riverbank protection works, and the SWTP (old town area) and SWTP (provincial bus station), these works will need to ensure that aquatic and riverine/wetland habitats are not impacted. Measures to mitigate these impacts include the following:

(i) Minimizing riparian vegetation removals.
(ii) For riverbank protection, installation of temporary berms between component footprints and the river/wetland, prior to the start of construction.
(iii) Installation of erosion and sediment controls prior to construction commencement to complement the berm.[46]
(iv) Limiting soil stripping to the dry season.
(v) Ensuring workers observe proper sanitation and good hygiene.
(vi) Ensuring where possible works close to the river are conducted in the dry season.
(vii) Ensuring the management of hazardous materials, and the containment of spills.
(viii) Ensuring that sites close to waterbodies are stabilized prior to the removal of erosion and sediment control measures following construction.
(ix) Monitoring water quality during and after construction.

144. **Wastewater**. During the construction works, wastewater will be generated by (i) on site sanitation facilities, campsites and other facilities, (ii) equipment maintenance and repairs, (ii) vehicle and equipment washing, (iii) construction site surface runoff, and (iv) borings and excavation works. Inadequate wastewater management will impact on the health and safety of construction workers and communities. It will pollute surface water resources, groundwater and soils within the areas of influence. These impacts will be mitigated by:

(i) Maintaining sanitation facilities onsite and at workers' campsites.
(ii) Strictly enforcing hygiene and sanitation practices.
(iii) Incorporating sediment controls, silt traps and wastewater collection.
(iv) Maintaining equipment washdown areas, complete with sediment control devices.
(v) Providing retention control for material stockpile areas.
(vi) Designating specific areas for repair and maintenance.
(vii) Ensuring regular wastewater collection by a recognized service provider.
(viii) Ensuring wastewater from boring and excavation works is properly managed and disposed of.

145. **Groundwater.** There is a potential that boreholes drilled during the controlled landfill design and construction phases are not properly sealed after completion, creating a direct

[45] Including (i) provision of adequate waste storage facilities; (ii) enforced sorting and disposal; (iii) separate storage for hazardous and non-hazardous wastes; and (iv) prompt disposal.
[46] For example, sediment control fences supplemented with sandbag barriers.

contaminant pathway from the surface to the groundwater table. This will be mitigated through the inclusion of detailed borehole construction specifications in the contractor's overall method statements for the drilling works to assure correct borehole construction. Other than this, potentially significant groundwater impacts during construction are not anticipated.

146. **Fauna, Flora and Potential Habitat Loss.** Although initial baseline assessment has not revealed specific impacts to fauna and flora at the proposed sites, it is recommended that further site assessment, potentially including site specific ecological surveys, be conducted at the riverbank protection sites during the final design stage in order to further evaluate, and where necessary mitigate any ecological impacts caused by the riverbank protection works.

147. **Physical Cultural Environment.** Although component sites are not within the close vicinity of historical and archaeological sites, the pipelines to be constructed for the SWTP network could be located close to pagodas, other religious monuments and other facilities. In adherence with the Law on National Heritage 2005, measures to mitigate any associated impacts are as follows:

(i) Ensure pre-construction coordination with authorities.
(ii) Cease construction works on discovery.
(iii) Declare to the local administration and local information, culture and tourism sector.
(iv) Prohibit exploration of the item/s found without the approval of the information, culture and tourism sector.

148. Chance finds procedures are set out in the EMP and will be followed.

149. **Community Health and Safety.** Communities will be exposed to health and safety hazards from dust, noise, access restrictions, local flooding, utility service disruptions, construction vehicle and equipment movements, and potential social conflicts and diseases (communicable and transmittable) from outside workers. Mitigation measures include:[47]

(i) Access restrictions:
    a. Manage material stockpiles to prevent blockages.
    b. Provide access restriction information in advance.
    c. Ensure vehicles park at previously agreed locations.
    d. Provide temporary, alternative access where possible.
(ii) Localized flooding:
    a. Divert main surface drainage routes when obstructions are unavoidable.
    b. Dispose of spoils and debris promptly.
(iii) Utility service disruptions:
    a. Repair service disruptions expeditiously.
    b. Provide alternative power and water supplies.
(iv) Worker social conflicts:
    a. Prioritize local employment.
    b. Provide health and safety training.

150. The waste pickers at the existing dumpsite will be allowed to continue their waste picking activities at the site but will be required to comply with the health and safety procedures. All waste pickers will be required to wear protective gear. Waste picking will only be during regular operating hours and minor will be prohibited from entering the premises.

[47] Air quality, dust and noise mitigation is provided earlier in this section.

151. **Traffic.** Traffic impacts caused by the subproject relate primarily to the implementation of the riverbank protection, drainage and SWTP works in the main urban area in the same period. Traffic impacts are anticipated during peak hours. Contractors will be required to mitigate traffic impacts by:

(i) Developing traffic management schemes in conjunction with local traffic authorities and affected community leaders.
(ii) Scheduling materials delivery and other traffic-causing activities outside of peak hours.
(iii) Assigning traffic staff during periods of peak disruption and peak hours.
(iv) Ensuring construction equipment and vehicles least impede traffic flow.
(v) Providing prior information on road and lane closures, and traffic diversions.
(vi) Providing safe access to pedestrians, motorbikes and bicycles.
(vii) Ensuring affected persons are aware of the GRM.
(viii) Ensuring contractors repair damages at their expense.

152. **Construction workers' health and safety.** Construction workers will be exposed to air emissions, noise, vibration, construction-generated wastes and wastewater, hazardous substances, social conflicts with communities, communicable and transmittable diseases in the community, chance finds of unexploded ordnances (UXO), large moving and operating construction vehicles and equipment, and pits and excavations. These impacts will be mitigated through:

(i) Contractor compliance with environmental and occupational health and safety guidelines.
(ii) Contractor's CEMPs will include health and safety plans.
(iii) Provision of personal protective equipment (PPE) for workers.
(iv) Adequate work site lighting, water supply, sanitation facilities and safe access
(v) Establishment of a first-response team comprising of trained staff, equipment, tools, supplies, and an adequate office/clinic. The first response team will be linked to ultimate responders.
(vi) Appointment of an Environmental, Health and Safety Officer.[48]

E. Anticipated Impacts/Issues/Concerns – Operation Phase

153. It is estimated that the largest environmental risks caused by the subprojects occur in the operation phase, and that these primarily relate to the operation of the controlled landfill and SWTP facilities. This is largely due to the risks of uncontrolled atmospheric, surface and subsurface emissions arising from (i) leachate, landfill gas and odor emissions from the controlled landfill and (ii) substandard effluents and odor that could be generated from the SWTP facilities. The identified impacts of the subproject components have been discussed in Section B of this chapter.

[48] To maintain worker's health records, and ensure compliance regarding the recommended minimum vaccinations and physical examinations for construction workers.

VI. ANALYSIS OF ALTERNATIVES

154. This section summarizes the alternatives considered in the selection of the design and locations of the proposed drainage, wastewater management, solid waste management and river embankment improvement components. Following initial component identification in April 2017, additional technical, environmental and other analyses were performed, leading to confirmation of priority subproject lists at the inception workshop in June 2017. These priorities were then adjusted and consolidated during the interim workshops in October 2017, and again during the joint Cambodia-Lao DPR Strategic Local Economic Development Plan workshop in November 2017.

A. Stormwater Drainage

155. **Without project.** Downstream areas of the town experiences annual flooding while the areas further from the Mekong River have poor drainage due to siltation and disposal of garbage by residents. Without the project, flooding in the lower areas of the town will continue and could worsen with climate change.

156. **With project.** Two options were considered. Option 1 is to rehabilitate existing open channel drains for the 3 main sub-catchments and extend their length further east, away from the Mekong, improving the trunk drainage for the full urban area. This would be supplemented with the provision of one gate on the outlet of the Houay Simang to the Mekong, and 4 pump stations, one on each of the streams running through Thakhek into the Mekong, namely Nam Sot, Nam Li, Houay Sakham and Houay Simang.

157. Option 2 is to construct a new combined drainage system throughout the urban area, including domestic wastewater connections, and a lagoon-based wastewater treatment plant (WWTP). This option however was rejected by DPWT on the basis that Laos is not ready for such a centralized system and has had bad past experiences with paying to run pumps. Additionally, the DPWT and District could not identify any public land for a lagoon system for the full urban area.

158. The option taken forward for development under the subproject is Option 1, with stormwater drainage separate from wastewater collection and treatment.

B. Wastewater Treatment

159. **Without project.** Households in Thakhek rely on septic tanks, soakaway pits or other facility. There is no National Building Code in place which would normally specify the requirement for multi-chamber septic tank on all new buildings. Many older septic tanks may be cracked or have non-sealed bases which allows liquid to escape into the ground. The removal of sludge from septic tanks is also lacking. When septage is collected these are often disposed directly to agricultural land which is dangerous to health because of virus and helminth eggs that this may contain. Without the project, untreated wastewater will therefore continue to contaminate surface and groundwater resources in the area, impacting negatively on public health and the environment.

160. **With project.** There are several technologically appropriate options to consider in identifying the most appropriate solution for treating wastewater in Thakhek to the year 2040, a 20-year design capacity having been selected by DHUP for wastewater treatment. The principle options presented are standard lagoon systems, aerated lagoon systems, trickling filters preceded

by settlement, and small-scale wastewater treatment plants. Technologies that are widely seen as inappropriate for countries at the beginning of their wastewater treatment capacity development have not been considered, and case studies of technologies that have succeeded or failed across the region have been reviewed in identifying these technologies. For this reason, activated sludge oxidation ditch technology, up-flow anaerobic sludge blanket (UASB) and sequencing batch reactors (SBR) for example, have not been considered further.

(i) **Option 1: Lagoon Systems.** Lagoons are shallow, artificial basins into which wastewater flows and from which, after a retention time of several days (rather than several hours in conventional treatment process), a well-treated effluent is discharged. Lagoon systems comprise a series of ponds in series including anaerobic, facultative, and several maturation ponds. The advantage of lagoon systems are their simplicity, low cost, and high efficiency. If a suitable amount of low value land is available, it is generally acknowledged that they should always be the first choice of technology in developing countries.

(ii) **Option 2: Aerated Lagoons.** With the ambient temperatures experienced in Lao PDR, aeration by mixing the upper layers of the lagoons has the potential to increase the capacity of a SWTP by two to two and a half times. If insufficient land is available for an unaerated lagoon system, this represents the most technically simple option for ease of operation and maintenance from a staff base of limited capacity and experience.

(iii) **Option 3: Trickling Filters.** Where sufficient land for a lagoon system is not available, an option is also to utilize trickling filters preceded by a settling pond, to avoid the filter becoming easily blocked. The key advantage of using trickling filters is that they require a smaller footprint than lagoon systems, and can have very small footprints if more modern "high rate" trickling filters are used. However, these are more suited to fully developed countries as they require skilled operators and an established institutional framework. Trickling filters are designed primarily to reduce biological oxygen demand (BOD) concentration. They are basically a form of biological filter as opposed to a physical filter in that solids are not removed. An underdrain system collects treated wastewater, which then usually requires further treatment and settlement in an oxidation pond prior to release into receiving waters. A standard low-rate trickling filter can reduce BOD concentration by 80-85% when operated correctly.

(iv) **Option 4:** Small-scale wastewater treatment plant. This is a separated sewer system suitable for pockets of the main urban area, feeding to decentralized SWTPs. It is the favored option of DHUP and MPWT, and has been heavily promoted over the last few years.

161. A multi-criteria assessment of the four wastewater treatment options was prepared for the IEE (Table 11). The results showed Option 4, the SWTP option, to rank more favorably than the other three options. This option is also the strong preference of the MPWT and DHUP in order to avoid a single combined system with lagoon-based treatment for the full urban area, or any technology of equal or greater complexity.[49] There are however no large enough land parcels in Thakhek to construct larger SWTP facilities that could serve 30-50% of the town with one system and so it is proposed that four medium sized systems of 300 m^3/d each placed to serve the majority of the central urban area. These require approximately 200m^2 of land for each treatment plant. These are to be located at the:

[49] In the late 1980s a lagoon-based treatment plant was constructed in the That Luang area but quickly deteriorated due to lack of funds to run pumps, and was abandoned to use as a fishpond. This historical experience has swayed favor away from lagoon-based systems within MPWT.

- Vicinity of the old town square (approximately 600m^2).
- Hospital grounds.
- Provincial bus station.
- Local bus station and market.

162. The treated effluent will be discharged to one of the open drainage canals and ultimately to the Mekong. No land is available for further tertiary treatment, and low footprint tertiary treatments such as a UV unit are not considered technologically appropriate.

Table 11: Multi-Criteria Analysis of Wastewater Treatment Options

Criteria	Option 1 Standard lagoon	Option 2 Aerated lagoon	Option 3 Trickling filter	Option 4 SWTP
Technical				
Efficiency in wet season treatment	Less effective wet season treatment.	Less effective wet season treatment.	Better wet season treatment	Separated system. Collects only wastewater. Uses HDPE, not rigid but flexible.
Availability of important parts	Low requirement	Replacement parts are available to prevent extended downtimes.	Not all parts and materials are available locally	Materials and inputs used are locally available
Suitability to developing countries	Most appropriate technology for countries with limited financial or trained operational staff resource.	Most technically simple O&M. Can be handled by staff with limited capacity and experience.	More suited to fully developed countries. Requires skilled staff for construction and operation.	Suitable. Low operation and maintenance requirement.
Economic				
Capital cost	Low capital cost where land prices are low.	Moderate to high	High capital cost.	Low capital cost
Operation and maintenance costs	Least operation cost	Low operation costs	High operation cost	Least operation cost
Environmental and social				
Land disturbed or converted	Higher land disturbance and higher surface area requirement	Less land requirement than the standard lagoon system	Requires far less land than standard lagoon system.	Less land requirement than standard lagoons (if to serve all of the town)
Energy consumption	Low	High.	High.	Low
Pollution to environment	May be used for unrestricted irrigation or for direct recharge in surface waters, if sized adequately to meet effluent standard.	Effluents of completely mixed ponds require post-treatment in a sedimentation pond.	Additional treatment may be needed to meet more stringent discharge standards	Effluent designed to meet standard will be dispersed into a planted gravel filter.
Waste to manage (sludge, etc.)	Sludge requires proper removal and treatment.	Settled sludge needs to be dug out regularly and requires further	The sludge that accumulates on the filter must be periodically	Long desludging intervals.

Criteria	Option 1 Standard lagoon	Option 2 Aerated lagoon	Option 3 Trickling filter	Option 4 SWTP
	Anaerobic ponds need to be desludged once every 2-5 years,	treatment or correct disposal.	washed away once in 5-7 years or more.	
Flies/mosquitoes and odors	No real problems with flies or odors if designed and maintained correctly. Mosquito control required.	No real problems with insects or odors if designed and maintained correctly.	Odor and fly problems require that trickling filters be built away from homes	Sealed (per design for the subproject)
Reuse of effluent	Effluent contains nutrients (e.g. N and P) and is therefore appropriate for reuse in agriculture. But may not be for direct recharge in surface waters.	The treated water can be reused or discharged if a secondary maturation/ settling pond follows the aerated lagoon/completely mixed aerated pond	Should be clarified prior to discharge	Can be reused.

Most favorable, 1
2
3
4
Least favorable, 5

C. Solid Waste Disposal

163. **Without Project.** The existing solid waste landfill was constructed under an ADB project in 1997.[50] The last remaining government-owned vehicle lasted until 2011. From 2014 a private company, Shinawat, was contracted to collect waste and manage the landfill, now reverted to an uncontrolled dumpsite. Shinawat utilizes 5 small collection trucks and 1 tractor. The dumpsite occupies around 10 ha of a larger 95-ha site, although currently only 4 ha is being utilized. Approximately 50 tonnes of waste is generated daily and around 30 tonnes of this is collected, the remainder being burnt or disposed to vacant land or drains. There was a septic sludge disposal facility constructed at the landfill but this has fallen into disuse. Of the 35 villages in urban Thakhek, 26 have at least a partial waste collection service, with coverage generally over 90%. Without the project, the dumpsite will continue to pollute groundwater, soil and air, and threaten the public health of nearby receptors.

164. **With Project.** The options that were considered for solid waste disposal for Thakhek generally relate to the level of advancement possible for a proposed landfill. This ranges from the current practice of open dumping at one end of the scale, to a controlled landfill that includes certain basic engineered systems, through to full sanitary landfill development. A multi-criteria assessment of these three waste disposal options was completed for the IEE, the results of which is shown on Table 12. The results indicate that Option 2 (controlled landfill) ranked more favorably

[50] ADB Secondary Towns Urban Development Project, final design report 1999.

than the other two options, given the size and relative development level of the town, funding level, and overall planning and implementation capacity of involved institutions.

Table 12: Multi-Criteria Analysis of Solid Waste Disposal Options

Criteria	Option 1 Open dump	Option 2 Controlled landfill	Option 3 Sanitary landfill
Technical	.		
Management of waste at the site	Waste dumped as collected	Waste dumped into lined cells	Waste dumped into lined cells
Materials recovery	Some sorting and recycling by informal pickers at dumpsite, often operating in dangerous conditions	Organized sorting and recycling at landfill	Sorting and recycling prior to collection and potentially also at landfill
Final disposal method	Limited compaction, no cover	Compaction and soil cover in layers (daily or periodic)	Compaction and soil cover daily and periodic
Hazardous waste management	No separate hazardous waste treatment	Incinerator or separate cell for hazardous waste	Incinerator or separate cell for hazardous waste
Onsite energy generation	None	None	Possible landfill gas recovery
Appropriateness for improving solid waste disposal in developing countries	Will not improve solid waste disposal.	Staged improvement and often more appropriate where there are operational capacity limitations	Improvements meet international standards, and require a high level of operational capacity
Economic			
Capital cost	Least	Moderate	High
Operation and maintenance costs	Least	Moderate	High
Environmental and social			
Risks to biodiversity	High	Low	Least
Waste burning	High	None	None
GHG emissions	Uncontrolled	Controlled, and possibly collected and flared	Controlled, collected and flared or converted to energy
Odor	High	Low	Least
Leachate	High, as exposed to rainfall	Lower, collected and reduced risk	Low, collected and least risk
Groundwater and soil pollution risks	High risk	Lower risk	Lowest risk
Risk of surface water pollution	High risk	Reduced risk	Least risk
Flies, mosquitoes, other disease vectors	High	Low	Low
Vulnerability to climate change effects	High	Low	Least
Health and safety hazards	High	Low	Low
Reuse of landfill gas	None	Potential flaring	Flaring or energy recovery

Most favorable, 1
2
3
4
Least favorable, 5

165. An analysis of landfill liner design has also been completed, which compared (i) a standard clay (soils with a low hydraulic conductivity) liner, with (ii) a composite liner of HDPE geomembrane with clay protection layers. Although the liner design will be confirmed during final design, at this stage a composite liner has been recommended by the PPTA engineering team.[51]

166. Options were also considered regarding the collection, storage and treatment of leachate generated within the facility. Although treatment options vary considerably, from rudimentary gravity draining, storage and reticulation, through to the capture and full treatment of leachate through relatively complex treatment processes, typically, leachate is collected through a system of underdrains to a lined and bunded leachate pond. From there, it is typically treated on site, or either pumped or transported to a SWTP.

167. The most basic means of leachate treatment is recirculation. This is the action of collecting leachate from the base of the cell and pumping it back over the top of the waste layers, where it can evaporate or be absorbed by the waste. A second approach that is appropriate for Lao PDR at this time is onsite lagoons, which operate in a similar way to municipal wastewater lagoons but are sized using different BOD loading requirements. However, given the current reluctance of MPWT to utilize lagoons for domestic wastewater treatment, these have not been included in the scope.

D. Riverbank Protection

168. **Without Project**. The riverbank of Thakhek is not completely protected. When the Mekong water level is high, the unprotected banks are eroded and areas alongside are flooded. Erosion causes damage to domestic structures along the river, loss of lands, and the potential for sediments and other pollutants to enter into the Mekong River. Without the Project, the regular flooding and erosion will seasonally persist and continue to damage establishments and farmlands.

169. **With Project.** The DPWT identified four separate lengths of riverbank protection are proposed for Thakhek, two being in the town area and two to the south where people live along the riverbank which is being eroded by high water levels.

VII. INFORMATION DISCLOSURE, CONSULTATION AND PARTICIPATION

170. Stakeholder consultation and participation are considered essential throughout the project. The following consultations were undertaken during project preparation: (i) an inception workshop held in Vientiane on 27 June 2017 with representatives from MPWT, other central government agencies, provincial officials from the project towns, ADB project staff and PPTA Team to present the overall work plan and obtain feedback and comments on key issues; (ii) consultations at the interim stage through key informant interviews, meetings, discussions and random interviews; (iii) a socio-economic survey in September 2017; and (iv) a joint Laos-Cambodia workshop, attended by the officials and representatives of the Project provinces in November 2017, which included disaster risk reduction as one of the topics. The socioeconomic survey, which covered 270 households, included key questions on environmental issues and concerns. Relevant findings from the survey are presented in Section IV(K).

171. Another consultation meeting was held on 26 April 2018 at the Thakhek District

[51] Due to its resilience, lower hydraulic conductivity, and relative assurance of quality.

Government Office to present the initial results of the IEE and resettlement plan and to solicit feedback from the stakeholders. The meeting was attended by representatives from the District Government, DPWT, UDAA, DONRE, Khammouane Provincial Hospital, and affected villages and households at the riverbank improvement works. The documentation of the environmental safeguard-specific consultations held on 26 April 2018 is presented in Appendix H.

172. During the consultation meeting last April 2018, the following issues were raised by the stakeholders:

Table 13: Issues raised during the public consultation on the IEE and RP

Stakeholder	Issue/Concern/Suggestion	MPWT/DPWT Response
District Governor	During construction: (i) solid waste should be disposed of at the dumpsite; (ii) waste pickers to continue to work and stay at the dumpsite, to continue to sort and recover recyclables for their daily income; (iii) measures to mitigate health and safety issues to be implemented. On compensation: (i) Government to compensate affected persons most suitably and fairly. (ii) The project should avoid cutting big trees. (iii) A committee will be set up for the detailed assessment of how to compensate or relocate affected HHs according to the laws/regulations of the Government of Lao PDR.	The suggestions will be considered during project implementation. Waste pickers will be allowed to continue their livelihood activities at the site and will be trained and required to abide by the safety guidelines. Households living at the site will be relocated and minors will not be allowed to enter the landfill site.
Mr. Sonthalee Kanyasone Owner, Provincial Bus Station	(i) Declared his support for the project. (ii) Had donated a piece of his land beside the bus station for the location of the SWTP. (iii) Asked if many HHs will be connected to the SWTP system and if those affected by the drainage component will be compensated.	Households close to the sewer lines in Ban Souksavanh will be connected to the system. Compensation will be based on the Resettlement Plan acceptable to affected HHs.
Bounpheng Xayyasin of DONRE	(i) Agree with the project implementation (Ii) Commented that the project had undertaken environmental and social studies that followed the safeguard policy of Lao PDR. Agreed to the scope of environmental and social studies of the project and that further studies would be made during project implementation.	An ESIA will be undertaken during detailed engineering design.
Mr. Khamtai Xaynasin of Khammoune Hospital	(i) Agreed to the SWTP system to be installed at the hospital compound. (ii) Requested for a specific bacteria waste treatment equipment for treatment of hospital waste prior to transport to the landfill for final disposal.	This will be considered in the detailed design.
Mrs. Vongphachanh Phonsuly, head of Nabo village	Agreed with the project and was glad to hear that the project will be implement in the near future.	Noted.
26 households affected by riverbank protection works	The affected households asked: (i) If affected land, infrastructure/house structure, grown vegetation would be compensated;	The compensation plan will be designed. The plan should be fair and acceptable to the affected HHs.

Stakeholder	Issue/Concern/Suggestion	MPWT/DPWT Response
	(ii) if resettlement area would provide convenient living conditions; (iii) if rentals would be compensated; (iv) how affected HHs (that are without another land to relocate to) would be resettled; and (v) if there would still be land available in the current area, would affected HH be allowed to stay on and not be resettled. To these concerns, the District Governor replied that compensation details would be finalized only after detailed assessment of HH conditions are made at the start of project implementation.	

173. The District Governor concluded the meeting with the following points:

a) The participants in the meeting agreed to the results of the IEE and RP.
b) The social and environmental studies will be endorsed accordingly.
c) For the detailed assessment and studies on the impacts on affected HHs, a committee at the provincial and district levels will be set up and consultation meetings will be conducted to arrive at the appropriate, fair, compensation acceptable to affected HHs.
d) The 26 affected HHs that will be affected by the riverbank improvement will be compensated appropriately, suitably and fairly for the betterment/improvement of their living conditions.
e) All participants from the relevant government offices and from affected villages to participate and carry out their respective responsibilities according to the project schedule.

174. Stakeholder consultations will continue throughout subproject implementation and operation, following the Project Stakeholder Participation Plan. To facilitate the engagement of stakeholders, the PCU and PIU will maintain good communication and collaboration with the district and village leaders. The PCU, PIU, Contractors and/or Operators can be contacted by the public on matters concerning the progress of the subproject, adverse impacts, mitigation measures and environmental monitoring and grievances. Future stakeholder consultations will include the following:

(i) During detailed design, if update of the IEE is warranted, the updated IEE will be disclosed to the affected communities to solicit feedback.
(ii) Prior to construction, the PCU will conduct an intensive information, education and communication campaign to ensure sufficient level of awareness/ information among the affected communities regarding the upcoming construction, its anticipated impacts, the grievance redress mechanism, contact details and location of the PCU, PIU and other key project contacts and status of compliance with Government's environmental safeguard requirements, among others.
(iii) Billboards about the subproject, implementation schedule and contact details of the executing agency, PCU, PIU and Contractors will be set up at strategic locations within the main areas of influence. The grievance redress procedure and details will be posted at the offices of the PCU, PIU and District and at the residences of concerned village leaders.

175. The IEE (in English) and the EMP (in English and Lao), as well as the MONRE/DONRE-approved IEE/ESIA Reports (in Lao), will be available at the offices of the PCU and PIU for

interested parties. Copies may be made available upon formal request. The updated IEE and EMP and semi-annual environmental monitoring reports will be disclosed on the ADB's website.

VIII. GRIEVANCE REDRESS MECHANISM

A. Purpose of the Mechanism

176. ADB requires that the borrower/client establish and maintain a grievance redress mechanism (GRM) to receive and facilitate resolution of affected peoples' concerns and grievances about the borrower's/client's social and environmental performance at project level.

B. Proposed Set-Up

177. The MPWT, as executing agency of the GMS-CTDP-4 will establish the GRM. The PCU's environmental safeguards officer (ESO) will oversee the implementation/observance of the GRM for the Project, in coordination with the Public Works and Transport Research Institute (PTRI) of MPWT. The ESO's counterparts in the PIUs (environmental focal points) will ensure the implementation of the GRM at the subproject level and will be responsible for keeping the PMU informed as prescribed in the GRM. Access points will be set up with the Village and District. Contractors and Operators will be required to designate their respective counterpart GRM staff.

178. The GRM will accommodate both informally and formally lodged, but eligible, grievances. Informally lodged grievances are those received by the Contractor during construction or Operator during operation. Formally lodged grievances are those received at the offices of the PIU, District and Village Leader. The PIU evaluates complaints for eligibility. The PIU and PCU maintains record of all grievances, informally and formally lodged, eligible and ineligible. The PCU will inform the ADB, as necessary, and report on the observance/implementation of the GRM in the quarterly progress and in the semi-annual Environmental Monitoring Report that will be submitted to ADB.

179. Sufficient support system, including GRM-oriented staff in the access points of the Village Leader and District, communication facilities, documentation/recording/reporting system, and posters declaring contact details that are displayed at strategic locations, will be in place to sustain the effective implementation of the GRM.

C. Access to the Mechanism

180. Any person who has environmental concerns/issues pertaining to the subproject during detailed design, construction and operation phases will have access to the GRM free of charge. The PCU, through its ESO and his/her counterparts in the PIUs, will ensure that:

(i) the mechanism is understandable, transparent, gender-responsive, culturally appropriate, and readily accessible to all segments of the affected people at no cost and without retribution;
(ii) the GRM is displayed in the offices of the PCU, PIU, District and Village Leader and at strategic places.

D. GRM Steps and Timeframe

181. Grievances raised on environmental impacts are critical to the health, wellness and safety of affected persons (APs). Hence, the proposed mechanism intends to be easily accessible and

promptly responsive to APs' complaints.

1. Informal Approach

182. Informally, APs can lodge complaints directly to the Contractor during construction or Operator during operation. Contractor/Operator shall document and assess the complaint immediately. If assessment shows the complaint as valid, the Contractor/Operator shall act on the complaint within 3 days from receipt of complaint. If assessment invalidates the complaint (i.e., reveals the complaint as ineligible or not associated with the subproject's environmental performance), the Contractor/Operator shall direct the AP to the District. The Contractor/Operator shall report to the PIU the complaints received, eligible or ineligible, actions to be taken, ineligible complaints directed to the District within 2 days from receipt of complaint. The PIU shall obtain a written confirmation of satisfaction from the AP after 7 days from completion of resolution by Contractor/Operator.

2. Formal Approach

183. If complaint is eligible but is not acted on within three days from receipt of complaint, or if AP is not satisfied with the resolution undertaken by the Contractor/Operator, he/she can access the formal mechanism, as follows:

Step 1 Lodging a Complaint (Day 1)
AP lodges complaint, by him/herself or with assistance from the Village Leader, at the access points of the PIU, District or Village Leader.

Step 2 Documentation & Registration of Complaint (Day 1)
PCU/PIU/District/Village Leader documents/registers lodged complaint, makes sure these are duly referenced and provides AP with a copy of referenced complaint. The District forwards documented complaint to the PIU; the Village Leader, through the District.

Step 3 Assessment and Discussion (Day1/Day 2/Day 3)
AP shall be informed if the grievance is eligible or ineligible. If it is ineligible, AP shall be directed to the District. If complaint is eligible, AP shall be informed of the expected action timelines as set out in the established mechanism.

If both of the AP and Contractor/Operator are available, the complaint shall be immediately reviewed, investigated and discussed. If not, both parties should agree to undertake the review, investigation and discussion within 3 days. The discussion will be on the cause and action/measure to implement based on the review and investigation. Agreement on actions and measures and time involved shall be made with the AP. Agreement shall be properly documented and filed; PIU, District, Village Leader and AP shall have copies of the agreement.

Step 4 Implementing the Agreed-on Resolution
(Day 3/Day 4) If complaint is minor, i.e., not requiring further investigation and would be easy to resolve, the Contractor/Operator shall immediately implement agreed on action/resolution.

(Day 3/Day 4 to Day 7/Day 8) If further investigation and/or procurement of supplies/parts would be necessary, the Contractor/Operator shall: (i) immediately provide the most suitable interim measure to reduce the magnitude of the impact; and (ii) start work on the final measure within 5 days from the day discussion meeting is held.

Step 5 Acceptance of Resolution (1 week after completion of action/measure taken)
If, according to the AP, the impact has been resolved satisfactorily, PIU shall obtain a written confirmation of satisfaction from the AP. This confirmation will signify closure of grievance and will form part of the grievance documentation. The District, Village Leader and AP shall retain their copies of the confirmation.

Step 6 Monitoring and Evaluation (for 1 week after closure of grievance)
The PCU shall monitor the effectiveness of the resolution for at least a week after closure of grievance (that is, when action implemented has been satisfactorily confirmed in writing by the complainant). Monitoring and evaluation shall be properly documented and included in the Environmental Monitoring Report (EMR).

Step 7 Appeal for Dissatisfied AP
When dissatisfied (or, in the event the issue/impact persists despite actions undertaken), AP can appeal for assistance from the District in the elevation of his/her complaint to the Province. The Province shall call all parties concerned to review the history of the grievance and resolution process taken and assess the validity of the appeal.

If appeal is found not valid, the Province shall write the AP and declare the grievance closed.

If appeal is assessed to be valid, Province and the parties discuss and agree on the quick resolution of the issue. PCU requires Contractor and Operator to implement the agreed resolution. Should the issue continue to persist despite the second action, dissatisfied AP can raise an appeal to the Provincial Court.
In the event of an appeal, the PIU shall immediately report to the PCU. The PCU shall ensure that the ADB is immediately informed.

184. The PCU will be the overall manager of GRM and should document and report on all complaints that have been raised in respect of the Project. All grievances and their resolution should be reported in quarterly project progress reports and semi-annual environmental monitoring reports.

185. The mechanism prescribes that the PIU shall inform the PCU (at least) whenever: (i) an ineligible complaint is directed to the District; (ii) a complaint is evaluated as a major issue; and (iii) a dissatisfied AP raises an appeal.

186. Adversely affected persons can also raise their grievances through the Accountability Mechanism of the ADB.

IX. ENVIRONMENTAL MANAGEMENT PLAN

187. A detailed EMP has been prepared for the subproject. The EMP will serve as the framework for the environmental management of the subproject, commencing from the detailed design phase through to operation and decommissioning. The EMP addresses the potential impacts and risks identified in the IEE. It includes: (i) mitigation measures; (ii) monitoring measures; (iii) implementation arrangements and responsibilities, (iv) capacity development, (v) public consultations; and (vi) preliminary costs for EMP implementation. The EMP will be updated by the PCU based on the detailed designs, with technical assistance from the Environmental Specialists of the Project Implementation Consultants (PIC). (Appendix I)

188. Environmental management of the subproject during implementation will be the joint responsibility of the: (i) Ministry of Public Works and Transport (MPWT) through its Project Coordination Unit (PCU); (ii) Department of Public Works and Transport through its Project Implementation Unit (PIU); (iii) Central Project Steering Committee (CPSC); (iv) Design Consultant; (v) Civil Works Contractors; (vi) Operators of completed components; (vii) Project Implementation Consultants; and (viii) Asian Development Bank (ADB). As executing agency, the MPWT will be responsible for overseeing the EMP implementation through its PCU. As implementing agency, the DPWT will supervise component activities carried out prior to construction, during construction and during operation through its PIU. The PIUs will be responsible for providing assistance to the PCU in environmental management at the subproject level. Table 14 presents the overall responsibilities of these key institutions in environmental management.

Table 14: Responsibilities of Key Institutions in Environmental Management

Entity	Overall Responsibility
Central Project Steering Committee (CPSC)	Strategic guidance and support to the MPWT and PCU and facilitate inter-agency coordination.
Project Coordination Unit (PCU)	Management of the day-to-day activities of the Subproject.
PCU Environmental Safeguard Officer (PCU-ESO)	Supervision of EMP implementation/compliance.
Project Implementation Unit (PIU)	Overseeing subproject implementation.
PIU environmental focal point	Responsible for subproject environmental monitoring.
Design Consultant	Ensuring detailed designs incorporate environmental and climate considerations.
Standard Contractor	Preparation of Contractor EMP (CEMP) that fully responds to the ADB-cleared EMP. Implement the CEMP.
Operators of completed components	Responsible for EMP implementation during operation.
Project Implementation Consultants (PIC)	Technical support and capacity building to the PCU and PIU.
International and national Environmental Specialists (ESs)	Technical support in environmental safeguard management during design and implementation.
Asian Development Bank (ADB)	Review of project performance against the commitments in the covenants, review of relevant documents and advise on corrective actions.

189. The MPWT has the Public Works and Transport Institute (PTRI) that conducts environmental monitoring of various projects of the agency. Two safeguards staff, i.e. one for environment and one for social/resettlement/gender, will be hired by the MPWT to work with the PTRI as part of the PCU to institutionalize the monitoring of safeguards compliance of subprojects

in Thakhek and Pakxan. The two safeguards staff of PTRI will be assigned to work under the PCU on safeguards monitoring of the GMS CTPDP4 project and concurrently on other ADB projects for a period of five years as full time PTRI staff.

190. The Environment Safeguards staff will have the following responsibilities:

a) Work with the PCU and PIUs in evaluating the environmental soundness of the design of the subproject components by ensuring that mitigation measures to address adverse environmental impacts are incorporated in the detailed design and that climate change resilient and adaptation measures are considered.
b) Provide support to the PCU and PIUs in ensuring compliance with the (i) Environmental Protection Law 2012 (No. 29/NA) and relevant associated ministerial agreements and guidelines; (ii) Safeguard Policy Statement (SPS) 2009 of the Asian Development Bank (ADB); and (iii) ADB-cleared EMP.
c) Review the Terms of Reference (TOR) prepared by the construction supervision consultants for the preparation of the Environmental and Social Impact Assessment (ESIA) / Initial Environmental Examination (IEE) reports to be submitted to MONRE/DONRE in securing the Environmental Compliance Certificate (ECC) of the subprojects.
d) Ensure that the firm to be engaged in the preparation of the ESIA/IEE is nationally certified/registered to provide ESIA/IEE services.
e) Review the ESIA/IEE prepared by the MONRE-registered firm and check the completeness documents prior to submission to MONRE/DONRE.
f) Monitor the status of the ECC approval process and ensure that the ECC of each subproject is secured by MPWT prior to start of construction.
g) Coordinate with the PCU and PIUs in organizing public consultations and information disclosure, and activating the grievance redress mechanism (GRM) at the subproject, town and village levels.
h) Work with the PMU, PIUs, and consultants during the Environmental Compliance Audit (ECA) of the existing dumpsite; provide recommendations/suggestions to improve environmental compliance.
i) Conduct monitoring and inspection of the subproject components and check compliance with the ESIA/IEE/ESMP.
j) Review the status reports for environmental compliance with the conditions set out in the approved ESIA/IEE reports.
k) Review the semi-annual environmental monitoring report to be submitted to ADB.

X. CONCLUSION AND RECOMMENDATION

191. This IEE was prepared to determine the environmental issues and concerns associated with the proposed subproject. The assessment confirms that the subproject is classified as Category B for environment. There are no significant adverse environmental impacts resulting from the subproject that cannot be mitigated if implemented effectively and efficiently. The proposed EMP will mitigate impacts on the natural environment and affected people to an acceptable level. The key parties involved in implementing the proposed mitigation measures are the construction contractors and operators. They will be supported by national and international environmental consultants within the Project Management and Construction Supervision Consultant team. Training in operation and maintenance of wastewater treatment and solid waste management facilities and urban asset will be provided. The subproject stakeholders will closely monitor, and report on, the implementation of the EMP.

192. Overall, the subproject is expected to improve the urban environment in Thakhek, reduce the town's vulnerability to environmental and climate risks, and improve its climate resilience level and quality of life. It will provide improved stormwater, wastewater and solid waste management services, and formulate a provincial development strategy and strengthen institutional capacities in resilient town planning. Cumulatively, the positive impacts are: (i) reduced flood risk, (ii) reduced risk of human contact with raw sewage during flooding, (iii) reduced health risks from and incidence of diseases caused by inadequate stormwater, (iv) improved environmental sanitation, (v) controlled GHG emissions from solid waste disposal, (vi) reduced pollution discharges and improved water quality, (vii) reduced air and land pollution, and (viii) improved social equity from access by all to recreational amenity.

193. The design of the stormwater drainage, SWTPs, and sewer network will take into consideration the assimilative capacity of the receiving water bodies, their intended uses, and the presence of sensitive receptors. Further to hydrological assessments, flood mitigation and emergency response measures will be developed and incorporated into the subproject component operations and maintenance manual. Additional baseline surveys (ecology, air, surface water and groundwater quality and noise) will be carried out during detailed engineering design as part of the domestic IEE/ESIA and in the updating of the IEE/EMP to be submitted to ADB.

194. The proposed subproject will be designed to ensure resilience to climate risks, particularly the proposed SWTP (Old Town Square) and SWTP (Provincial Bus Station). Additional measures will be considered during detailed engineering design, as set out in the Project Climate Risk Management Report and as presented in summary in this IEE.

195. The key parties involved in implementing the proposed mitigation measures are the construction contractors and operators. They will be supported by national and international environmental consultants within the Project Management and Construction Supervision Consultant team and the loan will finance a full-time Environment Safeguards Officer under the PTRI to support the PCU with implementation and monitoring of environmental compliance and EMP.

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Appendix A

Environmental Management Plan

Project No. 50099
June 2018

Lao PDR: Fourth Greater Mekong Subregion Corridor Towns Development – Thakhek Subproject

Prepared by the Ministry of Public Works and Transport for the Asian Development Bank

I. INTRODUCTION

1. This draft environmental management plan (EMP) is for the Thakhek Subproject of the Greater Mekong Subregion Corridor Towns Development Project (GMS-CTDP4). The EMP summarizes the potential impacts of the subproject, as identified in the initial environmental examination (IEE), and defines mitigation measures and monitoring requirements to reduce these impacts to acceptable levels.

2. The EMP also defines the institutional arrangements, procedures and budgets for implementation of the EMP. It seeks to ensure effective implementation of environmental protection activities during preconstruction, construction, and operation to prevent, reduce, and/or mitigate adverse impacts and risks.

3. This draft EMP is based on the proposed subproject design as of May 2018. It will be finalized by the Project Coordination Unit (PCU), based on the detailed design and results of the baseline environmental quality surveys, with technical support from the Environmental Specialist of the Project Implementation Consultant (PIC-ES). The final IEE/EMP will be disclosed on the ADB website in accordance with ADB's Public Communications Policy. The final EMP will be included in all bidding and contract documents.

4. Environmental monitoring results will be used to evaluate (i) the extent and severity of actual environmental impacts against the predicted impacts, (ii) the performance of the environmental protection measures and compliance with regulations, (iii) overall effectiveness of the project EMP, and (iv) the need for adjustment of the project EMP.

II. INSTITUTIONAL ARRANGEMENTS AND RESPONSIBILITIES FOR EMP IMPLEMENTATION

5. The environmental management of the project during implementation will be the joint responsibility of:

a) Ministry of Public Works and Transport (MPWT) through its PCU;
b) Public Works and Transport Institute (PTRI);
c) Department of Public Works and Transport (DPWT) through its Project Implementation Unit (PIU);
d) Central Project Steering Committee (CPSC);
e) Design consultant;
f) Civil works contractors;
g) Operators of completed components;
h) Project Implementation Consultant (PIC); and
i) Asian Development Bank (ADB).

6. Primary responsibilities are defined below and detailed in Table 1.

7. **Executing Agency.** The MPWT, the executing agency for the Project, through the Department of Housing and Urban Planning, will be responsible for overseeing the implementation of and compliance with loan assurances and the EMP. It will ensure the Subproject's compliance with environmental safeguard requirements identified in the EMP, and

that environmental approvals are obtained from the Ministry of Natural Resources and Environment (MONRE) prior to contract awards.

8. **Project Coordination Unit.** The PCU, established by the MPWT, will be responsible for managing the day-to-day activities of the Subproject. Prior to the commencement of the detailed engineering design (DED). The PCU will appoint an Environmental Safeguard Officer assigned under the PTRI.

9. **Implementing Agency.** The provincial DPWT will be the implementing agency for the project. It will supervise component activities carried out prior to construction, during construction and during operation. The DPWT will coordinate with the provincial Department of Environment for collaborative environmental impact monitoring.

10. A **PIU** for the subproject will be established within the provincial DPWT. Prior to the commencement of the DED, the PIU will appoint an environmental focal point for environmental safeguard matters at the provincial level. The PIU will provide assistance to the PCU in environmental management at the subproject level.

11. A **CPSC** will be established to provide strategic guidance and support to the MPWT and PCU, and facilitate inter-agency coordination. MONRE is among the proposed members of the CPSC.

12. **Civil works contractors** will be responsible for implementing the mitigation measures during construction. Design-build contractors will engage environmental management specialists during the design stage (and retain the same specialist or set up an environmental management unit/team during construction) to ensure compliance with environmental requirements and obligations in designs and during construction. Each contractor will appoint an environmental, health and safety officer.

13. **Design consultants** for components under standard construction contracts will incorporate environmental and climate considerations in designs, and key EMP clauses in tender and contact documents.

14. **Operators** will comprise the DPWT for the riverbank protection, and the Urban Development Administrative Authority for the controlled landfill, drainage and small-scale wastewater treatment plants (SWTPs). Operators will engage their respective environmental officers as the focal persons on EMP implementation during operation. Through their respective environmental officers, operators will: (i) ensure effective implementation of the EMP and the environmental management sections of operations manuals, (ii) submit the required environmental monitoring reports to the PIU until the project completion report is issued, and (iii) observe the grievance redress mechanism (GRM) in addressing pertinent complaints during operation.

15. The **PIC Consultant** will engage environmental specialists (1 international and 1 national), who will provide training for the PCU, PIU and contractors, and technical support during the updating of the IEE and EMP, implementation of EMP, monitoring and reporting.

16. **ADB** will: (i) review and supervise project performance against the commitments of the executing agency and implementing agencies as described in legal agreements, (ii) review relevant documents, such as the updated IEE and EMP, for clearance purposes, and (iii) carry out periodic review missions to review, among others, the implementation of the EMP.

Table 1. Environmental Responsibility

Responsible Entity	Project Stage and Environmental Responsibility					
	Project Preparation	**Post-Loan Approval & Prior to DED**	**Detailed Engineering Design**	**Tendering and/or Pre-Construction**	**Construction**	**Operation**
MPWT	As the executing agency (EA) for the project, the MPWT will be responsible for overseeing the implementation of and compliances with loan assurances and the EMP.					
		Ensure environment approvals from MONRE are obtained prior to contract awards. Establish the necessary collaboration with the MONRE for environmental impact monitoring. Ensure the PCU is staffed with a qualified environmental safeguard officer. Ensure PIUs have appointed their environmental focal points.		Clear CEMP.		
PCU	Established by the EA, the PCU is responsible for managing the day-to-day activities of the project. It has an overall responsibility, delegated by the EA, for supervising the implementation of environmental mitigation measures, coordinating the project level GRM and reporting to ADB.					
		<u>For works under DB contracts</u>. Incorporate the mitigation measures and EMP clauses (environmental conditions) in the bidding documents and contracts for DB works. Incorporate environmental criteria in the evaluation of bids for DB works.	Obtain the results of baseline survey from the national initial environmental impact assessment/environmental and social impact assessment consultant to inform design and update of IEE/EMP. Update the IEE and EMP based on the detailed designs and results of the baseline environmental surveys. Provide updated EMP to the Design Consultant. Conduct follow up consultations and information, education & communication activities to prepare the affected communities. Ensure readiness of the subproject for construction, especially with respect to environmental approvals/clearances and mine and unexploded ordnances clearances.	<u>For works under standard contracts</u> Ensure mitigation measures and EMP clauses (environmental conditions) are incorporated in the bidding documents and civil works contracts and environmental criteria are incorporated in bid evaluation. <u>For works under DB and standard contracts</u> Review CEMP. Clear CEMP.	Coordinate GRM; supervise EMP implementation; conduct regular site inspections; prepare monthly (periodic) progress reports; collaborate with the PIC-ES in the preparation of annual EMP monitoring & progress reports. Engage a licensed institute to conduct environmental effects monitoring.	Conduct compliance review; instruct PIUs on environmental management requirements; prepare semi-annual environmental monitoring reports and summary for quarterly project progress reports until PCR is issued. Engage a licensed institute to conduct environmental effects monitoring for an agreed period.

Responsible Entity	Project Stage and Environmental Responsibility					
	Project Preparation	**Post-Loan Approval & Prior to DED**	**Detailed Engineering Design**	**Tendering and/or Pre-Construction**	**Construction**	**Operation**
DPWT	As the IA of the subproject, the DWPT will supervise component activities carried out prior to construction, during construction and during operation. It will ensure that the EMP is implemented proactively and will respond to any adverse impact beyond those foreseen in the IEE and ensure that if there are any changes in scope, inform the PCU for the IEE/EMP to be updated, as needed.					
		Tie up with the Department of Natural Resources and Environment for collaborative environmental impact monitoring. Ensure PIU has appointed with an environmental focal point.				
PIU	Established by the IA, the PIU will be responsible for providing assistance to the PCU on environmental management at the subproject level.					
		Support the PCU in ensuring the incorporation of the mitigation measures and EMP clauses (environmental conditions) in the bidding documents and contracts for DB works.	Support the PCU in carrying out its responsibilities during DED phase.	Support the PCU in ensuring that mitigation measures and EMP clauses (environmental conditions) are incorporated in the bidding documents and civil works contracts and environmental criteria are incorporated in bid evaluation.	Monitor EMP implementation at component level and report to PCU.	Support the PCU in the environmental management of the subproject.
PPTA Team	Provide technical assistance in project preparation. Prepare FSR, IEE/EMP, RP/CP. Conduct public consultations.					
CPSC	The CPSC will be established to provide strategic guidance and support to the MPWT and PCU and facilitate inter-agency coordination. MONRE is among the proposed members of the CPSC.					
DB Contractor			Engage an EMS to: (i) ensure compliance with environmental requirements and obligations in designs; (ii) prior construction prepare the CEMP based on the ADB cleared updated IEE/EMP and reviewed and cleared by the PCU; and (iii) during construction, to monitor adherence to CEMP and need for any corrective actions. Engage the EMS or an environmental officer and health and safety officer for construction phase, and conduct workers' orientation	(Phase not applicable to works under DB Contracts)	Implement mitigation measures and conduct internal monitoring and supervision of environmental management during construction.	

Responsible Entity	Project Stage and Environmental Responsibility					
	Project Preparation	**Post-Loan Approval & Prior to DED**	**Detailed Engineering Design**	**Tendering and/or Pre-Construction**	**Construction**	**Operation**
			on health and safety and CEMP requirements. Ensure its design team incorporates: (i) mitigation measures in detailed designs and bidding documents; (ii) climate change adaptation measures in detailed designs; (iii) the results of baseline groundwater and soil quality surveys in the detailed designs of controlled landfills and wastewater treatment plant; & (iv) environmental management and climate change adaptation measures during operation in Operations Manuals.			
Design Consultant for standard civil works contracts			Incorporate key EMP clauses (or updated EMP or simplified matrix of mitigation measures for major impacts) in the tender documents and environmental conditions in standard civil works contracts. Incorporate environmental criteria in bid evaluation			
Standard Contractor				Prepare and submit Contractor's CEMP that is fully responsive to the ADB-cleared updated EMP. Engage an environmental officer and health and safety officer. Conduct workers' orientation on health & safety & pertinent EMP matters.	Implement mitigation measures and conduct internal monitoring and supervision of environmental management during construction.	
Licensed Institute					Conduct quarterly environmental quality monitoring & prepare monitoring report.	Conduct environmental quality monitoring following approved monitoring plan and prepare corresponding reports.
Operator						Implement mitigation measures as defined in the EMP

Responsible Entity	Project Stage and Environmental Responsibility					
	Project Preparation	**Post-Loan Approval & Prior to DED**	**Detailed Engineering Design**	**Tendering and/or Pre-Construction**	**Construction**	**Operation**
PIC			Provide TA and support to PCU in carrying out its responsibilities during DED phase.	Provide TA and support to PCU in ensuring that the mitigation measures and EMP clauses (environmental conditions) are incorporated in the bidding documents and civil works contracts and environmental criteria are incorporated in bid evaluation. Review tender documents and assess subproject's readiness. Review bid evaluation (environmental safeguards aspect) Review CEMP.	Advise on the mitigation measures; provide comprehensive TA and support to the PCU and PIUs in environmental management, conduct or facilitate lectures/training; conduct annual EMP compliance review; prepare annual EMP monitoring & progress reports.	If ES is engaged to provide TA & support in the first year/or first few years of operation, advise on mitigation measures during operation. Support the PCU in its task in environmental management in operation.
ADB	Engaged a PPTA Team. Review and clear the draft IEEs/EMPs.		Review and clear the updated IEEs/EMPs. Disclose the updated IEEs/EMPs on ADB project website.	Review and clear tender documents. Review and concur on bid evaluation.	Conduct review missions; review an approved semiannual monitoring reports and disclose on ADB project website.	Review and approve EMP monitoring ad progress reports, disclose on ADB project website.

ADB = Asian Development Bank, CEMP = construction environmental management plan, CPSC = central project steering committee, DB = design-build, DED = detailed engineering design, DPWT = Department of Public Works and Transport, EA = executing agency, EMP = environmental management plan, IA = implementing agency, IEE = initial environmental examination, MONRE = Ministry of Natural Resources and Environment, MPWT = Ministry of Public Works and Transport, PCU = project coordination unit, PIC-ES = project implementation consultant-environmental specialist; PIU = project implementation unit, PPTA = project preparatory technical assistance, TA = technical assistance.

III. SUMMARY OF POTENTIAL IMPACTS AND MITIGATION

17. Table 2 summarizes potential environmental impacts and mitigation measures designed to avoid and/or minimize identified impacts to acceptable levels. Mitigation measures that will become part of the permanent infrastructure (such as landscaping) and temporary construction mitigation measures (such as dust suppression) should be included within the bills of quantities for the civil works.

18. The mitigation measures defined in the EMP will be (i) reviewed and where necessary updated by the Environmental Safeguard Officer (ESO) working under the PTRI and assigned to the PCU and with technical support from the PIC-ES during detailed design, (ii) incorporated into tender documents, construction contracts, and operation and maintenance (O&M) manuals, and (iii) implemented by contractors under supervision of the PCU/PIU and PIC. The effectiveness of these measures will be evaluated based on the results of the environmental quality monitoring conducted by the licensed institute, and through EMP compliance verification monitoring conducted by the PIU environmental focal person, PCU-ESO and PIC-ES.

Table 2. Environmental Mitigation Plan

Item	Impact Factor	Potential impact, concerns and/or Issues	Mitigation Measures	Implementing Entity	Supervising Entity	Source of funds
A. PRE-CONSTRUCTION PHASE						
Design	Existing environmental conditions	Lack of baseline data on environmental quality	• Conduct supplementary baseline assessments to further refine component designs and inform any necessary IEE and EMP modifications, e.g., an inventory of affected trees and mitigation in accordance with forestry and other regulations, re-evaluation and verification of the hydrology of receiving waters from each SWTP facility and stormwater drainage improvement sections, and air quality and groundwater quality assessment at controlled landfill. • Obtain results of baseline studies carried out as part of the national IEE/ESIA to inform the detailed engineering design • Use the baseline studies and monitoring data and results of national IEE/ESIA to update the ADB IEE/EMP.	PCU	PIC-ES	Included in PIC sot
		Waste picker health and safety	• Implement waste picker relocation and employment transition initiatives. • Provide training for waste pickers and require them to abide by guidelines set out by management of the landfill to ensure their safety. • Ensure budget for protective gear for waste pickers such as rubber gloves, rubber boots, and crush helmets. • Develop an operational manual that includes occupational health and safety provisions including regulations on waste picking during regular operating hours and prohibitions on persons below 18 years of age from entering the landfill or conducting waste picking activities.	UDAA	PCU, PIC-ES	Government budget
	++	Impact of the SWTPs on hydrology, water logging, receiving water bodies and sensitive receptors	• Undertake hydrological studies, determine assimilative capacity, intended uses, and presence of sensitive receptors dependent on receiving water bodies of the SWTPs • Undertake baseline water quality tests on Mekong River and wetland at Ban Souksavanh at the upstream and downstream of the proposed outfalls of the SWTPs • Assess the suitability of discharge of the SWTP near the provincial bus station to the wetland in Ban Souksavanh and determine options for supporting the Department of Natural Resources and Environment with managing and restoring the wetland during DED • Ensure that the final effluent of the SWTPs conforms to the prescribed National Environment Standards and the Mekong River Commission target values • Undertake ecology baseline survey of the wetland associated with SWTP in Ban Souksavanh to assess impacts on biodiversity (if any) and water users • Design an emergency response plan based on the results of the hydrological studies in coordination with stakeholders	PCU	PIC-ES	Included in the PIC cost
	Controlled landfill	Impact on trees, leachate, sensitive receptors at collection service area, groundwater, and surface water	• Design concrete roads and larger drains at the controlled landfill • Provide leachate treatment and recirculation system • Provide a sorting area to facilitate recovery of recyclable materials brought to the landfill • Conduct an inventory of trees and other vegetation that will be affected prior to site clearing at the controlled landfill site and at riverbank improvement works and coordinate with the Department of Agriculture and Forestry • Design a tree replacement plan • Conduct consultation with the waste pickers staying at the existing dumpsite and villages surrounding the existing dumpsite regarding the results of the			

Item	Impact Factor	Potential impact, concerns and/or Issues	Mitigation Measures	Implementing Entity	Supervising Entity	Source of funds
			groundwater quality monitoring to inform the communities about the contamination in the sampled well; present planned leachate collection and treatment measures and monitoring activities to be integrated in the implementation of the future controlled landfill. • Undertake further assessment of geological condition, groundwater levels and surface water bodies that will be affected by possible leaching based on detailed design • Design a leachate collection and treatment system to avoid percolation into groundwater or discharge into streams • Design measures to control air and odor pollution • Provide buffer/fence surrounding the controlled landfill • Design measures to enhance occupational health and safety and livelihood security of existing waste pickers through formalized employment contracts with UDAA, toilet and washing facilities, covered rest area, and personal protective equipment (PPE) for workers. • Prepare a Landfill Operations Manual to includes specifications for the cover material, procedures for periodic and final cover, operational measures to safeguard liner during waste dumping, and proper operation and maintenance of the septage treatment plant.			
	Closure of existing dumpsite	Impacts of leachate, landfill gas, and erosion to surface water, groundwater and sensitive receptors	• Conduct an environmental compliance audit (ECA) of the dumpsite and incorporate corrective actions and post closure requirements in detailed design and operations and maintenance requirements (TOR for ECA in IEE Appendix G) • Design a post-closure monitoring plan that includes monitoring of surface and groundwater quality, landfill gas, erosion control, and leachate collection.	PCU	PIC-ES	Included in the PIC cost
Environmentally responsible readiness	Preparation & readiness of key subproject stakeholders and affected communities	Engaging qualified environmental specialists	• Engage an international Environmental Specialist and a national Environmental Specialist based in the PIC	ADB		Included in the PIC cost
			• Engage a full-time national Environmental Safeguards Officer under the PTRI in the PCU over the subproject's five-year implementation period	PCU	PIC-ES	Recurrent cost
			• Appoint an environmental focal point in the PIU.	PIU	PIC-ES	Government budget
		Environmental training and capacity building	• Train environmental personnel of the PCU, PIU, contractors and the DOE in environmental management and technical strengthening in EMP implementation, GRM implementation, climate adaptation, disaster risk resilience, public consultation, and monitoring and reporting.	PIC	ADB	Included in PIC cost
		Mine and Unexploded Ordnance Clearances	• Have all subproject sites and their areas of influence cleared by the National Regulatory Authority for UXO/Mine Action Sector in Lao PDR at least two weeks prior to construction mobilization	PCU	PIC-ES	Government budget
			• In collaboration with the National Regulatory Authority for UXO, PCU and PIU, o hold a preconstruction workshop to orientate workers on health and safety requirements, and particularly the procedures to follow when mines or unexploded ordnances are encountered during construction o incorporate information and key contacts in an emergency response plan.	Contractor	PCU, PIC-ES	Included in the Contractor's contract
		Preparing the National IEE/ESIA and Obtaining Clearances	• The Ministry of Public Works and Transport will engage a registered environmental assessment entity to prepare the national IEE/ESIA and secure clearances prior to contract awards.	PCU	PIC-ES	Government budget

Item	Impact Factor	Potential impact, concerns and/or Issues	Mitigation Measures	Implementing Entity	Supervising Entity	Source of funds
		Grievance redress mechanism	• Ensure establishment of the GRM at the subproject level. • Ensure information about the GRM is posted at the offices of the PIU, town and affected villages prior to construction mobilization.	PCU, PIU	PIC-ES	Government budget
		IEE and EMP updates	• Update IEE/EMP based on the final design of subproject components. Have this reviewed and cleared by ADB.	PIC-ES, PCU	ADB	Included in PIC cost
		Inclusion of EMPs in bidding documents	• Include the ADB-cleared updated EMP in bidding and contract documents. • Ensure contracts require Contractors to prepare site-specific CEMPs that fully respond to the ADB-cleared EMPs.	PCU PIC-ES	ADB	Included in PIC cost
		Consultations and disclosures	• Maintain consultation and disclosure activities with affected people and other involved stakeholders to ensure continued communication regarding for example, overall subproject implementation schedule, details of construction activities and particularly activities that result in nuisances and disturbances, the status of claims and compensation, and other aspects.	PCU, PIU	PIC-ES	Included in PIC cost
		Environmental compliance audit	• Conduct ECA for existing dumpsite to assess compliance with existing environmental requirements, evaluate impacts, identify compliance issues and propose remedial recommendations for dumpsite closure and post closure monitoring and maintenance.	PCU, PIU	PIC-ES	Included in PIC cost
Estimated cost for Pre-construction phase: Included in the Government budget, PIC cost, Contractor's contract						
B. CONSTRUCTION PHASE						
Construction site good practice	Air quality	Dust & suspended particles in air, and gas emissions/fumes	• The spraying of water at borrow pits, construction sites, access roads and material handling areas where fugitive dust is generated. • Ensuring dust suppression systems are included in asphalt and concrete batching facilities, and that they are located at least 500 m downwind from the nearest receptors. • Covering trucks to encapsulate dry construction materials. • Ensuring that vehicles and machinery are maintained to a high standard to minimize emissions. • Ensuring suitable advanced notice is provided for pipeline and other excavation works. • Ensuring that formal and informal waste workers at the dumpsites, and receptors within 500 m of these facilities, are suitably informed in advance when these activities are planned. • Ensuring that appropriate environmental and occupational health and safety provisions are followed during the disturbance and movement of solid waste at the dumpsites, to be defined in the controlled landfill final design.	Contractor	PIU, PCU, PIC-ES	Included in Contractor's Contract
	Noise	Noise impact caused by the operation/movement of construction vehicles, drilling, excavations	• Utilizing low-noise, well maintained vehicles and equipment, and ensuring that exhaust systems are in good working order. • Establishing noise barriers such as temporary fences around active work areas, and barriers to be as close to the source or to the receptor location as possible. • Installing sound-absorbing enclosures around generators and other equipment. • Restricting heavy and noisy machinery operations to between 8am-5pm, particularly at sites near temples and residential areas. • Providing construction workers with and enforcing the use of PPE. • Enforcing the non-use of vehicle horns unless absolutely necessary. • Maintaining close coordination with affected persons and communities, to ensure that advanced warning is provided, considerations are given, and the GRM widely understood so that grievances and complaints are handled expeditiously. • Monitoring noise levels, particularly of nearby sensitive receptors.	Contractor	PIU, PCU, PIC-ES	Included in Contractor's Contract

Item	Impact Factor	Potential impact, concerns and/or Issues	Mitigation Measures	Implementing Entity	Supervising Entity	Source of funds
	Surface Water		• Adequate management of sediments, soils, stockpiles and aggregate materials utilized in facility construction. o Use of sediment detention basins, silt fences, sediment sandbag barriers, along main surface drainage routes and around stockpiles of excavated soils and natural aggregates. o Prohibit stockpiling of excavated materials, spoils and natural aggregates on the riverside (where water body is in the area of influence). Stockpiles/storage of construction materials should be located sufficiently away from water bodies (not less than 50 m away) and main surface drainage routes; and installed with effective diversion drains o Avoid excavation in the rainy season, as practicable. o Stockpile natural construction aggregates only in amounts necessary for the short-term. o Dispose of residual soils/spoils promptly and properly if no longer reusable. • Monitoring of upgradient and downgradient surface water quality during and after construction. • Monitor river quality in relation to riverbank protection embankments. • Have adequate sanitation facilities at active work site and ensure workers observe proper sanitation and good hygiene. • Ensuring the management of hazardous materials, and the containment of spills • Management of solid and hazardous wastes. o Provide adequate storage facilities for solid wastes. o Enforce proper sorting and disposal of solid wastes. o Separate storage for hazardous and non-hazardous wastes o Ensure hazardous substances and wastes have safe storage that can contain spillage, raised at least 1 foot (or higher as may be advised during detailed design) above ground & sited at areas not vulnerable to water impoundment. o Manage the amount of hazardous substances brought on site, ensuring not more than what would be needed in two weeks are brought to or stored on site. o Protect storage areas for solid wastes and hazardous materials and wastes from stormwater, placed under a shed as much as possible, with peripheral channels to lead runoffs away from the storage area. o Dispose of wastes regularly. o Link with junkshops and itinerant buyers of recyclables for reusable and recyclable materials. • For works close to river/stream/wetland (riverbank protection, SWTPs) o Minimize riparian and lagoon/wetland vegetation removals. o Installation of temporary berms between the component footprints and river/stream, prior to construction commencement. Pump out the water in the confined space created by the berm by a vacuum truck for reuse in construction washing or in agricultural lands close by or in watering plants along the streets, as appropriate. o Install effective erosion and sediment controls, prior to construction commencement to complement the berm. e.g., sediment fence supplemented with sandbag barriers. o Limit soil stripping to the dry season o Ensure site and all areas to waterbody are stabilized prior to removal of	Contractor	PIU, PCU, PIC-ES	Included in Contractor's Contract

Item	Impact Factor	Potential impact, concerns and/or Issues	Mitigation Measures	Implementing Entity	Supervising Entity	Source of funds
			erosion and sediment control measures following construction. o Reporting of wildlife and rare animal species sightings, and prohibition of poaching. o Avoid damage and removal of vegetation beyond component footprints. Physically mark the limits of construction footprints, including work easements, and ensuring limits ae observed. Replant and reinstate disturbed areas, as possible. o Ensure, where possible, works close to the river are conducted in the dry season.			
			For sewer works: • Minimize riparian vegetation removals. • Installation of erosion and sediment controls prior to construction commencement.1 • Limit soil stripping to the dry season. • Ensure workers observe proper sanitation and good hygiene. • Ensure where possible works close to the river are conducted in the dry season. • Ensure the management of hazardous materials, and the containment of spills. • Ensure that sites close to waterbodies are stabilized prior to the removal of erosion and sediment control measures following construction. • Monitor water quality during and after construction.	Contractor	PIU, PCU, PIC-ES	Included in Contractor's contract
	Wastewater		• Maintain sanitation facilities onsite and at workers' campsites. • Strictly enforcing hygiene and sanitation practices. • Incorporate sediment controls, silt traps and wastewater collection. • Maintain equipment washdown areas, complete with sediment control devices. • Provide retention control for material stockpile areas. • Designate specific areas for repair and maintenance. • Ensure regular wastewater collection by a recognized service provider. • Ensure wastewater from boring and excavation works is properly managed and disposed of.	Contractor	PIU, PCU, PIC-ES	Included in Contractor's Contract
	Groundwater.	Improper sealing of boreholes after completion of construction	• Include of detailed borehole construction specifications in the contractor's overall method statements for the drilling works to assure correct borehole construction.	Contractor	PIU, PCU, PIC-ES	Included in Contractor's Contract
	Biodiversity	Fauna, flora and potential habitat loss	• Further site assessment, including site specific ecological surveys, be conducted at the final design stage in order to identify, evaluate and where necessary mitigate ecological impacts caused by the siting of these facilities.	Contractor	PIU, PCU, PIC-ES	Included in Contractor's Contract
	Damage to items of cultural/ historical/ archaeological significance	Potential chance to find items of cultural/historical/ archaeological significance	• In case of chance find, stop construction work and make a declaration to the local police, who shall transmit the declaration to the Provincial Governor. o Ensure pre-construction coordination with authorities. o Cease construction works on discovery. o Declare to the local administration and local information, culture and tourism sector. o Prohibit exploration of the item/s found without the approval of the information, culture and tourism sector.	Contractor	PIU, PCU, PIC-ES	Included in Contractor's Contract
		Religious structures within the area of influence	For SWTP network and trunk drain works: • Coordinate with concerned village leader and temple/church authorities for the			

[1] For example, sediment control fences supplemented with sandbag barriers.

Item	Impact Factor	Potential impact, concerns and/or Issues	Mitigation Measures	Implementing Entity	Supervising Entity	Source of funds
			measures to protect temple/church structure and parts along the road.			
	Community health and safety	Communities exposed to health and safety hazards	• Access restrictions: o Manage material stockpiles to prevent blockages. o Provide access restriction information in advance. o Ensure vehicles park at previously agreed locations. o Provide temporary, alternative access where possible. • Localized flooding: o Divert main surface drainage routes when obstructions are unavoidable. o Dispose of spoils and debris promptly. • Utility service disruptions: o Repair service disruptions expeditiously. o Provide alternative power and water supplies. • Worker social conflicts: o Prioritize local employment. o Provide health and safety training.	Contractor	PIU, PCU, PIC-ES	Included in Contractor's Contract
	Traffic	Traffic impacts	• Develop traffic management schemes in conjunction with local traffic authorities and affected community leaders. • Schedule materials delivery and other traffic-causing activities outside of peak hours. • Assign traffic aide during periods of peak disruption and peak hours. • Ensure stockpiles and construction equipment and vehicles least impede traffic flow. • Provide adequate prior information on road and lane closures, and traffic diversions. • Provide safe access to pedestrians, motorbikes and bicycles. • Ensure affected persons are aware of the GRM. • Ensure contractors repair damages at their expense.	Contractor	PIU, PCU, PIC-ES	Included in Contractor's Contract
	Construction workers' health and safety – risks	air emissions, noise and vibration, construction wastes and wastewater, hazardous substances, potential social conflicts with surrounding communities, potential communicable and transmittable diseases in the community, chance finds of UXO, large moving and operating construction vehicles and equipment pits and excavations	• Contractor compliance with environmental and occupational health and safety guidelines. • Contractor's CEMPs will include health and safety plans. • Provision of PPE for workers. • Adequate work site lighting, water supply, sanitation facilities and safe access • Establishment of a first-response team comprising of trained staff, equipment, tools, supplies, and an adequate office/clinic. The first response team will be linked to ultimate responders. • Appointment of an Environmental, Health and Safety Officer.	Contractor	PIU, PCU, PIC-ES	Included in Contractor's Contract
Estimated cost for Construction phase: Included in Contractor's Contract						
C. OPERATION PHASE						
Standard operational practices	Air quality	Landfill gas, odor	• The proposed solid waste volume is low and is therefore no expected to generate large quantity of landfill gas. In the medium term, more sophisticated landfill gas management systems will be evaluated once the landfill reaches critical mass. • Mitigate odor from controlled landfill through:	Operator	PCU, PIU PIC-ES	Included in the Operator's budget

Item	Impact Factor	Potential impact, concerns and/or Issues	Mitigation Measures	Implementing Entity	Supervising Entity	Source of funds
			○ enforcing waste encapsulation in waste trucks while in transit ○ constructing perimeter fences and berms around the facility ○ minimizing exposed tipping areas ○ covering all exposed waste on a regular basis ○ washing vehicles on facility exit. • Mitigate odor from operation of SWTP facilities through perimeter berms and tree line.			
	Surface water quality	Water contamination from effluent discharge	• For SWTPs: ○ Specify maintenance procedures in the SWTP operations manual. ○ Ensure adequate budget and equipment for routine maintenance activities. ○ Conduct operator training for SWTP operations and maintenance (O&M) ○ Monitor water quality and implement corrective actions for non-compliance. • For controlled landfills, ○ mitigate the potential for waste mass inundation from precipitation through: (i) the provision of cover materials over waste mass surfaces and ensuring contoured surfaces to encourage flow to drains; and (ii) vegetation of completed waste mass surfaces to reduce cover material erosion. • implementation of the rudimentary leachate collection and disposal system that will allow leachate to be collected and stored, for disposal back onto and into the controlled landfill, as prescribed in the operations manual.	Operator	PCU, PIU PIC-ES	Included in the Operator's budget
	Vadose zone & groundwater	Leachate contamination due to failure in the integrity of SWTP liner, controlled landfill liner and leachate collection system	• Provision of surface cover systems for controlled landfills and closed dumpsites. • Provision of liner and leachate collection system for controlled landfills. • Provision of liners for SWTP tanks. • Strengthened operations and maintenance procedures through training in monitoring and evaluation	Operator	PCU, PIU PIC-ES	Included in the Operator's budget
	Water logging at downstream of SWTP sites and stormwater drainage	Flooding of downstream communities	• Conduct regular inspection of pump stations to ensure operation during flood events • Identify flood risk areas along with evacuation sites and routes • Implement the emergency response plan in case of flooding that includes a community-based flood warning system and information dissemination	PIU Operator	PCU, PIU PIC-ES	Included in the Operator's budget
	Effluent quality	Discharge of effluent above the prescribed standards	• Monitor the quality of resulting effluent on a monthly basis to check compliance with the prescribed discharge standards. • Report the results of monitoring to the PCU	Operator	PCU, PIU PIC-ES	Included in the Operator's budget
	Sludge from SWTPs	Disposal of sludge	• Implement sludge management through sludge drying and landfilling • Analyze the bacterial content during the first two years of operation to check if appropriate for application to agricultural land.	Operator	PCU, PIU PIC-ES	Included in the Operator's budget
	Health and safety	Operational hazards to community and workers' health and safety	• Routine inspections for the early detection of leaks of sewer network and SWTP system, together with close and ongoing collaboration with communities in leak monitoring and reporting. • Implement the OHSP which forms part of the operations manual of the SWTP. For controlled landfill: • Implement the OHSP which forms part of the operations manual of the controlled landfill. • Conduct training on, and enforce the observance of, proper occupational health and safety practices. • Provide personal protective equipment, adequate sanitation facilities, water supply (potable & non-potable but safe for washing), lighting & safe accesses. • Provide workers with a shaded/roofed, clean rest & eating area, with seats and	Operator	PCU, PIU PIC-ES	Included in the Operator's budget

Item	Impact Factor	Potential impact, concerns and/or Issues	Mitigation Measures	Implementing Entity	Supervising Entity	Source of funds
			tables and first aid kits.			
Estimated cost for Operation phase: Included in Operator's budget						

ADB = Asian Development Bank, CEMP = construction environmental management plan, EMP = environmental management plan, EMS = environmental management specialist, ESIA = environment and social impact assessment, GRM = grievance redress mechanism, IA = implementing agency, IEE = initial environmental examination, MONRE = Ministry of Natural Resources and Environment, OHSP = occupational health and safety plan, PCR = project completion report, PCU = project coordination unit, PIC-ES = project implementation consultant-environmental specialist, PIU = project implementation unit, PPE = personal protective equipment, SWTP = small-scale wastewater treatment plant, UDAA = Urban Development Administrative Authority, UXO = unexploded ordnances.

IV. ENVIRONMENTAL MONITORING AND REPORTING

A. Environmental Monitoring

19. Environmental monitoring will consist of:

a) Subproject readiness monitoring, to be undertaken by the PCU, with technical assistance from the PIC-ES.
b) Environmental effects monitoring, to be undertaken by a licensed institute engaged by the PCU.
c) EMP compliance monitoring or verification, to be undertaken by the PCU and PIU, with technical assistance from the PIC-ES.

20. The ADB will oversee project compliance on the basis of the annual environmental monitoring reports provided by the PCU, and site visits conducted generally once or twice a year. Monitoring and reporting arrangements for this project are described below.

21. **Project readiness monitoring.** Before construction, the PIC will assess the project's readiness on environmental management based on the set of indicators presented in Table 3, and report to the ADB and the PCU. This assessment will demonstrate that environmental commitments are being carried out and environmental management systems are in place before construction starts or suggest corrective actions to ensure that all requirements are met.

Table 3. Project Readiness Assessment Indicators

Indicator	Criteria	Assessment	
Compliance with loan covenants	• Borrower has complied with loan covenants relative to detailed design and environmental	Yes	No
EMP update	• EMP updated after approval by the Asian Development Bank of detailed designs and environmental management.	Yes	No
Households affected by land or right-of-way acquisition	• Affected households compensated at the latest one month prior to construction mobilization.	Yes	No
Ministry of Natural Resources and Environment/Department of Natural Resources and Environment approvals	• Secured at the latest one month prior to contract award.	Yes	No
Mine/UXO clearance	• Secured at the latest one month prior to contract award.	Yes	No
CEMP cleared	• PCU-cleared CEMP obtained at prior to construction mobilization.	Yes	No
Contractors' needed pre-construction coordination	• Contractor has made coordination with proper authorities on: - Waste and wastewater disposal - Steps to take in case of discovery of items of cultural/historical significance - Steps to take in case of discovery of UXO/mine - Religious items of temples exposed to risk of accidental damaged during construction - Traffic management.	 Yes Yes Yes Yes Yes	 No No No No No
PCU/PIU prepared	• PCU-environment safeguard officer appointed • PIU environmental focal point appointed • PCU and PIU oriented on the initial environmental examination/environmental management plan • Monitoring and reporting systems in place	Yes	No

Indicator	Criteria	Assessment	
Relevant communities preparation	• Meaningful consultations completed • GRM established with entry points formally at commune, Town, PIU, PCU and informally, contractor and operator • Posters on health and safety strategically assigned • Posters on GRM assigned at PCU, PIU, commune and Town offices) • Posters and billboards with subproject details and contact numbers assigned/installed	Yes	No
Informal waste picker initiatives	• Waste picker relocation and employment transition initiatives implemented	Yes	No
Construction workers prepared	• Orientation of workers on health and safety and CEMP completed. • Contractor has appointed an environmental management officer to oversee CEMP implementation and reporting.	Yes	No
Bidding documents and contracts with environmental safeguards	• Bidding documents and contracts has incorporated the environmental activities and safeguards listed as loan assurances. • Bidding documents and contracts has incorporated the environmental contract clauses.	Yes	No
EMP financial support	• Funds for EMP implementation has been set aside.	Yes	No

CEMP = construction environmental management plan, EMP = environmental management plan, GRM = grievance redress mechanism, PCU = project coordination unit, PIU = project implementation unit, UXO = unexploded ordnances.

22. Environmental effects monitoring will be undertaken by a licensed institute engaged by the PCU. It includes the following:

<u>For the stormwater drainage and riverbank protection:</u>

a) Baseline: ambient air quality, noise, ecological survey and hydrological assessment of receiving wetland of SWTP near provincial bus station in Ban Souksavanh during pre-construction
b) Semi-annually: ambient air quality and noise during construction

<u>For the controlled landfill and closure of existing dumpsite:</u>

a) Baseline: ambient air quality, noise, surface water quality, groundwater quality, soil quality during pre-construction
b) Semi-annually: ambient air quality, noise, groundwater quality and soil quality during construction
c) Semi-annually: ambient air quality, noise, groundwater quality, and leachate/effluent quality during operation.
d) Annually: ambient air quality, groundwater quality, soil quality and leachate during operation.
e) Post-closure of dumpsite: ambient air quality, groundwater quality, leachate and soil quality

<u>For the SWTPs:</u>

a) Baseline: surface water quality, hydrology[2] during pre-construction
b) Semi-annual: ambient air quality, noise and surface water quality during construction.
c) Monthly: Effluent quality during operation.

[2] Evaluate hydrological flow regimes at receiving waterbodies, intended water uses and presence of sensitive receptors relying on the water bodies.

d) Annually: effluent quality, surface water quality and hydrology[3] during operation.

23. Environmental effects/quality monitoring results will be evaluated against both national and international standards, as shown in Table 4. The more stringent limit will apply. Refer to Appendix C of the IEE. In the event pre-construction or pre-operation levels of some parameters have exceeded standard levels, the target results should be not exceeding pre-construction or pre-operation levels. Performance will be assessed on the exceedance over the stringent standard level or the pre-construction/pre-operation levels if these have exceeded standard levels.

24. On the discharge of treated effluents from the SWTPs, baseline water quality studies will be undertaken during detailed design at the receiving waterbodies. Further assessment on the suitability of discharge to the wetland and options for supporting DONRE with the management and rehabilitation of the wetland in Ban Souksavanh will be considered during detailed design

Table 4. Key Standards to Apply in the EMP

Particular	National Environmental Standard (No. 81/NA) 21 February 2017	International Standard
Ambient air quality	Table 5 General Ambient Air Quality Standard	WHO Air Quality Guidelines, global update 2005
Noise	Table 15 General Noise Standard	WHO Guidelines for Community Noise, 1999
Surface water quality	Table 10 Standard for Surface Water Quality	US EPA National Recommended Water Quality Criteria
		MRC Technical Guidelines for the Protection of Aquatic Life
		MRC Technical Guidelines for the Protection of Human Health
Groundwater quality	Table 11.1 Groundwater Standard for Domestic Consumption	WHO Guidelines for Drinking-water Quality, Fourth Edition, 2011
Soil quality	Table 8.2 Soil Quality Standard for Other Purposes	-
Wastewater discharge	Table 14.4 Standard of Pollution Control to River from Toilet	EHSG for Water and Sanitation, 2007
	Table 14.5 Standard of Pollution Control to River from Public Drainage	EHSG for Waste Management Facilities, 2007

EHSG = Environment, Health and Safety Guidelines, MRC = Mekong Region Commission, WHO = World Health Organization.

25. EMP compliance during construction will be verified by the PCU-ESO, with the support of the PIU and the PIC-ESs. The PCU will report on environmental safeguard performance of the contractors and their environmental compliance through the quarterly project progress reports and the semi-annual environmental monitoring reports. The PCU will monitor environmental compliance during operations until loan closure or as agreed.

26. The environmental monitoring plan is presented as Table 5.

B. Reporting

27. Environmental monitoring activities and findings shall be documented for purposes of reporting, recording, verifying, referring on and evaluating the environmental performance of the Subproject. The documentation shall also be used as a basis in correcting and enhancing further

[3] Evaluate changes in hydrological flow regimes at receiving waterbodies, flood/water logging instances and conditions.

environmental mitigation and monitoring. A suggested outline for the environmental monitoring report is presented as Annex B.

28. Environmental monitoring reports will be prepared as follows:

a) Monthly, by contractors during construction, and submitted to the PCU.
b) Quarterly, a progress report, prepared by the PCU for submission to the ADB, which will cover safeguard matters.
c) Semi-annually, a safeguards report prepared by the PCU for submission to the ADB.
d) Semi-annually, by the PCU during operation until loan closure or as agreed, to be submitted to the ADB.

Table 5. Environmental Effects Monitoring

Monitoring Location	Item	Monitoring Parameter	Monitoring Frequency & Duration	Implementing Entity	Supervising Entity
STORMWATER DRAINAGE					
Pre-Construction Phase					
○ One at active segment of each of five drainage channels (assuming all channels are improved at the same time)	Air quality	See F below	Once	Licensed Lab (for PCU)	3,000
○ One at active segment of each of five drainage channels (assuming all channels are improved at the same time)	Noise	L_{Aeq}	Once		250
				Sub-Total Pre-Consutrction – Storm drainage	**3,250**
Construction Phase					
○ One at active segment of each of five drainage channels	Air quality	See F below	Semi-annual	Licensed Lab (for PCU)	6,000
○ One at active segment of each of five drainage channels	Noise	L_{Aeq}	Semi-annual		500
				Sub-total – stormwater drainage	**6,500**
SWTPs					
Pre-Construction Phase					
Two stations each (upstream and downstream) ○ SWTP (close to old town area (2 streams) ○ SWTP at hospital grounds (1 stream) ○ SWTP at local bus station and market (1 stream) ○ SWTP near provincial bus station (1 wetland)	Surface water quality	See E below	Once	Licensed Lab (for PCU)	12,000
Baseline ecological and hydrological survey at wetland outfall of SWTP near provincial bus station	Biodiversity and assimilative capacity of wetland		Once	Consultant	75,000
				Sub-total Pre-construction - SWTPs	**87,000**
Construction Phase					
Two stations each (upstream and downstream) ○ SWTP (close to old town area (2 streams) ○ SWTP at hospital grounds (1 stream) ○ SWTP at local bus station and market (1 stream) ○ SWTP near provincial bus station (1 wetland)	Surface water quality	See E below	Semi-annual	Licensed Lab (for PCU)	24,000
○ 1 location for sewer network of 4 SWTPs	Air quality	See F below	Semi-annual		4,800
Two stations in each SWTP	Noise	L_{Aeq}	Semi-annual		200

Monitoring Location	Item	Monitoring Parameter	Monitoring Frequency & Duration	Implementing Entity	Supervising Entity
○ Center of SWTPs site ○ Nearest receptor					
				Sub-total – SWTPs	**29,000**
Operation Phase					
○ At discharge point	Effluent	See B below.	Semi-annual	Licensed Lab (for PCU)	2,400
Two stations each (upstream and downstream) ○ SWTP (close to old town area (2 streams) ○ SWTP at hospital grounds (1 stream) ○ SWTP at local bus station and market (1 stream) ○ SWTP near provincial bus station (1 wetland)	Surface water quality	See E below	Semi-annual		24,000
				Total Operation SWTPs (annually)	**26,400**
CONTROLLED LANDFILL and CLOSURE of EXISTING DUMPSITE					
Pre-Construction Phase ○ At two locations, one close to the existing dumpsite and one at proposed controlled landfill site	Air quality	See F below	Once	Licensed Lab (for PCU)	1,200
○ At two locations, one close to the existing dumpsite and one at proposed controlled landfill site	Noise	L_{Aeq}	Once		100
○ One upgradient (at site), 2 downgradient	Groundwater quality	See A below.	Once		3,600
○ One at site, one at downgradient	Soil quality	See C below.	Once		2,000
			Sub-total Pre-Construction – Controlled landfill/closure of existing dumpsite		**16,900**
Construction Phase ○ At two locations, one close to the existing dumpsite and one at proposed controlled landfill site	Air quality	See F below	Semi-annual	Licensed Lab (for PCU)	2,400
○ At two locations, one close to the existing dumpsite and one at proposed controlled landfill site	Noise	L_{Aeq}	Semi-annual		200
○ One upgradient (at site), 2 downgradient	Groundwater quality	See A below.	Semi-annual		7,200
○ One at site, one at downgradient	Soil quality	See C below.	Semi-annually		4,000
			Sub-Total Construction - Controlled landfill/closure of existing dumpsite		**13,800**
Operation Phase ○ At two locations, one close to the active waste cell, one close to the entrance from NR13	Air quality	See F below	Semi-annually		2,400
○ One upgradient, 2 downgradient	Groundwater quality	See A below.	Semi-annually		7,200
○ One upgradient, 2 downgradient	Soil quality	See C below.	Semi-annually		6,000
○ At sump at lower end of the waste cell (where leachate gathers at pump area)	Leachate	See D below	Semi-annually		2,400
			Sub-Total Operation – Controlled landfill/closure of existing dumpsite (annually)		**18,000**
Post-Closure of Existing Dumpsite ○ At two locations, one close to the active waste cell, one close to the entrance from NR13	Air quality	See F below	One year	Licensed Lab (for PCU)	2,400
○ One upgradient, 2 downgradient	Groundwater quality	See A below.	One year		3,600
○ At sump at lower end of the waste cell	Leachate	See D below	One year		1,200

Monitoring Location	Item	Monitoring Parameter	Monitoring Frequency & Duration	Implementing Entity	Supervising Entity
(where leachate gathers at pump area)					
○ One upgradient, 2 downgradient	Soil quality	See C below.	One year		3,000
Sub-Total Post-Closure of Dumpsite (one year)					**10,200**
RIVERBANK PROTECTION					
Pre-Construction Phase					
○ At three locations (1 in active northern segment outside the old town and 2 in active southern segment at residential and temple areas)	Air quality	See F below	Once	Licensed Lab (for PCU)	1,800
○ At three locations (1 in active northern segment outside the old town and 2 in active southern segment at residential and temple areas)	Noise	L_{Aeq}	Once		150
Sub-total Pre-construction – Riverbank protection					**1,950**
Construction Phase					
○ At three locations (1 in active northern segment outside the old town and 2 in active southern segment at residential and temple areas)	Air quality	See F below	Semi-annual	Licensed Lab (for PCU)	3,600
○ At three locations (1 in active northern segment outside the old town and 2 in active southern segment at residential and temple areas)	Noise	L_{Aeq}	Semi-annual		300
○ At three locations, one each upstream, mid-stream and downstream of Mekong River	Surface water quality	See E below.	Semi-annually		7,200
Sub-total Construction Phase – Riverbank Protection					**11,100**

PCU = project coordination unit.

Suggested parameters to monitor:

A. Groundwater quality – Faecal coliform, e-coli, total coliform, As, Cd, Cr+6, Cr-3, CN, F Pb, Hg, Ni, NO2, NO3, odor, color, turbidity, conductivity, pH, temperature, TDS, hardness, Cu, Cl, Fe, Mn, SO4, Zn, Al, H2S. Selected from the National Drinking Water Quality Standards 2004.
B. Effluent (SWTP) –color, COD, BOD, TSS, pH, PO4, phosphates, NO3, Ammonia, Faecal coliform, E Coli.
C. Soil quality – pH, As, Cu, Zn, Cr, Pb, Hg, Fe, Cd, electrical conductivity, WHC, soil moisture, Cl, alkalinity, K, Na, Organic C, organic matter, Ca, Ng, NO3, soil salinity.
D. Recirculated leachate – Temperature, color, odor, turbidity, pH, conductivity, COD, BOD, TSS, Total organic carbon, TVS, TDS, ammonia-N, PO4, Chloride, faecal coliform, phenols, SO4, NO3, Ca, Mg As, CN, Pb, Cu, Ni, Cr, Zn, Cd, Mn, Hg, grease oil, Fe, DO.
E. Surface water quality – pH, BOD, SS, DO, Faecal Coliform, Total Coliform, Temperature, Total NO2+NO3, Total P, COD, NH3 as N, As, Cd, Pb, CN, Total Hg, Se, Cr+6, oil & grease, phenol, total organochlorine pesticide. These includes all the parameters for the protection of human health and aquatic life in the MRC Technical Guidelines for the Implementation of Water Quality, approved in the Meeting of the MRC Council on 22 November 2016, in Pakse, Lao PDR.
F. Ambient air quality and Landfill gas – CO, NO_2, SO_2, $PM_{2.5}$, Pb, Ch_4

V. CAPACITY DEVELOPMENT

29. The PPTA environment team conducted an interview with the Deputy Director of DPWT of Khammouane Province in November 2017, in order to assess the capacity of the PIU in project environmental management. Meeting was also held with the Director of PTRI's Environment and Social Division to assess the responsibilities and capacity of the institute to provide support on

environmental management.

30. The PIU had not been established (and up to this reporting). The DPWT does not have an environmental management unit or section that is responsible for environmental matters or requirements. There is no one staff specifically assigned to deal with environmental matters unless there is a project that would require one. The Deputy Director expressed the lack of capacity and experience in project environmental management as a key issue. Also emphasized was the need for capacity building and technical support during subproject implementation. Primary areas of needed capacity strengthening are (i) knowledge of O&M procedures for controlled landfills and wastewater treatment facilities, (ii) knowledge of the country safeguard system and ADB's Safeguard Policy Statement, (ii) to be familiar with the IEE and EMP of the subproject, (iii) monitoring and reporting, (iv) implementing the GRM, and (iv) climate change matters.

31. The PTRI is a unit under the MPWT with about 45 staff. It has 5 divisions of which one division is in-charge of environmental monitoring. The Environment and Social Division of PTRI conducts monitoring and prepares monthly environmental monitoring reports of project funded by foreign donors. It has an Environmental and Social Manual that was developed in 2003 that guides the PTRI in screening environmental concerns of projects. However, this manual needs to be updated to meet the recent MONRE requirements. Considering the experience of PTRI in conducting environmental monitoring of projects, the environment safeguards staff will be hired on a full-time basis to work at the PTRI during the duration of the project. The aim is to institutionalize the monitoring of safeguards compliance of the subprojects in Thakhek and Pakxan. The PTRI staff will be assigned to work with the PCU as ESO of the project and to coordinate with the PIC-ES.

32. The PIC-ES will provide 'hands-on' training for the PCU-ESO and PIU environmental focal point. Among the responsibilities specified in the outline terms of reference for the Environmental Specialists of the PIC (Appendix I), the following relate to capacity development:

a) Provide close technical supervision and guidance to the PCU ESO and PIU environmental focal points.
b) At the onset of DED, in collaboration with the MONRE/DONRE, conduct an orientation on the: (i) Environmental Protection Law 2012 (No. 29/NA), (ii) Safeguard Policy Statement (SP) 2009, and (iii) ADB-cleared draft EMP to the PCU, PIUs and, if any, Environment Specialist of the design consultant.
c) Finalize training needs based on the preliminary consultations. In collaboration with the PCU and PIUs, develop a training plan for incorporation in the overall capacity building program of the Project. Develop an evaluation sheet on the usefulness of the training/capacity building design and performance of the trainers.

33. The capacity building program will (i) prepare the PIU to assume their responsibilities and to support the PCU, and (ii) provide other relevant agencies an understanding of basic principles of project management, including social and environmental safeguards.[4] Target participants include the PCU, PIU, nominated staff from the provincial and municipal Governors offices, provincial and municipal procurement committee members, other relevant staff of the DPWT and DONREs, and other provincial government agencies.

[4] Through 'on-the-job' training, tutorials, e-manual tutorials and local workshops.

34. Topics recommended to be covered through training sessions, lectures and/or workshops are: (i) those that are relevant to the environmental management responsibilities of the PCU and PIUs under the Project,[5] and (ii) those that interviewed officers have expressed interest in, and others that may be agreed on during subproject implementation. Funds for seminars, workshops and training are allocated under the PIC cost.

Table 6. Capacity Building – LAO PDR

Training	Attendees	Contents	Time	Days	Persons	Unit Cost/ person	Total Cost
Orientation Training	PCU, PIUs, PTRI, contractors, DONRE, DPWT, Town, Province	- Lao PDR's environmental safeguard system, - ADB Safeguard Policy Statement - environmental management plan (mitigation measures, monitoring measures, roles and responsibilities, reporting, grievance redress mechanism carrying out consultations) - Overseeing & monitoring CEMP compliance.	Pre-construction	1	25	LS	* 1,500 (held in 1 town)
Project environmental management	PCU, PIUs, PTRI, contractors, DONRE, DPWT, Town, Province	- Environmental management practices in improvement and maintenance of basic urban services (drainage, small-scale wastewater treatment plant, solid waste management) - Bes practices other countries on the same	1st year of construction period	1	25	LS	1,500 (held in 1 town)
Assessment after one year	PCU, PIUs, PTRI, contractors, DONRE, DPWT, Town, Province	- An evaluation of the 1st year of environmental management – sharing of the two towns. - Sharing experiences with other GMS projects	After 1st year of construction period	1	25	LS	1,500 (held in 1 town)
Climate change and risks, adaptation and disaster management	PCU, PIUs, PTRI, contractors, DONRE, DPWT,	- Relative to the infrastructure components under the project.	2nd year of construction period	1	25	LS	1,500 (held in 1 town)

[5] Such as the EMP requirements, monitoring and reporting, carrying out consultations, and the GRM.

Training	Attendees	Contents	Time	Days	Persons	Unit Cost/ person	Total Cost
	Town, Province	- And other topics that may be suggested by the PCU/PIU					
1 other seminar	PCU, PIUs, contractors, DONRE, DPWT, Town, Province	- Environmental management during operation - Suggested topic/s by PCU and PIUs later.	After construction but before start of operation	1	25	LS	4,000 (held in VTE)
							10,000
						Engagement of a total of 6 invited lecturers, all national	**1,800**
						TOTAL	**11,800**

DONRE = Department of Natural Environment and Environment, DPWT = Department of Public Works and transport, PCU = project coordination unit, PIU = project implementation unit, PTRI = Public Works and Transport Institute.
Notes: Lump sum (LS) cost provided by the PPTA Team Leader: (i) USD1,500 for a workshop/seminar held in the town, 25 participants, and (ii) USD4,000 for a workshop in the capital city, 25 persons.

VI. PUBLIC CONSULTATIONS

35. As discussed in Section VII of the IEE, public participation and consultation has been essential in project preparation, and this will continue through to subproject implementation and operation. As indicated in Table 7, this will include:

a) Pre-construction phase: discussions on: (i) subproject environmental benefits, positive impacts and results, (ii) anticipated impacts and health and safety hazards during construction, (iii) the GRM, (iv) opportunities for participating in monitoring, and (v) subproject contact details.
b) Construction and operation phases: to solicit feedback on: (i) environmental impacts and the effectiveness of mitigation measures implemented by contractors and operators, and (ii) efficiency of the GRM.

Table 7. Public Consultation Plan – Thakhek

Organizer	Format	No. of Times	Subject	Attendees	Budget
Prior construction PCU	Public consultation	1 time, prior to mobilization	Environmental impacts during construction, health and safety risks, grievance redress mechanism, persons to contact in case of concerns, among others	Residents in the immediate influence areas of components	$206
During construction					

Organizer	Format	No. of Times	Subject	Attendees	Budget
PCU	Public consultation	1st and 2nd years of construction	Solicit feedback on environmental impacts and mitigation measures implemented by contractors	Residents in the immediate influence areas of components	$413
During operation PCU	Public consultation	Once each in the 1st, 3rd and 5th year	Solicit feedback on environmental impacts and mitigation measures implemented by operators	Residents in the immediate influence areas of components	$619
				Sub-Total	**$1,238**
				10% contingency	**$124**
				Total	**$1,362**

PCU = project coordination unit.
Notes: unit cost for snack is estimated at $1.88/participant, 110 estimated participants in Thakhek, and consultations are estimated at: prior construction – 1, during construction – 2, and during operation – 3.

VII. PRELIMINARY COSTS

36. The preliminary costs for EMP implementation are presented on Table 8.

Table 8. Preliminary Cost for EMP Implementation

EMP Item	Estimated Cost (USD)		
	Fixed Cost	Annual Cost	Fund source
Environmental mitigation			Included in Contractor's contract
Environmental effects monitoring			
Pre-construction (baseline)	109,100		PIC cost
During construction	60,400		PIC cost
During operation (for an agreed period)		44,400	Operator's annual budge
Post-closure monitoring of dumpsite	10,200		
Environmental compliance audit of existing dumpsite	15,000		
PIC Environmental Specialists (fees only)			
Fee for international and national	99,500		PIC cost
Travel and out-of-pocket expenses			
Project Coordination Unit Environmental Safeguard Officer (5 years)	144,000		Recurrent cost
Preparation of Borrower's initial environmental examination/environment and social impact assessment and obtaining MONRE/DONRE clearance	100,000		PIC cost

MONRE/DONRE monitoring (quarterly for 5 years)[a]	16,800		PIC cost (5 years) Recurrent cost after 5 years c/o Government cost
Consultations	1,362		PIC cost
Training (inclusive 2 towns)	11,800		PIC cost
Total fixed cost			

DONRE = Department of Natural Resources and Environment, MONRE = Ministry of Environment and Natural Resources and Environment, PIC = project implementation consultant.
Costs above exclude taxes and inflation.
[a] covers the per diem, transportation, and report writing of 3 MONRE staff and 2 DONRE staff during project construction.

VIII. MECHANISM FOR FEEDBACK

37. The EMP will be reviewed when there are changes in the design, construction methods and program, unfavorable environmental monitoring results or inappropriate monitoring locations, or ineffective or inadequate mitigation measures. Based on the environmental monitoring and reporting systems in place, the PCU, with the technical guidance and support of the PIC-ES, shall assess whether further mitigation measures are required as corrective action, or improvement in environmental management practices. The PCU will inform the ADB promptly of any changes to the project and necessary adjustments to the EMP. The updated EMP will be submitted to ADB for review and approval, and will be disclosed on the ADB website.

RELEVANCE OF OTHER ENVIRONMENTAL LAWS, REGULATIONS AND GUIDELINES TO THE PROJECT

Protecting water resources. The Law on Water and Water Resources 1996 requires government approval for the following activities: (i) building dams or raising embankments to divert water flow for navigation or for building small reservoirs to produce electrical power, or for irrigation, livestock, fishing, and others; (ii) extracting stones, gravel, sand, soil, mud, minerals, trees, and others, in or around a water source having a minor impact on nature and the environment; and (iii) installing small mechanical water pumps to undertake production or services. In another article of the Law, the following activities are prohibited unless granted approval: (i) constructing by a water resource, on shore or in a water resource; (iii) digging drainage canals; or filling, modifying or changing the area of rivers, lakes, ponds, swamps so as to damage the interests of the public or other persons; (iv) constructing things that obstruct the flow of water; and (v) modifying water flows, building sluice gates, digging or excavating medium or small-scale drainage ditches.
Chance find of cultural heritage items. The Law on National Heritage 2005 provides that, in case of chance find of cultural heritage item/s during the conduct of activities: (i) the find must be reported immediately to the local administration and local information, culture and tourism sector; (ii) the activity must be suspended until approval for continuation of activity is granted; and (iii) finder shall be prohibited from exploring the item/s without the approval of the information, culture and tourism sector.
Labor health and safety. The Labor Law 2013 requires: (i) work conditions (workplace, machinery, equipment and procedures) to be safe and well-maintained; (ii) working hours of those in sectors that involved working directly with constantly vibrating equipment as not to exceed 6 hours per day or 36 hours per week; and (iii) employers to enforce appropriate measures to ensure the health and safety of workers at workplaces. The Law on Hygiene, Disease Prevention and Health Promotion 2011 requires employers to provide safe equipment to workers and ensure hygiene at workplaces, such as among others, to ensure generated vibration, noise, odor and dust do not exceed regulations.
Labor and community health and safety. The Law on Hygiene, Disease Prevention and Health Promotion 2011 requires construction sites to be safe, clean and accessible, installed with warning signs, fences, among others, to prevent health hazards to workers, neighboring people and passers-by. The revised Law on Public Roads 2016 requires a public road contractor to ensure safety and environmental protection during construction. The contractor shall be responsible of the safety procedure for the workers and neighboring communities locate close to the construction sites.
Establishment of public parks. The Law on Hygiene, Disease Prevention and Health Promotion 2011 provides for the necessity of establishing public parks planted with substantial number of trees to ensure clean and fresh air for widespread health promotion.
Use of "water area land". The Land Law 2003 defines "water area land" as submerged land, land surrounding water bodies, riverbanks, islands, land formed when water recedes, or land formed by a change or diversion of waterways. The Law requires that the use of water area land shall not, among others: (i) cause erosion, obstruction to waterways, water levels to recede or flood; (ii) pollute or poison water bodies; (iii) cut trees; and/or (iv) dig or take away soil from swamps and wetlands, except in case of necessity with prior authorization from concerned organization.

Damage of community facilities and infrastructure during project execution. The Decree on the Compensation and Resettlement of the Development Project 2005 provides that Project Proponent shall: (i) restore or repair community facilities and infrastructure damaged by the project, at no cost to the community; and (ii) in case of impacted/restricted access to resources managed by affected community, ensure arrangements are made for safe access to the managed resources or to at least equivalent resources, on a continuing basis.
Solid waste management (SWM). Decree on Disposal site management (No 520 / TCPC, dated 23 Feb 2007), regulates site selection and design of disposal sites.
Quarrying/extraction of construction aggregates. The Revised Law on Public Roads 2016 requires the extraction of natural construction aggregates, such soil, gravel, stone to be approved by the government authorities.
Cutting of trees. If there are trees in the list of protected trees by the Department of Agriculture and Forestry (DAF), a project proponent needs to provide the DAF with the detailed survey and then DAF will report to the Provincial Governor's office. If the affected trees are in a national protected area or national biodiversity conservation area (NPA/NBCA), the DONRE will inform (i) the DAF for site survey and (ii) get the list of trees to be cut including details on protected tree, other trees and quantity of trees to be cut in the protected area. The DAF will inform the Provincial Governor's office for consideration. The Provincial Governor will convene a meeting of the provincial national assembly to deliberate the project or stop the project activities in the NPA/NCBA.

ENVIRONMENTAL QUALITY STANDARDS APPLICABLE IN THE IEE

B.1 Ambient Air Quality Standards

Parameter	Averaging Period	LPDR's General Ambient Air Quality Standard *		WHO Air Quality Guidelines (mg/m^3)	
		(ppm)	(mg/m^3)	Global Update 2005 ** (mg/m^3)	1999 *** (mg/m^3)
CO	1-hour	30	^ 37.0	-	30
	8-hour	9	^ 11.1	-	10
NO_2	1-hour	0.11	^ 0.223	0.20	-
	1-year	0.02	^ 0.0405	0.04	-
SO_2	1-hour	0.13	^ 0.367	-	
	24-hour	0.05	^ 0.141	0.02	-
TSP	24-hour	-	0.33	-	-
	1-year	-	0.10	-	-
PM_{10}	24-hour	-	0.12	0.05	-
	1-year	-	0.05	0.02	-
$PM_{2.5}$	24-hour	-	0.05	0.025	-
	1-year	-	0.015	0.01	-
O_3	1-hour	-	0.20	-	-
	8-hour	-	0.14	0.10	-
Pb	1-year	-	0.00015	-	0.0005

WHO guideline value more stringent. To appy in the 4th GMS Corridor Towns Development Project.

* Article 5: General Air Quality Standard. National Environmental Standard (No. 81/NA). 21 February 2017.

** Source: Environmental, Health, and Safety General Guidelines. IFC. April 30, 2007.

*** Air Quality Guidelines for Europe. Second Edition. WHO Regional Publication, European Series, No. 91. 2000.

^ Converted ppm to mg/m3 via https://www.lenntech.com/.

B.2 Noise Level Standards

LPDR General Noise Standard (dBA) *		WHO Guidelines for Community Noise 1999 (dBA) **		
		Receptor	One-Hour L_{eq} (dBA)	
			Daytime 07:00 - 22:00	Nighttime 22:00 - 07:00
Maximum Sound Level (Lmax)	115	Residential, institutional, educational	55	45
Leq 24 hour	70	Industrial, commercial	70	70

WHO guideline value more stringent. To apply in the 4th GMS Corridor Towns Development Project.

* Table 15: General Noise Standard. National Environmental Standard (No. 81/NA). 21 February 2017.

** Environmental, Health, and Safety General Guidelines. IFC. April 30, 2007.

B.3 Surface Water Quality Standard

Parameter	Unit	LPDR Surface Water Quality Standard [1] Standard Values for Each Type of Surface Water					MRC Target Values [2] For the protection of	
		1	2	3	4	5	human health [2]	aquatic life [2]
Color, odor and taste	-	n	n'	n'	n'	-	-	-
Temperature	^{0}C	n	n'	n'	n'	-	Natural	Natural
pH	-	6 - 8	6 - 8	5 - 9	5 - 9	-	6 - 9	6 - 9
DO	mg/l	> 7	6	4	2	< 2	≥ 6 *	> 5
EC	µS/cm	< 500	≤ 1000	≤ 2000	≤ 4000	> 4000	700 - 1500	-
COD	mg/l	< 5	5 - 7	7 - 10	10 - 12	> 12	5	-
Total coliform bacteria	MPN/100 ml	n	5,000	20,000	-	-	5,000	-
Fecal coliform bacteria	MPN/100 ml	n	1,000	4,000	-	-	1000 *	-
TSS	mg/l	< 10	≤ 25	≤ 40	≤ 60	> 60	-	-
PO_4	mg/l	< 0.1	0.5	1	2	> 2	-	-
NH_4	mg/l	< 0.5	≤ 1.5	≤ 3	≤ 4	> 4	-	-
NO_3 - N	mg/l	n		5.0		-	-	5
NH_3 - N	mg/l	n		0.5		-	0.5 **	0.2 *
Phenol	mg/l	n		0.005		-	0.005	0.005
Cu	mg/l	n		1.5		-	-	0.1
Ni	mg/l	n		0.1		-	-	-
Mn	mg/l	n		1.0		-	-	-
Zn	mg/l	n		1.0		-	-	-
Cd	mg/l	n		0.003		-	0.005 **	0.005 **
Cr^{+6}	mg/l	n		0.05		-	0.05	0.05 *
Pb	mg/l	n		0.01		-	0.05	0.05 *
Hg	mg/l	n		0.001		-	0.002 ***	0.001 ***
As	mg/l	n		0.01		-	0.01 ***	0.01
CN	mg/l	n		0.07		-	0.01	0.005
Radioactive alpha	Becquerel/l	n		0.1		-	-	-
Radioactive beta	µg/l	n		1.0		-	-	-
Organochlorine pesticide	mg/l	n		0.05		-	0.05 ***	0.05 ***
Dichlorodiphenyltrichloroethane	µg/l	n		1.0		-	-	-
Alpha-Benzene hexachloride	µg/l	n		0.02		-	-	-
Dieldrin	µg/l	n		0.1		-	-	-
Aldrin	µg/l	n		0.1		-	-	-
Heptachlor & heptachlorepoxide	µg/l	n		0.2		-	-	-
Endrin	µg/l	n		none		-	-	-

Mekong River Commission (MRC) guideline value more stringent. To apply in the 4th GMS Corridor Towns Development Project.

1 Table 10: Standard for Surface Water Quality. National Environmental Standard (No. 81/NA). 21 February 2017.

2 Technical Guidelines on the Implementation of the Procedures for Water Quality. Mekong River Commission. Approved in the 23rd Meeting of the MRC Council on 22 November 2016.

* An interim target value requiring further review by the MRC Technical Body on Water Quality.

** When the water hardness is <100 mg/l as Ca CO_3

*** Total

Remarks: (Unofficial translation)

Type 1 This is a natural water resource or ambient river, the raw water does not pass any treatment process and the water quality is not mixed with any chemical from industrial factories or other activities.

Type 2 This is a water source that will be used for consumption, but requires treatment. This water source is suitable for aquatic life conservation, fish farm and others.

Type 3 This is a water source that will be used for consumption; but requires treatment. This water source is suitable for agriculture, livestock farming and others.

Type 4 This is a water source that will be used for consumption; but requires trteatment. This water source is suitable for industrial activities, as receiving water body of wastewater discharge from the town or communities and others.

Type 5 The water source is useful for the communication, transportation and as receiving water body of wastewater discharge from the town and others.

n A natural water resource

n' A natural water resource but is disturbed by other factors, such as "temperature + 3"

B.4 Groundwater Quality Standard

Parameter	LPDR's Standard for the Quality of Groudwater for domestic Consumption *		WHO Guidelines for Drinking-water Quality **	
	Unit	Standard	Unit	Guideline Value
Color	-	15	-	None established
Turbidity	NTU	20	-	None established
pH	-	6.5 - 9.0	-	None established
Fe	mg/l	1.0	-	None established
Mn	mg/l	0.5	-	None established
Cu	mg/l	1.5	mg/l	2
Cr^{+6}	mg/l	0.05	mg/l	0.05
Zn	mg/l	15.0	-	None established
SO_4	mg/l	250	-	None established
Chloride	mg/l	600	-	None established
F		1.0		1.5
NO_3	mg/l	45	mg/l	50
Total Hardness ($CaCO_3$)	mg/l	500	-	None established
Hardness (non-carbonate as $CaCO_3$)	mg/l	250	-	None established
TSS		1,200		None established
As	mg/l	0.01	mg/l	0.01
CN	mg/l	0.07	-	None established
Pb	mg/l	0.01	mg/l	0.01
Hg	mg/l	0.001	mg/l	0.006
Cd	mg/l	0.003	mg/l	0.003
Se	mg/l	0.01	mg/l	0.04
Bacteria (SPC Method)	Colonies/cm3	500	-	None established
Coliform Bacteria	MPN/100 cm3	2.2	MPN/100 ml	Must not be detectable in any 100 ml sample.
E. coli Bacteria	-	None	MPN/100 ml	Must not be detectable in any 100 ml sample

* Table 11.1: Standard for Groundwater Quality for Domestic Consumption. National Environmental Standard (No. 81/NA) 21 February 2017

** Guidelines for drinking-water quality, fourth edition incorporating the first addendum. Geneva. World Health Organization, 2017.

B.5 Effluent/Discharge Quality Standard

A. Controlling Pollution of Rivers from Toilet

Parameter	Lao PDR Standard for Controlling Pollution of Rivers from Toilets		IFC EHS Guideline Value (Treated Sanitary Sewage Discharges)
	Unit	Standard Value	
pH	-	6-9	6 – 9
BOD_5	mg/l	30	30
COD	mg/l	125	125
TSS	mg/l	50	50
TKN	mg/l	10	10
Phenol	mg/l	2	-
Fats, oil, grease	mg/l	5	10
E.coli	mg/l	400	-
Total coliform	MPN/100ml	-	400

B. Controlling Pollution of Rivers from Public Drainage

Parameter	Lao PDR Standard for Controlling Pollution of Rivers from Toilets		IFC EHS Guideline Value (Treated Sanitary Sewage Discharges)
	Unit	Standard Value	
pH	-	5.5 - 8.5	6- 9
EC	µS/cm	2,000	-
TDS	mg/l	1,300	-
BOD_5	mg/l	30	30
TSS	mg/l	30	50
MnO_4	mg/l	6.0	-
H_2S	mg/l	1.0	-
CN	mg/l	0.2	-
Fats, oil, grease	mg/l	5.0	10
CH_2O	mg/l	1.0	-
Phenol & cresol	mg/l	1.0	-
Residual Cl	mg/l	1.0	-
Radioactive	mg/l	None	-
Color & odor	mg/l	Not visible	-
Tar	mg/l	None	-
Heavy metals/elements			
Zn	mg/l	5.0	-
Cr^{+6}	mg/l	0.3	-
As	mg/l	0.25	-
Cu	mg/l	1.0	-
Hg	mg/l	0.005	-
Cd	mg/l	0.03	-
Ba	mg/l	1.0	-
Se	mg/l	0.02	-

Parameter	Lao PDR Standard for Controlling Pollution of Rivers from Toilets		IFC EHS Guideline Value (Treated Sanitary Sewage Discharges)
	Unit	Standard Value	
Pb	mg/l	0.1	-
Ni	mg/l	0.2	-
Mn	mg/l	0.5	-

B.6 Soil Quality Standard

Parameter	Unit	Standard Value *
Volatile organic compound		
Benzene	mg/kg	15
Carbon Tetrachloride	mg/kg	5.3
1.2 Dichloroethane	mg/kg	7.6
1.1 Dichloroethylene	mg/kg	1.2
Cis-1.2 Dichloroethylene	mg/kg	150
Trans-1.2 Dichloroethylene	mg/kg	210
Dichloromethane	mg/kg	210
Ethylbenzene	mg/kg	230
Styrene	mg/kg	1,700
Tetrachloroethylene	mg/kg	190
Toluene	mg/kg	520
Trichloroethylene	mg/kg	61
1.1.1 Trichloroethane	mg/kg	1,400
1.1.2 Trichloroethane	mg/kg	19
Xylene	mg/kg	210
Heavy metals		
As	mg/kg	27
Cd	mg/kg	810
Cr+6	mg/kg	640
Pb	mg/kg	750
Mn	mg/kg	32,000
Hg	mg/kg	610
Ni	mg/kg	41,000
Se	mg/kg	10,000
Pesticides		
Atrazine	mg/kg	110
Chlordane	mg/kg	110
2.4 Dichlorophenoxyacetic	mg/kg	12,000
Dichlorodiphenyltrichloroethane	mg/kg	120
Dieldrin	mg/kg	1.5
Heptachlor	mg/kg	55
Heptachlor epoxide	mg/kg	2.7
Lindane	mg/kg	29
Pentachlorophenol	mg/kg	110
Others		
Benzo (A) pyrene	mg/kg	2.9
CN	mg/kg	35
Polychlorobiphenyls	mg/kg	10
Vinyl Chloride	mg/kg	8.3

* Table 8.2: Soil Quality Standard for Other Purposes. National Environmental Standard (No. 81/NA). 21 February 2017.

RESULTS OF THE GROUNDWATER QUALITY STUDY

PAKXAN AND THAKHEK DUMPSITES

Lao People's Democratic Republic
Peace Independence Democracy Unity Prosperity
======00000======

Department of Natural Resource and
Environments of Borikhamxay Province
Water Resource Division No...../ຂຊນ.DONRE
Borikhamxay, Date.....……

Report about the field ground water sampling and analysis of existing dumpsite at Pakxan and Thakhek districts

To: Representative of the ADB TA 9192 REG: Fourth Greater Mekong Subregion Corridor Towns Development Project.
Subject: To report of the results of Ground Water Sampling results for Pakxan and Thakhek District

I. Introduction

1. The history of laboratory and team of water quality analysis

1.1. The history of laboratory

This laboratory service is under the Department of Natural Resources and Environment, supervised by the Water Resource Division of Borikhamxay Province. The equipment for laboratory analysis are involved the Spectrom ® prove300, this equipment is supported by Environmental Protection Fund in year 2016 and the water quality equipment for analysis in the field is used the WTW 330i, this supported by water quality analysis project from Finland in year 2013. The Water Quality testing of the existing ambient rivers which locates in Pakxan District, Borikhamxay province are including Nam Theun-Kadding river, Nam Xan and Nam Niep. The Total sampling location are 12 points. The frequency of sampling is every quarterly of a year.

The Capacity building for the staff at the Laboratory including are:

- Provide training how to use the water quality testing equipment onsite for three times already.
- Participant the training of how to use the water quality equipment such the Spectroquant ® prove 300 during testing the water quality in the laboratory for 2 times.
- Participant the training how to monitor the water quality by using the insect in the ambient river as the indicator of the water quality, how to evaluate surrounding environment of the water quality by visual inspection for 2 times.
- Participant the technical seminar about how to use the technology as appropriate way for waste management and pollution control of the wastewater treatment, small and medium of enterprise business.

1.2. Team of water quality analysis

- Mr. Khamdi Phimmasone , deputy of DONRE, acting as the general director of the Laboratory
- Mr. Viengkeo Saipakdee , head of division of Water resource division, acting as the deputy director of the Laboratory
- Mr. Khampasert Keomany, deputy of head division
- Mrs. Yenpapha Vilavong, a laboratory technician
- Mr. Phonesavanh Phommavong, a laboratory technician
- Ms. Toy Keobundith, a laboratory technician
- Ms. Phimmasone Keovilay, a laboratory technician

1.3. Onsite water quality parameters analysis by team

- temperature of ambient water
- temperature
- humidity
- Dissolved oxygen (DO)
- Conductivity (EC)
- pH
- color, odor and test

1.4. Water quality parameters analysis in the Laboratory

- Cadmium (Cd)
- Asenic (As)
- Lead (Pb)
- Zinc (Zn)
- Copper (Cu)
- Ferrous (Fe)
- Hardness ($CaCO_3$)
- Cyanide (CN)
- Alkalinity
- Sulfide (S_2)
- Sulfate (SO_4)
- Phosphate (PO_4)
- T.Phosphate (P)
- Nitrite (NO_2)
- Nitrate (NO_3)
- Magnesum (Mg)
- COD
- BOD
- Ammonium (NH_4)
- Coliform
- Chlorine (Cl)

1.5. The process results and time spending of each analysis

Each time of water quality testing or analysis will be spent time in the maximum is 15 days (according to the proposed parameters of the analysis period), Department of Natural Resource will be issued the water quality certificate.

2. The Ground Water Sampling of Thakhek and Pakxan District

The existing dumpsite locates at Pakxan district was established in year 2007, of Thasommor village, Pakxan district, Borikhamxay Province. This existing dumpsite is managed by Urban Development Authorities Agency which it locates far from the Town around 9 kilometers. The total dumpsite area is around 9.6 hectars and it has used for waste dumped area around 1.8 hectares, every day the dumped waste's quantity is around 5 kg/per person (or approximately 47 tons/per day) which it provided a service for the households in the town up to 1,495 households. This dumpsite area also has a separate waste for recycling process which it has different waste's types are plastic bottles, steel, iron and for the other waste that couldn't recycled then it will be dump into the pit and cover by soil.

The existing dumpsite locates at Thakhek district was established in year 1997, of Nadonh village, Thakhek district, Khammoun Province. This existing dumpsite is managed by Urban Development Authorities Agency (UDAA) and Sinnawat Company which it locates far from the Town around 9 kilometers. The total dumpsite area is around 95 hectars and it has used for waste dumped area around 2 hectares. This dumpsite area also has a separate waste for recycling process which it has different waste's types are plastic bottles, steel, iron and for the other waste that couldn't recycled then it will be dump into the pit and cover by soil.

On the date 18 Dec 2017, the water quality analysis team from DONRE has conducted the field visit in dumpsites of Pakxan and Thakhek Districts. This objective of the field visit was to conduct onsite ground water analysis and took the samples to the Laboratory analysis, in order to conduct some existing contaminated hazardous parameters that could results to the people's health by using this ground water for daily consumption or drinking, the process of taking samples will be done as followed below:

2.1. Field visit and taking the samples in the dumpsites

- Field survey and taking Ground water samples
- To observe the physical reaction such as the color, odors and taste of ground water quality
- To measure the ground water quality at the dumpsites by WTW 330i for pH, DO, EC, and temperature

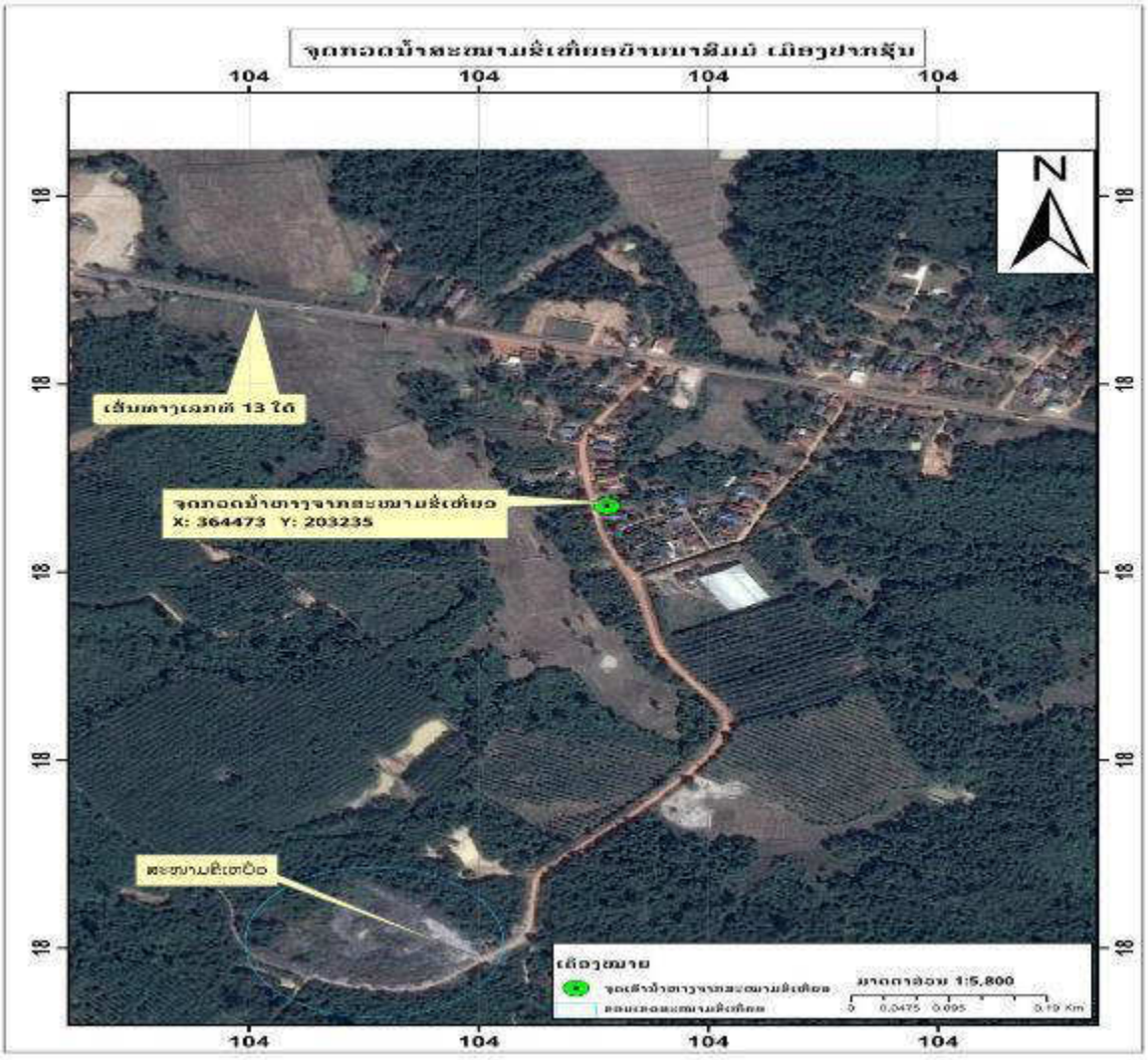
2.2. Ground water analysis in the Laboratory

The ground water samples divides to analysis into two Laboratories are included the laboratory of the Ministry of Natural Resource and Environments in Vientiane Capital and laboratory of the Department of Natural Resource and Environments in Borikhamxay Province. The ground water samples has analysis some parameters in the Laboratory of MONRE are include the TSS, Turbility, Mn, F, Total Coliform, E.Coli. For the Laboratory of DONRE in Borikhamxay has analysis some parameters which are included the Cu, Fe, Pb, Zn, Cd, As, Hardness ($CaCO_3$), Cl, NO_3, CN, COD, SO_4 which are analysis by the equipment of the Spectroquat ® prove 300.

II. Location of the Ground Water Sampling

- Dumpsite at Pakxan district, Borikhamxay Province
- Depth of ground water is around 7 meters
- Location marked by the GPS X: 364473
  Y: 203235

Figure 1: Location of the Ground Water Sampling



- Dumpsite at Thakhek district, Khammoun Province
- Depth of ground water is around 40 meters
- Location marked by the GPS X: 488173
  Y: 1918512

Figure 2: Dumpsite at Thakhek district, Khammoun Province

III. Results of Ground Water Analysis

Table 1: Parameters of Dumpsite at Pakxan

No	Parameters	Unit	Results	Standard values*
1	ກົດ ດ ແລະ ດ່າງ (pH)	-	6.23	6.5 - 9
2	ອອກຊີເຈນລະລາຍໃນນ້ຳ (DO)	mg/l	0.01	6
3	ການຊັກນຳໄຟຟ້າ (Cond.)	µS/cm	27	<1000
4	ສີ (Color)	-	ໃສ or no color	-
5	ອຸນຫະພູມນ້ຳ (Water)	T^{oC}	25	-
6	ອຸນຫະພູມອາກາດ (Air)	T^{oC}	25.7	-
7	ທອງ (Cu)	mg/l	<0.1	1.5
8	ເຫຼັກ (Fe)	mg/l	0.13	1
9	ຊີນ (Pb)	mg/l	**0.5**	**0.01**
10	ສັງກະສີ) Zn)	mg/l	<0.20	5
11	ແຄັດເມຽມ (Cd)	mg/l	**<0.025**	**0.003**
12	ອາເຊນິກ (As)	mg/l	**0.073**	**0.01**
13	ຄວາມກະດ້າງຂອງນ້ຳ (Hardness)	mg/l	<5	500
14	ຄຼໍໄຣ (Cl_2)	mg/l	0.09	600

15	ไນເຕຣດ (NO_3)	mg/l	21.4	45
16	ໄຊຢາໄນທ໌ (CN^-)	mg/l	<0.05	0.07
17	COD	mg/l	45	150
18	ຊັນເຟດ (SO_4)	mg/l	50	250
19	ແອມໂມເນຍ (NH_3)	mg/l	<0.05	1.5
20	TSS	mg/l	0.83	1,200
21	ຄວາມຂຸ່ນ (Turbidity)	NTU	-	20
22	ມັງການີສ (Mn)	mg/l	0.002	0.5
23	ຟຼູອໍໄຣ (F)	mg/l	0.07	1
24	Total Coliform	MPN/100 ml	>100	**2.2**
25	E.Coli (Faecal Coliform – T44)	-	7	**None**

Note * :National Environmental Standard value according to the National standard Number 81/GOL, date 21 Feb 2017.

Table 2: Parameters of Dumpsite at Thakhek

No	Parameters	Unit	Results	Standard values*
1	ກົດ ແລະ ດ່າງ (pH)	-	8.26	6.5 - 9
2	ອອກຊີເຈນລະລາຍໃນນ້ຳ)DO)	mg/l	0.21	6
3	ການຊັກນຳໄຟຟ້າ (Cond.)	µS/cm	751	<1000
4	ສີ (Color)	-	ໃສ	-
5	ອຸນຫະພູມນ້ຳ (Water)	T^{oC}	25.6	-
6	ອຸນຫະພູມອາກາດ (Air)	T^{oC}	12	-
7	ທອງ (Cu)	mg/l	<0.1	1.5
8	ເຫຼັກ (Fe)	mg/l	<0.1	1
9	ຊີນ (Pb)	mg/l	**0.49**	**0.01**
10	ສັງກະສີ) Zn)	mg/l	<0.20	5
11	ແຄັດເມຽມ (Cd)	mg/l	**<0.025**	**0.003**
12	ອາເຊນິກ (As)	mg/l	**0.063**	**0.01**
13	ຄວາມກະດ້າງຂອງນ້ຳ (Hardness)	mg/l	<5	500
14	ຄຼໍໄຣ (Cl_2)	mg/l	0.03	600
15	ໄນເຕຣດ (NO_3)	mg/l	**66**	**45**
16	ໄຊຢາໄນທ໌ (CN^-)	mg/l	<0.05	0.07
17	COD	mg/l	114	150
18	ຊັນເຟດ (SO_4)	mg/l	80	250
19	ແອມໂມເນຍ (NH_3)	mg/l	<0.05	1.5
20	TSS	mg/l	0.5	1,200
21	ຄວາມຂຸ່ນ (Turbidity)	NTU	-	20
22	ມັງການີສ (Mn)	mg/l	0.002	0.5
23	ຟຼູອໍໄຣ (F)	mg/l	0.07	1
24	Total Coliform	MPN/100 ml	**59**	**2.2**
25	E.Coli (Faecal Coliform – T44)	-	**6**	**None**

Note * :National Environmental Standard value according to the National standard Number 81/GOL, date 21 Feb 2017.

IV. Results and Conclusion

The results of ground water analysis from two dumpsites of Pakxan and Thakhek districts which conducted the contaminated of hard heavy metals in the ground water quality, which is identified as the hard and heavy metals parameters are exceeded the limitation of National Environmental Standard Value, 2017.

The dumpsite of Pakxan District, Borikhamxay Province, the ground water quality analysis results could conduct that the Dissolve Oxygen is lower than the standard value due to during the taking sample for onsite analysis by the small tube therefore, there is limited of oxygen of the ground water sample. The Cd, Pb, As, Coliform and E.Coli values are exceed the National Environmental Standard Value, 2017*.

The dumpsite of Thakhek District, Kammoun Province, the ground water quality analysis results could conduct that the Dissolve Oxygen is lower than the standard value due to during the taking sample for onsite analysis by the small tube- sampling therefore, there is limitation of oxygen of the ground water sample. These parameters including the $\mathrm{Nitrate}\ (NO_3)$, Lead (Pb), Arsenic (As), Cadmium (Cd), Coliform and (E.Coli) values are exceed the National Environmental Standard Value, 2017.the accumulated the exceeded parameters ($\mathrm{Nitrate}\ (NO_3)$, lead (Pb), As, Cadmium (Cd) ,Coliform and E.Coli values) will be raised the health impacts such a diarrhea, problem with their breath issue, vomits, impact to the brain, their health will be weak, there will have a cancer of lungs and skin, having spots of their skin, dangerous of baby in pregnancy.

The conclusion, the two dump site areas are contaminated with the heavy metal parameters in ground water quality. Therefore, if the community or village living close to these dump site areas of Pakxan and Thakhek districts consume those ground water quality will have potential health issues. The clean ground water or treated ground water (ground water quality is acceptable from the standard's value) for their consumed is necessary and to avoid their health issues may be raised in the futures. The accumulated the heavy metal parameters to their health and raised the health issues problems.

I. Weak and good points of the field works

1. Good points

- Good cooperate with the related government sectors.
- Good Access to the ground water site

2. Weak points

- Time of site visit and sampling is limited

Photos during the field survey work

Location of sampling GWQ at Dumpsite at Thakhek District, Khammoun Province

Location of sampling GWQ at Dumpsite at Pakxan District, Borikhamxay Province

Note: during taking samples do not wear gloves because the GW sample goes straight inside the bottle sample directly by tube of pumping.

Photos of Laboratory's equipment for GW analysis

Photos during analysis samples

CALCULATING DIMENSION OF THE DEWATS FOR THAKHEK SUBPROJECT

The calculation spreadsheet for the recommended dimension of the AF for 300 m^3/day wastewater flow shows a BOD5 outflow of 42 mg/L (standard value is 30 mg/L) and COD would be 123 mg/L (standard value is 125 mg/L). This was obtained from the PPTA Engineering Team.

II) Urban area with daily wastewater flow of 300 m3/d

1) Spreadsheet for calculating septic tank dimensions

General spreadsheet for septic tank, input and treatment data

daily waste water flow	time of most waste water flow	max. flow at peak hours	COD inflow	BOD5 inflow	HRT inside tank	settleable SS/COD ratio	COD removal rate	COD outflow	BOD5 outflow
m^3/day	h	m^3/h	mg/l	mg/l	h	mg/l	%	mg/l	mg/l
300	12	25	633	333	18	0.42	0.46	343	171
	Range: 12-24 h		0.35-0.42						

Dimension of septic tank

desludging interval	inner width of septic tank	min. water depth at outlet point	inner length of first chambe		length of second chamber		volume incl. sludge	actual volume of septic tank	biogas 70% CH4 50% dis solved
chosen	chosen	chosen	required	chosen	required	chosen	required	check	calculated
months	m	m	m	m	m	m	m^3	m^3	m^3/d
12.0	18.0	3.0	6.7	6.0	3.4	5.00	545.0	594.0	21.8

2) Spreadsheet for the calculation of anaerobic baffled reactor dimensions

General spreadsheet for Anaerobic baffled reactor (ABR) with integrated settler

daily waste water flow	time of most waste water flow	max. peak flow per hour	COD inflow	BOD5 inflow	COD/BOD ratio	settleable SS / COD ratio	lowest digester tempera ture	de-sludging interval	HRT in settler (no settler HRT=0)	COD removal rate in settler
m³/day	h	m³/h	mg/l	mg/l	ratio	mg/l	°C	months	h	%
300	12	25	633	333	1.9	0.42	25	12	1.5	23

Treatment data

BOD5 removal rate in settler	inflow into baffled reactor		COD/ BOD5 ratio after settler	factors to calculate COD removal rate of anaerobic filter			COD rem. 25°, COD 1500	theor. rem. rate according to factors	COD removal rate baffle only	COD out
	COD	BOD5								
%	mg/l	mg/l	mg/l	f-overload	f-strength	f-temp	f-HRT %	%	%	mg/l
24	489	253	1.94	1.00	0.91	1.00	87.00	79.00	81.00	93

1.06 COD/BOD Removal factor

COD/BOD Removal factor =1.025

								ABR		
total COD removal rate	total BOD5 removal rate	BOD5 out	inner masonry measurements chosen acc. to required volume		sludge accumulat e rate	length of settler	length of settler	max. upflow velocity	number of upflow chambers	depth at outlet
			width	depth		calculated	chosen			
%	%	mg/l	m	m	l/g COD	m	m	m/h	No.	m
87.00	89	36	18	3.0	0.0042	1.4	2.5	1.8	5	3.0
							1.4-2 m/h			

Dimension of ABR

length of chambers should not exceed half dept		area of single upflow chamber	width of chambers		actual upflow velocity	width of downflow shaft	actual volume of baffled reactor	actual total HRT	org. load (BOD5)	biogas (ass: CH4 70%; 50% dissolved)
calculated	chosen	calculated	calculated	chosen	calculated	chosen	calculated	calculated	calculated	calculated
m	m	m^2	m	m	m/h	m	m^3	h	kg/m^3*d	m^3*/d
1.5	1.5	13.9	9.3	18.0	0.9	1.2	729.0	61.2	0.4	40.5

Spreadsheet for calculating aerobic filter dimension
HRT inside AF: range 24-48h;

Chosen:	24	h
Disludging interval: chosen:	36	months
Specific surface of filter medium	80-120	
Voids in filter mass: 30-45%		

General spreadsheet for anaerobic filter (AF) with integrated septic tank (ST)

daily waste water flow	time of most waste water flow	max. peak flow per hour	COD inflow	BOD5 inflow	SS settl./ COD ratio	lowest digester temperature	HRT in septic tank	de sludging interval	COD removal septic tank	BOD5 removal septic tank
given	given	calculated	given	given	given	given	chosen	chosen	calculated	calculated
m^3/day	h	m^3/h	mg/l	mg/l	mg/l	°C	h	month	%	%
300	12	25	633	333	0.42	25	2	36	35	37

Treatment data

COD inflow in AF	BOD5 inflow into AF	specific surface of filter medium	voids in filter mass	HRT inside AF react	factors to calculate COD-removal rate of anaerobic filter				COD removal rate (AF only)	COD outflow of AF
calculated	calculated	given	given	chosen	calculated according to graphs				calculated	calculated
mg/l	mg/l	m^2/m^3	%	h	f-temp	f-strength	f-surface	f-HRT	%	mg/l
411	209	100	35	24	1.00	0.91	1.00	0.69	70	123

Dimension of septic tank

BOD/ COD removal factor	BOD5 rem. rate of total system	BOD5 outflow of AF	inner width of septic tank	min. water depth at inlet point	inner length of first chamber		length of second chamber		sludge accum.	volume incl. sludge
calculated	calculated	calculated	chosen	chosen	calculated	chosen	calculated	chosen	calculated	required
ratio	%	mg/l	m	m	m	m	m	m	l/kg BOD	m³
1.1	86	42	10	2.9	2.30	4.00	1.15	2.00	0.0	100

Dimension of aerobic filter

							Biogas production			Check
volume of filter tanks	depth of filtertanks	length of each tank	number of filter tanks	width of filter tanks	space below perfora ted slabs	filter high (top 40cm below water level)	out of septic tank	out of anaerobic filter	total	org. load on filter volume COD
calculated	chosen	calculated	chosen	required	chosen	calculated	assumption: 70% CH4: 50% dissolved			calcul.
m³	m	m	No.	m	m	m	m³/d	m³/d	m³/d	kg/m³*d
300	2.9	5.0	3	9	1.10	1.4	17	22	38	1.89
								< 4.5		< 2

ESTIMATING GHG EMISSIONS OF THAKHEK CONTROLLED LANDFILL

A. Controlled Landfill

The tool used was "Estimation Tool for Greenhouse Gas (GHG) Emissions from Municipal Solid Waste (MSW) Management In a Life Cycle Perspective". Nirmala Menikpura. Janya Sang-Arun. Institute for Global Environmental Strategies (IGES).

Inputted data:

	Thakhek	Remarks
Solid waste generated (tonnes per month)	1700	Per Engr's report, all 3 cells may be used up even before 2035. Hence, used the average of SW generated per month in 2034 and 2035.
Collection vehicle capacity (m3)	15	
Diesel consumption per trip including collection	10.4L round	
Diesel consumption of landfill equipment, per month	25% of that of collection truck	
Waste composition	(See Table 1)	
Recyclable at the landfill	(See Table 2)	

Table 1: Adopted Waste Composition of Thakhek

Please enter the compostion of landfilling waste

Component	Percentage (%)
Food waste	24.00
Garden waste	26.00
Plastics	13.60
Paper	5.20
Textile	1.30
Leather/rubber	1.70
Glass	11.30
Metal	3.50
Hazardous waste	0.00
Others	13.40
Total	**100.00**

Source: Solid Waste Management Solid Waste Management in Laos.
A power point presentation by:
Mr Thevarack Phonekeo
Director
Socio- Environment Division. National Secretariat for GMS.
Water Resources and Environment Administration (WREA)
Mr. Phouthasom Inthavong
Deputy Head
Urban Development Division Department of Housing and Urban Planning
Ministry of Public Works and Transport (MPWT)
https://www.iges.or.jp/en/archive/wmr/pdf/activity100728/5_Lao_Day1_Session2.pdf

Table 2: Composition of Recyclables at Dumpsite*

Type of recyclable	Percentage (%)
Paper	15.58
Plastic	74.13
Aluminium	1.90
Steel	0.00
Glass	8.40
Total	**100.00**

*Based on: Composition of Municipal Solid Waste at Dumpsite
Source: Waste Management and Activities of Cambodia in the Application of Basel Convention.
A PPt presentation prepared by:
Mr. Chin Sothun
Department of Environmental Pollution Control, MOE, Cambodia.
Workshop 2010 of Asian Network of Prevention of Illegal Transboundary Movement of Hazardous Waste. 29 November-02 December 2010.
Allson Paradise Angkor Hotel, Siem Reap, Cambodia.

Results: GHG Emissions from Controlled Landfill Operations

Thakhek

Activity	Direct GHG Emissions	Indirect GHG Savings	Net GHG Emissions	Unit
Transportation	1.87	0.00	1.87	kg of CO2-eq/tonne of waste
Landfilling of mix MSW	666.39	0.00	666.39	kg of CO2-eq/tonne of mix waste
Composting	0.00	0.00	0.00	kg of CO2-eq/tonne of organic waste
Anaerobic digestion	0.00	0.00	0.00	kg of CO2-eq/tonne of organic waste
Mechanical Biological Treatment (MBT)	0.00	0.00	0.00	kg of CO2-eq/tonne of waste
Recycling	1844.79	2252.79	-408.00	kg of CO2-eq/tonne of mixed recyclables
Incineration	0.00	0.00	0.00	kg of CO2-eq/tonne of incinerated waste
Open burning	0.00	0.00	0.00	kg of CO2-eq/tonne of open burned waste
GHG emission from whole system	**881.94**	**408.51**	**473.44**	**kg of CO2-eq/tonne of collected waste**
Total GHG emissions per month	**1,830,699.14**	**848,289.21**	**982,409.93**	**kg of CO2-eq/monthly managed waste**

Climate Mitigation Calculations

Results: Simulation of GHG Emissions from Controlled Landfill Operations With Mitigation Measures in Place

Mitigation Measures:

- Waste to be collected is reduced by 15% due to active recycling at source.
- Waste collection frequency is every other day except for market waste.
- Composting of about 20% of the waste collected at the landfill site

Thakhek

Activity	Direct GHG Emissions	Indirect GHG Savings	Net GHG Emissions	Unit
Transportation	1.87	0.00	1.87	kg of CO2-eq/tonne of waste
Landfilling of mix MSW	666.39	0.00	666.39	kg of CO2-eq/tonne of mix waste
Composting	177.00	892.50	-715.50	kg of CO2-eq/tonne of organic waste
Anaerobic digestion	0.00	0.00	0.00	kg of CO2-eq/tonne of organic waste
Mechanical Biological Treatment (MBT)	0.00	0.00	0.00	kg of CO2-eq/tonne of waste
Recycling	1844.79	2252.79	-408.00	kg of CO2-eq/tonne of mixed recyclables
Incineration	0.00	0.00	0.00	kg of CO2-eq/tonne of incinerated waste
Open burning	0.00	0.00	0.00	kg of CO2-eq/tonne of open burned waste
GHG emission from whole system	**783.02**	**476.60**	**306.42**	**kg of CO2-eq/tonne of collected waste**
Total GHG emissions per month	**945,439.57**	**575,869.61**	**369,569.96**	**kg of CO2-eq/monthly managed waste**

TERMS OF REFERENCE FOR THE CONDUCT OF ENVIRONMENTAL COMPLIANCE AUDIT OF EXISTING DUMPSITE

A. Introduction

The Asian Development Bank (ADB) is supporting the Government of Cambodia (GOC) in enhancing competitiveness of the districts of Thakhek and Pakxan in Borikhamxay Province, which is located along the Mekong River and along the Mekong Economic Development Corridor in the Greater Mekong Subregion. The Project is expected to be achieved through integrated regional and local planning and through investment in basic urban infrastructure. Among the infrastructures that are proposed under the Project is the development of controlled landfill at existing dumpsites to improve current solid waste management services.

The Ministry of the Public Works and Transport (MPWT) is the executing agency of the Project. This Terms of Reference will serve as basis for the environmental compliance audit of existing solid waste management disposal and management.

B. Objective and Purpose of the Assignment

The environmental compliance audit of existing facilities is required based on ADB Safeguard Policy Statement (2009) to determine existence of any areas which may cause or is causing environmental risks or impacts. Since the proposed landfills under the Fourth Greater Mekong Subregion Corridor Towns Development Project will be located within the compound of the existing dumpsites, an environmental compliance audit is necessary to determine areas where the existing facilities and current practices are causing environmental impacts and risks. The ECA should identify and plan appropriate measures to address outstanding compliance issues which could cause legacy or reputational risks for ADB.

The objectives of the environmental compliance audit are to:

a) Determine whether the activities at the dumpsite and solid waste collection and disposal practices are environmentally sound and in accordance with ADB's safeguard principles and Lao PDR laws and regulations;
b) Assess the hydrogeology and groundwater quality at the dumpsite and in areas within 300 meters from the site;
c) Assess the soil quality underlying the dumpsite and at the new sanitary landfill site;
d) Evaluate the risks of the existing dumpsite on groundwater pollution, air quality, surface water quality, and other hazards to communities;
e) Assess possible rehabilitation options and/or proposed dumpsite closure options;
f) Evaluate the mitigation measures, monitoring plan and institutional arrangements to manage environmental impacts of waste disposal; and
g) Develop a corrective action plan with budget and timeframe on how to address identified environmental issues and to ensure that these issues are avoided and addressed in the ADB-financed project.

C. Scope of Work

a) Assess compliance with environmental requirements of the Government of Lao PDR;

b) Determine differences/gaps between Government environmental laws and regulations and ADB Safeguards Policy Statement of 2009 (ADB SPS) on environment;
c) Determine environmental issues arising from implementation of the project;
d) Propose recommendations to address identified environmental issues to meet national requirements for Government's consideration;
e) Propose recommendations to ensure that environmental issues identified in the existing facilities are avoided/addressed in the ADB-financed projects.

D. Detailed Tasks and/or Expected Output

a. Desk Review

1. Gather and review relevant materials on environmental assessment and environmental management planning for the project, including:
    a. Government policies and requirements for environmental safeguards such as regulations, decrees, design standards, technical, parameters and guidelines in the solid waste management sector.
    b. Environmental safeguard documents (e.g. ESIA, IEE, EMP[1]) and other related reports such as feasibility study, technical reports, etc. of the existing facility.
    c. Environmental approvals obtained by the project and the Government conditions imposed on the existing dumpsite; and
    d. Contract documents of existing solid waste management services and environment-related provisions.
2. Determine the Government's environmental impact assessment requirements specific to solid waste management projects, Government review process in getting the environmental approvals, requirements for public consultation, monitoring and reporting.
3. Develop a chronology of major events that occurred during the environmental assessment process of the existing project.
4. Assess procedural compliance with Government environmental clearance (e.g. reviewing environmental clearance certificate, approval letters, etc.)
5. Determine whether there are violations, sanctions, and pending administrative and criminal cases related to the operation of the existing dumpsite.
6. Determine if the ESIA/IEE report adequately identified environmental impacts associated with the existing facility.
7. Identify specific environmental clearances or approvals required for the existing facility. Indicate which approvals have been obtained. For approvals that are yet to be issued, indicate the timeframe for securing these and reasons for the delay in obtaining the approval (if applicable).
8. Assess progress of implementing project EMP through review of available project performance monitoring reports.

b. Field Investigation

1. Conduct discussion with site personnel/workers, review of relevant site records, and inspection of project facilities.
2. Conduct field investigation and sampling to assess impacts of the existing project on surface water and ground water quality, soil quality, geology and geologic hazards, air

[1] ESIA – refers to the Environmental and Social Impact Assessment; IEE – Initial Environmental Examination; EMP – Environmental Management Plan

quality, and noise based on relevant environmental quality standards. Refer to Attachment 1 for details of field sampling.
3. Consult project-affected households/people and local officials to determine problems and concerns with the operation of the existing solid waste disposal facilities and the consultations and social development programs being implemented by the facility operator.
4. Assess the existing dumpsite operation (size, length of operation, types of wastes received including hazardous waste, if any, average weight of solid wastes deposited on a monthly basis, depth of dumped wastes, etc.) and environmental and socio-economic conditions in and around the site (topography, slope, geology, soil, wind direction, climate, occurrence of floods, surface water bodies (flows and water quality), beneficial uses of water in the vicinity including shallow wells, irrigation, domestic water, groundwater table and depth, leachate quality, air quality, noise, nearby land uses, health status of community including leading causes of morbidity and mortality, among others).

c. Assessment

1. Assess the capacity of the existing dumpsite and the future landfill, including other project facilities such as runoff water collection system, leachate treatment, etc.
2. Assess substantive compliance of the facility with (i) Government requirements and (ii) ADB SPS.
3. Assess the risks of pollution, health, and safety from the existing landfill and ascertain presence of hazardous wastes, leachate, groundwater and surface water contamination.
4. Assess the degree to which environmental mitigation measures and monitoring requirements detailed in the ESIA/IEE and EMP are being implemented.
5. Assess effectiveness of the implemented mitigation measures in achieving the desired level of environmental protection including proposed closure options of existing dumpsite.
6. Prepare the corrective action plan that includes a rehabilitation plan, closure plan, and monitoring plan and address other issues that will be identified from the desk review and site assessment.
7. Based on the results of the hydrogeological study and leachate sampling analysis, recommend leachate management and monitoring solutions.
8. Based on the results of the ambient air quality tests, recommend gas control measures and monitoring plan.
9. Verify results of environmental monitoring reports.
10. Assess adequacy of public consultation efforts.
11. Present the current project organizational structure and assess the capacity of the facility operator, its contractors, and environmental regulatory agency to implement provisions of the environmental management plan (mitigation and monitoring); assess the roles, responsibilities and capacities of the different units/agencies involved in solid waste management and the existing facility.
12. Determine if adequate budget and personnel are allocated to implement mitigation measures and monitoring plan. Identify the funding options for the cost of any corrective actions and recommend an institutional mechanism to ensure implementation of the plan.
13. Determine any gaps to bring the existing facility to compliance with Government requirements and with ADB SPS.

d. Report Preparation

1. Prepare the draft and final reports. The following is a suggested outline of the report:

(i) Introduction
   a. Rationale of the ECA
   b. Methodology for environmental compliance audit
(ii) Overview of the project and status of project implementation
   a. Project location (include location map of components)
   b. Description of existing dumpsite, components, capacities and processes
   c. Status of project implementation
   d. Organization and management
(iii) Overview of environmental laws, standards and requirements (Government and ADB SPS)
   a. Government's environmental laws and regulations applicable to the project
   b. Chronology of events on environmental assessment and approval process
   c. ADB Safeguard Policy Statement
   d. Assessment of project's compliance with Government and ADB procedural requirements
(iv) Public consultation and social issues
(v) Assessment of environmental impacts and risks of pollution
   a. Description of site and surrounding areas
   b. Land use
   c. Soil
   d. Geology and geohazards
   e. Hydrology and Surface water quality
   f. Hydrogeology and Groundwater quality
   g. Leachate quality and toxicity tests
   h. Air quality
   i. Noise
   j. Socio-economic impacts (including health data)
(vi) Assessment of environmental compliance
   a. Evaluation of adequacy of mitigation measures, monitoring plan, institutional arrangements and budgets
   b. Assessment of the environmental management capacity of the EA/IA, contractors and environmental regulatory agency on implementation of the EMP
   c. Gap analysis
   d. Recommendations and lessons learned
(vii) Corrective action plan and communication plan to address identified social issues (if any)
(viii) Attach as annexes the following: (a) List of collected and reviewed documents, (b) Minutes of meetings/consultations/interviews; (c) List of organizations and individuals met; (d) photo documentation during field investigation, (e) results of laboratory tests.

E. Minimum Qualification Requirements

The Consultant team must have at least 10 years experience on environment and social safeguards. The team must be familiar with ADB's Safeguard Policy Statement (2009) and IFC Environment, Health and Safeguard guidelines on waste management.

Attachment 1: Environmental Quality Sampling

A. Groundwater sampling

Groundwater sampling locations will be at:
- existing wells (at least 1 upgradient and 2 down-gradient of the dumpsite);
- developed groundwater wells from among the boreholes drilled for geologic and soil site investigations during detailed design.

This will be determined in collaboration with the PMU, PIU and Environmental Specialist of the Project Management and Construction Supervision.

The groundwater quality parameters to measure, test and analyze are listed in the table below. The results will be compared with the Drinking Water Quality Standards of Lao PDR and WHO Guidelines for Drinking Water Quality, 2017.

Groundwater Parameter	**Location of Measurement/Test/Analysis**
Depth of water table	At well site
Temperature (^{O}C)	At well site with portable meter
pH	At well site with portable meter
Dissolved Oxygen (mg/L)	At well site with portable meter
Conductivity	At well site with portable meter
COD (mg/L)	In laboratory
Total dissolved solids (mg/L)	In laboratory
Heavy metals: As, Cd, Pb, Hg, Fe, Z, Cu, Cr^{+6} (mg/L)	In laboratory
Oil and grease (mg/L)	In laboratory
Total and faecal coliform (MPN)	In laboratory
Nitrogen: TN, NH_3, NO_3, NO_2 (mg/L)	In laboratory
Phosphorous (TP, PO_4 (mg/L)	In laboratory
Hydrogen sulphide (mg/L)	In laboratory
Surfactants (detergents) (Mg/L)	In laboratory
Cyanide (CN) (mg/l)	In laboratory

B. Surface water quality

Surface water sampling locations will at the upstream and downstream of the nearest surface water (river, creek, lake). This will be determined in collaboration with the PMU, PIU and Environmental Specialist of the Project Management and Construction Supervision.

The parameters to measure, test and analyze are listed in the table below. Parameters below are a combination of selected parameters from the applicable decrees and from the Technical Guidelines on the Implementation of the Procedures for Water Quality of the Mekong River Commission[2].

[2] Approved in the 23rd Meeting of the MRC Council on 22 November 2016.

Surface Water Parameter	Location of Measurement/Test/Analysis
Temperature (^{O}C)	In situ
pH	In situ
Dissolved Oxygen (mg/L)	In situ
Conductivity	In situ
COD (mg/L)	In laboratory
BOD_5	In laboratory
TSS (mg/L)	In laboratory
Heavy metals: As, Cd, Pb, Cu, CN, Total Hg, Cr^{+6}, (mg/L)	In laboratory
Total and faecal coliform (MPN)	In laboratory
Nitrogen: TN, NH_3, NO_3, NO_2 (mg/L)	In laboratory
Phosphorous: TP, PO_4 (mg/L)	In laboratory
Oil & grease (mg/L)	In laboratory
Phenol (mg/L)	In laboratory
Total Organochlorine Pesticide	In laboratory
Cyanide	In laboratory

C. Soil quality

Soil sampling locations will be determined in collaboration with the PMU, PIU, Environmental Specialist of the Project Management and Construction Supervision and Department of Environment. Soil samples could be acquired through:

- boreholes constructed for geotechnical investigations; and/or
- boreholes drilled intentionally for the soil quality study.

It is recommended that the conduct of soil quality study be coordinated with the geotechnical investigations, particularly in the aspect of taking soil samples and the parameters to analyze to avoid duplication. The appropriate number of samples to take must meet the study objectives and standard data quality.

The parameters to measure, test and analyze would include: pH, As, Cu, Zn, Pb, Cr, Hg, Fe, Cd, Conductivity, Cl, Alkalinity, Na, K, Organic C, Organic matter, Ca, Mg, NO_3, P, particle size, soil color, soil salinity, water holding capacity, and soil moisture.

D. Ambient air quality

Four sampling stations will be identified, comprising of two at the community areas, one at the upwind of the dumpsite and one at the downwind side of the dumpsite. The final locations of the sampling stations will be agreed on with the PMU, PIU and Environmental Specialist of the Project Management and Construction Supervision. The appropriate number of measurements to take must meet the study objectives and standard data quality.

The parameters to measure and analyze are CO, $PM_{2.5}$, PM_{10}, CH_4, H_2S, NO_2, and SO_2, (at 1-hr and 24-hr averaging period).

E. Noise

Two sampling stations will be identified, at the community areas, at the access road to the

dumpsite, at the upwind of the dumpsite and at the downwind side of the dumpsite. The final locations of the sampling stations will be agreed on with the PMU, PIU and Environmental Specialist of the Project Management and Construction Supervision. The measurements must meet the study objectives and WHO Guidelines for Community Noise, 1999.

F. Leachate quality

Leachate quality will be analyzed at two stations, i.e. (i) influent (raw leachate) and (ii) effluent (after treatment from the WWTP). The parameters to measure, test and analyze will include temperature, turbidity, pH, Conductivity, COD, BOD, TSS, Total organic carbon, DO, TDS, ammonia-N, PO4, Chloride, faecal coliform, phenols, NO3, SO4, Mg, As, Cd, Pb, Se, Cu, Ni, Mn, Hg, Fe, oil and grease.

DOCUMENTATION OF STAKEHOLDERS CONSULTATIONS

A. Public Consultation Meetings

Thakhek District Government Hall

- Attended by 24 village representatives:
  - 9 affected by roads (roads now removed from the project)
  - 4 affected by drainage
  - 3 affected by riverbank protection
  - 1 affected by garden park (now removed from the project)
  - 7 not affected at all but would want to raise village concerns and request for inclusion.

- Highlights below are only from those affected by drainage and riverbank works.

Date/Time	Organization/s	Person/s Met	Highlights
22Aug2017	District Government and Village Officials	Mr. Somdeth Deputy head of B. Houynanglee	o His village will be affected by the riverbank protection works. o The road is very bad condition, there is a big hole on the access road. o The stormwater stays stagnant inside their property because there is no drainage system. o Bank erosion occurs every year.
		Mr. Phousadeth Head of B. Thakhek nguea	o His village will be affected by the drainage works. o Bank erosion occurs every year, at the area of the old border or migration station of Thakhek town, close to Mekong hotel. o During the construction of bank protection, there will be impact on the households along the Mekong bank. o The road floods in the rainy season because stormwater could not drain well.
		Mr. Chanthanon Head of B. Moungsum	o His village will be affected by the riverbank protection works. o Bank erosion occurs due to the Mekong flow from Thailand side hitting the bank in the village. o There is a sand and gravel quarry of Mekong River. Every year the loss of land is around 10 meters at the middle of Mekong and along the bank of our village was lost around 5 meters x 1,7 km long in each year .
		Mr. Khamtan Deputy Head of B. Phonsaarth	o His village will be affected by drainage works. o His village also requests for access road to be improved, length of around 2 km.
		Mr. Soulivanh Head of B. Phasimang	o His village will be affected by drainage works. o His village is also requesting for the improvement of their school.
		Mr.Khamsouk Deputy Head of B. Nabo	o His village will be affected by riverbank protection works. o The drainage system of the road is not in good condition. o The riverbank protection is of poor standard.
		Mr.Lonesay	o His village will be affected by drainage works.

Date/Time	Organization/s	Person/s Met	Highlights
		Head of B. Sivilay	○ His village also requests for: - Their access road be of new construction because during the rainy season, it is difficult to use this road. - Their school to be improved. - The improvement of the bridge across to sano. (B.sivilay). ○ Construction of drainage will not have impacts.

B. Random Interviews – Thakhek

Date/Time	Organization/s	Person/s Met	Highlights
12Feb2018		Mrs. Sombath Head of Administrative Section Khammouane Provincial Hospital	○ Hospital was established in1924, there are mixed buildings between the old and new building of more than 7 buildings in area of 1,000m2. ○ A big new hospital building is currently being constructed, starte 2 years ago, but progress to date is only 30%. Slow progress due to lack of funds ○ The existing hospital building has many buildings such the patient's bed building, the operation building, Isolation building, emergency building, treatment building, baby delivery building. ○ The operation, isolation, baby delivery buildings have the septic tank; this septic tank is not floored. In the case of the septic tank is full, the hospital staff will contact to the truck for delivery wastewater to dump site. ○ There is big septic tank with lined the concrete in the bottom, this septic tank sizes (7meters x 15 meters and depth around 5 meters) and it receives all wastewater from other buildings that excludes the operation, isolation, baby delivery building.
12Feb2018		Mr .Bounyalath Dounta Thakhekkang village	○ Affected by DEWATS A – Houaysakham ○ He has lived in this village for more than 10 years. ○ In rainy season, waste would accumulate at Houaysakham, site of proposed DEWATS A. ○ There is flooding when the water level of Mekong River is high and the water at Houaysakham could not flow out out properly. ○ The site in Houaysakham for DEWATS 1 floods every year. The water stays around a few days and then it drains out.
12Feb2018		Mrs. Bualien Thakhekkang village	○ Affected by DEWATS A – Houaysakham ○ She has lived in this village for more than 10 years. ○ Her house is located about 80-100 m away from the site of the proposed DEWATS. The main drainage at Houysakham has high water level, but it does not flood to her house. ○ The access road to her house is unpaved; hence, the road is dirty and some water stagnant in rainy season.
12Feb2018		Mr. Khounmee Manager of Laksam Market	○ Affected by DEWATS C – market and local bus station ○ The market has sections for meat, vegetables, fruits, dry foods, clothes and small restaurants. There are more than 100 shops in this market. ○ There is a closed drainage system line under the floor of the market and discharge directly to the main drainage system of town. The discharge area is near to the main road of NR 13. ○ There are three septic tanks inside the market area. The septic tank for the toilets, are not sealed in the bottom. ○ This market is located in the high level; hence, has never been flooded.
Thakhek 12Feb2018		Mrs. Sombath , Head of administrative section Khammouane Provincial Hospital	○ Hospital was established in1924, there are mixed buildings between the old and new building of more than 7 buildings in area of 1,000m2. ○ A big new hospital building is currently being constructed, starte 2 years ago, but progress to dat is only 30%. Slow progress due to lack of funds

Date/Time	Organization/s	Person/s Met	Highlights
			○ The existing hospital building has many buildings such the patient's bed building, the operation building, Isolation building, emergency building, treatment building, baby delivery building. ○ The operation, isolation, baby delivery buildings have the septic tank; this septic tank is not floored. In the case of the septic tank is full, the hospital staff will contact to the truck for delivery wastewater to dump site. ○ There is big septic tank with lined the concrete in the bottom, this septic tank sizes (7meters x 15 meters and depth around 5 meters) and it receives all wastewater from other buildings that excludes the operation, isolation, baby delivery building.
		Mr .Bounyalath Dounta Thakhekkang village	○ He has lived in this village for more than 10 years. ○ In rainy season, waste would accumulate at Houaysakham, site of proposed DEWATS 1. ○ There is flooding if the water level from Mekong River high and the drainage at Houysakham could not drain out properly. ○ The site in Houysakham for DEWATS 1 floods every year. The water stays around a few days and then it drains out.
		Mrs. Bualien Thakhekkang village	○ She has lived in this village for more than 10 years. ○ Her house is located about 80-100 m away from the site of the proposed DEWATS. The main drainage at Houysakham has high water level, but it does not flood to her house. ○ The access road to her house is unpaved; hence, the road is dirty and some water stagnant in rainy season.
		Mr. Khounmee Manager of Laksam Market	○ The market has sections for meat, vegetables, fruits, dry foods, clothes and small restaurants. ○ There are more than 100 shops in this market. ○ There is a close drainage system line under the floor of the market and discharge directly to the main drainage system of town. The discharge area is near to the main road of NR 13. ○ There are three septic tanks are located inside the market. That septic tank for the toilets, they are the not sealed in the bottom. ○ This market is located in the high level; hence, has never been flooded.

22 Aug 2017 (11:00 AM) Nam Papa of Khammouane Province Mr. Outhone, Director Mrs. Outhid Manpholin, Head of Trade Service Mr. Saykham, Technical Staff Highlights o Nam Papa conducts analysis of the quality of raw water from Mekong River as follows: - For turbidity and pH, daily. - For 11 other parameters, annually and these are: EC, NO2, NO3, SO4,Cl-,CaCO3, Fe, F, Zn ,CN and E.Coli. o Available data for baseline could be those during the rainy and dry seasons of 2016. The Director committed to give information to the PPTA Environment Team. o Projects I he next 3 years: - There are plans to extend services to 2,000 HHs more until 2020. But budget not yet firmed up. - Maintenance works (changing meters). o The water supply system started in 1995. Because of improvements and expansions, the system now produces 15,000 m3/day. o Daily consumption is 9,000 m3/day. o No money to install meters. o There is illegal connection but minimal. o Based on information provided, there were 6,397 meters installed for HHs, as of June 2017.

C. Public Consultation Meeting (Presentation of IEE and RP)

Meeting Room of Thakhek District Government Office

Date/Time	Organization/s	Attendees	Highlights
26Apr2018	District Government, DPWT, UDAA, DONRE, Khammouane Provincial Hospital, affected villages and HHs	○ Mr. Chan Boupha, District Governor ○ Mr. Bounthong Keohanam, MPWT ○ Mr. Bounpheng Xayyasin, DONRE ○ Mr. Khamtai Xaynasin, Director of Khammouane Provincial Hosptial ○ Mr. Buala, UDAA ○ Mr.Saysomvang, DPWT of Khammouane province. ○ Representatives of affected villages and affected HHs (See complete list in the Attendance Sheets below.)	○ Objectives of the meeting: ○ to present the results of the IEE and Resettlement Plan; and ○ to solicit feedback on the results from the participants. ○ Feedback included: ○ From the District Governor: During construction: (i) solid waste to be disposed of at the dumpsite; (ii) waste pickers to continue to work and stay at the dumpsite, to continue to sort and recover recyclables for their daily income; (iii) measures to mitigate health and safety issues to be implemented. ○ From Mr. Sonthalee Kanyasone, owner of the business of Provincial Bus Station: (i) Declared his support for the project. (ii) Had donated a piece of his land beside the bus station for the location of the DEWATS treatment plant. (iii) Asked if many HHs will be connected to the DEWATS system and if those affected by the drainage component will be compensated. ○ District Governor on compensation: (i) Government to compensate affected persons most suitably and fairly. (ii) Project should avoid cutting big trees. (iii) A committee to be set up for the detailed assessment of how to compensate or relocate affected HHs according to the laws/regulations of the Government of LPDR. ○ Mr. Bounpheng Xayyasin of DONRE: (i) Agreed for the project to be implemented. (i) Commented that the project had undertaken environmental and social studies that followed the safeguard policy of LPDR. Agreed to the scope of environmental and social studies of the project and that further studies would be made during project implementation. ○ Mr. Khamtai Xaynasin of Khammoun Hospital: (i) Agreed to the DEWATS system to be installed at the hospital compound. (ii) Requested for a specific bacteria waste treatment equipment for treatment of hospital waste prior to transport to the landfill for final disposal. ○ Mrs. Vongphachanh Phonsuly, head of Nabo village: Agreed to the project and was glad to hear of the project to be implement in the near future. ○ Concerns raised by the 26 HHs affected by the proposed riverbank protection work were: (i) If affected land, infrastructure/house structure, grown vegetation would be compensated; (ii) if resettlement area would provide convenient living conditions; (iii) if rentals would be compensated; (iv) how affected HHs (that are without another land to relocate to) would be resettled; and (v) if there would still be land available in the current house area, would affected HH be allowed to stay on and not be resettled. To these concerns, the District Governor replied that compensation details would be finalized only after detailed assessment of HH conditions are made at the start of project implementation. ○ District Governor concluded the meeting with the following points: ○ The participants in the meeting agreed to the results of the IEE and RP. ○ The social and environmental studies to be endorsed accordingly.

Date/Time	Organization/s	Attendees	Highlights
			○ For the detailed assessment of and studies on the impacts on affected HHs, a committee at the provincial and district levels to be set up, consultation meetings to be conducted to arrive at the appropriate, fair, compensation acceptable to affected HHs. ○ The 26 affected HHs to be compensated appropriately, suitably and fairly for the betterment/improvement of their living conditions. ○ All participants from the relevant government offices and from affected villages to participate and carry out their respective responsibilities according to the project schedule.

GMS4

FORM NO. 1A

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ໂຄງການພັດທະນາຕົວເມືອງຕາມແລວເສດຖະກິດອານຸພາກພື້ນແມ່ນ້ຳຂອງສີ່

TA-9192 REG: Fourth Greater Mekong Subregion Corridor Towns Development Project(GMS4)

ຊື່ຫ້ອງການໂຄງການຂັ້ນແຂວງ: ຫ້ອງການປະສານງານໂຄງການພັດທະນາຕົວເມືອງຕາມແລວທາງອະນຸພາກພື້ນແມ່ນ້ຳຂອງ4, ເມືອງ:........................

ກອງປະຊຸມ: ເຜີຍແຜ່ ຂໍ້ມູນ ຜົນການສຶກສາ

ການປົກປັກຮັກສາ ສິ່ງແວດລ້ອມ ແລະ ການປົກປ້ອງສັງຄົມ-ການຍົກຍ້າຍສິ່ງກີດຂວາງ

ຂອງໂຄງການພັດທະນາຕົວເມືອງ, ເມືອງ: ..ທ່າແຂກ

ເວລາ: 8:30 - 12:00

ສະຖານທີ່ ...[illegible] ທ່າແຂກ.

ວັນທີ ...26/4/2018

ລ/ດ	ຊື່ ແລະ ນາມສະກຸນ	ເພດ (ຍິງ/ຊາຍ)	ພາກສ່ວນ (ຫ້ອງການ)	ຕຳແໜ່ງ	ເບີໂທ	ລາຍເຊັນ
1	2	3	4	5	6	7
1	ທ. [illegible]	ຊາຍ	[illegible]	[illegible]	58950555	[signature]
2	ທ. [illegible]	ຊາຍ	[illegible]	[illegible]	99288899	[signature]
3	ນ. [illegible]	ຍິງ	[illegible]	ຮອງນາຍບ້ານ	22194477	[signature]
4	ນ. [illegible]	ຍິງ	ບ. [illegible]	ນາຍບ້ານ	0305229645	[signature]
5	ນ. [illegible]	ຍິງ	[illegible]	ຮ. ນາຍບ້ານ	55656340	[signature]
6	ທ. [illegible]	ຊາຍ	ບ້ານ [illegible]	ນາຍບ້ານ	91922969	[signature]
7	ທ. [illegible]	ຊາຍ	ບ. [illegible]	[illegible]	56430261	[signature]
8	ທ. [illegible]	(ຊາຍ)	ບ້ານ [illegible]	ນາຍບ້ານ	0309735746	[signature]
9	ທ. [illegible]	(ຊ)	ບ. [illegible]	ຮ. ນ.ບ້ານ	98507412	[signature]
10	ທ. [illegible]	ຊ.	ບ. [illegible]	ຮ. ນາຍບ້ານ	99421676	[signature]
11	ທ. [illegible]	ຊ	[illegible]	[illegible]	22197952	[signature]
12	ທ. [illegible]	ຊ	[illegible]	[illegible]	55656113	[signature]
13	ທ. [illegible]	ຊ	[illegible]	[illegible]	56551487.	[signature]
14	ທ. [illegible]	ຊ	ບ. [illegible]	ຮ. ນາຍບ້ານ	55651855	[signature]
15	ທ. [illegible]	ຊ	[illegible]	[illegible]	22324505	[signature]
16	ນ. [illegible]	ຍ	[illegible]-PPTA	[illegible]	22237779	[signature]

2

GMS4 FORM NO. 1A

ໂຄງການພັດທະນາຕົວເມືອງຕາມແລວເສດຖະກິດຂອງອານຸພາກພື້ນແມ່ນ້ຳຂອງ4

TA-9192 REG: Fourth Greater Mekong Subregion Corridor Towns Development Project(GMS4)

ຊື່ຫ້ອງການໂຄງການຍ້ອນຮອງ: ຫ້ອງການປະສານງານໂຄງການພັດທະນາຕົວເມືອງຕາມແລວທາງອະນຸພາກພື້ນແມ່ນ້ຳຂອງ4, ເມືອງ:.....

ກອງປະຊຸມ: ເຜີຍແຜ່ ຍົກຍ້ອງ ຜົນການສຶກສາ
ການປົກປັກຮັກສາ ສິ່ງແວດລ້ອມ ແລະ ການປົກປ້ອງສັງຄົມ-ການຍົກຍ້າຍສິ່ງກີດຂວາງ
ຂອງໂຄງການພັດທະນາຕົວເມືອງ, ເມືອງ: ...

ເວລາ :8:30 - 12:00 ວັນທີ 26/4/2018

ສະຖານທີ ຫ້ອງປະຊຸມ ...

ລ/ດ	ຊື່ ແລະ ນາມສະກຸນ	ເພດ (ຍິງ/ຊາຍ)	ພາກສ່ວນ (ຫ້ອງການ)	ຕຳແໜ່ງ	ເບີໂທ	ລາຍເຊັນ
1	2	3	4	5	6	7
1	...	...	...	...	55779999	
2	...	...	...	...	22221361	
3	...	...	...	...	22824505	
4	...	...	...	...	55751218	
5	...	...	PPTA-consultant Team.	Envi-Specialist	22416988	
6	...	...	...	...	58547777	
7	...	...	...	...	23478288	
8						
9						
10						
11						
12						
13						
14						
15						
16						

GMS4

FORM NO. 1A

ໂຄງການພັດທະນາຕົວເມືອງຕາມແລວເສດຖະກິດອານຸພາກພື້ນແມ່ນ້ຳຂອງທີ່

TA-9192 REG: Fourth Greater Mekong Subregion Corridor Towns Development Project(GMS4)

ຊື່ຫ້ອງການໂຄງການຂັ້ນແຂວງ: ຫ້ອງການປະສານງານໂຄງການພັດທະນາຕົວເມືອງຕາມແລວທາງເສດຖະກິດອະນຸພາກພື້ນແມ່ນ້ຳຂອງ4,
ເມືອງ:........................

ກອງປະຊຸມ: ເຜີຍແຜ່ ຂໍ້ມູນ ຜົນການສຶກສາ

ການປຶກສາຫາລື ສິ່ງແວດລ້ອມ ແລະ ການປົກປ້ອງສັງຄົມ-ການຍົກຍ້າຍສິ່ງກີດຂວາງ

ຂອງໂຄງການພັດທະນາຕົວເມືອງ, ເມືອງ: [illegible]

ເວລາ 8:30 - 12:00

ສະຖານທີ່ [illegible] ວັນທີ 26/4/2018

ລ/ດ	ຊື່ ແລະ ນາມສະກຸນ	ເພດ (ຍິງ/ຊາຍ)	ພາກສ່ວນ (ຫ້ອງການ)	ຕຳແໜ່ງ	ເບີໂທ	ລາຍເຊັນ
1	2	3	4	5	6	7
1	[illegible]	ຊ	[illegible]	[illegible]	55774999	[signature]
2	[illegible]	ຊ	[illegible]	[illegible]	22215361	[signature]
3						
4						
5						
6						

GMS4

FORM NO. 1A

4

ໂຄງການພັດທະນາຕົວເມືອງການແລວເສດຖະກິດອານຸພາກພື້ນແມ່ນ້ຳຂອງສີ່

TA-9192 REG: Fourth Greater Mekong Subregion Corridor Towns Development Project(GMS4)

ທີ່ຫ້ອງການໂຄງການຂັ້ນແຂວງ

ຫ້ອງການປະສານງານໂຄງການພັດທະນາຕົວເມືອງການແລວທາງອະນຸພາກພື້ນແມ່ນ້ຳຂອງ4,

ເມືອງ.........................

ກອງປະຊຸມ: ເຜີຍແຜ່ ຂໍ້ມູນ ພື້ນການສຶກສາ

ການປົກປັກຮັກສາ ສິ່ງແວດລ້ອມ ແລະ ການປົກປ້ອງສັງຄົມ-ການຍົກຍ້າຍສິ່ງກີດຂວາງ

ຂອງໂຄງການພັດທະນາຕົວເມືອງ, ເມືອງ: [illegible]

[illegible] 14:00 – 16:

ສະຖານທີ່ [illegible]

ວັນທີ 26/4/2018

ລ/ດ	ຊື່ ແລະ ນາມສະກຸນ	ເພດ (ຍິງ/ຊາຍ)	ພາກສ່ວນ (ຫ້ອງການ)	ຕຳແໜ່ງ	ເບີໂທ	ລາຍເຊັນ
1	2	3	4	5	6	7
1	[illegible]	ຍ	[illegible]	[illegible]	55756989	[illegible]
2	[illegible]	ຍ	[illegible]	[illegible]	030-5651067	[illegible]
3	[illegible]	ຍ	[illegible]	[illegible]		[illegible]
4	[illegible]	ຍ	[illegible]	[illegible]		[illegible]
5	[illegible]	ຍ	[illegible]	[illegible]	020.5424816	[illegible]
6	[illegible]	ຍ			58870028	[illegible]
7	[illegible]	ຍ	[illegible]		97343491	
8	[illegible]	ຍ	[illegible]	[illegible]		
9					02099393223	
10	[illegible]	ຍ	[illegible]		020567[illegible]011	[illegible]
11	[illegible]	ຊ	[illegible]		55902106	
12	[illegible]	ຍ	[illegible]		0305698196	
13	[illegible]	ຊ	[illegible]	[illegible]	22822233	[illegible]
14	[illegible]	ຍ	[illegible]	[illegible]	55055503	[illegible]
15	~~[illegible]~~			~~[illegible]~~	~~[illegible]~~	~~[illegible]~~
16	[illegible]	ຍ	[illegible]	[illegible]	56788588	[illegible]

17. [illegible] ຊ –/– [illegible] 55450094 [illegible]

18. [illegible] –/– [illegible]

19. [illegible] –/– [illegible]

20. [illegible] –/– [illegible] 56549192 [illegible]

Right: Mr. Chan Boupha, District Governor of Thakhek.
Left: Mr. Bounthong Keohanam, MPWT representative

Representatives of relevant offices/departments.

Representatives of the households that will be affected by the riverbank protection component.

TERMS OF REFERENCE OF INTERNATIONAL AND NATIONAL ENVIRONMENTAL SPECIALISTS OF THE PROJECT IMPLEMENTATION CONSULTANT

REG: Fourth Greater Mekong Subregion Corridor Towns Development Project

The Environmental Specialists (ES) will provide technical assistance and support to the Project Coordination Unit (PCU), Project Implementation Units (PIUs) and the Public Works and Transport Research Institute (PTRI) in environmental safeguard policy compliance and conduct and/or facilitate capacity building in project/subproject environmental management. He/she will ensure that while performing his/her tasks, capacity building in environmental management is carried out. Capacity building will be highly focused in training the PCU, particularly its Environmental Safeguard Officer (ESO) and the environmental focal points in the PIUs), as well as staff of the PITR.

A. International Environment Specialist (4 person-months)

- Provide technical assistance and support to the PCU in incorporating relevant mitigation measures in the detailed designs.
- Finalize the capacity building plan based on the preliminary activities outlined by the PPTA Team in collaboration with PCU, PIUs, and PTRI.
- At the onset of DED, in collaboration with the MONRE/DONRE, conduct an orientation on the: (i) Environmental Protection Law 2012 (No. 29/NA) and relevant associated ministerial agreements and guidelines; (ii) Safeguard Policy Statement (SPS) 2009 of the Asian Development Bank (ADB); (iii) ADB-cleared EMP to the PCU, PIUs, the Design Consultant and PTRI, including its implementation, monitoring, and reporting.
- Support the PCU and PIUs in establishing the mechanisms for EMP implementation, monitoring, reporting, conducting public consultations and information disclosure, and activating the grievance redress mechanism (GRM) at the project, subproject, town and village levels.
- Provide technical assistance to the PCU in complying with the country's environmental safeguard requirements to ensure no delay in the commencement of the construction phase resulting from delay in obtaining the required environmental clearance/permit from the MONRE/DONRE. This would include assistance in the: (i) drafting of the TOR for the conduct of ESIA/IEE for the subprojects in coordination with PTRI; (ii) ensuring the TOR for the controlled landfill ESIA/IEE includes the conduct of environmental studies required by MONRE/DONRE that are not covered in the scope of works of the Environmental Compliance Audit (ECA) of the existing dumpsite; and (ii) engagement of a firm that is nationally certified/registered to provide the ESIA/IEE services.
- Monitor compliance of the subprojects with the environmental assessment and clearance requirements of the MONRE/DONRE and that the Environmental Compliance Certificate (ECC) of each subproject is secured by MPWT prior to start of construction.
- Assist the PMU in preparing for procurement by ensuring that the Environmental Management Plan (EMP) is part of the tender documents and civil works contracts and that environmental criteria is included in the evaluation of bids.
- Contract third party environmental monitoring group/institutes for the conduct of baseline environmental surveys.
- Assist the PMU in ensuring that contractors prepare their respective contractor's EMP (CEMP) that complies with the requirements of ADB Safeguards Policy Statement (2009).
- Assist the PMU in institutionalizing and implementing the grievance redress mechanism, undertaking pre-construction environmental quality monitoring as recommended in the

EMP, and reviewing and evaluating the CEMP to ensure that these are responsive to ADB SPS (2009).

- Coordinate with the MPWT/DPWT, DHUP, MONRE/DONRE, UDAA, PTRI, and other agencies on regulatory compliance issues that may affect or are affecting the subproject during implementation.
- Prepare the necessary status reports for compliance with the conditions set out in the approved ESIA/IEE reports.
- Assist the PMU and PTRI in the preparation of monthly report on status of implementation of EMP and monitoring plan for input to the PMU's monthly progress report.
- Assist the PMU and PTRI in the preparation of semi-annual environmental monitoring report to be submitted to ADB.

B. National Environment Specialist (20 person-months)

- Assist the International Environment Specialist, in designing and carrying out initial orientation to PCU and PIUs in environmental assessment and management, including the preparation of material and instruction in the Lao language.
- Visit each subproject town and provide guidance on the updating of the IEE/EMP, in based on the detailed design.
- Coordinate with the consultants who will conduct the Environmental Compliance Audit (ECA) of the existing dumpsites and ensure that environmental sampling and meaningful public consultations are conducted and relevant issues are identified and assessed into the corrective action plan.
- Coordinate with the social and resettlement specialists on stakeholder consultations related to environment aspects and/or responses to grievances through the grievance redress mechanism.
- Assist with preparation and review of IEEs/EMPs and coordinate with PIUs for any further investigations or reporting that may be necessary.
- Provide inputs to bidding and construction supervision team, design engineer and procurement specialist to ensure that EMPs are integrated in contract and bidding documents.
- Monitor compliance of the subprojects with the environmental assessment and clearance requirements of the MONRE/DONRE and that the Environmental Compliance Certificate (ECC) of each subproject is secured by MPWT prior to start of construction.
- Work with the PMU, PIUs and PTRI to ensure EMP implementation monitoring is included within the overall project monitoring progress reports.
- Provide inputs to progress reports, environmental monitoring reports and project completion report.
- Visit subproject towns during construction and provide guidance on supervision and compliance monitoring, advise PIUs of any actions required to ensure EMP compliance.
- Visit subproject towns where construction has been completed and assist with establishing environmental monitoring procedures for the operation phase of the subprojects.
- Review, revise and update the EMPs for each subproject.

Qualifications:

The Environmental Safeguard Specialists will meet the following minimum qualification requirements:

A. International Environment Specialist

- Master's degree in environmental science/engineering or equivalent;
- 10 years of professional experience in environmental impact assessment, and in managing the environmental performance including environmental monitoring and environmentally responsible procurement, of infrastructure projects for basic urban services; and
- 10 years of relevant experience in Southeast Asia, preferably in the Mekong Region.

B. National Environment Specialist

- Master's degree in environmental science/engineering or equivalent;
- 5 years of professional experience in environmental impact assessment and in managing the environmental performance including environmental monitoring, of donor-financed urban infrastructure projects in Lao PDR; and
- a good command of written and spoken English and experienced in preparing reports in English and Lao.

Duration of Assignment:

The duration of assignment will be: (i) 4 person-months for the International ES; and (ii) 20 person-months for the national ES – spread over 5 years.