Initial Environmental Examination

March 2021

Cambodia: Second Urban Environmental Management in the Tonle Sap Basin Project

Landfill Subproject in Battambang Town, Battambang Province

Prepared by Ministry of Public Works and Transport for the Asian Development Bank. This is an updated version of the draft originally posted in May 2018 available on https://www.adb.org/projects/documents/cam-50102-002-iee.

CURRENCY EQUIVALENTS

(as of February 2020)

Currency unit	–	riel (KR)
KR 1.00	=	$ 0.000250
$1.00	=	KR 4,000

ABBREVIATIONS

ADB	–	Asian Development Bank
AP	-	Affected Person
BOD	–	Biochemical Oxygen Demand
CDIA	–	Cities Development Initiative for Asia
CEMP	–	Construction Environmental Management Plan
C-EHS	–	Contractor Environmental Health and Safety Officer
COD	–	Chemical Oxygen Demand
CRVA	–	Climate Risk Vulnerability Assessment
DDIS	–	Detail Design Implementation Suppervision
DDPP	–	Detailed Design and Project Preparation
DED	–	Detailed Engineering Design
EA	–	Executing Agency
EHS	–	Environmental, Health and Safety
EIA	–	Environmental Impact Assessment
EMP	–	Environmental Management Plan
FGD	–	Focus Group Discussion
FS	–	Feasibility Study
GHG	–	Greenhouse Gas
GRM	–	Grievance Redress Mechanism
IA	–	Implementing Agency
IEE	–	Initial Environmental Examination
IEIA	–	Initial Environmental Impact Assessment
MoE	–	Ministry of Environment
MOWRAM	–	Ministry of Water Resources and Meteorology
MPWT	–	Ministry of Public Works and Transport
MRF	–	Materials Recovery Facility
O&M	–	Operation and Maintenance
PDoE	–	Provincial Department of Environment
PDPWT	–	Provincial Department of Public Works and Transport
PMC	–	Project Management Consultants
PMC-I/NES	–	PIM-International and National Environment Specialists
PIU	–	Project Implementation Unit
PIU-SFP	–	PIU Safeguards Focal Point
PMU	–	Project Management Unit
PMU-ESO	–	PMU Environmental Safeguards Officer
PPCR	–	Pilot Program for Climate Resilience
PPP	–	Public Private Partnerships
PPTA	–	Project Preparation Technical Assistance
PSC	–	Project Steering Committee
RCP	–	Representative Concentration Pathway
SHC	–	Sewer Household Connection
SPS	–	Safeguards Policy Statement
TS-2	–	Tonle Sap Urban Environmental Improvement Project
TSBR	–	Tonle Sap Biosphere Reserve
TSS	–	Total Suspended Solid
WHO	–	World Health Organisation
WWTP	–	Wastewater Treatment Plant

WEIGHTS AND MEASURES

dBA	–	A-weighted Decibel
km	–	Kilometre
km2	–	Square kilometre
LAeq	–	Equivalent Continuous Level ‘A weighting’ - ‘A’-weighting = correction by factors that weight sound to correlate with the sensitivity of the human ear to sounds at different frequencies
m	–	Meter
^{o}C	–	Degree Celsius
PM10	–	Particulate Matter 10 micrometres or less
PM2.5	–	Particulate Matter 2.5 micrometres or less
µg/m3	–	Microgram per cubic meter

GLOSSARY

District	–	Sub-divisions of the 24 provinces in Cambodia
Commune	–	Sub-divisions of districts, referred to as Sangkats in urban areas

NOTE

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

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1. EXECUTIVE SUMMARY

1.1. The Project

1. The Battambang Landfill subproject is part of the Second Urban Environmental Management in the Tonle Sap Basin Project (TS-2 Project) which aims at supporting the Government of Cambodia in improving urban services and enhancing climate resilience in the Tonle Sap Basin. The project is part of ADB's programmatic approach in the Tonle Sap Basin, and will build on an ongoing project, under which similar interventions are financed in two of the basin's towns. The TS-2 project focuses on improvement of solid waste management through the development of controlled landfills (LF), and improvement of wastewater treatment, through the development of wastewater treatment plants (WWTP) and storm water drainage. A summary of the TS-2 project interventions and their locations is shown in Table 1.

Table 1: Summary of TS-2 Project Interventions

Sub-Project City	Wastewater and drainage	Drainage	Landfill
Serei Saophoan	✓	✓	✓
Battambang	✓	X	✓
Stueng Saen	✓	✓	✓

2. The current subproject concerns the Battambang's Solid Waste project, which entails the construction of a new landfill and its operation.

3. A preliminary Feasibility Study (FS) was conducted in 2018 during a Project Preparation Technical Assistance (PPTA) and this IEE has been prepared in conjunction with the completion of the Detailed Engineering Design (DED) thereby ensuring consistency between the environmental measures and the engineering designs.

4. The PPTA considered a range of landfill standards and determined that the appropriate type would be a controlled landfill with planned cell development.

5. After a site selection process, it was decided to locate the landfill in an upland area currently used as a quarry/borrow pit. The site is located within Poar Svay Village, Ta Keam Commune, Banan District, Battambang Province. The landfill location was approved by The Ministry of Environment (MoE) in February 2020.

6. The proposed site location is:

   - About 3 kilometres from Poar Svay Village, Ta Keam Commune, where there are: houses, school, pagoda, health centre, water well and pond.
   - About 3 kilometres from Road 1570.
   - About 22 kilometres from Battambang town.

7. With a design period of 20 years, the project components/facilities are planned up to the year 2040, with initial construction designs focusing on the period from 2021 to 2030. The conceptual design prepared during the feasibility study stage formed the basis for the development of the final Detailed Engineering Design for Battambang Landfill under the TS-2 project. The Detailed Engineering Design comprise the following:

   - A total landfill area of 25 hectares
   - Upgrading and elevating 420 m of the external access road to the landfill site, with levels to be above flood levels. (out of a total of 3.5 km of access road, which may be upgraded in the 2040 horizon).
   - Construction of 1 (one) controlled landfill cell out of a total of 4 (four) cells with grading, drainage in site preparation, improved leachate and surface water

management. The Initial Environmental Examination (IEE) covers the whole landfill site.

- Construction of 1 (one) hazardous waste landfill cell.
- Construction of leachate collection, storage, treatment system and recirculation system.
- Construction of concrete internal road and rainwater drainage system along with peripheral embankments.
- Construction of fencing and entrance gate.
- Construction of weighbridge and office building; staff dining and rest room; supply room; workshop, electrical and mechanical room.
- Construction of a non-mechanical materials recovery facility (MRF)
- Construction of hazardous waste storage facility.
- Construction of vehicle washing facility.
- Provision of operations & maintenance equipment.

8. Operation will entail:

- Regular (not daily) cover.
- Waste compaction.
- Fencing.
- Basic record-keeping.
- Controlled waste picking.
- Leachate management
- Gas management.
- Monitoring of leachate, surface water, groundwater and ambient air quality.

9. The solid waste management subproject entails the construction of a new controlled landfill but does not involve the closure of the existing dumpsite in Battambang town, where activities related to the material recovery facility (MRF) and composting will remain. The closure of the dumpsite is expected to occur following the opening of the new landfill, which will fall under the government responsibility. The dump site will require surveys and remediation. However, these components are not covered in this current phase of work.

10. The Project is classified as category B for environment as confirmed during the project preparation. A preliminary IEE was drafted at the PPTA phase which covered all three cities and infrastructures of the TS-2 project. This lEE addresses the Battambang solid waste management subproject and has been undertaken in accordance with ADB Safeguards Policy Statement (SPS) 2009. This IEE has led to the preparation of a separate Environmental Management Plan (EMP). The IEE and EMP will be updated as needed according to variations on detailed designs. The IEE and EMP are in line with the domestic Initial Environmental Impact Assessment (IEIA) which was approved by the Ministry of Environment (MoE) on 10 February 2021 (see Annex 7).

1.2. Key Findings

11. The environmental baseline study established that the most sensitive receptors around the proposed project sites are the local communities and groundwater: Poar Svay village, located 3 km from proposed site, along the access road, and some isolated houses are located within 500 m of the proposed site. In addition, the baseline surveys identified that groundwater was near the bottom of the pits of the proposed site due to over excavation. The groundwater is used in the village, but not in the house 500 m from the site.

12. The landfill site is located within a hilly area, currently used as borrow pit and quarry sites, surrounded by agricultural fields (mango farms). There are no protected areas or habitats and species of conservation value identified within the project area of influence.

13. Impacts during construction will be mostly localized to project sites and short-term (duration will be limited to the construction period) and limited to the common impacts

associated with any project construction activities and its associated groundworks. These impacts will be mainly linked to the generation of atmospheric emissions, noise, dust, pollutants and greenhouse gas emissions, and impacts on local traffic flow and associated health and safety risks, and the generation of solid waste and wastewater.

14. The most significant environment risks associated with the landfill project are expected during the operation phase when waste from the service area will be disposed off at the constructed landfill.

15. Landfill sites can cause environmental pollution if they are not managed and maintained effectively. Such pollution can include long-term impacts to ground water from poor leachate management which in turn will potentially cause health and safety risks for nearby communities using groundwater for consumption. The designs are considering these risks and monitoring of groundwater is planned to control that the protection measures in place are efficient.

16. The landfill will also generate biogas by the degradation of organic waste within the landfill cells. The controlled landfill will enable to better capture the generated biogas and control the emissions. Treatment and flaring can be retrofitted at a later stage to better manage biogas if necessary.

17. Additional impacts during operation are typically associated with the discharge of untreated effluents or runoff from the landfill cells during rain events. However, the Battambang Landfill is designed with leachate collection and treatment systems and will under normal conditions be operated as a zero-discharge facility.

18. Landfills can also be the source of windblown litter and can attract pests and insects if waste is not regularly covered. In addition, traffic will increase on the roads as waste trucks will transport waste from the service area – centred in Battambang town, 23 km away - in particular on the portion of roads that lead to the future landfill, leading to risks for the health and safety of communities, in addition to air quality impacts from exhaust fumes of waste trucks.

19. If effectively managed, the project facilities will bring about environmental improvements to the local project areas and urban core. Field visits show that the environment is currently being contaminated with litter and the growing pressures on the urban areas means that this would likely continue. The development of a well-engineered waste management facility will reduce pollution of the environment and therefore lower the risks to human health and water quality. In addition, the area will have improved disaster and climate change resilient infrastructures.

20. In Battambang, the new landfill site will be adequate for the next 20 years (up to 2040) and will solve the emerging problems of pollution created from uncontrolled dumping of waste at the existing solid waste dump site. This in turn will contribute to the aesthetics and hygiene of the urban environment and improve the quality of life or “liveability” of the cities. In addition, the Battambang landfill site will be used as a demonstration site which will provide opportunities for operator training on all aspects of landfill operations and facility maintenance including compliance with the operational environmental monitoring and management plans.

21. The community consultations undertaken for this IEE show support for the project as the residents recognize the need for improved waste management. During consultations, the communities and their representatives nevertheless expressed their concerns regarding impacts on surface and groundwater quality of the village area near the landfill site and mentioned their worries about pests and bad odour. These concerns have been addressed in the design and operation of the landfill.

1.3. Environmental Management Plan

22. The EMP is developed in accordance with the “mitigation hierarchy” and aims to avoid impacts where possible and mitigate those impacts which cannot be eliminated to an acceptable and minimum level. The EMP includes detailed requirements for:

    - Mitigation and monitoring measures;
    - Institutional arrangements and project responsibilities;
    - EMP budget for implementation;
    - Capacity building and training requirements;
    - Public consultation and information disclosure;
    - GRM including clearly defined timescale and responsibilities.

23. The Contractor will be mainly responsible for the implementation of the mitigation measures, pre-construction and during the construction phase, and the future operator will be responsible for implementation during the operation phase.

24. The project includes a capacity building program to address technical and institutional issues and ensure the sustainable provision of quality services.

25. The Project Management Consultant (PMC) will be responsible for ensuring adequate training during project implementation and will include training as follows:

    - EMP adjustment and implementation - Development and adjustment of the EMP, roles and responsibilities, monitoring, supervision and reporting.
    - Grievance Redress Mechanism (GRM) – roles and responsibilities.
    - Environmental protection - Pollution control on construction sites (air, noise, surface water, groundwater, wastewater, and solid waste).
    - Environmental monitoring - Monitoring methods, data collection and processing, reporting systems.

26. The key mitigation measures during construction will include:

    - Good construction practices will be adopted to ensure minimal disturbance of people and communities from construction related nuisance, such as noise, dust and emission or other pollutants.
    - Access to properties and agricultural land will be maintained and encroachment avoided to allow people to continue their activities unimpeded.
    - The contractor will submit a site-specific construction environmental management plan (CEMP) and associated subplans covering in more detail the key activities which will be conducted during construction, and how associated impacts will be mitigated.
    - The contractor is required to implement additional stakeholder engagement to ensure that all stakeholders are clear on where activities will take place. The contractor shall act as a local entry point for the project GRM to receive concerns or complaints from local people and collaborate with the PMU to facilitate resolution of grievances about the social or environmental performance of the construction work. The GRM will address affected people's concerns and complaints promptly, using a transparent process that is readily accessible to all affected persons. It will contain multiple entry points to allow affected people to approach the Contractor, Project Implementation Unit (PIU), their local leaders, the Ministry of Public Works and Transport (MPWT) or ADB.
    - A community and occupational health and safety plan is required as part of the CEMP, emphasizing the need to address risks to site operatives including risk of COVID-19 transmission.

27. Mitigation and monitoring measures will also be required for the operation phase. The importance of training in landfill operations and management is emphasized to ensure that the investments are sustainable, and that landfill operations are effectively carried

out. Recognizing that operator performance is critical to environmental performance, a detailed long-term operator training plan and associated budget is provided in the capacity development component of this project.

1.4. Conclusion

28. This IEE was undertaken to determine the environmental issues and concerns associated with the subproject activities, based on DED. The assessment confirms that the project is classified as Category B for environment. There are no significant adverse impacts that cannot be readily mitigated if implemented effectively, the EMP proposes measures that will mitigate or compensate impacts on the natural environment and affected people to an acceptable level. The key parties for mitigation measure implementation are the construction contractors and the operators. They will be supported by qualified national and international environmental consultants within the PMC teams. The implementation of this EMP will be closely monitored and reported on by the relevant stakeholders in the project.

29. The most significant impacts from the project are expected during operations. The design of the facilities aims at preventing these impacts and there is a comprehensive training and capacity building component to the project which is essential for ensuring that the implementation of the project is both financially and environmentally sustainable and achieves anticipated outcomes.

30. Overall, the expected project outcome is improved urban environmental services in Battambang Province. The project is anticipated to bring environmental benefits to the populations of the project service area and Battambang city in particular. It will serve to improve waste management in the town, reduce pollution impacts and provide long term urban environmental improvements, health benefits and promote sustainable city development.

31. The next step of environmental safeguards implementation is the preparation of the CEMP, which is to be based on the EMP, but is expected to include detailed measures to be implemented by the contractor. The CEMP will be the backbone of the environmental management system of the contractor and will be supported by associated subplans which will deal with specific topics, such as health and safety, waste management, soil and borrow sites management, traffic management, etc.

32. When operations will start, the operator shall also develop its own environmental management plan, specific to the operations.

33. Environmental assessment in Cambodia is governed by Sub-decree on EIA Process No. 72 (1999) and Declaration on Guideline for Conducting IEIA and EIA Reports No. 376 (2009). The MoE through its Environmental Impact Assessment (EIA) Department regulates and monitors the EIA Process. The project owner (public or private) is required to submit the necessary project document (IEIA/EIA report) to MoE for review and approval.

34. A meeting held between the MoE, MPWT and consultant teams for ADB projects on 06 December 2017 confirmed that this project requires and IEIA report by a registered authorized company in Cambodia. An IEIA for the subproject has subsequently been prepared and it was approved by MoE on 10 February 2021 (approval attached in Annex 7).

2. INTRODUCTION

2.1. Project Background and Location

35. A preliminary Feasibility Study (FS) was conducted in 2018 during a Preparatory Technical Assistance (PPTA) and this IEE has been completed in conjunction with the completion of the Detailed Engineering Design (DED) thereby ensuring consistency between the environmental measures and the engineering designs.

36. As described in the DED and in this IEE, the proposed landfill subproject is designed as a controlled engineered landfill located in an upland area currently used as a quarry/borrow pit. The site is located within Poar Svay Village, Ta Keam Commune, Banan District, Battambang Province. The location of the landfill was approved by MoE in February 2020.

37. The proposed site location is:

- Within an agricultural area, also presenting quarries and associated activities, where sparse houses can be found (there are houses located within 500 m of proposed site).
- About 3.5 kilometres from Poar Svay Village, Ta Keam Commune, where there are: houses, school, pagoda, health centre, water wells and ponds.
- About 3.5 kilometres from Road 1570.
- About 22 kilometres from Battambang town.

38. With a design period of 20 years, the project components/facilities were planned up to the year 2040, with initial construction designs focus on the period 2021 to 2030 which correspond to the construction a first landfill cell. The concept designs prepared during the feasibility study stage were updated and elaborated upon as the basis for preparing the detailed designs described herein. Investment works to be implemented for Battambang under TS-2 project comprises the following:

- Total landfill area is 25 hectares
- Project requires upgrading and elevating 420 m of the external access road to the landfill site, with levels to be above flood levels. (out of a total of 3.5 km of access road, which may be upgraded in the 2040 horizon).
- Construction of 1 (one) controlled landfill cell out of a total of 4 (four) cells with grading, drainage in site preparation, improved leachate and surface water management. The Initial Environmental Examination (IEE) covers the whole landfill site.
- Construction of 1 (one) hazardous waste landfill cell.
- Construction of leachate collection, storage, treatment system and recirculation system.
- Construction of concrete internal road and rainwater drainage system along with peripheral embankments.
- Construction of fencing and entrance gate.
- Construction of weighbridge and office building; staff dining and rest room; supply room; workshop, electrical and mechanical room.
- Construction of a non-mechanical materials recovery facility (MRF)
- Construction of hazardous waste storage facility.
- Construction of vehicle washing facility.
- Provision of operations & maintenance equipment.

39. Construction design of non-mechanical type material recovery facility (MRF)The closure of the existing dumpsite is also not included in this project, considering the presence of the MRF and of a composting plant on that site. The rehabilitation and closure of this site may be considered at a later stage and will be subject to a specific environmental and social due diligence.

40. Operations will entail:

- Regular (not daily) cover.
- Waste compaction.
- Leachate management
- Fencing.
- Basic record-keeping.
- Controlled waste picking.
- Gas management.
- Monitoring of groundwater.

41. The solid waste management subproject entails the construction of a new controlled engineering landfill but does not include the closure of the existing dumpsite in Battambang town, where activities related to MRF and Composting will remain. Eventually the closure of the dumpsite is expected to occur following the opening of the new landfill. This activity is expected to fall under the government responsibility. Closing of the existing landfill will entail detailed designs to plan closure and remediation, which requires surveys and further studies. However, these components are not covered under this subproject.

2.2. Objectives of IEE

42. This IEE was developed in conjunction with the DED ensuring consistency between environmental requirements and technical designs. The purposes of the IEE study are as follow:

- To understand the natural and social environments which are existing in the project area, through studying the physical environment, biological environment, and social environment prior to implementation of the project.
- To inform the project development activities to local agencies, affected people, and concerning parties to receive relevant information, key feedbacks, issues, and comments concerning the environmental and social safeguards or impacts and proposed solutions or responses.
- To assess the impacts on the environmental-social resources in and around project site by the proposed project activities in order to provide the mitigation measures or correcting actions.
- To assess and predict the impact on environmental and social resources during construction, operation, and after closure of the project.
- To extract valuable comments and experiences from ministries, related institutions, local authority, community, and stakeholders to improve the project activities with environmentally sound technologies.
- To develop an EMP for conducting implementation and monitoring on the project activities during all project phases.
- To ensure the project will contribute to economic development of Cambodia within a sustainable environment.

2.3. IEE Requirements

43. The project classification of environment category B has been confirmed during PPTA. This specific IEE covering only Battambang landfill sub-project has been prepared based on the detailed designs and information available at the PMC level. This IEE is completed by a separate EMP. The IEE and EMP have been undertaken in accordance with ADB

Safeguards Policy Statement (SPS) 2009, ADB Environmental Assessment Guidelines 2003, and Royal Government of Cambodia environmental requirements: Laws, sub-decrees, guidelines, and standards and will be updated where necessary to meet the final detailed designs.

44. The requirements for MoE approvals under Cambodian law are set out in detail in Section 3.1.2. An approved company registered with the MoE has prepared an IEIA for the proposed landfill project which was submitted to the MoE in July 2020 and subsequently approved by the Ministry on 10 February 2021.

2.4. Structure of the Report

45. This IEE report follows the format prescribed in ADB SPS 2009. For the purposes of this project, this is a consolidated IEE containing information for all subprojects including:

- The policy legal and administrative framework;
- A description of the project and subprojects;
- The environmental baseline for the project locations;
- Alternatives analysis for all subproject interventions; and
- Information on disclosure and consultation for this IEE.

46. Appendices to this report contain the EMP for landfill subproject, and existing dumpsite closure. The EMP is designed to aid the construction contractors and operators in management of environmental impacts and therefore contain:

- Brief subproject description.
- Institutional arrangements and responsibilities for EMP implementation.
- Summary of environmental impacts on key receptors.
- Mitigation measures for implementation during construction and operation.
- Monitoring requirements.
- Consultation requirements during construction.
- GRM; and
- Estimated costs of environmental safeguard measures.

47. In addition, the EMP also includes detailed receptor maps and site location maps to support the preparation of the Construction EMP (CEMP). The CEMP will be prepared and implemented by the contractor and shall include specific protection and monitoring measures.

3. POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

3.1. Environmental Assessment Requirements

3.1.1. Environmental Assessment Requirements of ADB

48. Safeguard requirements for all projects funded by ADB are defined in SPS 2009 which establishes an environmental review process to ensure that projects undertaken as part of programs funded through ADB loans are environmentally sound; are designed to operate in compliance with applicable regulatory requirements; and are not likely to cause significant environmental, health, or safety hazards. SPS 2009 is underpinned by the ADB Operations Manual, Bank Policy (OM Section F1/BP, October 2013). The policy also promotes adoption of international good practice as reflected the World Bank Group's Environmental, Health and Safety (EHS) Guidelines. This IEE is intended to meet SPS 2009 requirements.

49. SPS 2009 environmental assessment requirements specify that:

- At an early stage of project preparation, the borrower/client will identify potential direct, indirect, cumulative, and induced environmental impacts on and risks to physical, biological, socioeconomic, and cultural resources and determine their significance and scope, in consultation with stakeholders, including affected people and concerned nongovernment organizations. If potentially adverse environmental impacts and risks are identified, the borrower/client will undertake an environmental assessment as early as possible in the project cycle.
- The assessment process will be based on current information, including an accurate project description, and appropriate environmental and social baseline data.
- Impacts and risks will be analysed in the context of the project's area of influence.
- Environmental impacts and risks will be analysed for all relevant stages of the project cycle, including preconstruction, construction, operations, decommissioning, and post-closure activities such as rehabilitation or restoration.
- The assessment will identify potential transboundary effects as well as global impacts.

50. Other requirements of SPS 2009 include:

- Analysis of alternatives. There is a requirement to examine alternatives to the project's location, design, technology, and components and their potential environmental and social impacts including considering the no project alternative. SPS 2009 states that this is only for projects which have ''significant adverse environmental impacts that are irreversible, diverse, or unprecedented'' i.e., category A projects. This does not apply to this category B IEE but is included for completion.
- Environmental management plan. The borrower/client will prepare an EMP that addresses the potential impacts and risks identified by the environmental assessment.
- Consultation and participation. The borrower/client will carry out meaningful consultation with affected people and other concerned stakeholders, including civil society, and facilitate their informed participation.
- Information disclosure. Environmental information on the project, including the IEE and other safeguards information will be disclosed in accordance with ADB's Public Communications Policy (2011) and SPS (2009). This includes: (i) The EMP will be translated into Khmer language and be made available at each Provincial Department of Public Works and Transport (PDPWT); (ii) The IEE will be disclosed on ADB's project website (www.adb.org);

- GRM. The borrower/client will establish a mechanism to receive and facilitate resolution of affected people's concerns, complaints, and grievances about the project's environmental performance.
- Monitoring. The borrower/client will monitor and measure the progress of implementation of the EMP.

51. As stated in the "Guidelines for Climate Proofing Investments in the Water Sector: Water Supply and Sanitation, Climate Impacts", ADB (2016) there may be impacts from climate change on wastewater treatment and solid waste disposal. Warmer temperatures can mean (i) Increased operating challenges to biological and chemical processes of treatment facilities; (ii) Increased temperatures and increased evaporation in receiving water bodies, changing chemical balances and increased eutrophication; (iii) Reduced capacity to meet wastewater treatment requirements and standards. More frequent and/or intense extreme weather events can lead to (i) increased risk of direct flood damage to landfill site, treatment plant, pumping and conveyance, and outfall and (ii) Increased risk of untreated sewage overflows contaminating water supply sources.

52. These climate change risks are assessed in the project Climate Change Assessment and are reflected where appropriate in the project designs.

3.1.2. Environmental Assessments Requirements of Cambodia

53. Environmental assessment in Cambodia is governed by the following law and guideline document:

- Sub-decree on EIA Process No. 72 (1999). This law provides the detailed guidelines for implementation of the EIA Process. Its Annex requires the conduct of IEIA or EIA on the following activities under the Project: (i) waste processing, burning activities, all sizes; (ii) wastewater treatment plants, all sizes; (iii) drainage systems, >5,000 ha.

- Declaration on Guideline for Conducting IEIA and EIA Reports No. 376 (2009). This declaration specifies the basic contents of IEIA/EIA Reports, which should include: (i) introduction; (ii) legal framework; (iii) project description; (iv) description of the existing environment; (v) public participation; (vi) assessment of, and mitigation measures for, significant environmental impacts; (vii) environmental management plan; (viii) cost-benefit analysis; and (ix) conclusion and recommendations.

54. The Ministry of Environment (MoE) through its EIA Department regulates and monitors the EIA Process. The MoE is responsible for: (i) review and approval of IEIA/EIA reports in collaboration with other relevant ministries; and (ii) monitoring the EMP implementation of Project Proponents/Owners throughout the different project phases. MoE operates at the municipal and provincial levels through its Provincial Department of Environment (PDoE).

55. The project owner (public or private) is required to submit the necessary project document (IEIA/EIA report) to MoE for review and approval. After submission of IEIA/EIA report, it should take a maximum of 30 working days for a decision.

56. A meeting[1] held between the MoE, MPWT and consultant teams for ADB projects on 6th December 2017 confirmed that for the projects and their subprojects discussed, the following is required:

- EIA department agrees that this project needs to prepare IEIA report which can be informed by the IEE report and incorporate the additional baseline environmental survey (air and water quality) results.
- The IEIA report for landfills should be prepared in separate report from other subprojects.
- EIA department agrees with and supports the project and will facilitate MoE to give a general approval letter to MPWT after receiving IEIA report and request letter from MPWT.

57. A registered company, authorized to complete IEIA reports in Cambodia, is required to submit the IEIA report on behalf of the project owner, MPWT.

3.2. National Environmental Policies and Legislations

3.2.1. Legal Framework for Environmental Management

58. In 1993 the new Constitution of Cambodia included environmental considerations for the first time. Specifically, Article 59 states: ''The State shall protect the environment and balance of abundant natural resources and establish a precise plan of management of land, water, air, wind, geology, ecological system, mines, energy, petrol and gas, rock and sand, gems, forests and forestry products, wildlife, fish and aquatic resources''. This led to the establishment of the Ministry of Environment.

59. The hierarchy of legislation in Cambodia is:

- Royal Decree signed by the King;
- Sub-decree signed by the Prime Minister;
- Ministerial Decision signed by a Minister; and
- Regulation issued by a Ministry.

60. A Royal Decree ratifies laws passed by parliament. These can be supplemented by "Prakas" or ministerial decisions. These laws allow sub-decrees and regulations to be passed which can stipulate procedures and standards to be met in order to ensure compliance with the law. Many of these sub-decrees and standards have been drafted but have not yet been ratified by parliament.

3.2.2. Policies and Legal Instruments

61. Cambodia's main legal framework for addressing environmental protection, management of natural resources and public consultation is the Law on Environmental Protection and Natural Resource Management ('the Environment Law'), which was adopted in 1996.

62. The Environment Law has the following objectives:

- Protect and upgrade environmental quality and reduce pollution;
- Assess the impacts of proposed projects before approval;
- Ensure rational and sustainable use of the Kingdom's resources;
- Encourage public participation in environmental protection and natural resource management; and

[1] **Participants from MPWT and MoE**: 1. H.E Vong Pisith (PD), 2. Mr. Danh Serey (Head of EIA department), meeting held and MoE, Phonm Penh**.** Participants from consulting teams: 3. Mr. Taing Sophanara (Deputy Team Leader of 2nd GMS-CTDP2), 4 Mr. Srei Socheat (Deputy Team Leader Tonle Sap 1 Project), 5. Mr. Morm Deth, (Deputy Team Leader Tonle Sap 2 Project).

- Reduce activities which impact negatively on the environment.

63. Specific regulations and standards for environmental quality are contained in three sub-decrees:

- Sub-decree on Solid Waste Management (1999);
- Sub-decree on Water Pollution Control (2009); and
- Sub-decree on Air Pollution Control and Noise Disturbance (2000)

64. A summary of other legislative and policy instruments relevant to the project is presented in Table 2. A summary of national and international guidance for landfill site criteria are presented in Table 3. The key environmental quality standards applied to the EMP for this IEE are listed in Table 4 and presented in detail in Annex 1. The most stringent limit (national or international) shall apply.

Table 2: Relevant Laws, Regulations and Guidelines

Law/Regulation/Guideline	Year	Summary
Royal Decree on the Protection of Natural Areas	1993	Classified 23 protected areas in Cambodia into four categories: (i) natural parks; (ii) wildlife sanctuaries; (iii) protected landscapes; and (iv) multiple-use areas. Designated the Tonle Sap (316,250 ha) as a multiple-use area or area necessary for the stability of the water, forestry, wildlife and fishery resources, for tourism, and for conservation of long-term existing natural resources with a view to assure sustainable economic development.
Law on the Protection of Cultural Heritage (NS/RKM/0196/26)	1996	Regulates the protection of national cultural heritage and cultural property in general against illegal destruction, modification, alteration, excavation, alienation, exportation or importation. Its Article 37 stipulates that in case of chance find of a cultural property during construction, work should be stopped and the person who found the property should immediately make a declaration to the local police, who shall, in turn, transmit the property to the Provincial Governor without delay.
Labour Law (1997) Decree No. CS/RKM/0397/01	1997	This law governs relations between employers and workers resulting from employment contracts to be performed within Cambodia. The key sections relevant to this project include: Chapter VIII Health and Safety of Worker. The key provisions relate to the quality of the premises; cleaning and hygiene; lodging of personnel, if applicable (such as workers camp); ventilation and sanitation; individual protective instruments and work clothes; lighting and noise levels in the workplace. Article 230: Workplaces must guarantee the safety of workers. However, the only specific occupational health and safety Prakas relates to the garment industry and brick manufacture. Chapter IX Work-Related Accidents Article 248: All occupational illness, as defined by law, shall be considered a work-related accident. The law sets out how accidents should be managed in terms of compensation.
Sub-decree on Solid Waste Management (Sub-decree No. 36 ANK/BK),	1999	Article 1: Regulates solid waste management to ensure the protection of human health and the conservation of biodiversity through using appropriate technical approaches.

Law/Regulation/Guideline	Year	Summary
		Article 2: This sub-decree applies to all activities related to disposal, storage, collection, transport, recycling, dumping of garbage and hazardous waste. Article 4: The Ministry of Environment shall establish guidelines on disposal, collection, transport, storage, recycling, minimizing, and dumping of household waste in provinces and cities in order to ensure the safe management of household waste. The authorities of the provinces and cities shall establish the waste management plan in their province and city for short, medium and long-term.
Sub-decree on Control of Air Pollution and Noise Disturbance (Sub-decree No. 42 ANK/BK	2000	Regulates air and noise pollution from mobile and fixed sources through monitoring, curb and mitigation activities to protect the environmental quality and public health. It contains the following relevant standards: (i)) ambient air quality standard (Annex 1); and (ii) maximum allowable noise level in public and residential areas (Annex 6). Article 3 A. “Source of pollution” is defined and separates mobile sources (including transport) and fixed sources such as factories and construction sites. Article 3 B. “Pollutant” is defined as smoke, dust, ash particle substance, gas, vapour, fog, odour, radio-active substance.
Law on Land (NS/RKM/0801/14)	2001	Provides that: (i) unless it is in the public interest, no person may be deprived of ownership of his immovable property; and (ii) ownership deprivation shall be carried out according to legal forms and procedures and after an advanced payment of fair and just compensation. (Article 5)
Royal Decree on the Establishment and Management of Tonle Sap Biosphere Reserve (Royal Decree No. NS/RKT/0401/070)	2001	Establishes the Tonle Sap Biosphere Reserve (TSBR) in accordance with the statutory framework of the World Network of Biosphere Reserves. Divides the TSBR into 3 zones: (i) core areas; (ii) buffer zone and (iii) flexible transition zone. Core area: set aside for long term protection, human activity is limited to monitoring and research. Buffer zone: is area surrounding the core areas helping to protect the environment. It may accommodate education and training activities. Transition area: may contain a variety of agricultural activities and human settlements. Here all stakeholders have to cooperate to achieve sustainable development.
Environmental Guidelines on Solid Waste Management	2006	Contains a Landfill Ordinance that regulates landfill requirements to: (i) reduce as far as possible the adverse effects of waste disposal on the environment; (ii) preserve groundwater, surface water & air quality & to reduce emissions of greenhouse gases (iii) ensure waste is not harmful to human, natural & animal health during operation & decommissioning; and (iv) provide information and technical recommendation on the construction, operation and closing/follow-up management

Law/Regulation/Guideline	Year	Summary
		of landfills to ensure public health and safety and environmental protection.
Law on Water Resources Management (NS/RKM/0607/016)	2007	Requires license/permit/written authorization for the: (i) abstraction & use of water resources other than for domestic purposes, watering for animal husbandry, fishing & irrigation of domestic gardens and orchards; (ii) extraction of sand, soil & gravel from the beds & banks of water courses, lakes, canals & reservoirs; (iii) filling of river, tributary, stream, natural lakes, canal & reservoir; and (iv) discharge, disposal or deposit of polluting substances that are likely to deteriorate water quality and to endanger human, animal and plant health. (Articles 12 & 22) Its Article 24 stipulates that Ministry of Water Resources and Meteorology (MOWRAM), in collaboration with other concerned agencies, may designate a floodplain area as flood retention area.
Royal Decree on Protected Areas (Royal Decree No. NS/RKM/0208/007)	2008	Defines the framework of management, conservation & development of protected areas to ensure the conservation of biodiversity, & sustainable use of natural resources in protected areas. The Law gives the Royal Government of Cambodia the authority to establish or modify Protected Areas (Article 9 and 10). A Protected Area shall be established by sub-decree. Article 11 divides the protected area into 4 zones namely, core zone, conservation zone, sustainable use zone & community zone. Article 36 strictly prohibits all types of public infrastructure in the Core Zone & Conservation Zone; & allows development of public infrastructures in the Sustainable Use Zone & Community Zone with approval from the Royal Government at MoE's request. Article 41 provides for the protection of each protected area against destructive/harmful practices, such as destroying water quality in all forms, poisoning, using of chemical substances, disposing of solid and liquid wastes into water or on land. Article 44 requires all proposals & investments within or adjacent to protected area boundary an Environmental and Social Impact Assessment. The law defines Protected Area as **"***An area of the State's public properties in land or water territories, including coasts and sea, located in the area established by a Royal Decree or a new area established in the jurisdiction of the Ministry of Environment. These areas are of physical and biological importance which requires management by law with the purpose of protecting and maintaining biological, natural and cultural resources, and shall be sustainably managed in every generation for environmental, social and economic benefits*". Each protected area shall be divided into four (4) management zoning systems: **1. Core zone:** management area(s) of high conservation values containing threatened and critically endangered species, and fragile ecosystems. Access to the zone is prohibited except the Nature Conservation and Protection Administration's officials and researchers who, with prior permission from the Ministry of

Law/Regulation/Guideline	Year	Summary
		Environment, conduct nature and scientific studies for the purpose of preservation and protection of biological resources and natural environment with the exception of national security and defence sectors. **2. Conservation zone:** management area(s) of high conservation values containing natural resources, ecosystems, watershed areas, and Natural landscape located adjacent to the core zone. Access to the zone is allowed only with prior consent of the Nature Conservation and Protection Administration at the area with the exception of national security and defense sectors. Small-scale community uses of Non-Timber Forest Products to support local ethnic minorities' livelihood may be allowed under strict control, provided that they do not present serious adverse impacts on biodiversity within the zone. **3. Sustainable use zone:** management area(s) of high economic values for national economic development and management, and conservation of the protected area(s) itself thus contributing to the local community, and indigenous ethnic minorities' livelihood improvement. After consulting with relevant ministries and institutions, local authorities, and local communities in accordance with relevant laws and procedures, the Royal Government of Cambodia may permit development and investment activities in this zone in accordance with the request from the Ministry of Environment. **4. Community zone:** management area(s) for socio-economic development of the local communities and indigenous ethnic minorities and may contain existing residential lands, paddy field and field garden or swidden (Chamkar).
Sub-decree on Water Pollution Control (Sub-decree No. 27 ANRK/BK)	2009	Regulates activities that cause pollution in public water areas in order to sustain good water quality so that the protection of human health and the conservation of biodiversity are ensured. Its Annexes 2, 4 and 5 provide the industrial effluent standards, including effluent from wastewater stabilization ponds, water quality standards for public waters for the purpose of biodiversity conservation, and water quality standards for public waters and health, respectively.
Expropriation Law	2010	Defines the principles, mechanisms, and procedures of expropriation, and defining fair and just compensation for any construction, rehabilitation, and public physical infrastructure expansion project for the public and national interests and development of Cambodia.
Sub-Decree on Demarcation of 647,406 Hectare Flooded Forest Domain in Six Provinces adjacent to Tonle Sap Lake (Kampong Chhnang, Pursat, Battambang, Banteay Meanchey, Siem Reap and Kampong Thom) (Sub-decree No. 197 ANKr/BK)	2011	Stipulates a zoning system for the area between the national highways and the Tonle Sap Lake system and the nature of agriculture activities that are permitted and banned in each zone.

<table>
<tr><th>Law/Regulation/Guideline</th><th>Year</th><th>Summary</th></tr>
<tr><td>Prakas on the Launch of Standards of the Quantity of Toxins or Hazardous Substances Allowed to be Disposed</td><td>2015</td><td>This Parkas includes the standards of the quantity of toxic chemicals or hazardous substances contained in hazardous waste which is allowed to be disposed in sanitary landfills and standards of the quantity of toxic chemicals or hazardous substances allowed in soils. Any disposal of chemical waste or hazardous substances as stipulated in the Parkas out of sites determined by the ministry and competent institutions shall be absolutely prohibited and deemed as the infringement of law.</td></tr>
<tr><td>Guidance on Selection of Landfill Sites (2016)</td><td>2016</td><td>The Guidance sets out the requirements for site selection in terms of:
<table>
<tr><th></th><th>MoE Landfill site Requirements (2016)</th></tr>
<tr><td rowspan="6">Distance to Receptors</td><td>1 km from any residential property</td></tr>
<tr><td>3 km from any school/health centre/natural resources/ water source</td></tr>
<tr><td>5 km from any place of worship and resort</td></tr>
<tr><td>8 km from an airport</td></tr>
<tr><td>10 km from town centre</td></tr>
<tr><td>15 km from any heritage site</td></tr>
<tr><td rowspan="2">Hydrology</td><td>Not in a flooded area</td></tr>
<tr><td>Depth to Groundwater – More than 3m</td></tr>
<tr><td rowspan="6">Cell Design</td><td>Gas collection (flaring)</td></tr>
<tr><td>Leachate collection system</td></tr>
<tr><td>Leachate treatment (lagoon)</td></tr>
<tr><td>Clay liner ≥ 1m (first liner)</td></tr>
<tr><td>HDPE liner (second liner)</td></tr>
<tr><td>Permeable liner (third liner)</td></tr>
<tr><td>Drainage system</td><td>Depth 1m, width 0,6 m</td></tr>
</table></td></tr>
<tr><td>Technical Guideline on Garbage and Urban Solid Waste Management</td><td>2016</td><td>The technical guideline provides standards for all activities related to disposal, storage, collection, transportation, recycling, dumping of municipal and hazardous waste as well as management of final dumpsite (closing Landfill) and continued management. The technical guidelines list the</td></tr>
</table>

Law/Regulation/Guideline	Year	Summary
		requirements to be implemented within 90 days for landfill closing (e.g. monitoring, gas management).

65. Landfill Site Guidance. A meeting was held at MoE[2] Phnom Penh on 31-10-17 in order to discuss the application of the guidance for ADB projects. MoE advised the project team to follow the guidance where possible, but recognized it was not always possible given the very stringent requirements. MoE emphasized that groundwater protection was the main concern however the requirements could be applied pragmatically with MoE review of the landfill design before it is finalised.

66. A comparison of national and international landfill siting guidance is shown in Table 3 below. The table shows that the minimum distance to houses in any of the international guidance is 250 m (ADB and World Bank/IFC) however ADB guidance also refers to daily cover indicating that 250 m is appropriate for a site which has daily cover. The highest depth to groundwater in any of the international guidance is 1.5 m (World Bank/IFC). The Cambodian guidance is most stringent for distance to housing and depth to groundwater.

Table 3: Comparison of Landfill Selection Criteria

Source of Guidance	Residential Receptors	Water Receptors
International Solid Waste Association (ISWA) - Guidelines for Design and Operation of Municipal Solid Waste Landfills in Tropical Climates (2013).	Not located in the immediate proximity of occupied dwellings Minimum 500 m	No distance given
ADB – Integrated SWM for Local Governments., A Practical Guide (2017)	No residential development within 250 m	The site must be located in an area where the landfill's operation will not detrimentally affect environmentally sensitive resources such as aquifer/ groundwater
World Bank / IFC EHS Guidelines: Sanitary Landfill (2007)	Typically, further than 250 meters (for gas only, no mention of dust /odour)	A landfill should not be located within 300 m up-gradient of a perennial stream Groundwater seasonally high table level (i.e., 10 year high) should be at least 1.5 meters below
Cambodian Landfill Site Selection Guidance	1 km from residences	Out of flooded area Depth to ground water over 3 m

Table 4: Key National Environmental Standards

Environmental Issue	National Standard	International Standard
Ambient air quality	Annex 1, Ambient Air Quality Standard, of Sub-decree on Control of Air Pollution and Noise Disturbance, 2000	WHO Air Quality Guidelines, global update 2005

[2] Participants: HE Heng Nareth, Director General, General Directorate of Environmental Protection, MOE; HE Vong Pisith, Deputy Director General, MPWT; Mr Dy Kiden, Director, Department of Solid Waste Management, MOE; Ms Genevieve O'Farrell, Environmental Specialist, ADB; Ms Rachel Wildblood, Environmental Specialist, TS-1; Mr Teemu Jantunen, Resettlement and Social Development Specialist.

Environmental Issue	National Standard	International Standard
Noise	Annex 6, Max. Standard of Noise Level Allowable in the Public and Residential Areas, of Sub-decree on Control of Air Pollution and Noise Disturbance, 2000	WHO Guidelines for Community Noise, 1999
Groundwater quality	Drinking water Quality Standards, 2004	WHO Guidelines for Drinking-water Quality, Fourth Edition, 2011
Surface water quality	Annex 4, Water Quality Standards for Public Waters for the Purpose of Biodiversity Conservation, and Annex 5, Water Quality Standards for Public Waters and Health, of Sub-decree on Water Pollution Control, 1999	US EPA National Recommended Water Quality Criteria Mekong River Commission (MRC)_ Technical Guidelines for the Protection of Aquatic Life MRC Technical Guidelines for the Protection of Human Health
Effluent quality (including leachate)	Annex 2, Effluent standard (Discharged wastewater to public water areas or sewers), of Sub-decree on Water Pollution Control, 1999	IFC EHS General Guidelines, April 2007 IFC EHS Guidelines for Water and Sanitation, December 2007 IFC EHS Guidelines for Waste Management Facilities, December 2007

67. In terms of SPS 2009 requirements, during the design, construction, and operation of the project the borrower/client will apply pollution prevention and control technologies and practices consistent with international good practice, as reflected in internationally recognized standards such as the World Bank Group's Environment, Health and Safety Guidelines. These standards contain performance levels and measures that are normally acceptable and applicable to projects. When host country regulations differ from these levels and measures, the borrower/client will achieve whichever is more stringent. If less stringent levels or measures are appropriate in view of specific project circumstances, the borrower/client will provide full and detailed justification for any proposed alternatives that are consistent with the requirements presented in this document. These Environment, Health and Safety Guidelines are considered throughout the Environmental Management Plans for the sub-projects.

68. The design complies with IFC EHS requirements. Landfill gas collection has been installed, as per the Cambodian Municipality Solid Waste Management Guidelines. This is a passive system, using vertical gas vents. No flaring or recovery of gas is initially planned for. However, the overall landfill cell and gas collection approach has been designed so that can be converted to an active system, which includes an induced exhaust system and flaring.

69. The IFC EHS Guideline also states: "Install and regularly sample boreholes surrounding the landfill to monitor for migration of landfill gas". Sample boreholes have not been initially installed around the site to monitor the migration of landfill gas. However, these can be installed following the completion of landfill cells. Lateral movement of gas out of cells should not occur due to the design of a robust liner and final capping system. In the unlikely occurrence of gas outbreaks, the site is remote and gas is unlikely to cause hazards in adjacent properties.

3.3. International Agreements

70. Cambodia is party to the following international environmental agreements relevant to the Project: (i) UNESCO World Heritage Convention, 1991; (ii) Convention on Biodiversity, 1995; (iii) UN Framework Convention on Climate Change, 1995; (iv) Washington Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), 1997; (v) Ramsar Convention on Wetlands of International Importance,

especially as Waterfowl Habitat, 1999; (vi) Basel Convention on the Control of Transboundary Movements of the Hazardous Wastes and Their Disposal, 2001; (vii) Vienna Convention for the Protection of the Ozone Layer and its Montreal Protocol on Substances that Deplete the Ozone Layer, 2001, and all Amendments, 2007; (viii) Climate Change Kyoto Protocol, 2002; and (ix) International Tropical Timber Agreement, 2006.

Cambodia joined the UNESCO Network of Biosphere Reserves in 1997. It is committed to the Millennium Development Goals, the seventh goal of which is to "ensure environmental sustainability". It is among the 168 Governments that adopted the Hyogo Framework for Action 2005-2015, a 10-year global footprint for disaster risk reduction efforts, in January 2005. At the regional level, it ratified the following ASEAN Agreements: (i) on Transboundary Haze Pollution in 2006; and (ii) on Disaster Management and Emergency Response, which entered into force in 2009. At the sub-regional level, Cambodia, along with Lao PDR, Thailand and Viet Nam, signed the "Agreement on the Cooperation for the Sustainable Development of the Mekong River Basin" (or the Mekong Agreement in April 1995).

4. DESCRIPTION OF THE PROJECT

71. The proposed project includes the construction and operation of a new controlled landfill. The project does not include the closure of the existing dumpsite located on public land in Battambang Town as it will remain open considering the presence of the MRF and a composting plant[3]. These facilities will not be operated as part of the new landfill project. The project will also provide training to ensure sustainable operation and maintenance (O&M) of project facilities.

4.1. Background of overall project

72. Cambodia's population was estimated at 15.2 million in 2016, spread across 24 provinces, 26 cities and numerous district cities. While Cambodia remains almost 80% rural, urbanization is accelerating and is expected to reach 30% of the national total by 2030. In recent years, Cambodia's robust 7% economic growth has been driven by garments, construction and tourism. With an increasingly urban economy, urban services contribute to environmentally sustainable and inclusive growth through laying basic infrastructure for businesses and households, creating jobs, safeguarding the surrounding environment and ecosystem, and reducing exposure to flooding and other extreme events. They also contribute to the health, welfare and protection of Cambodia's people. Strong urban-rural linkages mean that developments in Cambodia's growing provincial cities like Battambang (Battambang Province) have significant spill over effects to rural areas, where poverty is more acute.

73. **Tonle Sap Lake.** The Tonle Sap Basin is home to about a third of Cambodia's population, and nearly half of the population depends on the lake's resources, particularly its fish, for their livelihoods. Rural-urban migration is occurring at unprecedented rates. Cambodia's urban population growth rate of about 4%, one of the highest in Southeast Asia, translates into significant growth in the basin's cities. The project area is largely rural. Population of Battambang town as of 2018 was 163,347 and the population of the surrounding areas were estimated at 56,207. The town like the other ones in the Ton le Sap basin is key for economic growth and their development is linked to the surrounding Tonle Sap lake environment. The basin's urban areas are also sensitive to climate change, as they are located next to rivers and most experience flooding during the wet season.

74. **Access to services.** At present, solid waste services in urban area (excluding Phnom Penh) is inadequate. More than 75% of households in Cambodia's urban areas (excluding Phnom Penh) do not have access to solid waste services. The main reasons for these service delivery gaps are (i) inadequate coverage and delivery of urban environmental infrastructure and services; (ii) inadequate management of public investments, and (iii) poor urban planning that doesn't consider environmental management and climate change events.

75. **Institutional arrangements.** The MPWT is responsible for asset creation for urban sanitation, with the PDPWT responsible for operations and maintenance. Solid waste management is the responsibility of the city, although in practice the role of the city versus the MoE is not always clear. Due to limited technical capacities at the provincial and municipal level, MPWT continues to be involved with the construction of large-scale infrastructure including controlled landfills.

76. **The Project**. General observations indicate that the expansion in infrastructure and service provision has not been matched by equitable distribution, with disproportionate access in the capital region and certain municipalities. In order to contribute to the provision of a quality urban environment to this fast-growing urban population, including

[3] https://www.adb.org/projects/documents/cam-43319-033-iee-0

in secondary urban centres, the Second Urban Environmental Management in the Tonle Sap Basin Project will support the government of Cambodia in improving urban services and enhancing climate and disaster risk resilience in participating towns in the Tonle Sap Basin like in Battambang Town.

4.2. Project Impact, Outcome and Outputs

77. The expected project impact is sustainable, inclusive, equitable and resilient growth:

78. **Output 1: Improved urban services.** The project will finance the construction of the first cell of a controlled landfill in Battambang Town, Battambang Province and therefore improve the environmental situation related to waste disposal.

79. Projection of waste quantity to be disposed of at new landfill have been calculated during the design stage by the PMC team. The service area for Battambang landfill includes the ten sangkats in the municipality (Kdol Doun Teav, Slaket, Chamkar Samrong, Ou Char, Toul Ta Ek, Svay Por, Rattanak, Prek Preah, Sdach, Ou Mal and Wat Kor) and districts adjacent to the municipality as indicated on the map in Figure 9. Based on population projections, the amounts of waste to be disposed at the landfill until 2040 has been estimated to be 1,048,284 tons of waste, equivalent to 992,787 m^3 (Source: PMC, DED report, October 2020).

80. **Output 2: Improved institutional effectiveness.** The project will strengthen institutional effectiveness by: (i) improving staff capacity in critical areas (including improved urban service delivery, O&M of urban facilities, public private partnerships (PPPs) and other institutional arrangements); (ii) supporting the establishment of urban service units; and (iii) providing dedicated consultant support for project management. As a long-term contribution to the sector, the project will promote gender inclusivity and finance scholarships in civil engineering.

81. **Output 3: Improved policy and planning environment.** The TS-2 project will develop urban development strategies and master plans for the concerned cities. It will develop a road map for financial sustainability for solid waste management (including a proposed road map and arrangement for tariffs, and mechanism for ensuring household connections). It will build community awareness on the benefits of proper sanitation and safe disposal of solid waste.

4.3. Existing Situation of Solid Waste Management in Battambang

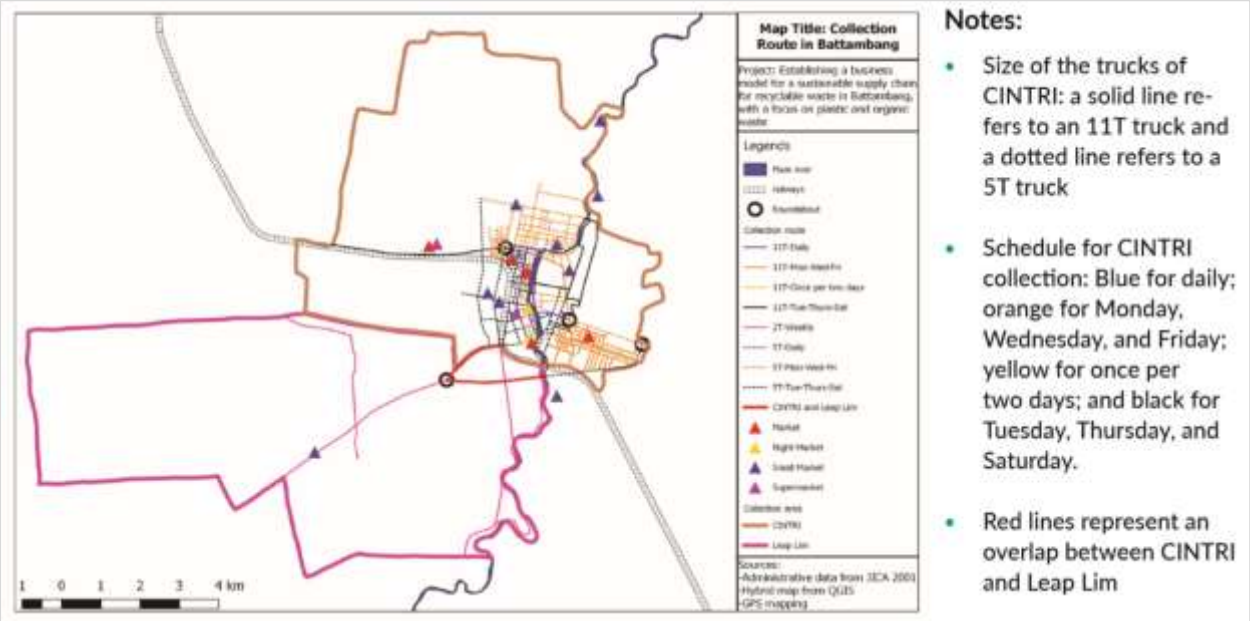
4.3.1. Waste Collection

82. Based on the 2018 census, Battambang has a total population of 163,347. Following discussions with the PIU and further analysis of the sangkats to determine the efficiency of collection services based on the rural/ semi-rural nature of the sangkats, the PMC team have estimated the total population covered by solid waste services in the municipality at 93,743, which is 57% of the total population. Currently, waste collection frequency is twice a week and daily waste collection is estimated at 200 tons. There is no weighbridge facility in the town to verify the amount of waste collected per day. For the collection of waste, a monthly charge of 1-1.5 US $ /household is levied.

Based on a survey conducted during the PPTA stage on existing waste management system within the serviced area, the following information were collected (Source: TS-2 – Feasibility Study Vol 2 Engineering concept designs). The main haulage company is CINTRY, which is a large waste collection firm operating in a number of larger cities in Cambodia. The current truck fleet operated by CINTRI is a mixture of refuse compactor vehicles and a hook lift truck. The CINTRY is collecting mixing wastes in 08 Sangkats

namely: Svay Poa, Or Char, Kdol Daun Teav, Slaket, Chamkar Samrong, Rottanak, Prek Preah Sdach, Toul Ta Eak ().

Figure 1: Waste collection schedule in the serviced area



Source: PIU, 2020

83. The second firm is LEAP LIM, a smaller haulage company that only collects waste from two of the predominantly rural sangkats using one 6 X 4 and one 4 x 2 open tip truck. The LEAP LIM is collection wastes in 02 Sangkats: Omal and Watkor, the LEAP LIM is responsible for clean-up and collection of waste in public areas. A collection waste route map is not available, but waste is collected once a day along National road number 5, the road to Bavel, the road to the train station and the road to Wat Chrouy Mates pagoda.

84. At PPTA stage, Government officials and municipal representatives noted that many households would rather self-dispose of waste through burial, burning or illegal dumping into either waterways or vacant properties, instead of paying the small fee to the haulage company for removal of their waste. At present, the municipality and agencies merely encourage householders to utilise the collection services and are not actively undertaking educational campaigns nor initiating punitive approaches to non-compliance such as illegal dumping and littering.

85. Battambang city centre is only approximately 4 km from the current dumpsite so quick turnaround is possible, meaning that up to 4 loads a day in the small compactor vehicles is an average. The prefeasibility study estimated the density of uncompacted waste between 150 and 300 kg/m^3.

86. According to Sub-decree on Solid Waste Management (Sub-decree No. 36 ANK/BK) Article 5, the collection, transport, storage, recycling, minimizing and dumping of waste in the provinces and cities is the responsibility of the authorities of provinces and city. The implementation shall comply with Environmental Guidelines on Solid Waste Management (MOE, 2006).

87. **Hospital waste**. Ten hospitals, nine clinics, and seven public health centres are situated in the town. At present, there is no proper hospital waste management system in the town and therefore it is expected that most waste ends up at the existing dumping site.

88. The local hospital has a new incinerator provided by JICA and manages their own medical waste. However, the municipal and agency officials noted that the health clinics and individual doctor surgeries do not take their medical waste to the hospital for incineration,

and merely mix it with the general waste generated at these locations. Appropriate education plus front-end controls and checking mechanisms will therefore be essential at the new landfill to ensure appropriate management of these and other special wastes. Waste piles at the current dumping site were inspected and no medical waste was observed. Hospital waste (biomedical waste) will not be accepted at the new landfill as per Sub-decree on Solid Waste Management (Sub-decree No. 36 ANK/BK) and this waste must be burnt at the incinerator.

89. **Commercial waste**, including market waste, is placed into hook lift bins. This is a very common approach and is supported for such a community. Moreover, there are twenty-one handicraft industries in the town. There is no major industry within the city that produces large quantities of special or hazardous waste. There are essentially cottage-based food processing operations, but these would not produce significant quantities of special or hazardous waste.

90. **Construction and demolition waste** is not collected by neither CINTRY nor LEAP LIM. This waste is either repurposed and used by the contractor on-site, or self-hauled to be used as non-structural fill. The improved waste collection system will need to account for this as particularly construction waste can have significant quantities of potentially toxic material, such as partially used solvent and paint containers.

In summary, it was noted during PPTA that whilst the current collection efficiency is only limited, the city remains relatively litter free. It was also observed that the major waterways locally were not overly filled with waste as is often the case in a city where the collection service efficiency is sub-optimal.

4.3.2. Waste Dumpsite

91. In Battambang, waste is delivered to one dumping site located north west of Battambang town, in Slaket Commune, partially on private land. The site covers an area of 8 ha with a depth of 6 m. The site has been in operation for the last ten years. It is operated by CINTRI which has a contract running to 2027. The government owns 2 ha and CINTRI owns the other 6 ha.

Figure 2: Location of Existing Dumpsite in Battambang town

92. The site is located in a semi-rural area, surrounded by fields but located only approximately 200 m from the edge of a residential area and a river is located 1.2 km from the site and therefore does not satisfy the Cambodian landfill siting criteria.

93. Disposal consists of crude dumping method in the existing dumpsite. It is a large uncontrolled open dump with no evidence of planned cell staging, stormwater diversion, mound shaping, compaction nor soil covering, as well as a complete absence of any leachate or landfill gas interventions. Most of the waste piles are 2 to 3 m above natural ground level with the highest waste areas being up to 4 or 5 m above the surrounding area. The waste height could easily be increased by many metres to provide steep batters and thereby minimize rainfall infiltration and subsequent leachate generation, as well as greatly increasing the overall site life. Overall, the dumping site is being operated as an uncontrolled dump and is resulting in significant socio-environmental impacts, both locally and downstream, and needs to be rehabilitated.

94. Spontaneous burning of waste was also observed at the landfill site.

Figure 3: Existing Dumpsite - Dumping area

95. There is a compost plant operated by the Cambodian Education and Waste Management Organization (COMPED) within the site. Four tons of solid waste from local markets are composted daily at the facility. In addition, one MRF is also present at the site.

Figure 4: Composting plant at the existing dumpsite

96. The Battambang MRF is located on an area of 1,350 m^2. The MRF is adjacent to the COMPED composting facility and the existing dumpsite operated by CINTRI (Cambodia) Ltd. that has a long-term contract with the provincial Government on waste collection in the urban areas.

97. The MRF is designed to only accommodate dry-source segregated wastes such as plastic bottles, tin cans, glass, metal containers, cardboard and paper, among others. The facility is not designed to accept mixed and hazardous wastes.

98. The MRF is fully manual sorting aided by payloader for movement of waste and recyclables and by a baler for compaction of the recovered materials. The facility can receive and manually process at least 60 m^3 of dry, source segregated non-biodegradable waste and truck sorted recyclable materials per day using a team of 30 pickers.

99. Informal waste pickers were observed in the landfill site picking recyclable materials. 40 waste pickers work at the existing dumpsite, out of which 16 waste pickers actually live on the existing dumpsite.

Figure 5: The Materials Recovery Facility at the Existing Dumpsite

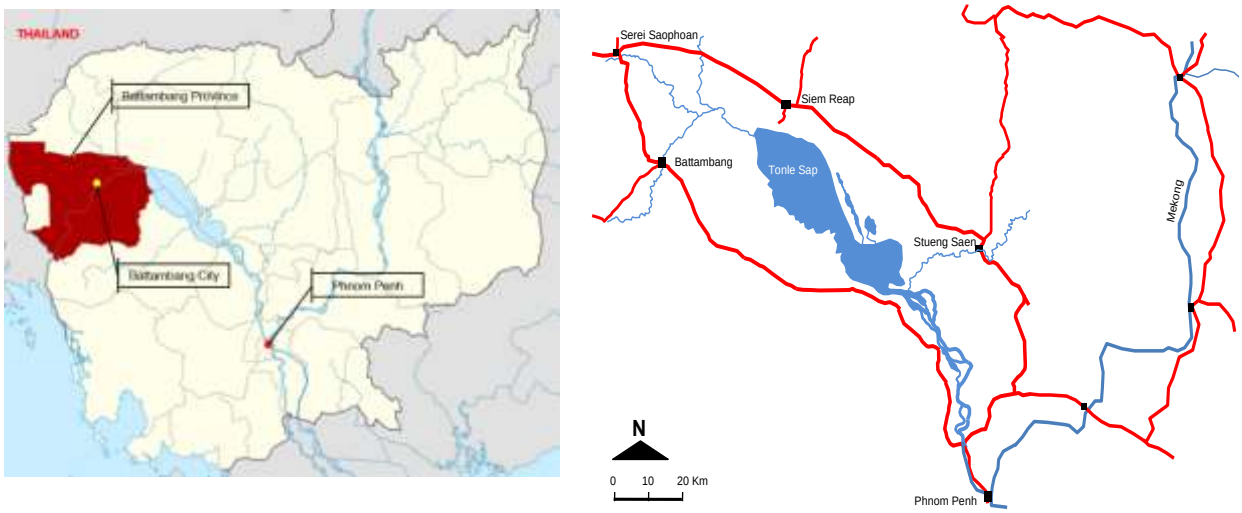
100. The existing dumpsite is impacting on the environment primarily through uncontrolled discharge of leachate which may reach water bodies, and through contamination of land with substances from decomposing waste. In addition, dumpsite fires cause localized air pollution and impacts on human health, particularly for waste pickers and residents near the site.

101. There is no environmental monitoring conducted at the existing dumpsite.

4.4. Project Location

102. The Landfill project is to be located near Battambang town, in Battambang province. Battambang is the capital city of Battambang province in north-western Cambodia, a leading rice growing area. Battambang is one of the country's most populated cities and is located approximately 300 km from the capital, Phnom Penh, which can be accessed via National Road No. 5. The city is situated on the Sangkae River, a tributary to Tonlé Sap Lake. Battambang is a main hub connecting Cambodia and Phnom Penh to Thailand, via road and rail networks.

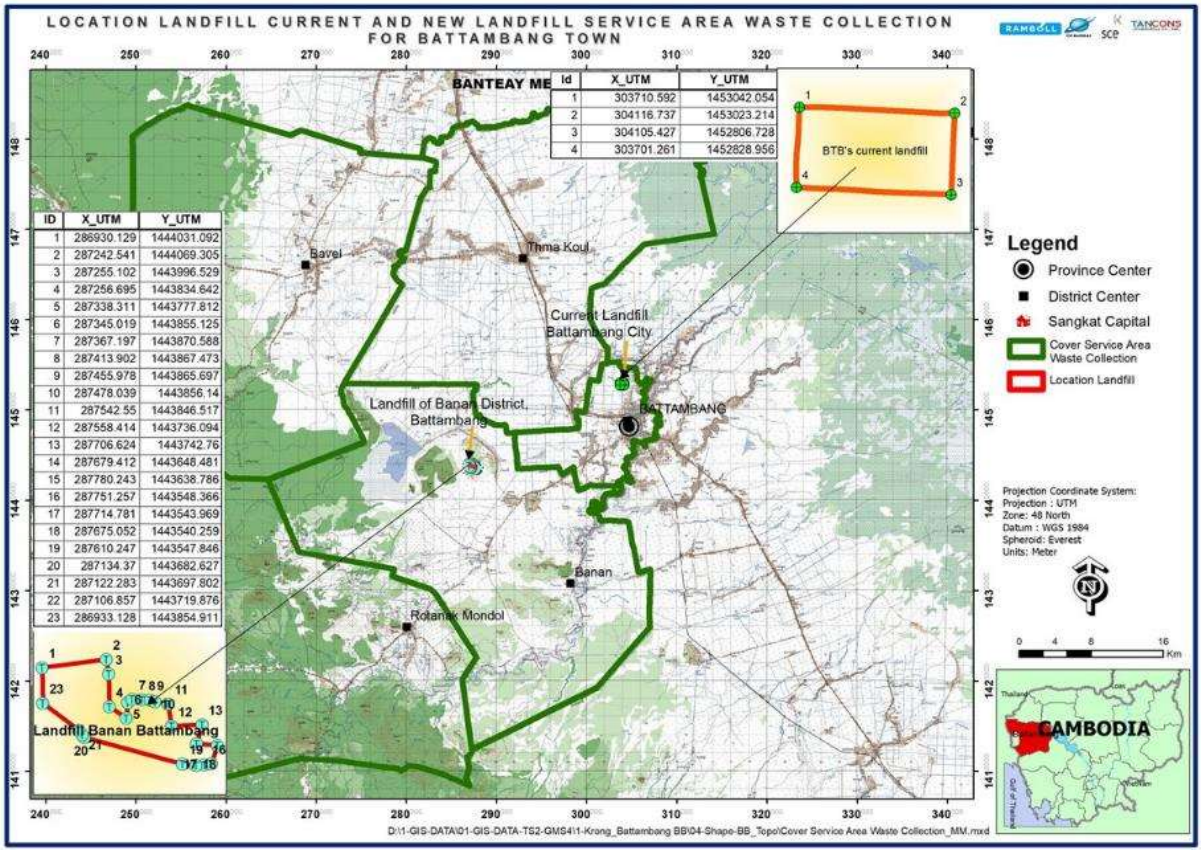
Figure 6: Location of Project Urban Centers of TS-2



103. The site is different from the ones initially proposed at the PPTA stage. The landfill is located 23.5 km from the centre of Battambang. It takes approximately 40 minutes to drive from the centre of the city to the site. Access to the site is achieved along the tarmacked National Highway 57 and then on dirt roads.

104. There is currently a reasonably large volume of lorries that utilise the route in order to access the quarries that are in the area. 3.5 km of access road will be upgraded from National Highway 57 (the first phase of the project will upgrade 420 m out of the 3.5 km access road). The site is approximately 20 kilometres from the nearest airport at Battambang.

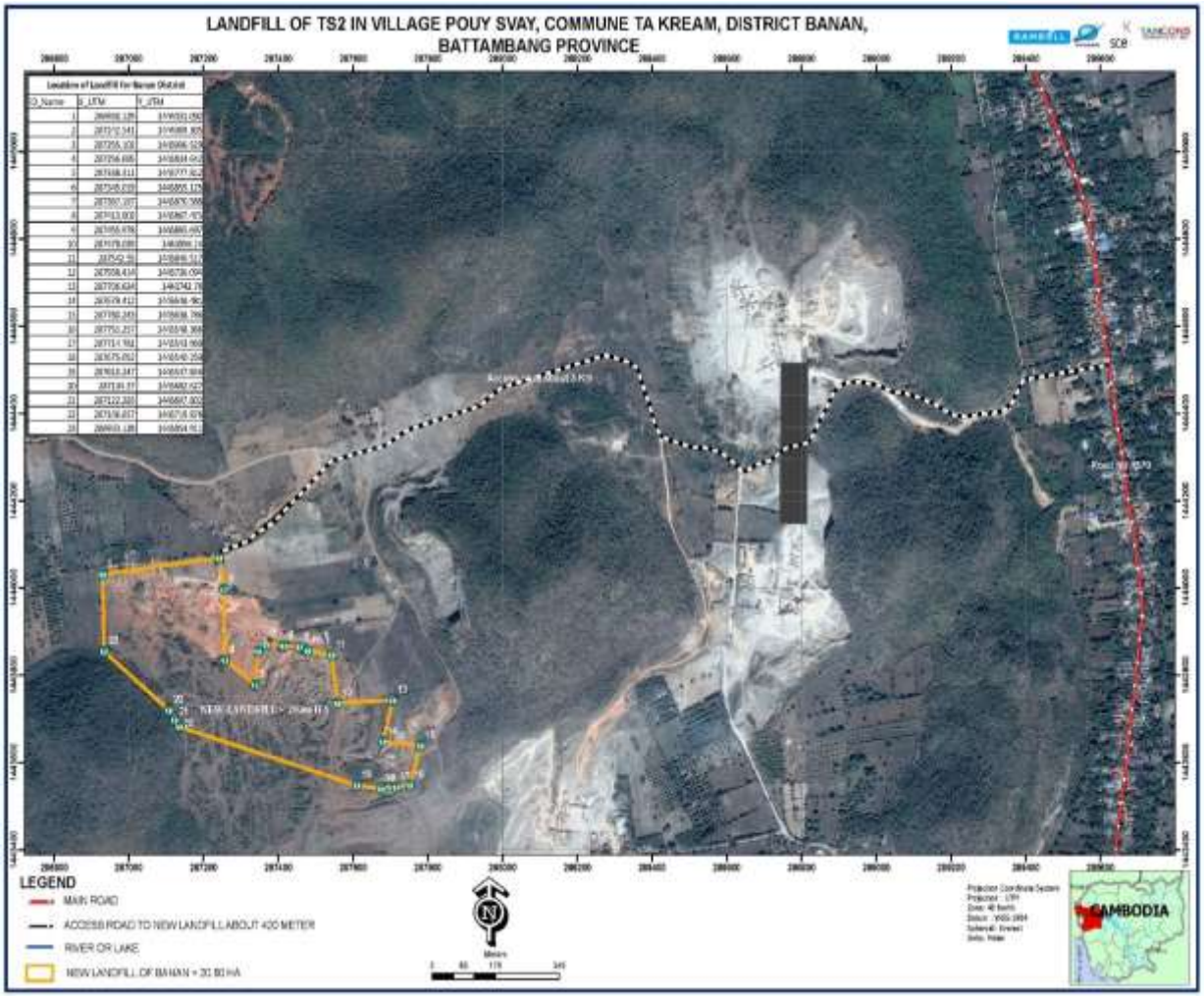
Figure 7: Location of Landfill site and proposed service area



Id	X_UTM	Y_UTM
1	303710.592	1453042.054
2	304116.737	1453023.214
3	304105.427	1452806.728
4	303701.261	1452828.956

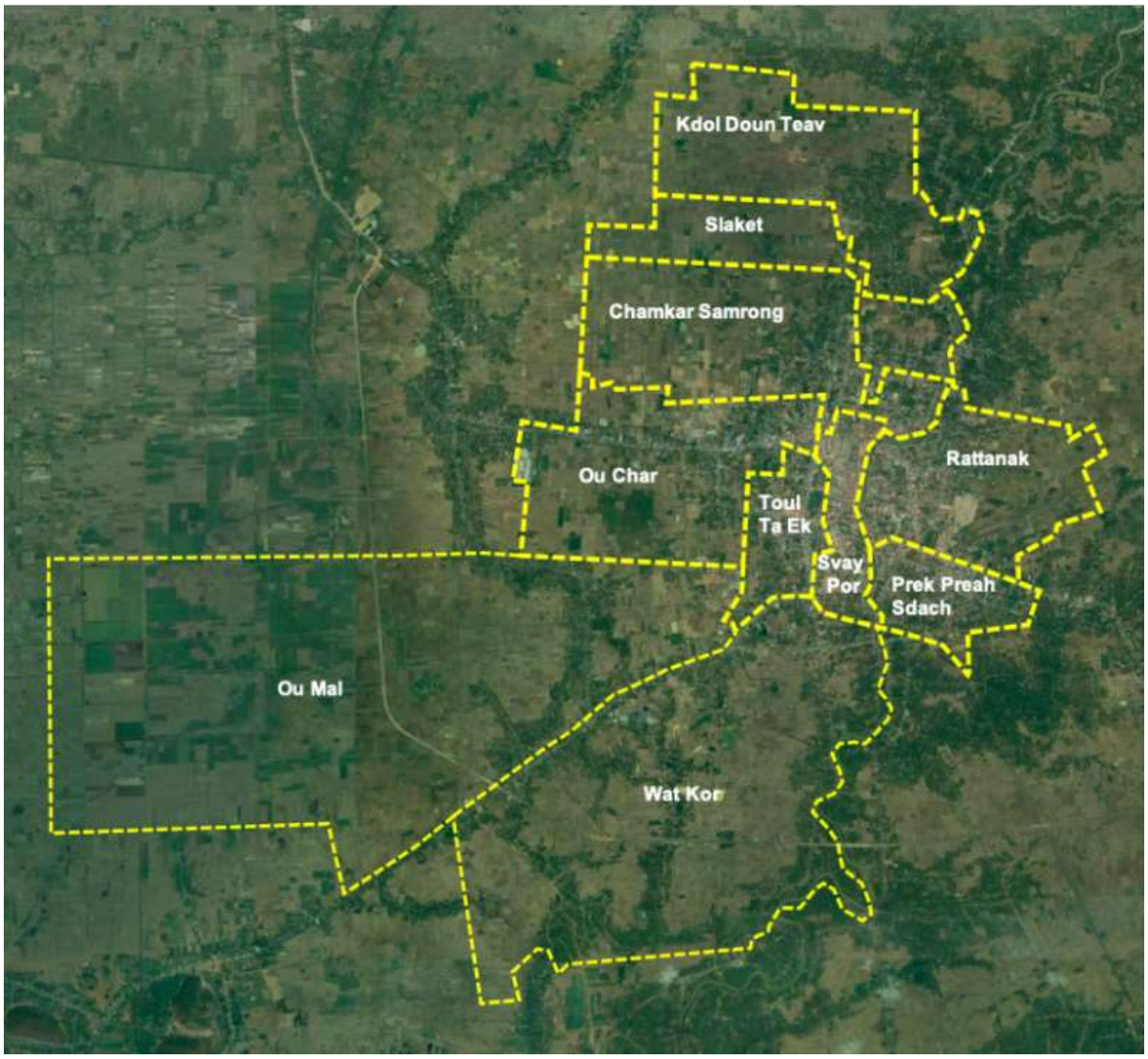
ID	X_UTM	Y_UTM
1	286930.129	1444031.092
2	287242.541	1444069.305
3	287255.102	1443996.529
4	287256.695	1443834.642
5	287338.311	1443777.812
6	287345.019	1443855.125
7	287367.197	1443870.588
8	287413.902	1443867.473
9	287455.978	1443865.697
10	287478.039	1443856.14
11	287542.55	1443846.517
12	287558.414	1443736.094
13	287706.624	1443742.76
14	287679.412	1443648.481
15	287780.243	1443638.786
16	287751.257	1443548.366
17	287714.781	1443543.969
18	287675.052	1443540.259
19	287610.247	1443547.846
20	287134.37	1443682.627
21	287122.283	1443697.802
22	287106.857	1443719.876
23	286933.128	1443854.911

Figure 8: Location of Landfill Sub-Project of Battambang Town



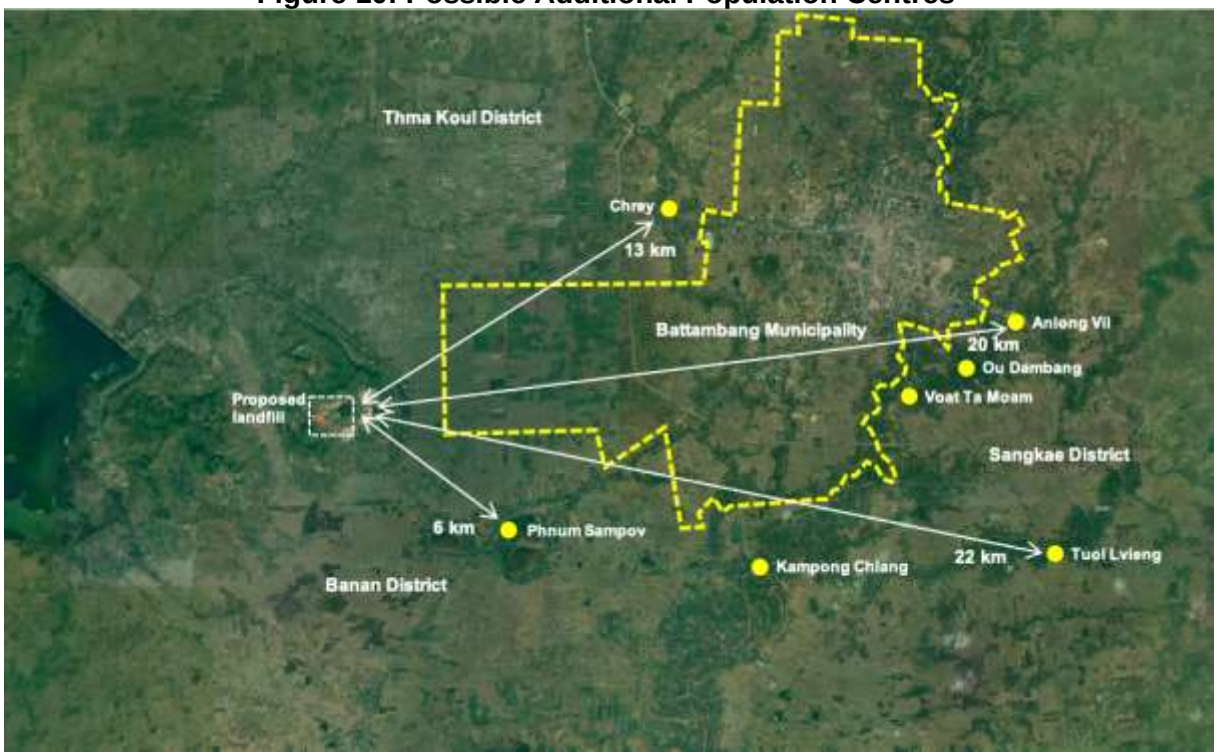
105. Initially the service area for solid waste collection for this sub-project was defined by the PIU as the ten sangkats in the municipality as shown in Figure 9. DPWT Battambang have requested consideration of extending the waste collection services to districts adjacent to the municipality. As the landfill is to the southwest of the urban area the areas that could potentially be included in the service areas are those to the west and south of the municipality. These are in the districts of Thma Koul, Banan, and Sangkae (Figure 10).

Figure 9: Proposed Service Area for Battambang town



Source: PMC team – DED report September 2020

Figure 10: Possible Additional Population Centres



Source: PMC team, DED report Battambang Landfill, draft version September 2020

4.5. Design considerations for the future landfill

4.5.1. Design Concept

106. The project is designed to service the main urban areas of Battambang, as well as some adjacent districts as shown on figure above. The PMC team has reviewed the PPTA population projection for Battambang, and the anticipated service areas for waste collection. Population projections for the service areas have been updated using the base population of 2018.

107. **Design Aim:** The proposed landfill is designed to provide for the safe disposal of waste by providing effective control measures to prevent or reduce as far as possible negative effects on the environment, in particular the pollution of surface water, groundwater, soil and air, as well as the resulting risks to human health arising from landfilling of waste. The design approach has taken into account Cambodian, ADB, and international guidelines, in order to provide the most cost-effective solutions that take into account Cambodia's climate, local conditions, and operational capacity.

108. **Landfill Life:** This disposal facilities have been planned for an initial 10-year period from 2021 to 2030, with further provisions for a full 20-year period up to 2040. It is estimated that available space will allow for another two years life beyond this planning horizon, to approximately 2042. Although waste volumes may change during this period and it is recommended that updates on predicted lifespan are calculated on a regular basis.

109. With a design period of 20 years, the project components/facilities were planned up to the year 2040.

110. **Service area**: As mentioned above; the service area for solid waste collection for this sub-project includes the ten sangkats in the municipality[4] and districts adjacent to the municipality (Table 5).

Table 5: Service area Population in 2018

	Sangkat	Population 2018 (CDB)	% Serviceable	Service Area Population 2018
	Total Battambang CDB	**163,347**	**57%**	**93,373**
Population Centres Adjacent to Municipality	Phnum Sampov	13,827		
	Anlong Vil	9,026		
	Voat Ta Moem	8,606		
	Ou Dambang	6,472		
	Tuol Lvieng	9,180		
	Kampong Chlang	9,096		
	Total	**56,207**	**60 % (est.)**	**33,000**
TOTAL SERVICE AREA		**219,554**		**Ca. 126,000**

Source: PMC team, DED Draft report

111. These estimates give a current total service area population (municipality and expanded areas) of approximately 126,000, which is 57% of the total population. In due course the collection operators will establish agreed routes and coverage, but the above total has been used for the purposes of planning the landfill capacity.

112. The service area is based on the use of standard waste collection trucks. It is expected that the service will be expanded in the future with the use of smaller vehicles and transfer stations. The latter might be small community collection points, as well as major transfer stations.

113. Population growth has then been estimated using projections based upon historical population growth in recent years in the sangkats. A medium annual average growth rate of 1.7% has been used for 2020-2040.

114. **Expected Waste Input:** The current and projected amount of waste to be collected and disposed into the landfill cells have been estimated. It is estimated that 78 tons per day will be disposed of in the landfill cells in 2021, and it will reach 266 tons per day in 2040.

115. **Density of Deposited Waste:** Landfill waste density of 850 kg/m^3 has been used for estimation of the capacity of the landfill. World Bank[5] guidelines recommend a final solid waste density of 800-1,000 kg/m^3 for developing countries (Table 6).

Table 6: Design Hypotheses for Battambang Landfill

	2018	2040
Population	219,554	318,128
Service Area Percentage Coverage	57%	95%
Service Area Population	126,000	284,904

[4] Kdol Doun Teav, Slaket, Chamkar Samrong, Ou Char, Toul Ta Ek, Svay Por, Rattanak, Prek Preah, Sdach, Ou Mal and Wat Kor

[5] World Bank (2004), “Sanitary Landfill Design and Siting Criteria”, Washington DC, USA.

	2018	2040
Waste per Capita	0.95 kg/cap/day	1.35 kg/cap/day
Total Waste Volume Generated in Service Area	88,047 kg/day**	358,424 kg/day
Collection Rate	80%	90%
Collection Amount	70,438 kg/day	322,581 kg/day
Waste Diversion rate	10%	30%
Waste Diversion Amount	7,044 kg/day	107,527 kg/day
Waste Amount to Landfill	63,394 kg/day	225,807 kg/day

Source: PMC team, Draft DED report September 2020

* Diversion: Percentage of waste recovered or recycled through MRF. Note: Initial percentages were based on ADB recommendations. It is envisaged that there will be significant increases in recovery of recyclable and biodegradable material.

** An initial compaction rate of 850 kilograms per cubic metre was considered.

116. The exact level of commercial waste from businesses, restaurants, markets and retail is unknown, since the waste collection service is user paid and optional. The pre-feasibility study undertaken by the Cities Development Initiative for Asia program estimated for all municipalities that the commercial waste generated is 30% of the household waste. However, it is estimated that currently only 80% of this waste is collected. The estimations in this report take a lower value for commercial waste of 20%, noting that there is no major commercial activities in the city, and taking into account the fact that in Phnom Penh it is estimated that commercial waste is 25% of residential waste.[6]

117. The total tons of waste that are estimated to be sent to the landfill, from both household and commercial sources, is estimated in Table 7:

Table 7: Total Waste to Landfill

Year	Household	Commercial	Total
2021	67	11	78
2030	103	18	121
2040	226	41	266

Source: PMC team, DED report September 2020

118. **Physical Composition of Waste:** A detailed composition study of the waste generated in Battambang has not been conducted. Table 8 shows the results of various solid waste management studies in Cambodia from which the waste composition for the serviced area (Table 5) has been extrapolated. In general, the biodegradable components make up at least 60% of the waste. The remaining 40% corresponds to the potentially recyclable and residual non-biodegradable waste.

[6] Yim, M., Fujiwara, T. and Sour, S., (2014). A study of commercial solid waste generation and composition in Phnom Penh City, Cambodia. *J Nat Sci Res*, *4*(13), pp.49-54.

Table 8: Physical Composition of Solid Waste

Waste Type	CDIA PFS	Cambodia
Food Waste & Green Waste	61%	50-63%
Paper and Cardboard	5.3%	2-6%
Plastic	13.5%	3-15%
Textiles	3.7%	1-4%
Glass	2.6%	1-8%
Metal	0.6%	0.6-8%
Wood	3%	-
Soil and Dirt	2%	10-30%
Miscellaneous	2%	2-8%

Source: ADB, 2018

119. Following initial deposition, over subsequent days, weeks, months and years, settlement will occur in the wastes at a landfill. These processes include immediate settlement through compression and expulsion of air; primary settlement through consolidation; and secondary settlement over the long term through mechanical creep (including ravelling) and biodegradation. Due to the high amount of biodegradable material in Cambodia's waste streams (in excess of 60%) it is suggested that there may be a high level of settlement, and that final compaction rates of 1.1 tonnes/m^3 may be achieved. As such, it is recommended that the waste cells are 'overfilled' by 20%.

120. Based on waste collection projections, and waste composition, the PMC team has updated the capacity of the landfill required for the next twenty years (Table 9).

Table 9: Proposed Capacity of Landfill for Battambang

	2018	2030	2040
Population of Service Area	219,554	268,777	318,128
Cumulative Tons of Waste	0	354,569	1,048,284
Space utilised in Landfill (after compaction & settlement)	**NA**	**356,655 m^3**	**992,787 m^3**

4.5.2. Climate Change Adaptation

121. Incorporation of a Pilot Program for Climate Resilience (PPCR) is an integral part of the TS-2 Development Project. Possible impacts of Climate change were taken into account in the proposed designs.

Possible Impacts of Climate Change

122. The climate resilience measures of the proposed infrastructure investments under the Project are intended to address the following possible future events, articulated under the

Strategic Program for Climate Resilience, prepared for the PCCR, Royal Government of Cambodia, Asian Development Bank, 2011:

123. According to the latest technical assessment, Cambodia's temperature has been rising steadily over the past 50 years. The average temperature has increased since 1960 by 0.8°C, and the frequency of unusually hot days and nights has increased. A further 0.3 to 0.6°C increase is expected by 2025, and some studies suggest temperatures may increase from 0.7°C to 2.7°C by the 2060s. All climate change models agree that average rainfall in Cambodia will increase, but the magnitude of change is uncertain. Estimates of the increase vary from as little as 3% to as much as 35% by the year 2100. Mean annual rainfall is predicted to increase, with the most significant increase in the wet season. In contrast, water flows in the dry season are predicted to decrease.

124. The urban area of Battambang is undergoing a process of urbanization, which is expected to accelerate with the increasing trade and traffic flows in the Tonle Sap basin. The inability of the carrying capacity of the present storm drainage systems coupled with future climatic events such as increased precipitation during the rainy season and possible occurrence of cloudbursts due to increased urban heat islands in these cities would cause sudden heavy rainfall which if not foreseen in the design and construction of urban infrastructures would lead to severe flooding in just a short time causing physical and economic losses. In addition, the absence of allowances for climate resilience measures for flooding in other urban infrastructures such as flood control and wastewater treatment would also cause these facilities to discontinue their operation and/or function and would hamper the services they are supposed to render to the local inhabitants.

Incorporating Climate Resilience Measures in the Design

125. This subproject supports climate resilience in Battambang by introducing the following measures:

- Landfill gas collection systems have been designed to allow for future retrofitting active systems and flaring of gas, including methane, a powerful greenhouse gas.
- The finished ground level of all the construction is considered to be above the flood level.
- Plinth level of all construction is kept above flood level.
- Embankments and interceptor surface water drainage has been utilised around the landfill, providing protection against storm events.
- All sidewalls and roofs are designed to withstand high wind velocity and storms up to 260 km/h.
- Concrete roads are introduced to avoid vehicle penetration in the ground.
- Leachate collection and treatment lagoons can take high volumes of wastewater in case of extreme events.
- The highest rainfall amount in the last 10 years has been considered towards the design of leachate collection and the rainwater discharge system.
- Cells have a single composite liver to avoid percolation of leachate into the groundwater.
- Staff and workers' restroom with bathing and toilet facilities are provided to provide comfort to the workers during extreme weather. Staff to have adequate PPE.

4.6. Landfill Site Description

126. An alternatives analysis (see section 7) concluded that a controlled landfill was the lowest life-cycle cost solution, which, in the local context, has most of the environmental and operational benefits without the technical complexities of a fully engineered sanitary landfill.

127. The landfill project incorporates the following features:

- **Upgrade and elevation of the 420 m access road to the landfill** with levels to be above flood levels. (out of a total of 3.5 km of road, which may be upgraded in the 2040 horizon).
- **Construction of Non-Hazardous waste dumping cells:** including groundwater protection layers at the bottom and sides. The current investment concerns 1 (one controlled landfill cells out of a total of 4 (four) cells.
- **Weighbridge and Office Building:** The buildings include a small kitchen, tea room, and toilets – 103 m^2 floor area. Weighbridge: 40-60 tonnes.
- **Hazardous Waste Storage and Secure Landfill for Hazardous Waste Facility:** A facility to store electronic and other hazardous wastes (batteries, paints) - 227 m^2 of floor space.
- **Staff dining and Rest Room:** A two storied building has been designed to provide dining and lodging facilities for the staff, officials, and security guards - 234 m^2 total floor area.
- **Workshop, Electrical, and Mechanical Room:** A workshop is provided to maintain all the vehicles within the facility. An electrical room is provided to maintain all electrical components of the facility. The mechanical room is provided for maintaining all mechanical parts, such as fans, exhaust fans, pumps, and motors etc - 35.6 m^2 of floor area.
- **Car Washing Facility:** A car washing ramp facility to clean and maintain the vehicles engaged with waste collection.
- **Material Recovery Facility (MRF)** 1,800 m^2 of floor area.
- **Access and Internal Roads and Parking**: Block concrete and utilising bunds.
- **Fence:** Required around the entire site to prevent unauthorised access and illegal dumping of wastes.
- **Electricity, Water Supply and Sanitation**: Electricity on site, Potable and non-potable water supply – using a borehole;
- **Groundwater monitoring boreholes** to be constructed upstream (1) and downstream (2) of landfill cells;
- **Stormwater drainage** systems and pump; and
- **Equipment** including a 20-ton bulldozer, a 20-ton tracked excavator and a 6 x 4 tipping truck.

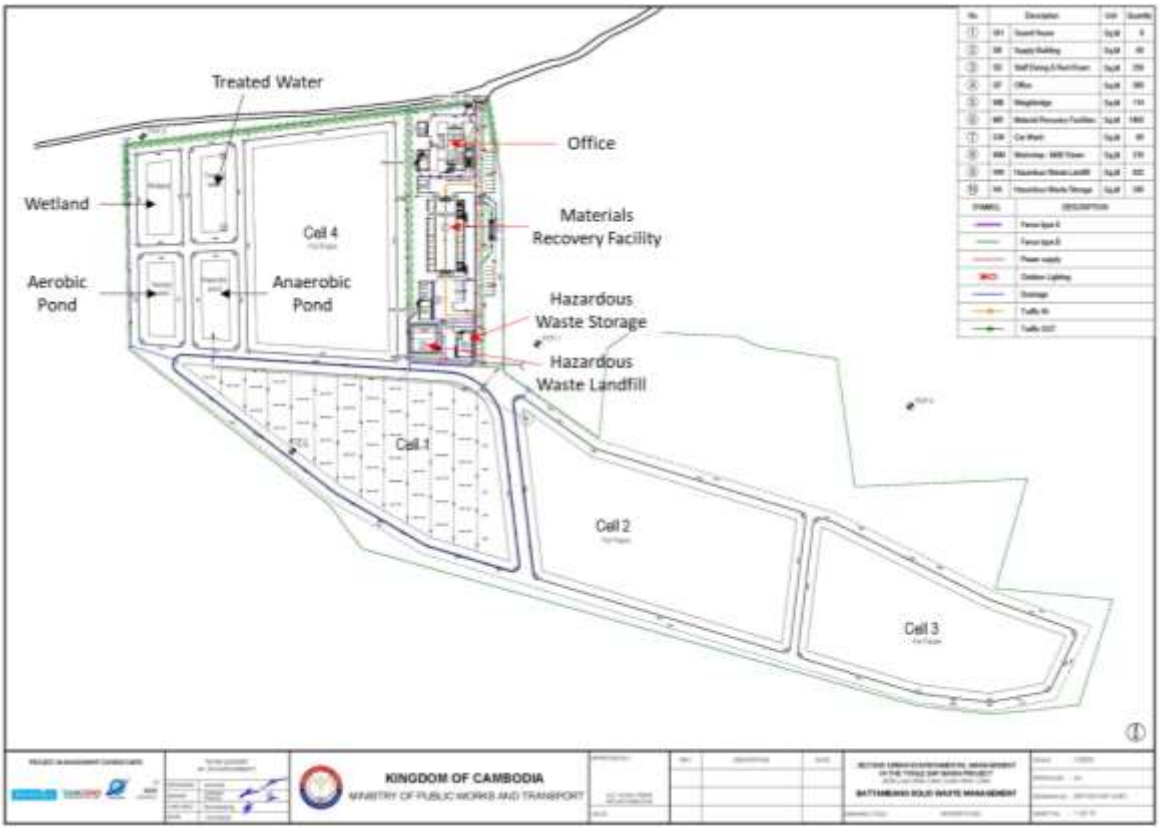
128. The objective of the controlled landfill design is to provide effective control measures to prevent or reduce as far as possible negative effects on the environment, in particular the pollution of surface water, groundwater, soil and air, as well as the resulting risks to human health arising from landfilling of waste.

129. One of the Key challenges of the design is to minimise the production of leachate, considering that in the area, there is a high rainfall rate with high peak falls: short rapid bursts of torrential rainfall.

130. The landfill site has a total area of 25 ha, out of which approximately 12 ha have been designated for use as landfill cells, just under 2 ha for leachate treatment facilities, and over 4 ha for buildings and facilities. The remaining 7 ha land is comprised of embankments, roads, areas for surface water discharge, and areas for the stockpiling of cover material.

131. The proposed site can accommodate up to 4 cells. The general layout of the site is presented in Figure 11.

Figure 11: Overall layout of Battambang Landfill

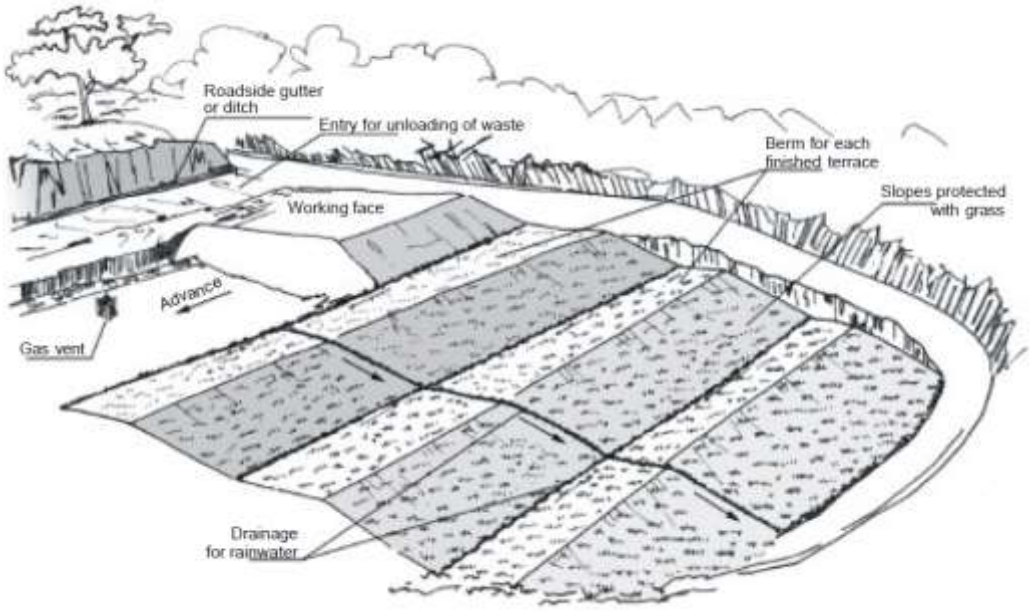


132. Battambang approach to Landfill design and operation therefore consider:

133. **The topography of the proposed landfill site**: As the proposed site is an old quarry, excavations should be limited. They will primarily occur to obtain cover material and backfilling of quarry to provide buffer between base of landfill and water table. In addition, a clay layer will be implemented at the bottom of the cells. The clay will originate from nearby quarries. Krolor located west of Battambang city was identified as potential source for clay material.

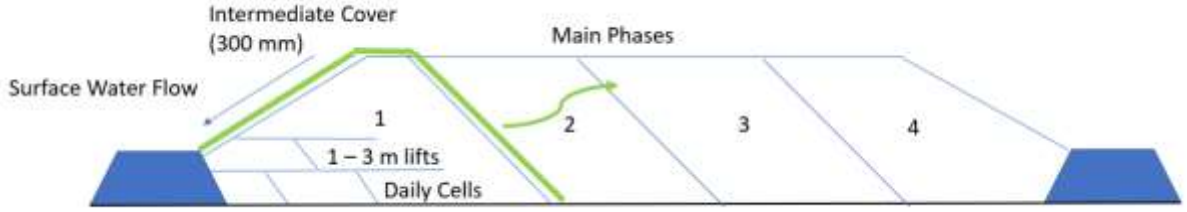
134. **Maximising benefits of site topography**, using gravity for water movement to leachate treatment ponds and storm water. Cells are therefore built at various elevations. The following diagram is not specific to Battambang but gives a broad outline of the suggested approach. At Battambang it is suggested a top down construction approach is adopted, as this will provide better surface water control across the whole site than a bottom-up construction.

Figure 12: Battambang Landfill construction approach



135. **Minimising exposure of operating face to rainfall.** The majority of leachate is produced in exposed wastes. Waste is to be built up in pyramid format during the dry months (Nov to April); Intermediate cover to be built up on both slopes as waste height increases. Prior to the start of wet season individual phases are to be completed with full intermediate cover.

Figure 13: Battambang Landfill design approach



4.7. Components of the Landfill

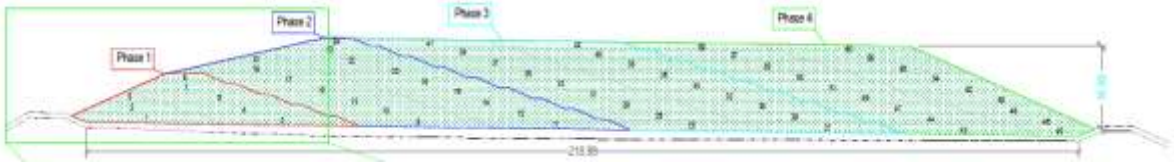
4.7.1. Landfill cells design and phasing

136. Due to the high-water table and compact underlying geology, there will be limitations on the ability to undertake any excavations. Consequently, this will be an area landfill, with waste deposited above ground. The maximum height of waste in any landfill cell will be 25 m, with a 1:2.5 slope, which through settlement is likely to achieve a final slope of 1:3.

137. **Approach to landfilling:** The overriding consideration for landfill operations will be to minimise the operational face and exposure of wastes to rain, therefore, minimising the production of leachate. Each cell is to be divided into a number of phases, which will be built up in alternating wet and dry seasons. The waste pile will be built up in a pyramid style profile, with maximum height of the final waste pile at 25 m, in order to maintain safe working practices and reduce the aesthetics impacts of the site.

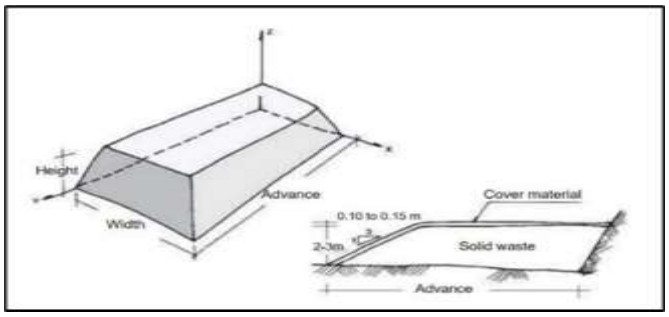
138. However, considering the current topography of the site, the final heights of waste cells are likely to be rather about 20 m high. The approach to cell 1 is detailed in Figure 14.

Figure 14: Landfill Cell phasing



139. Individual daily lifts may be between 2 to 3 m in height, as shown Figure 15, depending on the daily volume of refuse deposited. The maximum height of 3 m will allow for safe working practices. As the phases are built up, intermediate cover (300 mm of semi-impermeable clay-based material) is to be utilised on the side slopes of the waste pile to minimise rainwater infiltration and maximise surface water run-off. During the wet season, it is recommended that removable geosynthetic tarpaulins are utilised whenever possible to reduce the infiltration of rain into the exposed wastes.

Figure 15: Typical Daily Cell



4.7.2. Soil and Groundwater Protection

140. The foundation for the landfill should have the adequate bearing capacity. Based on the geotechnical survey, the bearing capacity was estimated at 18 t/m^2.

141. The underlying geology is extremely compact sandstone. Due to the fact that this layer may contain secondary openings, in the form of weathered joints and fractures, it is not possible to rely on these existing strata for the protection of groundwater from pollution as a result of the seepage of leachate.

142. The proximity of the groundwater to the surface affects the extent of excavation needed to generate the airspace for the landfill cells. The majority of international guidelines recommend that the base of a landfill cell should be a minimum 1.5 m above the water table. However, the Cambodian guidelines state that the base of the cell should be minimum 3 m above the water table. During the geotechnical survey, it was found that the ground water table in the landfill cell area varies between 2.1 m to 2.92 m below ground level. Parts of the site, particularly the northern sections, require significant fill, due to the presence of deep excavating borrow pits. In many cases these pits have breached the groundwater levels.

143. Fill will also be required for berm construction. These will be constructed around the landfill cells, in order to intercept surface water from flowing into the landfill cell, as well as providing a raised base for the internal roads.

144. The total amounts of fill required for the site are as follows:

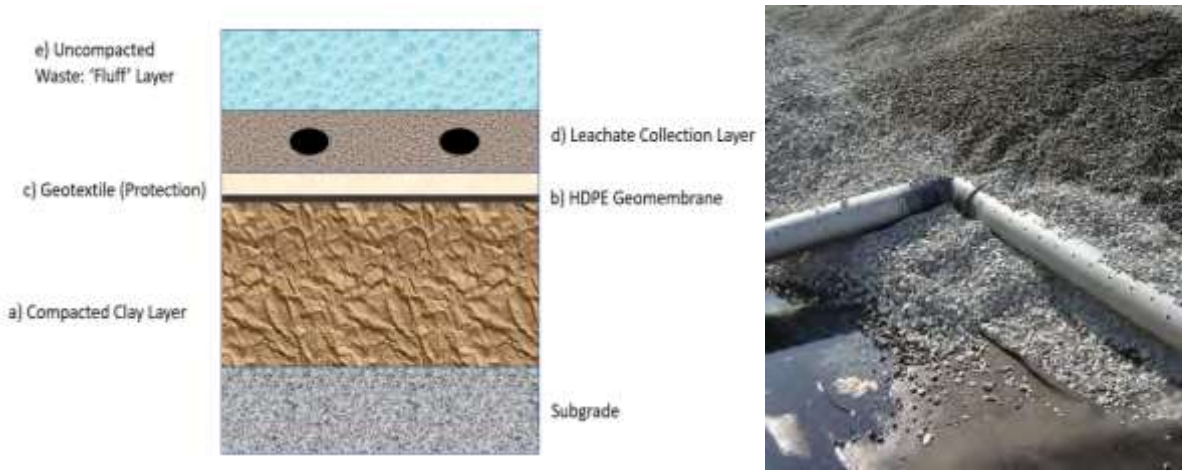
- Backfill volume: 330,053 m^3
- Berm volume: 86,011 m^3
- Total fill required: 416,064 m^3

145. There are major limitations within the site with respect to the presence of material for landfill construction (e.g., clay and gravel), so the backfill volume above also includes these elements. The amount of cut volume is 32,680 m^3. The restrictions on excavations and in-situ material means that a total of 383,384 m^3 of material will need to be imported into the site.

146. To protect groundwater, all cells will be lined with a 1.5 mm HDPE liner on bottom and sides. The primary function is to protect leachate movement into groundwater. The bottom liner will also be constructed on top of a 1 m compacted clay layer, to increase protection of groundwater. The geomembrane must be installed in direct contact with the clay layer without any kind of interposed material. It is essential that there is no air or extraneous material between the two liners that hinders close contact, as this may compromise the ability for these two layers to work harmoniously in preventing any leachate seepage.

147. Above these layers will be a leachate drainage layer, which is designed to cope with intense periods of rainfall. This will be comprised of 250 mm perforated HDPE pipes, contained within a 400 mm layer of gravel. These pipes will be spaced at 30 m intervals. A geotextile protective membrane will provide protection to the HDPE membrane from any angular material in the drainage layer. This geotextile will also provide protection to exposed parts of the landfill cell, prior to waste deposition, thereby protecting damage to the HDPE geomembrane from the sun's UV rays.

Figure 16: Cross section of bottom of landfil cells



4.7.3. Surface water management

148. **Rainwater** draining towards the landfill area could potentially increase leachate and bring about local flooding during major rain events.

The southern sections of the site are fringed by forested hills. There are no current plans for any deforestation and the hills appear to have no issues with landslips. However, it is likely that there will be high levels of surface water run-off from these hills during heavy rain. Consequently, it will be essential that open cut-off drains (500 mm wide) and 2 m high embankments are constructed around the site periphery to intercept surface water run-off from the adjacent hills and transport water around the landfill cells. These embankments will be 8 m wide 3,085 m long (across the 2040 horizon for all cells) and will also provide the foundations for the sites access roads.

149. **Final cover of landfill cells** will be maximum 20 m above ground level and will be capped with gas collection layer, protective layer, intermediate layer and topsoil to ensure

that rainfall does not infiltrate the completed cells; surface water drainage is maximized; gas migration is controlled; and there is a physical separation of wastes from humans and animals. Figure 17 shows the final slopes of the landfill.

Figure 17: Waste heap slopes

150. Water drains will also be included on the slopes in order to ensure:

- Contaminated surface run-off from the landfill does not enter surrounding watercourses.
- Rainfall run-off from surrounding areas does not drain into the landfill, resulting in excessive quantities of leachate.
- Ponding and erosion on filled and capped landfill surfaces is minimised.

151. Drainage will be put in place at the site periphery to intercept surface water runoff from surrounding hills; around the active landfill area; roads; and in final capped layers. Surface water does not require treatment – so should not go to leachate lagoons unless required.

152. Uncontaminated stormwater will be kept completely separate from the leachate interception and collection system to minimize the volume of contaminated water requiring management at the leachate treatment facilities. As such, the water collected in leachate collection pipes in areas (phases) within active landfill cells where waste is not yet deposited will not be permitted to enter the leachate transport pipes.

153. Surface water from all landfill cells will be discharged into an area located in the northern section of the site. This area will require excavations in order to ensure that the elevation is suitable for discharging storm water and that there is suitable storage capacity for the water prior to evaporation/ groundwater recharge. During peak rain it is likely that this area will be under water.

4.7.4. Leachate Management

154. Leachate management is a key factor in any landfill design. It was estimated that the degradation of the organic component of the waste mass would produce approximately 140-200 m^3/d (during June to October) of liquid leachate. Calculations for volumes of leachate have been undertaken for each phase across all landfill cells. These calculations take into account the rainfall intensity-duration-frequency using a 50-year return period (Table 10).

Table 10: Worst Case Leachate Produced per Day

Cell	Cell Size (m^2)	Leachate/ Day (m^3)
Cell 1	18,378	140
Cell 2	25,799	196
Cell 3	24,544	187

Cell	Cell Size (m^2)	Leachate/ Day (m^3)
Cell 4	21,210	161

155. The leachate produced is usually partially absorbed into the dry waste mass and partially lost as vapour due to the heat of the biodegradation process. However, rainfall onto operational areas will increase the liquid in the landfill cell, in particular during the rainy season. The key challenge in Cambodia is the variation in temperature and rainfall and subsequent output of leachate:

- Dry season: low volumes, but high concentrations of contaminants.
- Wet season high volumes of low concentrated leachate.

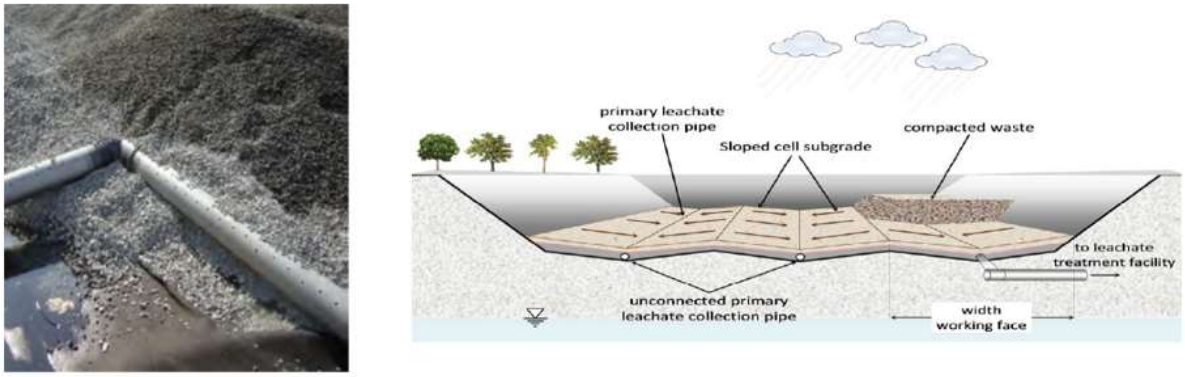
156. Leachate quantities will be minimised through landfill design and operations, including:

- Intercepting incoming surface water from upstream catchment areas through drains;
- Reducing ability for water to infiltrate wastes via heavy compaction of wastes;
- Building waste in phases as opposed to spread across the whole cell;
- Utilising intermediate cover to promote surface water run-off;
- Completing main phases prior to the onset of the wet season;
- Developing the site from a high elevation to a low elevation.

157. Clean rain surface water, which does not require treatment, will be separated from polluted seepage, ensuring that volumes in leachate treatment facilities are minimised. As such, landfill cells will have two transport pipes for liquids, one for leachate and one for stormwater. Each part of the landfill cell will be interchangeable (using a valve system), so that only those parts of the cell that have active waste are switched into the leachate transport pipes.

158. In order to collect leachates and prevent infiltration, the leachate collection system consists of: A high- permeability 400 mm drainage layer above the liner of the cell, comprised of 20 mm gravel and sand and perforated HDPE pipe with space interval of 30 m interval. Cell base is to be laid in accordion style with 1 percent slope to aid movement of leachate in collection pipe. Overall cell is to have slope of 3 degrees, moving leachate to a sump and subsequent gravity feed to the leachate treatment plant.

Figure 18: Leachate Collection System within the Cell



Leachate treatment

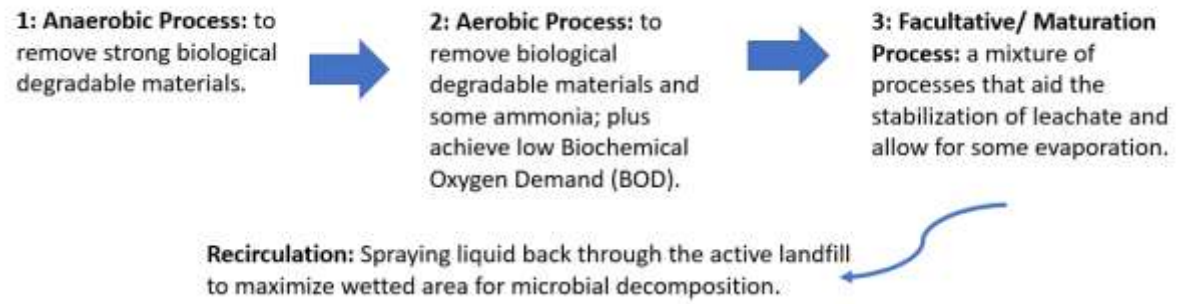
159. The main constituents of leachate requiring treatment are the ammoniacal content and the organic constituent of the leachates. Given the limited industrial activity in the project areas, the leachate is not anticipated to contain high levels of pollutants to the extent

which would mean it is inappropriate to use for irrigation within the site after appropriate treatment.

160. The country has limited resources and capacity for operation and management of advanced treatment plants: therefore, it was considered that biological treatment was the only cost effective and realistic option, noting that anaerobic processes alone will not remove ammonia.

161. The treatment consists of 3 stages (Figure 19):

Figure 19: Three Stage Treatment Process Using Gravity Fed Stabilization Ponds



162. The treatment will be conducted in a series of Lagoons. The lagoon will be constructed as a free water surface wetland to give a variety of depths and conditions, from vegetated zones to open water. All lagoons to be constructed using 1 m compact clay liner and a 2 mm HDPE geomembrane. Vegetation screening to be provided around lagoons to minimise odours in surrounding area (Figure 20).

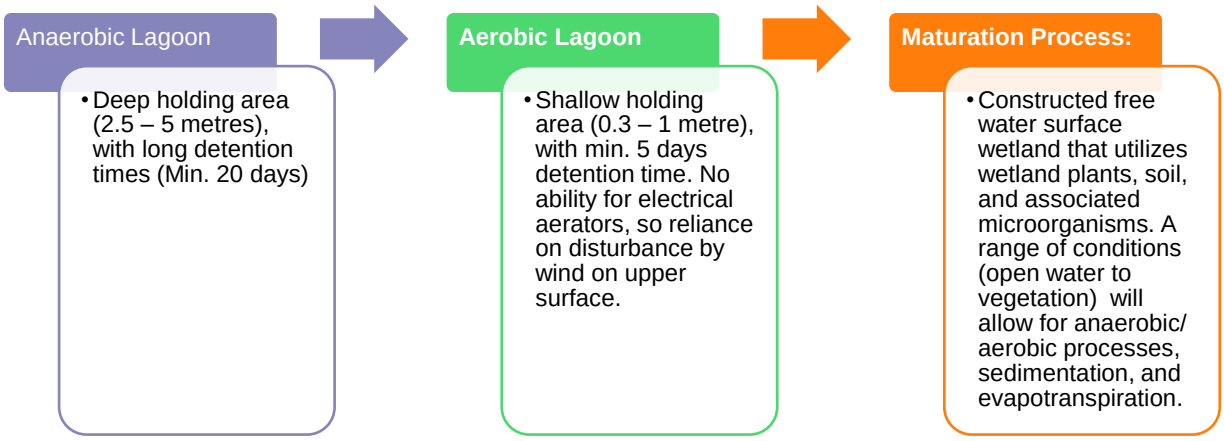
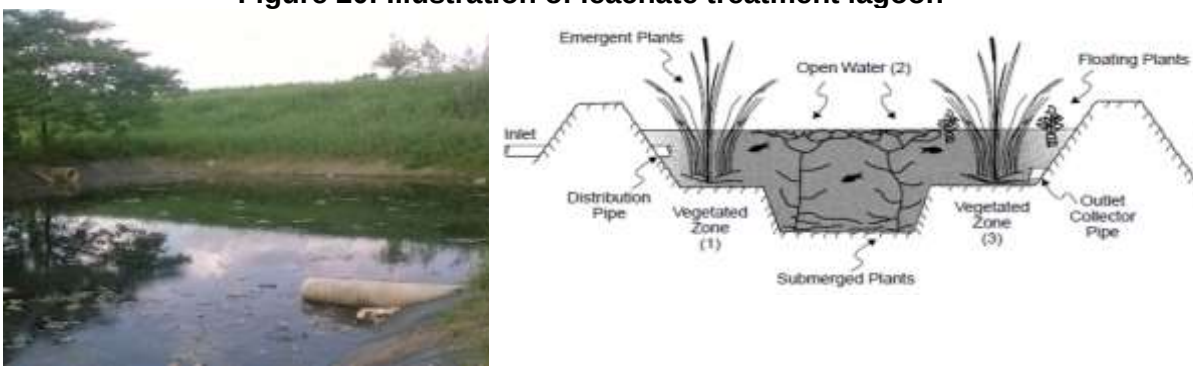


Figure 20: Illustration of leachate treatment lagoon



163. The wetland will have a range of emergent, submergent and floating wetland plants, including species such as Typha (cattail), *Phragmites* (reed), or *Scirpus* (bulrush). Many

macrophytes have the ability to transfer oxygen to their root systems and rhizomes, which stimulates the growth of bacteria that can break down organic substances. Other constituents of the leachate can be absorbed and immobilised by the plants themselves, as well as the soil.

164. Recirculation of leachate to the landfill: During the driest months, recirculation will be used to put moisture into the waste heap and help with uniform degradation and settlement of the wastes and as a short-term storage measure. A low volume pump will be used to pump leachate (after treatment) back into the landfill cells. The recirculation system will spray the leachate from a holding tank evenly over the waste. Recirculation is to be only practised during dry periods. This leachate can also be utilised on completed landfill cells that have been capped, in order to provide irrigated nutrients to vegetation, which will be particularly important in the dry season when vegetation may die due to lack of water and heat stress. This surface approach will also ensure that there is a high level of evaporation.

165. During wet period a second pump will be used to control water levels during extremely high rainfall, with water being pumped out and recirculated into the area that will be occupied by cell 4.

166. In the final leachate treatment pond (pond 4: treated water pond), the design includes a submersible pump for stormwater and a pump for leachate recirculation. The stormwater pump would only be utilised if there was excessive rain and the pond was liable to overflow uncontrollably.

167. The idea is that prior to the establishment of cell 4, the stormwater/ leachate could be pumped onto cell 4. The leachate in this pond will have gone through the treatment process, plus under such circumstances of heavy rain, will be further diluted. Consequently, it should not pose any environmental issues in terms of pumping this water onto this land.

168. Once Cell 4 is in use, this water can still be pumped through the cell (this would then essentially become a leachate recirculation exercise). After completion of Cell 4 (and therefore the end of the landfill's life), leachate can still be pumped onto the vegetated capped cells.

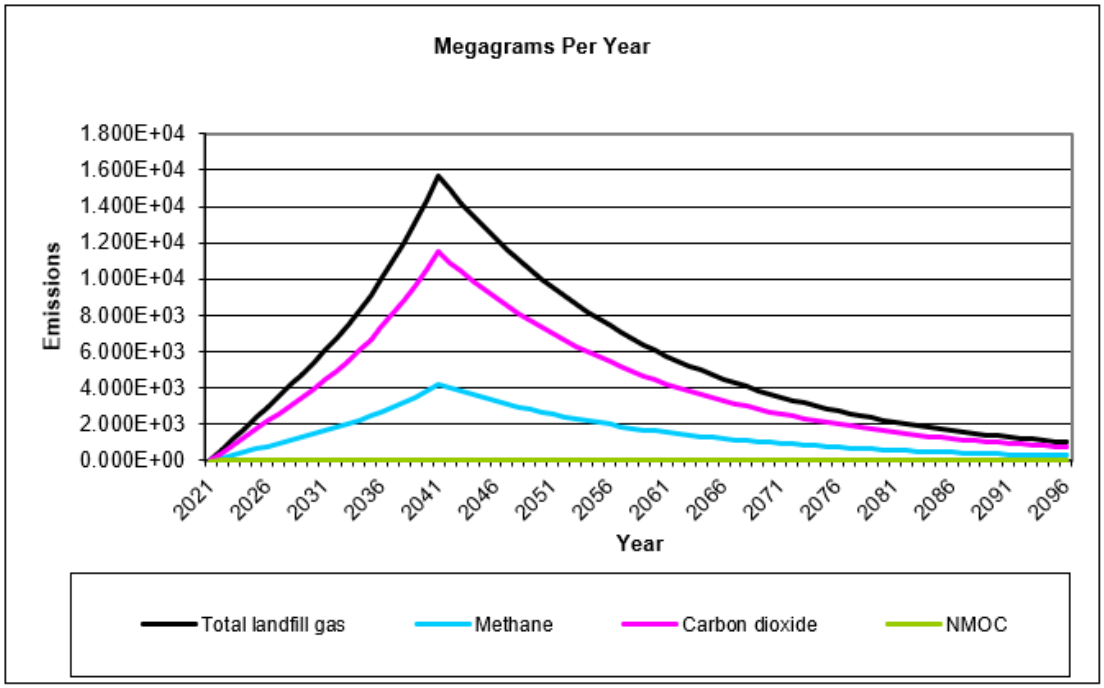
169. Leachate lagoons can result in odour and other nuisance problems (e.g., breeding ground for mosquitoes). Consequently, these lagoons will have a line of trees along the northern edge to shield the road from the site. To protect workers, health and safety equipment will be required at these lagoons, including lifebuoys.

4.7.5. Landfill Gas Management

170. Landfill gas results from the biodegradation of wastes, with the main constituents being methane and carbon dioxide. Generation rates vary throughout the landfill’s lifespan. Methane is highly flammable and is also a powerful greenhouse gas. The accumulation of a mixture of methane and air in a confined space within certain concentration limits can result in an explosion if ignited.

171. The PMC team estimated the amount of landfill gas generated over the lifespan (and after closure) of the future landfill, USEPA’s LandGEM model, which assumes 50%-50% split between carbon dioxide and methane. The graph below also shows the expected generation of non- methane organic compounds (NMOCs) which are gases which may result from volatilization of certain chemicals disposed of in the landfill.

Figure 21: Landfill Gas generation model



Source: PMC team, October 2020

172. According to this model, the total gases generated over the lifespan of the landfill shall be:

Yearly	Total landfill gas	Methane		Carbon dioxide		NMOC	
	(m^3	*(Tons)*	*(m^3)*	*(Tons)*	*(m3)*	*(Tons)*	*(m^3)*
Minimum (2021)	0	0	0	0	0	0	0
Maximum (peak in 2041)	12 551 946	4 187	6 275 973	11 488	6 275 973	27	7 531
Average	5 980 679	1 823	2 998 820	5 186	2 998 820	13	3 317
Total for 20 years of operation	299 033 960	91 161	149 941 008	259 322	149 941 008	644	165 832

Source: PMC, DED report, September 2020

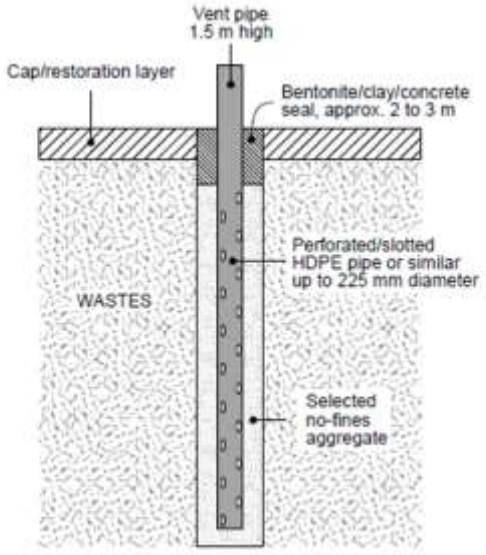
173. The aim of the proposed landfill gas management system is to minimize the risk of landfill fires and permit the effective control of gas emissions.

174. In order to prevent gas from building up into the landfill, a passive collection system will be put in place, consisting of vertical pipes to be spaced 50 – 60 m apart in landfill cells – and inserted after waste has reached 5 m in height.

175. Landfill gas will be managed through passive release via the vertical gas collection wells connecting through horizontal pipes into a central chamber for venting. In the future, should sufficient quantities of gas be produced as to be commercially viable, technology to collect and utilise the gas could be retrofitted to the gas wells, or flares fitted to combust the gas emissions.

176. Figure below shows for representative purposes a representation of a gas collection well, protected by a stone well head once final cover of the landfill has been put in place.

Figure 22: Illustration of landfill gas collection well



177. The passive vent pipes are to be placed vertically in the landfill cell when the waste reaches a height of five metres, which means that the pipes will be present in approximately 75% of the waste height. Additional lengths of pipe are to be added in accordance with progress of the landfilling to avoid being covered by the waste. This approach takes into account that in the early stages of filling a cell it is likely that the combination of waste quantity and age means that there are relatively low amounts of gas volumes being produced. The approach also makes an allowance for settlement of wastes, thereby giving plenty of space between the vent and the base of the landfill cell to reduce risk of damage to the liner. The pipes are to be spaced at 30 m to 50 m intervals (40 m optimum).

4.7.6. Landfill Cap

178. Once a landfill cell is full of waste it is essential to ensure that the cell is fully capped as soon as operations ceases. The primary purpose of the capping is to minimise infiltration of water into the waste and, therefore, the production of leachate. It achieves this by developing an impermeable barrier and also by promoting surface water drainage and maximising run-off. The capping also is important in controlling gas migration. It is recommended that the following layers are utilised in capping from top to bottom:

- Topsoil (150 mm).
- Intermediate layer (150-300 mm).
- Barrier layer (600 mm).
- Gas collection layer (150 – 300 mm).

4.7.7. Site Weighbridge and Equipment

179. Weighbridge. The site will include a 60-tonne weighbridge at the site entrance. It will allow determination of the exact mass of waste coming to site from public, institutional and commercial operators, and the issuance of any subsequent gate fees.

180. Vehicles. A Caterpillar D6 or equivalent 20-tonne bulldozer is essential on site to provide waste compaction and profiling activities, as well as pushing and compacting soil cover material. A Caterpillar 200 series or equivalent 20-tonne tracked excavator is required onsite. Traditionally excavators are used on landfills to load cover material into

trucks for placement as daily cover, intermediate or final cover. They also are required for digging drainage systems on the site as well as cleaning litter out of drains prior to it exiting the site, and other minor site development works. Finally, they can be used for short periods if the bulldozer becomes unserviceable.

181. In addition to these two items, a 10-wheeler body tip truck is required to be able to move soil around the site and assist with any drain clean-ups (litter removal) and other site haulage activities. The Water Tank. An 8,000 to 10,000-litre water tank equipped with a small pump and spray bar is also needed for dust control and fighting small fires. The tank will be placed in the tip truck body when required.

4.7.8. Material Recycling Facility (MRF)

182. The old dumpsite has a MRF which will be maintained, in addition to a composting plant. The MRF in the new landfill site will be a non-mechanical type material recovery facility, which will provide a covered building for the manual sorting of recyclable wastes (recoverable plastic, glass, paper, aluminium, and ferrous metals).

183. The MRF has been designed to allow for the sorting, baling, shredding, compacting and storage of recyclable materials in designated compartments. Ventilation and lighting (natural from the transparent fiberglass roof and lights) are provided in the design, in order to keep the area well lighted for a safe working environment. The unloading and sorting area of incoming waste is kept well ventilated by the introduction of exhaust fans and ventilation fans. Full facilities are provided for staff, including a manager's office room with toilet and separate changing rooms and toilets for workers (male and female). The MRF has 1,800 m^2 of floor area.

184. A major O&M and training program will be developed and implemented to create awareness and educate the municipalities and local community on the need to separate waste at source to ensure the new MRF only receives potentially recyclable waste for sorting and recycling. The improvements to solid waste collection for the landfill will need to include separate or dual compartment trucks to collect and transport segregated waste.

185. The facility is not designed to accept hazardous wastes. This makes it imperative that designated personnel thoroughly inspect incoming materials that will be processed/stored in the facility.

4.7.9. Hazardous Waste Management Facility

186. The joint disposal of untreated hazardous waste with municipal solid waste is not compliant with current legislation and international standards. The Sub-decree on Solid Waste Management (Sub-decree No. 36 ANK/BK) Article 15, establishes that storage, transportation and disposal of hazardous waste shall be performed separately from household waste which will be stipulated by the Prakas of the Ministry of Environment.

187. The landfill will require waste acceptance criteria and procedures compliant with Sub-decree No. 36 ANK/BK. The criteria will specify a list of inert non-hazardous and hazardous wastes that can or cannot be accepted. The waste acceptance procedures will detail a formal process that will need to be undertaken for identifying and checking the composition of wastes before acceptance.

188. The purpose of establishing waste acceptance criteria and procedures is to ensure that all wastes being disposed of in the landfill are compatible with the operation of the landfill and do not lead to immediate or longer-term adverse environmental effects or human health impacts and safety risks for site workers. Waste acceptance criteria and procedures will be developed under the O&M manual.

189. It is envisaged that these wastes would include wastes that may contain somewhat higher levels of contaminants than municipal wastes, such as heavy metals and

chemicals. The types of waste accepted will still need to meet the waste acceptance criteria, but may for example include used oil, out of date medicines, paints and solvents, certain e-waste, primary batteries, pesticides and herbicides, and other certain household/ business chemicals.

190. This approach seeks to avoid the improper disposal of these wastes, which may otherwise occur, such as dumping in rivers, in other natural environments, or on roadsides. Consequently, the landfill will be provided with a containment facility in the form of a hazardous landfill cell designed with more stringent and higher environmental controls than the standard landfill cells. The hazardous waste storage facility provides a facility where some wastes can be temporarily stored while awaiting analysis and classification, before appropriate decisions can be made regarding their disposal.

191. The waste acceptance policy for hazardous wastes will be detailed in the operation and maintenance manual. It is envisaged that the majority of this waste will be securely stored in either HDPE plastic or steel drums, with exact requirements specified in the O&M manual (plastic for corrosive wastes and steel drums for non-corrosive, oil-based and flammable liquids). These must conform to the United Nations standard for packaging materials. On completion of each layer of waste, these will be covered with 300 mm of intermediate cover material. On completion of the cell, final capping will be utilised, as per the standard waste cell.

192. This hazardous landfill cell will be constructed and operated in a similar way to the standard landfill cells, with the following additional requirements in order to achieve a higher level of protection to groundwater from the infiltration of leachate:

- Leachate collection layer: A 500 mm layer of gravel with a minimum hydraulic conductivity of $1x10^{-3}$ m/sec. One HDPE leachate collection pipe (250 mm diameter).
- Geomembrane: a 2 mm HDPE geomembrane.
- Clay liner: 1.5 m clay liner with hydraulic conductivity of $1x10^{-9}$ m/sec.
- Side walls to have the same level of protection as the base (clay and geomembrane).

193. The hazardous waste cell will require 2 m of excavations to create the base. Operators will use a ramp to access into the site, so that they can manually (e.g., using trolleys) transport barrels from the hazardous storage facility into the landfill cell. The system is not designed to permit vehicular access into the cell. The hazardous landfill will have a volume of 1,211 cubic metres and will be able to reach a final height of waste of 3 metres. This will be able to accommodate 3 layers of 220 litre drums.

194. One gas collection well will be provided, predominantly constructed in the same way as the standard landfill cell, with the exception that the gas collection pipes will go all the way to the bottom liner of the landfill cell.

195. There will be the provision of an emergency cut-off valve in the leachate collection pipe, which can be utilised in the case of accidental deposition and spillage of extremely hazardous material into this cell, in order to prevent flow of highly contaminated leachate into the leachate treatment facility.

4.7.10. Access Road

196. The implementation of the new landfill requires the upgrade of the access road from the main road (N57) to the landfill. Starting at the landfill, there is a ca 400 m dirt access road and a 3.1 km gravel road to Pouy Svay Village, and then 4.4 km on the paved Road 1570 before reaching the National road 57 (Figure 23).

Figure 23: Roads from Battambang to Future landfill

197. The existing access road is about 6-8 meters wide. The traffic can pass in both directions. It is not paved but made of dirt and gravel.

198. This current access road is serving adjacent quarry and aggregate production businesses for their transport of construction materials. This traffic causes fugitive dust emissions as seen on Figure 24.

Figure 24: Traffic on National road from site to Battambang town

4.7.11. Appurnant works

199. Apart from the front boundary (brick wall with columns) wall of the landfill facility, the entire site is surrounded by barbed wire fence. This fence will restrict access and help intercept any windblown wastes from being blown into adjacent land.

200. There is a 22 kV electric power line which crosses the site. This power line is owned by a private company, who is able to supply power to the site. A transformer of 160 kVA is required along with a 150 kVA back-up generator. Total connected load is calculated at 127 kW. The existing electric line crosses the middle of the site and will require approximately 1 km of rerouting around the periphery of the site to ensure that it does not interfere with landfill operations.

201. The site currently has no access to the public water supply system. A deep tube well needs to be installed to the landfill site.

4.8. Associated & Existing Facilities

202. Associated Facilities. SPS 2009 defines associated facilities as “facilities that are not funded as part of a project but whose viability and existence depend exclusively on the project, or whose goods or services are essential for successful operation of the project”.

203. Associated facilities for this project will include: Borrow pits and Construction camp**.**

204. The waste collection system for the Battambang Landfill service area is not part of the landfill subproject but falls under existing long-term Government contracts with private waste management companies.

205. Existing Facilities. SPS 2009 states that for projects involving facilities and/or business activities that already exist, the borrower/client will undertake an environment and/or social compliance audit, including on-site assessment, to identify past or present concerns related to impacts on the environment, involuntary resettlement, and Indigenous Peoples.

206. The current dumpsite of Battambang town is not part of the Battambang landfill subproject. Therefore, the dumpsite is not considered an “existing facility” as part of the Battambang solid waste management subproject, and an environmental due diligence audit is not required for this site.

207. The new landfill and the MRF at the existing dumpsite are independent facilities, neither of them relies on the other. The MRF at the existing dumpsite is therefore neither considered an “associated facility” nor an “existing facility” (in ADB Safeguard Policy terms). In any case, an IEE was carried out for the dumpsite MRF under the ADB funded Greater Mekong Subregion Southern Economic Corridor Towns Development Project in July 2020, which means that environmental and social impacts have already been assessed and taken into account for that facility.

4.9. Construction activities

208. The construction schedule will be developed by the Contractor for the 24 months duration construction period. The schedule should account for the wet season from the months of June to October. The main activities for the construction schedule are as follows:

(i) Mobilization

(ii) Site Clearance

   a. Topographic surveys

(iii) Soil Investigation

(iv) Preparation of Construction and Working Drawings

(v) Landfill Components

209. The construction activities include:

- Activity 1: Site clearance, earthworks, grading.
- Activity 2: Site Development and Backfilling Work: Raising of the southern part of the proposed site up to a height of 27 meters filled with alluvial soil as a backfilling material. A slope of 1:2 shall be maintained along the edge of the northern part of this backfilled site. This backfilling material of alluvial soil shall be filled up in 300 mm layers with proper compaction until it reaches the finished ground level. On top of the filled-up area, grass turfing with 250 mm thickness is proposed to control erosion.
- Activity 3: Construction of all the Building Structures and Facilities: The construction of building structures will be conducted: construction of front boundary walls, main gate, security room, dining and rest room, leachate collection, storage, and treatment system, weigh bridge and office, workshop, electrical room, and the mechanical room, car washing facility, hazardous waste storage, and secure hazardous waste landfill facility.
- Activity 4: Construction of Embankments for the Landfill Cells: After the completion of the 27-meter backfilling work on the landfill's front side (southern side), construction of the 8 m high embankments dividing the 4 (four) cells will be constructed. On top of this, concrete block internal roads will be constructed.
- Activity 5: Construction of Internal Roads: to make the road easy for construction and can be reused with changes of the height of the landfill cell with course of time. In addition to this, temporary roads will be constructed from the 8 m high embankment road will lead to the bottom of the landfill cells.
- Activity 5: Construction of Landfill Cells: After completion of Activity 3 and Activity 4, several detailed works will be carried out in Activity 5 to properly drain and treat the leachate from the bottom of the landfill cells. A drainage layer will be provided on top of the impermeable layer. This is done to collect leachate and avoid water stagnation in the landfill. Moreover, when cell 1 and cell 2 are entirely filled, the operation of cell 3 and cell 4 shall be started.
- Activity 6: Construction of Leachate Water Storage Tank and Leachate Water Storage Pond: After Activity 5, construction of the leachate water storage tank and leachate water storage pond located at the North West corner of cell 4 will be constructed to make the leachate treatment system operational as soon as the landfill operation starts after the completion of the construction.
- Activity 7: Construction of the Barbed Fence Wall: Construction of the barbed fence wall on the top of the 2.5 m high embankment will be constructed. The purpose of this is to protect the site and avoid water intrusion from the adjacent areas due to flood/heavy rainfall.
- Activity 8: Construction of Electrical Sub Station and Power Distribution.
- Activity 9: Construction of Deep Tube well and Water Supply System
- Activity 10: Planting of Vegetation Screens: Planting of trees along northern section of site, and around the western side of the buildings.
- Activity 11: Drilling of Groundwater Monitoring Borehole
- Activity 12: Procurement and Installation of Equipment
- Activity 13: Training of O& M Staff
- Activity 14: Testing and Commissioning

- Activity 15: Handover of the Facility
- Activity 16: Defects Liability Period

4.10. Operations

210. This project can only have environmental benefits if operated and maintained according to standards. Key operating considerations include:

- Ensuring integrity of artificial liner system (HDPE liner) and leachate collection system through proper construction practices, operational practices (in particular when operations are at the bottom of the cells), and monitoring of integrity of the system.
- Construction and operation of Environmental monitoring facilities such as upstream and downstream groundwater monitoring wells;
- Operating equipment such as a bulldozer, excavator, water tanker, leachate pumps and trucks for hauling cover material and relocating any litter;
- Landfill operations manual including complete record keeping systems and protocols for site management in terms of litter control, vermin control, proper compaction and so on; and
- An environmental monitoring and management plan developed and implemented.

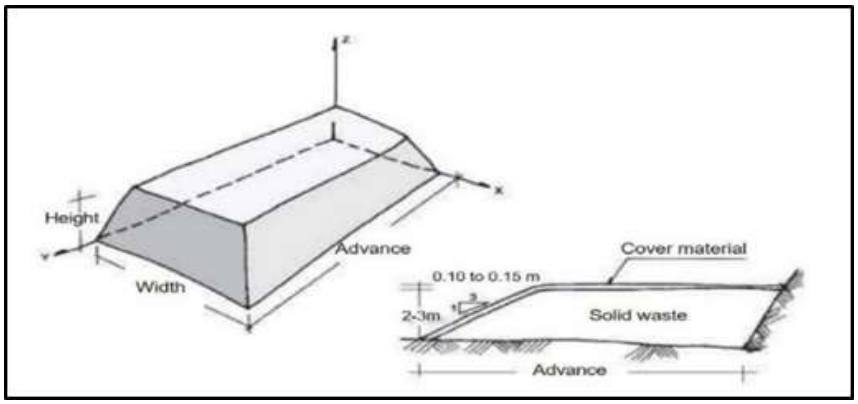
211. The approach to laying waste involves deposition by collection trucks at the working face, with 4 to 6 metres width required per vehicle. Initially, this approach will involve depositing waste from the side embankments to achieve an uncompacted operational layer, which will provide protection to the leachate collection layer. The surrounding open surface drain will require temporary infilling at the working face, in order to allow vehicle access.

212. The bulldozer will subsequently spread the waste in thin layers of between 300 mm and 500 mm, depending on the quantity and nature of incoming wastes, which will be compacted by approximately 6 passes. Individual daily lifts may be between 2 to 3 m in height, as shown on figure below, depending on the daily volume of refuse deposited. The maximum height of 3 m will allow for safe working practices.

213. This site will not utilise daily cover material. Intermediate cover will be used on slopes: the overriding consideration for landfill operations will be to minimise the operational face and exposure of wastes to rain, therefore, minimising the production of leachate.

214. The thickness of intermediate cover will be 300 mm – the actual amount use will vary over time, depending on the size of the phase (Figure 25).

Figure 25: Typical Daily Cell



215. The phases will be built up during the dry season and must be completed prior to the commencement of the wet season. During the wet season, it is recommended that

removable geosynthetic tarpaulins are utilised whenever possible to reduce the infiltration of rain into the exposed wastes.

216. At this stage, four cells are designed, with only cell 1 initially constructed, as well as a small cell for hazardous waste. Ideally, the construction on the site would start with the cell at the highest elevation and work in a downstream direction (i.e., cell 4). However, due to the need to keep initial construction within a reasonable budget, it has been decided that the best practicable option is to start with a cell closer to the leachate treatment facility and site facilities.

217. For final cover the following estimates for material for cell 1, based on four layers:

Layer	**Cubic Metres Required**
(A) Topsoil: final 150 mm layer of topsoil	4,630
(B) Intermediate Layer: 300 mm layer of silty/Sand/Gravel mix	9,261
(C) Protective Layer: clay-based layer of 600 mm thickness	18,522
(D) Gas Collection layer: 300 mm layer (Sand/gravel mix)	9,261
Total Cover material	**41,674**

Leachate Management

218. Regarding leachate management, the calculations show that, based on average rainfalls and evaporation rates, it will take just over two years before the water in pond 1 begins to reach the maximum level. During this period, levels in ponds 2 to 4 may be low. As such, under this scenario, it is recommended that the planting of the wetland does not take place until year two or three. Under a scenario where maximum rain is experienced month-on-month, the maximum levels in all ponds will be reached at the end of the wet season in year two of operations. When these levels are reached it will be necessary to undertake recirculation of leachate.

Groundwater Monitoring

219. There will be three groundwater quality monitoring wells constructed, which will provide the ability to measure the groundwater quality hydro-geologically. The exact location of these monitoring wells will be determined following the completion of a groundwater survey. In order to determine the impact of the landfill operations on groundwater, one well will be located upslope and two located down gradient of the landfill site. The monitoring wells are to be located on the sides of the landfill (no closer than 10 to 20 m from waste perimeter).

220. The wells will be constructed by drilling a borehole, with a minimum diameter of 8 cm (the exact depth will be dependent on the results of the groundwater survey). A polyvinyl casing will be utilised in order to provide resistance to strain induced by geological materials. Water will be extracted using a Kemmerer depth sampler. *[Note: the design of the monitoring well will be undertaken after the groundwater survey].*

Hazardous waste acceptance

221. The waste acceptance policy for hazardous waste will be detailed in the Operation and Maintenance manual (O&M manual) in compliance with Sub-decree No. 36 ANK/BK. It is envisaged that the majority of this waste will be securely stored in either HDPE plastic or steel drums, with exact requirements specified in the O&M manual (made as part of general equipment purchases) typically this will involve plastic drums for corrosive wastes and steel drums for non-corrosive, oil-based and flammable liquids). These must conform to the United Nations standard for packaging materials.

Existing Dumpsite Closure

222. The city has one existing dumping site with an area of 8 ha. This site has been in operation for the last ten years. Crude dumping method is used for disposal of waste.

223. The subproject does not include the closure of existing landfill in Battambang as the existing landfill site being used is partially on State land (2 ha, plus 6 ha private land) and there is a compost plant and material recovery facility (MRF) within the existing dumpsite.

224. Waste pickers are present at the current dumpsite and under the design of the project they should be able to continue their activity as the MRF will remain in operation. At this stage, there are no plans to relocate either the compost facility or the existing MRF to the new landfill site as it is closer to the source of waste than at the new Landfill location.

225. However, unrelated to this subproject, the government may consider closing and rehabilitating the existing dumpsite eventually, in which case, specific surveys and studies will be necessary.

5. DESCRIPTION OF THE ENVIRONMENT

5.1. Project Area of Influence

226. According to SPS 2009, the area of influence encompasses:

(i) The primary project site(s) and related facilities that the borrower/client develops or controls. The primary project sites for this project include direct construction sites, pipelines, canals, access roads, borrow pits, disposal areas, and construction camps.

(ii) Associated facilities that are not funded as part of the project whose viability and existence depends exclusively on the project.

(iii) Effects from cumulative impacts from further planned development of the project, other sources of similar impacts. No cumulative impacts in this regard are anticipated as a result of this or similar projects.

(iv) Effects from unplanned but predictable developments caused by the project that may occur later or at a different location.

227. The particular topics of attention to establish the area of influence of a project and the baseline situation are as follows:

- Sensitive natural environmental receptors such as water bodies, biodiversity and wildlife habitats;
- Sensitive human receptors;
- Cultural and heritage sites; and
- Potential health and safety issues.

228. The area of influence i.e. the area which is affected by the project, also depends on the environmental impact being considered. Local impacts with a narrow area of influence are those impacts arising from noise, dust and amenity issues. A larger area of influence results from impacts which contribute to global issues such as the embodied carbon associated with the manufacture, supply and use of concrete products, and the carbon emissions associated with material transport. SPS 2009 requires the assessment to identify potential transboundary effects, such as air pollution, and global impacts, such as emission of greenhouse gases.

229. For the proposed landfill project, the direct area of influence encompasses the project sites which includes the footprint of the landfill and access road, but also the associated facilities: workers camp, borrow sites, and the future service area.

230. As there are no effluents expected as part of the project, the indirect area of influence based on potential nuisances is taken to be 250 m around direct project footprint, based on noise levels, as follows:

- WHO Community Noise Limits: One Hour LAeq 55 dBA (Outside; residential receptor, daytime limit)
- Construction Noise: Backhoe excavator 80 dBA at 15 m and concrete mixer 79 dBA at 15 m. Source: Construction Noise Handbook (www.fhwa.dot.gov), US Department of Transport.
- Noise attenuation factor: a conservative 6 dBA each time the distance from the point source is doubled. Source: US Occupational Safety and Health Administration (www.osha.gov/dts/osta/otm/new_noise/). Note that in soft vegetated environments such as in agricultural fields, the noise attenuation will be significantly increased meaning the area of influence could be narrowed. However, this would not be the case where vegetation is removed.
- Calculation: At 250 m the noise at a receptor is approximately 55 dBA (WHO limit).

5.2. Baseline Receptor Summary

231. The following chapters of the IEE provide the environmental baseline (description of the environment) for the project sites. A site-specific summary table for key receptors is provided in Table 11**.** The distances given are approximate based on a centre point for the project sites.

232. These receptors are explored in more detail in the following sections describing the environmental baseline conditions.

Table 11: Summary of Environmentally Sensitive Receptors of Landfill Subproject

Project site	GPS	Surface Water /Groundwater Receptors	Socio-Economic & Cultural Receptors	Land Cover/ Ecological Receptors	Protected Area Status
Existing Dumpsite (for reference only)	103°11'30.80"E 13° 8'14.92"N	- No water body near the site - Closest river 1.2 km east of the site, surrounded by residential areas	- - Site located in Agricultural area - -No community directly surrounding the site. - - Closest houses ca 500 m from site - -40Ahs of waste pickers work at site, out of which 16 affected households live on site	- Site is enclosed by farmlands - No apparent natural habitat in the area	Closest area is Tonle Sap protected, 20 km east
New Landfill Site and access road	103° 2'12.19"E 13° 3'7.49"N	- Site located in upland or mountainous area of Ta Kream Mountain - No water body directly near the site - Wells and ponds in the Pouy Svay Village Ta Kream Commune about 3 km from site - Kamping Pouy River is about 7 km northwest of the landfill site - Sangke River is about 15 km east of the landfill site	- Site located about 3.5 km from Pouy Svay Village, where there are: houses, school, and health centre, pagoda. - Quarry work camps are located 2 km from the site - About 3.5 km from road N.1570 - 3 houses are located very close to the proposed new landfill (within 200 m radius) and 9 houses further away.	- The site itself is a Quarry and borrow-pit area, with little vegetation remaining - Sparse trees and bushes within footprint - Farms (fruit trees) are located north of landfill site. - On the South-West border, a hilly area uphill of project site is covered by a forest	Closest area is Tonle Sap protected, 40 km east

Source: PMC, 2020

5.3. Landfill Site Location and Surrounding Land use

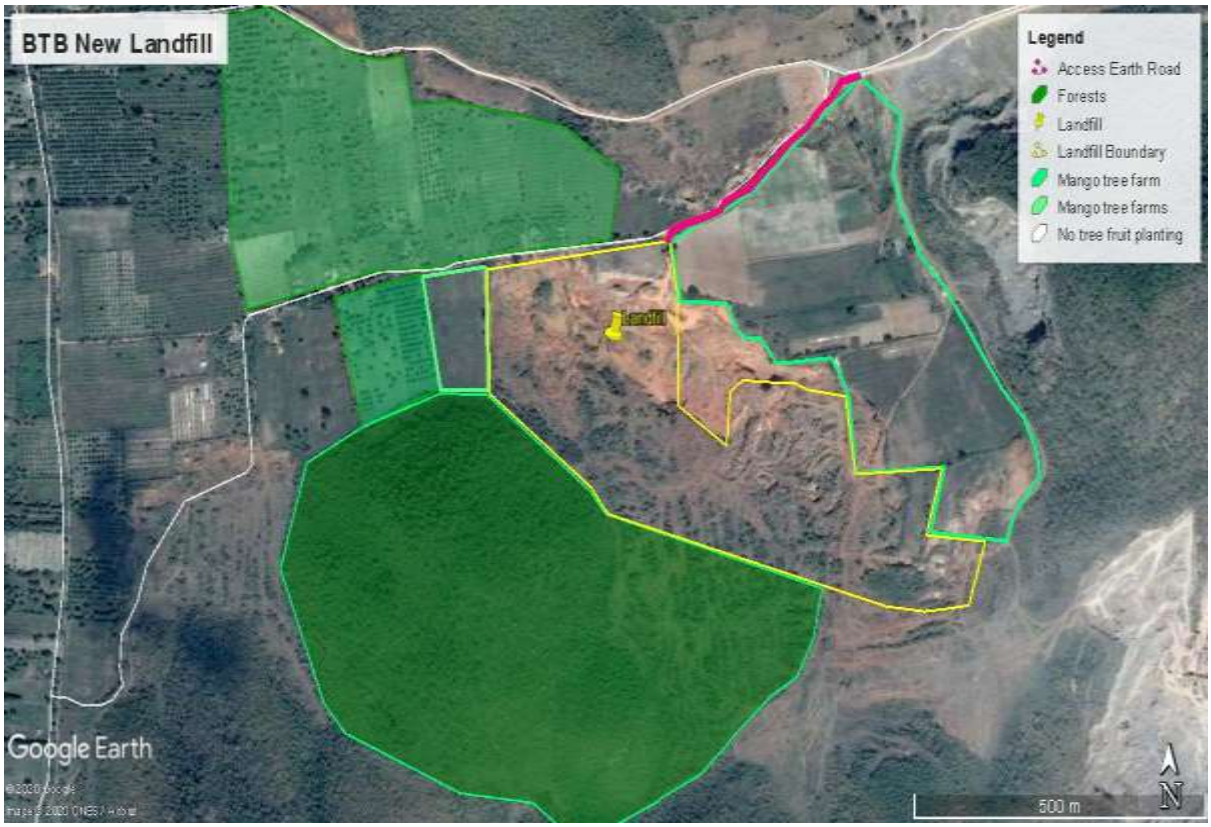
233. The proposed landfill site is currently a quarry site and borrow pit. It is about 22 km from Battambang town, about 3.5 km distant from Pouy Svay village, Ta Kream commune.

234. It is located in a rural area, primarily used for agriculture. However, the site itself is an old quarry site.

235. The new landfill site is on private land with one owner, to be purchased through willing buyer willing seller arrangement. The agreement concerns a total area of 25.3 ha. The proposed landfill site has no residential land or shelters within its footprint. There is also no crops or economically valuable trees on the proposed site.

236. There are agroforestry areas near the site (mango farms) and quarry work camps are located circa 2 km from the site.

Figure 26: Land use around the proposed Landfill site



Source: PMC 2020

237. There are 3 houses close to the proposed new landfill site, and 9 houses further away. The households are not directly impacted by the landfill project, but mitigation will be provided under EMP.

238. There is an existing ca 400 m long dirt access road which needs surface improvement. Remainder of the 3.1 km access road to road N1570 is a wide road used by quarry trucks in relatively good condition.

239. There are also houses along the access roads to main national road.

Figure 27: 1 km circle around the proposed landfill site

5.4. Soils and Topography

240. The Landfill project is located in Ta Kream Mounting, Ta Kream commune, Banan district, Battambang Province which is within the Tonle Sap Lake Basin dominated by alluvial soils.

241. The area of the site is situated within a belt of recent lacustrine (lake) sediments. Near the river shore, a belt of organic deposit is overlying alluvial of the Holocene period. In the flat area of the main Tonle Sap, they are reported to comprise gray silts, sands, clay and organic soils. The geological map also shows alluvial sediments on the project area, where it flowed from nearby highlands and the upper Mekong River to fill swamps and floodplain, as a delta deposit of originating from Vietnam.

242. The Battambang landfill site is located in a hilly area of approximately 120 m elevation above mean sea level. Bottom of the pits are circa 10 m below natural terrain levels. New studies were conducted for the detailed designs.

243. Main Characterisation of soil and topography at the site:

- Recent, weathered sediments - unconsolidated material and compacted rock.
- Limited clay/ semi-permeable material and potentially limited drainage material in-situ.
- Consolidated rock layer is between 0 to 4 metres below existing surface level.
- Groundwater table is between 2.1 m to 2.92 m below existing surface level.
- Presence of water at the bottom of the pits was observed on satellite imagery, potentially linked to rainwater retention.
- Topography (see Google Earth image in Figure 28): The site elevation is about 45 m asl. and surrounded by hilly terrain with elevations from 100 m asl. to 150 m asl. forming a drainage area of about 180 ha gently sloping from the south-eastern corner and southern section and draining to the west towards a flat agricultural area at about 25 m asl. with paddy fields and plantations. This topography will help with the design of the site, meaning that movement of leachate and surface water can be gravity fed, negating requirements for pumps. However, there are also low

points of the landfill site resulting from borrow pit excavations that cannot be utilised for landfill cells due to proximity to groundwater and the steep gradients. The highest elevation on the site is in the south-east corner at 49 m asl. and the lowest section is in the north-west corner at 21.5 m asl. The proposed facilities are located at the following current elevations:

- Building and facilities: 29 - 31.5 m asl.
- Landfill cells: 29 - 49 m asl.
- Leachate treatment: 21.5 - 24 m asl.

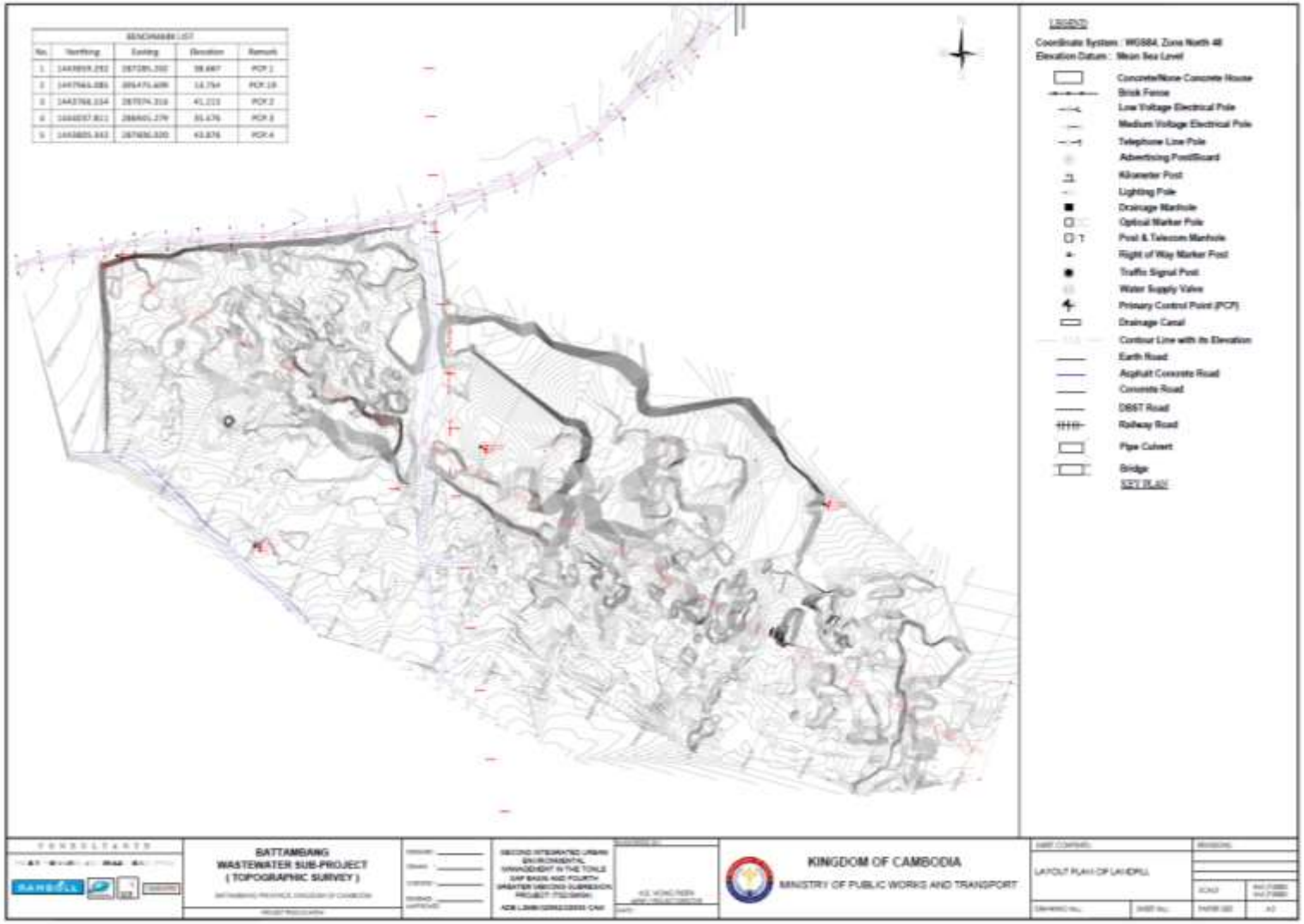
Figure 28: Google Earth Image (April 2017) of the Landfill Area

244. These characteristics imply that there will be a requirement to import material for construction and operations from outside of the site.

Figure 29: Picture of proposed Landfill site

Figure 30: roads and pits within proposed landfill site

Figure 31: Topography in Battambang Landfill area



5.4 Meteorology and Climate Change

245. **Climate**. Cambodia is situated in a tropical zone, between 10- and 14-degree latitude north of the equator. The climate is dominated by the monsoon cycle, with a distinct dry season and wet season. The northeast monsoon brings in the dry season from December to March. The dry season is cooler from November to January when cool air from Siberia flows in and is dry and hot from February to April. The wet season is from April to November, as southwest monsoon brings in moisture and rains from the Indian Ocean. Average temperature has minimal variations regionally and seasonally; within the Tonle Sap basin (Siem Reap) the average temperature ranges from 24°C in December/January to 31°C in April.

246. **Rainfall**. The average yearly rainfall over the past years in Battambang Province is around circa 1200 mm per year. The average Total Monthly Rainfall (mm) for the past 5 years are presented in Table 12 and Table 13below. Wettest months are observed between May and October.

Table 12: Battambang Average and Maximum Rainfall Data (years 2006-2019)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total mm
Average	7	11	50	91	130	140	136	165	201	232	64	6	1,234
Max	19	58	97	197	238	249	228	257	346	407	193	27	2,315

Source: PMC team, Battambang Landfill DED Draft report, September 2020

Table 13: Monthly Max and Min Temperature in Battambang

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total °C
Average Min	20.4	23.1	24.4	25.8	25.9	25.8	25.3	25.3	24.9	24.9	23.7	21.3	24.2
Average Max	31.3	33.9	35.3	35.7	34.9	33.8	33.2	32.8	31.8	31.4	31.2	30.7	33

Source: PMC team, Battambang Landfill DED Draft report, September 2020

247. **Wind.** The prevailing wind directions during the wet season are from the southwest to the northeast, and during the dry season, it is in the opposite direction. The highest average monthly wind speed is 4 to 6 m/s (PMC team, Battambang Landfill DED report, October 2020).

248. **Climate Change Projections.** A Climate Risk and Vulnerability Assessment (CRVA) has been undertaken for this project based on site visits and climate change projections for the Year 2050 and RCP 8.5. The CRVA noted that many sites are vulnerable to flooding and as such mitigation measures in the design are required; the most significant climate change risks associated with the sub-projects are during operation. The landfill site can be impacted by heavy rain and flooding. However, if effectively managed, the CRVA notes that new facilities will bring about improvements to the resilience to heavy rain events, and therefore improve living conditions of the population of the project areas.

249. Table 14below shows the potential impacts from climate change on the landfill sub-project as identified by the CRVA. These issues are managed through design mitigation measures where appropriate.

Table 14: Impacts from Climate Change on Landfill

Climate Change Factor	Impact
Warmer Temperatures	• Increased operating challenges to biological and chemical processes of treatment facilities. • Increased temperatures and increased evaporation in receiving water bodies, changing chemical balances and increased eutrophication.

Climate Change Factor	Impact
	• Reduced capacity to meet wastewater treatment requirements and standards
More Frequent and/or Intense Extreme Weather Events	• Increased risk of direct flood damage to landfill site, wastewater treatment plant, pumping and conveyance, and outfall. • Increased risk of untreated sewage overflows contaminating water supply sources. • Changes in quantity and quality of watershed runoff and in the resulting non-point source pollution loads to receiving waters.

250. **Rainfall variations**. The most intense rainfalls occurring during the three wettest months of the year, August to September. In low lying areas flooding is generally caused by the rainfall in this period and lasts for several weeks. In such a case, changes in monthly rainfall are of more importance than rain falling over a shorter time period. Projections suggest that there will be little, if any, increase by 2030 but could increase by over 20% by 2070. The CRVA concludes that under Representative Concentration Pathway (RCP) 6.0 with regards to changes in future precipitation:

- Annual rainfall may remain unchanged, but rainfall will increase more in the wettest months by being of stronger duration. This will lead to longer dry periods. There may be "mini-droughts" during the wet season.
- Precipitation will increase most in the south-west and decrease in the north-east.
- Both the maximum 5-day and 1-day storms are expected to increase. The projected increases are 10% for 2030, 20% for 2050 and 30% or more for 2070.
- The relative increase in rainfall is heavier for short durations.
- An increase of 20% on existing IDF curves will allow for a global temperature increase of 2^{o}C. This factor is conservative and is recommended as a design factor.

5.5. Surface Water and Ground Water

251. There are no natural permanent water bodies in the near vicinity of the site.

252. **Surface water.** The closest surface water bodies are the Kamping Pouy River and Kamping Pouy Reservoir. From the reservoir point of discharge, the Kamping Pouy River flows northeast towards Tonle Sap. The reservoir provides irrigation for a 12,000 ha large area in Banan and Thamal Kol districts. The reservoir is located circa 6 km to the west of the proposed landfill site and the Kamping Pouy River is about 7 km from the landfill site. Bigger rivers are located about 15 km from the proposed landfill site.

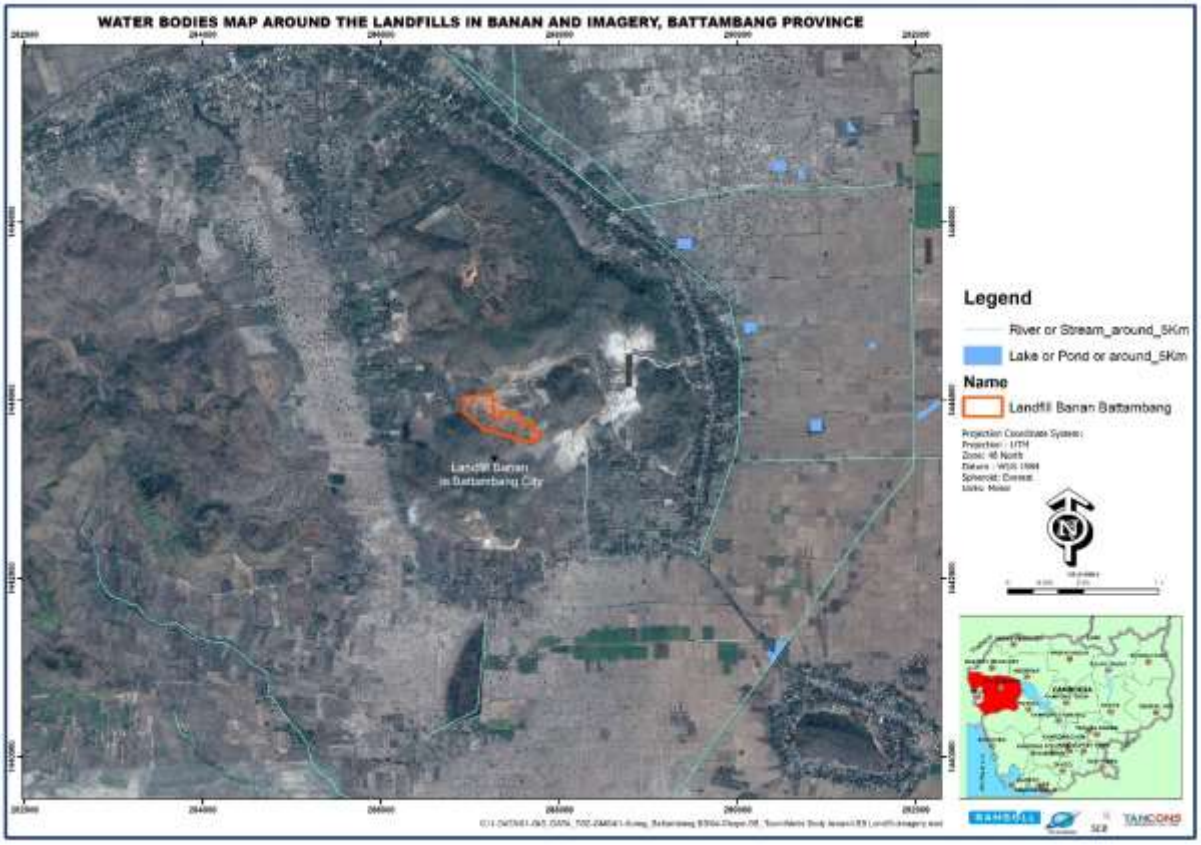
253. The Pouy Svay village, Ta Kream commune is about 3 km to the east of the project site. There are ponds and ground water (wells) within the village. The Water quality is not routinely monitored by MoE however specific projects offer limited water quality analysis which is relevant to the project areas as shown in Table 15. These data show national water quality standards were met at the time of sampling; however, it is recognized these data are now relatively old. Additional water chemistry analysis will take place to inform the domestic IEIA/EIA.

Table 15: Surface Water Quality, Battambang Town

No	Parameter	Unit	Standards	Result
Sampling point: in Sangke River, Watkor Village, Watkor Commune, BattambagTown, on bridge construction site				
1	pH	-	6.5-8.5	**8.22**
2	Total Suspended Solid (TSS)	mg/l	25-100	**76.00**
3	Biochemical Oxygen Demand (BOD)	mg/l	1.0-10	**1.40**
4	Oil and Grease		< 5.0	**3.83**

Source: National Road No5 Improvement Project, MoE March 2020

Figure 32: Water boides 5 km around Battambag landfill site



254. **Groundwater:** The geotechnical surveys found groundwater depths between 2.1 m to 2.9 m below ground level. However, in a few places, the borrow pits have breached the groundwater levels and pools of water can be seen at the bottom of the pits during the wet season.

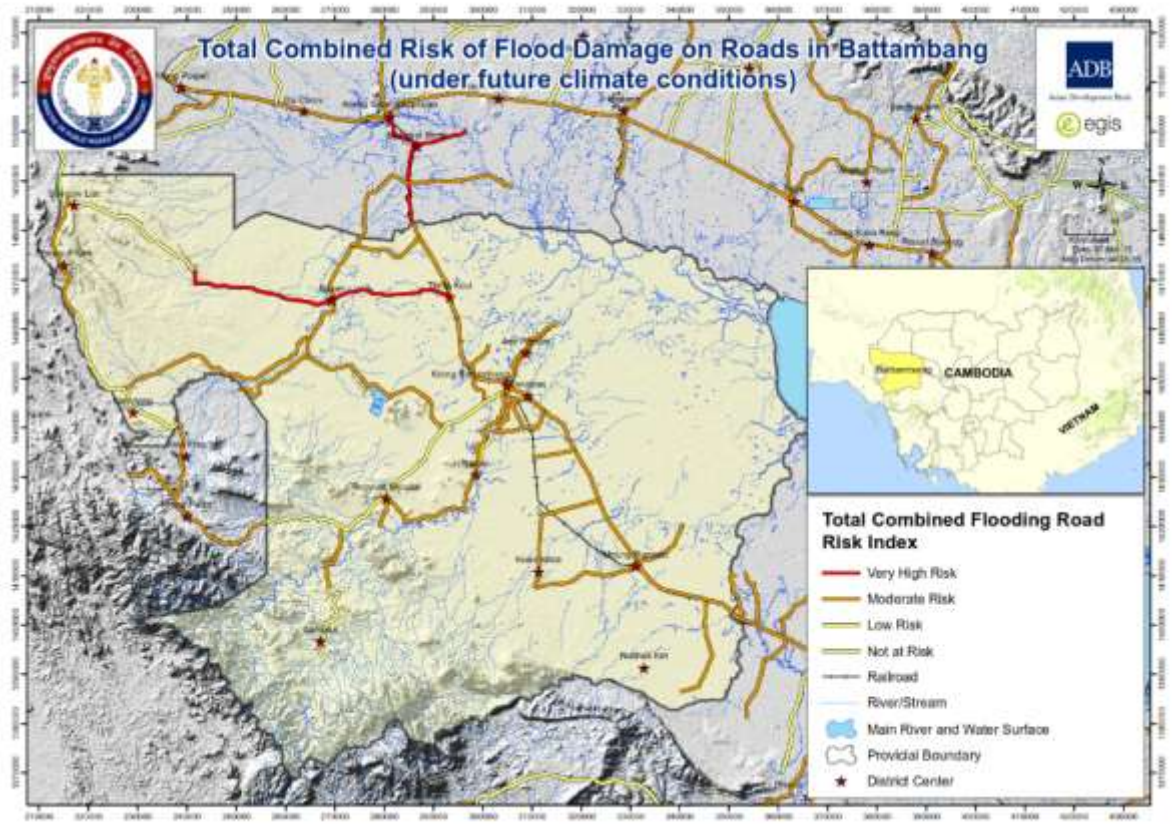
255. There is very limited data of groundwater quality in this area. Monitoring wells will need to be installed prior to the start of the project and baseline data and monitoring data shall be controlled prior to start of construction, during construction and during the implementation phase. Groundwater is not being used for the house located 500 m from the landfill site.

5.6. Natural Disasters

256. **Storms and typhoons**, are not usually considered a major problem in Cambodia as the country is protected by surrounding mountain ranges. Storms do occasionally affect the country, with most storm-related damage being caused by localized floods associated with heavy rain. Tropical storms can also affect the level of Mekong River flooding experienced in a given year. The damage occurs when these small storms arrive during September and October when the seasonal discharge of the Mekong River is already high, and a second significant peak to the annual flood is generated. Also, wind damages property, agriculture and ecological systems. Table 16 presents Natural Disasters occurring in Battambang town between 2012-2014. Most significant impact on the population is flooding. Also, of note is the increase in drought affected households in 2013 and 2014 for Battambang.

257. **Flood.** The area of Battambang city and to the north are classified as being at Moderate Risk of flooding. The flood risk map for Battambang Province is shown below.

Figure 33: FRMI Flood Risk Map Battambang



258. The site is in a location classified as being at Moderate Risk of flooding with with areas to the west being classified as being at Low Risk of flooding.

259. According to JICA study on Natural Disaster Risk Assessment and Area Business Continuity Plan Formulation for Industrial Agglomerated Areas in the ASEAN Region, March 2015 all area in Cambodia is categorized as V and below on the Modified Mercalli Scale with no significant earthquake ever recorded.

Table 16: Natural Disasters 2012-2014

City	Type	2012/Families Affected	2013/Families Affected	2014/Families Affected
Battambang	Flood	21	244	50
	Drought	0	7	74
	Storm	3	5	7

Source: Municipality of Battambang city (2015) in IEE for TA-8556 REG: CDIA.

5.7. Air Quality

260. Field visits indicated that air quality in the project sites is still good, as the project areas are located in rural areas without significant industrial/commercial activities to cause air quality degradation. Typically, in Cambodia, outside Phnom Penh or town centres there are few industrial pollution sources, and the traffic volume is low. Table 17 shows air quality in Battambang in 2020. Nitrogen Dioxide (NO2) and Sulphur Dioxide (SO2) and Total Suspended Particulate (TSP) are within the national standards.

261. However, truck traffic on the access road to road N1570 generates fugitive dust (see Figure 24).

Table 17: Air Quality in Battambang

No	Parameters	Unit	Air quality result (i)	Air quality result (ii)	Standards
1	CO	mg/m^3	0.155	0.375	20 (8 hours)
2	NO2	mg/m^3	0.024	0.026	0.1 (24 hours)
3	SO2	mg/m^3	0.018	0.022	0.3 (24 hours)
4	Ozone (Q3)	mg/m^3	0.064	0.064	0.2 (24 hours)
5	TSP	mg/m^3	0.266	0.139	0.33 (24 hours)
6	PM 10	mg/m^3	0.146	0.053	0.05 (24 hours)
7	PM 2.5	mg/m^3	0.061	0.028	0.025 (24 hours)
8	Lead (Pb)	mg/m^3	ND	ND	0.005 (24 hours)

Source: MoE Laboratory and IEIA report, SBK July 2020

5.8. Noise

Field visits indicate that noise level in the project landfill site is low, due to its location in rural areas without nearby industrial/commercial noise sources. No noise level data is available at landfill site or nearby area. Noise will have to be monitored prior and during construction and operations.

5.9. Special or Protected Area

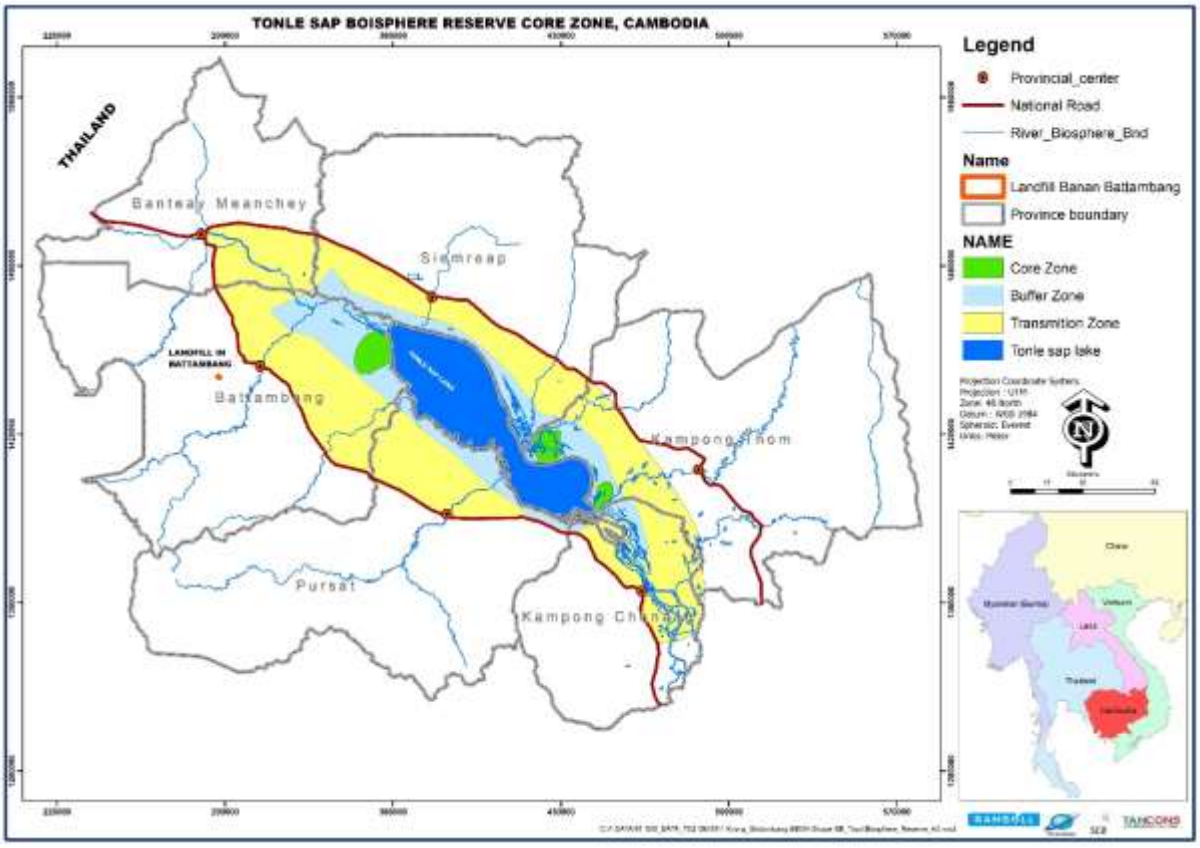
262. There are no protected areas near the proposed landfill subproject site.

263. Of the 23 Protected Areas in Cambodia, the closest to the project is the Tonle Sap Biosphere Reserve (TSBR) which is located in Kampong Chnang, Pursat, Battambang, Siem Reap, Banteay Meanchey, and Kampong Thom provinces (Figure overleaf). The TSBR is classified as a multiple use zone and covers an area of 316,250 ha. It has three core zones which are strictly controlled for biodiversity and conservation. The Tonle Sap Authority was established by the Royal Government of Cambodia in 2009. It is mandated to coordinate the management, conservation and development of the Tonle Sap Lake region and TSBR.

264. Battambang town is on the border of the transition zone. The proposed site is further to the west and therefore outside o the transition zone.

265. It is considered that the biosphere reserve is outside the area of influence and will not be impacted by the landfill sub-project.

Figure 34: Map of Tonle Sap Biosphere Reserve



Source: Adapted from TSBR

5.10. Ecological Resources

266. **Flora.** Biodiversity screening of the project sites using IBAT was carried out at PPTA stage. The project site does not contain any protected areas or habitats of particular biodiversity value. The landfill site is located in highly disturbed environments (quarry and borrow pit area), no trees within the site. Its surrounding is dominated by agricultural land with scattered trees and shrubs. The common species including rattan (Calamus sp), acacia (Acacia Auriculiformis) bamboo (Bambusa Arundinacea), snowy orchid (Bauhinia Acuminata) and some mango farm plantation areas are located just west of the proposed landfill site as shown on the land use map in chapter 5.3.

Figure 35: Proximity report generated by IBAT

ibat

Protected Areas and Key Biodiversity Areas

The following sites are found within the selected buffer distances:

Features within 1 km

There are no features within 1 km.

Features within 5 km

There are no features within 5 km.

Features within 20 km

There are no features within 20 km.

267. The southern sections of the site are fringed by forested hills. There are no current plans for any deforestation and the hills appear to have no issues with landslips. Table 18 summarizes observed vegetation/forest species outside the landfill site.

Table 18: Locally observed vegetaiont/forest species

No	Khmer Name	Scientific name	IUCN
1	Krakah	*Sindora cochinchinensis, Baill.*	LC
2	Porpel	*Shorea Roxburghii*	VU
3	Tbaeng	*Dipterocarpus obtusifolius, Teysm*	NT
4	Trarch	*Dipterocarpus intricatus*	EN
5	Kontout Prey	*Phyllanthus emblica*	LC
6	Jompus Tea	*Cyanotis cristata*	LC
7	Komplov Neang	*Homalium tomentosum*	LC
8	Sombok Mourn	*Barringtonia angusta*	LC
9	Chher Keo	*Murraya paniculata*	-
10	Romdoul Si Plae	*Goniothalamus repevensis*	-
11	Dangkeab Kdaam	*Antidesma ghaesembilla*	LC
12	A'hoa	*Diospyros ehretioides*	LC
13	Nhenh	*Melastoma sanguineum*	LC
14	Khlong	*Ternstroemia penangiana*	VU
15	Anchaanh	*Gmelina asiatica*	LC
16	Angkunh Sva	*Bauhinia bassacensis*	-
17	Trormung Sek	*Suregada multiflorum*	-
18	Rorkar	*Bombax ceiba*	LC
19	Srorm Dav	*Oroxylum indicurn*	-
20	Phluu	*Cyclea peltata*	-
21	Tuntrean Khaet	*Chromolaena odorata*	-
22	Bonla S'et	*Acacia concinna*	-
23	Voal Meas	*Cassytha filiformis*	LC
24	Voal Snaeng Ko	*Streptocaulon juventas*	-
25	Voal Chhuy	*Steptocaulon juventas*	-
26	Voal Sav Mao	*Passiflora foetida*	-
27	Pdao Preah	*Korthalsia bejaudii*	-
28	Ruessey Prech	*Arundinaria pusilla*	-
29	Domlong Chheam Mourn	*Dioscorca alata*	-
30	Domlong Chhruk	*Dioscorea oryzetorum*	-

Source: IEIA Report, SBK July 2020

268. **Fish Species.** Cambodia is rich in fish biodiversity with at least 500 fish species recorded in the Cambodia's Mekong River and nearly 300 fish species in Tonle Sap Lake. During the preparation of the initial CDIA IEE for this project, interviews were held with local people regarding their understanding of fish species in the project area. The results were similar for all project towns. As an example, some species were named, with the most common being (including Khmer name) Trey Riel, *Henicorhynchus* sp (carp); Trey

Andaing Toun, *Clarias macrocephalus* (catfish); Trey Phtuok/Raws, *Channa striata* (snakehead); Trey Kranh, and *Anabas testudineus* (climbing perch). It is noted that these species listed are not threatened, critical or endangered. No water body were observed during the visit within landfill site or its surroundings, therefore no threats to fishes.

269. **Bird Species.** Cambodia has a number of protected bird habitats, including Prek Toal Core Zone within the Tonle Sap lake. This core zone will not be impacted by the project. As with fish species, the initial CDIA IEE preparation team undertook consultations with resident in all the sub-project areas in 2016 (including Battambang Town) to identify actual bird species which are observed by local people. The IEIA Report, SBK July 2020 has listed the bird species observed in the project site (Annex 6).

5.11. Human Environment

5.11.1. Demography

270. The planning horizon for the Battambang landfill project is until the year 2040 with initial focus on 2030. The service areas for solid waste management have been confirmed with the PIUs and include the main urban areas of Battambang, as well as surrounding some adjacent districts. The PMC team has reviewed the PPTA population projection for Battambang, and the anticipated service areas for waste collection. Population projections for the service areas have been updated using the base population of 2018.

271. Within the urban area estimations have been made on the percentage of the sangkat populations that can be readily serviced and therefore included in the service area within the municipality. The results are shown in Table 19.

Table 19: Estimate of 2018 Service Area Population within the Municipality

Sangkat	Population 2018 (CDB)	% Serviceable	Service Area Population 2018
Kdol Doun Teav	10,279	50%	5,140
Slaket	8,965	50%	4,483
Chamkar Samrong	21,056	70%	14,739
Ou Char	18,897	60%	11,338
Toul Ta Ek	19,584	70%	13,709
Svay Por	22,503	100%	22,503
Rattanak	15,518	70%	10,863
Prek Preah Sdach	15,142	70%	10,599
Ou Mal	12,079	30%	3,624
Wat Kor	19,324	30%	5,797
Total	**163,347**		**93,373**

Source: CDB 2018 and PMC estimates

5.11.2.Socio-Economic Conditions

272. Socio-economic data were obtained from Commune/Sangkat. A survey of 1478 respondent was undertaken during the PPTA phase. A full analysis of the results from the survey is provided in Volume 4 of TS-2 Feasibility Study report. The analysis of this survey is not repeated here, however, a few key points relevant to environmental safeguards are summarized and combined for 3 provinces:

- Electricity / Infrastructure. 97% of households are connected to the electricity grid

- Waste Collection. 55% of respondents are aware of a waste collection service in their area, while the rest has no service offered. Of those who have a service available, 36% use it. Ninety-two percent of respondents have waste materials which they do not throw away. Of this, 99% of respondents sell recyclable waste to door-to-door collectors.

5.11.3. Water Users.

273. Fifty-seven percent of households connect to piped water supply, of which 63% connect to the public water supply and the remainder to a private connection. The responses showed that in the dry season, for those who are not connected to a piped water supply, some use water from ponds and lakes and canals as a water source. A small number of community residents use the canal network as water source. It is not known what subsequent treatment the resident may then undertake on the water, such as boiling, chemical or UV treatment. Boreholes and wells were also

5.11.4. Physical Cultural Resources

274. There are no cultural resources, in particular pagodas, temples and any cultural/ historical receptors within radius of 1km from the landfill site. The nearest pagodas are located in Poar Svay Village which is 3 km from the proposed landfill site.

275. There were also no graveyard or family graves identified in the proposed landfill area/ or directly near the landfill site.

6. ANTICIPATED IMPACTS AND MITIGATION MEASURES

6.1. Project Environmental Benefits

276. The project is anticipated to have significant localized environmental benefits. Field visits showed that the area is being polluted due to poor waste management practices, from littering, lack of collection to improper and uncontrolled dumping and open burning at the existing dump site. The growing urbanization of the project area means that this situation is likely to continue without the construction of adequate infrastructures.

277. The development of well-designed waste management facilities, with components dedicated to preventing leachate migration to soil and groundwater, leachate management separation of hazardous waste, collection of landfill gas, etc. will reduce the pollution of the environment and therefore lower the risks to human health and environmental quality. These benefits will depend on the services and facilities being maintained and operated at the environmental regulations and standards to which they are designed.

6.2. Environmental Impact Assessment Screening

278. The following discussion on environmental impacts screens the potential impacts according to the following factors and recommends mitigating activities on this basis:

(i) "**Receptor**": the resource (human/natural environment/economic/social) which is potentially going to receive and have to cope with potential impacts.

(ii) "**Sensitivity**": ability to cope with an impact and/or its importance to Cambodia. It is generally accepted that human health is always a high sensitivity receptor. However, in terms of environmental/natural resources, the sensitivity varies according to the receptor e.g. scrubland with no significant biodiversity is considered less sensitive than a water body which supports ecosystems and livelihoods through fishing.

(iii) "**Magnitude**": the size of the potential impact. Impacts may be short term and considered low magnitude (e.g. noise or temporary reduction of income during a short construction project) or high magnitude and long term (e.g. the pollution of water quality, air, and public health).

279. Where an impact may occur, if there is no receptor to potentially receive the impact, then mitigating actions or measures will not be required. This follows the source-pathway-receptor model, whereby in order for there to be an impact, the pollutant or issue (sources) needs to be present, the pathway to a receptor is needed (such as fissures in rocks, or water for human consumption) and a receptor must be present to receive the impacts, such as humans, flora or fauna.

Table 20: Screening of Impacts for Battambang Landfill

Impact	Source	Receptors
Construction		
Degradation of Air Quality	▪ Exhaust fumes from construction machinery and equipment, movement of haulage trucks ▪ Asphalt pouring ▪ Fugitive dust from borrow pits and all excavation works ▪ Fugitive dust from loading, unloading and haulage of construction materials ▪ Fugitive dust from concrete batching plants.	▪ Ambient Air ▪ Populations near project sites ▪ Workers
Noise nuisance	▪ Noise from construction machinery and haulage trucks ▪ Noise from Generators ▪ Movement of material / dumping of material (including waste from dumpsite)	▪ Populations near project sites ▪ Workers ▪ Waste pickers at the dumpsite
Impacts on water quality	▪ Discharge of contaminated stormwater (suspended material, spills) ▪ Accidental Spills ▪ Waste / litter ▪ Improperly drilled boreholes	▪ No surface water body identified nearby ▪ Ground water ▪ Nearby agricultural fields
Erosion or degradation of soil and land / Flooding	▪ Earthworks ▪ Accidental spills/ poor management of waste	▪ Surface water bodies ▪ Communities
Destruction of fauna and flora	▪ Clearing of construction sites (landfill, borrow pit)	▪ Trees, bushes and shrubs
Impacts on health and safety	▪ Traffic increase in residential areas from trucks movement ▪ Air emissions and effluents ▪ Co-activity ▪ Use of construction equipment/tools ▪ COVID-19	▪ Communities ▪ Workers
Operation		
Degradation of Air quality	▪ Biogas Generation ▪ Smoke from waste fires ▪ Emissions from waste trucks and cover material trucks	▪ Ambient air ▪ Nearby communities
Impacts on water quality	▪ Non-compliant discharged leachates ▪ Contaminated stormwater ▪ Spills and windblown litter	▪ No surface water body identified near the site ▪ Groundwater ▪ Nearby agricultural fields ▪ Fauna and Flora
Odour and Dust	▪ Landfill operations / open cells ▪ Dust from movement of vehicles	▪ Workers ▪ Communities
Impacts on Health and Safety	▪ Movement of waste trucks and trucks for cover material ▪ Accidental events such as fires and explosions ▪ Use of equipment/maintenance of landfill ▪ Presence of litter and pests around landfill ▪ Non-compliant effluents ▪ COVID 19	▪ Workers ▪ Communities

6.3. Environmental Impact and Mitigation Measures linked to pre-construction activities

280. Potential negative impacts associated with the pre-construction phase of the subproject mainly concern land acquisition.

281. The details of any required land acquisition and resettlement are addressed in the Resettlement Plan and Inventory of Losses that have been prepared separately. The Resettlement Plan includes a grievance redress mechanism and resettlement budget covering the direct compensation costs, implementation costs, and contingencies.

282. The measures to mitigate other impacts associated with the pre-construction phase include the following:

(i) The PMU has obtained approval by MoE of the IEIA on 10 February 2021. Conditions in the approval including baseline environmental surveys shall be met. The PMU should also ensure all other relevant permits are obtained prior to start of any works (including vegetation clearing).

(ii) Institutional set up and strengthening. (a) appointment of a Safeguards Focal Point within each PIU (PIU-SFP); (b) appointment of Environmental Safeguards Officer in the PMU (PMU-ESO); and (b) contracting of international and national Project Management Consultant for Environmental Safeguards (PMC-I/NES) will be carried out. Prior to the start of construction, an environmental capacity building and training program will be delivered by the consultant. The training will focus on ADB's and Cambodia's relevant environmental, health and safety laws, regulations and policies; implementation of the EMP, environmental monitoring, requirements for information disclosure, public consultation and the project GRM. Training will be provided to the PIU**,** and contractors.

(iii) Disclosure and Consultation: Information disclosure and consultation activities will be continued with affected people and other interested stakeholders, including but not limited to the project implementation schedule, key construction activities (in particular those that result in disturbance or nuisance) GRM and status of compensation (if relevant).

- The project implementation schedule,
- Key construction activities (in particular those that result in disturbance or nuisance)
- GRM and status of compensation (if relevant).

And discussions related to:

- Impacts/ Nuisance on the Environment and the communities reported by community members.
- Concerns and expectations from the project

(iv) Grievance Redress Mechanism (GRM). In accordance with the GRM (see Environmental Management Plan), the PIU-SFPs will be responsible for day-to-day monitoring of the GRM and the PMU-ESO will assume overall responsibility for co-ordinating and reporting on GRM. The PIUs/PMU will issue public notices to inform the public within the project area of influence of the GRM contact information (GRM website address, PIU/PMU address and telephone number, PIU/PMU contact point email address) and local entry points (e.g. contractors and country-system via Grievance Redress Committee.

(v) EMP in bidding document. The sub-project specific EMP will be incorporated in the bid documents and construction contracts to provide basis for Contractors to develop package specific CEMP.

(vi) The Contractor Environmental Management Plan (CEMP) will be prepared and updated by the Contractor. The CEMP shall comply with the approved IEE and EMP and shall be submitted to the PIU and PMC for approval before starting construction. It shall contain the following subplans:

- Materials, Spoil and Borrow Site Management Sub-Plan
- Solid and Liquid Waste Management Sub-Plan
- Community and Occupational Health and Safety and Emergency Response Sub-Plan
- Traffic Management Sub- Plan
- Construction Workers Camp Management Sub-Plan

(vii) Unexploded ordinance. A critical activity that must occur before any civil works or excavation activity is a review by the military to ensure all potential sites containing unexploded ordnance (UXO) are cleared. The EA/IU/PIU will coordinate required UXO identification and clearing with the military.

(viii) Associated facilities. Confirm location of the borrow pit and temporary spoil storage and final disposal sites, securing permits from relevant DOE.

(ix) Borrow sites. The proposed designs require backfill materials to keep the dumping cells 3 m above groundwater table levels. The Borrow sites to be exploited for the construction activities need to be identified within the CEMP, and site-specific spoil and borrow site management plans need to be prepared for each borrow site identified for construction.

(x) Prior to start of operations, the Operator will also conduct the same exercise as regular cover will be required at the site to limit nuisances. The Borrow sites will need to be identified and approved, the amount of cover material required on a yearly basis, and the source of material, shall be clearly stated in the future operation plan and spoil and borrow site management plan.

(xi) Groundwater study. A site-specific hydrogeological study is required prior to start of works in order to identify groundwater characteristics (depth, flow, direction, productivity, usage, variations), and identify the most appropriate location for monitoring wells. The groundwater study must include the identification of all groundwater wells and boreholes used by nearby villagers (farmers and industries) within a 3 km radius.

(xii) A method statement for the construction of groundwater monitoring wells and water supply wells are required during pre-construction period and should be included in the CEMP. The statement will be prepared by Contractor and approved by PMC-NES.

(xiii) Monitoring boreholes should also be put in place prior to start of excavation of landfill cells (minimum 1 borehole upstream and 2 boreholes downstream), and a baseline assessment of groundwater quality should be conducted prior to start of work. Samples must be taken from each borehole, and from nearby boreholes at the nearest receptors, to conduct laboratory analyses against drinking water guidelines.

(xiv) Registration of high trees and other vegetation at the project sites (landfill site, access road, construction camp site, and borrow sites) prior to start of works and the results integrated into the CEMP. This is to ensure that:

- existing vegetation is preserved where no construction activity is planned
- all trees over 3 m should are registered prior to construction works and reported to DWPT for protection or removal.
- relevant permits from DWPT and local authorities for removal or cutting of trees can be obtained.
- make provisions for plantation of new trees for each one removed (agree number with communities in affected area).

6.4. Environmental Impact and Mitigation Measures during Construction

6.4.1. Air Quality

283. Moderate to significant temporary air quality impacts can be expected during the construction stage of the project. The receptors for lower air quality are local residents close to the site particularly downwind of the construction activities, houses close to the dirt and gravel access road from the national road, and waste pickers working on the existing dumpsite.

284. Air quality impacts during construction are likely to result from the following sources:

(i) Emissions from construction machinery and equipment, movement of haulage trucks will lead to minor increases in levels of nitrogen oxides (NOx) and sulphur oxides (SOx).

(ii) In particular, these emissions will be associated with earthworks and truck movement to mobilize the expected 383,384 m^3 of material that need to be imported into the site. This amount has been estimated for the complete 20 years of operation and therefore for the construction of the first cell, it is approximated that only a ¼ of this amount will be required during the first stage of construction, which would still represent about 7,900 truckloads of 12 m^3 each to deliver backfill material to the site (only taking into consideration the landfill itself and not the access road works). The amount of associated atmospheric emissions will depend on the location of the borrow sites.

(iii) Asphalt for road pavement reinstatement will produce fumes containing small quantities of toxic and hazardous chemicals such as volatile organic compounds (VOC) and poly-aromatic hydrocarbons (PAH);

(iv) Fugitive dust from borrow pits and all excavations;

(v) Fugitive dust from loading, unloading and haulage of construction materials;

(vi) Fugitive dust and bioaerosols from movement of waste within existing dumpsites and to new sites; and

(vii) Fugitive dust from concrete batching plants.

(viii) Windblown litter from transport of old waste.

285. The mitigation measures to protect sensitive receptors from air quality issues are:

(i) Select Borrow sites located as close as possible to the proposed landfill site to reduce distances.

(ii) Concrete batching facilities will be located at least 500 m downwind from the nearest dwellings in order to reduce the impact of fumes on humans and to be fitted with necessary equipment such as bag house filters to reduce fugitive dust emissions.

(iii) Water will be regularly sprayed on construction sites, material handling areas, and borrow pits where fugitive dust is generated.

(iv) Trucks carrying dry construction materials such as earth or waste will be covered with tarpaulins or other suitable cover.

(v) Construction vehicles and machinery will be maintained to a high standard to minimize emissions for comply to National emission standards. All mobile equipment should be fitted with catalytic converters.

(vi) Vehicle speed will be reduced to 30 km/hr in each inhabited area.

(vii) Waste pickers and all residential areas within 500 m of existing dumpsite will be informed in advance of when waste movements will take place.

(viii) Unauthorized burning of construction and demolition waste material and refuse is prohibited.

(ix) Air quality will be monitored at landfill site and at receptor level and actions should be taken in case of complaints or non-compliance.

6.4.2. Noise

286. Noise nuisances will be temporary and localized in particular at construction sites (road access and landfill site) as construction machinery and vehicles generate noise as they operate. Other noise sources include loading and unloading of equipment and materials and the construction of boreholes for landfill groundwater monitoring. Significant noise impacts will be experienced by construction site operators. Construction machinery may produce noise levels up to 90 dB(A). For the project, no receptors other than construction workers will be this close to the machinery for extended periods of time. Noise disturbance will also result from the increase of traffic on roads from Battambang town to the landfill, in particular when they pass by inhabited areas.

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

(i) Maintain all exhaust systems: systems should remain at all time in good working order - undertake regular equipment maintenance;

(ii) Restrict construction activities between 8am-6pm;

(iii) Provide advance warning to the community on timing of noisy activities. Public notification of construction operations will incorporate noise considerations; information procedure of handling complaints through the Grievance Redress Mechanism will be disseminated.

(iv) Ensure noise monitoring is undertaken near sensitive receptors, particularly dwellings when construction machinery is operational; and ensure compliance with the noise standards of Sub-decree N.42 on air pollution control and noise disturbance, MoE, 2000.

(v) All construction workers will use appropriate Personal Protective Equipment (PPE) including ear defenders when operating machinery;

(vi) Use of mobile noise barriers in densely populated areas where excavations are taking place.

(vii) As part of traffic management plan, speed limits should be set for trucks and other work machinery when passing through residential areas. Vehicle speed will be reduced to 30 km/hour in each inhabited area. Engines should be turned off when not in use.

(viii) Regularly monitor noise levels at construction site boundaries and in villages crossed by construction vehicles (like Poar Svay). If noise standards are exceeded by more than 3 dB, equipment and construction conditions shall be checked, and mitigation measures shall be implemented to rectify the situation.

6.4.3. Flora and Fauna

288. The baseline assessment indicates that impacts on terrestrial flora and fauna will be limited at the landfill site during construction because the sub-project is in an already disturbed area (borrow pit/quarry and agricultural lands). There are still a few trees likely to be impacted by the development of the landfill, especially on the southern edge of the site. Additional impacts on fauna and flora may arise from use of material from borrow pits and quarry, especially if new areas of land need to be cleared to obtain material.

289. In line with ADB guidelines, there shall be no net loss of biodiversity associated with this project and all impacts or Potential impacts on terrestrial flora and fauna will be mitigated through the following measures:

(ix) Existing vegetation must be preserved where no construction activity is planned.

(x) An inventory of trees over 3 m high should be provided prior to construction works.

(xi) Trees/vegetations over 3 m encountered on construction site or access areas shall be protected from construction activities if they are not required to be removed.

(xii) Cutting of trees over 3 m high requires permit from DPWT and the local authority. In addition, replantation shall be sought upon completion of the work. where a tree must be removed, or an area of grassland disturbed, replant trees and re-vegetate the area after construction.

(xiii) Where possible, material from existing licensed borrow and quarry sites will be used. If new sites are needed, they will be subject to due diligence and approval by ADB and the relevant PDoE to ensure that sensitive habitats are avoided and that an appropriate restoration plan using native species is agreed following re-contouring.

(xiv) Construction workers shall be prohibited from capturing any wildlife in the project areas.

(xv) Relatively to impacts on agricultural fields, crops and trees, refer to Resettlement Action Plan.

6.4.4. Water Quality

290. Construction will take place in an upland area (hill area), used for quarrying and farming. At the landfill site, there is no surface water body identified nearby the site, and as the site is in the form of a depression and drainage will tend to be directed to the bottom of pits. Construction and operation of the site are planned to start at the lowest point of the site, therefore stormwater and leachates will have to be pumped out and discharged in the leachates treatment lagoons.

291. Although there is no surface water body nearby the site, during rainy season runoff from construction site with suspended solid content may flow into temporary water bodies in low lying areas and cause short term impact to water quality.

292. At the Borrow site there maybe surface water bodies in the vicinity. During rainy season runoff from construction site with suspended solid content may flow into water bodies in low lying areas and cause short term impact to water quality.

293. In addition, modification of drainage patterns linked to new infrastructures and topography at the landfill site, but also on access road and at the old dumpsite as well as at the Borrow site, may lead to ponding and flooding in areas.

294. Potential impacts on surface water will be mitigated through the following measures:

(i) Portable toilets and small wastewater treatment units will be provided on construction sites and construction camps for the workers and canteens. If there are nearby public sewers, interim storage tanks and pipelines will be installed to convey wastewater to those sewers. All sanitary facilities should be located at least 200m from surface water bodies.

(ii) Temporary ditches should be installed around the construction site to manage and control the runoff and prevent direct discharge of potentially polluted water to surrounding farmland or water bodies.

(iii) Sedimentation tanks will be installed on construction sites to treat process water (e.g. concrete batching for pier construction) and muddy runoff with high concentrations of suspended solids. If necessary, flocculants such as polyacryl amide will be used to facilitate sedimentation.

(iv) Runoff accumulating at the bottom of the cells during construction will be pumped out and discharged appropriately

(v) The discharge point for stormwater runoff, pumped out water, and other effluents must be identified prior to construction works. Capacity of receiving water body or irrigated land needs to be assessed, as well as risk of contamination from pumped out water or stormwater runoff.

(vi) Construction machinery will be repaired and washed at dedicated repairing shops. No onsite machine repair and washing shall be allowed.

(vii) The hazardous waste (oil waste) shall be properly collected and stored in closed container under shelter for reuse or recycle or disposal, to ensure they will not contaminate soil, groundwater or surface water.

(viii) Material stockpiles will be protected against wind by being covered and runoff waters which might transport them to surface waters. They shall be located further than 50 m from water bodies.

(ix) Storage of bulk fuel should be on covered concrete pads away from the public and worker camp, and 300 m from surface waters. Fuel storage areas and tanks must be clearly marked, protected, and lighted. Contractors should be required to have an emergency plan to handle fuel and oil spillage.

(x) All construction fluids such as oils, and fuels should be stored and handled on a bunded impermeable surface; a bund will be provided around any above ground fuel storage tanks with a capacity of 110% of the largest single tank.

(xi) No washing or repair of machinery should take place within 50m of surface watern bodies.

(xii) Implement all soil erosion protection measures needed to prevent erosion.

(xiii) A vegetation buffer shall be maintained between the construction sites and the nearest water bodies.

(xiv) Final design to incorporate adequate drainage management system like cross drains on all facilities and access roads to ensure project does not cause ponding or further flooding elsewhere.

(xv) Conduct monitoring of all discharged water (stormwater and treated leachates) around the project site for key parameters including turbidity, Hydrocarbon content and physical parameters.

6.4.5. Groundwater

295. Groundwater impact shall be primarily linked to the operation phase. However, the risk for groundwater, even at construction stage cannot be neglected as excavation activities need to be conducted, and construction works activities can be source of contamination (sanitary water, use of chemicals), and may also affect groundwater flow locally.

296. The PMC team has conducted geotechnical survey at the proposed landfill site and found that groundwater table is 2.1-2.9 m from the existing ground level. Development of landfill site requires extensive earth filling in some areas. Such filling work will risk impacting groundwater quality and groundwater movement.

297. Potential impacts on groundwater will be mitigated through the following measures

(i) Construction vehicles and machinery will be maintained to a high standard to prevent leak of oil, lubricant into the ground.

(ii) Pits must be backfilled to keep bottom of cells more than 3 m above highest ground water table level. Additional evaluation of groundwater level variations will be required to identify the seasonally highest level[7]. A site-specific Hydrogeological study is therefore required prior to start of works.

(iii) Backfilling material must be tested and controlled to ensure it does not impact ground water quality.

(iv) Implement mitigation measures for waste management as indicated in **Solid Waste Management** section.

(v) Ground water monitoring wells must be put in place prior to start of works and monitoring must be conducted on water upstream and downstream of future cells. Baseline water quality and depth needs to be controlled before the start of works. Method statement for the construction of groundwater monitoring wells and water supply wells are required during pre-construction period. The statement will be prepared by Contractor.

(vi) An inventory of all water wells used by populations around the site (within a 3 km radius) should be conducted, and monitoring should also be conducted on these wells against drinking water guidelines.

6.4.6. Soil and Land

298. Soil erosion is not anticipated at the landfill itself given the nature of the landfill project, however exploitation of borrow sites will potentially cause local impacts to the land through clearing of vegetation and modification drainage patterns.

299. Potential impacts on soil and land resources will be mitigated through the following measures:

(i) A map of all borrow sites will be developed and maintained with copies held by the Contractor and PIU.

(ii) Site specific spoil and borrow site management plan will be developed and approved by the relevant Municipal authorities or departments.

(iii) Safety measures will be implemented including the prevention of access by members of the public and livestock.

(iv) Measures to rehabilitate the borrow sites shall be implemented including contouring of the slopes within each site and replanting sites with native species;

(v) Topsoil present on construction sites will be removed and stockpiled in a labeled area for use on rehabilitation of the site post-construction or rehabilitation of borrow sites;

(vi) There shall be no disposal of spoil or dredged material on agriculturally productive land or within 50 m of a water course.

(vii) Construction working areas will be clearly demarcated and encroachment onto adjacent areas prevented.

[7] As a reference, IFC EHS guidelines for Waste management facilities mentions that “Groundwater's seasonally high table level (i.e., 10 year high) should be at least 1.5 meters below the proposed base of any excavation or site preparation to enable landfill cell development »

(viii) After exploitation of a borrow site is completed, the site should be rehabilitated, which means at minimum that slopes should be stabilized, and erosion prevented through re-vegetation and other measures as necessary.

6.4.7. Solid waste management.

300. Construction activities will generate waste (cleared vegetation, waste rock, debris, oily wastes, domestic waste from construction camps, etc.). If not managed properly these may cause impacts on the environment (soil, water) and populations.

301. Potential impacts from waste will be mitigated through the following measures.

(i) Preparation of a Waste Management Plan before construction which applies the waste hierarchy to ensure efficient use and management of resources with a priority to prevent waste at source as much as possible.

(ii) Clear arrangements for storage and transportation of all hazardous and non-hazardous waste to an authorised and approved disposal point (approved by PDoE or Local authority).

(iii) Recyclables to be separated at source and given/sold to recycler (plastic, metal, card, paper as a minimum).

(iv) No waste will be stored within 20 m of a water course and all solid waste to be stored in containers with lids.

(v) Prohibit burning of waste at all times;

(vi) Provide all vehicles/drivers with plastic bags for waste collection and prevent any unauthorized waste disposal with particular attention paid to prevention of waste entering water ways including irrigation canals.

6.4.8. Community and Occupational Health and Safety

302. Construction sites and access roads will present health and safety risks not only to construction workers, but also to people living around the sites. These risks can be linked amongst other things to:

- Temporary traffic diversion on access roads.
- Continual generation of noise and dust on hauling routes, and general hindrance to local access and services are common impacts associated with construction works within or nearby local settlements.
- The project may also contribute to increasing the risk and occurrence of road accidents because of the presence of heavy machinery on the roads.
- Community risks come from unauthorized access to construction sites and construction traffic.
- Other Occupational risks will come from a range of activities including the use of heavy machinery, earth moving, and use of chemicals.
- The potential presence of UXO also poses a threat to workers and communities, that is why UXO clearance must be conducted on all works site prior to any works (se chapter 6.3).

303. In addition to these usual construction risks, due to COVID-19 pandemic, workers and staff at constructing site can be infected by the virus, then some prevention and mitigation measures need to be applied.

304. Potential impacts on community and occupational health and safety will be mitigated through the following measures as defined in a Community and Occupational Health and Safety and Emergency Response Sub-Plan, that will have to be developed by the contractor based on measures also presented in detail in the EMP:

305. Sufficient signage giving health and safety warnings and information disclosure at the entrance of all sites.

(i) The contractor shall appoint an Environment, Health and Safety (HSE) Officer who is qualified engineer.

(ii) Access to construction sites will be prevented through appropriate fencing, protective barriers, and buffer zones.

(iii) Excavation sites will also be specifically fenced, and no person shall enter an excavation area without supervision/control.

(iv) Sufficient signage giving health and safety warnings and information will be displayed at all sites.

(v) Worker education and awareness seminars for construction hazards will be given on a regular basis. A construction site safety program will be developed and distributed to all workers.

(vi) The Contractor HSE supervisor shall conduct daily toolbox meetings (safety briefings)

(vii) An accident record book will be maintained where all major or minor accidents and incidents are recorded with actions taken.

(viii) The contractor shall ensure that all workers are equipped with and use Personal Protective Equipment.

(ix) Adequate first aid equipment will be made available on site.

(x) Provision will be made for safety precautions when using 220 V to 240 V Electric Power tools if the workers are likely to be working within wet or flooded environments.

(xi) Warning signs will be set up if mud is likely on public roads. Mud will be removed at the end of each day. Other spillages on public roads will be removed immediately.

(xii) Contractor will set out an Emergency Response Plan.

(xiii) The contractor will also develop a traffic management plan covering movement of vehicles within the construction sites, and outside the construction sites. Traffic management must include regular monitoring of traffic safety both within construction site and on public road. Traffic monitoring should entail, description of access roads, speed limits, controls and monitoring on drivers, training of drivers on Health and Safety, emergency numbers for road accidents, grievance mechanism.

306. Potential impacts to workers in construction due to COVID-19 will be mitigated through the following measures[8]:

(i) Plan and execute work in compliance with country-specific COVID-19 risk management regulations and directives including directions of the General Department of Labour, MoLVT.

(ii) Conduct workplace risk assessment to identify low, medium or high exposure risk to COVID-19. Prepare an action plan for prevention and mitigation of the spreading of COVID-19.

(iii) Conduct Risk communication, training, and education. Training of workers in infection prevention and control practices

[8] For more details, refer to WHO Guidelines for getting the workplace ready for COVID19: https://www.who.int/docs/default-source/coronaviruse/getting-workplace-ready-for-covid-19.pdf?ua=1 And ILO's Guide: https://www.ilo.org/wcmsp5/groups/public/---ed_dialogue/---act_emp/documents/publication/wcms_740212.pdf

(iv) Adopt engineering, organizational and administrative measures, plan work so employees can keep distance from each other and minimise contact.

(v) Provide clear and visible guidelines on how to prevent infection at the construction site and initiatives taken.

(vi) Dissemination about COVID-19 prevention and mitigation measures to staff and workers through orientation or distributing leaflet/poster at information/safety board at each construction and camp site;

307. More specifically, measures implemented shall entail:

(i) Daily checking temperature of staff and workers prior starting the works;

(ii) Staff and workers have to wear masks all the time and properly;

(iii) Do not share personal items or supplies such as phones, pens, notebooks, tools, etc.;

(iv) Avoid common physical greetings, such as handshakes;

(v) Maintain a minimum physical distance of one metre from others if possible;

(vi) Wash hands often with soap and water for at least 20 seconds after using the washroom, before handling food, after blowing nose, coughing, or sneezing, and before smoking. If hands are not visibly soiled, and soap and water are unavailable, alcohol-based hand sanitizer can be used;

(vii) All offices and jobsites implement additional cleaning measures of common areas. All door handles, railings, ladders, switches, controls, eating surfaces, shared tools and equipment, taps, toilets, and personal workstation areas are wiped down at least twice a day with a disinfectant, such as disinfectant wipes. Individuals are responsible for cleaning and disinfecting their workstations;

(viii) Commonly touched surfaces on vehicles and equipment are thoroughly cleaned and disinfected at the end of shifts and between users;

(ix) Coughing or sneezing into a tissue or the bend of your arm, not your hand; And dispose of any tissues you have used as soon as possible in a lined waste basket and wash your hands afterwards;

(x) Individuals who have been potentially exposed to the virus, or who are exhibiting flu-like symptoms such as fever, tiredness, coughing, or congestion are instructed to: Not come to work; Contact their supervisor and/or human resources department; Stay at home and self-isolate; and Contact local health authorities for further direction.

(xi) Such individuals are required to follow the directions of the local health authority and may not return to work until given approval by the proper health authorities;

(xii) Individuals who begin to display flu-like symptoms on site are instructed to avoid touching anything, take extra care to contain coughs and sneezes, and return home immediately to undergo self-isolation as directed by the local health authority;

(xiii) All areas on site potentially infected by a confirmed or probable case are barricaded to keep individuals two meters away until the area is properly cleaned and disinfected.

308. COVID-19 contaminations should be reported as part of the HSE monitoring report submitted to PMU/ADB.

6.4.9. Worker/Labourer Impacts

309. Construction sites worker camps can impact on the environment if not adequately managed or located. This will include impacts from latrines, waste and social impacts if an external (national or international) labour force is used.

310. Potential impacts on the community and environment from work camps and external labour supplies will be mitigated through the following measures:

(i) Construction camp outside the village requires the contractor to develop campsite management plan which includes map showing camp lay out. Provide adequate accommodation and sanitation for male and female workers. Campsite restoration plan after completion of work shall be developed.

(ii) The construction campsite should be located far from water sources with fencing and safety zone campsite.

(iii) If a construction camp is not required, the contractor will set out a management plan which includes: Provision of adequate waste disposal facilities, welfare facilities, and sanitation for both male and female workers.

(iv) Priority should be given to use of local labour and contractor should retain evidence of how local labour recruitment efforts were undertaken.

311. **Socio-Economic Impacts**

312. The community within and nearby construction areas will be disrupted by the noise and dust and by potentially impaired access to their properties, farming and businesses.

313. Potential socio-economic impacts from construction will be mitigated through the following measures:

(i) Warning given to residents 4 weeks in advance of any works in their area.

(ii) Develop traffic management plan and implement around the construction site. Avoid blockage the road and traffic sign shall be installed to indicate reduced driving speeds, changes to detour or traffic direction.

(iii) Restoration of any road surface damage.

(iv) Consideration and management of potential localised flood impacts due to construction work.

(v) Set up and follow up of grievance mechanism as prepared prior to works.

6.4.10. Cultural Impacts

314. There was no specific cultural site or cultural site identified on the proposed site location or on associated facilities such as access road (and Borrow site). However, it is possible that these might be identified by the contractor when starting construction works.

315. Potential impacts from construction will be mitigated through the following measures:

(i) The contractor will ensure awareness of all cultural resources in the area including individual family graves along access roads, cemeteries or other relevant sites.

(ii) The contractor will fence off any such resources to ensure that they are clearly marked and will not be affected by the construction.

(iii) The contractor will take and store a Pre-Condition photograph of any such resources and make this available to MWPT should any dispute occur.

6.5. Environmental Impact and Mitigation Measures during Operation

316. The largest risks posed to the environment by the sub-project are likely to occur during the operation phase. This is particularly the case for the operation of the landfill site. These types of facilities can cause environmental pollution if they are not designed, managed and maintained effectively. Contamination of the groundwater resources is among the most recognized impact of landfills. In cases of leakages, the contaminated

leachate will percolate into the ground and may find its way into existing groundwater resources. Such pollution may pose long-term risks to public health in the local communities.

317. The O&M budget for these facilities is outside the scope of this IEE, however the key mitigation measures for operational risk management relate to the capacity development of the operating staff and national and municipal governments who provide the budget for O&M.

318. As a result, the Environmental Management Plan for the sub-project include capacity building and awareness raising on the management of environmental risks during operations.

319. Waste pickers at the existing dumpsite will also be impacted by the construction of the new landfill, especially as this one is distant from the Existing site. The budget for site development has allowed for provision of sanitation facilities, potable water supply, PPE, training and support on health and registration of waste pickers to prevent unauthorized access. This is further defined in the resettlement plan for the project.

320. Details of potential impacts during operation are as follows:

6.5.1. Waste Management

321. Operations at the landfill and in particular the collection and disposal of waste is the source of all the impacts mentioned below.

(i) An operation plan shall be prepared by the operator of the landfill, and the Environmental Management Plan will need to be updated for the operational phase. Minimum requirements include:

a. compaction and cover of waste.

b. controlling and minimising windblown waste

c. clear arrangements for collections, transportation and storage of all hazardous and non-hazardous waste

d. controlling and recording waste disposed of at the landfill, including origin, quantity, type of waste, and collector.

e. Separating and managing hazardous waste according to their type and in line with local regulations and international guidelines.

(ii) Some people in Ta Kream commune, next to the proposed landfill site dispose of solid waste in their field or in the village area or burn them. The project is expected provide waste collection in their commune for disposal into the Battambang landfill.

6.5.2. Air Quality

322. Air quality will be impacted by emissions from:

Waste Trucks transporting waste from the service area to the landfill, located 23 km out of town. Collection rates are expected to be 65,659 kg/day by 2020 and 220,456 kg/day by 2040. Thus 60 tonnes to 220 tonnes collected each day on average, or 10 to more than 30 waste collection trucks transiting to the future landfill along the national road then the smaller access road. In addition, the operation of the landfill will require cover material which may be sourced from external borrow pits. This truck movement will cause the release of exhaust fumes (NOx, SOx, CO2, CO) and particulate matter.

- Occasional operation of a backup generator at the landfill will be a localized, temporary (likely only of short duration) and low source of atmospheric emissions.
- The site and waste trucks may also be a source of windblown litter.

- The decomposition of organic waste will lead to the generation of biogas as described in chapter 4.7.5. These landfill gasses are naturally released into the atmosphere. Whenever uncontrolled, these gasses might affect the general environment including the welfare of its employees and nearby communities and can potentially cause fires and explosions. Landfill gas contains certain pollutants responsible for climate change (methane, CO_2) but also carries a bad smell which may cause a nuisance and even lead to temporary discomfort, but it is not likely to cause permanent health effects. The proposed landfill will have a biogas collection system and a venting system in place, but no specific treatment nor flaring system to abate biogas generation.

323. With regards to Landfill gas, SPS 2009 states that:

- The borrower/client will promote the reduction of project-related anthropogenic greenhouse gas (GHG) emissions in a manner appropriate to the nature and scale of project operations and impacts.
- During the development or operation of projects that are expected to or currently produce significant quantities of GHGs, the borrower/client will quantify direct emissions from the facilities.
- The borrower/client will evaluate technically and financially feasible and cost-effective options to reduce or offset project related GHG emissions.

324. Significance threshold for these requirements is set out in SPS 2009 as ''generally 100,000 tons of carbon dioxide equivalent per year for the aggregate emissions associated with electricity purchased for own consumption''.

325. In landfill project case, the most significant GHG emissions sources will be the annual emissions of Biogas and the emissions from waste collection trucks; in comparison, electricity use is not a major component of the project.

326. It is worth noting that the current GHG emissions from the existing dumpsite in Battambang is already uncontrolled and includes a combination of aerobic and anaerobic degradation as well as combustion, through spontaneous or provoked fires, like those observed at the Existing Dumpsite. Unlike the Existing Dumpsite, the proposed project enables to better manage landfill gas emissions which would have occurred with or without the project; the project does not influence the quantity of waste generated and therefore is not directly adding to the GHG emissions associated with waste management.

327. An estimation of GHG emissions for the Battambang landfill project is provided in Table 21. It was conducted at PPTA stage for all landfills within the TS-2 project. There is no specific data available for Battambang Landfill subproject.

Table 21: Greenhouse Gas Emissions from Battambang Landfill

	Methane		**Carbon dioxide**	**Total**
	(T)	***(Teq CO_2)***[9]	***(T)***	**(TeqCO_2)**
Maximum per year (peak in 2041)	4,187	104,675	11,488	**116,163**
Yearly Average	1,823	45,575	5,186	**50,761**
Total for 20 years of operation	91,161	2,279,025	259,322	**2,538,347**

328. Given the relatively low quantities of waste produced in the city and the cost and complexity of gas utilization and flaring systems, it was considered at PPTA and Detailed

[9] https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator

Design stage that venting was the most appropriate option with regards to the nature and scale of the project operations and impacts.

329. However, through installation of slotted gas collection pipes, the project approach allows for retrofitting gas flaring technology as the landfill phases progress, should the operator consider it technically and financially viable to do so in the future.

330. In comparison to Biogas emissions, atmospheric emissions from waste collection trucks are very limited for this project. Based on waste collection quantities used for the design and an average waste collection truck of 6 m^3, the associated emissions were calculated (Table 22).

Table 22: Carbon emissions from Waste collection trucks

Waste collection trucks daily movement	10-30	Trucks/day	Approximate from waste collection schedule 2020 to 2040
Waste collection truck associated distances	200 – 600	km/day	Average
Associated CO_2 emissions	59 - 178	kg eqCO2 /day	0.296 kgCO2e/t.km[10] for mid duty vehicle, 3,5 - 7,5 tonnes – Fuel oil
	21 – 65	T eqCO2/year	

331. Mitigation measures will include:

(i) Controlled biogas generation and reduction of windblown litter through regular cover of waste and injection of leachate into waste heap to stimulate biogas generation.

(ii) Monitoring of Air Quality at source (vent) and at distant receptors level downwind to ensure the discharged gases do not affect nearby air quality.

(iii) Retrofitting of treatment systems and potentially flaring or gas recovery system, when economically viable.

(iv) Nets to collect windblown litter downwind of operated cells.

(v) Optimisation of waste collection routes, and study of construction of transfer stations to reduce transport distances

(vi) Monitoring of emissions from trucks to control that they respect Cambodian guidelines for vehicles

(vii) Regular maintenance should be conducted on machinery and vehicles.

(viii) Waste shall be covered during transport from existing dumpsites to new landfill site.

(ix) Use of fuel with the lowest sulphur content commercially available.

6.5.3. Surface Water

332. Discharge of effluent including potentially contaminated water runoff or leachate which does not meet required standards may cause pollution to surface water, soil, groundwater or agricultural fields. Effluents can be:

- Sanitary wastewater generated by workers on site, as sanitary facilities shall be provided at the landfill.
- Stormwater runoff, which can be contaminated with sediments, hydrocarbons from machinery, spills from vehicles or from the operation of generator.

[10] Source : www.bilans-ges.ademe.fr/fr/basecarbone

- Leachate collected at the bottom of the cells and recirculated may overflow during the wet season.

333. The designs prevent the discharge of effluents offsite, and treatment facilities are included which will enable to reduce the risks of pollution.

334. Mitigation measures will include:

(i) Ensure separation of hazardous waste to be treated at the hazardous waste facility. Ensure proper containment of hazardous waste facility.

(ii) The landfill site will have a cut-off drain on the outer side of a 1 m high embankment along the perimeter of the site. This drain will capture runoff from the surrounding hills and prevent it from entering the site. An internal drainage system will be provided within the site to collect surface water runoff from landfill mounds. These open cut-off drains will divert the internal uncontaminated stormwater to the natural drainage line outside the landfill site.

(iii) Leachate management consists of a three-pronged environmentally sustainable and low (least) cost approach taking into account constraints in terms of financial resources designed to ensure zero discharge of treated leachate under average rain events:

1) minimise leachate production by (i) intercepting surface water run-on to the site and internal runoff, (ii) intermediate cover and waste compaction to reduce infiltration into the waste, (iii) building waste in pyramidal phases as opposed to being spread across the whole cell; and (iv) completing the main phases prior to the onset of the wet season.

2) ensure that only waste leachate is sent to the leachate treatment facility by separating rainwater from the inactive parts of a cell and discharging it as clean stormwater. Each section of a cell will be equipped with an interchangeable pipe system, initially set to stormwater, and subsequently turned via a valve to the leachate transport system when waste is deposited in that particular area.

3) Operation of a low tech, easy to maintain, biological leachate treatment facility. Leachate is moved via gravity through a series of ponds: an anaerobic lagoon, aerobic lagoon, and a maturation lagoon in the form of a constructed wetland. There will also be a final treated water lagoon, which will provide a storage for the water and connected to a leachate recirculation system returning the liquid to the waste in order to manage flow rates and accelerate uniform settlement of wastes.

(iv) The leachate treatment system will likely ensure that any rare discharge of treated leachate during periods with unusual heavy rain will comply with applicable effluent standards including suitability for irrigation. The discharge will be further diluted when mixed with the stormwater runoff from the local catchment. The runoff will enter local ditches or canals connected to a wider drainage and irrigation canal system on the large agricultural area west of the landfill site. In practical terms, when mixed with the upstream stormwater runoff from the local catchment, any rare discharge of treated leachate will be diluted many times and is unlikely to pose any significant risk to human health or the environment.

(v) Allocate adequate budget for O&M of the landfill and surface water management.

(vi) Monitoring of discharged effluents and reporting on quality of receiving water bodies around the landfill site if there is any found.

6.5.4. Groundwater

335. Groundwater contamination may arise from ineffective containment of water within the landfill cell or failure of the liner. This may occur throughout the lifespan of the landfill and

after cell closure as some infiltration will occur and organic waste will continue to generate liquid. The impact may also be exacerbated by deposition of waste outside the landfill cells, damage to the landfill liner for example if a clay liner is allowed to dry and crack, and poor maintenance of any leachate management system. This is of high importance as people use water from local water supply (water source is Kamping Puy Reservoir) and ground water (well) for households use.

336. Potential mitigation measures will include:

(i) Landfill design to comply with best practices to prevent contamination of groundwater, including: Compacted clay layer at the bottom and on the side of the cells, HDPE liner bottom and side, drainage of leachates and pumping out of the cells, etc – see design.

(ii) Limit ingress of rainwater through use of drainage canals around the operating cells.

(iii) Ensure separation of hazardous waste to be treated at the hazardous waste facility. Ensure proper containment of hazardous waste facility.

(iv) Always comply with required operating standards to limit water infiltration and therefore the generation of leachate including compaction of waste, management of run off and use of (frequent) cover materials;

(v) Provision of adequate budget for O&M including three monitoring groundwater quality of wells in nearest village (locations to be confirmed) and addressing liner integrity failure (if identified through groundwater monitoring).

(vi) (cf. pre-construction impacts and measures) Monitoring will be required during operation and after closure of landfill. Monitoring wells should be installed prior to start of construction. Minimum one upstream and 2 downstream of landfill cells. Baseline conditions to be determined prior to start of works. Additional monitoring to be conducted on nearby wells if there are any identified within 3 km radius.

6.5.5. Odour, Dust and Pests (landfill) and Fire protection

337. Landfill sites will generate nuisance impacts without adequate attention to good practices. This includes dust and odour from movement of degrading wastes, dust from vehicle movements, windblown litter on access roads and pests such as rats and flies attracted by organic wastes. Fires can also declare because of waste degradation. These should be absolutely prevented.

338. Potential mitigation measures will include:

(i) Compaction of waste within the day: deposited at the site and cover the waste daily.

(ii) Nets downwind of operated cell when operations near the top of the pit, to capture potential windblown litter.

(iii) Weekly litter collections and removal of any wastes which are not deposited in cells, including waste at the boundary and access roads to the site.

(iv) Washing wheels of vehicles before they leave site if they are muddy from accessing the landfill cells to prevent dust increasing on public roads.

(v) Quarterly meetings with residents and / or their representatives to identify odour or nuisance issues.

(vi) Providing and maintaining a vegetation buffer with tree plantings around and inside the landfill site as a screen around the site to reduce noise, dust and odours.

(vii) All waste loads to be done with covered trucks

(viii) Provision of adequate budget for O&M.

(ix) There is no plan to flare recovered landfill gas. Gas generated at landfill will be ventilated to atmosphere. The design shall consider appropriate landfill gas ventilation system.

(x) A Strict control of fire risk should be implemented at the landfill site including prevention of burning, smoking.

(xi) A fire response team shall be designated and trained to intervene in case of fire at the landfill.

(xii) A water tank will be available at the dumpsite, in particular during the dry season.

6.5.6. Nuisance for neighbouring residents

339. The nearest houses will be likely affected by the nuisances mentioned above. Several houses were identified within 500 m of the landfill site boundary (3 houses within 200 m radius, 9 houses further away). These households will not be displaced as it is recognized that it is neither appropriate nor practical to resettle all households within 500m but those within this distance will be offered the following mitigations:

(i) Installation of glass windows that can be opened in all windows within the houses.

(ii) Provision of enough viable tree or shrub saplings (native species, to be determined through consultation) to provide a vegetation screen around the front or back, and sides of the property; the residents are responsible for aftercare.

340. In addition, a Grievance Mechanism should be in place at the site. Physical measures to be put in place will include:

(i) The operator will install a sign board with relevant contact details and operating hours at the entrance to the landfill site. It will state contact details for raising complaints.

(ii) The operator will record all public complaints and deal with them within a timeframe agreed with MPWT.

6.5.7. Flora and Fauna

341. As mentioned for construction, impacts on terrestrial flora and fauna should be limited. However, landfill sites tend to attract pests (birds and rats) and insects and operations can cause noise which might deter other fauna from the site. Ingestion of waste can lead to infection of fauna (like avian influenza and other bird diseases) that can then be carried off-site.

342. Potential impacts on fauna will be mitigated through the following measures:

(i) Prepare a Pest Management Plan complying with ADB Control presence of pest and take measures as necessary

(ii) Provide worker immunization and health monitoring (e.g. for Hepatitis B and tetanus).

(iii) Maintain good housekeeping in waste processing and storage areas.

(iv) Promptly compact and cover wastes in operated cells, especially for waste with the potential to attract vermin and flies, such as food wastes.

(v) Grade the area properly to prevent ponding (to minimize insect breeding areas)

(vi) Use integrated pest-control approaches to control vermin levels, treating infested areas.

(vii) Fully enclose the waste management site with fencing so that no livestock or wildlife is able to come in contact with the waste and thus prevent spread of livestock and zoonotic disease.

6.5.8. Community and Occupational Health and Safety

343. Landfill site and access roads will present health and safety risks not only to operators, but also to people living around the site.

344. Community risks come mainly from:

- Unauthorized access to landfill site.
- Traffic risks linked to the increase of movement of waste collection trucks and movement of vehicles, like trucks transporting cover material.
- Another risk is linked to leachate generation and discharge of effluents to nearby water bodies or agricultural land which may cause sanitary issues for communities working in the field or for cattle.

345. Occupational risks come from a range of activities including:

- The manipulation of waste at the cells or at the MRF.
- The presence of hazardous waste.
- The movement and operation of heavy machinery, earth moving.
- And risk of explosion and fires linked to degradation of waste.

346. In addition to health and safety measures linked to the operations, specific mitigation measures should be implemented to manage the risk from COVID-19 (see construction phase impacts).

347. Potential impacts on community and occupational health and safety will be mitigated through the following measures

(i) The Operator shall appoint an Environment, Health and Safety Officer who is a qualified engineer.

(ii) Access to site will be prevented through appropriate fencing, protective barriers, and buffer zones for all non-authorized personnel. All entrances should be recorded. Video cameras should also be put in place around the perimeter of the site.

(iii) Sufficient signage giving health and safety warnings and information disclosure at the entrance of all sites.

(iv) Worker education and awareness seminars for landfill-related hazards will be given. A site safety program will be developed by the operator and workers shall be trained regularly.

(v) The site operator HSE supervisor should conduct daily toolbox meetings (safety briefings)

(vi) An accident record book will be maintained where all major or minor accidents and incidents are recorded with actions taken.

(vii) Ensure that all workers and waste pickers are equipped with and use Personal Protective Equipment.

(viii) Adequate first aid equipment will be made available on site for landfill operators and Waste pickers.

(ix) Fire-fighting equipment and a trained fire-fighting team shall be present on site.

(x) The operator will set out an Emergency Response Plan.

(xi) The operator will develop a Traffic Management Plan for movement of vehicles within the landfill site, and to and from the landfill site. Traffic management must include regular monitoring of traffic safety both within construction site and on public road. Traffic monitoring should entail, description of access roads, speed limits, controls and monitoring on drivers, training of drivers on Health and Safety, emergency numbers for road accidents, grievance mechanism.

(xii) Monitoring should be conducted on discharged effluents (see surface and groundwater) to control sanitary innocuity.

348. Potential impacts to workers in operation due to COVID-19 will be mitigated through the following measures[11]:

(i) Plan and execute work in compliance with country-specific COVID-19 risk management regulations and directives including directions of the General Department of Labour, MoLVT.

(ii) Conduct workplace risk assessment to identify low, medium or high exposure risk to COVID-19. Prepare an action plan for prevention and mitigation of the spreading of COVID-19.

(iii) Conduct Risk communication, training, and education. Training of workers in infection prevention and control practices

(iv) Adopt engineering, organizational and administrative measures, plan work so employees can keep distance from each other and minimise contact.

(v) Provide clear and visible guidelines on how to prevent infection at the work site and initiatives taken.

(vi) Dissemination about COVID-19 prevention and mitigation measures to staff and workers through orientation or distributing leaflet/poster at information/safety board at each construction and camp site;

349. More specifically, measures implemented shall entail:

(i) Daily checking temperature of staff and workers prior starting the works.

(ii) Staff and workers have to wear masks all the time and properly.

(iii) Do not share personal items or supplies such as phones, pens, notebooks, tools, etc.

(iv) Avoid common physical greetings, such as handshakes.

(v) Maintain a minimum physical distance of one metre from others if possible.

(vi) Wash hands often with soap and water for at least 20 seconds after using the washroom, before handling food, after blowing nose, coughing, or sneezing, and before smoking. If hands are not visibly soiled, and soap and water are unavailable, alcohol-based hand sanitizer can be used.

(vii) All offices and jobsites implement additional cleaning measures of common areas. All door handles, railings, ladders, switches, controls, eating surfaces, shared tools and equipment, taps, toilets, and personal workstation areas are wiped down at least twice a day with a disinfectant, such as disinfectant wipes. Individuals are responsible for cleaning and disinfecting their workstations.

(viii) Commonly touched surfaces on vehicles and equipment are thoroughly cleaned and disinfected at the end of shifts and between users.

(ix) Coughing or sneezing into a tissue or the bend of your arm, not your hand; And dispose of any tissues you have used as soon as possible in a lined waste basket and wash your hands afterwards.

(x) Individuals who have been potentially exposed to the virus, or who are exhibiting flu-like symptoms such as fever, tiredness, coughing, or congestion are instructed to: Not

[11] For more details, refer to WHO Guidelines for getting the workplace ready for COVID19: https://www.who.int/docs/default-source/coronaviruse/getting-workplace-ready-for-covid-19.pdf?ua=1
And ILO's Guide: https://www.ilo.org/wcmsp5/groups/public/---ed_dialogue/---act_emp/documents/publication/wcms_740212.pdf

come to work; Contact their supervisor and/or human resources department; Stay at home and self-isolate; and Contact local health authorities for further direction.

(xi) Such individuals are required to follow the directions of the local health authority and may not return to work until given approval by the proper health authorities.

(xii) Individuals who begin to display flu-like symptoms on site are instructed to avoid touching anything, take extra care to contain coughs and sneezes, and return home immediately to undergo self-isolation as directed by the local health authority.

6.5.9. Landscape Alteration and erosion

350. Landfills cells will have limited elevation compared to the natural terrain (prior to quarry exploitation). The final covers should be designed to limit storm water infiltration but also to limit the risk of erosion. Considering the site is relatively remote from the main road, and that it is in a hilly area, visual impact should be limited.

351. Prevention measures will include:

(i) Preventing infiltration by adding a cover at the top of the cell, including a soil cover and a geosynthetic liner.

(ii) The elevated design of the landfill and the diversion channels should be maintained. Appropriate ripraps / retaining walls should be established and regularly checked.

(iii) Re-Vegetation of the cover shall be facilitated by a cover of topsoil and seeding with local appropriate species.

(iv) Monitoring should be conducted even after closure of the cells:

- Monitor movement of heap and settlement
- Groundwater
- Revegetation/Erosion

7. ANALYSIS OF ALTERNATIVES

7.1. Solid Waste Management Design and Technology Alternatives

352. Alternative technological solutions for waste management were considered in detail in the Feasibility Study Report -Volume 2, Engineering Designs[12]. A summary is provided in this section.

353. Four options ranging from uncontrolled open dumping to a fully engineered sanitary landfill were considered for the project. A brief summary of the key arguments for each option are as follows:

- **Option 1 open dumping**. This is essentially the 'do nothing' option as it is what is happening at present at all the current disposal facilities and cannot be supported in the future.
- **Option 2, a controlled dump**. This still does not have waste compaction and soil covering, leading to significant continuous environmental impacts. This option also could not be supported.
- **Option 3, a controlled landfill**. This includes groundwater protection, landfill gas collection which means that it has most of the environmental and operational benefits of Option 4 but without the technical complexities of leachate treatment plants for example, and social impacts of banning all waste pickers from site. The controlled landfill option can be upgraded with scale-appropriate additional interventions for leachate and gas management, but not burdened with the additional constraints of the full sanitary landfill option which are undesirable and unnecessary for such relatively small operations.
- **Option 4, an engineered sanitary landfill**. This compulsorily includes the following requirements in addition to those of a controlled landfill (the third level of complexity)
  - A leachate treatment plant;
  - Mechanized material recovery facilities;
  - Mandated removal of all waste pickers from the site; and
  - Full Gas control and use.

354. Given that there is little difference in cost or operational difficulty between a controlled dump and a controlled landfill, but the controlled landfill has significantly more environmental benefits, a controlled landfill is the most appropriate disposal system for the project interventions. This could be upgraded over time to a higher standard if later mandated. It is important that the basic infrastructure (such as liners and leachate collection systems) is put in place initially to protect the surrounding environment (including groundwater), as these systems cannot be retrofitted later.

355. Option 4 is considered too expensive for the relatively small cities and far too complex to operate sustainably without ongoing external technical support at least for some years. Also, the additional operating costs for items like the leachate treatment plant are significant but yield little environmental gains at this scale. Furthermore, the required removal of all waste scavenging activities from the site would likely have significant social impacts at this time.

7.2. Siting options

[12] https://www.adb.org/sites/default/files/linked-documents/50102-002-sd-05.pdf

356. During Feasibility Studies, the three siting options were considered for the city, described below, including pros and cons for each site. (PPTA 2018):

- **Option 1 was at Prey Torteung**, located approximately 22.5 km from the city centre. The sealed dual carriageway main road runs for the first 15 km. A dual lane gravel farm-to-market road then runs for approximately another 6 km before the turnoff to the possible landfill site. This north-south local access road option from this farm-to-market road is approximately 1.4 km long and will have to be significantly improved as it is currently essentially a one-lane track. Also, there is a possibility of alternative east-west access roads that will need to be upgraded. The first east-west option to the north west of the site is about half the length of the north-south option but will have to be two lanes for the entire length given the number of corners and turns involved. The costs for the 980m long access road to the north west of the site have been assumed at this stage.
- **Option 2 (Chay Rumport)** was located two kilometres to the west of Option 1. The site is approximately the same distance from the city centre and on a main road so an access road is not required. The site has a good slope away from the access road in the order of 2%. This is ideal for the longitudinal slope of the base of the landfill and therefore would reduce the number of preparatory earthworks required. The soil type is generally similar to that of the private land site being a leached silt with significant quantities of clay being present. The nearest house is virtually adjacent to the proposed site and at least 20 other houses are located in the contiguous village environs. Furthermore, given the recent upgrade to the local section of the access road, significant housing development is currently underway as ribbon development and could be expected to effectively surround the landfill site in the short to medium term.
- **Option 3 was at Prey Torteung**, one kilometre to the North of option 1, and is located at the South East corner of the gravel road (Farm to Market road) and the proposed upgraded North-South access road to site No 1. It is similar to Option 1 in terms of use and geology and is flood free. The site is a little over 20km from the city. There is a housing development of at least 10 to 20 houses within the 400 to 700 metres range from the site edge. Some of the houses are workers huts that are only used during crop harvest. Overall, the site will need to be more closely investigated as an option, but the amount of nearby housing will be a major issue requiring detailed assessment.

357. These options were not approved by the authority.

358. During detailed design the provincial authority, PIU and PMU proposed a new landfill site which is located in the upland mountainous area (currently a borrow pit and quarry sites) of Ta Kream Mounting in Pouy Svay village, Ta Kream commune, Banan district. The area of new landfill site is 25 hectares and located about 22 km from centre of Battambang Town. The site has been visited and got approval from Ministry of Environment in February 2020.

7.3. The “no project” alternative

359. The No-project alternative means that the project does not happen, and that the situation continues as it is now: operations in the Existing Dumpsite, located close to an urbanized area, with no prevention of pollution in place.

360. This means continued and increased pollution of the soil and groundwater, as dumped quantities will likely increase in the coming years.

361. Also, considering the current urban growth trend, it is likely that the residential areas will come closer to the existing site causing health and safety threats to the residents.

362. If the project is not implemented, urban environmental quality will remain poor and potentially even decrease. It also limits the chances of socio-economic development of the area.

8. INFORMATION DISCLOSURE AND PUBLIC CONSULTATIONS

8.1. Public Consultations during Project Preparation

363. During Project Preparation, meetings were held with stakeholders to obtain views and opinions on the project and this also assisted the project team with development of the sub-project designs.

364. **CDIA Preparation Phase**. During the preparation of the first IEE and EMPs for TS-2 project, consultation took place within each sub-project area. An outline of the consultation meetings held is provided in Table 23. The details of these consultations are not repeated here but are available in the disclosed IEE documents for the CDIA phase. In general, the consultations found the sub-project to be welcomed for the positive benefits they will bring, however, concerns were raised regarding impacts during implementation, arising primarily from construction. In Battambang, the issues of land availability and land titles were raised at a number of meetings.

Table 23: CDIA Phase Consultations Held

Location	Dates	Stakeholders or Groups Met*	
Battambang	From 15/12/17 To 03/01/2018	PDPWT PDoE PDLMUPC Municipality of Battambang Waste collection Company Women Group Vulnerable Group	Local Authority Group Sangkat Rattanak Sangkat Svay Poar Sangkat O Char Sangkat Prek Preah Sdach
	on 02 July 2020	Commune-village leaders and communities	Ta Kream Commune, Banan district
PDoE	Provincial Department of Environment		
PDPWT	Provincial Department of Public work and Transportation		
PDWRAM	Provincial Department of Water Resources and Minerals		
PDLMUP	Provincial Department of Land Management and Urban Planning		
PDoP	Provincial Department of Planning		

365. **Preparation of this IEE.** Further consultations were undertaken in two formats during this IEE preparation: (i) a household socio-economic survey which was undertaken by a trained team of researchers, and which included a number of questions to inform this IEE; and (ii) consultation focus groups, undertaken by collaboration of the environmental and social team members and aimed to inform the project team on concerns people may have and how they may wish to see their concerns mitigated.

366. Household socio-economic surveys were conducted in January 2018 and included the questions relevant to environmental safeguards. The respondents' views are summarized in Table 24. Where appropriate, corresponding mitigation measures are included in the EMP.

Table 24: Socio-Economic Survey Questions

Household Question	Response	EMP Response
Concerns over construction impacts (Dust, Noise, Water Quality, Other suggestions) – Rank two responses	Combining the two scores, 75% of responses included dust as a concern, 41% included noise, 15% included water quality and no other suggestions for concerns were given.	Mitigation measures for noise and dust Control of construction near water bodies

Household Question	Response	EMP Response
8Connection to piped water supply	57% of households are connected to a piped water supply, of which 63% are connected to the public water supply and the remainder to a private connection	-
What is your main water sources during dry season? – Rank two responses	The majority of responses confirm piped water as the main water supply (833 responses) with the primary alternatives being bottled water (147 responses) own well (104 responses). No respondents use water from public or private ponds/lakes or a public well.	Measures to prevent water pollution in all surface water bodies during operations in particular where the risk to receptors is higher
What is your main water sources during wet season? (if have piped water) – Rank two responses	The majority of responses confirm piped water as the main water supply (815 responses) with the primary alternatives being bottled water (80 responses) own well (46 responses) and the river (32 responses).	Measures to prevent water pollution in all surface water bodies during operations in particular where the risk to receptors is higher
If you are not connected to pipe water supply. What is your main water sources during dry season? Rank two responses	The majority of responses confirm their own drilled well is used as a water supply (290 responses) with the primary alternatives being own drilled well (290) responses, own open well (128 responses), water seller (120 response), bottled water (121 responses) pond/lake (109 responses), rainwater (92 responses). 3 responses were also 'canal' as an alternative water source.	Measures to prevent water pollution in all surface water bodies during operations in particular where the risk to receptors is higher
If you are not connected to pipe water supply, what is your main water sources during WET season? Rank 2 responses	509 responses confirmed rainwater to a water source. The remainder being own drilled well (275) responses, own open well (125 responses), water seller (51 responses), bottled water (66 responses) pond/lake (68 responses), own pond (13responses).	Measures to prevent water pollution in all surface water bodies during operations in particular where the risk to receptors is higher
During Construction, what mitigation measures would you like to see to reduce any potential impacts on you and your environment	The main responses are spray water on the road (to avoid dust) (62%), Ensure the security of road traffic (lighting) (17%) Limit the hours of work during the day (noise) (10%). 8% had no concerns. Alternative responses include concerns over construction safety, traffic safety (10 responses) and concern over impact to land or access (9 responses).	Traffic management to be implemented by contractor via the Community and Occupational Health and Safety and Emergency Response Sub-Plan Noise and dust control measures to be used.
If you are living close to the new landfill site, would you be interested in mitigation measures?	Glass in windows 35% Tree screens 22% Fly screen 26% 'Other' responses include operational requests to bury waste after it is deposited (28 responses) and requests for odour control.	Mitigation measures and budget for house improvements included for houses close to landfill sites.

Source: PPTA 2018

367. **Focus group discussions (FGD).** FGDs were conducted by the DDPP social and environmental team in 15 December 2017 to 03 January 2018 at the project sites in each town for landfill and WWTP subprojects. The objectives of the FGDs were to:

- Present to the stakeholders and affected people the sites for subprojects in the provincial towns and inform them of the project activities;

- Understand the main issues that may occur in the proposed sub-project areas, as raised by local people;
- Understand the potential social and environmental resources located/used in the subproject sites;
- Receiving issues, feedback, and comments from stakeholders or affected people regarding social, gender and environmental issues/resources in the proposed sites; and
- Receiving comments and suggestions for mitigation measures to improve adverse impacts from project design, construction, and operation stages.

368. **Inclusion of Affected People's Views**. The mitigation measures in the EMPs for this project reflect the result of the consultations during IEE preparation. The results of the consultation discussions are summarized in Table 25. Where appropriate, a response to the comment or concern is signposted in the EMP.

Table 25: Consultation FGD Battambang Town, Battambang Province, PPTA stage

Consultation in Prek Preah Sdach Commune, BTB Town	
Issues/Comments/Suggestions raised by the Stakeholders	**EMP Response**
Waste: - In our commune the solid waste and wastewater are the major problems (i) waste collector (CINTRI Company) can't collect from all the households and the waste truck comes is about 1week/time. (ii) some areas are small access roads, waste truck cannot access them (iii) lack involvement from communities, a few households do not pay for waste collection fee, so they dump their waste instead	Project will improve waste management with institutional / tariff improvements
Wastewater - Waste water is a problem too caused by very old culverts without maintenance. Some villages do not have culverts and have seasonal flooding due to run-off and wastewater.	Project WWTP and network improvements will support this
- This project is important for our commune as same as for BTB Town to manage our environment and sanitation, we support to this project, because BTB Town is developing.	None required
- The people use Town Water Supply for households, and use pond water for crops, farming, and washing 20%) - There are no sensitive ecological resources in this area – it is an urban village area. Some people they plant vegetable and irrigate with pond water.	None required – project will not impact on water supply
Waste: - Awareness on Environmental waste management and promote public involvement. - Increase the member waste truck 2-3 time/week - Provide small truck or cart for waste collection - All the families agree to pay for solid waste collection service, if service is good.	None required
- Enforcement environmental waste laws, the penalty should be implemented	Included in Awareness Raising Campaign, defined in proposed TA Package
Consultation in Rotanak Commune, BTB Town	
Issues/Comments/Suggestions raised by the Stakeholders	**EMP Response**
We support this project for improvement our environment and sanitation as well as runoff (flooding) and waste management in BTB Town.	None required
- The key problem is wastewater and waste: (i) the drainage system is poor and causes flooding. Old and not maintained. (ii) Solid waste – many problems with CINTRI e.g. Limited capacity and equipment (collecting only on main roads (1 time/week) and small roads are in	None required

accessible (Rumchak1, 2, and 3 Village). A few houses do not want to pay for waste collection fee.	
All the people in Rottanak Commune use water from Town Water Supply for households use	None required
There are no sensitive impacts of improving landfill and WWTP, because Rottanak Commune is located in the Town area, far from project locations. But can be impacts can occur from truck transport of waste (without covering trucks may drop waste or wastewater)	Mitigation measures request waste (operation) and construction materials to be covered during transport
- This project will benefit for our commune for wastewater and solid waste management.	None required
- Please provide suitable and enough drainage/culverts for wastewater in BTB Town. Increase the capacity and equipment of waste collection company.	Designed for population predictions and climate change predictions
Awareness of waste laws and enforcement is lacking	Included in Awareness Raising Campaign, defined in proposed TA Package
Consultation in Svay Por and O Char Commune, BTB Town	
Issues/Comments/Suggestions raised by the Stakeholders	**EMP Response**
- In Svay Por Commune is located in central urban area of Town, so all houses have access of solid waste collection by CINTRI Company. But the waste collection time is limited (1 time/week). - Some solid wastes is seen on the streets. A few people still dispose waste on the streets - Most households in O Char Commune have solid waste collection and a few not yet, because of no access road and people do not want to pay for waste collection fee. However, most of families agree to pay for solid waste collection service, if good service	None required
During rainy season some streets in Town are flooded by rainy water 2-3 days. During raining the waste flows into the drainages, culverts, and river (some drainage is jammed). So, the drainage, canal, and culvert for wastewater should be improved too	None required
The improvement of landfill for BTB Town is very important of our environment and public health, for us we are very happy with project. So the project should collaborate with concerned agencies and CINTRI Company for improving waste collection system.	Training for operators is included in capacity development – will include collection issues
The environmental and laws awareness should be conducted first and enforcement laws (penalty).	Included in Awareness Raising Campaign, defined in proposed TA Package

369. Additional field visits and stakeholder consultations were conducted during the DED studies.

370. A site visit was organized by the Resettlement team in May 2020 at the future landfill site and at the existing dumpsite. Information was collected on the 2 areas. This site visit identified 3 houses close to the proposed new landfill, and 9 houses further away. The households are not directly impacted by the subproject, but mitigation and/or on-site relocation (for nearest houses) will be provided under EMP. 40 affected households of waste pickers work at the existing dumpsite, out of which 16 affected households actually live on the existing dumpsite.

371. Another site visit was conducted with the PMC technical team on 02 July 2020, At Ta Keam commune Office, Banan District, Battambang in order to Present the work plan and activities of project to local authorities and people, receive information on environmental

and social sensitive receptors in and near the project area and receive comments, feedbacks, and questions concerning to environmental consideration from the project.

Consultation in Ta Kream Commune, Banan District, BTB Province – Commune of proposed landfill site	
Issues/Comments/Suggestions raised by the Stakeholders	**EMP Response**
- All the people in Ta Kream commune are farmers. Most of farmers plant the wet rice, some rice fields can grow 02 time/year, but this year, they can plant only 1 time/year because of raining is late and small rain. - The people use water from local water supply (water source is Kamping Puy Reservoir) and ground water (well) for households use. - There are not sensitive receptors (water, cultural resources, and protected ecology) are located near the landfill site - There are a few houses (3-4 houses) are located about 0.5km from landfill site - The village area, where school, health centre, and houses is located about 3km from landfill site.	Included in Surface water and groundwater protection measures
- A landfill in upland area may impact groundwater (water well) in the village - Where the wastewater and leachate from landfill - Odour from landfill may affect local people - There may be an increase in flies and other pests from the landfill affecting the village - Waste transportation by truck on the road pass the village, should be well managed, no spills of leachate or waste. - Some people in Ta Kream commune dispose or burn solid waste in the field or in the village area. The project will provide waste collection in our commune and dumping to this landfill too?	will include in detailed design for mitigation and landfill management. Training for operators is included in capacity development. The waste collection for this Ta Kream commune will inform to operator agency
Generally, they support the project, but more they are concerned during operation how to manage and control landfill for reduce the impacts on social and environment in and around the project site.	Consultation and engagement to continue during implementation and operation

372. And a final consultation was undertaken during the site visit of the MoE on the 11th of August 2020; to validate the Battambang Landfill site. On 10-11 August 2020, The MoE Reviewing Team conducted site visits to Landfill subproject site in Poar Svau village, Ta Kream commune, Banan district, PDPWT/PIU, and PDoE. During visit, the team has consuled with village and commune authorities in Ta Kream commune. The key feedbacks, issues, and comment from consultation meeting are summarized below:

Consultation in Ta Kream Commune, Banan District, BTB Province – Commune of proposed landfill site – During MoE visit in August 2020	
Issues/Comments/Suggestions raised by the Stakeholders	**EMP Response**
- The nearest village is Poar Svay village on the downstream of landfill site which is about 3.4 km. There are school, health centre, and houses in the village area. - The people use water from local water supply (water source is Kamping Puy Reservoir, is more than 10 km for site) and ground water (well) for households use. - There are no sensitive receptors (water, cultural resources, and protected ecology) are located near the landfill site - There are a few houses (5 houses) are located about 0.5 km from landfill site.	- groundwater study will be implemented and groundwater monitoring. Measures are in place in the design to protect the GW resource

Consultation in Ta Kream Commune, Banan District, BTB Province – Commune of proposed landfill site – During MoE visit in August 2020	
- Some people use ground water (well water) which is from 30-50m deep - The existing road to the site is issues (dust, and damage or potholes) by many quarry trucks companies with poor maintenance. - The people in Ta Kream will be impacted for Landfill subproject, because the wastes will bring from town to dump in our area (long term during operation). - We support to project for improvement our province, so the project should provide proper technical design to reduce impacts on natural and social resources in this area. - Control and manage the runoff and leachate wastewater from landfill to avoid the impact on ground water quality. - Use the technical or mitigation for reduce the odour from landfill, fly, and other insects/pests from landfill - Strictly manage the waste transportation by truck on the road passing the village area (use waste truck sanitation). To ensure no spill of leachate and fall down the wastes on the road. - Provide road maintenance schedule (access road to landfill site). - Ta Kream Commune Leader said: If possible, the project should rehabilitate the existing road only for Landfill Project uses. Because the existing road is used by many quarry companies, when the road is damaged and dusty, they are waiting each other (unclear responsibility). It is difficulty to solve this issue, and our people complain to commune authority (dust, damage, and potholes)	Only a small part of the access road is to be upgraded at this stage.

8.2. Public Consultations during Project Implementation

373. In addition to consultation undertaken during preparation of the sub-project, consultation will take place during implementation. The PIU Safeguard Focal Point (PIU-SFP) will undertake consultation following the finalisation of the detailed design, and again will conduct consultation interviews within 4-6 weeks of construction starting and then again every 3 months until the end of construction. This is set out in the Environmental Monitoring Plan provided in the Environmental Management Plan.

374. It is suggested that the consultations take the form of meetings and site-based discussions and include the following:

- Environmental impacts of civil works (e.g., solid & liquid waste, erosion, local flooding, pollution);
- Any unforeseen impacts caused accidentally e.g. through spillages;
- Civil nuisance (e.g., noise, dust, disrupted business & farming activity, social issues, community health and safety);
- Impaired use of access road to landfill site (e.g. traffic issues and access); and
- GRM and its procedures including details of persons to contact and contact details

375. In summary, informal monitoring interviews with affected people will focus on complaints about community disturbance from construction activities, as well as public concerns about ecological protection, soil / land concerns and access issues. A sample Environmental Monitoring Interview Form is in the EMPs for this project. This will contribute to project monitoring.

8.3. Consultation during Operation

376. The mitigation measures for this IEE specify that the landfill operator, in collaboration with PDPWT undertake quarterly consultation with local residents to discuss any operational impacts or concerns to provede proper mitigation measures or response plans.

8.4. Information Disclosure

377. Environmental information on the project, including the IEE and other safeguards information will be disclosed in accordance with ADB's Public Communications Policy (2011) and SPS (2009). This includes:

(i) The EMP will be translated into Khmer and be available for review PDPWT offices;

(ii) The IEE will be disclosed on ADB's project website (www.adb.org);

(iii) Copies of the IEE will be made available upon request; and

(iv) Quarterly and Semi-annual environmental monitoring reports on project's compliance with the Environmental Management Plan (EMP) and other necessary information will be available at www.adb.org.

9. GRIEVANCE REDRESS MECHANISM

378. A grievance redress mechanism (GRM), consistent with the requirements of the ADB Safeguard Policy Statement (2009) will be established to prevent and address community concerns, reduce risks, and assist the project to maximize environmental and social benefits. In addition to serving as a platform to resolve grievances, the GRM has been designed to help achieve the following objectives: (i) open channels for effective communication, including the identification of new environmental issues of concern arising from the project; (ii) demonstrate concerns about community members and their environmental well-being; and (iii) prevent and mitigate any adverse environmental impacts on communities caused by project implementation and operations. The GRM is accessible to all members of the community.

379. The Access Points to the GRM are critical for ensuring it is useable for affected people (APs). The GRM Access points for this project, as set out in this GRM Mechanism will be:

- The contractors/operator
- District and Commune Councils
- The PIU office
- The Provincial Department of Public Works and Transport (PDWT).

380. Full details of the GRM, its access points, and responsible parties are found in the EMP.

10. ENVIRONMENTAL MANAGEMENT PLAN

381. A detailed EMP is provided as appendix to this IEE. The EMP aims to avoid impacts where possible and mitigate those impacts which cannot be eliminated to an acceptable and minimum level. The EMP includes detailed requirements for:

- Mitigation and monitoring measures;
- Institutional arrangements and project responsibilities;
- EMP budget for implementation
- Capacity building and training requirements
- Public consultation and information disclosure
- GRM including clearly defined timescale and responsibilities.

382. The overall responsibility for EMP implementation and compliance with loan assurances lies with the Executing Agency, the Ministry of Public Works and Transport (MPWT). The EA will establish a Project Steering Committee (PSC) and Project Management Unit (PMU) based in Phnom Penh, responsible for general project implementation. The Implementing Agency is the Provincial Department of Public Works and Transport (PDPWT) in each sub-project city. The PDPWT will establish a Project Implementation Unit (PIU) in each province, comprising relevant provincial government representatives including the Provincial Department of the Environment.

383. A summary of the key functions for project implementation and therefore environmental safeguards is presented in Table 26:

Table 26: Key Roles for Project Implementation

Role	Abbreviation	Location	Summary of Overall Function
Project Steering Committee	PSC	Phnom Penh	Policy and technical guidance for subproject implementation
Project Management Unit	PMU	Phnom Penh within MPWT	Responsible for general project implementation and reporting
PMU Environment Safeguards Officer	PMU-ESO	Phnom Penh within PMU	EMP compliance across the sub-projects for environmental and social safeguards
Project Implementation Unit	PIU	Provinces within PDPWT	Responsible for sub-project implementation
PIU Safeguards Focal Point	PIU-SFP	Provinces within PIU	Responsible for sub-project environmental and social safeguard monitoring
Contractor Environmental Health & Safety Officer	C-EHS	Construction Site	Mitigation measure implementation and reporting
Project Management Consultant	PMC	Phnom Penh	Project final design and implementation, support and capacity development
International and National Environment Specialists	PMC-I/NES	Phnom Penh within PMC team	Environmental safeguards and reporting support during design and implementation
Asian Development Bank	ADB	-	Review project progress, compliance with covenants and advise on corrective actions.

11. CONCLUSIONS AND RECOMMENDATIONS

11.1. Conclusions

384. This IEE was undertaken to determine the environmental issues and concerns associated with the subproject activities, based on Detailed Engineering Designs. The assessment confirms that the project is classified as Category B for environment. There are no significant adverse impacts that cannot be readily mitigated if mitigation measures are implemented effectively. The EMP associated with this IEE proposes measures that will mitigate or compensate impacts on the natural environment and affected people to an acceptable level.

385. The most significant impacts from the project are expected during operations. The design of the facilities aims at preventing these impacts and there is a comprehensive training and capacity building component to the project which is essential for ensuring that the implementation of the project is both financially and environmentally sustainable and achieves anticipated outcomes.

386. The key parties for mitigation measure implementation are the construction contractors and the operators. They will be supported by qualified national and international environmental consultants within the Project Management Consultant teams. The implementation of this EMP will be closely monitored and reported on by the relevant stakeholders in the project.

387. Overall, the expected project outcome is improved urban environmental services in Battambang Province. The project is anticipated to bring environmental benefits to the populations of the project service area and Battambang city in particular. It will serve to improve waste management in town, reduce pollution impacts and provide long term urban environmental improvements, health benefits and promote sustainable city development.

388. The next step of Environmental Safeguards implementation is the preparation of the Contractors Environmental Management Plan (CEMP), which is to be based on the EMP, but is expected to develop in more details the measures to be implemented by the Contractor. The CEMP will be the backbone of the Environmental Management System of the operator and will be supported by associated sub-plans which will deal with specific topics, such as Health and Safety, Waste management, Soil and Borrow sites management, traffic Management, etc.

389. When operations will start, the operator shall also develop its own Environmental Management System, specific to the operations.

390. A robust Grievance Redress Mechanism will be established, as outlined in this IEE and the EMP. It will ensure that all unplanned impacts which cause grievances for affected people are managed and a satisfactory outcome brought about swiftly.

11.2. Recommendations

391. The project will include assurances that the key risks from the sub-project will be mitigated as set out in the EMP. In particular, the landfill subproject activities (pre-construction, construction and operation stage), the contractor should implement the mitigation measures as presented in IEE and EMP documents to reduce and avoid the negative impacts, in collaborating with consultant, PMU/PIU, local authorities, and affected people. The project shall be provided with adequate O&M budgets to ensure operation in accordance with the design recommendations. During landfill operation, the implementing agency or PIU and concerned provincial departments and authorities to properly implement the environmental and social management or mitigation measures or responses described in the IEE and EMP.

392. It is important define the solid waste strategy for Battambang before the operation of the new landfill. Currently Battambang has a dumpsite, MRF and compostiong plant which are not part of this project. On-going discussion with MPWT/PMU, ADB and PMC are considering the following:

1. Current MRF (at current dumpsite) designated as the “clean MRF” for source-segregated waste and city green waste (from parks). This would ensure there are no odours and the current MRF would be a useful source of employment (waste pickers). All source segregated waste and city green waste should be sent to this site (which can take up to 8 tonnes / day at the moment) and this should be specified in the operator contract. TS 2 Project will support the development of new model collection contracts.
2. Current dumpsite will need to be rehabilitated under the TS-2 IEE/EMP – this can become a green space or be used for a green business linked to composting (e.g. a tree nursery).
3. The MRF at the new landfill will be a mixed waste MRF, for all mixed waste from the city. Waste pickers will be allowed to the new landfill although the site may be too far away for them.
4. It is also recommended to improve the collection system in the service area which is currently procured to a private company and not compliant with Sub-decree No. 36 ANK. According to Article 5, the collection, transport, storage, recycling, minimizing and dumping of waste in the provinces and cities is the responsibility of the authorities of provinces and city. The implementation shall comply with Environmental Guidelines on Solid Waste Management (MOE, 2006). Therefore, it is recommended that Battambang authority to conduct a due diligence on the collection system.

ANNEX 1 Environmental Quality Standards

(1) Ambient Air Quality Standards

Source: Sub-decree No. 42 ANRK.BK on Air Pollution Control and Noise Disturbance, MoE 2000.

Parameter	Averaging Period	Standard	
		Unit	Value
Nitrogen Dioxide (NO2)	24 hours	mg /m3	0.1
Sulfur Dioxide (SO2)	24 hours	mg /m3	0.3
Carbon Monoxide (CO)	24 hours	mg /m3	20
PM 2.5	24 hours		-
PM 10	24 hours		-

(2) Ambient Noise Standards

Source: Sub-decree No. 42 ANRK.BK on Air Pollution Control and Noise Disturbance, MoE, 2000.

Areas	Time Period (24 hours)	Standard	
		Unit	Standard Value
Area is not identified	Day time (from 6:00am to 6:00pm)	Noise Level dB(A)	70.0
	Evening Time (from 6:00pm to 11:00pm)	Noise Level dB(A)	65.0
	Night time (from 11:00pm to 6:00am)	Noise Level dB(A)	50.0

(3) Surface Water Quality Standard

Referring to Sub-decree, No. 27 ANRK.BK on Water Pollution Control, MoE, 1999, the standards of water quality are divided as follows:

Annex 2 of Sub-decree on Water Pollution Control

Effluent standard for pollution sources discharging wastewater to public water areas or sewer

No	Parameters	Unit	Allowable limits for pollutant substance discharging to	
			Protected public water area	Public water area and sewer
1	Temperature	0C	< 45	< 45
2	pH		6 – 9	5 - 9
3	BOD5 (5 days at 200 C)	mg/l	< 30	< 80
4	COD	mg/l	< 50	< 100
5	Total Suspended Solids	mg/l	< 60	< 120
6	Total Dissolved Solids	mg/l	< 1000	< 2000
7	Grease and Oil	mg/l	< 5.0	< 15
8	Detergents	mg/l	< 5.0	< 15

9	Phenols	mg/l	< 0.1	< 1.2
10	Nitrate (NO3)	mg/l	< 10	< 20
11	Chlorine (free)	mg/l	< 1.0	< 2.0
12	Chloride (ion)	mg/l	< 500	< 700
13	Sulphate (as SO4)	mg/l	< 300	< 500
14	Sulphide (as Sulphur)	mg/l	< 0.2	< 1.0
15	Phosphate (PO4)	mg/l	< 3.0	< 6.0
16	Cyanide (CN)	mg/l	< 0.2	< 1.5
17	Barium (Ba)	mg/l	< 4.0	< 7.0
18	Arsenic (As)	mg/l	< 0.10	< 1.0
19	Tin (Sn)	mg/l	< 2.0	< 8.0
20	Iron (Fe)	mg/l	< 1.0	< 20
21	Boron (B)	mg/l	< 1.0	< 5.0
22	Manganese (Mn)	mg/l	< 1.0	< 5.0
23	Cadmium (Cd)	mg/l	< 0.1	< 0.5
24	Chromium (Cr)+3	mg/l	< 0.2	< 1.0
25	Chromium (Cr)+6	mg/l	< 0.05	< 0.5
26	Copper (Cu)	mg/l	< 0.2	< 1.0
27	Lead (Pb)	mg/l	< 0.1	< 1.0
28	Mercury (Hg)	mg/l	< 0.002	< 0.05
29	Nickel (Ni)	mg/l	< 0.2	< 1.0
30	Selenium (Se)	mg/l	< 0.05	< 0.5
31	Silver (Ag)	mg/l	< 0.1	< 0.5
32	Zinc (Zn)	mg/l	< 1.0	< 3.0
33	Molybdenum (Mo)	mg/l	< 0.1	< 1.0
34	Ammonia (NH3)	mg/l	< 5.0	< 7.0
35	DO	mg/l	>2.0	>1.0
36	Polychlorinated Byphemyl	mg/l	<0.003	<0.003
37	Calcium	mg/l	<150	<200
38	Magnesium	mg/l	<150	<200
39	Carbon tetrachloride	mg/l	<3	<3
40	Hexachloro benzene	mg/l	<2	<2
41	DTT	mg/l	<1.3	<1.3
42	Endrin	mg/l	<0.01	<0.01
43	Dieldrin	mg/l	<0.01	<0.01

44	Aldrin	mg/l	<0.01	<0.01
45	Isodrin	mg/l	<0.01	<0.01
46	Perchloro ethylene	mg/l	<2.5	<2.5
47	Hexachloro butadiene	mg/l	<3	<3
48	Chloroform	mg/l	<1	<1
49	1,2 Dichloro ethylene	mg/l	<2.5	<2.5
50	Trichloro ethylene	mg/l	<1	<1
51	Trichloro benzene	mg/l	<2	<2
52	Hexaxhloro cyclohexene	mg/l	<2	<2

Remark: The Ministry of Environment and the Ministry of Agriculture, Forestry and Fishery shall collaborate to set up the standard of pesticides which discharged from pollution sources.
Public water areas refers to water areas that are for public use such as : tonle, stung (rivers), stream, gully, lake, pond, well, sea, peam (river mouth) and include canal irrigation system and other waterways that are for public use and ground water.

Annex 4 of Sub-decree on Water Pollution Control

Water Quality Standard in public water areas for bio-diversity conservation

Source: Sub-decree No. 42 ANRK.BK on Water Pollution Control, MOE, 1999.

a) River

Parameter	Standard	
	Unit	Value
pH	mg/l	6.5 – 8.5
BOD5	mg/l	1 – 10
Suspended Solid	mg/l	25 – 100
Dissolved Oxygen	mg/l	2.0 - 7.5
Coliform	MPN/100ml	< 5000

b) Lakes and Reservoirs

Parameter	Standard	
	Unit	Value
pH	mg/l	6.5 – 8.5
COD	mg/l	1 – 8
Suspended Solid	mg/l	1 – 15
Dissolved Oxygen	mg/l	2.0 - 7.5
Coliform	MPN/100ml	< 1000
Total Nitrogen	mg/l	1.0 – 0.6
Total Phosphorus	mg/l	0.005 – 0.05

Annex 5 of Sub-decree on Water Pollution Control:

Water Quality Standard in public water areas for public health protection

Source: - Ground water quality monitoring MoE, 2016.

- The CNDWQS Standard is National Standard of the Ministry Industry and Handicraft.

No	Parameter	Unit	Standard Value
1	Carbon tetrachloride	µg/l	< 12
2	Hexachloro-benzene	µg/l	< 0.03
3	DDT	µg/l	< 10
4	Endrin	µg/l	< 0.01
5	Diedrin	µg/l	< 0.01

6	Aldrin	µg/l	< 0.005
7	Isodrin	µg/l	< 0.005
8	Perchloroethylene	µg/l	< 10
9	Hexachlorobutadiene	µg/l	< 0.1
10	Chloroform	µg/l	< 12
11	1,2 Trichloroethylene	µg/l	< 10
12	Trichloroethylene	µg/l	< 10
13	Trichlorobenzene	µg/l	< 0.4
14	Hexachloroethylene	µg/l	< 0.05
15	Benzene	µg/l	< 10
16	Tetrachloroethylene	µg/l	< 10
17	Cadmium	µg/l	< 1
18	Total mercury	µg/l	< 0.5
19	Organic mercury	µg/l	0
20	Lead	µg/l	< 10
21	Chromium, valent 6	µg/l	< 50
22	Arsenic	µg/l	< 10
23	Selenium	µg/l	< 10
24	Polychlorobiohenyl	µg/l	0
25	Cyanide	µg/l	< 0.005

(4) Groundwater Quality Standard

No	Parameter	Standard	
		Unit	Value (CNDWQS Standard)
1	pH	-	6.5-8.5
2	Turbidity	NTU	5.0
3	Dissolved Oxygen (DO)	mg/l	NV
4	Total Suspended Solid (TSS)	mg/l	NV
5	Chloride (Cl-)	mg/l	250
6	Nitrate (NO3)	mg/l	50
7	Phosphate (PO4)	mg/l	NV
8	Sulphate (SO4)	mg/l	250
9	(BOD)5	mg/l	NV
10	(COD) Mn	mg/l	NV
11	Aluminum (Al)	mg/l	0.2
12	Arsenic (As)	mg/l	0.05
13	Copper (Cu)	mg/l	1.0
14	Iron (Fe)	mg/l	0.3
15	Lead (Pb)	mg/l	0.01
16	Manganese (Mn)	mg/l	0.1
17	Mercury (Hg)	mg/l	0.001
18	Zinc (Zn)	mg/l	3.0
19	Total Coli form	MPN/100mlml	0

(5) Effluent Quality Standard

(Effluent from WWP and from Leachate Treatment Facility at the controlled disposal facility)

Source: Sub-decree No. 42 ANRK.BK on Water Pollution Control, MOE, 1999.

No	Parameter	Standard (Allowable limits for pollutant substance discharging) to

		Unit	Value (Protected public water area)	Value (Public water area and sewer)
1	Temperature	0C	< 45	< 45
2	pH		6 – 9	5 - 9
3	BOD5 (5 days at 200 C)	mg/l	< 30	< 80
4	COD	mg/l	< 50	< 100
5	Total Suspended Solids	mg/l	< 50	< 80
6	Total Dissolved Solids	mg/l	< 1000	< 2000
7	Grease and Oil	mg/l	< 5.0	< 15
8	Detergents	mg/l	< 5.0	< 15
9	Phenols	mg/l	< 0.1	< 1.2
10	Nitrate (NO3)	mg/l	< 10	< 20
11	Chlorine (free)	mg/l	< 1.0	< 2.0
12	Chloride (ion)	mg/l	< 500	< 700
13	Sulphate (as SO4)	mg/l	< 300	< 500
14	Sulphide (as Sulphur)	mg/l	< 0.2	< 1.0
15	Phosphate (PO4)	mg/l	< 3.0	< 6.0
16	Cyanide (CN)	mg/l	< 0.2	< 1.5
17	Barium (Ba)	mg/l	< 4.0	< 7.0
18	Arsenic (As)	mg/l	< 0.10	< 1.0
19	Tin (Sn)	mg/l	< 2.0	< 8.0
20	Iron (Fe)	mg/l	< 1.0	< 20
21	Boron (B)	mg/l	< 1.0	< 5.0
22	Manganese (Mn)	mg/l	< 1.0	< 5.0
23	Cadmium (Cd)	mg/l	< 0.1	< 0.5
24	Chromium (Cr)+3	mg/l	< 0.2	< 1.0
25	Chromium (Cr)+6	mg/l	< 0.05	< 0.5
26	Copper (Cu)	mg/l	< 0.2	< 1.0
27	Lead (Pb)	mg/l	< 0.1	< 1.0
28	Mercury (Hg)	mg/l	< 0.002	< 0.05
29	Nickel (Ni)	mg/l	< 0.2	< 1.0
30	Selenium (Se)	mg/l	< 0.05	< 0.5
31	Silver (Ag)	mg/l	< 0.1	< 0.5
32	Zinc (Zn)	mg/l	< 1.0	< 3.0
33	Molybdenum (Mo)	mg/l	< 0.1	< 1.0
34	Ammonia (NH3)	mg/l	< 5.0	< 7.0
35	DO	mg/l	>2.0	>1.0
36	Polychlorinated Byphemyl	mg/l	<0.003	<0.003
37	Calcium	mg/l	<150	<200
38	Magnesium	mg/l	<150	<200
39	Carbon tetrachloride	mg/l	<3	<3
40	Hexachloro benzene	mg/l	<2	<2
41	DTT	mg/l	<1.3	<1.3
42	Endrin	mg/l	<0.01	<0.01
43	Dieldrin	mg/l	<0.01	<0.01
44	Aldrin	mg/l	<0.01	<0.01
45	Isodrin	mg/l	<0.01	<0.01
46	Perchloro ethylene	mg/l	<2.5	<2.5
47	Hexachloro butadiene	mg/l	<3	<3
48	Chloroform	mg/l	<1	<1
49	1,2 Dichloro ethylene	mg/l	<2.5	<2.5
50	Trichloro ethylene	mg/l	<1	<1
51	Trichloro benzene	mg/l	<2	<2
52	Hexaxhloro cyclohexene	mg/l	<2	<2

(6) Soil Quality Standard

Source: Cambodia National Quality Standards for Agriculture, Ministry of Agriculture, Forest, and Fishery (MAFF).

Parameter	Standard	
	Unit	Value
pH		
Salinity	ppt	6-8
Oil & Grease	mg/kg	-
Chloride	mg/kg	-
Petroleum Hydrocarbons		
Kerosene hydrocarbons (c10-c14)	mg/kg	-
Diesel hydrocarbons (c15-c28) (mg/L)	mg/kg	-
Heavy oil hydrocarbons (c29-c36) (mg/L)	mg/kg	-
BTEX		
Ethylbenzene	mg/kg	0.018
Benzene	mg/kg	0.0068
Toluene	mg/kg	0.08
Xylene	mg/kg	2.4
Metals		
Nickel	mg/kg	50
Copper	mg/kg	63
Zinc	mg/kg	200
Arsenic	mg/kg	12
Cadmium	mg/kg	1.4
Lead	mg/kg	70
Iron	mg/kg	-
Chromium	mg/kg	64
Mercury	mg/kg	6.6

ANNEX 2 Site Field Notes & Descriptions

Landfill Sub-project, Battambang

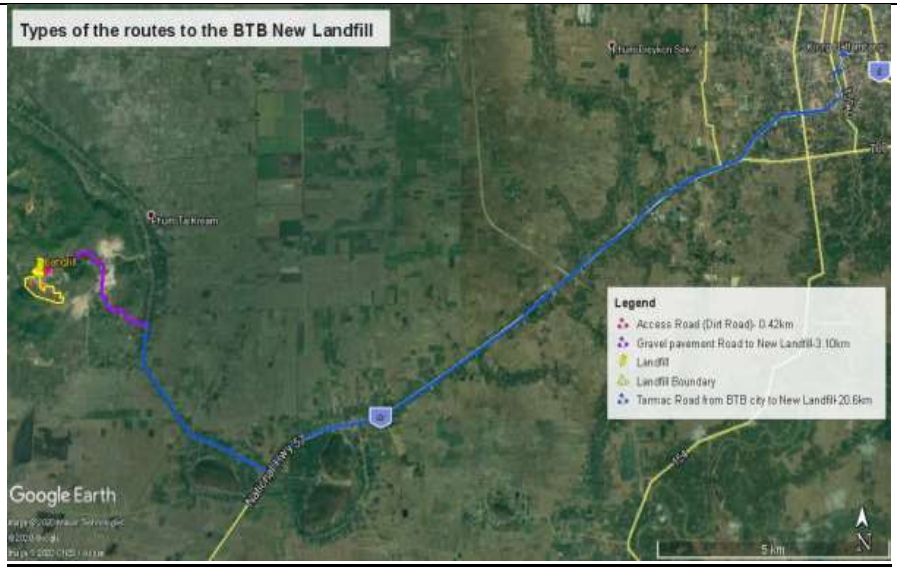
Battambang Proposed Landfill – Site Visit July 2020

Observer: Mr. YIN Somean

Date: 22-24/07/2020

Unexploded Ordnance (UXO): It is critical to check the site history and potential for UXO. An assessment is likely to be required, which needs to include 50m either side of access roads to the site. If UXO is present, then a land clearance certificate will be required from the Cambodia Mine Action Authority.

Question	Response
1. Access Need to determine logistics of waste transportation and the engineering requirements for road access into the site. Require separate details on the state of: a) the access road that leads to the site; b) the main access track into and within the site:	
a) Access Road [please take pictures]	
What is the nature of this road: dirt/ tarmac?	Dirt Road, and Gravel Road. **Picture:**  
What is the estimated width of this road – is it a single carriageway or can traffic pass in both directions?	The current road width is about 6-8 meters. The traffic can pass in both directions.
Who are the current main users of the road and is this a route used for any other industrial vehicles?	This current access road is serving for stone mining businesses, using heavy loading trucks. **Picture:**

	
How long would it typically take to drive to the site from the centre of Battambang?	It takes about **40min** to drive to the site from the centre of The Battambang city. It is approximately **23.5km** from the city centre.
What are traffic conditions like along the route (i.e., are sections prone to congestion at certain times of the day)?	The traffic condition is good, no heavy traffic (no traffic jam) in day time. But there are a lot of stone and soil transporting as saw in the pictures above.
b) Site Access Track [please take pictures and short video]	
Are there any existing engineered foundations or are existing access tracks simple dirt roads?	Base on site observation: I would like to confirm that there are no any existing engineering foundations. Inside the proposed landfill, the exiting access tracks is simple dirt roads as shown in picture below: Please find the photos and videos from line below: https://ramboll.sharepoint.com/:f:/r/sites/CAM-TS2-GMS4/Shared%20Documents/02-Project%20Folder/01-DED/01-Battambang%20Solid%20Waste/09-Site%20Visit/Site%20observation?csf=1&web=1&e=VYZ8Xs
What is the average width of this track?	It is about 6m-8m width

Is the track raised in any sections (i.e., on a bund)? If so, to what height above surrounding land?	
Is this road prone to flooding in any sections during wet season?	The road is not prone to flooding at the any sections during wet season.
What is the capacity and state of the existing road network – between Battambang and the proposed landfill site (e.g. tarmac/ dirt road; single/ duel carriageway)?	• These are the duel carriageway • The capacity of these roads handling both normal and heavy vehicles. See the detail below for the type of these roads.
2. Utilities Not expecting much in the way of utilities, but useful to get an understanding of proximity to existing networks.	
How is the site fixed in relation to linking in with existing electricity supply, water supply, wastewater supply?	Electricity: There is transmission line form the entrance into the landfill site. Water supply: No any water supply facilities Wastewater: No
Are there any existing electricity transmission lines, telecommunications cables, underground cables, or water piping etc. that cross the site?	There is an existing electricity transmission line, no telecommunications, cables, underground cables, or water piping etc. **Picture:**  
3. Surrounding land [*please take pictures and short video*] We need to determine the potential impact that the landfill may have on surrounding communities, livelihoods and the environment; and, what threats (e.g., landslips) there may be to the landfill from the adjacent land.	
Detail the surrounding land and what activities are taking place (e.g., agriculture and what type); give an indication (rough sketch map) of location.	* The surrounding the site, there are the rock mining businesses * For the agriculture: Mango tree **Please see the sketch map below:**

[e.g., it appears that there is a plantation located to the north/north-west of the site – what kind of plantation is this; also, there may be agricultural land to the east]?	
	
What is the proximity of the site to any existing development (e.g., farm buildings)? Indicate presence and rough distance from the site periphery on a rough sketch map. [It appears there are buildings just outside the north-east corner of the site; and the north-west corner].	There are no the any exiting development (farm building), beside the rock mining sites surrounding the landfill site.
Are there any existing natural screens between the proposed landfill site and the surrounding land? Of key interest here is the presence of any trees/ tall vegetation that may shield surrounding activities and development from the landfill.	
Regarding the forested hills surrounding the site: • Who owns this land? • Is this natural or plantation forest?	• The land surrounding the site is mostly stone mining business and some part of it are the mango field and other tree fruit field. • This is the natural forest.

• Are there any plans or is potential for deforestation during the lifespan of the landfill [may increase surface water runoff into the landfill)? • Can you ascertain any potential risk of landslide from these hills that may impact the landfill site [i.e., steep unvegetated slopes/ signs of existing unstable land]?	• There are only stone mining business activities during lifespan. • There were no any risks of landslide remarkable at the site.
4. Surface Water [*please take pictures of any water bodies or areas where there is evidence (channels, erosion) of significant water flow in wet season*] This is a key area of interest in order to understand water movements, drainage requirements and the impact that any unintentional discharge of leachate would have on the surrounding environment. Not expecting a through survey here, but just casual observations.	
Are there any permanent water bodies within or crossing the site, or in adjacent land that you can observe (up to 1 kilometer from the site)? If so, please describe: • The nature of these water bodies (e.g., rivers, streams, lakes, drainage channels, wetlands). • The approximate size and depth of these water bodies (not looking for exact measurements). • The speed of flow (fast, slow, still) and indicate general direction of flow (sketch map). • The biodiversity in these wetlands (e.g., indicate if there is a presence of vegetation in the water or on banksides; any other animals – just a broad description). • Any signs of pollution in the water (e.g., discoloration, odour, floating debris).	There are no any permanent water bodies within or crossing the site. The presence of the water in the landfill site sourced form the rainfall water.
Provide general observations on the flow of water across the actual site during the rain. For example, are there any signs of significantly eroded channels that cross the site. We are particularly interested in where water runs off the surrounding hills and what main routes it takes.	
If possible, please try and find out any local knowledge on surface water and groundwater movement in the area (i.e., what are the broad variations in water levels, where does the flow, how are individual waterbodies and groundwater systems connected).	
Do people fish in any of the water bodies or use them for the collection of any other products?	
How do surrounding properties access water for both human and any livestock drinking water consumption (i.e., boreholes). If boreholes are utilized then we need to understand where the water flows from, since	

contamination of these water supplies by the landfill would result in human health issues.	
5. Air pollution Potential The key here is understanding the impact the construction and the operations may have in terms of wind-blown odours/ pollutants.	
What are the prevailing wind directions?	
Are any communities/ activities/ existing developments downwind from the proposed landfill?	There are no any communities/ activities/ existing developments downwind from the proposed landfill.
6. Biodiversity and Nuisances Here we are looking to understand the possible impact on surrounding ecology and also any existing nuisance problems (birds, rats), which the landfill is likely to exacerbate.	
Indicate the presence of any significant numbers of mammals/ birds that you observe on the site (e.g., large flocks of birds).	**No.**
Are there any ecological designations in the vicinity of the site (e.g., Ramsar site).	**No.**
7. Cultural Sites Need to understand the presence of any cultural/ spiritual sites within the site or close by.	
Are there any sites of cultural significance (e.g., family graves) in the proposed landfill area/ or in adjacent land, which may be impacted by the landfill and its operations?	There are no any sites of cultural significance (e.g., family graves) in the proposed landfill area/ or in the adjacent landfill site.
Are the current rights of way well used?	
8. Construction Materials We want to source as much material from within the site as possible for the construction of natural liners, bunds, drainage layers, landfill cover. Based on the geotechnical survey, there may be some limitations, so to keep costs low it is useful to understand what material may be available in the wider vicinity.	
Ascertain from local knowledge the presence of any areas in the vicinity that have a good supply of clay-based/ semi to impermeable soils that could be utilized in the construction of the recompacted natural liner [based on the geotechnical report the availability of suitable material in situ is highly unlikely].	The clay material, is available with the price of 15usd/truck (6cu.m) where located in Koh Kralor as well as in the west of BTB city. According to the PIU, confirmed that there are many areas for clay material availabilities.

There appears to be two quarries to the east and south-east of the site – what are they extracting [could be useful in the landfill construction]?	Yes, these areas are both of the quarry and laterite soil mining.
9. Siting Infrastructure Looking to get a basic feel for on the ground observations and the lie of the land to determine suitable locations for some of the site's facilities.	

ANNEX 3 Consultation During IEE Preparation

Public Consultation Meetings: Focus Group Discussion (FGD)

The main objectives of FGDs are to:

- Present to the stakeholders and affected people the sites for subprojects in the provincial towns and inform them of the project activities
- Understand the main issues that may occur in the proposed sub-project areas, as raised by local people.
- Understand the potential social and environmental resources located/used in the subproject sites.
- Receiving issues, feedback, and comments from stakeholders or affected people regarding social, gender and environmental issues/resources in the proposed sites.
- Receiving comments and suggestions for mitigation measures to improve any adverse environmental and social impacts from project design, construction, and operation stages.

Identification of Participants to Consultation Meeting

Stakeholders invited to attend FGDs were identified by National Social Specialist and National Environmental Specialist with assistance from commune chiefs of subproject areas. These focus group members come from:

- Representative of communities or affected communities (men and women)
- Chiefs/ deputy village chiefs, the villages are located in and close to the subproject sites
- Commune chiefs/deputy commune chiefs and commune council members. These communes are located in and around the proposed subprojects sites.

The discussion questions concerned:

- Physical Resources: Water resources and water quality, soil quality, and air quality (noise and odour)
- Ecological Resources: forest/vegetation, wildlife and fish.
- Social Issues/Resources: Land use, water use, agricultural activities, cultural resources, infrastructure, utility services, education, and cultural-touristic resources.

The format of the FGD is summarized as follows:

1. Introduction to the project - describe the project and potential construction activities.
2. Mitigation Measures. Describe potential mitigation measures (EMP) and monitoring
3. Consultation Discussion. Discussion on topics and questions:

    - A. How does the community use the environment & natural resources? Example: what are water sources (drinking, washing etc). Vegetation/Fish/Forest, land use etc
    - B. What are the community's concerns regarding Construction Impacts?
    - C. What are the community's concerns regarding Operation Impacts?
    - D. What are the Mitigation Measures the community would like during Construction?
    - E. What are the Mitigation Measures the community would like during Operation?

Summary of the results of consultations

On 09 to 12 February the National Social and Gender Specialist and National Environmental Specialist of the TA 9203-CAM: Second Urban Environmental Management in The Tonle Sap Basin Project undertook FGDs in the proposed sub-projects areas for *Battambang, Serei Saophoan, and Stueng Saen Town.* The key points from the consultation meetings are presented in Section Consultation of this IEE.

Consultations for Landfill subproject in Battambang Province

- Consultation pictures in BTB Province



Consultation in Prek Preah Sdach Commune, BTB Town



Consultation in Rotanak Commune, BTB Town



Consultation in Svay Por and O Char Commune, BTB Town



Consultation in Ta Kream Commune, Banan District

- Participants List for Consultations in BTB Province

1. Consultation in Rrek Preahsdach Commune, BTB Town, BTB Province

No	Name	Agency/Commune	Position	Phone
1	Mr. Leuk Sam Ath	Rrek Preahsdach Commune	Villager	092 752 092
2	Mr. Thean Phong	Rrek Preahsdach Commune	Villager	092 265 019
3	Ms. Seng Lyna	Rrek Preahsdach Commune	Villager	
4	Ms. Oun Rany	Rrek Preahsdach Commune	Villager	
5	Ms. Om Naran	Rrek Preahsdach Commune	Villager	
6	Ms. Tim Sokhom	Rrek Preahsdach Commune	Villager	
7	Ms. Heng Bunthay	Rrek Preahsdach Commune	Village Chief	092 254 963
8	Ms. Houm Pisin	Rrek Preahsdach Commune	Deputy Village Chief	
9	Ms. Van Sarum	Rrek Preahsdach Commune	Villager	
10	Ms. Pin Saveun	Rrek Preahsdach Commune	Villager	
11	Ms. Soun Touch	Rrek Preahsdach Commune	Villager	
12	Ms. Om Maly	Rrek Preahsdach Commune	Villager	
13	Ms. Ros Sreyneth	Rrek Preahsdach Commune	Village Member	070 920 598
	Total: 13 persons (female: 11 persons)			

2. Consultation in Rottanak Commune, BTB Town, BTB Province

No	Name	Agency/Commune	Position	Phone
1	Mr. Reas Son	Rumchak-4 Village, Rottanak	Village Chief	092 738 831
2	Ms. Kao Sras	Rumchak-4 Village, Rottanak	Villager	
3	Mr. Chan Oeun	Rumchak-4 Village, Rottanak	Villager	
4	Mr. Teu Savoun	Rumchak-5 Village, Rotatnak	Village Chief	017 340 509
5	Mr. Chham Lap	Rumchak-5 Village, Rotatnak	Deputy Village Chief	078 964 923
6	Mr. Bun Nann	Rumchak-5 Village, Rotatnak	Villager	
7	Mr. Real Sambo	Rumchak-1 Village, Rottanak	Villager	
8	Ms. Pem Poa	Rumchak-1 Village, Rottanak	Villager	
9	Ms. Theun Theap	Rumchak-1 Village, Rottanak	Villager	
10	Mr. Leap Chhorn	Rumchak-1 Village, Rottanak	Villager	
11	Mr. Sim Samnang	Rumchak-2 Village, Rottanak	Deputy Village Chief	012 263 475
12	Mr. Leng Dy	Rumchak-2 Village, Rottanak	Villager	
13	Ms. Chhay Phary	Rumchak-2 Village, Rottanak	Villager	
14	Mr. Ngorn Sam Ol	Rumchak-3 Village, Rottanak	Deputy Village Chief	
15	Ms. Phan Sophorn	Rumchak-3 Village, Rottanak	Villager	
16	Mr. Mork Neth	Rumchak-3 Village, Rottanak	Villager	
17	Mr. Liv San	Rumchak-3 Village, Rottanak	Villager	
18	Mr. San Vuthchheun	Rumchak-3 Village, Rottanak	Villager	
19	Mr. Chheum Chheat	Rumchak-3 Village, Rottanak	Villager	

20	Ms. Song Piseth	Rottanak Coomune	Commune Clerk	092 505 559
21	Mr. Touch Phany	Rumchak-3 Village, Rotanek	Village Chief	071 777 826
	Total: 21 persons (female: 06 persons)			

3. Consultation in Svay Por and O Char Commune, BTB Town, BTB Province

No	Name	Agency/Commune	Position	Phone
1	Mr. Yous Sareun	Kamakar Village, Svay Por	Village Chief	012 536 506
2	Ms. Chhun Sothy	--	Community Leader	012 542 937
3	Ms. Lot Sokhunthea	--	Community Member	
4	Mr. Hing Bunla	Svau Por Commune	Commune Clerk	017 945 662
5	Mr. Oun Sophy	O Char Village, O Char	Village Chief	012 977 219
6	Mr. Teav Vuthy	Prek MohaTep, Svay Por	Village Chief	012 974 235
7	Mr. Mean Sophal	Svay Por Commune	Village Chief	
8	Mr. Lim Sokhan	--	Villager	
9	Mr. Khoun Teuk	--	Commune Assistant	012 680 650
	Total: 09 persons (female: 02 persons)			

Second Urban Environmental Management in the Tonle Sap Basin Project

Activity Report

Component	Site visit for Subproject TS-2
Type of Activity	Site visit at Battambang city
Sub-project/s	Landfill in Ta Kream commune, Battambang province
Start date	02-07-2020
End date	02-07-2020
Planned Activities	Consutation Meeting with commune authorities and local people
Activities Carried Out	Present of landfill subproject, discussion and received feedbacks, comments and questions from participants
Appendix 1: Participants	
Appendix 2: Pictures	

Consultant Signature	Date
Mr. Richard Mabbitt Team Leader	

Consultant Signature	Date
Mr. Yim Chamnan National Environmental Specialist	

Consultation Meeting with Commune Authority and people in Ta Keam

- **On 02 July 2020. Time 2:0 pm, At Ta Keam commune Office, Banan District, Battambnag**

Meeting discussion at DPWT Office at Battambang province. Self-introductions with PIU Deputy Director of PDWT and PIU staff. Meeting Attendees are shown in Appendix 1.

The objectives were:

- Present the project location, work plan and activities to participants
- Identify key impacts on environment and social
- Receive primary data and information for local communities or affected people
- Receive feedbacks (concerned issues, comments, and questions) for participants
- Analyse the feedbacks for prepare or update the IEE and EMP reports of Landfill subproject.

Meeting discussion:

The proposed consultation: Present the work plan and activities of project to local authorities and people. Receive sensitive environmental and social receptor are setting in and near the project area. Receive comments, feedbacks, and question are concerning to environmental consideration from the consultation.

The key concerns, comments, and questions form participants

- All the people in Ta Kream commune are farmers. Most of farmers plant the wet rice, some rice fields can grow 02 time/year, but this year, they can plant only 1 time/year because of raining is late and small rain.
- The people use water from local water supply (water source is Kamping Puy Reservoir) and ground water (well) for households use.
- There are not sensitive receptors (water, cultural resources, and protected ecology) are located near the landfill site
- There are a few houses (3-4 houses) are located about 0.5km from landfill site
- The village area, where school, health centre, and houses is located about 3km from landfill site.

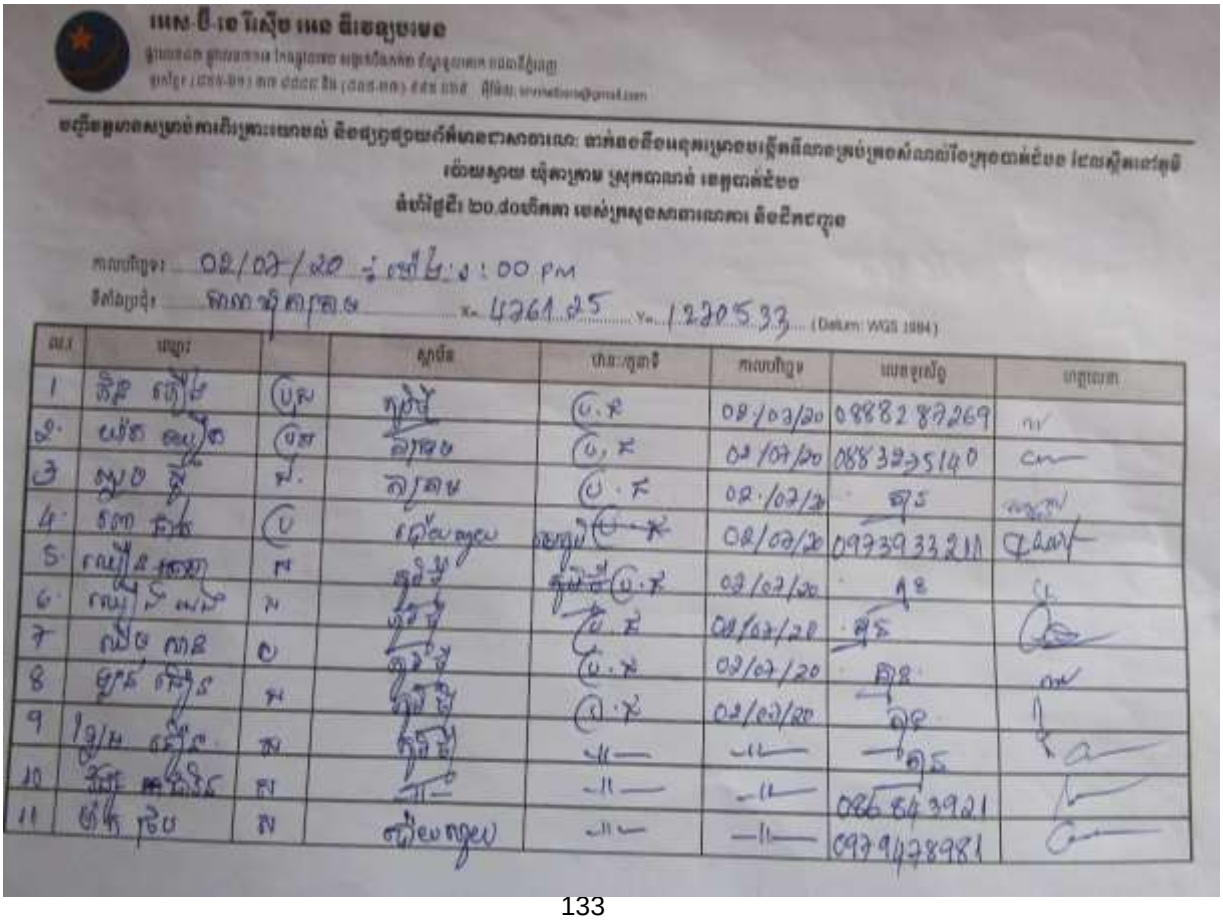
The considers:

- The landfill in upland can be impacted to Ground water (water well) in the village
- Where the wastewater and leachate from landfill
- Odour from the landfill can affect the local people
- Maybe increase fly and animal pest from landfill to village
- Waste transportation by truck on the road pass the village, should well manage, no spill leachate and fall down the wastes.
- Some people in Ta Kream commune dispose solid waste in the field or on the village area or burn. The project will provide waste collection in our commune and dumping to this landfill too?

Conclusion

Generally, they support the project, but more they are concerned during operation how to manage and control landfill for reduce the impacts on social and environment in and around the project site.

Appendix 1: List of Participants



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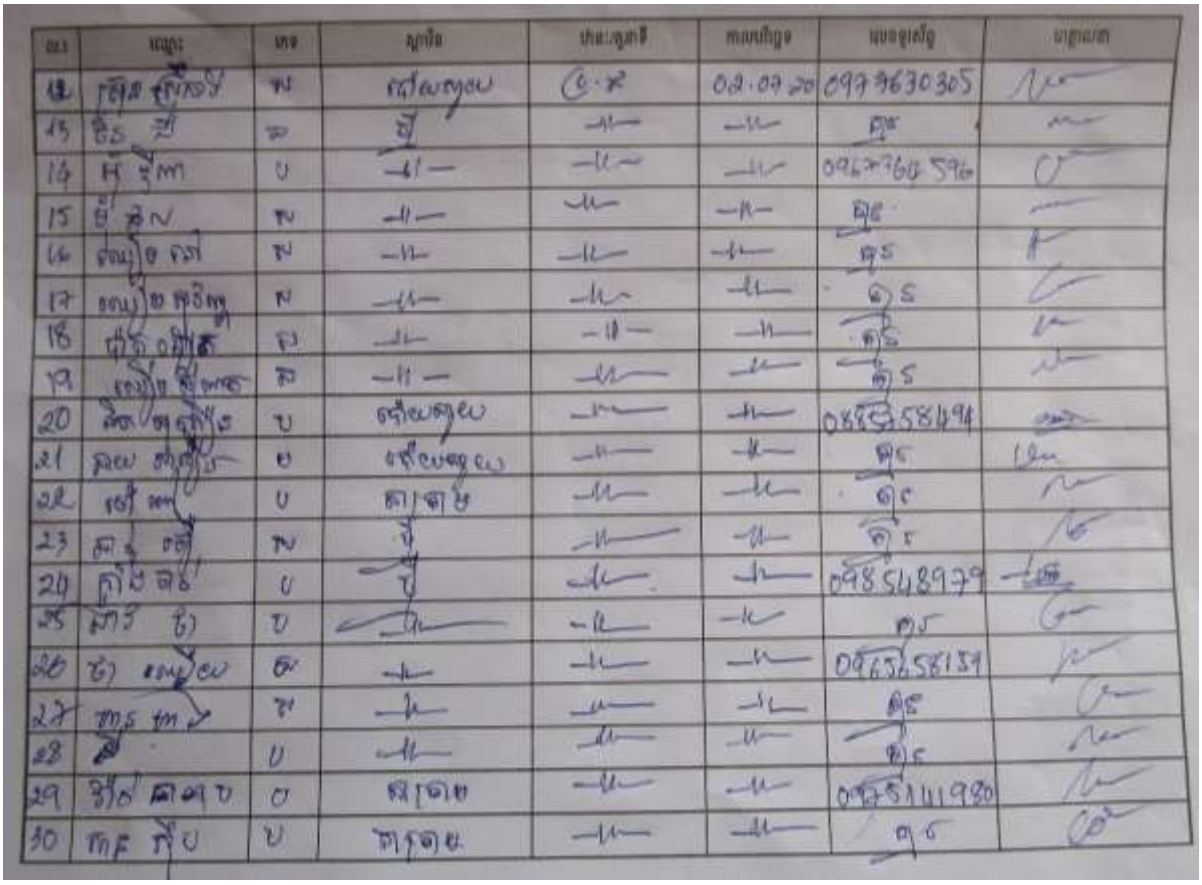
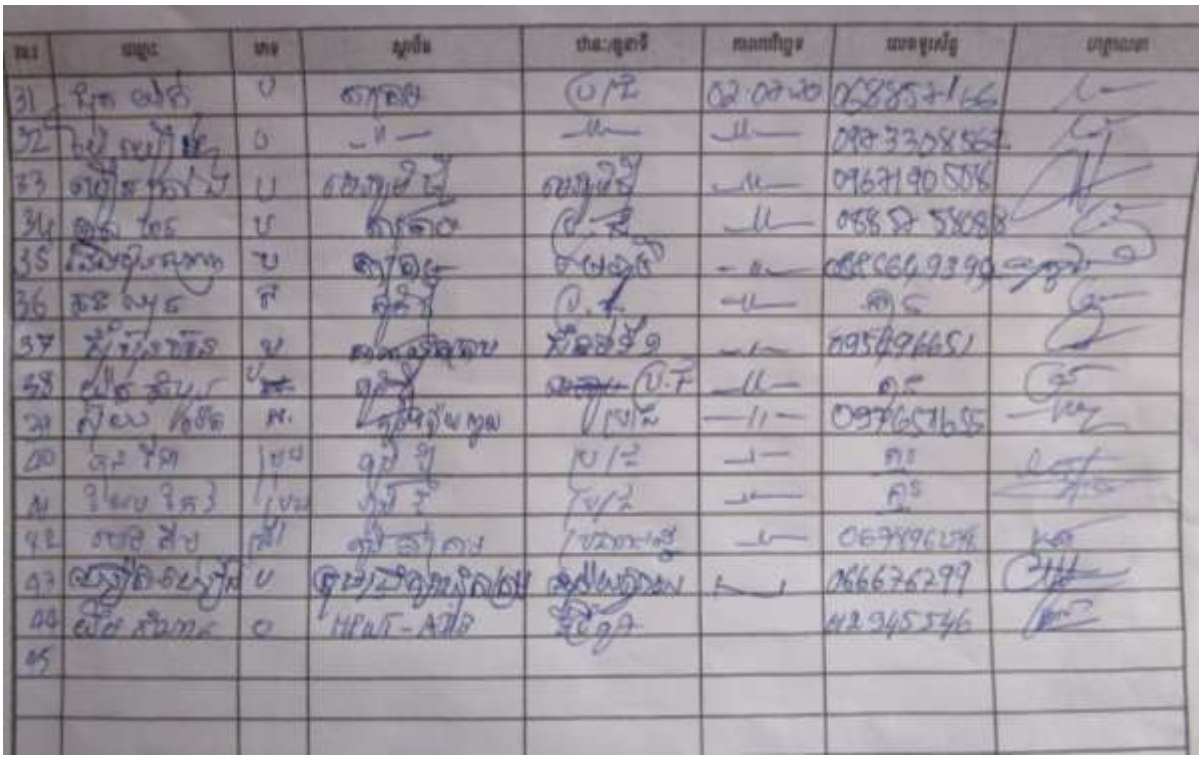
4		ប្រុស			02/03/20	097 39 33 211	
5		ប្រុស			02/03/20		
6		ប្រុស			02/03/20		
7		ប្រុស			02/03/20		
8		ប្រុស			02/03/20		
9		ប្រុស			02/03/20		
10		ប្រុស			02/03/20		
11		ប្រុស			02/03/20	086 84 3921	
					02/03/20	097 9478981	





Appendix 2: Pictures

ANNEX 4 Environmental Management Plan – Battambang

See EMP Report

ANNEX 5 Leachate Management Design considerations

[This Annex has been extracted from Consultant Report Technical Overview – ADB Solid Waste Management Projects in Cambodia and Laos, April 2018]

Leachate composition

Leachate Characteristics

Leachate strength is highly variable and depends upon waste type and composition, landfill waste age, temperature, moisture content, rainwater or groundwater infiltration, re-injection of leachate and so on. The possible range of leachate strengths for the key parameters is listed below, based on international data:

- BOD – 4 to 60,000 mg/L
- COD – 4 to 100,000 mg/L
- Ammonia – 2 to 3,000 mg/L
- pH – 4.5 to 9.0

A COD of 20,000 mg per litre is commonly adopted for the raw effluent quality for design. As the waste ages, the organic strength of the leachate reduces.

For comparison, the latest monitoring results collected from the Payatas landfill in Manila indicated a COD of 1140 mg per litre in June 2017, and a BOD of approximately half this. Most of the waste in the site is at least 10 years of age, and therefore the leachate strength emanating from this stage of waste is significantly reduced beyond that of fresh waste.

Parameter	**Unit**	**Design Value**		**Typical Effluent Standards**
pH	-	5 – 8.5		5.5 –9.0
		Average	**Maximum**	
COD	mg/l	20,000	30,000	<100
BOD	mg/l	12,000	20,000	<50
TSS	mg/l	500	1,000	<100
Ammonia.N	mg/l	200	800	<1
Nitrate.N	mg/l	25	40	-
Total N	mg/l	-	-	<60
Total P	mg/l	10	30	<6
Alkalinity (as $CaCO_3$)	mg/l	500	1000	-
Coliforms (MPN/100mL)	MPN/100ml	10^7	10^8	10,000

Values or ranges are typically not provided for heavy metals, organics including biocides and other contaminants such as generic solvents and oils because these are so highly variable ranging from zero to possibly high concentrations in some cases.

The cities within TS-2 all have very low to no industrial activity. The worst case is some cottage industry with garment manufacturing and also shoes. None of these activities would generate particularly toxic leachate, however this may change in the future as the cities become more industrialised.

Industries generally of most concern are metal plating works when the plating bath is emptied and the waste is taken to landfill rather than to a hazardous waste site. Similarly, biocide manufacturing facilities and other organics such as solvents can be of concern if taken to and dumped indiscriminately in the landfill. At present there are no plans for such manufacturing

facilities in the region.

With the move away from the very persistent organochlorine pesticides to the organophosphates and other less stable compounds, the concerns about partially empty pesticide containers being disposed of in the landfill is also greatly reduced.
Similarly, waste oil at present is not taken to the landfill but is used within the city. As the quantity of waste oil increase, then small recycling facilities can be established to reuse the oil rather than dispose of it.

In any case if and when these heavy industrial facilities may be developed within the landfill catchments, it is expected that better controls would be required by the city and the Environment Department such that any toxic or hazardous waste generated therein will be appropriately managed, reprocessed and then disposed of in a suitably registered facility.
Overall, leachate discharging from landfills developed and operated many decades ago is generally far more toxic than the leachate coming from modern landfill facilities, even in developing countries. However, this does not mean that leachate is innocuous and it still must be appropriately managed to prevent impacts on the water and soils environment.

Acid and methane landfill stages and impact on mobility

The biggest issue with landfill leachate strength and toxicity relates to the age of the landfill.
When a new landfill is being developed, the facility goes through a number of stages with the first being the development of acid forming bacteria within the waste mound. This can last from 6 to 24 months and is the period when the metals within the landfill are most mobile due to the acid phase significantly reducing the bond strength of metals to the various attachment sites including carbonates, organics and the cation exchange capacity overall.

Following the acid phase, methane forming bacteria dominate and the pH rises resulting in greatly reduced mobility of the metal ions within the landfill mound.
As the biochemical breakdown of the organics within the waste mound continues further, the resulting leachate strength significantly reduces until it becomes innocuous as the waste mound becomes effectively inert. This can take up to 20 years in many cases.

Front end controls

The landfills operation manual will provide details on the four waste categories to assess the acceptance or otherwise of waste being allowed into the landfill. This applies equally to organic and inorganic heavy-metal contaminants as well as other material such as hot loads or potentially explosive waste.
This landfills operation manual will provide guidance on each of the four waste categories in terms of how to identify them, whether they are always or sometimes acceptable and whether they are classed as difficult wastes that will require specific management interventions. The final category is of course unacceptable waste which is never allowed into the landfill.
By ensuring that the landfill staff member at the front gate has been suitably trained to identify and reject unacceptable loads, then the quantity of highly toxic or hazardous waste entering the site and therefore potentially further contaminating the leachate will be significantly reduced.

Leachate strength summary

Modern day leachate is far less toxic than historical leachate flows given the significantly better control over highly contaminated waste which previously was disposed of in landfills, such as metal plating wastes as well as biocides and various solvents and other refractory organics.

As the landfill goes through various stages from acid forming through to methane forming to finally inert, the leachate characteristics change significantly. One advantage of the reinjection

system proposed is that this accelerates the biochemical activity throughout the leachate mound thereby significantly reducing the acidic phase period when metals are highly mobile. This biochemical acceleration also means that the period over which leachate is generated is also significantly shortened.

Leachate flow balance

Battambang Example

Leachate management is a key factor in any landfill design. The system proposed consists of a series of slotted pipes in the landfill base leading to leachate pumping station. Leachate will then be pumped either to be reinjected at the top of the mound in wet weather or irrigated in dry periods.

The average moisture content of municipal waste ranges from about 20 to 45 percent, with most of the moisture being held in foodstuffs and green waste. Commercial and industrial waste mixed with non-putrescible municipal waste has a moisture content of less than 20 percent.

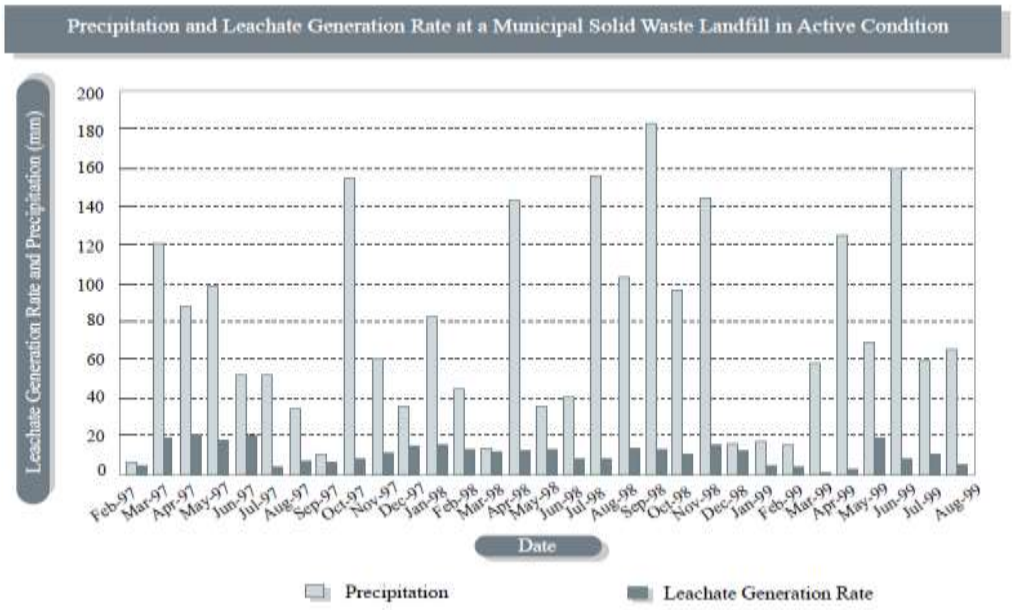
The degradation of the organic component of the waste mass produces a small quantity of liquid leachate and gaseous by-products. The leachate produced is partially absorbed into the dry waste mass and partially lost as vapour due to the heat of the biodegradation process. Under these conditions virtually no free liquid is produced.

Due to unavoidable direct rainfall entry over operational areas of the landfill, the volume of liquid within the waste mass increases. The direct entry of rain is expressed as a percentage of the rainfall on the site. Well run sites with excellent surface water controls have limited their annual leachate production to less than 5 percent of annual rainfall. Poorly run sites where even external runoff water from adjoining catchments has not been excluded have an annual leachate production in excess of 100 percent of annual rainfall.

Once the moisture content of the waste mass approaches 60 to 70 percent or so, the waste becomes saturated and any water excess becomes free to move by gravity. Under these conditions, leachate collects at the base of the landfill or above low permeability soil layers within the waste mass and expresses itself in springs around the toe of the landfill or even up the sides of the perimeter batters.

The external final batters will become grassed in any case as the soil becomes covered with seeds and external sources of sward generation. The proposal to irrigate external batters will further encourage sward growth in any case, particularly in the drier periods.

Precipitation and Leachate Generation Rate



Ref: "Qian, X., R. M. Koerner, and D. H. Gray, "Geotechnical aspects of landfill design and construction, upper Saddle River, New Jersey". Prentice-Hall, 2002

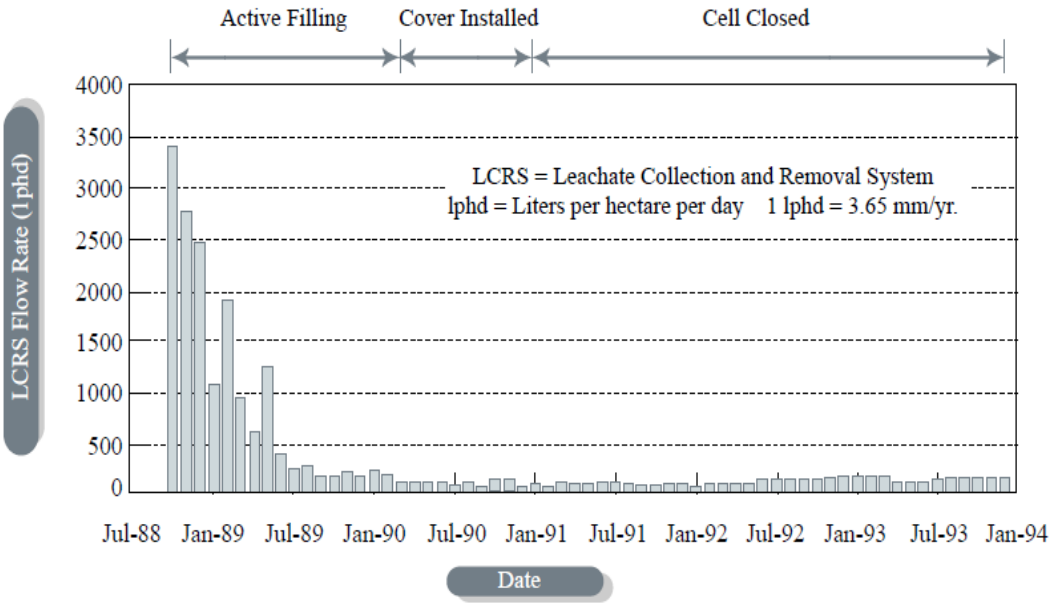
Once Stage 1 is complete, the potential infiltration of rainwater is expected to be totally lost by evapotranspiration (depending upon the lushness of the ground cover), retention in available pore space and absorption/vaporization. This does not include the allowance for irrigation of the completed and undeveloped stages to enhance vegetation cover, or the allowance for leachate losses in the saturated landfill gas emissions, which provides a further buffer against leachate migration.

However, if for some reason the recommended leachate reinjection and irrigation systems were not implemented, the average leachate production has been determined below. This essentially is a reversion to the old traditional system of simply collecting all leachate and treating it, rather than proactively managing leachate generation as recommended herein.

The design flow for the leachate system should be based on the net leachate flow rate, allowing for the porosity retention ability of the landfill to attenuate leachate flows during the annual production cycle. The net flow requiring management should therefore be based on the long-term average net leachate flow.

There are many theoretical design models for determining the quantity of leachate generated, but all require extensive data inputs which rely on numerous assumptions that may or may not happen in reality. Given the many factors affecting leachate generation rates mentioned above, and the correspondingly numerous methods of disposing of the untreated leachate, the only real determination of leachate flow rates possibly requiring treatment must be empirical.

Leachate collection and Removal Rates



Ref: Qian, X., R. M. Koerner, and D. H. Gray, "Geotechnical aspects of landfill design and construction. upper Saddle River, New Jersey": Prentice-Hall, 2002.

Well run landfills with appropriate stormwater diversion controls can achieve a leachate generation rate of 5-15% of annual rainfall. Conservatively this equates to say 10% of 1,306 mm of annual rainfall over the final landfill area within the long-term period of this study (Stages 1 through 4) of approximately 16.0 ha, or 20,000 m^3 per year, or say 57 m^3/d. This is approximately 0.66 litre per second.

One of the most comprehensive studies measuring actual leachate flows from landfills receiving similar annual rainfall amounts is "Qian, X., R. M. Koerner, and D. H. Gray. Geotechnical Aspects of Landfill Design and Construction. Upper Saddle River, New Jersey: Prentice-Hall, 2002." They measured long-term leachate formation rates of 200L/ha.d once final cover had been installed and over 2,000L/ha.d during initial landfill development. This later (maximum) rate equates to 32 m^3/d over the 16-ha final landfill.

Therefore 45 m^3/d (0.5L/s) has been adopted as the conservative design flow rate for the leachate management systems, but expect to only operate the management options such as reinjection and irrigation intermittently following protracted wet weather. Well operated landfills even in wetter climates do not need to operate the leachate pumping system for many months in the dry seasons.

In physical terms at the end of Stage 1, the landfill will consist of 348,000 m^3 of waste and soil. With a porosity of about 30 percent, it has the capacity to accept 104,000 m^3 of liquid into the voids prior to leachate flowing. This pore capacity equates to approximately 6.5 years leachate flow at the estimated total site leachate flow rate of 45 m^3/d. This ignores the capacity of the paper, cardboard and some other components to absorb leachate.
In terms of a theoretical water balance for Stage 1:

- Stage 1 surface area = 40,000 m^2
- Average annual rainfall = 1,306 mm
- Average annual evaporation = 1,540 mm
- Infiltration coefficient = 0.25
- **Infiltration** = 40,000 m^2 x 1,306 mm x 0.25 =>**13,000 m^3/year**

Evapotranspiration:

- 40,000 m^2 x 1,540 mm x 0.625 => 38,500 m^3/yr. (for lush grass cover)
- 40,000 m^2 x 1,540 mm x 0.35 => 21,600 m^3/yr. (for moderate grass)
- 40,000 m^2 x 1,540 mm x 0.15 => 8,200 m^3/yr. (for no grass cover)

Therefore, the **annual net potential infiltration** is theoretically as follows:

- zero for sealed, grassed site (vigorous /lush grass cover)
- zero for sealed, grass site (moderate grass cover),
- **4,800 m^3/yr. for sealed, non-grassed site**, or 13 m^3/d (or 0.15 L/s).

It is critical that the external landfill batters are grassed as quickly as possible and then irrigated to maximise grass sward growth in the otherwise dry periods.
In summary, the void space in Stage 1 could retain over 6 years theoretical leachate generation from the total site. Provide that the final batters are grassed, there will not be any net leachate yield requiring additional management beyond reinjection and irrigation. If other areas within the landfill are irrigated, such as future development areas, then the likelihood of having excess leachate is even further reduced.

Leachate flow balance summary

The results of the of the above very conservative calculation for Battambang is typical of the results for the other two TS-2 cities using local rainfall and the transpiration data.
Similar results have been derived in many other countries, whereby even during the critical first stage, there will be no need for leachate to be discharged provided that the external batters of previously completed areas are grassed as quickly as possible. This is a very essential component of satisfactory landfill operation in any case as the grass prevents erosion of the soil cover by wind and especially by water run-off.

Irrigation areas/EMMP controls

The introductory sections above note that the toxicity of modern day leachate is greatly reduced from that which resulted in serious concerns about the potential for health and environmental impacts. However, the waste still must be classified as a potentially hazardous liquid.

As a result, untreated leachate should only be irrigated on areas which are within the landfill site boundary which should be registered as a contaminated site and therefor would be unsuitable for growing crops for human consumption such as vegetables or rice.

The Environmental Monitoring and Management Plan would also specify irrigation protocols in terms of when leachate can be irrigated as opposed to having to be reinjected into the top of the landfill mound.
Typical irrigation constraints would be that less than 10 mm of leachate would be applied per day to any of the external batters, previously worked areas or future landfill cell sites. There would also be the obvious requirements that leachate should not be applied when the soil has a high moisture content which would encourage leachate run-off rather than infiltration with subsequent evapotranspiration.
The landfill operator would also be required to take account of weather predictions and would obviously not irrigate when a large storm event was expected in the short term.
The types of soils that can be irrigated would also typically be specified. However, being a landfill, then there should not be large areas of highly permeable low organic soil such as sands, gravel or glacial tills. These soils would not be expected to be present both as the natural soil around the site prior to cell development nor used as final cover material on the external batters. Therefore, infiltration rates should only be moderate given the low permeability of the soil profile and also the very low head applied in terms of irrigant depth.

The EMMP would also specify controls relating to worker safety and health which is discussed in later subsections.

Contaminant movement

Organics

The above section notes that the cities within this study do not have extensive industrial precincts and therefore the likely generation of toxic organics such as biocides, solvents, paints and so forth would generally be only from individual users rather than bulk volume is associated with the manufacturing process.
Therefore, it is considered extremely unlikely that large volumes of these organic waste would enter the landfill at any one time thereby significantly contaminating the leachate flow. There will always be opportunities for illegal dumping of small quantities of organic liquid wastes associated the with partially full used containers which may pass unnoticed at the front gate screening.
However, based on the analytical results from many modern landfills, elevated levels of these organics would be most unlikely as they are either absorbed by the paper and cardboard within the waste mound or highly diluted during the slow process of percolation from the upper mound down to the leachate interception system at the landfill base.

Heavy metals

The mobility of selected heavy metals such as Cu, Pb, Zn, Cr, Fe and Mn depends not only on the permeability of the soil but also potential attachment sites such as those resulting from the soluble/exchangeable sites (cation exchange capacity), carbonates, Fe and Mn oxides, and organic matter fractions.

Typically, Copper and Pb are largely adsorbed by the organic and oxide fractions, while a significant amount of Zn is extracted by the carbonate fraction. The potential mobility and biological availability of the metals in many soils generally shows Zn is greater than Cr, Cu and Pb, which are all very similar in terms of movement through a soil profile.

As noted above, the local soils both in terms of the natural profiles and cover material used on the batters will typically not be gravels or sands, so these soils which contain silt and clay fractions will have a lower permeability thereby giving more time for the leachate as it moves through the soil to attach to one of the bonding mechanisms described above.

Furthermore, the landfill sites and external batters will not be saturated for protracted periods. The resulting unsaturated zones provide improved bonding potential from CEC and carbonates as well as from the iron and manganese oxides. These are the most common attachment methods for the key metals and therefore the local soil will provide significant attachment sites for any heavy metals associated with the leachate migration.

Whilst not a key attachment mechanism, the presence of organics or humus always improves the retention of metal ions. As noted above, it will be essential to provide a growing medium (which is usually rich in humus) on the final batter slopes as well as any compost provided by the degradation of the grass sward over time. The organics and humus material will provide further attachment sites limiting the migration of the metal ions off-site.
The cation exchange capacity of the local soils, regardless of the other bonding mechanisms, will be elevated as both the local soils and cover material will have some clay components providing elevated CEC bonding sites. A lot of the soil in the region contains quantities of laterites which are extremely rich in iron. This provides not only attachment sites through the initial oxides but also the opportunity for the formation of very stable sesquioxides which essentially permanently lock the metal ions into a complex iron matrix preventing any future

leaching and subsequent migration.

Based on all the above factors, it is expected that there will be high retention rates of the heavy metals potentially in the leachate. These will be retained by the various ionic bonding mechanisms to be followed by incorporation into a complex iron matrix sesquioxide which will prevent any liberation of metals in the future. These bonding mechanisms are somewhat contingent upon the soil remaining unsaturated which will be a requirement of the EMMP in terms of leachate irrigation and also general site location requirements whereby the groundwater table must be some metres below the base of the landfill.

The standard toxic characteristics leaching procedure (TCLP) undertaken on many contaminated soils generally indicates that zinc is the most mobile metal in these types of soils. Environmental and health risk assessments undertaken at some landfills have concluded that the site did not represent a risk, despite "Total" concentrations of some metals being up to 40 times the investigation threshold value stated in many international guidelines such as the Dutch B standards.

Monitoring results – East Timor dumpsite

A 10-ha uncontrolled dumpsite which has served Dili in East Timor for over a decade was investigated on another ADB project. Less than 10% of the entire waste mound has ever been covered, and the waste has not been profiled nor effectively compacted resulting in significant potential for leachate migration through the waste to the base of the site, which is unlined.

The soil type at the site was similar to those noticed in the current project area with the presence of laterites in some soils as well is the presence of highly leached soils in other areas. In general, the soil types from Dili in East Timor and the three sites under consideration in theTS2 project are somewhat similar.

A dozen test pits were excavated through the waste in Dili and into the soil underneath. Soil samples were taken at various steps and then analysed for a comprehensive range of parameters in a registered laboratory internationally.

The laboratory testing of the soils samples from below the waste layers indicated that the soil at the very base of and essentially touching the lowest waste layers had detectable amounts of hydrocarbons (oil) and phenols in a few isolated samples but no pesticides, PCBs or PAHs/MAHs. The heavy metals were generally above detection limits but mostly below the guideline levels for using such a soil as clean fill.

None of the results exceeded the investigation threshold levels for Category B or C contaminated soils investigation protocols.
The results of samples collected one or more metres below the actual bottom of the waste layer in all areas of the site indicated that the soil here is uncontaminated. This ties in with the visual observations.

The soil of depth had increasing clay content so the lack of vertical migration of the metals and organics is as would be expected.

Contaminant movement summary

The combination of local soils types at the TS-2 cities (not highly permeable, low CEC and organics sands and gravels), the need for landfills to be located well above the local groundwater level, the ongoing improved front end controls on waste acceptance procedures, the significant decrease in the toxicity of waste entering landfills and the implementation of appropriate environmental Management and Monitoring Programs would suggest that the likelihood of significant ground water pollution due to leachate migration is unlikely, even if

leachate is irrigated without treatment.

Soils impacts

Irrigating high biological strength wastewater and soils can result in damage to the soil structure and soil chemistry. As a result, there has been significant investigations of irrigation of animal waste water, especially ponded piggery effluent, on a wide variety of soil types. The BOD of ponded piggery effluent is similar to that of a strong raw leachate.
These studies indicate that the application of 10mm / day of irrigant during dry periods does not result in anaerobic conditions developing in the upper soil layers, thereby potentially leading to higher rates of metals movement. Similarly, these reasonably low effluent irrigation rates do not appear to damage the soil structure.

One issue that requires monitoring however is potentially elevated TDS in the leachate causing grass sward burn – in essence the leachate is too salty for good grass growth. There have been cases where the raw leachate has in fact had to be diluted with groundwater to reduce the TDS to a suitable level for healthy grass growth.

This potential sensitivity of some species, be it grass or small shrubs, to elevated levels of TDS or other contaminants, supports the landfill management approach of avoiding monocultures in the greening program. It is better to aim for wide mix of species including some which are specifically planted and some which occur naturally as the green area matures. Natural selection will favour the more tolerant species over time.

Because there are large areas at a landfill site that can be irrigated in addition to just the previously worked areas, the overall effluent application rate remains low which ensures that the majority of the water requirements of the grass and shrubs can be provided through normal rainfall events. These wet weather periods provide relief from the leachate organic load as well.

Soils impacts summary

The proposed very low application rates together with the suitability of the soil types indicates that soil structure will not be a concern. This is supported by detailed studies undertaken with similar high organic strength waste have been irrigated at much higher rates over protracted periods from animal husbandry activities.

Health Risks

A range of interventions would be implemented to protect worker and public safety and generally minimise health risks.

For example, the general public would not be allowed onto parts of the landfill where leachate was or had been recently irrigated.

The irrigation system would consist of a HDPE or similar pipe with 5 to 10 mm holes drilled along one face at say 500 mm spacings. Effluent would be pumped into this pipe which would be laid along the contour of a previously worked and grassed area, and the leachate would merely trickle down the face of the external batter. The pressure would not be sufficient to form mist or airborne droplets which may drift away from the immediate irrigation area.

All workers would be provided with training on the safe operation of such a system and would obviously be provided with the requisite PPE such as gloves and masks, as well as waterproof footwear.

There have been a number of studies on the concentration of pathogens within raw leachate. A major study in France indicated that the faecal coliforms levels are typically 1×10^4 plaque

forming units per hundred millilitres. Other pathogens such as helminths, protozoa and moulds were not detected.

By comparison raw sewage has a faecal coliform count commonly in the order of 1 X $10^{6 \text{ to } 7}$ plaque forming units per hundred millilitres. Sewage which has been secondary treated but not specifically disinfected would have a faecal coliform level similar to that of raw leachate.

It should also be noted that faecal coliforms can be produced by any warm-blooded animal. Therefore, the health risks associated with indicator organisms such as faecal coliforms in sewage are far higher than those in a leachate flow where significant fractions of the indicator organism may well come from vermin. Vermin-sourced indicators result in a much lower health risk than similar indicator numbers from raw sewage.

Health risks summary

Appropriate engineering design of the irrigation scheme will minimise the generation of small droplets or mists avoiding any off-site dispersion of leachate from the irrigation process.
Operators will be trained in the correct manner of operating the scheme to minimise contact with the leachate, and have appropriate PPE.
The health risks associated with leachate remains significant but are far smaller (in terms of orders of magnitude) to exposure to raw sewage by wastewater treatment plant operators and sewer maintenance gangs.

Legality aspects of leachate irrigation

The local environmental legislation is silent on these specifics. The requirements are generally generic in terms of do no environmental or health harm.
Irrigation of untreated leachate is common throughout both the developed and developing world provided that it is operated under a suitable operations regime and also in accordance with the requisite Environmental Management and Monitoring Plans.

ANNEX 6 Wildlife species

Bird species (result from discussion with local people).

No.	Khmer Name (Local Name)	English Name	Scientific Name	MAFF 2007	CITES	IUCN Red List	Source	
							Interview	Inspection
1.	Krouch Inn	Indochinese Bushlark	*Mirafra marionae*	C		LC	√	
2.	Krouch Itt	Barred Buttonquail	*Turnix suscitator*	C		LC	√	
3.	Klaeng Sraak	Barn Barn-Owl	*Tyto alba*	C	II	LC	√	
4.	Jek Tum Kloun Tnoat Chhas	Maroon Oriole	*Oriolus traillii*	C		LC	√	
5.	Jek Tum	Black-naped Oriole	*Oriolus chinensis*	C		LC	√	
6.	Jek Tum Khbal Kmao	Black-hooded Oriole	*Oriolus xanthornus*	C		LC	√	
7.	Jek Tum Kheav	Asian Fairy Bluebird	*Irena puella*	C		LC	√	
8.	Chharb Puuk Trung Leung	Asian Golden Weaver	*Ploceus hypoxanthus*	R		NT	√	
9.	Chharb Jongkrong	Scaly-breasted Munia	*Lonchura punctulata*	C		LC	√	
10.	Trajeak Kam Kontuy Chhek	Fork-tailed Swift	*Apus pacificus*	C		LC	√	
11.	Staeng Lorlork	Black-shouldered Kite	*Elanus caeruleus*	C	II	LC	√	
12.	Sek Aat	Blossom-headed Parakeet	*Psittacula roseata*	C	II	NT	√	
13.	Ka Traet	Ruddy-breasted Crake	*Zapornia fusca*	C		LC	√	
14.	Kok Kruong Toch	Little Egret	*Egretta garzetta*	C		LC	√	
15.	Kok Kruong Mo Chhum	Intermediate Egret	*Ardea intermedia*	C	III	LC	√	√
16.	Kok Kruong Khbal Tnoat Chhas	Chinese Pond Heron	*Ardeola bacchus*	C		LC	√	
17.	Chharb Konlang	Olive-backed Sunbird	*Nectarinia jugularis*	C		LC	√	
18.	Chharb Konlang Tnoat Chhas	Brown-throated Sunbird	*Anthreptes malacensis*	C		LC	√	
19.	Chharb Doun Tah Knorng Pror Phaes	Grey-backed Shrike	*Lanius tephronotus*	C		LC	√	
20.	Chharb Ptaes	Eurasian Tree Sparrow	*Passer montanus*	C		LC	√	√

No.	Khmer Name (Local Name)	English Name	Scientific Name	MAFF 2007	CITES	IUCN Red List	Source	
							Interview	Inspection
21.	Kanchhak Slaa Chenh Cherm Sor	White-browed Fantail	*Rhipidura aureola*	C		LC	√	
22.	Kanchhak Slaa Pous Kmao	White-throated Fantail	*Rhipidura albicollis*	C		LC	√	
23.	K'eak	Large-billed Crow	*Corvus macrorhynchos*	C		LC	√	
24.	Chhangkeal Kjorng	Asian Openbill	*Anastomus oscitans*	C		LC	√	
25.	Chherng Tean	Black-winged Stilt	*Himantopus himantopus*	C		LC	√	
26.	Tradev Vich Khbal Brorphes	Grey-headed Lapwing	*Vanellus cinereus*	C		LC	√	
27.	Tradev Vich Khbal Baitong	Blue-tailed Bee-eater	*Merops philippinus*	C		LC	√	
28.	Tradev Toch	Green Bee-eater	*Merops orientalis*	C		LC	√	
29.	Teav Kheav	Indian Roller	*Coracias benghalensis*	C		LC	√	
30.	Porpech Kmao Slaab Brorphes	Eurasian Blackbird	*Turdus merula*	C		LC	√	
31.	Punlaek Ju Vech	Savanna Nightjar	*Caprimulgus affinis*	C		LC	√	
32.	Reek	Common Myna	*Acridotheres tristis*	C		LC	√	√
33.	Lor Lork Toch	Peaceful Dove	*Geopelia striata*	C		LC	√	√
34.	Lor Lork Traeng	Red Collared Dove	*Streptopelia tranquebarica*	C		LC	√	√
35.	Lor Lork Bay	Spotted Dove	*Spilopelia chinensis*	C		LC	√	
36.	Lor Lork Bay Thom	Oriental Turtle Dove	*Streptopelia orientalis*	C		LC	√	
37.	L'oudh Thom	Greater Coucal	*Centropus sinensis*	C		LC	√	
38.	L'oudh Thom	Lesser Coucal	*Centropus bengalensis*	C		LC	√	
39.	Lor Lork Phnom	Barred Cuckoo Dove	*Macropygia unchall*	C		LC	√	
40.	Lvea Jek	Oriental Magpie Robin	*Copsychus saularis*	C		LC	√	
41.	Lvea Jek Kloun Kmao	White-tailed Robin	*Myiomela leucura*	C		LC	√	
42.	Sat Jam Trapaeng	Coral-billed Ground Cockoo	*Carpococcyx renauldi*	C		VU	√	
43.	Chharb Si Ruy Kheav Pous Sor	Blue-and-white Flycatcher	*Cyanoptila cyanomelana*	C		LC	√	

No.	Khmer Name (Local Name)	English Name	Scientific Name	MAFF 2007	CITES	IUCN Red List	Source	
							Interview	Inspection
44.	Krouch Inn Veal Sre	Paddyfield Pipit	*Anthus rufulus*	C		LC	√	√
45.	Orn Tep Kmao	Black Drongo	*Dicrurus macrocercus*	C		LC	√	√
46.	Jek K'chhey T'ngas Plerng	Golden-fronted Leafbird	*Chloropsis aurifrons*	C		LC	√	
47.	Kchhob Dei Pous Loeung	Yellow Wagtail	*Motacilla flava*	C		LC	√	
48.	Jek Chao Slaab Kmao	Great lora	*Aegithina lafresnayei*	C		LC	√	√
49.	Trordok Toch	Lesser Adjutant	*Leptoptilos javanicus*	R		VU	√	
50.	Trordok Thom	Greater Adjutant	*Leptoptilos dubius*	EN		EN	√	
51.	Tea Ka Pa Prey	Comb Duck	*Sarkidiornis melanotos*	C	II	VU	√	
52.	Rumpay Jompus Veng Kley	Indian Skimmer	*Rynchops albicollis*	R		VU	√	
53.	Rumpay Kmao Knorng Brorphes	Bridled Tern	*Sterna anaethetus*	C		LC	√	
54.	Khrouch Truung Sor	Japanese Quail	*Coturnix japonica*	C		NT	√	
55.	Khrouch Inn Truung Leadh	Australasian Bushlark	*Mirafra javanica*	C		LC	√	
56.	Chhork Vork Toch	Large Scimitar Babbler	*Pomatorhinus hypoleucos*	C		LC	√	
57.	K'vaek Samuth Thom Pous Tnoat	Bar-tailed Godwit	*Limosa lapponica*	C		NT	√	
58.	Tor Tea Truung Loeung	Orange-necked Partridge	*Arborophila davidi*	R		NT	√	
59.	Porpuul Khbal Prorlaet	Pale-capped Pigeon	*Columba punicea*	R		VU	√	
60.	Porpuul Kontuy Mchhul	Pin-tailed Green Pigeon	*Treron apicauda*	C		LC	√	
61.	Preap Sor Kmao	Pied Imperial Pigeon	*Ducula bicolor*	C		LC	√	
62.	Mourn Prey	Red Junglefowl	*Gallus gallus*	C		LC	√	
63.	Staeng Kmao Sor Slaab Chhaek	Black Baza	*Aviceda leuphotes*	C	II	LC	√	
64.	Saek Saom	Alexandrine Parakeet	*Psittacula eupatria*	R	II	NT	√	
65.	Kordorb Prey	Banded Kingfisher	*Lacedo pulchella*	C		LC	√	
66.	Kook Mtes Tum	Cinnamon Bittern	*Ixobrychus cinnamomeus*	C		LC	√	

No.	Khmer Name (Local Name)	English Name	Scientific Name	MAFF 2007	CITES	IUCN Red List	Source	
							Interview	Inspection
67.	Kook Sambork Trapaeng	Yellow Bittern	*Ixobrychus sinensis*	C		LC	√	
68.	Chharb Kanlorng Kuut Loeung	Yellow-vented Flowerpecker	*Dicaeum chrysorrheum*	C		LC	√	
69.	Chharb Kanlorng Jomheang Kloun Tnoat	Chestnut-flanked White-eye	*Zosterops erythropleurus*	C		LC	√	
70.	Chharb Krorch	Yellow-vented Bulbul	*Pycnonotus goiavier*	C		LC	√	
71.	Chharb Krook	Striated Grassbird	*Megalurus palustriis*	C		LC	√	
72.	Chharb Doun Tah Kantuy Kudh	Asian Stutail	*Urosphena squameiceps*	C		LC	√	
73.	Chharb Doun Tah Knorng Tnoat	Brown Shrike	*Lanius cristatus*	C		LC	√	
74.	Chharb Doun Tah Chhung Knorng Chhres	Rusty-rumped Warbler	*Locustella certhiola*	C		LC	√	
75.	Kan Chhres	Slaty-breasted Rail	*Gallirallus striatus*	C		LC	√	
76.	Chharb Europe	House Sparrow	*Passer domesticus*	C		LC	√	
77.	Chharb Srok	Plain-backed Sparrow	*Passer flaveolus*	C		LC	√	√
78.	K'eak Teuk Toch	Little Cormorant	*Phalacrocorax niger*	C		LC	√	
79.	Kror Saar Th'nung	Purple Heron	*Ardea purpurea*	C		LC	√	
80.	Krorling Krorlong	Black-collared Starling	*Sturnus nigricollis*	C		LC	√	
81.	Chor Chaart Kreum	Common kingfisher	*Alcedo atthis*	C		LC	√	
82.	Jek Kchhei Slaab Kheav	Blue-winged Leafbird	*Chloropsis cochinchinensis*	C		EN	√	
83.	Jek Tes Thom	Scarlet Minivet	*Pericrocotus Flammeus*	C		LC	√	
84.	Dom Dul Toch	Baillon's Crake	*Porzana pusilla*	C		LC	√	
85.	Tah Vao Khbal Brophes Sraal	Indian Cuckoo	*Cuculus micropterus*	C		LC	√	
86.	Tradev Khbal Tnoat Kchhei	Chestnut-headed Bee-eater	*Merops leschenaulti*	C		LC	√	
87.	Trorses Toch Khbal Loeung	Yellow-crowned Woodpecker	*Dendrocopos mahrattensis*	C		LC	√	
88.	Teet Leet Kor Krorhorm	Red-necked Stint	*Calidris ruficollis*	C		NT	√	
89.	Tun Treet Tonle	Small Pratincole	*Glareola lactea*	C		LC	√	

No.	Khmer Name (Local Name)	English Name	Scientific Name	MAFF 2007	CITES	IUCN Red List	Source	
							Interview	Inspection
90.	Porpus Teuk	Little Grebe	*Tachybaptus ruficollis*	C		LC	√	
91.	Porpech Khbal Kmao Chung Knorng Sor	Sooty-headed Bulbul	*Pycnonotus aurigaster*	C		LC	√	√
92.	Porpech Tracheak Chhnot	Streak-eared Bulbul	*Pycnonotus blanfordi*	C		LC	√	
93.	Porpech Bompung Kor Sor Truung Loeung Chhas	Puff-throated Bulbul	*Alophoixus pallidus*	C		LC	√	
94.	Meam Thom Kouk	Brown Wood Owl	*Strix leptogrammica*	C	II	LC	√	
95.	Meam Thom Wu	Spotted Wood Owl	*Strix seloputo*	C	II	LC	√	
96.	Meam Toch Prey	Asian Barred Owlet	*Glaucidium cuculoides*	C	II	LC	√	
97.	Lvea Jek Prey	White-rumped Shama	*Copsychus malabaricus*	C		LC	√	
98.	Orntep Kompouy Ksae	Spangled Drongo	*Dicrurus hottentottus*	C		LC	√	
99.	Ov Lor Krabei	Oriental Bay Owl	*Phodilus badius*	C	II	LC	√	
100.	Ov Lor Ov Lerk	Collared Scops Owl	*Otus bakkamoena*	C	II	LC	√	
101.	Sareuk Keo Krabei	White-vented Myna	*Acridotheres grandis*	C		LC	√	√
102.	Orntep Brophes	Ashy Drongo	*Dicrurus leucophaeus*	C		LC	√	√

Source: IEIA Report, SBK July 2020

The Reptile Species (result from discussion with local people)

No.	Khmer Name (Local Name)	English Name	Scientific Name	MAFF 2007	CITES	IUCN Red List	Source	
							Interview	Inspection
1.	Pous Vek Dombuk	Indochinese Spitting Cobra	*Naja siamensis*	R	II	VU	√	
2.	Pous Vek Rorneam	King Cobra	*Ophiophagus hannah*	R	II	VU	√	
3.	Pous Vek Krabei	Monocle cobra	*Naja kaouthia*	R	II	LC	√	
4.	Bongkouy Soun Chhbar	Garden Fence Lizard	*Calotes versicolor*	C			√	√

No.	Khmer Name (Local Name)	English Name	Scientific Name	MAFF 2007	CITES	IUCN Red List	Source	
							Interview	Inspection
5.	Tok Kae	Tokay Gecko	*Gekko gecko*	C		LC	√	
6.	Pous Ksae Ko	Common Butterfly Lizard	*Leiolepis belliana*	C		LC	√	
7.	Pous Slab Kongkep	Barron's Kukri Snake	*Oligodon barroni*	C		LC	√	
8.	Tlan Toch	Burnmese Python	*Python molurus bivittatus*	C	II	VU		
9.	Chheas Krohorm	Common Butterfly Lizard	*Leiolepis belliana*	C		LC	√	
10.	Tlan Thom	Reticulated Python	*python reticulatus*	C	II	LC	√	
11.	Tlaen Chnoot Knorng	Common sun skink	*Eutropis multifasciata*	C	I	LC	√	√
12.	Kontrorng	Water Dragon	*Physignathus cocincinus*	C		VU	√	
13.	Tlaen Chnoot Knorng Thom	Speckled Forest Skink	*Mabuya macularia*	C			√	
14.	Bongkouy Kloun Kmao	Northern Forest Crested Lizard	*Calotes emma alticristatus*	C			√	
15.	Pous Punlaek Tnoat Khbal Uch	Barren's Kukri Snake	*Oligodon barroni*	C		LC	√	
16.	Pous Kray Kloun Chrung Klei	Malayan Krait	*Bungarus candidus*	C		LC	√	
17.	Pous Kray Kloun Chrung Veng	Banded Kraited	*Bungarus fasciatus*	C		LC	√	
18.	Pous Ksae Ko Khbal Chnoot	Mountain Bronzeback Tree Snack	*Dendrelaphis subocularis*	C		LC	√	
19.	Pous Dey	Common Pipe snake	*Cylindrophis ruffus*	C		LC	√	
20.	Pous Teuk	Wart Snake	*Acrochordus granulatus*	C		LC	√	
21.	Pous Punleak Kheav Kontuy Krohorm Tnoat	White-lipped Pit Viper	*Trimeresurus albolaris*	C			√	
22.	Pous Punleak Kheav Pnek Krohorm Thom	Big-eyed Pit-viper	*Trimeresurus macrops*	C		LC	√	
23.	Pous Prey	Common Ratsnake	*Ptyas mucosus*				√	

Source: IEIA Report, SBK July 2020

ANNEX 7 Ministry of Environment's Approval of the IEIA

ព្រះរាជាណាចក្រកម្ពុជា
ជាតិ សាសនា ព្រះមហាក្សត្រ

ក្រសួងសាធារណការ និងដឹកជញ្ជូន
លេខ:...៣.៣.៣.....សក.កបទ២

គោរពជូន
ឯកឧត្តមរដ្ឋមន្ត្រីក្រសួងបរិស្ថាន

ម្ចាស់គម្រោង តំណាងដោយ **ឯកឧត្តមទេសរដ្ឋមន្ត្រី រដ្ឋមន្ត្រីក្រសួងសាធារណការ និងដឹកជញ្ជូន** មានអាសយដ្ឋាន ផ្លូវ៥៩៨ សង្កាត់ច្រាំងចំរេះ២ ខណ្ឌឫស្សីកែវ រាជធានីភ្នំពេញ។

សូមធ្វើកិច្ចសន្យាការពារបរិស្ថាន

ដើម្បីរួមចំណែកធានានូវនិរន្តរភាពបរិស្ថាន ក្នុងកិច្ចដំណើរការអភិវឌ្ឍប្រទេសជាតិ ក្រសួងសាធារណការ និងដឹកជញ្ជូន(ម្ចាស់គម្រោង) សូមធ្វើកិច្ចសន្យាការពារបរិស្ថានចំពោះក្រសួងបរិស្ថាន សម្រាប់អនុគម្រោងសាងសង់ទីលានទុកដាក់សំរាមក្រុងបាត់ដំបង នៃគម្រោងកែលម្អគ្រប់គ្រងបរិស្ថានក្រុងជុំវិញបឹងទន្លេសាបជំហាន២ លើផ្ទៃដីទំហំ ២០,៨០ហិកតា (ម្ភៃហិកតា និងប៉ែតសិបអា) ដែលមានទីតាំងស្ថិតនៅក្នុងភូមិសាស្ត្រភូមិប៉ោយស្វាយ ឃុំតាគ្រាម ស្រុកបាណន់ ខេត្តបាត់ដំបង របស់ក្រសួងសាធារណការ និងដឹកជញ្ជូន តាមប្រការដូចខាងក្រោម៖

ប្រការ១.-

ធានាទទួលខុសត្រូវ និងអនុវត្តន៍នូវខ្លឹមសារដែលបានរៀបរាប់នៅក្នុងរបាយការណ៍វាយតម្លៃហេតុប៉ះពាល់បរិស្ថាន និងសង្គមជំបូង(IESIA) សម្រាប់អនុគម្រោងសាងសង់ទីលានទុកដាក់សំរាមក្រុងបាត់ដំបង នៃគម្រោងកែលម្អគ្រប់គ្រងបរិស្ថានក្រុងជុំវិញបឹងទន្លេសាបជំហាន២ របស់ក្រសួងសាធារណការ និង ដឹកជញ្ជូន នៅខេត្តបាត់ដំបង ដែលក្រសួងបរិស្ថានបានឯកភាព។

ប្រការ២.-

ធានាផ្តល់របាយការណ៍អង្កេតតាមដានបរិស្ថាន (Environmental Monitoring Report) ០១ដង/ឆ្នាំ នៅក្នុងដំណាក់កាលសាងសង់ ០១ដង/ឆ្នាំ នៅដំណាក់កាលប្រតិបត្តិគម្រោងជូននាយកដ្ឋានវាយតម្លៃហេតុប៉ះពាល់បរិស្ថាននៃក្រសួងបរិស្ថាន ដើម្បីពិនិត្យ និងវាយតម្លៃ។

ប្រការ៣.-

ធានាផ្តល់របាយការណ៍សង្ខេបនៃការសិក្សាលម្អិត (Summary Detailed Design Report) សម្រាប់អនុគម្រោងសាងសង់ទីលានទុកដាក់សំរាមក្រុងបាត់ដំបង នៃគម្រោងកែលម្អគ្រប់គ្រងបរិស្ថានក្រុងជុំវិញបឹងទន្លេសាបជំហាន២ របស់ក្រសួងសាធារណការ និងដឹកជញ្ជូន នៅខេត្តបាត់ដំបង ដែលមិនបានលម្អិតនៅក្នុងរបាយការណ៍វាយតម្លៃហេតុប៉ះពាល់បរិស្ថាន និងសង្គមជំបូង (IESIA) ដើម្បីដាក់ជូនក្រសួងបរិស្ថានពិនិត្យ និងផ្តល់យោបល់។

ព្រះរាជាណាចក្រកម្ពុជា
ជាតិ សាសនា ព្រះមហាក្សត្រ

ក្រសួងបរិស្ថាន
លេខ: ៥៧០៨/ស.ប.ស

សូមគោរពជូន
ឯកឧត្តមទេសរដ្ឋមន្ត្រី រដ្ឋមន្ត្រីក្រសួងសាធារណការ និងដឹកជញ្ជូន

កម្មវត្ថុ ៖ ការពិនិត្យ និងផ្តល់យោបល់លើរបាយការណ៍វាយតម្លៃហេតុប៉ះពាល់បរិស្ថាន និងសង្គមជំបូង (IESIA) សម្រាប់អនុគម្រោងសាងសង់ទីលានទុកដាក់សំរាមក្រុងបាត់ដំបង នៃគម្រោងកែលម្អគ្រប់គ្រងបរិស្ថានក្រុងជុំវិញបឹងទន្លេសាបជំហាន២ របស់ក្រសួងសាធារណការ និងដឹកជញ្ជូន នៅខេត្តបាត់ដំបង

យោង ៖
- ព្រះរាជក្រមលេខ នស/រកម/១២៩៦/៣៦ ចុះថ្ងៃទី២៤ ខែធ្នូ ឆ្នាំ១៩៩៦ ដែលប្រកាសឱ្យប្រើច្បាប់ស្តីពីកិច្ចការពារបរិស្ថាន និងការគ្រប់គ្រងធនធានធម្មជាតិ
- អនុក្រឹត្យលេខ ៧២ អនក្រ.បក ចុះថ្ងៃទី១១ ខែសីហា ឆ្នាំ១៩៩៩ ស្តីពីកិច្ចដំណើរការវាយតម្លៃហេតុប៉ះពាល់បរិស្ថាន
- លិខិតលេខ ២៧១៥ សក.កបទ២ ចុះថ្ងៃទី២៩ ខែកក្កដា ឆ្នាំ២០២០ របស់ក្រសួងសាធារណការ និងដឹកជញ្ជូន
- លិខិតលេខ ៣៣៦៣ សក.កបទ២ ចុះថ្ងៃទី២៥ ខែកញ្ញា ឆ្នាំ២០២០ របស់ក្រសួងសាធារណការ និងដឹកជញ្ជូន
- លិខិតលេខ ៤៩០៦ សក.កបទ២ ចុះថ្ងៃទី៣១ ខែធ្នូ ឆ្នាំ២០២០ របស់ក្រសួងសាធារណការ និងដឹកជញ្ជូន
- លិខិតលេខ ១៧៣២ សជណ ប.ស្ថ ចុះថ្ងៃទី១៧ ខែធ្នូ ឆ្នាំ២០២០ របស់ក្រសួងបរិស្ថាន
- លិខិតលេខ ១២៣៧ វ.ហ.ប.ស្ថ ចុះថ្ងៃទី០៤ ខែកញ្ញា ឆ្នាំ២០២០ របស់នាយកដ្ឋានវាយតម្លៃហេតុប៉ះពាល់បរិស្ថាននៃក្រសួងបរិស្ថាន

សេចក្តីដូចមានចែងក្នុងកម្មវត្ថុ និងយោងខាងលើ ខ្ញុំសូមគោរពជម្រាបជូន **ឯកឧត្តមទេសរដ្ឋមន្ត្រី** មេត្តាជ្រាបថា ក្រសួងបរិស្ថានឯកភាពលើរបាយការណ៍វាយតម្លៃហេតុប៉ះពាល់បរិស្ថាន និងសង្គមជំបូង (IESIA) សម្រាប់អនុគម្រោងសាងសង់ទីលានទុកដាក់សំរាមក្រុងបាត់ដំបង នៃគម្រោងកែលម្អគ្រប់គ្រងបរិស្ថានក្រុងជុំវិញបឹងទន្លេសាបជំហាន២ លើផ្ទៃដីចំហំ ២០,៨០ហិកតា (ម្ភៃហិកតា និងប៉ែតសិបអា) ដែលមានទីតាំងស្ថិតនៅក្នុងភូមិសាស្ត្រភូមិប៉ោយស្វាយ ឃុំតាគ្រាម ស្រុកបាណន់ ខេត្តបាត់ដំបង របស់ក្រសួងសាធារណការ និងដឹកជញ្ជូន (ម្ចាស់គម្រោង) ដោយម្ចាស់គម្រោងត្រូវគោរពតាមកិច្ចសន្យាការពារបរិស្ថានលេខ ៣៣៣ សក.កបទ២ ចុះថ្ងៃទី០៣ ខែកុម្ភៈ ឆ្នាំ២០២១ របស់ក្រសួងសាធារណការ និងដឹកជញ្ជូន។

អាស្រ័យដូចបានគោរពជម្រាបជូនខាងលើ សូម **ឯកឧត្តមទេសរដ្ឋមន្ត្រី** មេត្តាអនុវត្ត និងចាត់ចែងដោយសេចក្តីអនុគ្រោះ។

សូម **ឯកឧត្តមទេសរដ្ឋមន្ត្រី** មេត្តាទទួលនូវសេចក្តីគោរពពីខ្ញុំ។

ថ្ងៃអង្គារ ១៣កើត ខែ ចេត្រ ឆ្នាំជូត ទោស័ក ព.ស. ២៥៦៤
រាជធានីភ្នំពេញ ថ្ងៃទី ១០ ខែ កុម្ភៈ ឆ្នាំ២០២១

ជា រដ្ឋមន្ត្រី
រដ្ឋលេខាធិការ

នេត្រ ភក្ត្រា

ទទួលផ្ញើន៖
- ទីស្តីការគណៈរដ្ឋមន្ត្រី
- ក្រសួងសេដ្ឋកិច្ច និងហិរញ្ញវត្ថុ
- ក្រសួងរៀបចំដែនដី នគរូបនីយកម្ម និងសំណង់
- រដ្ឋបាលខេត្តបាត់ដំបង
- មន្ទីរបរិស្ថានខេត្តបាត់ដំបង
- ឯកសារ កាលប្បវត្តិ

ប្រការ៤.-

ក្នុងករណីក្រសួងបរិស្ថានតម្រូវឱ្យម្ចាស់គម្រោងធ្វើការកែប្រែនូវបច្ចេកទេសបរិស្ថានណាមួយ ដើម្បីឱ្យសមស្របទៅតាមគោលការណ៍ណែនាំ និងកម្រិតបទដ្ឋានបរិស្ថានម្ចាស់គម្រោងនឹងទទួលអនុវត្តទៅតាមគោលការណ៍ណែនាំនោះទាំងស្រុង។

ប្រការ៥.-

ទៅថ្ងៃអនាគត បើម្ចាស់គម្រោងមានគម្រោងពង្រីកបន្ថែម ឬផ្លាស់ប្តូរ ឬកែសម្រួលរបាយការណ៍សិក្សាសមទិលទ្ធភាព (Feasibility Study Report) ឬផ្ការកសកម្មភាព ម្ចាស់គម្រោងនឹងរាយការណ៍ជូនក្រសួងបរិស្ថានឱ្យបានមុន ០១ខែ។

ប្រការ៦.-

អនុញ្ញាតឱ្យមន្ត្រីជំនាញពីក្រសួងបរិស្ថាន ឬមន្ទីរបរិស្ថានខេត្តបាត់ដំបង ដែលមានលិខិតបញ្ជាបេសកកម្មត្រឹមត្រូវ ដើម្បីធ្វើការត្រួតពិនិត្យនៅទីតាំងតំបន់គម្រោង។

ប្រការ៧.-

ក្នុងករណីដែលម្ចាស់គម្រោងពុំបានគោរពតាមប្រការណាមួយ ឬអនុវត្តផ្ទុយពីកិច្ចសន្យានេះ ឬលិខិតបទដ្ឋានគតិយុត្តចូលជាធរមានផ្សេងៗទៀត ម្ចាស់គម្រោងនឹងទទួលខុសត្រូវចំពោះមុខច្បាប់ជាធរមាន។

ថ្ងៃ៧ ខែ ឆ្នាំជូត ទោស័ក ព.ស២៥៦៤
រាជធានីភ្នំពេញ ថ្ងៃទី ០៧ ខែ កុម្ភៈ ឆ្នាំ២០២១
ឧ.រដ្ឋមន្ត្រីក្រសួងសាធារណការ និងដឹកជញ្ជូន

ស៊ុង សាន

បានឃើញ និងគោរពជូន
ឯកឧត្តមរដ្ឋមន្ត្រីក្រសួងបរិស្ថាន មេត្តាពិនិត្យ និងសម្រេច
លេខ: ២៣៨ ប.ហ.ប.ស
ថ្ងៃអង្គារ៍ ១៣កើត ខែ ឆ្លូវ ឆ្នាំជូត ទោស័ក ព.ស.២៥៦៤
រាជធានីភ្នំពេញ ថ្ងៃទី ០៩ ខែ កុម្ភៈ ឆ្នាំ២០២១
ប្រធាននាយកដ្ឋានវាយតម្លៃហ៊ោតុប៉ះពាល់បរិស្ថាន

ជា ឈៀ សេរី

បានឃើញ និងឯកភាព
ថ្ងៃពុធ ១៣កើត ខែ ឆ្លូវ ឆ្នាំជូត ទោស័ក ព.ស.២៥៦៤
រាជធានីភ្នំពេញ ថ្ងៃទី ១០ ខែ កុម្ភៈ ឆ្នាំ២០២១
ឧ.រដ្ឋមន្ត្រីក្រសួងបរិស្ថាន
រដ្ឋលេខាធិការ

នេត្រ ភក្ត្រា