Initial Environmental Examination

July 2021

Cambodia: Fourth Greater Mekong Subregion Corridor Towns Development Project

Solid Waste Management Subproject, Kratie City, Kratie Province

Prepared by the 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-50099-002-iee.

CURRENCY EQUIVALENTS

(as of 2021)

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

ABBREVIATIONS

ADB	–	Asian Development Bank
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
EA	–	Executing Agency
EIA	–	Environmental Impact Assessment
EMP	–	Environmental Management Plan
FGD	–	Focus Group Discussion
GHG	–	Greenhouse Gas
GRM	–	Grievance Redress Mechanism
IA	–	Implementing Agency
IEE	–	Initial Environmental Examination
IESIA	–	Initial Environmental and Social Impact Assessment
MoE	–	Ministry of Environment
MOWRAM	–	Ministry of Water Resources and Meteorology
MPWT	–	Ministry of Public Works and Transport
PDoE	–	Provincial Department of Environment
PMC	–	Project Management Consultant
PMC-I/NES	–	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
PSC	–	Project Steering Committee
RCP	–	Representative Concentration Pathway
SHC	–	Sewer Household Connection
STP	–	Sewage Treatment Plant
SPS	–	Safeguards Policy Statement
TS-1	–	First Tonle Sap Urban Environmental Management Project
TS-2	–	Second Tonle Sap Urban Environmental Management Project
TSBR	–	Tonle Sap Biosphere Reserve
TSS	–	Total Suspended Solid
WHO	–	World Health Organisation
WWTP	-	Wastewater Treatment Plant

WEIGHTS AND MEASURES

dB(A)	–	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	–	Metre
°C	–	Degree Celsius
PM10	–	Particulate Matter 10 micrometres or less
PM2.5	–	Particulate Matter 2.5 micrometres or less
µg/m3	–	Microgram per cubic metre

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. Project Introduction

1. The Fourth Greater Mekong Subregion Corridor Towns Development Project (GMS4/CTDP-4 or Project) will support the Governments of Cambodia and the Lao People's Democratic Republic (PDR) in enhancing the competitiveness of selected towns located along the Central Mekong Economic Corridor in the Greater Mekong Subregion (GMS). It is aligned with the Government of Cambodia's Rectangular Strategy for national development. The third phase (RS-III 2013–2018) identified integrated urban development as a priority and recognized the need to manage environment and climate change to ensure the sustainability of Cambodia's economic growth and social development. The Project is also underpinned by Cambodia's National Green Growth Road Map (2010) which promotes access to clean water and sanitation. In Cambodia, the Project will result in better integrated regional and local planning, and improved urban infrastructure such as drainage, wastewater treatment, solid waste management, and municipal services in the participating cities of Kampong Cham, Kratie, and Stung Treng province.

2. The CTDP-4 Project outputs include: (i) separate the wastewater/sewage system and stormwater drainage facilities to improve sanitation and control flood risks, (ii) Wastewater Treatment Plant (WWTP) and drainage system, (iii) controlled landfills for improved municipal waste disposal, solid waste collection vehicles to enhance collection activities, and the closure of existing dumpsites (Stung Treng and Kratie), (iv) town centre landscaping and rehabilitation to create liveable public spaces that foster tourism benefits, (v) information and communications technology (ICT) based government systems to optimize operational transparency and resource efficiency in managing the new infrastructures, and (vi) provincial five-year socioeconomic development plans to promote regional economic connectivity and coordinate their strategies (***Table 1***).

Table 1: Summary of CTDP-4 Sub-projects

Subproject City	Lagoon based WWTP	Wastewater System	Drainage	Landfill
Kampong Cham	5,000 m^3/day	137 km	4,3 km	436,208 m3
Kratie	4,900 m^3/day	143 km	12 km	203,119 m3
Stueng Treng	3.650 m^3/day	147 km	12 km	181,230 m3

3. The project environment classification is confirmed as Category B. This report constitutes the Initial Environmental Examination (IEE) for the proposed Kratie Solid Waste Management Subproject. The IEE was carried out in accordance with the Safeguard Policy Statement (2009) of the Asian Development Bank (ADB), and Cambodia's Law on Environmental Protection and Natural Resource Management (Preah Reach Kram/NS-PKM-1296/36) 1996, and its sub-decrees and implementing guidelines. A separate Environmental Management Plan (EMP) has been prepared (latest version dated July 2021), which will be part of the bidding documents. The IEE and EMP have been updated in conjunction with the finalization of the Detailed Engineering Design (DED) ensuring consistency between engineering designs and environmental mitigation measures. The previous IEE/EMP of May 2018 prepared and disclosed during the preparation of the CTDP-4 Project covering all the CTDP-4 subprojects is available on ADB's website[1]. The IEE and EMP also incorporate the findings of the Initial Environmental and Social Impact Assessment (IESIA) approved by the

[1] https://www.adb.org/projects/documents/cam-50099-002-iee

Ministry of Environment (MoE) on 20 May 2021 (***Annex 7***). The IEE and EMP will be further updated if necessary.

4. The Kratie City Solid Waste Management Subproject consists of the following works and components:

- Upgrading of 2,020 metres of external access road to the landfill site to be above flood levels.
- Construction of one controlled landfill cells out of a total of four cells.
- Construction of one hazardous waste landfill cell.
- Construction of a non-mechanical material recovery facility (MRF).
- Construction of drainage, leachate collection, treatment, and recirculation system.
- Construction of weighbridge, office, staff dining and rest room (combined building); workshop, electrical and mechanical room; and supply building.
- Construction of 1,721 metres of concrete internal roads, with associated bunds and drainage.
- Construction of wire mesh fencing, brick entrance wall, gate and security guardhouse.
- Construction of car/vehicle washing facility.
- Construction of hazardous waste storage building.
- Provision of utilities, including construction of grid-tied solar system.
- Provision of operations & maintenance (O&M) equipment.
- Closure of the existing waste dump at the landfill site and relocation of up to 7,344 tonnes of waste to the new landfill cell.
- Closure of the old waste dumpsite.

5. The subproject components and facilities have a design life of 20 years up to 2040. Operations are expected to start in 2023.

6. The controlled landfill site is located on state land in Khsar Village, Dar commune, Cheatr Borei District, Kratie Province. The site covers an area of 27.85 ha.

7. The location of the landfill site and its surroundings are summarized below:

- about 15 km for Kratie City centre.
- about 2 km from Khya Village located along National Road No.7, Dar commune.
- about 17 km from the Mekong River.
- Small stream runs across the north-eastern corner and connects to Or Kantuot Stream (0,2 km from the site measured from the north-eastern site boundary).
- The nearest housing is a small cluster of houses/buildings 1.7 km southwest of the site.
- A stone quarry is located 350 m northwest of the site.
- The site is covered with shrub regrowth.
- The surrounding area in a 2 km radius is dominated by shrubland with patches of agricultural land
- There are some ground water wells in Khya Village.
- There are no known sensitive receptors and protected areas near the site.

8. The key objectives of closing and remediating the existing dumpsite and the old dumpsite include:

a) Minimise the risk that leachate from the dump may infiltrate groundwater resources that are or may in the future be used as a source of drinking water
b) Minimise the risk of contamination of nearby waterways
c) Minimise the risk to public health from spread of infections
d) Eliminate the generation of harmful air emissions from open burning of waste
e) Control migration of landfill gasses
f) Eliminate generation of odour and windblown waste

g) Create an area that can be safely used for predetermined purposes
h) Improving the livelihoods and living conditions of informal recyclers.

9. The existing dumpsite will be closed by relocating the existing waste in the new landfill cell as soon as the cell is ready to receive waste. The dumpsite area will then be backfilled and rehabilitated and become part of the landfill operation area.

10. The method of closure and remediation of the old dumpsite will be finally determined based additional physical investigations and assessments as recommended in this IEE. The conceptual methods for closure and remediation[2] under consideration include:

(i) Closure by removing the waste from the dump and disposing it at the new landfill.

(ii) In-place closure by capping the waste,

(iii) Closure by upgrading into a controlled engineered landfill, or

(iv) Isolation of waste from groundwater, using drainage/ engineered containment.

1.2. Key Findings

11. The environmental baseline study confirms that the local communities are the most sensitive receptors in the project area. The landfill site and its immediate surroundings are dominated by secondary shrubs and patches of agricultural land. The nearest areas of conservation value include the Mondulkiri - Kratie Lowlands Key Biodiversity Area located about 11 km east of the site and the Mekong River Kratie to Lao Border Key Biodiversity Area about 15 km to the west.

1.2.1. Pre-construction

12. The pre-construction phase will involve development of the Contractor's Environmental Management Plan (CEMP) incorporating and detailing the environmental protection measures described in the EMP. The Contractor shall submit the CEMP to the Project Management Unit (PMU) for review and the Contractor is not allowed to start construction work until the CEMP has been approved. Preparation and training for the implementation of the CEMP will be undertaken. The construction site(s) must be surveyed and cleared for UXOs before construction is allowed to start.

1.2.2. Construction

13. Impacts associated with the construction works will be localized and short-term and limited to common well-known impacts from earthworks and construction of buildings. Potential impacts include generation of noise, dust, uncontrolled discharge of sediment-laden runoff, and waste generation.

14. Potential impacts associated with the remediation of the two dumpsites include generation of odour, dust and noise, windblown litter in the surroundings and displacement of vectors seeking new sources of food. These potential impacts are temporary and localized, and mostly related to health and safety for the workers. Implementation of conventional good practice pollution control technologies will effectively mitigate these impacts.

[2] A Roadmap for closing Waste Dumpsites, The World's most Polluted Places, ISWA, 2016, https://www.iswa.org/fileadmin/galleries/About%20ISWA/ISWA_Roadmap_Report.pdf

15. The existing dumpsite located at the new landfill site will be closed by relocating the waste in the new waste cell. For the other, old dumpsite, a final decision on remediation and closure awaits the results of additional physical site investigations.

16. Additional measures will be implemented to properly control disposal of incoming domestic waste at the existing dumpsite while Cell-1 is being built.

1.2.3. Operations

17. The most significant environmental impacts and risks associated with the subproject are during the operation phase. Typically, landfill operations can cause environmental pollution if not properly managed and maintained. Such pollution can include long term risks to groundwater, soil and nearby surface water bodies from poor leachate management or contaminated runoff, and windblown litter if waste is not regularly covered. Odour, dust and noise from handling of waste may affect nearby residents or workplaces. In addition, traffic will increase on the roads that lead to the landfill, leading to risks for the health and safety of communities. Landfill impacts are well-known, and the subproject will employ well-established and proven pollution control technologies to effectively prevent or otherwise mitigate the anticipated impacts.

18. The subproject facilities will bring about significant environmental improvements to the local project areas and urban core. Field visits show that the current environment is being contaminated with litter and the growing pressure on the urban areas means that this would likely continue. The development of well-engineered waste management facilities will mean that the pollution to the environment will be reduced and therefore the risks to human health and water quality, will be less. In addition, climate change projections have been taken into account ensuring that the design of the solid waste management facilities and infrastructure is resilient against climate change risks.

19. The community consultations undertaken during the IEE preparation at PPTA and DED stages show widespread support for the subproject as the residents recognize the need to improve waste management.

1.2.4. Health and Safety Aspects

20. Appropriate occupational health and safety measures for the construction workers and the landfill operators will be implemented. Typical health and safety procedures include safety procedures for truck movements; use of PPEs to protect against dust, sharps, vectors, falling objects, and noise; access control; provision of first aid kits; and repeated training of employees and truck drivers in safety procedures.

1.3. Environmental Management Plan

21. The separate 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 the environmental monitoring plan
- Capacity building and training requirements
- Public consultation and information disclosure
- GRM including clearly defined timescales and responsibilities

22. The project includes a Capacity Building Program to address technical and institutional issues and ensure continued provision of quality services. The Project Management Consultant (PMC) will be responsible for ensuring adequate training during project implementation. The training will focus on:

- roles and responsibilities for implementation of the EMP (oversight, monitoring, supervision, reporting and actual on-the-ground implementation)
- updating of the EMP
- Grievance Redress Mechanism – roles and responsibilities
- Environmental protection and pollution control on construction sites (management and control of odour, dust, noise, leachate)
- Environmental monitoring methods, data collection, interpretation and reporting.
- Emergency preparation and response and other important site-specific environmental measures

23. The key mitigation measures during construction will include:

- Good construction practices will be adopted to ensure minimal disturbance to affected persons from construction related nuisance, such as noise, dust and pollutant emissions.
- Temporary waste disposal control measures will be implemented at the existing dumpsite while Cell-1 is being built (control of odour, windblown litter, open burning of waste, polluted runoff)
- Community and occupational health and safety measures will be implemented to prevent traffic accidents, workplace accidents and transmission of infectious diseases including in particular COVID-19.

24. The key mitigation and monitoring measures to prevent or otherwise mitigate environmental impacts during operation of the landfill include design measures as well as operational measures:

- Leachate barrier, collection, treatment, and recirculation system.
- Innovative leachate drainage system that collects clean and dirty water separately.
- Passive landfill gas venting.
- Separate secure landfill cell for hazardous waste.
- Materials recovery facility to increase recycling and reduce waste disposal.
- Daily waste compaction and regular soil cover.
- Minimise the area of exposed waste.
- Regular odour, dust, groundwater and surface water quality monitoring.
- The landfill operator's staff will be trained and instructed in proper landfill operation, monitoring and maintenance.

25. A Grievance Redress Mechanism (GRM) has been established to receive and promptly facilitate resolution of affected peoples' concerns and grievances about project social and environmental safeguards performance. The GRM is a transparent process that is readily accessible to all affected persons. The GRM contains multiple entry points to allow affected people to approach the Contractor, PIU, their local leaders, the Ministry of Public Works and Transport or ADB.

1.4. Conclusion

26. This IEE was undertaken to determine the environmental issues and concerns associated with the solid waste management subproject in Kratie City. The assessment confirms that the subproject is classified as Category B for environment. All significant adverse impacts are well-known from experience with similar types of projects and will be effectively mitigated by conventional proven pollution control technologies and practices. The direct responsibilities for implementing the mitigation measures lies with the construction

contractor during the construction phase and with the landfill operator during the operational phase. They will be supported by qualified national and international environmental consultants of the Project Management Consultant. The implementation of the mitigation measures will be closely monitored and reported on by the relevant stakeholders in the project.

27. The most significant impacts from the project will arise from operation of the landfill. To ensure that the investment is both financially and environmentally sustainable and achieves anticipated outcomes, the subproject includes a comprehensive training and capacity building component.

28. The subproject is anticipated to bring environmental benefits to the population of Kratie City and adjacent areas. It will serve to improve solid waste management in the city, reduce pollution impacts and provide long term urban environmental improvements, health benefits and promote sustainable city development.

29. A Grievance Redress Mechanism has been 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.

2. INTRODUCTION

2.1. Background and Location

30. The Fourth Greater Mekong Subregion Corridor Towns Development Project (GMS4 or CTDP-4 Project) will support the Governments of Cambodia and the Lao People's Democratic Republic (PDR) in enhancing the competitiveness of selected towns located along the Central Mekong Economic Corridor in the Greater Mekong Subregion (GMS). It is aligned with the Government of Cambodia's Rectangular Strategy for national development. The third phase (RS-III 2013–2018) identified integrated urban development as a priority and recognized the need to manage environment and climate change to ensure the sustainability of Cambodia's economic growth and social development. The Project is also underpinned by Cambodia's National Green Growth Road Map (2010) which promotes access to clean water and sanitation (PPTA 2018).

31. In Cambodia, the CTDP-4 Project includes three wastewater and drainage subprojects and three solid waste management subprojects, one of each in the following three cities along the GMS Inter-corridor Link Kampong Cham, Kratie, and Stung Treng – see ***Table 2*** and ***Figure 1***.

Table 2: Summary of CTDP-4 Subprojects

Subproject City	Lagoon based WWTP	Wastewater System	Drainage	Landfill
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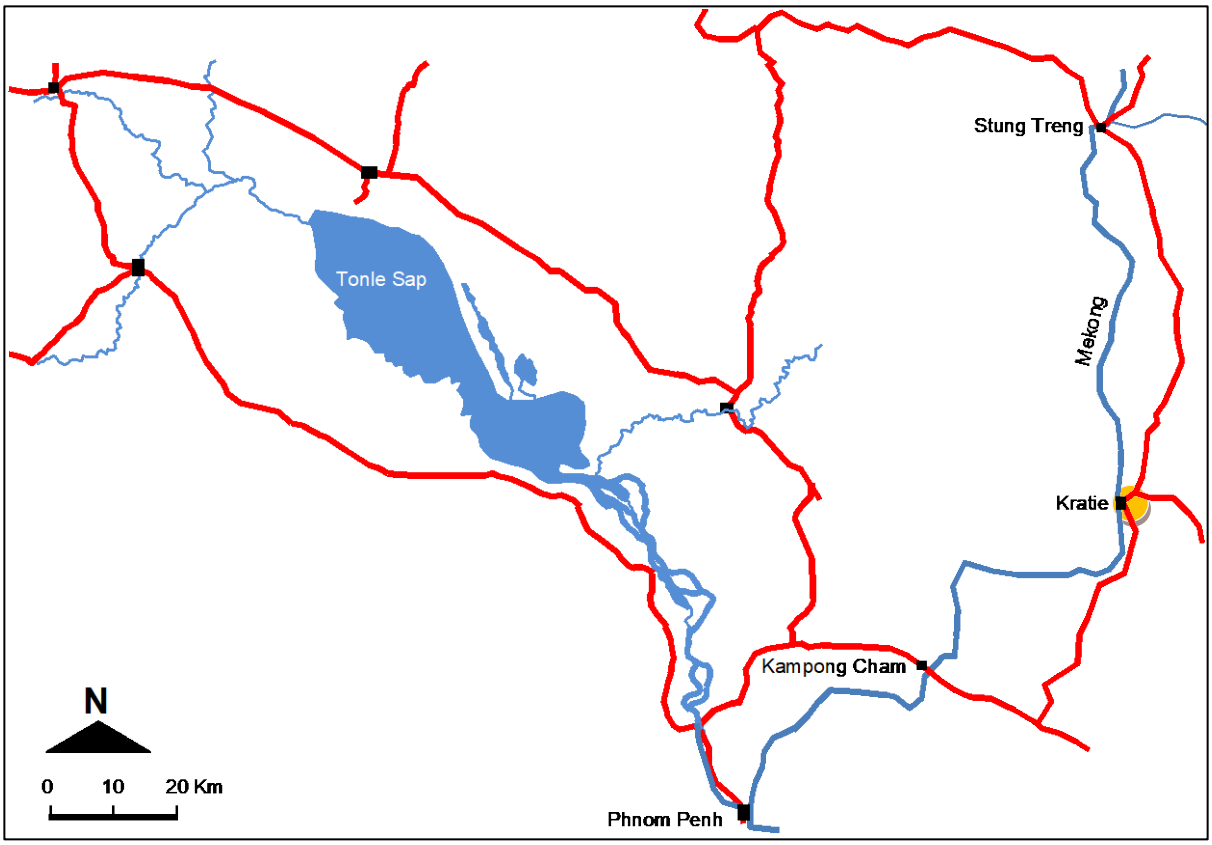
Figure 1: Locations of Project Towns



32. The Kratie City Solid Waste Management Subproject consists of the following works and components:

- Upgrading of 2,020 metres of external access road to the landfill site to be above flood levels.
- Construction of one controlled landfill cells out of a total of four cells.
- Construction of one hazardous waste landfill cell.
- Construction of a non-mechanical material recovery facility (MRF).
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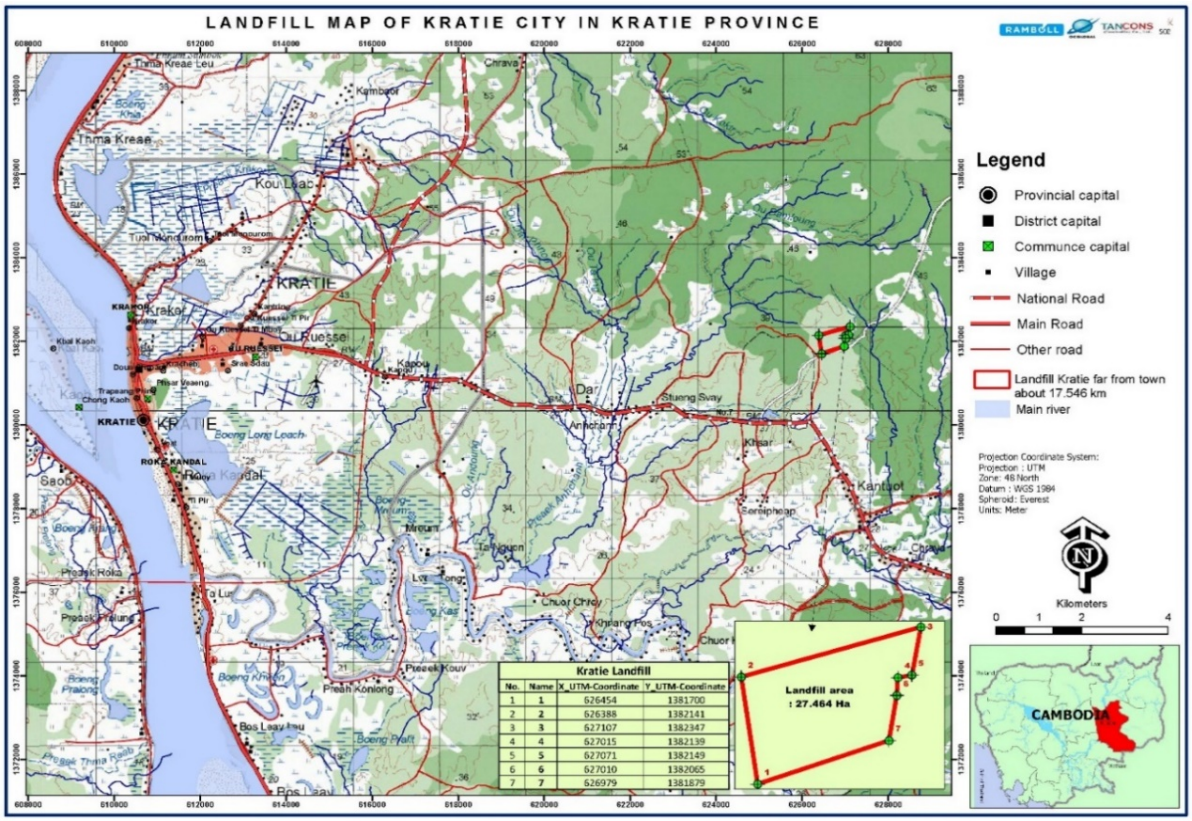
- Provision of utilities, including construction of grid-tied solar system.
- Provision of operations & maintenance (O&M) equipment.
- Closure of the existing waste dump at the landfill site and relocation of up to 7,344 tonnes of waste to the new landfill cell.
- Closure of the old waste dumpsite.

33. The subproject components and facilities have a design life of 20 years up to 2040. Operations are expected to start in 2023.

34. The site for the controlled landfill is located on State Land in Khya Village, Dar commune, Cheatr Borei District, Kratie Province – see ***Figure 2***.

Figure 2: Kratie City Solid Waste Management Subproject



2.2. Objectives of the IEE

35. This IEE covering the Kratie Solid Waste Management Subproject has been prepared in conjunction with the finalization of the detailed engineering design for the subproject and it incorporates the findings of the Initial Environmental and Social Impact Assessment (IESIA) which was approved by the MoE on 20 May 2021 (Certificate attached in ***Annex 7***).

36. The objectives of the IEE study are as follows:

- To study the existing natural and social environment in the area that may be affected by the subproject and identify environmental and social components that need to be protected against potential subproject impacts.
- To identify and assess the potential environmental impacts of the subproject (construction and operation), assess relevant alternative technologies and locations and develop appropriate mitigation measures sufficient to prevent or where prevention is not practicable, otherwise mitigate the impacts to an acceptable level.
- To inform the subproject stakeholders (project owner, lenders, regulators, affected people) and the general public about the potential impacts of the subproject and how these impacts are planned to be effectively mitigated.
- To solicit comments and recommendations from the stakeholders, and to the extent these comments and recommendations are relevant, practicable and assessed to lead to improved environmental performance, take these comments into consideration in the final design of the subproject components.
- To form the basis for the development of the Environmental Management Plan for the subproject.

2.3. ADB and National Environmental Due Diligence

2.3.1. IEE Requirements

37. The project classification of environment category B has been confirmed during project preparation. This IEE has been prepared in conjunction with the preparation of the detailed engineering design thereby ensuring that engineering designs, construction methods and operations are environmentally sound and in compliance the laws, regulations and guidelines of the Royal Government of Cambodia (RGC) and with ADB Safeguard Policies.

38. Based on the IEE, a standalone Environmental Management Plan (latest version of July 2021) has been prepared.

39. The IEE and/or EMP will be updated if found necessary to address any significant future changes to the Subproject and/or the context of the subproject.

40. The requirements for Ministry of Environment (MoE) approvals under Cambodian law are set out in detail in ***Section 3.2.2*** . An approved company, registered with the Ministry of Environment (MoE) has prepared the separate Initial Environmental and Social Impact Assessment (IESIA) report.

2.4. Structure of This Report

41. This IEE report follows the format prescribed in ADB SPS 2009 and contains:

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

42. The Environmental Management Plan (EMP) for the Subproject is a standalone document that determines the environmental mitigation measures and sets out the environmental monitoring programmes for all phases of project implementation. The EMP is structured in the following main sections:

- Brief subproject descriptions
- Institutional arrangements and responsibilities for EMP implementation;
- Summary of environmental impacts on key receptors;
- Mitigation measures for implementation at all phases of construction and operation;
- Monitoring requirements;
- Consultation requirements during construction;
- Grievance Redress Mechanism; and
- Estimated costs of environmental safeguard measures.

43. Based on the EMP, the Contractor is required to develop the Contractor's Environmental Management Plan (CEMP), which shall include specific protection and monitoring measures taking sensitive receptors into account. The contractor shall obtain approval of the CEMP from the PMU before starting construction works.

3. LAW, POLICY, AND ADMINISTRATIVE FRAMEWORK

3.1. Environmental Assessment Requirements

3.1.1. Environmental Assessment Requirements of ADB

44. 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.

45. 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; and
- The assessment will identify potential transboundary effects as well as global impacts;

46. Other requirements of SPS 2009 include:

- Analysis of alternatives. SPS 2009 states that for projects which have ''significant adverse environmental impacts that are irreversible, diverse, or unprecedented'' i.e., category A projects, the potential environmental and social impacts of alternatives to the project's location, design, technology including the no project alternative shall be analysed. 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);
- Grievance redress mechanism. 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.

47. 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 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) more frequent and/or intense extreme weather events can lead to increased risk of direct flood damage to the landfill site.

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

3.1.2. Environmental Assessments Requirements of Cambodia

49. 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 requirements for implementation of the EIA Process and designates roles and responsibilities for preparation, review and approval of EIA and IESIA reports
- Sub-decree on EIA Classification for Development Projects No. 21 (2020) determines the types and sizes of project that have to undertake a full EIA or an IESIA.
- Declaration on Guideline for Conducting IESIA and EIA Reports No. 376 (2009). This guideline specifies the basic contents of IESIA/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.

50. 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).

51. The project owner (public or private) is required to submit the necessary project documents (IESIA/ESIA report) to MoE for review and approval. After submission of IESIA/ESIA report, MoE will complete the review and make a decision within a maximum of 30 working days.

52. A meeting[3] held between the MoE, Ministry of Public Works and Transport (MPWT) and consultant teams for ADB projects on 6th December 2017 confirmed that for the projects and their subprojects:

- The EIA department agrees that the subprojects need to prepare an IESIA report which can be informed by the IEE report and incorporate the additional baseline environmental survey (air and water quality) results.
- The EIA department agrees with and supports the project and will facilitate MoE to issue a letter of approval to MPWT after reviewing the individual IESIA reports.

- IESIA reports for the subprojects shall be prepared on behalf of the project owner, MPWT, by a registered and duly authorized company.

3.2. National Environmental Policies and Legislations

3.2.1. Legal Framework for Environmental Management

53. 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 (MoE).

54. 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.

55. 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

56. 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.

57. 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
- Reduce activities which impact negatively on the environment.

58. 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 (1999); and
- Sub-decree on Air Pollution Control and Noise Disturbance (2000)

59. A summary of these and other legislative and policy instruments relevant to the project is presented in ***Table 3***. The Table includes national landfill location guidelines.

Table 3: 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

Law/Regulation/Guideline	Year	Summary
		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 No. 36 ANK/BK on Solid Waste Management	1999	Article 1: Regulates solid waste management to ensure the protection of human health and the conservation of biodiversity through using appropriate technical approaches. 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 No. 27 ANRK/BK on Water Pollution Control	1999	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. Annex 2 contains effluent standards. Discharge of landfill leachate shall comply with the effluent standards for discharge of wastewater to public water area and sewer. Annex 4 contains ambient water quality standards for biodiversity conservation, and annex 5 includes ambient water quality standards for public health.
Sub-decree No. 42 ANK/BK on Control of Air Pollution and Noise Disturbance	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

Law/Regulation/Guideline	Year	Summary
		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, closure and aftercare management 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 No. NS/RKM/0208/007 on Protected Areas	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

Law/Regulation/Guideline	Year	Summary
		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 for the Nature Conservation and Protection Administration's officials and researchers who, with prior permission from the Ministry of 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 defence 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

<table>
<tr><th>Law/Regulation/Guideline</th><th>Year</th><th>Summary</th></tr>
<tr><td></td><td></td><td>indigenous ethnic minorities and may contain existing residential lands, paddy field and field garden or swidden (Chamkar).</td></tr>
<tr><td>Expropriation Law</td><td>2010</td><td>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.</td></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 3 m</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 ≥ 1 m (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 1 m, 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 requirements to be implemented within 90 days for landfill closing (e.g. monitoring, gas management).</td></tr>
<tr><td>Prakas on Environmental Impact Assessment Classification for Development Projects No. 21 PRK.BST</td><td>2020</td><td>The Prakas determines the types and sizes of projects that are required to prepare environmental impact assessments. Projects having minor environmental impacts are required to prepare an Environmental Protection Agreement together with an Environmental Management Plan. Projects having medium impacts shall prepare an Initial Environmental Impact Assessment report, and projects with significant impacts are required to prepare a full EIA.
All sizes of rubbish disposal sites are required to undertake an IESIA and all sizes of industrial waste disposal sites are required to undertake an EIA</td></tr>
</table>

60. Landfill Site Guidance. A meeting was held at MoE[4] Phnom Penh on 31 October 2017 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.

61. A comparison of national and international landfill siting guidance is shown in ***Table 4*** 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 the most stringent for distance to housing and depth to groundwater.

Table 4: Comparison of Landfill Selection Criteria

Source of Guidance	Residential Receptors	Water Receptors
International Solid Waste Association (ISWA)[5]	- Not located in the immediate proximity of dwellings - Minimum buffer distance 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: Waste Management Facilities (10 December 2007)	- Typically, farther than 250 m (for gas only, no mention of dust /odour)	- A landfill should not be located within 300 m up-gradient of a perennial stream - Groundwater's seasonally high table level (i.e., 10- year high) should be at least 1.5 m below to cell bottom
Cambodian Landfill Site Selection Guidance	- 1 km from residences	- Out of flooded area - Depth to ground water over 3 m

62. The key national environmental quality standards applied to the subproject are listed in ***Table 5*** together with relevant international guidelines. The numeric values of the national standards are presented in ***Annex 1***. The effluent standards applicable to the subproject are those stipulated in Sub-decree No. 27 ANRK/BK 1999 on Water Pollution Control: Annex 2, effluent standards for discharge of wastewater to public water areas and sewer.

Table 5: Key National and International Environmental Standards and Guidelines

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

[4] 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.

[5] Landfill Operational Guidelines, 2nd Edition, International Solid Waste Association (ISWA), January 2010

Environmental Issue	National Standards	International Guidelines
	and Noise Disturbance, 2000	
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	Sub-decree No. 27 ANRK/BK 1999 on Water Pollution Control: 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	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)	Sub-decree No. 27 ANRK/BK 1999 on Water Pollution Control: Annex 2, Effluent standards for discharge of wastewater to public water area and sewer	IFC EHS General Guidelines, April 2007 IFC EHS Guidelines for Water and Sanitation, December 2007 IFC EHS Guidelines for Waste Management Facilities, December 2007 USEPA Effluent Limitations

63. The siting of project components (in this case the controlled landfill) is considered and approved through the IESIA review and approval process led by the Ministry of Environment where all concerned national and provincial authorities through inter-ministerial procedures can also raise objections or propose requirements.

64. 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 subproject.

65. 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.

3.3. International Agreements

66. 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.

67. 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).

68. Cambodia also supports the global efforts against climate change by being a Party to the United Nations Framework Convention on Climate Change (UNFCCC) since 1996. Cambodia has adopted and ratified the Paris Agreement, and in 2020 the Government submitted an updated Intended Nationally Determined Contribution, which puts forward mitigation targets and adaptation actions towards a cleaner and greener economy to improve the lives of the citizens, in particular the vulnerable. The 2030 mitigation targets include a 18% reduction in greenhouse gas emissions from the waste sector from a share of 2.1% of the total greenhouse gas emissions in 2016 to 0.9% in 2030. This is planned to be achieved through source segregation and composting of the organic fraction in the municipal solid, increased recycling and increased extraction of landfill gases.

4. DESCRIPTION OF THE PROJECT

4.1. Rationale

69. While Cambodia remains almost 80% rural, urbanization is accelerating with urban population expected to reach 30% by 2030. Economic development has been mostly concentrated in the north-western, western, and south-eastern regions where the large secondary cities, economic infrastructures (e.g. international seaports and airports), and tourism attractions are located; while the north-eastern provinces remain underdeveloped. The five provinces in the north-east contributed less than 8% of the national economy in 2016, suffering from low income per capita and high poverty incidence.

70. Located along the GMS Inter-corridor Link, Kratie City is connected to Sihanoukville and Phnom Penh to the south, and to the north along National Highway No 7 to Stung Treng and from there on to Pakse and Savannakhet in the Lao PDR meeting the East–West Economic Corridor. Thus, Kratie City has geographical advantages and potential to benefit from and contribute to economic growth in the region and reduce regional development disparities.

71. Kratie City consists of five sangkats with a total population of just over 37,000 (2019). The economy is underpinned by the development of government services and associated construction, imports of goods and services. The most significant economic sector in the city economy is government, trade, transport, and tourism. Solid waste collection service currently extends to 4 of the 5 sangkats but only 50% of the populations is served. Solid waste is disposed of in an open dumpsite 15 km from the City, but during the wet season due to flooding problems, an old dumpsite about 8 km from the City centre is used which causes negative impacts on the city environment.

72. As part of the Fourth Greater Mekong Subregion Corridor Towns Development Project (CTDP-4 Project), the Kratie Solid Waste Management Subproject will improve urban waste

management services and thereby attract economic growth and promote Kratie City as a node in the regional economic corridors.

73. The Ministry of Public Works and Transport (MPWT) is responsible for strategic planning of urban environmental services and infrastructure with the provincial branches of the ministry being responsible for operations and maintenance. 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.

4.2. Project Impact, Outcome and Outputs

74. The expected impact of the project is sustainable, inclusive, equitable and resilient growth, and the outcome will be improved urban environmental services in Kratie City.

75. **Output 1: Improved urban waste management services in Kratie City:** The output includes establishment of a controlled landfill with a design capacity (up to 2040) of 215,000 tons of waste. The landfill site will have space for two more cells of similar size and capacity.

76. **Output 2: Improved institutional effectiveness.** The output will strengthen the provincial governments' institutional capacity for urban development and climate and disaster resilience planning, ICT and social and environmental management: (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.

77. **Output 3: Improved policy and planning environment.** The project will develop urban development strategies and master plans for the city. 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 in control landfill.

4.3. Existing Solid Waste Management

78. The existing solid waste collection in Kratie City covers four out to the five sangkats of the City, namely Kracheh, Krakor, Ou Ruessei, and Roka Kandal, but not Kaoh Trong – the island in the Mekong River (see ***Figure 3***). Only about 50% of the population in these four sangkats are being serviced. The current waste collection is estimated to about 14 tons/day.

79. A detailed composition study of the waste generated in Kratie has not been conducted. ***Table 6*** summarises results of various solid waste management studies in Cambodia which have formed the basis for the design of the Kratie landfill. 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. There are no major industries or other generators of any significant amounts of hazardous waste in Kratie City, and the content of hazardous substances in the waste is therefore likely rather limited and will mainly include the types and amounts commonly found in waste from small-businesses and households in low-income areas.

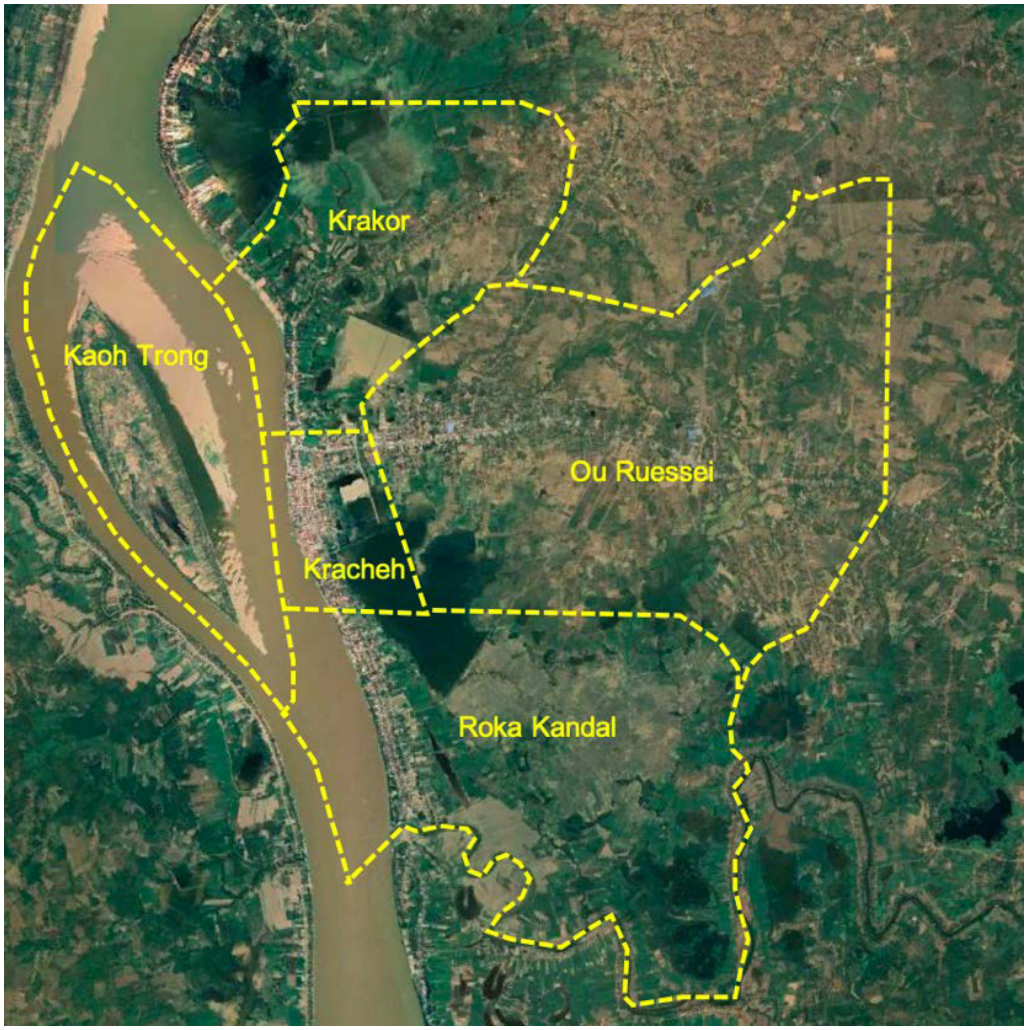
Table 6: Physical Composition of Solid Waste in Cambodia

Waste Type	Percentage
Food Waste and Green Waste	50-63%
Paper and Cardboard	2-6%
Plastic	3-15%

Waste Type	Percentage
Textiles	1-4%
Glass	1-8%
Metal	0.6-8%
Wood	-
Soil and Dirt	10-30%
Miscellaneous	2-8%

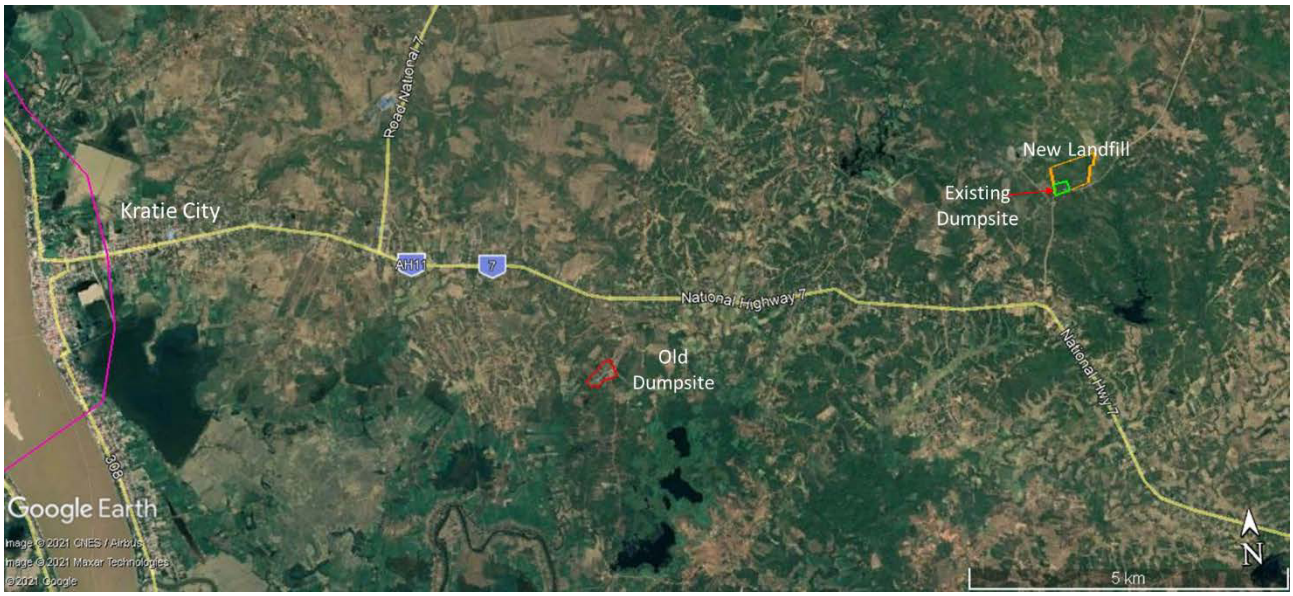
Source: Detailed Engineering Design, Kratie Landfill Subproject, May 2021

Figure 3: Sangkats of Kratie City



80. There are two sites that are used for disposal of waste. One site is known as “the old dumpsite” located about 8 km east of the city and the other is known as “the existing dumpsite” located within the proposed new landfill site about 15 km from Kratie City centre (see ***Figure 4***). Both the old dumpsite and the existing dumpsite have originally been approved by Kratie Provincial Authorities for daily operation.

Figure 4: Overview Map of the Dumpsites and the New Landfill Site



4.3.1. The Old Dumpsite

81. The old dumpsite will be closed as part of this Subproject. The dumpsite is currently only operating during the wet season. It is on State Land and managed by the provincial government, and there is some distribution of waste with bulldozer. The waste is transported by Tuk Khun Company. The total land size is approximately 10 ha (see also the description in ***Section 5.11***).

Figure 5: The Old Dumpsite

4.3.2. The Existing Dumpsite

82. The total land area of the dumpsite is approximately 3.6 ha. A recent picture of the dumpsite is shown in ***Figure 6*** and a satellite image of the dumpsite (November 2018) is displayed in ***Figure 7***. Informal recyclers from eleven households occasionally collect waste for recycling at the site.[6]

[6] PMC Pre-screening Note, 28 January 2020

Figure 6: The Existing Dumpsite

83. The dumpsite is comprised of four cells, which are not lined or have leachate collection systems. To date, only three of the cells have been utilised, with the bottom right cell so far unused entirely (this is the area where the landfill buildings will be located). Waste has been deposited to varying depths, from a visually estimated 1 m to 2.5 m depth.

84. The exact volume of waste on this site is unknown. A rough estimate suggests that there may be between 3,525 to 5,875 tonnes of waste, depending on the level of compaction/ settlement. Due to the high level of uncertainty, a 25% contingency on the maximum value is added. Therefore, it is assumed that there may be up to 7,344 tonnes of waste.

85. A small pond is located at the dumpsite. This is probably a former borrow pit (see ***Figure 38***).

86. The composition of the waste disposed at the existing dumpsite is unknown but based on various solid waste management studies in Cambodia, at the time of disposal, the waste is likely to have contained about 60% biodegradable components and the remaining 40% would include potentially recyclables and non-biodegradable waste. The biodegradable content has most likely already decomposed to a certain extent and only the most recent waste will still contain significant amounts of biodegradable components. There are no major industries or other generators of any significant amounts of hazardous waste in Kratie City, and the content of hazardous substances in the dumpsite waste is therefore likely rather limited and will mainly include the types and amounts commonly found in waste from small-businesses and households in low-income areas. The possible content of infectious waste from health care facilities is unknown but cannot be ruled out. However, as pathogenic micro-organisms have a limited capacity of survival in the environment, these organisms are unlikely to have survived in waste that is older than 1-2 months[7].

[7] ICRC 2011, Medical Waste Management, International Committee of the Red Cross, November 2011

Figure 7: Satellite Image of the Existing Dumpsite, November 2018

87. The existing dumpsite will be remediated and closed as part of the Subproject. The remediation and closure measures are summarized in ***Section 6.5.3*** and detailed in the EMP.

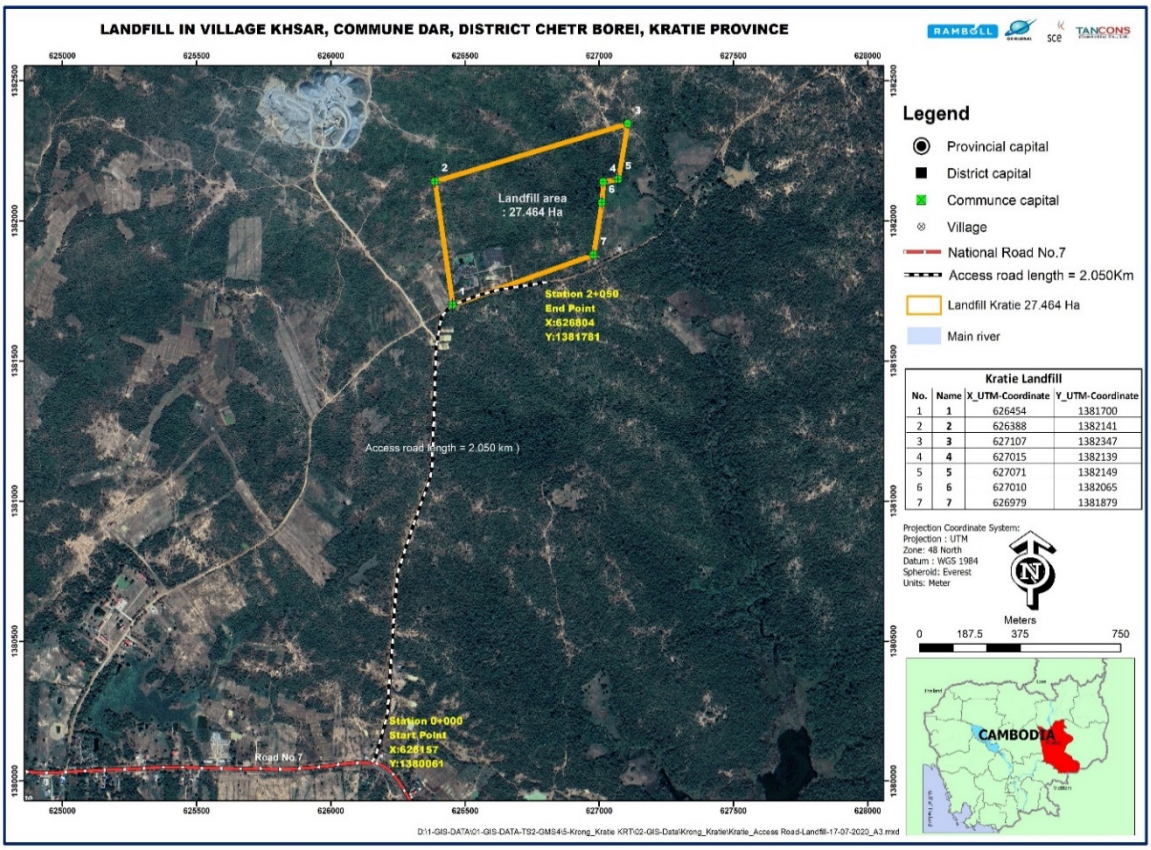
4.4. Landfill Design Basis

4.4.1. Location

88. The landfill site is on State Land in Khya Village, Dar commune, Cheatr Borei District, Kratie Province (see ***Figure 8***). The site covers an area of 27.85 ha. The site is covered by secondary shrub. The immediate surroundings also mainly consist of secondary shrub and forest with patches of agricultural land. A stone quarry is located 350 m northwest of the site and the nearest village is about 2 km south of the site. The proximity to sensitive receptors is detailed in ***Section 5.1.2***.

89. The site was deforested prior to 2011 but has not been used for agriculture, pasture or other uses. There are no structures on the site.

Figure 8: Kratie Landfill Site



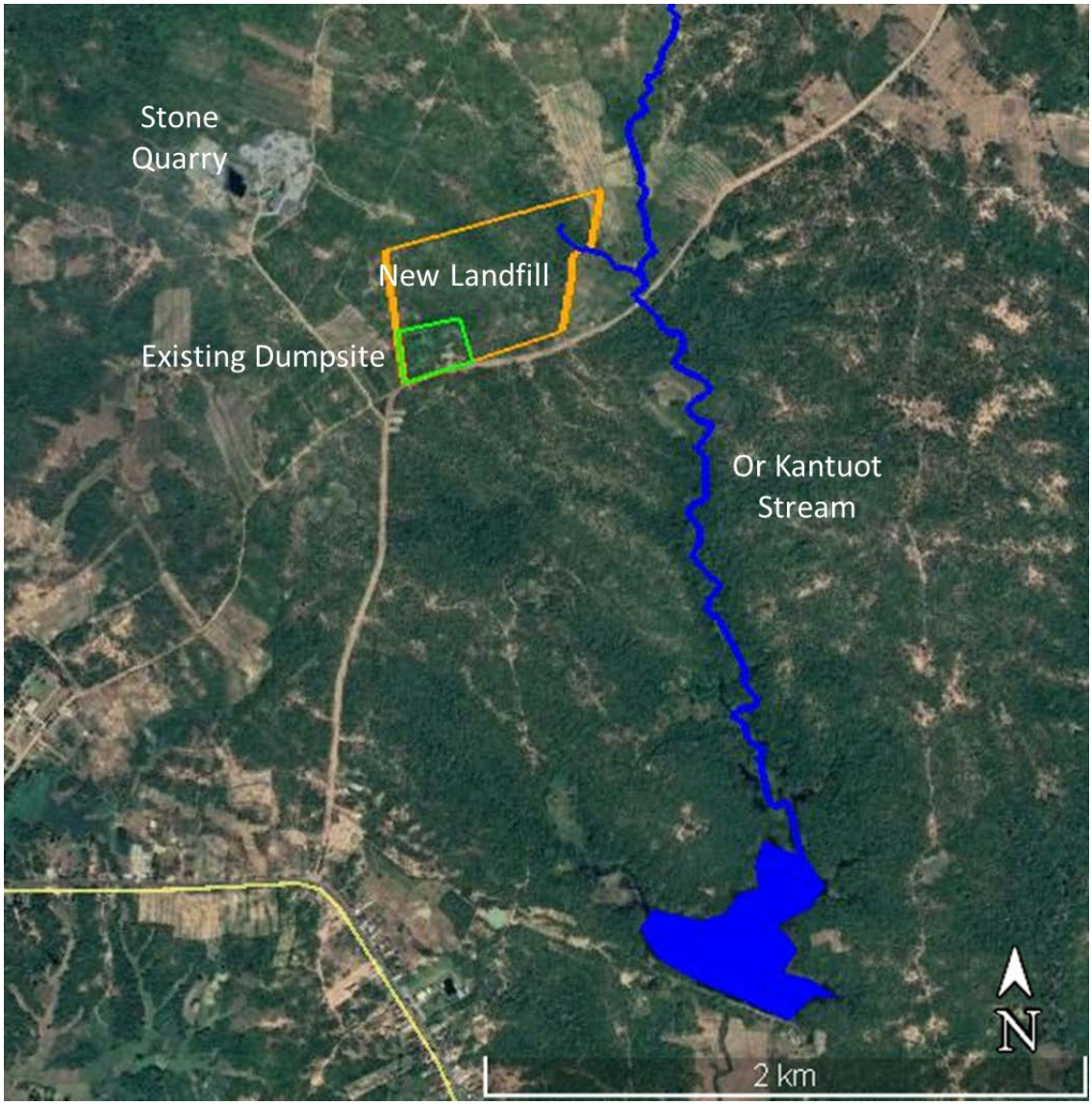
4.4.2. Site Physical Characteristics

90. The topography of the site is fairly flow with elevations generally between 39 m asl. and 44 m asl.

91. As shown in ***Figure 9***, there is a stream that crosses the north-eastern corner of the site and meets with Or Kantuot Stream, which then flows into a reservoir 1.8 km to the south. It appears that this reservoir is used for irrigation.

92. Geotechnical investigations at the site show the presence of an extremely compact sandstone layer from near surface which will provide a good natural impermeable layer but will likely require use of rock excavation equipment for the excavation of the leachate ponds. During the geotechnical survey no groundwater was encountered with drilling depths of 5 m (except one borehole down to 8 m).

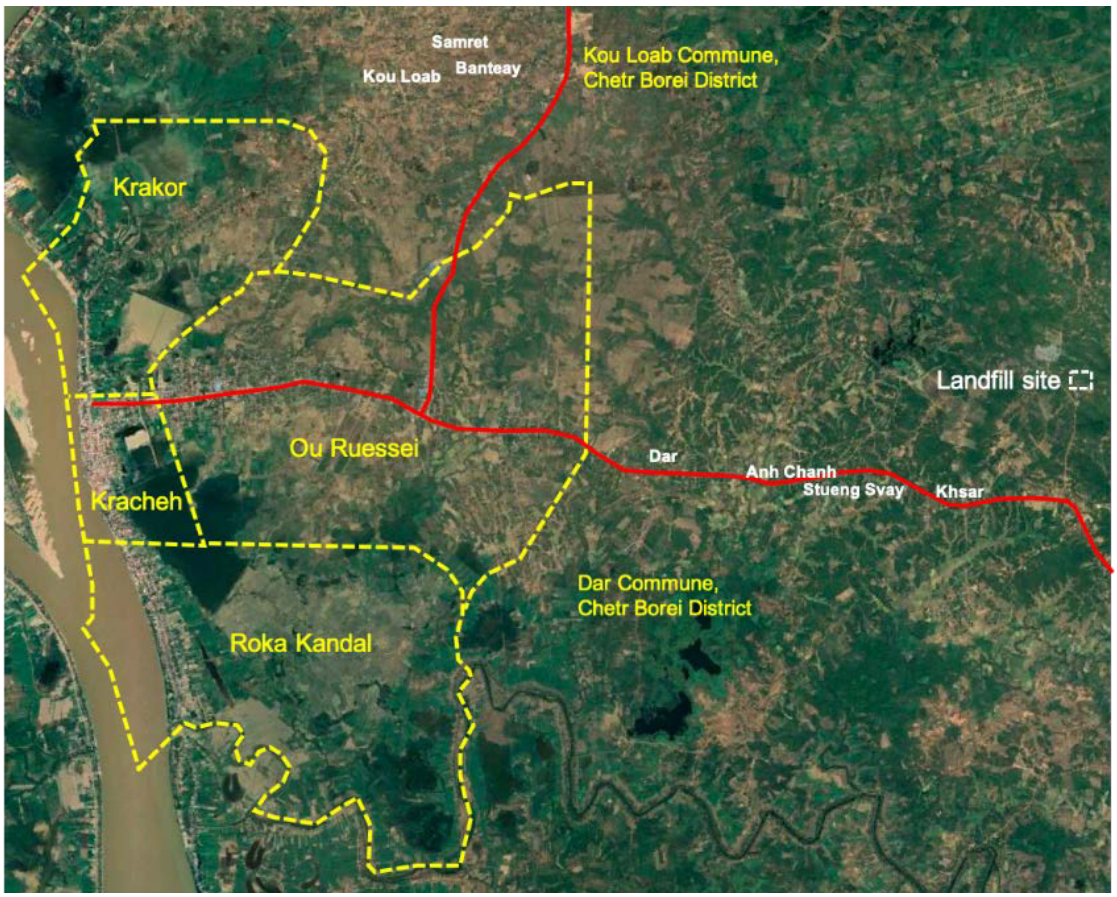
Figure 9: Kratie Landfill and Surroundings



4.4.3. Service Area and Population

93. The planning horizon for the project is until the year 2040, with initial construction of landfill cells to cover the period to 2030. The intended service area for the new landfill covers the four sangkats of Kracheh, Krakor, Ou Ruessei, and Roka Kandal. It will not include Kaoh Trong, which is an island in the Mekong. Villages close to the City along National Road No. 7 to the north (Samret, Kou Loab, and Banteay villages) and along the road towards the landfill site (Dar, Anh Chanh, Stueng Svay and Khsar villages) may also be included in the service area. The waste collection service area is displayed in ***Figure 10***.

Figure 10: Waste Collection Service Area



94. Based on the 2019 census, the service area including the mentioned four sangkats of Kratie and the additional villages have a population of just over 37,000. The estimated population growth until 2040 and the gradual increase in service coverage from 80% at the baseline to 95% by 2040 are tabulated in ***Table 6***. Note that although the baseline service coverage of 80% is likely higher than the actual collection coverage, this percentage has been used in the forecasts to ensure that there is enough space in the landfill for incoming waste.

Table 7: Estimated Population Growth and Service Coverage

Year	Total Population	Serviced Population	Percentage of Total Population
2018	37,000	29,600	80%
2023	39,750	33,155	83%
2030	43,600	38,447	88%
2040	48,200	45,790	95%

Source: Detailed Engineering Design, Kratie Landfill Subproject, May 2021

4.4.4. Waste Forecasts

95. The Detailed Engineering Design has estimated the daily waste amounts from households and businesses until 2040. The results of the estimates are presented in ***Table 7***. The waste estimates have taken the following factors into account:

- Increase in waste generation from 0.7 to 1.35 kg/cap/day (2018 to 2040)
- population growth and increase in service coverage from 80% to 95% (***Table 6***),

- an estimated increase in the amount of waste put out for collection from 80% to 90% by 2040
- an estimated increase in diversion of waste for recycling from 10% today, to 20% by 2030 and 30% by 2040.

Table 8: Waste Amount Forecast

Year	Residential Waste (tons/day)	Commercial Waste (tons/day)	Waste to Landfill (tons/day)
2019 (Baseline)	15	2	**17**
2023	18	3	**21**
2030	25	4	**29**
2040	39	7	**46**

Source: Detailed Engineering Design, Kratie Landfill Subproject, May 2021

96. The estimated increase in waste generation from 0.7 to 1.35 kg/cap/day that has been applied in the waste forecast above is the rate that has been applied to all landfill subprojects under the TS2 Project and the CTDP4 Project. Due to a lack of credible area specific surveys and data, it is challenging to determine a precise rate. While the applied rates may appear high, it has been decided to take a precautionary approach and rather overestimate the amounts of waste than risking running out of the landfill space prematurely.

4.5. Landfill Design and Technology

4.5.1. Overview

97. The landfill will be designed, constructed and operated as a controlled landfill with sufficient capacity to accommodate the predicted waste flow until 2030 (including waste to be relocated from the existing dumpsite). The landfill site and the design allow for development of additional landfill cells sufficient to serve the needs of Kratie City until at least 2040.

98. This will be an area landfill, with waste deposited predominantly above ground. The maximum height of waste in any landfill cell will be 20 m, with a 1:2.5 slope, which through settlement is likely to achieve a final slope of 1:3.

99. The landfill design and construction include the following components:

- Upgrading of 2,020 metres of external access road to the landfill site to be above flood levels.
- Construction of one controlled landfill cells out of a total of four cells.
- Construction of one hazardous waste landfill cell.
- Construction of a non-mechanical type material recovery facility (MRF).
- Construction of drainage, leachate collection, treatment, and recirculation system.
- Construction of weighbridge, office, staff dining and rest room (combined building); workshop, electrical and mechanical room; and supply building.
- Construction of 1,721 metres of concrete internal roads, with associated bunds and drainage.
- Construction of wire mesh fencing, brick entrance wall, gate and security guardhouse.
- Construction of car/vehicle wash bay.
- Construction of hazardous waste storage building.
- Provision of utilities, including construction of grid-tied solar system.
- Provision of operations & maintenance (O&M) equipment.

- Relocation of up to 7,344 tons of waste from the existing waste dump to the new landfill cell.

4.5.2. Climate Change Design Considerations

100. The design of the subproject incorporates important climate change related measures (see also summary of climate change projections in ***Section 5.4***), which not only addresses climate change adaptation but also contributes to reduction in greenhouse gas emissions:

- Landfill gas collection systems that will allow for future retrofitting an active system and flaring of gas, including methane, a powerful greenhouse gas.
- Installation of a grid-tied solar system.
- 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 to protect against storm events.
- All sidewalls and roofs are designed to withstand high wind velocity and storms up to 260 km/hr.
- Concrete roads are introduced to avoid vehicle penetration in the ground.
- Leachate collection and treatment lagoons designed to manage high volumes of wastewater in case of extreme events.
- Maximum rainfall has been considered towards the design of leachate collection, treatment and the stormwater discharge system. An additional volume of 25% has been considered.
- Staff and workers' restroom with bathing and toilet facilities are provided to provide comfort to the workers during extreme weather.

4.5.3. Landfill Masterplan

101. The landfill masterplan layout is presented in ***Figure 11***. The landfill site has a total area of 27.8 ha, with 8.3 ha designated as a buffer zone. The initial construction includes landfill cell 1, hazardous waste cell, leachate treatment ponds, installation of utilities, all buildings, fencing and walls around the entire site, and all roads, drainage associated with these facilities.

102. As shown in ***Figure 11***, four landfill cells are designed, with only cell one initially constructed for the 2030 period (and a small hazardous waste cell located in the building area), a second cell for 2040 to 2050, and further two cells beyond 2040.

103. The capacity of cells 1 and 2 is summarized in ***Table 8***. The cells have a total design airspace of 300,196 m^3 equivalent to 330,216 tonnes of settled waste, which will be able to more than accommodate the estimated 214,533 tonnes of waste (equivalent to 210,319 m^3 of space for settled waste) forecasted to be collected up to 2040 including relocation of the waste in the existing onsite waste dump estimated to 7,344 tonnes (see ***Section 6.5.3***).

Figure 11: Landfill Masterplan Layout

Source: Detailed Engineering Design, Kratie Landfill Subproject, May 2021

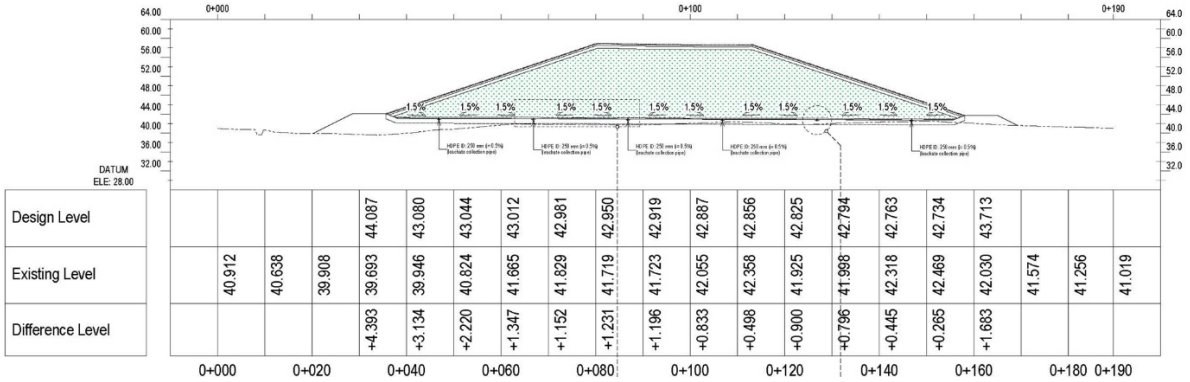
Table 9: Landfill Cell Capacity

Cell Number	Predicted years covered	Total Base Area (m^2)	Total Space (m^3)	Tonnes of Waste[8]
Cell 1	2022-2035	16,629	125,035	137,539
Cell 2	2035-2045	19,802	175,161	192,677
Total		**36,431**	**300,196**	**330,216**

Source: Detailed Engineering Design, Kratie Landfill Subproject, May 2021

104. As mentioned in ***Para 95***, this will be an area landfill and as illustrated in ***Figure 12*** , the cells will practically be constructed on the existing ground involving minimal excavation.

Figure 12: Profile of Cell 1



Source: Detailed Engineering Design, Kratie Landfill Subproject, May 2021

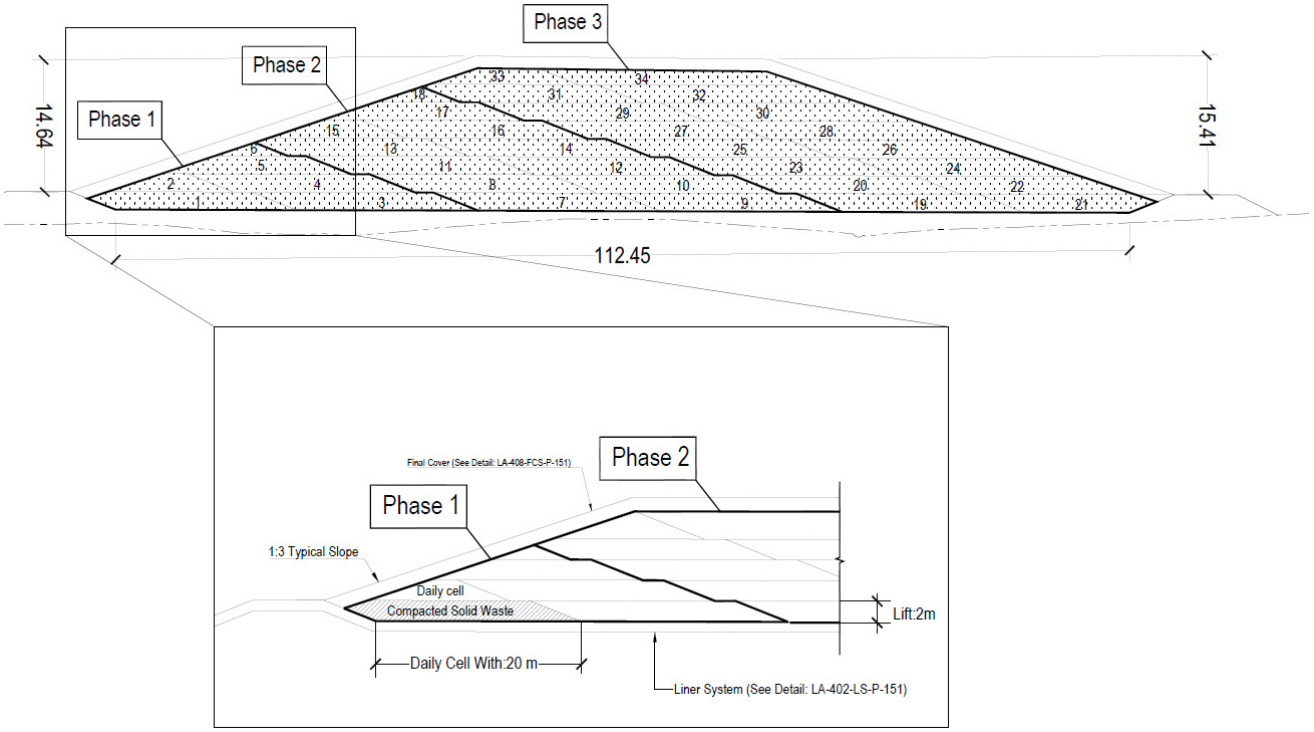
4.5.4. Cell Volumes and Phasing

105. Many landfills in Asia are developed by depositing waste in flat plateaus, which maximizes rainfall infiltration and therefore leachate generation. It is proposed that a more contemporary approach is adopted, taking into account Cambodia's climate and the wet and dry seasons. This will have the key objective of minimising the amount of waste that is exposed to rain, in order to minimise the amount of leachate that is generated.

106. As outlined in ***Figure 13,*** each cell will 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 side slopes of the waste pile profiled to 1:2.5 initially, with a final settlement to 1:3. This staged approach will prolong the period before waste is spread across the entire cell and minimise the area of waste that is exposed to rain, as well as encouraging surface water runoff. The final heights are likely to be in the vicinity of 15-20 m.

[8] This refers to final settled tonnes of waste (based on twenty years settlement)

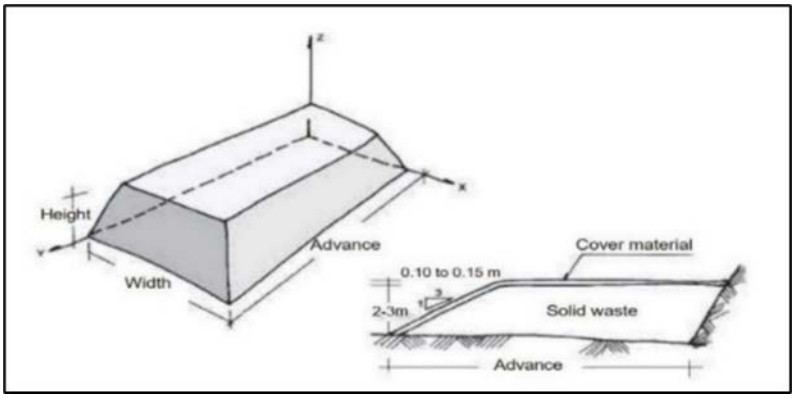
Figure 13: Landfill Cell Phasing



107. 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 may require temporary infilling at the working face, in order to allow vehicle access.

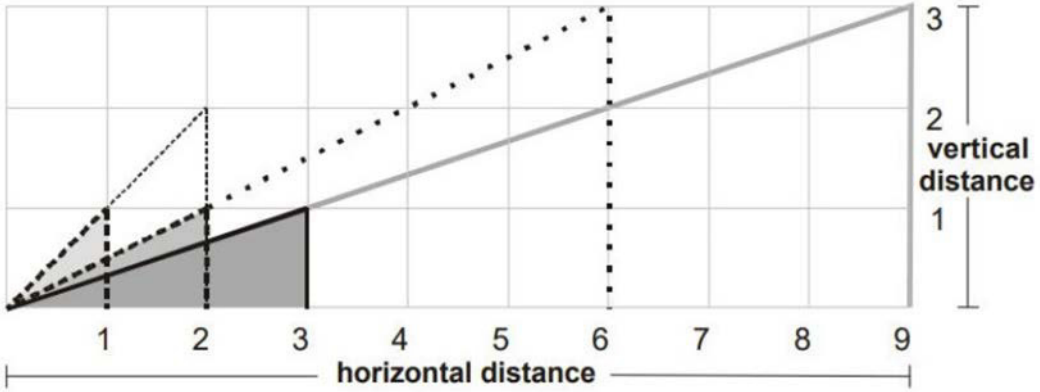
108. A bulldozer will subsequently spread the waste in thin layers of between 300 mm and 500 mm, depending on the quantity and nature of incoming wastes, which will be compacted by approximately six passes. Individual daily lifts may be between 2 to 3 m in height, as shown in ***Figure 14***, depending on the daily volume of refuse deposited. The maximum height of 3 m will allow for safe working practices.

Figure 14: Typical Daily Cell



109. The material is to be spread and compacted in horizontal layers or sloping layers with a gradient of 3:1 or 2:1 (advance: height), which provides a better degree of compacting, better surface drainage, less consumption of soil, and better retention and stability of the landfill, as shown in Figure 15.

Figure 15: Ways of Representing the Gradient of a Site



110. As the phases are built up, intermediate cover (which will be the bottom layer of the final capping, including 300 mm of the gas collection layer and 200 mm of the clay barrier layer) is to be utilised on the side slopes of the waste pile. The aim of this is approach is to minimise rainwater infiltration and maximise surface water run-off. 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.

4.5.5. Groundwater Protection

111. The geotechnical survey did not strike groundwater with drilling depths of 5-8 m. The Cambodian guidelines require an unsaturated zone of minimum 3 m below the bottom of the landfill cells (this is more restrictive than international guidelines which generally require a minimum of 1.5 m to the highest seasonal water table). The excavations at Kratie clearly comply with the 3 m buffer requirements.

112. The sides of the landfill cell will be comprised of earth bunds, minimum 1 m in height, with an inner clay core that is connected to the underlying clay liner in order to prevent any lateral movement of leachate out of the landfill cell.

113. To protect leachate infiltration into groundwater a single composite liner will be installed which will block or minimize the flow of liquid and gas. The liner will consist of the following natural and synthetic components (as illustrated in ***Figure 16***):

- 1 m compacted clay or other low permeability soil liner with a hydraulic conductivity of between $1x10^{-7}$ m/s and $1x10^{-9}$ m/s.
- 1.5 mm High Density Polyethylene (HDPE) geomembrane, which will provide good chemical and biological resistance. The geomembrane will cover the inner slopes and bottom of the cell including the side bund and will be installed in direct contact with the clay layer.
- Protective geotextile (minimum 400 gram per square metre). This layer will consist of a needle-punched non-woven geotextile, with a minimum mass per unit area of 400 grams per square metre. This will provide mechanical protection to the HDPE geomembrane against punctures and tears from angular material in the drainage layer or sharps in the waste. The geotextile will also protect exposed parts of the geomembrane from the sun's ultraviolet radiation, which could otherwise reduce the strength of the geomembrane.

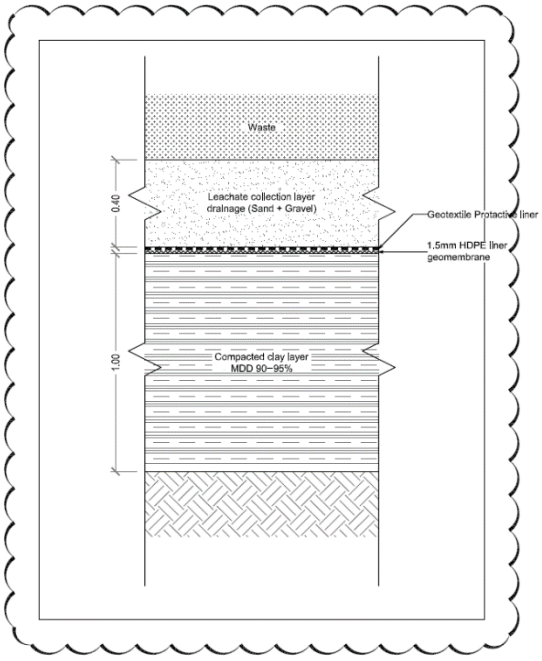


Figure 16: Landfill Liner

114. The use of a filter layer above the drainage layer is not recommended. In some landfills a 300-500 mm layer of soil or compost, overlain with a geotextile filter layer, is used to prevent fine particles from washing out of the waste into the drainage layer. However, these filter layers can become clogged, preventing the migration of leachate to the collection system. Instead of a protective layer, it is recommended that the first two metres of waste are deposited without compaction and that all bulky and hard waste is removed from this initial waste layer. This operational layer ('fluff' layer) will provide protection to the drainage layer, HDPE pipes, and the geomembrane.

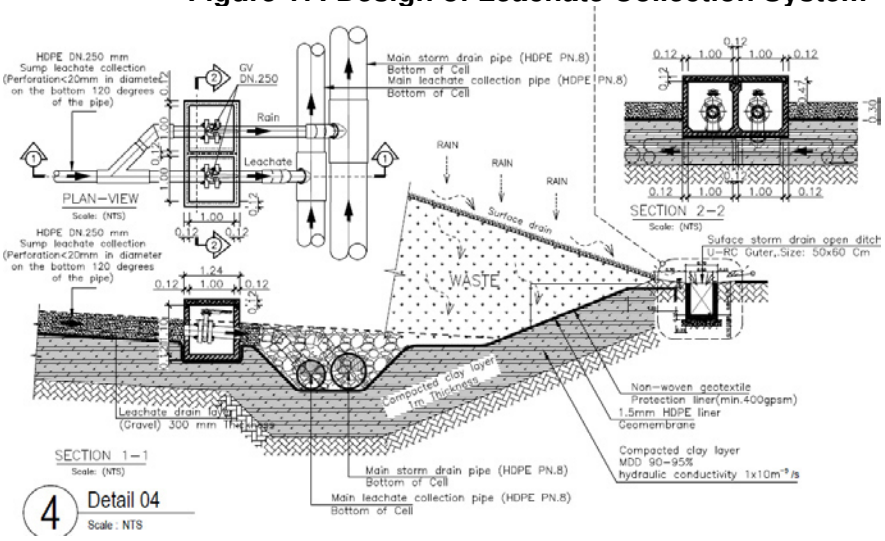
4.5.6. Leachate Collection

115. Drainage will be provided at the base of the landfill, promoting the collection and removal of fluids blocked by the liner, thus avoiding perched water tables in the waste mass. To avoid accumulation of liquids in the waste layers, the system has been designed with pipes that have adequate diameters to allow rapid water conveyance.

116. The leachate collection system, detailed in ***Figure 17***, is comprised of the following key features:

- Drainage layer of gravel.
- Perforated leachate/ stormwater collection pipes set in channels.
- Leachate and stormwater valves system and transport pipes.

Figure 17: Design of Leachate Collection System



117. *Landfill Base:* The surface of the landfill cells will be profiled with longitudinal and cross gradients. The longitudinal base of the cell (i.e., clay upper liner) will have a minimum 0.2% slope. This slope will facilitate drainage of leachate out of the cell into the sump and the leachate transport pipe network and will help to avoid sedimentation and clogging of pipes from hardened, insoluble incrustations.

118. *Drainage Layer:* The 300 mm drainage layer will be well graded and comprised of coarse rounded material, in order to allow for high permeability (hydraulic conductivity approximately $1x10^{-3}$ m/s) and minimise the risk of puncturing the underlying HDPE membrane.

119. *Collection Pipes:* The HDPE collection pipes will be spaced at a maximum of 30 m intervals and positioned so that they are rectilinear to landfill edges.

120. In order to achieve proper bridging of the compression stresses, the surrounding drainage layer must encase the HDPE pipe, with a minimum of 150 mm of gravel being placed below the collection pipe in the pipe channel (in addition to gravel being placed above the pipe). The HDPE pipes are to have perforations on the bottom section, set at intervals of 25 cm, with approximately 120 degrees of coverage, and holes that are small enough to prevent gravel entering (< 20 mm).

121. Valve *System and Transport Pipes:* Each collection pipe will have a valve, which will allow each part of the cell to drain interchangeably into either the leachate transport system (designated as main leachate collection pipes in the drawings) or the stormwater transport system (storm drainpipes). The overall system is designed so that clean rainwater and leachate follow the correct pathway. Only rainwater from active phases will be transported to the leachate treatment ponds, since this will be deemed to be leachate and will require treatment. Conversely, rainwater that falls within inactive phases is not leachate and will be transported as stormwater, which can be simply discharged without treatment into receiving environments. This approach will ensure that water volumes sent to the leachate ponds are minimised.

122. The valves will be contained within manholes at the bottom end of each collection pipe across the landfill cell. The valves will initially be switched to the stormwater transport system. Prior to the initial deposition of wastes in each section, it will be critical that these valves are switched to the leachate transport system position and, therefore, it is essential that adequate signposting is written on the manholes themselves. This will become a permanent switch, as once the waste is deposited these manholes become covered by the

developing waste pile. Leachate will continue to be produced post completion of the entire landfill cell, so any liquids draining out will need to continue be treated in the leachate treatment system for many years post closure of the cell.

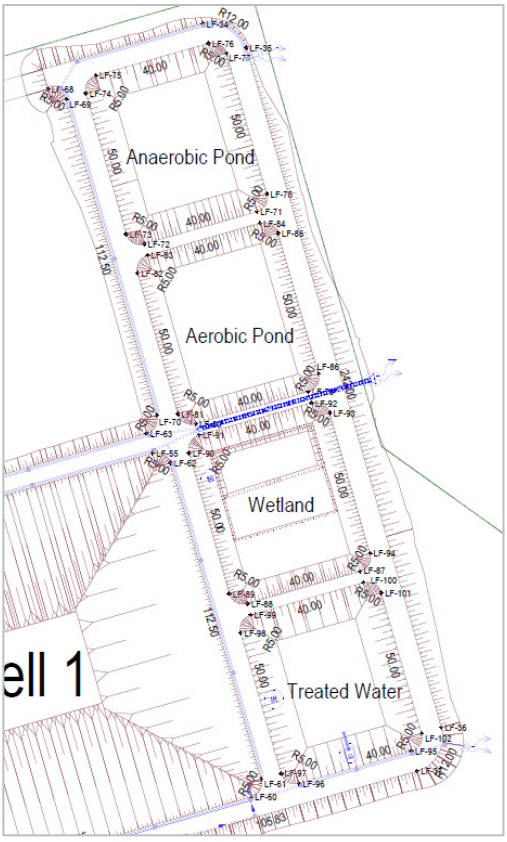
123. Due to the slopping nature of the site, leachate will be predominantly transported via gravity. These main leachate and storm water collection pipes will be manufactured from HDPE. The leachate pipes will have a diameter of 500 mm and the stormwater pipes will have a diameter of 600 mm. The diameter of these pipes takes into account flow, gravity, and the need to minimise the likelihood of clogging in the lower sections of the pipes.

124. Drainage will also be provided for the MRF, with liquids transported via HDPE pipes along with leachate from the hazardous waste cell and sent to the leachate treatment ponds.

4.5.7. Leachate Treatment

125. The leachate treatment system designed for the landfill consists of biological and physical treatment by a series of stabilization ponds including an anaerobic lagoon (absence of air), an aerobic lagoon (presence of air), a constructed wetland for final stabilization, and a lagoon for storage of treated leachate from where the leachate will be recirculated on to the landfill cells (see ***Figure 18***).

Figure 18: Leachate Treatment System



126. Waste stabilization ponds combined with a constructed wetland is a treatment that relies entirely on natural processes by algae, water plants and bacteria with sunlight as the only energy source. This is a well-established, low-cost, low-maintenance, highly efficient, entirely natural and sustainable technology for domestic landfill leachate treatment in tropical climates. This method has proven effective in removing COD, BOD5 and ammonium-N from landfill leachate in tropical climates[9].

127. Given that at this stage it is not possible to determine what the leachate quality and concentration will be (the exact composition of leachate will depend on a range of factors, including the specific waste composition, temperature, and moisture content), it is not possible to guarantee that the treatment method will ensure full compliance with the applicable effluent standards. The leachate collection and treatment system is therefore designed as a zero-discharge system. Any rare unavoidable discharge of treated leachate will be as land application to the buffer zone inside the landfill premises north of the landfill cells.

[9] Rathnayake, P., et al., Leachate Treatment using Stabilization Ponds in Tropical Environments, Conference Paper, January 2021, https://www.e3s-conferences.org/

128. The main constituents of leachate requiring treatment are the ammoniacal content, soluble salts, and the organic constituent of the leachates. The exact composition of leachate will depend on the waste composition, temperature, and moisture content. The stage of decomposition of the wastes will be a critical factor in determining the quality of leachate. There are typically two phases in anaerobic condition. The first acid phase is usually characterised by leachate with a low pH due to a high concentration of organic acids and inorganic ions, resulting in a high Biochemical Oxygen Demand (BOD) and high BOD/ COD (Chemical Oxygen Demand) ratios. The stable methanogenic phase resulting an increase of pH to between 6 and 8, with low BOD volumes and low ratios of BOD/COD. Ammonia continues to stay at a relatively high level.

129. Due to the climate in Kratie, there will be a difference between leachate generation in the wet and dry season. In the wet season high volumes of a low concentrated leachate would be expected, compared to the dry season when volumes will be lower, but concentrations of contaminants higher. Landfills will continue to produce leachate after they are closed and capped, although at a lesser rate, so treatment must continue for many years. One of the challenges of effective treatment is finding a system that will work for a wide range of leachate compositions and flow rates, because these characteristics vary with time at any landfill site.

130. There are various physical, chemical and biological options for the treatment of leachate. In developing countries in Asia, biological processes are generally used, as these are the easiest to maintain and most cost-effective ways of treating leachate. The biological treatment processes at this landfill will involve passing leachate through three stabilization lagoons, before reaching a final storage lagoon for treated water:

- Anaerobic lagoon (absence of air).
- Aerobic lagoon (presence of air).
- Maturation lagoon (constructed wetland) for final stabilization.
- Final storage lagoon for treated leachate

131. The leachate treatment ponds will be located close to cell 1 and leachate will be transported via gravity, requiring no pumps to move liquid from the bottom of the cell.

132. *Anaerobic Lagoon:* The first lagoon will remove strong biological degradable materials (generally >2,000 milligrams per litre), using anaerobic processes. This lagoon will be 3 m deep. The ideal retention time for leachate in this lagoon will be approximately 20 days.

133. *Aerobic Lagoon:* The second lagoon's purpose is to remove biological degradable materials, some ammonia, plus achieve low BOD. This is achieved through an aeration process to diffuse and mix the water. In order to minimise operational costs and resources electric aerators will not be utilised. Instead, this will be a shallow pool, with a depth of 1.2 m, which relies on disturbance of the upper surfaces by the wind to mix up the layers of water. The retention time in this pond will be 5 days.

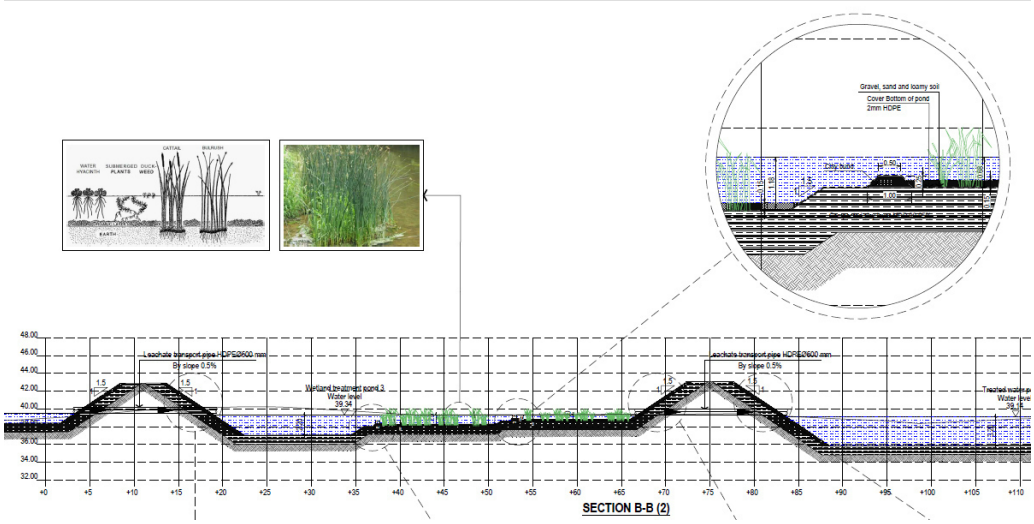
134. *Maturation Lagoon:* This will involve a constructed wetland, which have been shown to provide cost effective, low energy, easy operation, and highly efficient processes for the treatment of a range of leachates. The year-round warm temperatures and abundant rainfall in tropical countries provide ideal conditions, favouring vegetation growth and biogeochemical processes that promote well-constructed wetland performance. This lagoon will be designed to mimic a natural wetland system, utilizing vegetation, substrate, and associated microorganisms. Wetlands provide natural filtration, removing contaminants through a range of physical, chemical and biological mechanisms including sedimentation, microbial degradation, plant uptake, and absorption. In addition to removing organic matter, inorganic mater, pathogens and other contaminants, the wetland will have the ability to substantially reduce leachate volume due to vegetation evapotranspiration and evaporation.

135. 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. As shown in ***Figure 19*** below,

this approach will involve a series of shelves of different heights for the establishment of plants: a shelf with 1 m depth and one with 0.5 m depth. The deepest parts of this lagoon will be 2.2 m. As such, the lagoon will provide both aerobic and anaerobic microsites. Shallow areas will allow for additional aeration and evaporation of leachate. Previous studies have shown that between 5 to 14 days detention time is adequate in most constructed wetland systems.

136. 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. Substrate media will comprise of gravel, sand and loamy soil, and will be deep enough to allow rooting of the emergent plants (50 – 150 mm). Smooth round rocks will be placed at the end of each shelf to ensure that substrate is not washed down to lower levels.

Figure 19: Constructed Wetland



137. *Treated Water Lagoon:* This lagoon of 3.2 m metres depth will provide a holding area for treated water. As mentioned in ***Para 127***, it is not possible to guarantee that this water will comply with the applicable effluent standards, and the treated leachate will therefore not be discharged to the environment, but will be recirculated on the waste cells. The leachate will be kept in the constructed wetland for as long as possible. Following rain, if flow levels are high, then water will be passed from the wetland into this final lagoon from where it will be recirculated.

138. *Construction of Lagoons:* The three types of lagoons will require liners to ensure that leachate does not infiltrate groundwater. This will involve a similar approach to the landfill cells, with a 1 m clay liner, overlain with a 2 mm HDPE geomembrane (using a slightly thicker geomembrane than the landfill cells for additional protection). A final 300 mm layer of compacted clay will be placed over the HDPE geomembrane to provide protection to the HDPE layer from UV rays from the sun (when water levels are low this layer is likely to be exposed), thereby extending the life of this liner.

139. The lagoons are arranged in a way where leachate is driven by gravity through each lagoon, reducing in height from the anaerobic lagoon to the final treated water lagoon. Control between each lagoon will be provided via a 600 mm overflow HDPE pipe.

140. A 60 HP submersible stormwater pump will be positioned in a manhole in the final treated water lagoon, in order to control water levels during extremely high rainfall, with

water being pumped out and applied on land in the vegetated buffer zone within the landfill premises north of the landfill cells. During such events, the discharged leachate will be further diluted when mixed with stormwater runoff in the buffer zone.

141. To protect workers, health and safety equipment will be required at these lagoons, including lifebuoys.

142. Summary information on each treatment lagoon is outlined in ***Table 9***. The square metres refer to the maximum water limit and metres cubed refers to the maximum level of water.

Table 10: Leachate Treatment System Details

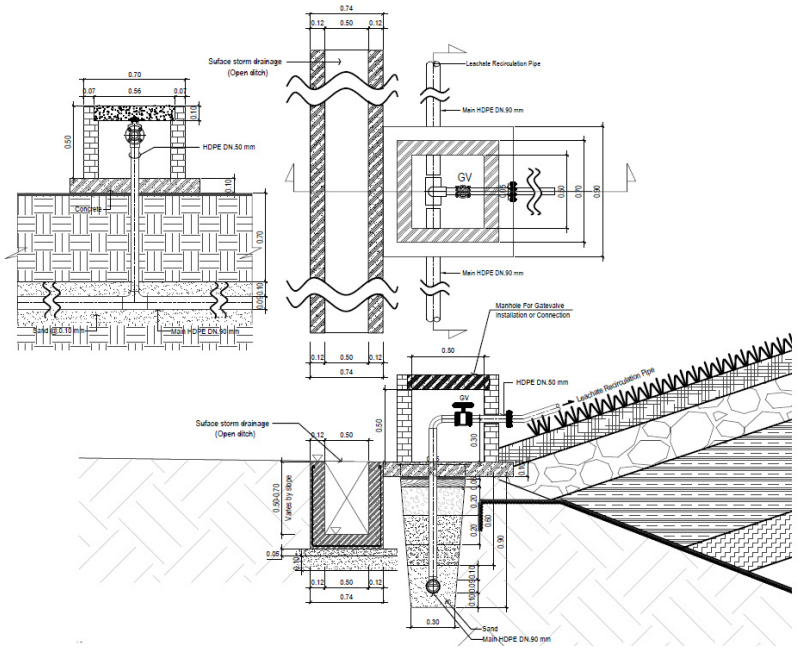
Lagoon	Square Metres	Metres Cubed	Depth Range	Retention Time
Anaerobic	2,091	5,112	3 m	20 Days
Aerobic	1,955	1,825	1.2 m	5 Days
Wetland	1,850	1,937	0.6 – 2.2 m	5 to 14 Days
Treated	1,747	4,187	3 m	Unlimited
Total	**7,644**	**13,060**		

143. *Recirculation System:* The practice of returning leachate back into the waste is undertaken for a variety of reasons, including managing flow rates in treatment lagoons and achieving and seasonal balancing, accelerating uniform settlement of wastes, stabilisation of organic waste, and flushing of contaminants. 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. Prior to recirculation it is preferable to ensure that the leachate has been pre-treated as much as possible, only using leachate with low organic acid concentrations.

144. The recirculation system involves a portable pump, which will be used to pump leachate into a leachate distribution system around the landfill cells. The 60 HP petrol driven pump will have the capacity of 4,500-5,000 litres per minute (a backup pump is also required). As this pump are portable, they will also be able to stormwater from the sump into the leachate ponds. This may be required during the dry seasons in the first few years of operations when pond levels are low.

145. Platforms will be constructed at the side of both the final treated lagoon and the wetland to allow liquid to be extracted for leachate recirculation. The system will allow leachate to be extracted from either of these ponds via two pumping stations that the portable pump can connect to. These stations connect to an underground pipe that allows leachate to be distributed at various points around cell 1. Connectors and valves, as shown in ***Figure 20***, allow for the leachate to be distributed using either drip irrigation (trickle) or sprinkler irrigation. The drip irrigation will be administered via a 100 m long flexible HDPE pipe, with perforations across the final 30 m to achieve a broad distribution and fairly uniform wetting (the end of the pipe is to be sealed).

Figure 20: Connection System for Leachate Recirculation



146. This surface approach will also ensure that there is a high level of evaporation. Recirculation is to be only practised during dry periods as opposed to just the dry season (this approach can be used in the wet season during periods when there is no rain) and will require staff to move pipes throughout the day in order to avoid ponding of leachate. Vehicle traffic is not to be allowed in areas where surface application of leachate has recently occurred.

4.5.8. Leachate and Pond Volumes

147. Leachate quantities will be minimised through landfill design and operations, including intercepting incoming surface water from upstream catchment areas through drains (***Para 154*** and ***155***); reducing ability for water to infiltrate wastes via heavy compaction of wastes (***Para 108***); building waste in phases as opposed to spread across the whole cell (***Para 105*** and ***106***); utilising intermediate cover to promote surface water run-off (***Para 110***); and completing main phases prior to the onset of the wet season (***Para 110***). 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 (***Para 121***).

148. Calculations for volumes of leachate have been undertaken for each phase across cell 1 up until 2030, as shown in ***Table 10***. Calculations have been made based on average rainfalls, as well as separate calculations based on the maximum rain for each month. These calculations take into account the level of exposed waste, level of intermediate cover being used, and adsorptive capacity of waste.

Table 11: Estimated Leachate Volumes

Year	Active Phase	Season	Average Rainfall Leachate produced m^3				Maximum Rainfall Leachate produced m^3			
			Season	Month	Week	Day	Season	Month	Week	Day
2022	1	Dry	0	0	0	0	0	0	0	0
2022	2	Dry	1	0	0	0	1	0	0	0
2023	3	Wet	1,133	189	47	6	1,697	283	71	9

Year	Active Phase	Season	Average Rainfall Leachate produced m³				Maximum Rainfall Leachate produced m³			
			Season	Month	Week	Day	Season	Month	Week	Day
2023	3	Dry	147	24	6	1	432	72	18	2
2024	3	Wet	1,320	220	55	7	1,974	329	82	11
2024	3	Dry	176	29	7	1	505	84	21	3
2025	3	Wet	1,515	253	63	8	2,261	377	94	13
2025	3	Dry	208	35	9	1	581	97	24	3
2026	3	Wet	1,722	287	72	10	2,566	428	107	14
2026	3	Dry	240	40	10	1	661	110	28	4
2027	4	Wet	1,792	299	75	10	2,671	445	111	15
2027	4	Dry	247	41	10	1	681	113	28	4
2928	4	Wet	1,973	329	82	11	2,939	490	122	16
2028	4	Dry	275	46	11	2	751	125	31	4
2029	4	Wet	2,161	360	90	12	3,216	536	134	18
2029	4	Dry	304	51	13	2	823	137	34	5
2030	4	Wet	2,360	393	98	13	3,510	585	146	20
2030	4	Dry	335	56	14	2	900	150	38	5

149. These calculations assume that the relocation of waste, from the existing waste dump into the new cell, will take place during the dry season, with translocated waste covered using intermediate cover prior to the commencement of the wet season. This waste will take up the first two phases of cell 1.

150. Leachate production will increase year-on-year. There will be minimal leachate produced during the dry season, even in years with particularly high rainfall for this season.

151. The water balance and flow in the ponds have been calculated (see ***Annex 9***) taking into account the inputs of leachate from landfill cells, rainfall into the ponds, and evaporation, across the wet and the dry season, based on average levels of leachate and evaporation.

152. The composition and volume of leachate will vary during the lifetime of the landfill. In the first few years, leachate volumes will be low. As such, the amount of water in the treatment ponds is likely to be extremely low and at times these ponds may require topping up. In addition to the input of leachate from cell 1, all of the ponds will be exposed to the elements and will receive inputs directly from rainfall. Inputs from the rain will exceed leachate volumes, which will help dilute concentrations. There are predicted to be high rates of evaporation from these ponds. The levels of soluble salts may increase when there is high evaporation and low water levels and these conditions will require observation, as these may result in issues for wetland plants.

153. The calculations show that, based on average rainfalls and evaporation rates, capacity levels will be reached only after approximately four years of operations, at the end of the wet season in 2026. In the event of persistent maximum rain capacity levels will be reach much earlier, in the 2023/ 2024 wet season.

4.5.9. Surface Water Drainage

154. Drains will be constructed throughout the site in the form of reinforced concrete-lined open ditches and reinforced-concrete covered drains. These drains will divert storm water away from roads, landfill cells, buildings and facilities. The storm water will be discharged into the buffer zone.

155. In some landfill sites storm water is allowed to enter leachate collection systems, which results in the production of a large volume of highly diluted leachate that is difficult to manage. 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. Each landfill cell will have a separate storm water transport pipe, as well as a leachate transport pipe. The end of each leachate collection pipe will have a valve contained in a manhole, which will allow operators to switch between the two systems. Storm water will subsequently enter the internal drainage system, bypassing the leachate treatment system. These stormwater transport pipes will be manufactured from HDPE.

156. Waste will be built from the highest elevation in a downstream direction in each landfill cell. This will ensure that in peak rainfall water does not come from higher elevations and pass through the waste layers. The leachate collection system is designed to cope with high rainfall. However, in actual operations it may be necessary to create small ridges of clay-based soil material at the lowest point of the current waste deposition phase, in order to intercept any leachate that could pass from the waste mound into the lower parts of the cell and subsequent discharge via stormwater pipes.

4.5.10. Groundwater Monitoring

157. Five groundwater quality monitoring wells will be installed to determine if the landfill operations have any impacts on groundwater. The wells will be installed both upstream and downstream the landfill as indicated in ***Figure 21*** and in accordance with the conceptual design presented in ***Figure 22***. The exact depth will be determined during the drilling work.

158. The Contractor shall install the monitoring wells not later than 6 months after start of construction work.

Figure 21: Tentative Location of Groundwater Monitoring Wells

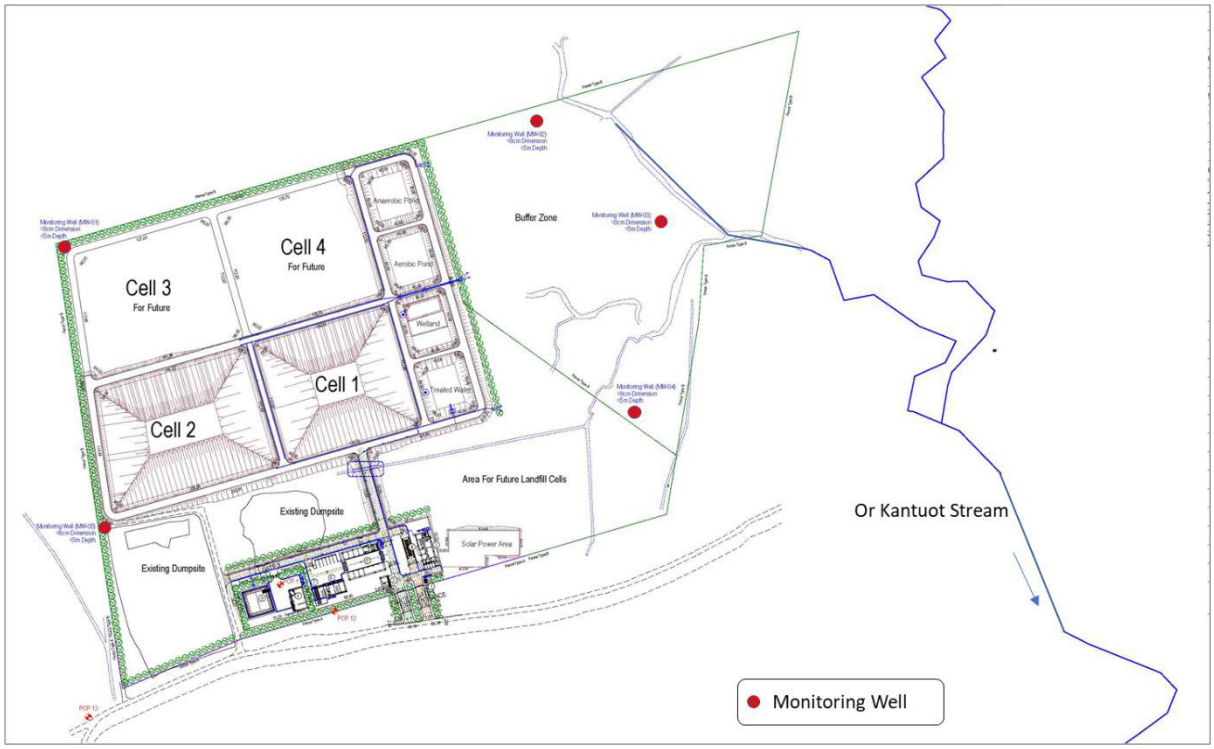
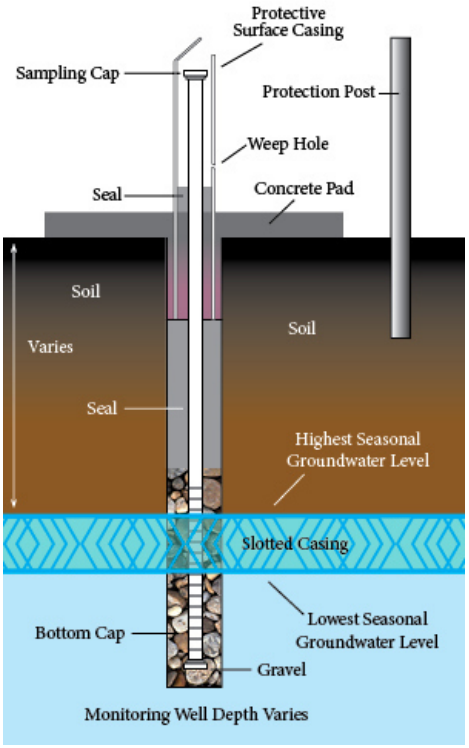


Figure 22: Conceptual Design of the Groundwater Monitoring Wells



4.5.11. Landfill Gas Control

159. 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. Estimated landfill gas volumes are provided in ***Annex 6***. 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. 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. The system has also been designed in a way that will allow for the system to be converted into an active system with gas flaring at a later date. This active system would involve suction and burning of gas in order to safely dispose of flammable constituents, control odour nuisance, and reduce the implications from releasing greenhouse gases into the atmosphere.

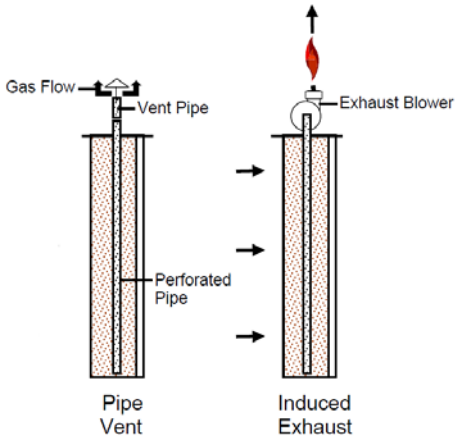
160. The approach to landfill gas management will be to utilise passive vents, using vertical wells, which use existing variations in landfill pressure and gas concentrations to vent landfill gas into the atmosphere. These vents are constructed using 2 m lengths of perforated/ slotted HDPE pipe, with a dimension of 200 mm. The final section of pipe at the surface and final section below the surface are to contain no perforations (perforation to begin in the gas collection layer – approximately 1 m below the surface). The end of the pipe at the surface will need to have a u-bend to prevent infiltration of rain into the landfill cell.

161. The pipe is to be encased in a lime-deficient coarse gravel and rock filled wick, which will provide preferential pathways for the gas to reach the vent pipes. The gas collection layer in the final capping will also provide additional pathways. It is essential that there is a good clay seal around the gas pipe at the surface when final capping is put in place across the landfill cell (this will go from the surface to the barrier layer of the final cap). This will ensure that gas is emitted via the pipe. The landfill cells have been designed so that there is no lateral movement of gas out of the sides/ bottom of the landfill. This approach will ensure

that a vacuum can be created, which is critical if an active approach to landfill gas is required at a later stage.

162. As shown in ***Figure 23,*** the passive gas collection system can be converted to an active system, which includes an induced exhaust system and flaring.

Figure 23: Potential Future Transition from Passive to Active System



163. The 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). As these vents will only be required once the waste pile reaches 5 m in height, they will not be constructed during the initial construction phase. Although materials will need to be provided upfront, the actual construction will be undertaken by operational staff. The only landfill gas vent that will be initially constructed will be in the hazardous waste cell.

4.5.12. Landfill Cap

164. 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).

165. *Topsoil:* The principal function of the 150 mm topsoil is to allow for the establishment of vegetation, which is necessary in minimising erosion. This layer must be uniform, with a minimum slope of 1:30 to prevent surface water lagooning and allow for run-off. The side slopes of the waste must have a maximum final slope of 1:3, in order to minimise erosion and slumping.

166. *Intermediate layer:* This 300 mm layer provides a transition between the topsoil and the barrier layer. The layers main function is to provide drainage, reducing the percolation of water through the subsequent barrier layer, while reducing saturation in the topsoil layer.

This layer can be comprised of a mix of fairly unspecific material (coarse rock, gravel or other granular material, crushed rock, coarse sand, silt, soil), which allows for a hydraulic conductivity equal to or greater than $1x10^{-3}$ m/s.

167. *Barrier layer:* The primary function of the barrier layer is to prevent the infiltration of water and control landfill gas. The barrier layer is to consist of 600 mm of compacted clay or other material of a low permeability, with a hydraulic conductivity of between $1x10^{-7}$ m/sec and $1x10^{-9}$ m/sec. In a similar approach to the landfill liner, this layer is to be compacted in uniform layers no greater than 250 mm, achieving standard compaction rates of 90% to 95%, placed using a moisture content of at least 3% above optimum.

168. *Gas collection layer:* The purpose of this layer is to transmit gas to the passive wells and the subsequent removal of gas out of the landfill cell. The material utilised in this 150 mm to 300 mm layer of good permeability, hydraulic conductivity equal to or greater than $1x10^{-3}$ m/sec, comprised of sand, soil, gravel and rock (similar to the intermediate layer).

169. The final capping of landfill cell 1 will be completed post 2030. As such, only material associated with the intermediate cover needs to be initially provided. The intermediate cover will be stored in the area where cell 2 will be located.

4.5.13. Hazardous Waste

170. The joint disposal of untreated hazardous waste with municipal solid waste is not considered an appropriate management practice. As such, a separate hazardous waste landfill cell is included in the design. The waste acceptance policy for hazardous wastes will be detailed in the Operation and Maintenance manual (O&M manual). ***Table 12*** provides preliminary hazardous waste acceptance guidelines to be further elaborated and considered in the O&M manual.

171. 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 and purchases 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. 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.

Table 12: Preliminary Hazardous Waste Acceptance Guidelines

Acceptable Hazardous Waste	Unacceptable Hazardous Waste
• Electronic waste not containing gasses (e.g. chlorofluorocarbons) • Solid-state batteries • Residues from incineration of infectious waste and sharps • Fluorescent lamps • Empty cans and containers for chemicals (pesticides, paints, hydrocarbons) • Wiring • Soil, sweeps, cloth or other solid materials contaminated with hazardous chemicals	• All types of liquid hazardous waste (hydrocarbons, paint, acids, bases) • Asbestos containing waste • Lead batteries • Untreated infectious waste including sharps • Radioactive waste • Flammable waste • Compressed flammable gasses • Explosives • Oxidizing agents • Gas cylinders

172. The conceptual design of the hazardous landfill cell is displayed in ***Figure 24*** and the location is indicated in ***Figure 25***. The cell will be broadly constructed 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 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).

173. The side walls will have a slope of 1:2, with a 3 m wide section that has a 1:4 ramp into the cell. This will allow site operators safe 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 m3 and will be able to reach a final height of waste of 3 metres. This will be able to accommodate three layers of 220 litre drums. One gas collection well will be provided and constructed upfront (not by operational staff as per the standard landfill cell).

174. An emergency cut-off valve will be installed in the leachate collection pipe, located within a manhole cover to the side of the hazardous landfill cell. This valve can be utilised in case of accidental deposition or spillage of extremely hazardous material into the cell, in order to prevent flow of highly contaminated leachate into the leachate treatment facility.

Figure 24: Hazardous Waste Landfill Cell

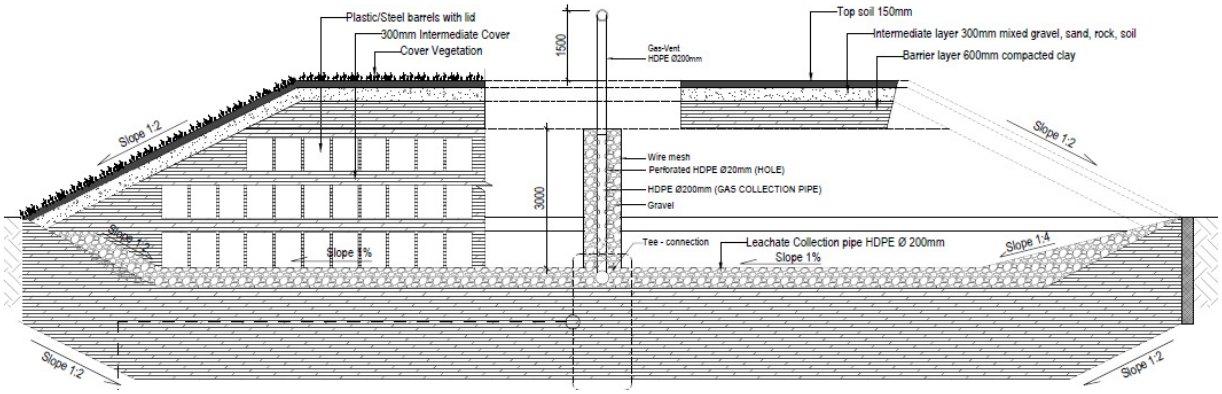
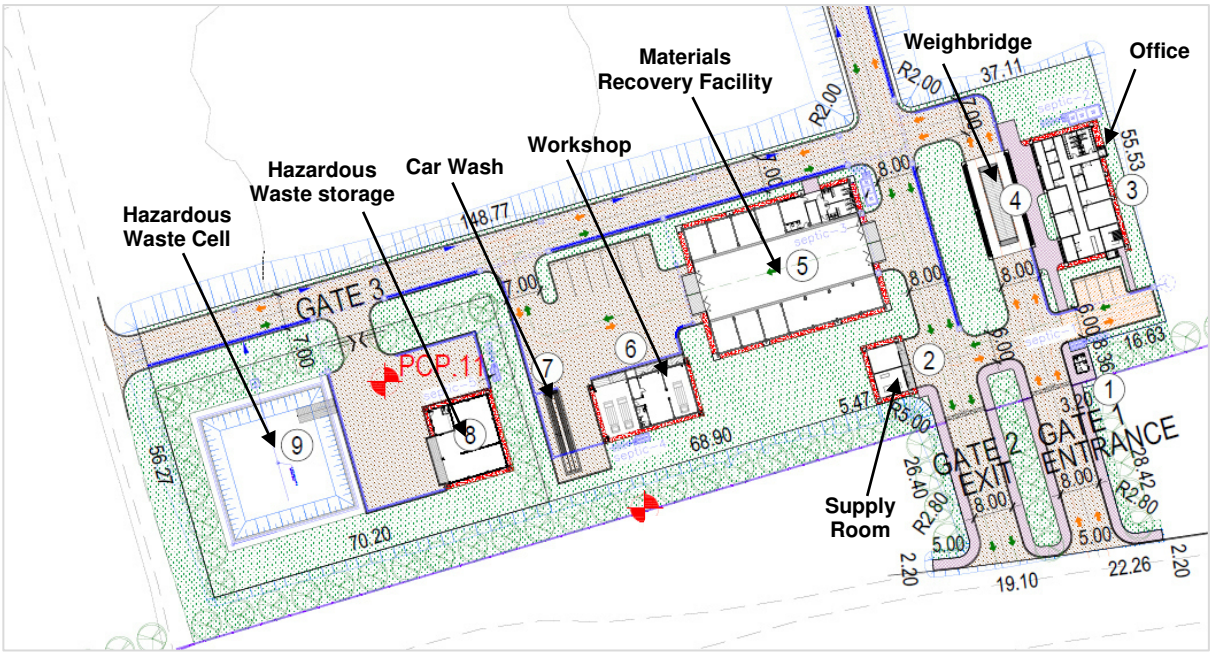


Figure 25: Landfill Facilities Master Plan

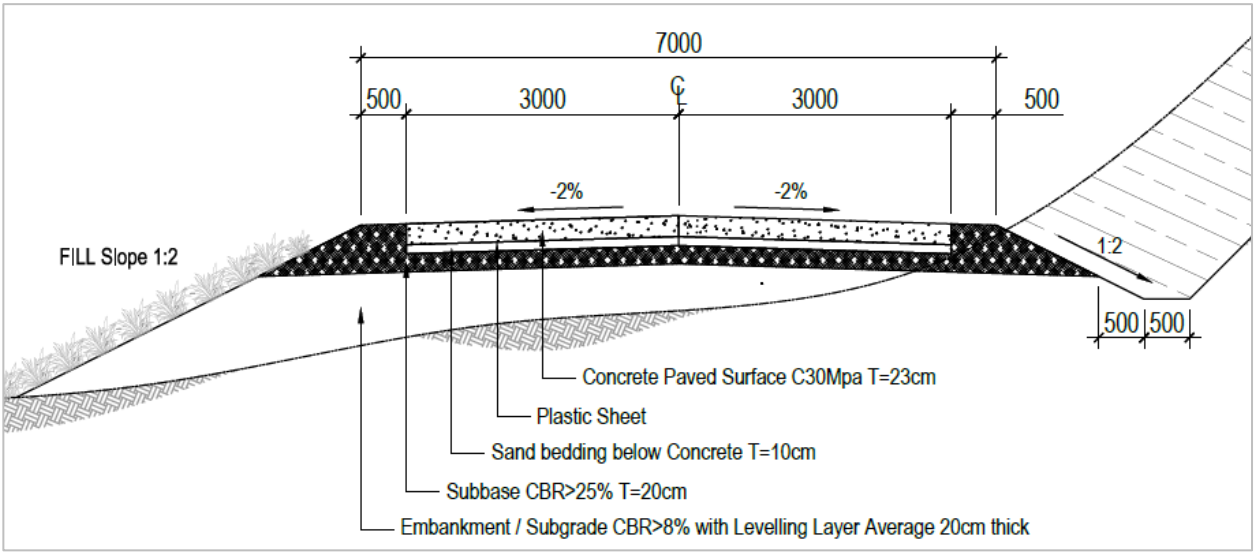


4.5.14. Landfill Facility Civil Works

175. The layout of the facilities is presented in ***Figure 25***. The layout and road system are designed to ensure that vehicle movements are efficient, and crossing is minimised.

176. ***Access Roads:*** 2 kilometres (2,020 m) of access road to the site will be upgraded using a concrete construction, which is 6 m wide by 23 cm deep and has a load bearing capacity of 25 tons (***Figure 26***).

Figure 26: Access Road Profile



177. ***Guardhouse:*** A room for security staff is provided at the very entrance to the site.

178. ***Weighing Bridge, Office Building, Rest & Dining Facilities:*** This is a combined facility, providing the office, weighbridge, and dining facilities all in one two-storey building. This facility will provide the main point of access into the site and will be where processes will be undertaken in respect to identifying and checking wastes to ensure that they meet

waste acceptance criteria (which will be specified in the O&M manual), as well as weighing incoming wastes.

179. ***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.

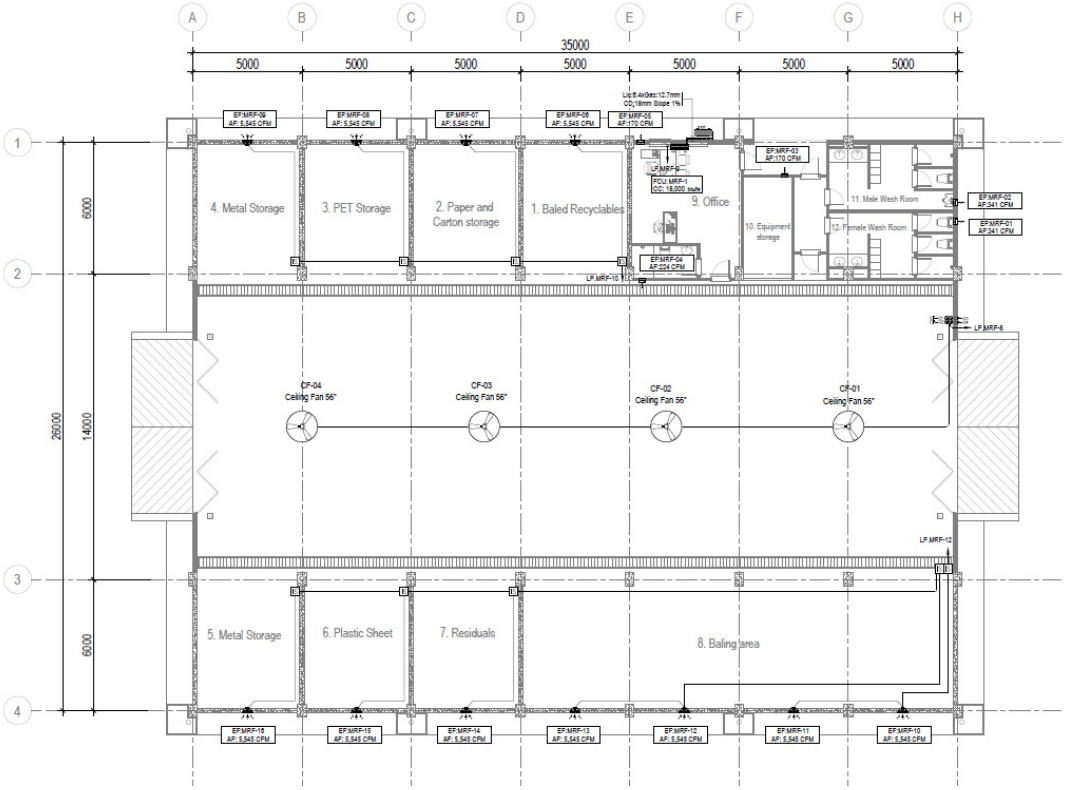
180. ***Supply Room:*** This small building will have two rooms a) Plumping technical room for the groundwater pump and supply; b) Electrical technical room for the generator and main distribution boards (MDB) for electricity supply.

181. ***Material Recovery Facility (MRF):*** This is a non-mechanical type material recovery facility, which will provide a covered building for the manual sorting of recyclable wastes. The layout is shown in ***Figure 27***. Seven bays have been provided to allow for the separation and storage of materials that are likely to have marketable value (e.g. recoverable plastic, glass, paper, aluminium, and ferrous metals). It is estimated that over the planning horizon there will be significant increases in the volume of waste that is diverted from landfill, as a result of new policies in relation to recyclable material, development of processing technologies, and improvement in regional markets for post-consumer materials. As such, it is predicted that by 2040 diversion rates of approximately 30% will be reached, amounting to an estimated 20 tons per day.

182. Space has been allocated for a baling area, where baling, shredding, and compacting of materials can take place. Ventilation and lighting are provided in the design, in order to keep the area well lighted for a safe working environment.

183. Full facilities are provided for staff, including an office room, equipment storage, and separate toilets and changing rooms for male and female workers. The MRF has 910 m^2 of floor area across two floors.

Figure 27: Materials Recovery Facility Layout



184. ***Hazardous Waste Storage Facility***: This facility is for storing hazardous waste in a safe and secure way. The facility is positioned in an area of the site that is slightly away from other buildings and contained within a dedicated secure fence and gate.

185. The hazardous waste storage facility will be able to store electronic wastes from households that are generated along with the regular hazardous wastes (paint, batteries, electrical items, etc.) that require proper attention. In this facility, hazardous waste with values such as electronic waste can be disassembled/ stored in the facility, until interested parties (recyclers) purchase or collect it for the purpose of recycling and treatment. The use of shredding, heat or chemicals to disaggregate valuable components from electronic waste will not be allowed.

186. The building is to be well covered and ventilated, with a sealed floor to control any spills. A small office is also provided. Floor space: 180 m^2.

187. ***Vehicle Washing Facility***: A vehicle washing ramp facility has been provided to clean and maintain the vehicles engaged with waste collection.

188. ***Internal Roads and Parking***: Internal site roads and parking bays will be constructed using a concrete construction, which is 23 cm deep and has a load bearing capacity of 25 tons. The width of these roads varies, and the total length of these roads is 1,721 m in the initial construction (not including roads required for future landfill cells).

189. ***Fence and Wall***: 2,213 metres of wire-mesh fence will be constructed around the site boundaries (including future cells), to avoid unauthorised people entering the landfill and to prevent illegal dumping. The buffer zone will also be fenced off. 446 metres of brick masonry wall will also be constructed around the hazardous waste facility (storage building and hazardous landfill cell).

190. ***Vegetation Screens:*** A line of trees will be provided to screen the operational buildings and the landfill. These screens will help minimise dust and odours along the public road and in neighbouring properties.

191. ***On-Site Drainage***: Drainage is provided in the form of reinforced concrete-lined open ditches, reinforced-concrete covered drains, and a natural ditch that drains into the existing on-site pond. These drains will divert storm water away from roads, landfill cells, buildings and facilities.

192. ***Electricity***: A transformer of 160 KVA is required, with a 66 KVA back-up generator also provided, along with a grid-tied solar system that will provide contribution to the load during the day. Total connected load is calculated at 140 KW.

193. ***Water Supply***: Water supply will come from a deep tube well on the site. An overhead HDPE tank will be installed for water storage.

194. ***Sanitation Facility***: Wastewater from the toilets and showers will be collected by PVC sewer pipes and will be conveyed to the septic tank for treatment.

4.6. Closure of the Existing Dumpsite

195. The existing dumpsite is described in ***Section 4.3.2***. and the closure method is presented in ***Section 6.5.3***.

4.7. Construction Implementation

4.7.1. Construction Schedule

196. The construction is scheduled to be completed within 14 months as outlined in ***Figure*** 28. The schedule takes into account wet season constraints.

Figure 28 Tentative Time Schedule for Construction

Construction Activities		Months													
		1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Site Clearance & Earth Works	■	■	■											
2	Deep Tube Well		■	■	■										
3	Electrical Power Connection		■	■	■	■									
4	Boundary Fence				■	■									
5	Main Buildings			■	■	■	■	■	■	■	■	■			
6	Materials Recovery Facility									■	■	■	■	■	
7	Hazardous Waste Storage									■	■	■	■	■	
8	Hazardous Waste Cell									■	■	■	■	■	
9	Construction Landfill Cell-01				■	■	■	■	■						
10	Leachate Water Treatment Ponds							■	■	■	■				

Construction Activities		Months													
		1	2	3	4	5	6	7	8	9	10	11	12	13	14
11	Access Road														
12	Internal Roads														
13	Entrance Gate with Security														
14	Tree Planting														
15	Relocate Existing Waste														
16	Groundwater Monitoring Wells														
17	Quarterly Environmental Monitoring (air, noise, water)														

4.7.2. Construction Activities

197. The main construction activities are outlined below:

- Activity 1: Site Clearance and earthworks. This will involve levelling of the site, clearance of vegetation, earthworks including cutting and filling, compaction of foundations.
- Activity 2: Construction of deep tube well and water supply system
- Activity 3: Construction of electrical substation and power distribution
- Activity 4: Construction of the Fence
- Activity 5: Construction of building structures and facilities
- Activity 6: Construction of the Materials Recovery Facility
- Activity 7: Construction of Hazardous Waste Storage
- Activity 8: Construction of Hazardous Waste Landfill Cell
- Activity 9: Construction of one Landfill Cell: Construction of cell 1 including clay layer laid and compacted geomembrane laid; geotextile laid; gravel layer with leachate collection pipes. Leachate and storm water transport pipes to be installed from landfill cell 1 to leachate treatment lagoons and storm water discharge points.
- Activity 10: Leachate Treatment Lagoons: Four separate lagoons to be excavated. Clay liner to be installed below and to the sides of leachate treatment lagoons, overlaid by HDPE liner and final protective layer of compacted clay. Interconnecting pipes to be installed between the four lagoons to allow gravity flow. The leachate recirculation system will be constructed for cell 1.
- Activity 11: Internal Roads, 1.7 km of internal roads to be constructed. Initial dirt roads are likely to be required to provide access for construction equipment. Later these roads are to be upgraded to concrete roads. Side drainage to be constructed alongside the roads.
- Activity 12: Upgrade of the external access road to the Site, 2 km of external dirt road to be upgraded to a concrete road.
- Activity 13: Construction of the entrance, wall and security guardhouse
- Activity 14: Planting of trees as vegetation screens

- Activity 15: Relocation of waste from the existing dumpsite in the southeast corner of the site to the newly constructed landfill cell. No compaction is required, as this waste will likely be the first waste disposed of in the landfill cell. This waste will provide the operational layer that provides protection to the drainage layer, HDPE pipes, and the geomembrane (see ***Section 6.5.3***).
- Activity 16: Drilling of groundwater monitoring boreholes
- Activity 17: Procurement and installation of equipment
- Activity 18: Training of O&M Staff
- Activity 19: Testing and Commissioning
- Activity 20: Handover of the Facility
- Activity 21: Defects Liability Period

198. **Management of incoming waste**. Throughout the construction phase, the Contractor will be required to manage incoming waste. The incoming waste will be temporarily deposited at the existing dumpsite area and the management of the incoming waste will be combined with temporary remediation of potential impacts from the existing waste. A description of the required management and mitigation activities is included in the EMP.

4.8. Associated and Existing Facilities

199. 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.

200. 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. The two dumpsites are considered existing facilities under the wider CTDP4 Project and as such an Environmental Compliance Audit (ECA) is required for the dumpsites. An ECA for the two dumpsites has been prepared and is attached in ***Annex 10***. The results of the ECA have been incorporated in relevant sections of the IEE.

5. DESCRIPTION OF THE ENVIRONMENT

5.1. Project Area of Influence and Sensitive Receptors

5.1.1. Area of Influence

201. According to ADB's 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, temporary impacts and construction camps.

ii. **Associated facilities** that are not funded as part of the project whose viability and existence depends exclusively on the project. No associated facilities are anticipated for this 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. As a result of this project, it is anticipated that the development of the urban centers will continue, leading to further developments around the sub-project areas.

202. 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 other 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. ADB's SPS 2009 requires the assessment to identify potential transboundary effects, such as air pollution, and global impacts, such as emission of greenhouse gases.

203. For the purposes of this IEE, the area of influence is the project sites which includes the footprint of the landfill and access road, workers camp, borrow sites, and the future service area taken to be the service area, but shall also include a wider area estimated at 250 m around the construction sites boundaries, as this is considered the distance to reach acceptable sound levels from construction equipment noise:

- 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.
- Calculation: At 250 m the noise at a receptor is approximately 55 dBA (WHO limit).

5.1.2. Sensitive Receptors

204. The assessment of impacts on sensitive receptors have considered:

- 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.

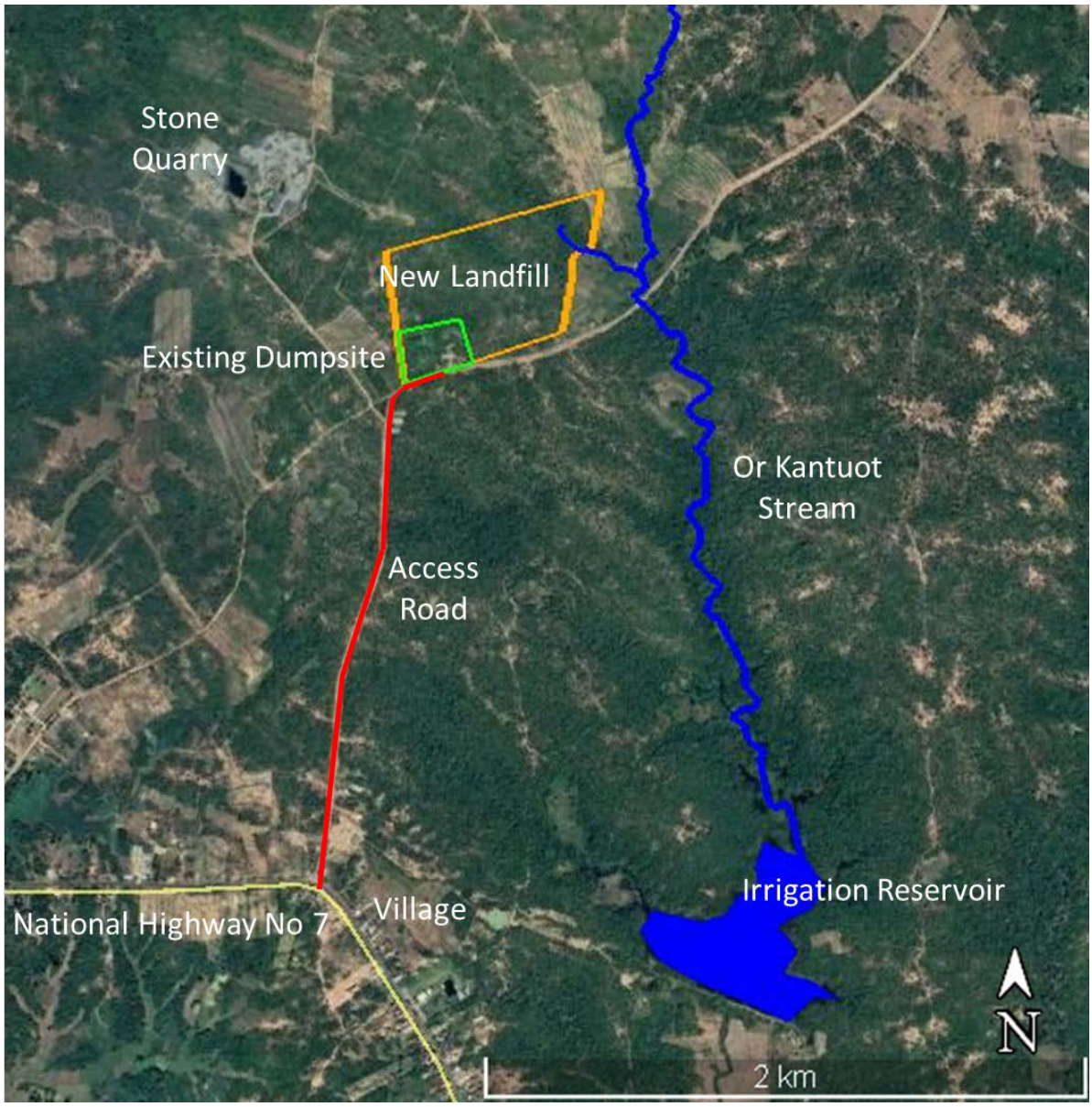
205. The identification and proximity of sensitive receptors is summarised in ***Table 13*** and the receptors in the immediate surroundings are displayed in ***Figure 29***.

Table 13: Summary of Sensitive Receptors

Project Component	Surface Water Receptors	Socio-Economic & Cultural Receptors	Land Cover/ Ecological Receptors	Protected Area Status
Landfill site including the existing dumpsite	- Small stream that connects to Or Kantuot Stream crosses over the buffer zone in the north-eastern corner of the site - Or Kantuot Stream flows 2 km to a 16 ha irrigation reservoir	- State Land - about 15 km for Kratie City and 17 km from Mekong River - 2 km from national road No. 7 - 2 km from Khsar village, Dar commune, with houses, schools, pagoda and other rural local utilities. - Primary school 1.7 km southwest of the site. - A stone quarry 350 m northwest of the site	- The site is covered with degraded forest and secondary shrub - Surrounding area is upland area with secondary forest/shrub and patches of agricultural land	- Mondulkiri - Kratie Lowlands Key Biodiversity Area located about 11 km to the east - the Mekong River Kratie to Lao Border Key Biodiversity Area about 15 km to the west
Old Dumpsite	- Wetlands 1.3 km to the southeast and a small pond 0.3 km south of the site - 3 km from Prek Te River and within its catchment	- single houses/buildings next to the dumpsite and along the access road - 1.3 km to the nearest village along National Highway No. 7. - big buddha statue along the dumpsite access road	- The site is covered with degraded forest and secondary shrub - Surrounding area is secondary forest/shrub in-between areas of agricultural land	- the Mekong River Kratie to Lao Border Key Biodiversity Area about 7.5 km to the west - Prek Prasab Protected Area 17 km to the northwest

Source: Google Earth, IBAT proximity assessment, PMC site visits

Figure 29: Receptors in the Immediate Surroundings of the Landfill



5.2. Topography and Geology

206. The landfill is located in upland area with fairly flat topography with elevations generally between 39 m asl. and 44 m asl. gently sloping towards Or Kantuot Stream.

207. The geotechnical survey at the site carried out for the landfill design, shows that the underlying geology is comprised of extremely compact sandstone, which is present at the surface and will provide a good natural impermeable layer. The geotechnical survey shows that there is very little soil or organic material above this sub-base, which will make excavations challenging.

Figure 30: Pictures of the Landfill Site

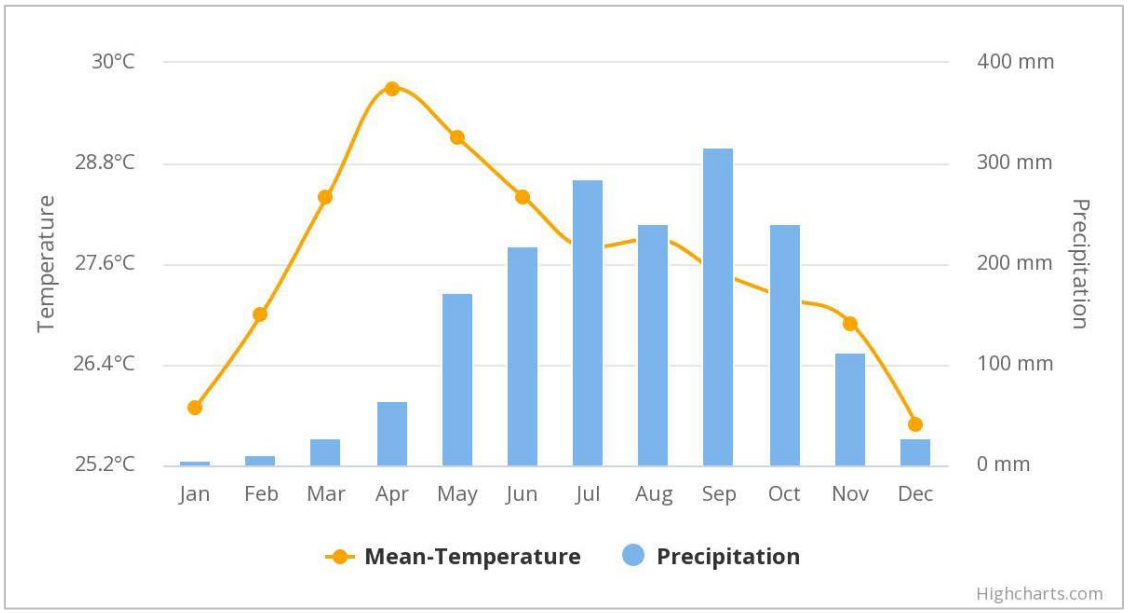
5.3. Meteorology and Climate

208. The climate for Kratie Province is classified as tropical wet and dry climate (*Aw*) according to the Köppen-Geiger climate classification.

209. In Kratie, the average annual temperature is 27.5 °C and the annual rainfall is 1610 mm. The average monthly temperature varies very little.

210. The average monthly rainfall (mm) and temperature for 1991-2020 is presented in ***Figure 31***. The climate is dominated by the monsoon cycle, with a distinct dry season from November to April and wet season May to October.

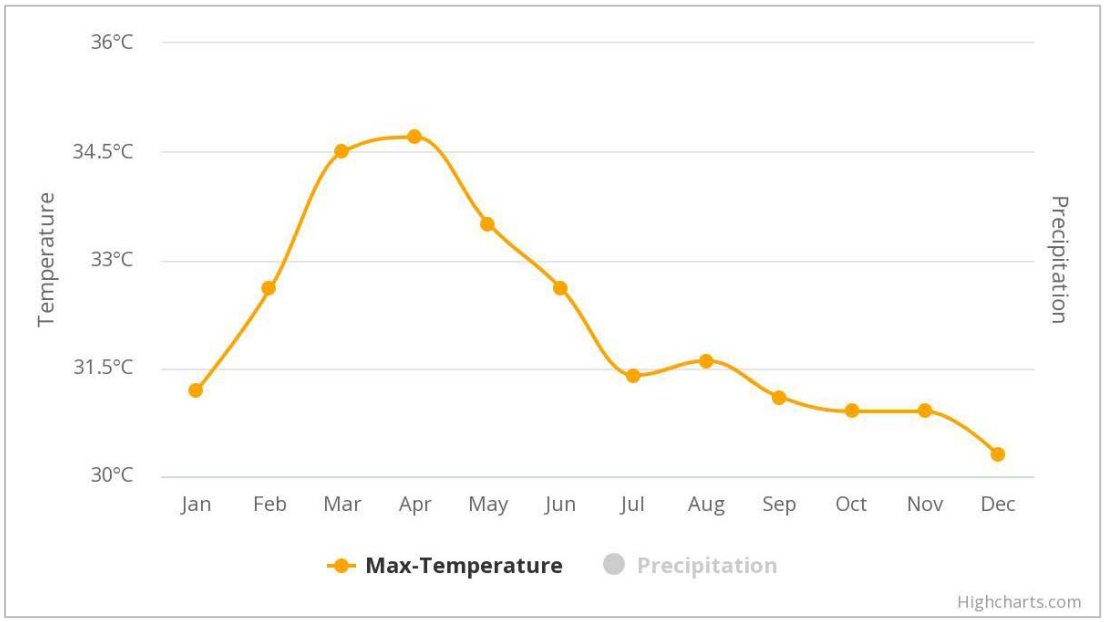
Figure 31: Monthly Average Rainfall and Temperature, Kratie (1991-2020)



Source: https://climateknowledgeportal.worldbank.org/country/cambodia/climate-data-historical accessed on 17-Jun-2021

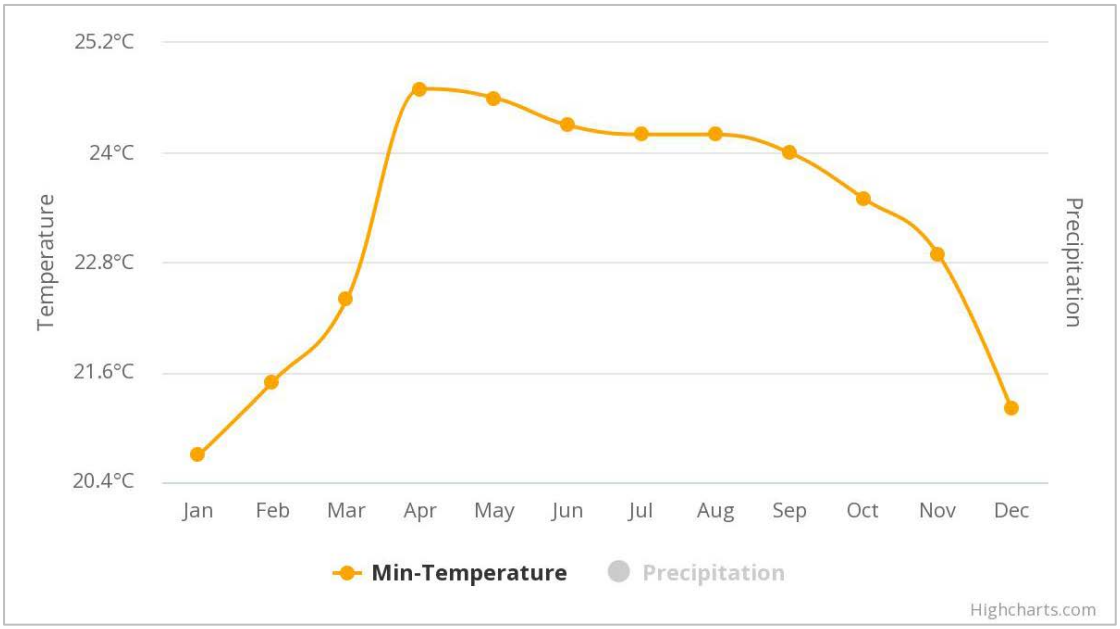
211. The average monthly maximum and minimum temperatures (1991-2020) are displayed on the chart in ***Figure 32*** and ***Figure 33*** respectively. April is the warmest month of the year with an average temperature of 29.6 °C and December is the coldest with an average temperature of 26.1 °C.

Figure 32: Average Maximum Monthly Temperatures 1991-2020, Kratie



Source: https://climateknowledgeportal.worldbank.org/country/cambodia/climate-data-historical accessed on 17-Jun-2021

Figure 33: Average Minimum Monthly Temperatures 1991-2020, Kratie



Source: https://climateknowledgeportal.worldbank.org/country/cambodia/climate-data-historical accessed on 17-Jun-2021

212. 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.

5.4. Climate Change Projections

213. According to the World Bank's Climate Change Knowledge Portal (https://climateknowledgeportal.worldbank.org/), for Cambodia, the mean annual temperatures have increased by 0.8°C since 1960, at a rate of about 0.18°C per decade.

The rate of increase is most rapid in the drier seasons (December-February and March-May), increasing 0.20-0.23°C per decade, and is slower in the wet seasons (June-August and September-November), increasing 0.13-0.16°C per decade. Since 1960, the frequency of 'hot' days has increased significantly (+46, with strongest increases noted in September-November), as has the frequency of 'hot' nights (+63, with strongest increases noted in December-February). The frequency of 'cold' days has decreased significantly in the September-February period. The average number of cold days per year has decreased by 19 (5.2%). This rate of decrease is most rapid in December-February. Mean rainfall trends over Cambodia are unclear, with some areas experiencing increases and others decreases, but these changes are not statistically significant[10].

214. The key climate change predictions for Cambodia available in the World Bank's Climate Change Portal include that[11]:

a) mean annual temperature will rise by 1.54 °C (1.06 °C to 2.50 °C) in 2040-2059 (RCP[12] 8.5, Ensemble[13])
b) annual precipitation will rise by 82.77 mm (-268.57 mm to 557.23 mm) in 2040-2059 (RCP 8.5, Ensemble)
c) annual Maximum 5-day Rainfall (25-year Return Level) will rise by 34.42 mm (-91.71 mm to 455.53 mm) in 2040-2059 (RCP 8.5, Ensemble)

215. The projected change in monthly temperature for Cambodia is shown in ***Figure 34*** and the projected change in monthly precipitation is presented in ***Figure 35***. As indicated in the large spread of precipitation projections there is not yet a clear picture for precipitation change, due to large model uncertainties. However, increases in rainfall appear to be likely during the monsoon season.

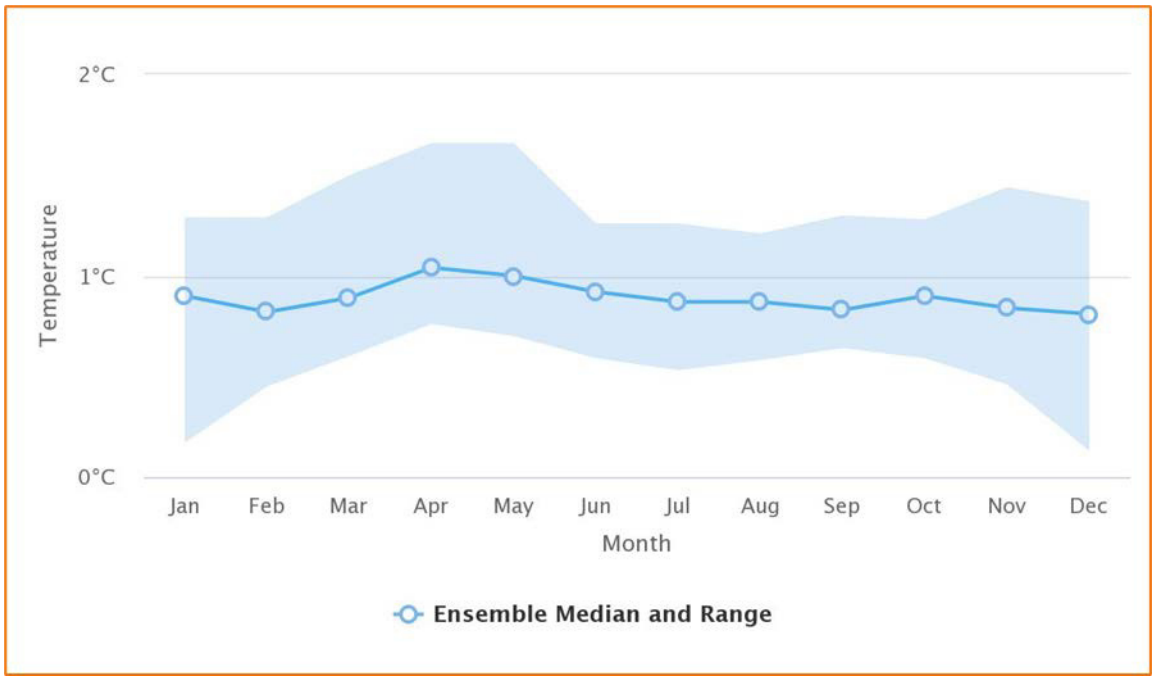
[10] https://climateknowledgeportal.worldbank.org/country/cambodia/climate-data-historical. Accessed on 01-May-2021

[11] https://climateknowledgeportal.worldbank.org/country/cambodia/climate-data-projections. Accessed on 01-May-2021

[12] RCP means Representative Concentration Pathways for different emission level scenarios

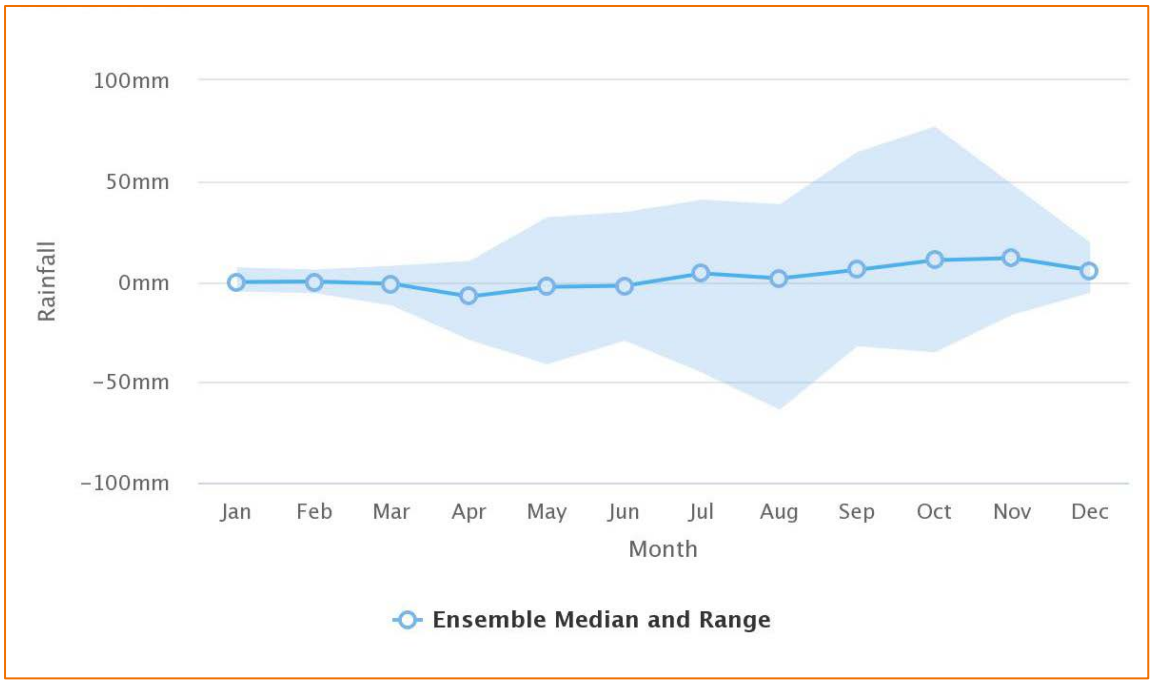
[13] A collection of model simulations characterizing a climate prediction or projection

Figure 34: Projected Change in Monthly Temperature for Cambodia for 2020-2039



Source: https://climateknowledgeportal.worldbank.org/country/cambodia/climate-data-projections

Figure 35: Projected Change in Monthly Precipitation for Cambodia for 2020-2039



216. ***Table 14*** indicates typical impacts from climate change on the subproject as identified by the CRVA. These issues are managed through design mitigation measures where appropriate.

Table 14: Impacts from Climate Change on Landfill Operations

Climate Change Factor	Impacts
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

Climate Change Factor	Impacts
	eutrophication.
More Frequent and/or Intense Extreme Weather Events	• Increased risk of direct flood damage to landfill site. • Increased risk of untreated leakage overflowing and contaminating water bodies.

Source: PPTA 2018

5.5. Surface Water and Ground Water Quality

5.5.1. Surface Water

217. The Landfill is located within the catchment of Prek Te River (about 10 km from the river) – a tributary to the Mekong River. As described in ***Section 4.4.2*** (***Figure 9*** and in ***Section 5.1.2*** (***Figure 29***), a small stream (***Figure 36***) runs across the buffer zone in the north-eastern corner of the site and connects to the Or Kanuot Stream which flows into an irrigation reservoir about 2 km southeast of the site. The stream appears only to have continuous water flow in the wet season.

Figure 36: Small stream crossing the north-eastern corner of the landfill site

218. The IESIA study analysed the water quality of samples collected upstream and downstream the landfill site and the results are summarized in ***Table 15***. The sampling points are indicated in (Coordinates. upstream: X: 627217 & Y: 1382578, 12°30'14.8"N 106°10'14.8"E and downstream: X: 627421 & Y: 1381739, 12°29'47.4"N 106°10'21.5"E)

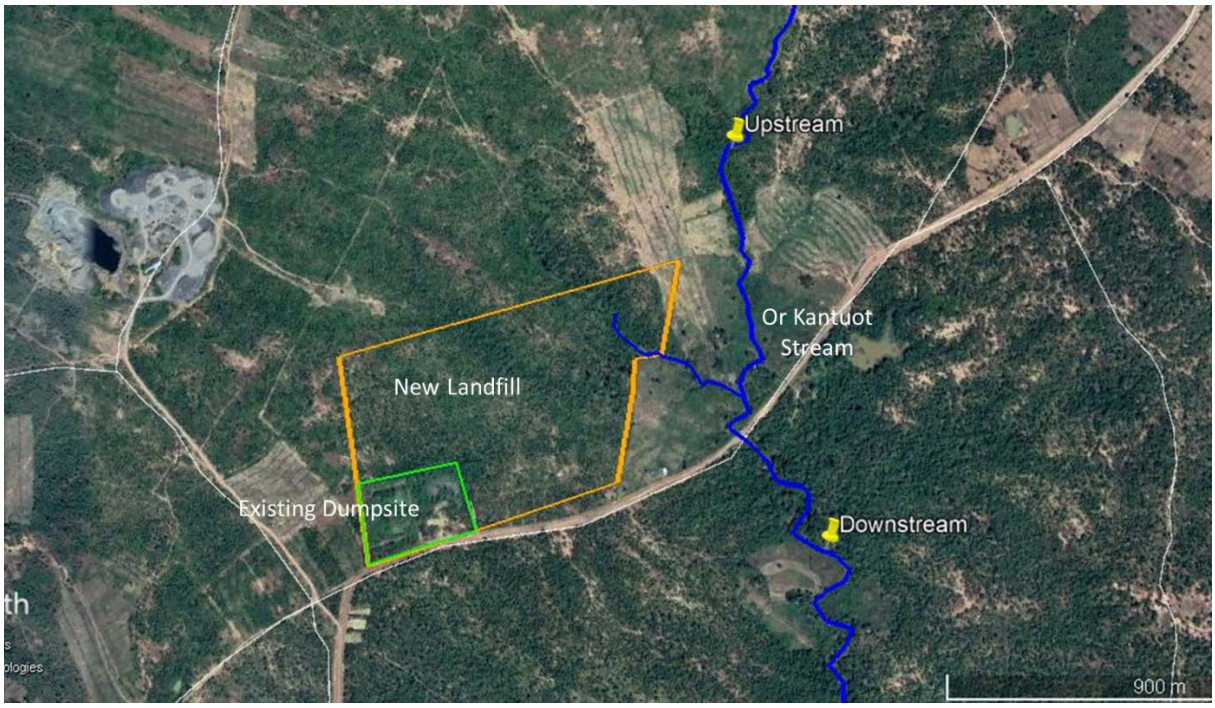
Table 15: The surface water quality in Or Kantuot sources

N.	Parameters	Unit	Standards	Or Kantuot Upstream	Or Kantuot downstream
1	Degree Celsius °C	°C	-	27.8	30.3
2	pH	No Unit	6.5-8.5	7.88	7.29
3	Total Dissolved Solid (TDS)	mg/l	<1000	38.6	78.2
4	Total Suspended Solid (TSS)	mg/l	2.5-100	**181.00**	**152.00**
5	Dissolved Oxygen (DO)	mg/l	7.5-2.0	2.33	2.47
6	Biochemical Oxygen Demand (BOD_5)	mg/l	01-10	2.40	2.00
7	Chemical Oxygen Demand (COD) Mn	mg/l	<50	7.63	7.44
8	Oil and Grease	mg/l	<0.5	**7.73**	1.80
9	Phosphate (PO_4)	mg/l	NV	0.10	0.10
10	Sulphate) $SO_{(4}$	mg/l	<300	29.00	22.00
11	Total Nitrogen (TN)	mg/l	0.1-0.6	**1.08**	**0.75**

N.	Parameters	Unit	Standards	Or Kantuot Upstream	Or Kantuot downstream
12	Total Phosphorus (TP)	mg/l	0.005-0.05	**0.10**	**0.06**
13	Nitrate (NO_3)	mg/l	<50	11	6.16
14	Arsenic (As)	mg/l	<0.01	0.006	0.009
15	Iron (Fe)	mg/l	**<1**	0.41	**1.49**
16	Mercury (Hg-Total)	mg/l	**<0.0005**	0.0002	0.0003
17	Total Coliform	MPN/100 (ml)	**<5000**	**$1.1x10^5$**	**$1.1x10^5$**

Source: IESIA report, SAWAC-MoE August 2020

Figure 37: Surface Water Sampling Points



219. The low dissolved oxygen levels just above 2 mg/L, the elevated concentrations of BOD5 and COD, the high concentration of total suspended solids, coliform bacteria and oil and grease - all except oil and grease both upstream and downstream - indicate that the stream may be affected by human activities.

5.5.2. Groundwater

220. The nearest groundwater well identified by the IESIA study is located about 1.2 km north of the landfill site (X: 626446 and Y: 1383392). The IESIA study analysed the groundwater quality and the results are summarized in ***Table 16***. The results indicate that the groundwater quality is within the drinking water standard.

Table 16: Groundwater Quality in nearby Water Well

No	Parameters	Unit	Standard	Result
1	pH	-	**6.5-8.5**	6.67
2	Turbidity	NTU	**5**	3
3	Electrode Conductivity (EC)	NTU	**500-1500**	1172
4	Total Dissolved Solid (TDS)	mg/l	**800**	586
5	Total Hardness (as $CaCO_3$	mg/l	**300**	140.00

No	Parameters	Unit	Standard	Result
6	Chloride (Cl^-)	mg/l	**250**	17.50
7	Fluoride (F)	mg/l	**1.5**	0.28
8	Nitrate (NO_3)	mg/l	**50**	6.6
9	Sulfate (SO_4)	mg/l	**250**	ND
10	Iron (Fe)	mg/l	**0.3**	0.04
11	Arsenic (As)	mg/l	**0.05**	0.002
12	Mercury (Hg-Total)	mg/l	**0.001**	ND
13	Chromium (Cr-Total)	mg/l	**0.05**	ND
14	Manganese (Mn)	mg/l	**0.1**	**2.3**
15	Aluminium (Al)	mg/l	**0.2**	0.11
16	Cadmium (Cd)	mg/l	**0.003**	ND
17	Total Coliform	MPN/100ml	**0**	0
18	*E-coli*	MPN/100ml	**0**	0

Source: IESIA report, SAWAC August 2020

5.6. Air Quality

221. Field visits indicate that the air quality in the project site is still good, as the project areas are located in rural areas without industrial/commercial activities. The IESIA study measured the air quality at the landfill site (X: 0626560 and Y: 1381764, 12°29'48.3"N 106°09'53.0"E) and the results are summarized in ***Table 17***. The results are within the relevant air quality standards, but it should be noted that the concentrations of fine particulate matter (PM10 and PM2.5) are rather close to the thresholds.

Table 17: Air Quality Data of subproject area

No	Parameter	Unit	Result	Standard	Reference Method
1	Carbon Monoxide	mg/m^3	3.7	**<20**	Method Carbon Monoxide Passive Dositube
2	Nitrogen Dioxide (NO_2)	mg/m^3	0.027	**<0.10**	Method Saltzman [ISO 6768:1998(E)]
3	Sulphur Dioxide (SO_2)	mg/m^3	0.025	**<0.30**	Method Pararosaniline [ISO 6767:1990(E)]
4	Ozone (O_3)	mg/m^3	0.011	**<0.2**	Method Professional Gas Detector GT-901 03
5	Total Suspended Particles (TSP)	mg/m^3	0.076	**<0.33**	Method Weight Concentration Measuring
6	PM10	mg/m^3	0.04	**<0.05**	Method Weight Concentration Measuring
7	PM2.5	mg/m^3	0.021	**<0.025**	Method Weight Concentration Measuring
8	Lead (Pb)	mg/m^3	ND	**<0.005**	Method 3500-Pb C(HNo3, HCl Digestion)

Source: IESIA Report. SAWAC August 2020

222. The IESIA study measured the noise levels at the landfill site and the results are summarized in ***Table 18***. The results indicate that the noise levels are within the noise standards for residential areas[14].

Table 18: Noise Levels at the Landfill Site

Time	Survey Period	Nosie Level dB (A) 16 July 2020 (Wet Season)				Mean
		Laeq	Standard Residential Area Laeq	Lmax	Lmin	
Day	6:00 - 7:00	**51.7**	60	67.2	41.1	**51.35**
	7:00 - 8:00	**51.2**		64.5	42.8	
	8:00 - 9:00	**52**		64.6	40.2	
	9:00 - 10:00	**53.2**		65.6	41.6	
	10:00 - 11:00	**53.9**		66	42.5	
	11:00 - 12:00	**50.8**		70	37.4	
	12:00 - 13:00	**47.4**		68.9	41.8	
	13:00 - 14:00	**45.2**		67.4	30.8	
	14:00 - 15:00	**52.5**		68.6	40.2	
	15:00 - 16:00	**51.3**		70.2	40.3	
	16:00 - 17:00	**51.6**		69.8	40.3	
	17:00 - 18:00	**55.4**		67.6	41	
Evening	18:00 - 19:00	**50.8**	50	61.4	38.1	**46.38**
	19:00 - 20:00	**45.8**		59.7	36.7	
	20:00 - 21:00	**45.4**		59.9	37.7	
	21:00 - 22:00	**43.5**		58.8	36.1	
Night	22:00 - 23:00	**44**	45	47.1	35.8	**44.89**
	23:00 - 00:00	**42.9**		48.2	34.3	
	00:00 - 1:00	**43.3**		48.7	36.7	
	1:00 - 2:00	**47.8**		47.8	36.7	
	2:00 - 3:00	**44.2**		48.9	38.4	
	3:00 - 4:00	**46.8**		48.8	37.6	
	4:00 - 5:00	**45**		51.9	36.9	
	5:00 - 6:00	**45.1**		51.1	38	
24 hours Average		**48.4**		**60.1**	**38.5**	

Source: IESIA report, SAWAC August 2020

[14] Sub-decree No. 42 ANK/BK on Control of Air Pollution and Noise Disturbance, 2000

5.7. Natural Disasters

223. 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.

224. Kratie City experiences flooding every rainy season, usually after heavy rainfall and in combination with high flows of the Mekong River.

5.8. Physical Cultural Resources

225. There are no cultural resources, in particular pagodas, temples and any cultural/ historical receptors within radius of 2 km from the landfill site.

5.9. Ecological Resources

5.9.1. Protected Areas and Key Biodiversity Areas

226. The proximity of the landfill site to Key Biodiversity Areas (KBI) and National Protected Areas, Ramsar Sites etc. has been analysed using the Integrated Biodiversity Assessment Tool (IBAT). The IBAT Proximity Report (attached in ***Annex 8***) shows that the nearest Key Biodiversity Area is the Mondulkiri - Kratie Lowlands Key Biodiversity Area located about 11 km to the east. The Mekong River Kratie to Lao Border Key Biodiversity Area is located about 15 km to the west. Based on the IBAT proximity assessment it can be concluded that the landfill site is not located within any legally protected area or area that is internationally recognized for biodiversity.

5.9.2. Flora

227. The IESIA study undertook a site screening for flora species of significant biodiversity value based on the IUCN Red List[15]. The results of the survey are summarized in ***Table 19***. The PMC together with officials from Kratie Provincial Department of Public Works and Transport inspected the site on 01-Oct-2020. Pictures from this site inspection are shown in ***Figure 38***. Overall, the site surveys show that the site is covered with secondary degraded forest and shrub. The IESIA screening identified one Endangered species (No. 6 in the Table) and one Critical Endangered species (No. 20).

Table 19: Tree and Shrub Species in Subproject Site

No	Local Name (Khmer)	Scientific Name	IUCN
1	Phcheak	*Shorea obtusa*	
2	Sokrom	*Xylia dolabriformis*	
3	Chhlek	*Terminalia tomantasa*	
4	Raing	*Shorea siamenesis*	
5	Traseak	*Peltophorum ferrugineum*	

[15] The IUCN Red List Categories divides species into nine categories: Not Evaluated (NE), Data Deficient (DD), Least Concern (LC), Near Threatened (NT), Vulnerable (VU), Endangered (EN), Critically Endangered (CR), Extinct in the Wild (EW) and Extinct EX).

No	Local Name (Khmer)	Scientific Name	IUCN
6	Popeal	*Hopea recopei /shoprea*	EN
7	Klong	*Dipterocarpus tuberculatus*	
8	Phdeak	*Anishoptera grabra*	
9	Srol	*Trema orientalis*	
10	Tbeng	*Dipterocarpus obtusifolius*	LC
11	Lngeang	*Cartoxylon orunifolium*	
12	Pram Damleung	*Terminalia mucronata*	
13	Kandorl	*Careya sphaerica*	
14	Chun Or Tmat	*Vitex pinnata. L.*	
15	Sophy	*Ochrocarpus siamensis*	
16	Phaoung	*Callophyllum sp*	LC
17	Po Plear	*Grewia paniculata*	
18	Lang Chhrey		
19	Tranum Kampem	*Dipterocarpus obtusifolius*	
20	Khvav	*Adina cordipolia/ dipterocarpus turbinatus*	CR
21	Ngor Prey	*Morinda tomentosa*	
22	Pone Sva	*Spondias sp*	
23	Kantuok Prey	*Phyllanthus emblica*	
24	Chhung Moan		
25	Popeal Khe	*Terminalia bialata*	
26	Chonlong Moan	*Gardenia obtusifolia*	
27	Sdoav Prey	*Azadirachta indica*	
28	Porn Ta Ly	*Lophopetalum wightianum*	LC
29	Krasain Phnom	*Feroniella lucida*	
30	Cam Bork	*Irvingia malayana*	LC
31	Chheung Kor	*Bauhinia acuminata*	LC
32	Poror	*Schleicher oleosa*	
33	Rokar	*Bombax sp*	
34	រមាំង Romaing	*TristaniaC merguensis*	
35	Rumport Chrouk	*Goniothalamus repevensis*	
36	Slab Pang	*Pterospermum sp*	

Source: IESIA Report. SAWAC August 2020

Figure 38: Landfill Site Vegetation

Dumpsite in the southwestern corner of the landfill site

Pond at the existing dumpsite in the southwestern corner of the landfill. Probably former borrow pit

Stream in the northeastern corner of the landfill site

5.9.3. Fauna

228. The IESIA studies included interviews with local residents to identify wildlife species observed in the local area around the landfill site. During the interviews, a photo catalogue of likely species was used to help identify the species. It should be noted that the identification of species through this process is subject to considerable uncertainties and should not be understood as a scientific identification.

229. The wildlife species listed by local residents are presented in ***Table 20.*** The interviews identified one Vulnerable species, Fishing Cat (*Prionailurus viverrinus*), while all other listed species are classified as Least Concern. The Fishing Cat (*Prionailurus viverrinus*) is a medium-sized cat whose disjunct global range extends from eastern Pakistan through portions of India, Nepal and Sri Lanka, throughout Bangladesh and Mainland Southeast Asia to Sumatra and Java[16]. However, in 2015, the species was discovered at two sites in southwest Cambodia: Peam Krosaop Wildlife Sanctuary (Koh Kong Province) and Ream National Park (Sihanoukville Province)[17]. It would be quite remarkable if it is present in the

[16] https://wildcatsmagazine.nl/wild-cats/fishing-cat-prionailurus-viverrinus/

[17] https://wildcatconservation.org/tag/prionailurus-viverrinus/

local area surrounding the landfill site and the listing of the species should be taken with caution.

Table 20: Wildlife Species in subproject area

№	Khmer/Local Name	Scientific Name	English Name	IUCN
1	Chhlous	*Muntiacus muntjak*	Red Muntjac	LC
2	Scar Toch	*Herpestes javanicus*	Small Asiun Mongoose	LC
3	Sampoch Leuk	*Martes flavigula*	Yellow-throated Marten	LC
4	Sampoch Thnot	*Paradoxurus hermaphroditus*	Common palm Civet	LC
5	Kamprok Pour	*Callosciurus finlaysonii*	Variable Squirrel	LC
6	Kamprok Praphes	*Callosciurus caniceps*	Greu-bellied Squirrel	LC
7	Kamprok Kraharm	*Dremomys rufigenis*	Red-cheecked	LC
8	Kamprok Chhnot	*Callosciurus erythraeus*	Pallas's Squirrel	LC
9	Kamprok Rum Chheug	*Trogopterus pearsonii*	Hiry-footed Flying Squirrel	
10	Kamprok Thpal Kraharm	*Hylopetes spadiceus*	Red-cheecked Flying Squirrel	LC
11	Kanhen	*Menetes berdmorei*	Berddmore's Squirrel	LC
12	Kanheach	*Tamiops maritimus*	Eastern Striped Squirrel	LC
13	Kanheach Khmer	*Tamiops rodolphii*	Cambodian Striped Tree Squirrel	LC
14	Kantheuk	*Tupaia belangeri*	Northern Treeshew	LC
15	Tonsay Kuol	*Lepus peguensis*	Burmese Hare	LC
16	Chrouk Prey	*Sus scrofa*	Wild Pig (Wild Boar)	LC
17	Sva Kres	*Macaca fascicularis*	Long-tailed Macaque	LC
18	Khla Trei	*Prionailurus viverrinus*	Fishing Cat	VU
19	Pra Cheav	*(Order: CHIROPTERA)*	Bats	
20	Pra Chev Phnom	*Otonops wroughtoni*	wroughton's Free-tailed Bat	
21	Chhreug Ankam	*Cynopterus sphinx*	Lesser Short-nosed Fruit Bat	LC

Source: IESIA report, SAWAC August 2020

230. The fish species listed by local residents and identified at local markets by the IESIA survey are listed in ***Table 21***. The Table includes one Endangered species, Leaping barb, *Chela caeruleostigmata*. This species is found in the Mekong and Chao Phraya basins and it occurs at the surface of large rivers and flooded forests. It seems to move back into large rivers in March or April at the very end of the flood cycle. Its diet consists mostly of exogenous insects caught at the surface. Probably used to make fermented fish. Occasionally seen in the aquarium trade[18].

Table 21: Fish Species found in the Local Area

№	Khmer Name	English name	Scientific Name	Family Name	IUCN	from people	site survey
1	Trei Kachach Chras	Inridescent glassy perclet	*Parambassis apogonoides*	AMBASSIDAE	LC	✓	✓
2	Trey Kanchos Thmar	Asian bumblebee catfish	*Pseudomystus siamensis*	BAGRIDAE	LC	✓	
3	Trey Kanchchos Chhnot		*Mystus atrifasciatus*	BAGRIDAE	LC	✓	
4	Trey Chhlang		*Hemibagrus spilopterus*	BAGRIDAE	LC	✓	

[18] https://www.fishbase.se/summary/6102

№	Khmer Name	English name	Scientific Name	Family Name	IUCN	from people	site survey
5	Trey Krem Prey		*Betta prima*	BELONTIIDAE	LC	✓	
6	Trey Krem Tonsay	Talking gourami	*Trichopsis pumila*	BELONTIIDAE	LC	✓	✓
7	Trey Krem Kda	Croaking gourami	*Trichopsis vittata*	BELONTIIDAE	LC	✓	
8	Trey Ksan	Walking snakehead	*Channa orientalis*	CHANNIDAE		✓	
9	Trey Phtouk/ Rors	Common Snakehead	*Channa striata*	CHANNIDAE	LC	✓	✓
10	Trey Angdeng Reang	Walking catfish	*Clarias batrachus*	CLARIIDAE	LC	✓	
11	Trey Anfdeng Tone	Broad head catfish	*Clarias macrocephalus*	CLARIIDAE	NT	✓	
12	Trey Angdeng Sleuk	Blackskin catfish	*Clarias meladerma*	CLARIIDAE	LC	✓	
13	Trey Kahe	Puntius Altus	*Barbodes altus*	CYPRINIDAE		✓	
14	Trey Ronong Chhnot		*Onychostoma gerlachi*	CYPRINIDAE	NT	✓	
15	Trey Bandol Ampoa	Borneo river sprat	*Clupeoides borneensis*	CYPRINIDAE	LC	✓	✓
16	Trey Bandol Ampoa	Bangkok river sprat	*Corica laciniata*	CYPRINIDAE		✓	✓
17	Trey Krous Chhnot		*Crossocheilus siamensis*	CYPRINIDAE		✓	
18	Trey Srakakdam	Beardless barb	*Cyclocheilichthys apogon*	CYPRINIDAE	LC	✓	
19	Trey Srakakdam Sar	Mekong barb	*Cyclocheilichthys repasson*	CYPRINIDAE	LC	✓	✓
20	Trey Srakakdam Touch	Cyclocheilichthys Tapiensis	*Cyclocheilichthys lagleri*	CYPRINIDAE	LC	✓	✓
21	Trey Arch Kok		*Labiobarbus lineatus*	CYPRINIDAE		✓	✓
22	Trey Khnog Veng	Siamese long fin carp	*Labiobarbus siamensis*	CYPRINIDAE	LC	✓	
23	Trey Changvar	Danio Malabaricus	*Danio aequipinnatus*	CYPRINIDAE		✓	
24	Trey Changvar Stung	Leaping barb	*Chela caeruleostigmata*	CYPRINIDAE	EN	✓	✓
25	Trey Changvar Ronong	Loboheilus Nigrovittantus	*Lobocheilos melanotaenia*	CYPRINIDAE	LC	✓	
26	Trey Changvar	Red-line rasbora	*Rasbora pauciperforata*	CYPRINIDAE	LC	✓	
27	Trey Changvar Moul	Pale rasbora	*Rasbora aurotaenia*	CYPRINIDAE	LC	✓	✓
28	Trey Changvar Chhnot	Yellowtail rasbora	*Rasbora tornieri*	CYPRINIDAE	LC	✓	
29	Trey Changvar	Silver rasbora	*Rasbora myersi*	Cyprinidae		✓	
30	Trey Changvar Chhet	Slender rasbora	*Rasbora daniconius*	CYPRINIDAE	LC	✓	
31	Trey Changvar Chhnot	Lambchop rasbora	*Rasbora espei*	CYPRINIDAE	LC	✓	
32	Trey Changvar Phleang	Esomus Goddardi	*Esomus longimanus*	CYPRINIDAE		✓	✓
33	Trey Changvar Phleang	Striped flying bard	*Esomus metallicus*	CYPRINIDAE	LC	✓	✓
34	Trey Changvar Ronang		*Garra fasciacauda*	CYPRINIDAE	LC	✓	
35	Trey Thman Sar		*Hampala dispar*	CYPRINIDAE	LC	✓	
36	Trey Thman		*Hampala macrolepidota*	CYPRINIDAE	LC	✓	
37	Trey Thpean Meas		*Hypsibarbus wetmorei*	CYPRINIDAE	LC	✓	
38	Trey Kros Memay	Silver sharkminnow	*Osteochilus hasselti*	CYPRINIDAE	LC	✓	✓
39	Trey Chrakeng		*Puntioplites proctozysron*	CYPRINIDAE		✓	
40	Trey Ankort Prak	Swamp barb	*Puntius brevis*	CYPRINIDAE	LC	✓	

№	Khmer Name	English name	Scientific Name	Family Name	IUCN	from people	site survey
41	Trey Ampel Tom	Puntius Simus	*Puntius orphoides*	CYPRINIDAE		✓	
42	Trey Damrei	Marbled sleeper	*Oxyeleotris marmorata*	ELEOTRIDAE	LC	✓	
43	Trey Phtung Chhek		*Hyporhamphus limbatus*	HEMIRAMPHIDAE	LC	✓	
44	Trey Phtung	freshwater garfish	*Xenentodon cancila*	BELONIDAE	LC	✓	✓
45	Trey Chhloch Chhot	Peacock eel	*Macrognathus siamensis*	MASTACEMBELIDAE	LC	✓	
46	Trey Chhloch	Shortspine eel	*Macrognathus taeniagaster*	MASTACEMBELIDAE	LC	✓	
47	Trey Kantrap	Catopra	*Pristolepis fasciata*	NANDIDAE	LC	✓	✓
48	Trey Slat	Bronze featheback	*Notopterus notopterus*	NOTOPTERRUS	LC	✓	
49	Trey Kampleach Plok	Moon light gourami	*Trichogaster microlepis*	BELONTIIDAE		✓	
50	Antong Beung	Swamp eel	*Monopterus albus*	SYNBRANCHIDAE	LC	✓	

5.10. Socio-Economic Data

231. The population in the waste management service area covering 4 sangkats and nearby villages is summarized in ***Table 22***.

Table 22: Population in the Service Area (2019 Census)

District	Sangkat/Commune	Village	Population 2018/19
Kratie Municipality	Kracheh	All	6,404
	Krakor	All	4,078
	Ou Ruessei	All	12,749
	Roka Kandal	All	6,032
	Sub-total Kratie		**29,263**
Chetr Borei	Dar	Dar	1,235
		Anh Chanh	1,675
		Steung Svay	1,604
		Khsar	828
	Kou Leab	Samret	631
		Kou Leab	952
		Banteay	1,056
	Sub-total Chetr Borei		**7,981**
	Total		**37,244**

232. The population in the two nearest villages to the landfill site Khsar Village, Dar commune and Kantuot Village, Kantuot commune is summarized in ***Table 23***.

Table 23: Khsar and Kantuot Village Population

Village Name	Family	Total Population	Total Female
Khsar	193	839	442
Kantuot	353	1644	822

Source: Commune Data 2020

233. The IESIA survey team collected socioeconomic data representing the two communes and the villages closest to the landfill site. The results are presented in ***Table 24*** (land use) ***Table 25*** (occupation), ***Table 26*** (water use), ***Table 27*** (diseases), ***Table 28*** (health centres), and ***Table 29*** (education).

Table 24: Land Use in Dar and Kantuot Communes

Commune Name	Rice land (ha)	Farmland (ha)	Village land (ha)	Other (ha)
Dar commune	3255	850	2,100	6,295
Kantuot commune	940	2,930	820	120,310

Source: Commune Data Book 2020

Table 25: Main occupation in subproject area

Study village and commune	Official	NGS	Farmer	Worker	Business	Other	Total
Khsar village, Dar commune	4		16	11	4	1	36
Kantuot village, Kantuot commune	3	2	33	8	2	7	55
Total	**7**	**2**	**49**	**19**	**6**	**8**	**91**
%	**8%**	**2%**	**54%**	**21%**	**7%**	**8%**	**100%**

Source: Interviews with 91 households, IESIA, SAWAC 2020

Table 26: The Water use in Khsar and Kantuot village

Village and Commune	Interview Number	Water Use Sources				
		Digging well	Pumping well	Pond/Lake	Rainy	Local water supply
Khsar village, Dar commune	36	1	11	2	7	22
Kantuot, Kantuot commune	55	10	0	1	30	44
Total	**91**	**11**	**11**	**3**	**66**	**66**

Source: Interviews with 91 households, IESIA, SAWAC 2020

Table 27: Type of Diseases occur in subproject site

Village Name	Interview #	Fever	Diarrhea	Typhoid	Respiratory	Others
Dar Commune	36	14	3	13	2	6
Kantuot Commune	55	9	5	37	0	10
Total	**91**	**23**	**8**	**50**	**2**	**16**

Source: Interviews with 91 households, IESIA, SAWAC 2020

Table 28: Health Centre in subproject site

Commune Name	Health Post			Health Centre		
	Building	Room	Staff	Building	Room	Staff
Dar Commune	0	0	0	1	5	9
Kantuot Commune	0	0	0	1	3	8
Total	0	0	0	2	8	17

Table 29: Education data in subproject site

Commune	Primary School			Secondary School			High School		
	Room	Teacher	Student	Room	Teacher	Student	Room	Teacher	Student
Dar Commune	50	52	1393	16	19	249	0	0	0
Kantuot Commune	32	27	1375	7	9	306	9	10	313

Source: Commune data book 2020

5.11. The Old Dumpsite Environment

234. The location of the old dumpsite is displayed in ***Figure 4***. The dumping operations at the old dumpsite site started in 2006, but officially closed in 2015 in response to requests from communities to have the dumping operations moved to another place. However, the dumpsite continues to receive waste. The dumpsite has one lined cell with leachate drains, with a dimension of 120 m x 120 m x 10 m (length, width, depth), and a capacity of 144,000 m^3.[19]

235. The dumpsite is left open, without fence. The dumpsite is about 4.5 km from the runway of Kratie Airport which is still operational. There are buildings next to the dumpsite and housing structures along the access road. The closest water body is a wetlands 1.3 km southeast and small pond 0.3 km south of the site. A big buddha statue is located near to the dumpsite access road. Surrounding the site are agricultural land with shrub/grasslands and forested areas in between.

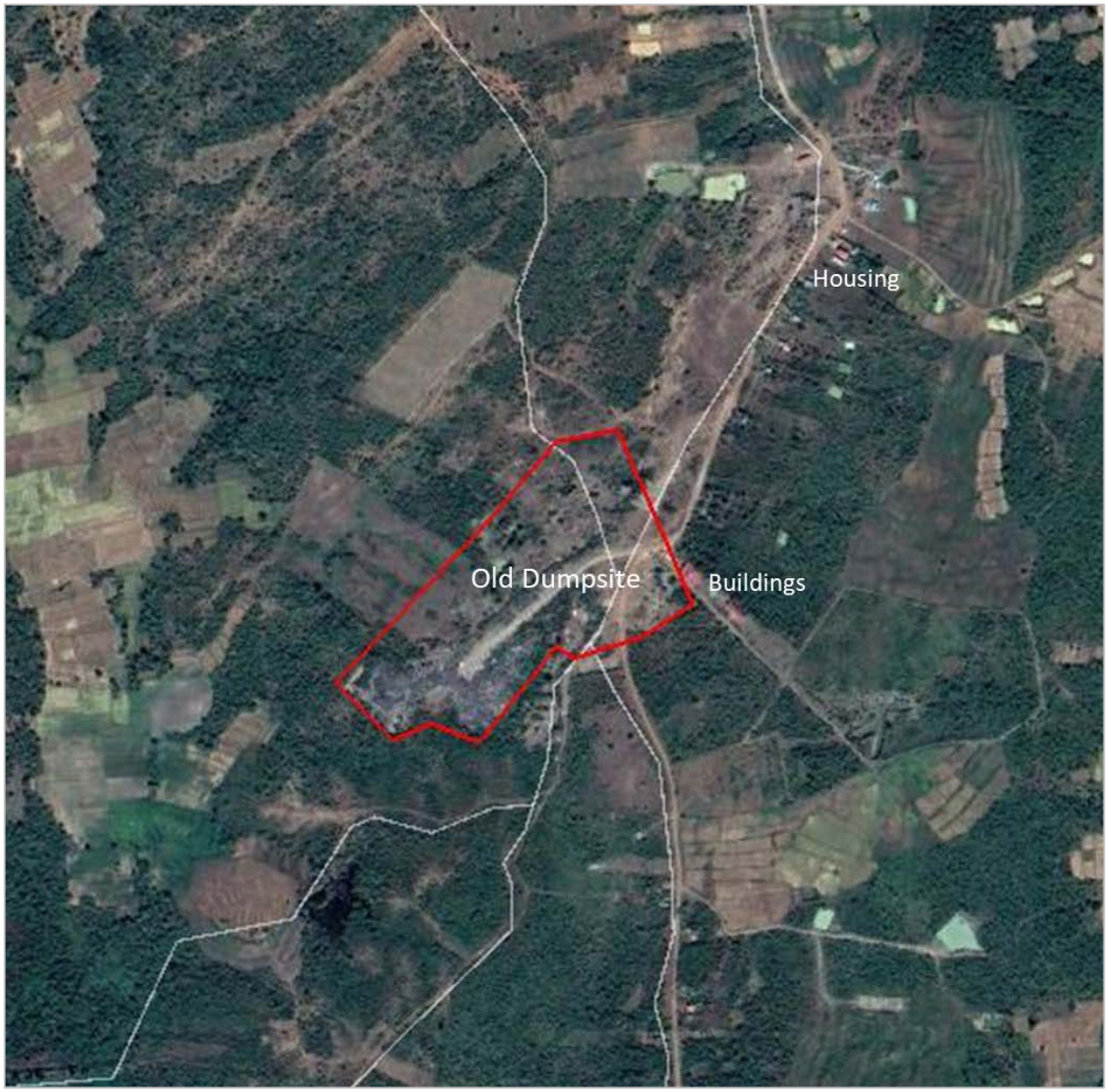
236. The composition of the waste disposed at the old dumpsite is unknown but based on various solid waste management studies in Cambodia, at the time of disposal, the waste is likely to have contained about 60% biodegradable components and the remaining 40% would include potentially recyclables and non-biodegradable waste. The biodegradable content has most likely already decomposed and only the most recent waste will still contain biodegradable components. There are no major industries or other generators of any significant amounts of hazardous waste in Kratie City, and the content of hazardous substances in the dumpsite waste is therefore likely rather limited and will mainly include the types and amounts commonly found in waste from small-businesses and households in low-income areas. The possible content of infectious waste from health care facilities is unknown but cannot be ruled out. However, as pathogenic micro-organisms have a limited capacity of survival in the environment, these organisms are unlikely to have survived in waste that is older than 1-2 months[20].

237. ***Figure 39*** is a satellite image of the old dumpsite from November 2018. The demarcation on the image is only indicative and is not intended to show the boundary of the future clean-up and closure.

[19] IEE, May 2018, CAM: Fourth Greater Mekong Subregion Corridor Towns Development Project Stung Treng Subproject Kratie Subproject Kampong Cham Subproject, Ministry of Public Works and Transport

[20] ICRC 2011, Medical Waste Management, International Committee of the Red Cross, November 2011

Figure 39: Satellite Image of the Old Dumpsite, November 2018



238. The old dumpsite is located on slightly higher ground (elevation about 38 m asl. to 40 m asl. sloping toward the south) than the surrounding area. This is also visible from the pictures in ***Figure 40***.

239. The pictures in ***Figure 40*** indicate that the site is not managed and operated properly. There is open burning and waste is not covered with soil. It appears that waste is being pushed downslope.

Figure 40: Pictures of the Old Dumpsite, October 2020

Shrine on the road towards the old dumpsite

240. A number of waste pickers operate at the old dumpsite as seen on the pictures in ***Figure 41***[21].

The proximity of the old dumpsite to Key Biodiversity Areas (KBI) and National Protected Areas, Ramsar Sites etc. has been analysed using the Integrated Biodiversity Assessment Tool (IBAT). The IBAT Proximity Report (attached in ***Annex 8***) shows that the nearest Key Biodiversity Area is the Mekong River Kratie to Lao Border Key Biodiversity Area about 7.5 km to the west, and beyond this site is the Prek Prasab Protected Area about 17 km to the northwest. Based on the IBAT proximity assessment it can be concluded that the old dumpsite is not located within any legally protected area or area that is internationally recognized for biodiversity.

[21] IEE, May 2018, CAM: Fourth Greater Mekong Subregion Corridor Towns Development Project Stung Treng Subproject Kratie Subproject Kampong Cham Subproject, Ministry of Public Works and Transport

Figure 41: Waste Pickers at the Old Dumpsite (2018)

Source: IEE, May 2018, CAM: Fourth Greater Mekong Subregion Corridor Towns Development Project Stung Treng Subproject Kratie Subproject Kampong Cham Subproject, Ministry of Public Works and Transport

6. ANTICIPATED IMPACTS AND MITIGATION MEASURES

6.1. Project Environmental Benefits

241. The project is anticipated to have significant localized environmental benefits. Field visits showed that the existing and the old dumpsites are not properly managed and not provided with any environmental controls. The dumpsites pose significant risks to the surrounding environment and residents in terms of infiltration to groundwater and runoff of polluted leachate, air pollution from open burning, odour nuisances and risk of infectious diseases from vectors. The growing urbanization of the project area means that this situation is only going to get worse unless adequate landfill infrastructure and operations are put in place.

242. The development of well-designed waste management facilities, with components dedicated to preventing leachate migration to soil, groundwater and surface water, separation of hazardous waste, collection of landfill gas, etc. and the proper maintenance and operation of those facilities will ensure that the risk of impacts on human health or the environment will be prevented or minimized.

243. The Materials Recovery Facility to be constructed at the new landfill will provide safe and healthy working conditions with proper sanitary facilities for the waste pickers while improving the efficiency of waste recycling and increasing the amount of waste being recycled.

6.2. Environmental Impact Assessment Screening

244. The potential environmental impacts have been screened based on the following factors:

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

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

(iii) "**Magnitude**": the size, scale or intensity and spatial extent 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).

245. 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.

246. ***Table 30*** summarizes the anticipated impacts during construction and operation of the landfill. These impacts are further described in ***Sections 6.3, 6.4, and 6.6***.

Table 30: Screening of Impacts for Kratie 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	▪ Or Kantuot Stream ▪ Groundwater ▪ 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 ▪ 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
Odours and Dust	▪ Landfill operations / open cells ▪ Dust from movement of vehicles	▪ Workers ▪ Communities

Impact	Source	Receptors
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. Impacts Associated with Project Location, Planning and Design

247. The purpose of carrying out environmental and social impact assessment is to predict likely significant environmental or social risks and impacts and to ensure that appropriate mitigation measures are planned and designed as part of the project development and ultimately implemented as integral parts of project construction and operation. Ideally, this will prevent harm to people and the environment, reduce the risk of delays and cost overruns and, in addition, for environmental infrastructure projects such as this Subproject, improve the local environment and facilitate socioeconomic progress for the involved communities.

248. To ensure that the impact assessment is constructive and effective and that it will lead to the desired outcomes, the following measures have been developed and will be initiated prior to start of construction:

a) **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)[22]; and (c) contracting of international and national Project Management Consultant for Environmental Safeguards (PMC- I/NES). Prior to the start of construction, an environmental capacity building and training program will be delivered by the PIC. 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 the contractors.

b) **Grievance Redress Mechanism**. The GRM is designed to receive, evaluate and facilitate the resolution of residents' concerns, complaints and grievances during the subproject implementation. The Grievance Redress Committee (GRC) covering the Subproject was established on 31 January 2019 and is fully operational. 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 coordinating 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.

c) **Disclosure and Consultation**: Information disclosure and consultation activities will be continued with potentially affected people and other interested stakeholders. This will include (but is not limited to) dissemination and consultations on the project

[22] CAM: Fourth Greater Mekong Subregion Corridor Towns Development Project will fund a full-time ESO position within PMU that can also support this project and TS1 during implementation.

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

d) **Unexploded ordinance**. The EA/IU/PIU will coordinate with the Cambodia Mine Action Centre to undertake UXO clearance in the project area of influence prior to civil works, as deemed necessary. UXO clearance will include surveys and explosive detection, removal, transport and destruction in accordance with the national regulations. During this process warning signs will be erected to warn households and communities. The UXO clearance certificate will be provided to ADB prior to construction.

e) **EMP in bidding documents**. The EMP related to this IEE will be incorporated in the bid documents and construction contracts to provide basis for the Contractor to develop the CEMP.

f) **The Contractor's Environmental Management Plan (CEMP).** The Contractor shall prepare the CEMP in alignment with the approved IEE and EMP and submit it to the PMU for approval before starting construction. The CEMP shall include subplans that address the following:

- Materials, Spoil and Borrow Site Management
- Solid and liquid waste management
- Air emissions management and monitoring
- Noise and vibrations management and monitoring
- Hazardous materials management
- Management of incoming solid waste
- Relocation of existing waste and clean-up of the existing waste dump
- Erosion and sediment control
- Surface water and groundwater monitoring
- Community and Occupational Health and Safety
- Emergency Preparedness and Response
- Traffic Management
- Labour Camp Management
- COVID-19 health and safety subplan in accordance with national COVID-19 instructions and regulations.

g) **Inventory of trees**. Prior to start construction works, the Contractor will be required to register all trees 3 m or higher in the Subproject sites (landfill site, access road, construction camp site, and borrow sites) that have to be removed, and seek approval from the PMU and the local authorities. The results shall be integrated into the CEMP. This is to ensure that:

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

h) **Borrow sites.** The construction of the landfill requires import of soil and clay materials. The Contractor will be required to include a borrow sites management plan in the CEMP.

i) **Site Selection**. Assessment of impacts associated with the proposed location of the landfill site using selection criteria from Cambodian regulations and international guidelines (see ***Section 6.3.1***).

(i) **Environmental compliance audit**. Audit of existing dumpsites to inform detailed design of dumpsite closure. See ***Annex 3*** for Terms of Reference for the audit. The results of the audit have been incorporated into this IEE.

6.3.1. Landfill Siting

249. The location of the landfill and proximity to sensitive receptors (see also ***Section 5.1.2***) compared with the landfill siting guidelines is presented in ***Table 31***.

Table 31: Location of the Landfill compared with Siting Criteria

Landfill Siting Guidelines (2016)		Landfill Location
Minimum distances to Receptors	1 km from any residential property	- 2 km to residential area
	3 km from any school/health centre/natural resources/ water source	- 1.7 km to the nearest school - A small temporary stream that connects to Or Kantuot Stream crosses over the buffer zone in the north-eastern corner of the site. - Or Kantuot Stream flows 2 km to a 16 ha irrigation reservoir
	5 km from any place of worship and resort	- 2.5 km to nearest pagoda
	8 km from an airport	- 15 km to the airport
	10 km from town centre	- 15 km to the city
	15 km from any heritage site	- No heritage site within a 20 km radius - Mondulkiri - Kratie Lowlands Key Biodiversity Area located about 11 km to the east - the Mekong River Kratie to Lao Border Key Biodiversity Area about 15 km to the west
Hydrology	Not in a flood prone area	- the landfill is not located in a flood prone area
	Depth to groundwater from the bottom of the cell > 3 m	- groundwater is at least 5 m below ground and the bottom of the cells will be at or close to ground level

250. As indicated in ***Table 31***, some of the minimum distance guidelines are not fully met (school, water body), however, as noted in ***Para 63***, the siting of project components (in this case the controlled landfill) is considered and approved through the IESIA review and approval process. In terms of proximity to water bodies, it should be taken into account that the design and operation of the landfill incorporate precautionary measures ensuring practically zero discharge of leachate. The nearest school (1.7 km from the site) is located on a dirt road that will not be used by the neither the contractor nor by subproject related traffic during operations.

251. The proximity to Protected Area and Key Biodiversity Area has been assessed using the IBAT tool (***Para 226)***. Based on the IBAT proximity assessment it can be concluded that the landfill site is not located within any legally protected area or area that is internationally recognized for biodiversity. Furthermore, as the nearest Key Biodiversity Area is 11 km from the landfill site, there is no direct disturbance of biodiversity in this area, and the construction and operation of the landfill will not cause nor contribute to any increase in illegal wildlife hunting, harvesting of biological resources or encroachment in these areas.

6.4. Environmental Impact and Mitigation Measures During Construction

6.4.1. Air Quality

252. Minor to moderate temporary and localized air quality impacts are anticipated during the construction stage of the subproject. The main sources of lower air quality include:

a) Engine exhaust emissions from construction machinery and equipment, haulage trucks will lead to minor increases in levels of nitrogen oxides (NOx) and sulphur oxides (SOx).

b) Fugitive dust from earthworks, loading and unloading of soil at the landfill site and at borrow pits;

c) Fugitive dust, bioaerosols and odour from excavating and moving waste from the existing dumpsite to the new landfill cell.

d) Fugitive dust, bioaerosols and odour from managing incoming waste.

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

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

b) Concrete batching facilities will be located at least 500 m (0.5 km) downwind from the nearest dwellings in order to reduce the impact of dust and fumes on humans and to be fitted with necessary equipment such as bag house filters to reduce fugitive dust emissions.

c) Water will be regularly sprayed to suppress fugitive dust at construction sites, material handling areas, access road and borrow pits.

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

e) Construction vehicles and machinery will be maintained to a high standard to minimize emissions and ensure compliance with the National exhaust emission standards. All mobile equipment should be fitted with catalytic converters.

f) A speed limit of 30 km/h for construction related traffic through inhabited areas and on the access road will be enforced.

g) Unauthorized burning of waste or other materials will be prohibited.

h) The air quality will be monitored at the landfill site and at receptors. Actions will be taken in case of complaints or non-compliance.

6.4.2. Noise

Construction work at the landfill site and movement of trucks to and from the site will generate noise. The impacts will be temporary (daytime only) and localized. The noise impacts will mainly be a concern for construction workers and residents near the access road. Potential impacts from noise will be mitigated through the following measures:

a) Maintain all exhaust systems in good working order and undertake regular equipment maintenance to ensure compliance with applicable regulations and manufacturers' instructions.

b) Restrict construction activities using heavy machinery work between 8 am and 6 pm.

c) Ensure that noise control options such as silencers and mufflers are fitted to exhausts, compressors and fans for construction equipment (such as hydraulic excavator, bulldozer, front loader, backhoe and trucks).

d) Provide advance warning to the community on timing of noisy activities. Seek suggestions from community members to reduce noise annoyance and notify the communities about how to raise their concerns (if any) through the Grievance Redress Mechanism.

e) Undertake noise monitoring at the closest residential area and other noise sensitive receptor during times with ongoing construction work to ensure compliance with the relevant noise standards.

f) The contractor shall provide all construction personnel working in the vicinity of noisy construction activities (defined as those activities generating noise levels greater than 80 dB(A)), or any construction personnel who requests hearing protection, with hearing protection equipment.

g) A speed limit of 30 km/h for construction related traffic through inhabited areas and on the access road will be enforced.

6.4.3. Flora and Fauna

254. The landfill site is already a disturbed area with waste dumped at the southwestern corner of the site and the part of the site that will be cleared for vegetation is covered with secondary shrub and small trees. The impacts on flora and fauna are therefore considered negligible with the implementation of the following mitigation measures:

a) Based on the inventory of trees and the permission obtained from the PMU and local authorities to remove trees (see ***Para 248***), to the extent practicable, avoid removing big trees or vegetation of conservation value at the construction site. In addition, trees (native species) will be planted on the landfill site as vegetation screen (see ***Para 190***).

b) 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, the PMU and Kratie PDoE to ensure that sensitive habitats are avoided and that an appropriate restoration plan (recontouring and replanting with native species).

c) Set out the area to be cleared for vegetation and restrict land clearance to only the land required for the landfill components.

d) Provide awareness to construction staffs and follow up strictly monitoring on forest and wildlife resources management. The cutting of timber, and hunting or fishing and trading in wildlife will be prohibited.

e) Burning to clear and control vegetation will be prohibited.

f) The use of herbicides to control vegetation will be prohibited.

g) For impacts on aquatic resources and mitigation, see ***Section 6.4.4.***

6.4.4. Surface Water

255. The construction work will take place about 150 m from the small temporary stream that crosses the north-eastern corner of the site and about 500 m from Or Kantuot Stream. Impacts on surface water are likely to be temporary and localized and are not likely to pose any significant risk to the water quality of Or Kantuot Stream. However, mitigation measures toward the following potential impacts are considered relevant:

a) Uncontrolled vegetation clearance in the buffer zone causing sediment-laden runoff during rain events to discharge into the small stream and then on to Or Kantuot Stream.

b) Uncontrolled drainage of polluted runoff from the construction area.

c) Uncontrolled discharge of untreated sanitary wastewater.

d) Spills or leaks of fuel or oil from fuel tanks and oil drums, and from refuelling or maintenance of construction equipment.

256. The following mitigation measures will effectively mitigate potential impacts on surface water:

a) Installation of temporary non-erodible ditches or bunds at the construction site to divert clean runoff away from exposed areas and convey potentially dirty runoff to sediment control devises.
b) Stockpiles and materials will be stored at least 50 m from surface waters with drainage directed away from the canals or drainage channels and streams or water sources.
c) No washing or repair of machinery within 50 m of surface waters.
d) Topsoil present on the construction site will be removed and stockpiled in labelled areas for later use in rehabilitation of the construction site.
e) Construction working areas will be clearly demarcated and encroachment onto adjacent areas avoided.
f) Portable toilets and small wastewater treatment units will be provided at the construction site and labour camps. All sanitary facilities will be located at least 50 m from surface water bodies. All workers must be instructed to use these facilities, which shall be kept clean at all times.
g) Pit latrines and septic tanks should be placed at least 2 m above the groundwater table must be located at least 50 m from surface water bodies and water wells and in areas of suitable soil profiles.
h) All hazardous materials including hazardous waste will be stored on an impervious surface, under cover, in adequate tanks or containers and within secondary containment. A bund will be provided around any above ground fuel storage tank with capacity of 110% of the largest single tank. Storage of chemicals or hydrocarbon products shall be at least 50 m from surface water bodies with no direct drainage to surface water.
i) Areas where spills of fuel or oil may occur will be equipped with easily accessible spill control kits to assist in prompt and effective spill control.
j) Refuelling of machineries by service vehicles will be conducted with measures preventing oil spillage during refuelling including placement of buckets under refuelling nozzles.
k) Stationary equipment such as motors, pumps, generators will be positioned over drip pans.
l) Portable toilets and small wastewater treatment units will be provided on construction sites and construction camps for the workers and canteens. All sanitary facilities will be located at least 50 m from surface water bodies.
m) Runoff accumulating at the bottom of excavation pits during construction will be pumped out, reused where practicable or otherwise conveyed to appropriate sediment retention devises before being discharged to the environment.
n) Hazardous waste (e.g. oil waste) shall be properly collected and stored in closed containers under shelter (as required under item (h) above) for recycling or disposal by a duly authorizes enterprise.

6.4.5. Groundwater

257. The groundwater resources under the landfill site are well-protected by a minimum 5 m thick layer of compact sandstone with low permeability (see ***Para 207***). The deepest excavations (for the leachate treatment ponds) will not reach the groundwater table and there is therefore no risk that the construction activities will involve direct contact with the groundwater.

258. Protection of the groundwater from any residual pollution risk will be mitigated by the measures that will be applied for protection of surface water (***Para 256***).

6.4.6. Soil Erosion

259. Soil erosion is not anticipated at the landfill itself given the design of the landfill and the local geology. The risk of soil erosion at borrow pits is addressed in ***Section 6.4.8***.

6.4.7. Solid Waste Management

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

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

a) Preparation of a Waste Management Plan as part of the CEMP before construction which applies the waste hierarchy to ensure efficient use and management of resources with a priority to prevent waste at source followed by recycling, and with disposal as the last resort.
b) Recyclables will be separated at source and given/sold to recycler (plastic, metal, card, paper as a minimum).
c) Safe temporary storage of hazardous waste (see ***Para 256***). To the extent possible, a duly authorized waste company will be contracted to recycle hazardous waste. Any remaining hazardous waste will be disposed in the Hazardous Waste Cell once completed.
d) Non-hazardous, non-recyclable solid waste will be temporarily deposited and managed together with the incoming domestic waste (see ***Section 6.5.3***) and relocated to Cell 1 once the cell is ready to receive waste.
e) There will be no burning of waste at the site.
f) All vehicles/drivers will be provided with plastic bags for waste collection and prevent any unauthorized waste disposal with particular attention paid to prevention of littering.
g) The Contractor will be required to train the workers in proper waste management.

6.4.8. Borrow Pits and Spoil Disposal

262. The contractor shall propose borrow pits and spoil disposal sites in the CEMP. Where possible existing borrow pits or spoil disposal sites shall be used. If new sites are needed, the contractor shall obtain approval from the relevant authorities and from PMU/PMC to ensure compliance with the site selection criteria (see ***Table 32***), and that appropriate mitigation and rehabilitation measures will be implemented.

263. ***Table 32*** contains key selection criteria which the contractor shall apply for the proposed sites and present the results in the CEMP. The proposed sites shall be clearly marked on topographic maps and site layout drawings in the CEMP and provided with information about the amounts and types of materials to be excavated or disposed.

Table 32: Borrow Pit and Spoil Disposal Site Selection Criteria

Site Selection Criteria	Proposed Site Conditions
Preferably on degraded or lower value land such as grasslands, land devoid of forest or with highly degraded forest cover, or land with poor soil quality	
Not in ecological sensitive area (e.g. Protected Area or Key Biodiversity Area or on land that hosts Threatened (IUCN Red List) plant or animal species	
Not in wetlands, waterways or in riparian zones	
Not in agricultural productive land	
Not in land with spiritual, cultural, historical or archaeological value	
On lower slope land, so that stable landforms can be created. If possible, land with a slope more than 10% shall generally not be used for spoil disposal, where possible	
Not on unstable slopes, where the added weight could trigger mass movement	
Not where groundwater emerges, or a thick organic layer is present	
Above the 0.05 (5%) Annual Exceedance Probability flood line	
Backfilling of excavation voids (for spoil disposal)	

264. The contractor is required to implement the following mitigation measures with respect to handling/excavation of borrow materials and disposal of spoils:

a) obtain and document agreement with the landowner;
b) ensure minimisation of vegetation and habitat loss and limit land clearance to only the land required for the borrow pit / spoil disposal;
c) Set out the site boundaries and ensure that the surrounding land is not disturbed;
d) prohibit the use of burning to clear and control vegetation;
e) ensure that spoil is disposed of only at the designated disposal sites and that no material is side tipped along roads or down slopes, dumped on private or public land, or dumped in water bodies;
f) ensure that all necessary disposal site preparation activities are completed prior to the start of the related spoil generation, handling and disposal;
g) The contractor shall install erosion and sediment controls such as sedimentation ponds, non-erodible channels or bunds at each site and progressively adjust the measures as the landform changes, to minimise on-site erosion and prevent off-site sedimentation;
h) ensure that only inert waste is disposed of at spoil disposal sites;
i) ensure that roots and stumps and other vegetation debris are separated from the spoil materials prior to disposal and either mulched on-site for reuse in landscaping or ground stabilization works, left to decompose naturally, or otherwise safely disposed;
j) conduct routine inspections, not less frequently than once a week, of water pollution, erosion and sediment control measures, and promptly undertake necessary maintenance, repair and upgrading works to ensure that the design capacity is maintained;
k) undertake inspections within 24 hours of a heavy rainfall event;

l) undertake progressive rehabilitation of disturbed areas taking into consideration what the final land use will be;

m) conserve topsoil for later site rehabilitation;

n) recontour the sites, fill depressions and revegetate the sites to create a final surface that is consistent with the original topography of the area;

o) design the final landforms and slopes to protect groundwater quality, to prevent surface water ponding, to facilitate revegetation, to convey runoff in a non-erosive manner, and to account for long term settlement;

p) revegetate the sites in such a way as to establish a diverse, effective, and long-lasting vegetative cover that is capable of self-regeneration without continued dependence on irrigation, soil amendments or fertilizer, and is at least equal in extent of cover to the natural vegetation of the surrounding area;

q) use appropriate native and non-invasive plant species for re-vegetation and rehabilitation work.

6.4.9. Community and Occupational Health and Safety

265. Health and safety risks for the communities associated with air, water, noise and odour emissions from the construction work are addressed under the relevant headings in this chapter. The other main community health and safety risks include:

a) Risk of traffic accidents due to increased heavy traffic in populated areas;

b) Risk of transmission of the SARS-CoV-2 virus due to influx of workers;

c) Transmission of sexually transmitted infectious diseases due to influx of workers and location of labour camps close to communities.

266. The key community health and safety measures include:

a) Prior to start of construction work, the contractor in cooperation with the PIU will consult with the local authorities and potentially affected residents. Inform them about the upcoming construction work, safety precautions and how to raise concerns or file complaints (GRM);

b) The contractor shall fence off the landfill construction area and control access to the site.

c) A speed limit of 30 km/h for construction related traffic through inhabited areas and on the access road will be enforced.

d) The contractor shall install traffic signage and fluorescent bollards and warning lights to direct traffic and prevent vehicles driving into the lanes with construction activities.

e) The contractor in cooperation with the local authorities shall implement traffic management to ensure a smooth traffic and prevent congestion.

f) The contractor in cooperation with the PIU and the local authorities shall enforce speed limits for construction related traffic to max 30 km/hour within populated areas.

g) Mitigation measures towards the risk of SARS-CoV-2 transmission and transmission of sexually transmitted diseases are included under ***Section 6.4.12***.

6.4.10. Socio-Economic Impacts

267. Socio-economic impacts related to the Subproject are limited to potential impacts on the livelihood of informal recyclers operating at the existing dumpsite and the old dumpsite – both of which will be closed as part of the Subproject. Compensation and livelihood restoration measures will be set out in the relevant social safeguard documents (detailed resettlement plan, income restoration plan) following consultations with the informal recyclers to be carried out by the General Department of Resettlement with assistance from the Project's social safeguards specialist prior to start of construction work. The general livelihood options for consideration include one or a combination of the following measures (more options may be developed in the course of preparing the social safeguard documents):

- Continue recovering waste at the new landfill
- Opportunity to work for the landfill contractor during the construction phase
- Opportunity to work at the Materials Recovery Facility during the landfill operation
- Opportunity to be involved in livelihood improvement programmes
- Provide compensation.

268. It is anticipated that the informal recyclers at the old dumpsite will be allowed to continue recovering recyclables until the dumpsite remediation and closure activities kick-off. When the closure work starts, they will lose the site as a source of income. In the meantime, they will be provided with appropriate PPE and given training on health and safety to ensure safe working conditions.

269. At this stage, it is planned, that the informal recyclers operating at the existing dumpsite will be allowed to collect recyclables from the dumpsite until the waste relocation work starts. During the relocation of waste, they will not be allowed to work at the dumpsite but will be allowed to recover recyclables at the new landfill cell 1 under strict safety rules (elaborated in the EMP). These recyclers will also be provided with appropriate PPE and be instructed in health and safety measures.

6.4.11. Occupational Health and Safety

270. The main occupational health and safety risks include:

a) Infection with diseases from vectors or from contact with waste;
b) Accidents due to movement of trucks and other construction equipment;
c) Working in excavations (leachate treatment ponds);
d) Injury from sharp objects in the waste;
e) Odour emissions from existing and incoming waste;
f) Noise and dust emissions from construction activities.

271. To mitigate the Occupational Health and Safety Risks, the Contractor will be required to:

a) prepare a health and safety plan containing site-specific precautions in accordance with relevant occupational health and safety guidelines[23];

[23] For example, guidelines issued by the US Department of Labour, Occupational Safety and Health Administration, https://www.osha.gov/ or the US National Institute for Occupational Safety and Health, https://www.cdc.gov/niosh/index.htm

b) inspect and check the relevant construction equipment to ensure that it meets the applicable mechanical and safety requirements;
c) inspect the worksite to ensure that the equipment can be safely mobilized and operated, and that there are no unmitigated risks;
d) install appropriate fencing and control access to the site;
e) install appropriate safety signage and markings;
a) provide fall protection when workers are exposed to unguarded platforms or walkways higher than 2 m;
b) ensure there are safe ways to enter and exit the excavation;
c) keep excavations dry;
d) provide safety precautions when using high voltage electric power tools;
e) carry out daily toolbox meetings (safety briefings);
f) maintain an accident record book where all major or minor accidents and incidents are recorded with actions taken;
g) educate the workers on construction hazards;
h) train drivers on safe driving skills;
i) appoint an Environment, Health and Safety Officer who is a qualified engineer;
j) make adequate first aid equipment available on site;
k) carry out training and awareness of the workers on HIV-AIDS prevention;
l) implement emergency preparedness and response procedures (to be incorporated in the CEMP).

272. All workers and visitors to the worksites will be provided with and shall wear the relevant Personal Protective Equipment. Standard mandatory PPE includes:

a) hard hat
b) high visibility clothing in yellow or orange material with reflective panels
c) safety shoos with metal toe cap

Work specific PPE includes:

a) Cut-resistant work gloves.
b) Ear protection (earplugs or muffs) wherever it is not feasible to reduce the noise levels or duration of exposures to those specified in internationally recognized guidelines[24].
c) Safety glasses (waste handling, crushing/grinding, cutting).
d) Welding hoods with clear safety glasses under (welding).

6.4.12. Labour Camp Impacts

273. Labour camps can impact on the environment and the local communities if not adequately managed and located. This will include impacts from latrines, waste and health and safety risks for the local communities.

274. The contractor will prepare and implement a Camp management plan (the plan shall be included in the CEMP) which shall include at least:

a) Map showing camp lay out, adequate accommodation and sanitation for male and female workers.

[24] Occupational Noise Exposure Revised Criteria 1998, Centers for Disease Control and Prevention, https://www.cdc.gov/niosh/topics/noise/reducenoiseexposure/regsguidance.html

b) Sanitation commodities: toilets, showers (minimum 1 per 15 pax), waste storage areas and adequate containers.
c) Health and safety equipment, including firefighting equipment.
d) Labour recruitment procedures with priority to local labour.
e) Rehabilitation plan for how the camp site will be restored to its original condition after the construction work has been completed.
f) Contractor camps will be located away from residential areas, schools and other populated areas. The camps will be fenced, and access will be controlled.

275. The risk of transmission of the SARS-CoV-2 virus will be prevented or minimised by implementation of the relevant measures instructed by the Royal Government of Cambodia, General Department of Labour as well as any updated guidelines of the WHO or ADB. The key measures include:

a) Conduct risk communication, training, and education for the contractor and the workers on the relevant infection prevention and control practices.
b) Adopt engineering, organizational and administrative measures, plan work so employees can keep distance from each other and minimise contact.
c) Provide Personal Protective Equipment (facemask) and inform workers of its correct use.
d) Provide clear and visible guidelines on how to prevent infection at the construction site and initiatives taken.
e) Regularly clean and disinfect toilet and bathrooms.
f) Promote personal hygiene (including hand and respiratory hygiene), make wash basins and sanitizers available.
g) Screen on entry the temperature of each person entering the work site and record their contact details to facilitate tracking of infected persons should there be a need.
h) Health surveillance and insurance.
i) Review and update preventive and control measures as the situation evolves.
j) Individuals who have been potentially exposed to the virus, or who are exhibiting flu-like symptoms shall immediately to inform their supervisor, stay at home and self-isolate; and contact local health authorities for further direction. Such individuals may not return to work until the proper health authorities have lifted the self-isolation;
k) All areas on site potentially infected by a confirmed or probable case will be barricaded to keep individuals two meters away until the area has been properly disinfected.

6.5. Closure of the Dumpsites

6.5.1. Incorporation of Environmental Compliance Audit Findings

276. The two dumpsites are considered existing facilities under the wider CTDP4 Project and as such an Environmental Compliance Audit (ECA) is required for the dumpsites. An ECA for the two dumpsites has been prepared and is attached in ***Annex 10***. The results of the ECA have been incorporated in relevant sections of the IEE. In accordance with the Terms of Reference for the ECA attached in ***Annex 3***, the ECA has two phases, where phase 1 is an initial assessment of the risks, possible solutions and the need for immediate mitigation measures at the dumpsite to minimise any on-going pollution and risks to human health and the environment as much as practical until the long-term solution can be implemented. Phase 2 is an optional phase in case a permanent solution has not been found under the first phase. Phase 2 will then include more detailed site investigations and analyses as may be necessary to make a decision on the long-term solution and to provide information for the preparation of the detailed remediation design.

277. For the existing dumpsite at the new landfill site, the findings of phase 1 were sufficient to determine the closure method.

278. In terms of the old dumpsite, there are still significant gaps and uncertainties in the information, which as discussed in following sections will require additional investigations before a permanent solution can be developed.

6.5.2. Impacts and Closure Objectives

279. Both the old dumpsite and the existing dumpsite have originally been approved by Kratie Provincial Authorities for daily operation. However, the actual implementation and operation of the dumpsites are not consistent with the relevant regulations and guidelines (lack of daily management, lack of leachate control, lack of waste compaction and daily cover, indiscriminate dumping and spreading of waste, lack of fire control, lack of access control, no fencing).

280. The type of potential impacts caused by the old dumpsite and the existing dumpsite are similar and mainly affect the surrounding environment, informal recyclers collecting and sorting waste at the sites and any nearby residents or productive use of adjacent land. However, the impacts of the old dumpsite are more significant than the impacts from the existing dumpsite due to much larger amounts of waste and proximity to residents.

281. The key impacts associated with both dumpsites are summarized below:

a) generation and discharge of leachate affecting surface water and possibly groundwater;
b) contamination of land with decomposing waste and chemicals;
c) air pollution including with toxic substances such as Persistent Organic Pollutants from open burning of waste;
d) spread of infectious diseases by vectors.

282. The objectives of closing and remediating the dumpsites include to:

- minimise the risk that leachate from the waste dump may infiltrate groundwater resources that are or may in the future be used as a source of drinking water;
- minimise the risk of contamination of nearby waterways;
- minimise the risk to public health from spread of infections;
- eliminate the generation of harmful air emissions from open burning of waste;
- control migration of landfill gasses;
- eliminate generation and odour and windblown waste;
- create an area that can be safely used for predetermined purposes;
- improve the livelihoods and living conditions of informal recyclers.

6.5.3. Closure of the Existing Dumpsite

283. The options[25] considered for the closure of the existing dumpsite included:

a) In-place closure by capping the waste,
b) Closure by upgrading into a controlled engineered landfill, or
c) Closure by removing the waste from the dump and disposing it at the new landfill.

[25] A Roadmap for closing Waste Dumpsites, The World's most Polluted Places, ISWA, 2016, https://www.iswa.org/fileadmin/galleries/About%20ISWA/ISWA_Roadmap_Report.pdf

284. It is recommended to implement option c) *closure by removing the waste from the dump and disposing it at the new landfill* on the following grounds:

a) Option b) is irrelevant;
b) The amount of waste (the existing waste is estimated to 7,344 tonnes and a similar amount of incoming waste will be added during the construction of cell 1) is relatively small, and it can easily be accommodated in the new landfill cell;
c) Option c) provides the best environmental protection;
d) Option c) is the least costly[26];
e) Option c) ensures that the dumpsite area can be used for other purposes.

285. The closure and remediation measures for the existing dumpsite include to remove the existing waste including any later incoming waste and deposit it in the newly constructed waste cell 1 as soon as it is ready to receive waste.

286. Temporary measures will be implemented in preparation for the relocation of the waste and to mitigate any ongoing environmental impacts:

a) the dumpsite area will be fenced off;
b) any existing fires will be extinguished;
c) the vegetation will be cleared and removed without mixing it with waste;
d) water in the small pond will be tested and then reused for dust suppression or treated, if necessary, before being discharged to the environment;
e) the existing waste will be bulldozed into low waste cells, increasing compaction and waste density, and covered with soil to minimise nuisances;
f) narrow trenches may be excavated to determine the depth of the waste deposits;
g) incoming waste will be deposited and compacted into waste cells adjacent to existing waste and covered with soil;
h) if necessary, ditches and bunds will be constructed to control leachate and manage surface runoff;
i) if necessary, leachate will be conveyed to a small pond/tank for temporary storage until the leachate treatment system is ready to receive leachate;
j) the informal recyclers will be trained in health and safety precautions and provided with appropriate PPE;
k) a registration process will be established so only licensed adult recyclers will be allowed on site.

287. The relocation of the waste will start as soon as cell 1 is ready to receive waste and may extent into the Contractor's three months operations and maintenance period during which the Contractor is required to train the Operation and Maintenance Operator. The work is estimated to require a total of 29 workdays and involve the use of an excavator and a small dump truck.

288. After all waste has been disposed at the new cell 1, the former dumpsite area will be rehabilitated. Voids will be backfilled with clean materials and the site will be shaped in accordance with the detailed engineering design.

6.5.4. Closure of the Old Dumpsite

289. The options under consideration for the closure of the old dumpsite include:

[26] The Detailed Engineering Design estimates the costs of option a) to 80,000 USD and option c) to 22,000 USD

a) Closure by removing the waste from the dump and disposing it at the new landfill.
b) In-place closure by capping the waste,
c) Closure by upgrading into a controlled engineered landfill, or
d) Isolation of waste from groundwater, using drainage/ engineered containment.

290. The significant gaps and uncertainties in the information about the dumpsite mentioned in ***Para 278*** include:

a) Amount of waste and size of the area with waste dumped
b) Potential risk to groundwater
c) Potential risk to surface water from runoff with polluted leachate
d) Planned future land use

291. In order to address these gaps and uncertainties it is essential that further survey work is undertaken before a final decision is made on the most suitable remediation approach. The necessary additional surveys are included in Phase 2 of the ECA – see ***Annex 3.***

292. The closure options are discussed here below, with the first option involving relocation of wastes and the final three options remediation in-situ:

(i) **Closure by removing the waste from the dump and disposing it at the new landfill**. This alternative will be dependent on the economic feasibility assessment. The approach could be combined with sorting the waste for recyclable materials and separation of hazardous waste. In principle, deposition of the waste at the new landfill would inevitably reduce the design-life of the new landfill. It has been reported that the amount of waste could be as much as 144,000 m^3 (see ***Para 234***); however, the basis for this estimation has not been verified and must be taken with caution. Such an amount would occupy almost two waste cells (as designed for the new landfill). The excavated void should be backfilled with suitable locally available materials. This would in principle ensure that there would not be any land use restrictions and no need for monitoring and aftercare. However, if the groundwater underneath the waste dump has already been contaminated, there may be a need for additional mitigation measure and/or monitoring activities.

(ii) **In-place closure by capping the waste**. This preferred in-situ method includes a low permeability cap and a topsoil layer (typically comprised of 4 layers: (1) gas drainage, (2) low permeable clay layer, (3) soil drainage layer and (4) a topsoil layer). The final grading of the closed dump should be designed to ensure slope stability and proper drainage that prevents ponding of water and which is not causing erosion. Seepage of polluted leachate on side slopes would have to be collected and treated. Installation of landfill gas vents would also be considered, retrofitted into the waste. The site would likely be suitable for sport activities, park or recreation, agriculture (cropland, plantation, grazing land), but not for buildings or installations or infrastructure that require good foundation.

Long-term aftercare and monitoring would be required, and this would likely include groundwater monitoring (monitoring wells would have to be established), monitoring of seepage /leachate, landfill gas monitoring. Aftercare would consist of regular cleaning and repairs as required to the leachate collection and disposal systems, reinstatement of eroded batters, replacement of soils that are eroded, replanting any vegetation that dies back, filling any depressions that occur on site due to differential settlement, reparation of access roads to allow access at all times, and repairs to the perimeter and internal fences as needed.

The remediation costs mainly depend on the size of the area as opposed to the total amount of waste. The area could potentially be reduced by bulldozing and compacting the waste to form one "cell".

The implementation of this option could be done independently of the new landfill construction.

(iii) **Closure by upgrading into a controlled engineered landfill**. If surveys show that there is contamination of groundwater and there is sufficient available space at the dumpsite, a controlled waste cell could be constructed at the site. The waste would be excavated and disposed in the cell with proper compaction of the waste in thin layers thereby potentially reducing the area or the footprint and thus also the generation of leachate. Ideally, the waste would be encapsulated in a cell with liner, leachate collection system, and landfill gas venting. The cell would be provided with a cap as in the 'in-place closure'. Leachate could be treated (possibly also recirculated) onsite or trucked to the new landfill or the future wastewater treatment plant for treatment. Segregating recyclable materials from the excavated waste could be part of the remediation. The future land use of the capped cell would be restricted similar to the 'in-place closure' alternative, but it may be possible to free-up some land that would be free of waste and that would not have any land use restrictions. The excavated void should be backfilled with suitable locally available materials. Monitoring and aftercare would likely be similar to the 'in-place closure' alternative.

The implementation of this option could be done independently of the new landfill construction.

(iv) **Isolation of waste from groundwater.** If waste is leading to the contamination of groundwater, it may be possible to isolate the waste without the need to construct a full controlled landfill cell, as per option iii. Depending on the results of the hydrogeological survey, it may be possible to construct engineered approaches to isolate the waste from the groundwater. These may include enhanced drainage, which relocates the groundwater flows and bypasses the waste area; or the use of vertical cut-off barriers of low permeability to prevent the lateral spread of contaminated groundwater beneath the base of the dumpsite.

293. In addition, it is recommended to implement temporary mitigation measures similar to the temporary measures for the existing dumpsite (see ***Para 286***) including:

- Fencing off the dumpsite and controlling access
- Extinguishing fires
- Covering the waste with soil
- Temporary leachate management such as diversion of leachate to a temporary pit
- Training of informal recyclers and providing them with PPEs.

6.6. Environmental Impact and Mitigation Measures During Operation

6.6.1. Overview

294. The most important risks to the environment and communities associated with the operation of the landfill and the closure of the dumpsites include potential nuisance odour, seepage of polluted leachate into groundwater or surface water, uncontrolled discharge of polluted leachate to surface water bodies, risk of infectious diseases due to improper handling of waste.

295. Overall, these risks are mitigated through application of appropriate and internationally acceptable engineering standards, control and supervision to ensure that the facilities are constructed as designed, and by ensuring that the landfill will be duly and properly operated and maintained throughout the design life of the subproject.

296. To ensure that the subproject will be duly and properly operated and maintained, operation and maintenance equipment is included in the construction contract and the contractor is required to prepare an operation and maintenance manual and conduct training of the operator. In addition, at the end of the commissioning period, there shall be a three (3) months operations and maintenance period where the contractor shall provide an operations and maintenance manager and relevant operations and maintenance staff to operate the landfill. During this period, the contractor shall provide on-the-job training for operator's employees.

297. Capacity building on operational phase environmental management is outlined in the EMP.

298. The informal recyclers at the existing dumpsite will be allowed to continue to operate using the Materials Recovery Facility for sorting and packaging recyclables. The budget for site development has allowed for provision of sanitation facilities, potable water supply, PPE, training and support on health and registration of the informal recyclers. This is further detailed in the separate Livelihood Restoration Plan for the subproject.

6.6.2. Landfill Gas

299. 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.

300. The significance threshold for these requirements is set out in SPS 2009 as ‘’generally 100,000 tonnes of carbon dioxide equivalent per year for the aggregate emissions associated with electricity purchased for own consumption’’. In this case, the most significant GHG emissions would be the annual emission of landfill gas. The estimated generation of greenhouse gas is attached in ***Annex 6*** and shows that in the year with the maximum annual emission of greenhouse gasses (2041), the estimated amount of greenhouse gasses would include 948 tonnes methane and 2,602 tonnes carbon dioxide, which converted to carbon dioxide equivalents (CO2e) amount to 26,302 tonnes and thus well below the threshold.

301. Greenhouse gas emissions are challenging to quantify given the phased nature of waste degradation i.e. phases of aerobic and anaerobic degradation and methanogenesis. Direct field measurements of landfill methane emissions at small scale can vary over seven orders of magnitude depending on variables including waste composition, cover materials, soil moisture and temperature.

302. The current level of greenhouse gas emissions at the old dumpsite is unknown. This will be addressed in the recommended further investigations (See ***Section 6.5.4***).

303. As described in detail in ***Section 4.5.11***, greenhouse gasses will be managed by a passive venting system. Venting is a simple, proven and low-cost method to manage landfill gas emissions. In addition, 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.

6.6.3. Odour, Dust, Pests and

304. Landfill sites are known to generate odour, dust and other nuisance impacts if not managed properly. These impacts include:

a) fugitive dust from waste handling and truck movement;
b) odour from decomposing waste;
c) windblown litter on access roads;
d) pests such as rats and flies attracted by organic wastes;
e) spontaneous fires at the landfill.

305. The following mitigation measures will be implemented:

a) The site is located about 1.7 km from the nearest sensitive receptor which is much farther away than the minimum distance of 500 m recommended by ISWA.[27]
b) Compaction of the waste daily and cover of waste regularly will significantly reduce odour problems and limit scavenging by pests (birds, rodents).
c) Spray water for dust suppression, particularly over exposed waste surfaces.
d) Nets downwind of operated cell to capture potential windblown litter.
e) 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.
f) All transport of waste to be done with covered trucks.
g) The access road and the internal roads will have concrete pavement thereby reducing dust generation.

[27] Landfill Operational Guidelines, 2nd Edition, International Solid Waste Association (ISWA), January 2010

h) Washing wheels of vehicles before they leave site if they are muddy from accessing the landfill cells.

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

j) Provide and maintain a vegetation buffer with tree plantings around and in the landfill site to reduce noise, dust and odours.

k) There is no plan to flare recovered landfill gas. Gas generated at landfill will be ventilated to atmosphere. The design considers appropriate landfill gas ventilation system (ref ***Section 4.5.11***).

l) A strict control of fire risk will be implemented at the landfill site including prevention of burning and smoking.

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

n) A fire water tank will be available at the landfill.

6.6.4. Surface Water

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

a) Sanitary wastewater from sanitary facilities for the workers at the landfill.

b) Stormwater runoff, which may be contaminated with sediments, hydrocarbons from machinery, spills from vehicles or from the operation of generator.

c) Leachate collected at the bottom of the cells and recirculated which may overflow during a heavy rain event in the wet season.

d) Accidental release (spills, leaks) of hazardous substances entering stormwater canals/ditches or infiltrating into groundwater.

307. The landfill is designed and will be operated to ensure that offsite discharge of effluents is prevented. The following mitigation measures will be applied:

a) Ensure separation of hazardous waste to be disposed at the hazardous waste cell. Ensure proper containment of the hazardous waste facility and cell.

b) Drains will be constructed throughout the site in the form of reinforced concrete-lined open ditches and reinforced-concrete covered drains. These drains will divert storm water away from roads, landfill cells, buildings and facilities. This uncontaminated water will be diverted into the buffer zone.

c) Leachate management consists of a three-pronged environmentally sustainable and low (least) cost approach (taking into account constraints in terms of financial resources), which is designed to ensure zero discharge of treated leachate under most rain events (see detailed design in ***Section 4.5.6***, ***4.5.7*** and ***4.5.8***):

    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 lagoon for treated water, which will provide a storage for the water and which will be connected to a leachate recirculation system returning the liquid to the waste in order to manage flow rates and accelerate uniform settlement of wastes.

d) The leachate management system is designed to ensure zero discharge under most rain events. Modelling suggests that ponds will start to reach maximum capacity after approximately five years of operations. This will occur towards the end of the wet season, with levels substantially reducing through the dry season as a result of evaporation and evapotranspiration. It is important to note that water balance modelling in the ponds does not take into account recirculation. The use of recirculation will be an important approach to ensure that water levels are kept within the capacity of the ponds. Recirculation will be practised during dry periods, even in the wet season.

e) In addition, the treatment system when properly operated and maintained is likely to ensure that any rare discharge of treated leachate during periods with unusual heavy rain will not cause any significant harm to the receiving stream. The final treatment pond is equipped with a submersible stormwater pump, which will allow for water control in this extreme occasions. This water will be pumped into outflows, along with other stormwater, into the buffer zone in the north-eastern corner of the site. This buffer zone is 200 metres from the stream and is heavily vegetated and, therefore, it is highly unlikely that this will lead to any pollution of the Or Kantuot Stream. In practical terms, considering the low leachate flow rates, and that the effluents will be applied on land in the vegetated buffer zone within the premises of the landfill north of the landfill cells and there mixed with stormwater runoff from the local catchment, any rare discharge of treated leachate that may eventually drain into the small stream will be diluted and is unlikely to pose any significant risk to human health or the environment. In addition, any such rare unavoidable discharge of treated leachate when mixed with other stormwater runoff will likely comply with the applicable effluent standard[28].

f) Always comply with required operating standards to ensure effective treatment of leachates.

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

h) Recirculation of leachate to the landfill.

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

[28] Sub-decree No. 27 ANRK/BK 1999 on Water Pollution Control: Annex 2, Effluent standards for discharge of wastewater to public water area and sewer

6.6.5. Groundwater

308. The risk of groundwater contamination from leachate escaping the leachate collection system in the cells or from spills with oil or chemicals is considered low due to the local geology consisting of a compact, low permeable thick layer of sandstone, and the installation of a liner system based on international standards. The mitigation measures are summarised below:

a) The landfill cell design includes a single composite liner, which will block infiltration of leachate (see ***Section 4.5.5***). The liner will consist of a 1 m thick low permeable compacted clay layer, a HDPE geomembrane and a protective geotextile. A drainage system on top of the liner will collect leachate and convey it to the leachate treatment ponds.
b) Ingress of rainwater will be limited through use of drainage canals around the operating cells.
c) Strict implementation of the leachate management procedures.
d) Ensure separation of hazardous waste to be treated at the hazardous waste facility. Ensure proper containment of hazardous waste facility.
e) The groundwater will be monitored during operation and after closure of landfill. A total of five monitoring wells will be installed during the construction phase (see ***Section 4.5.10***).

6.6.6. Community and Occupational Health and Safety

309. Community risks come mainly from:

a) Unauthorized access to landfill site;
b) Traffic risks linked to the increase of movement of waste collection trucks and movement of vehicles including trucks transporting cover material.

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

a) The manipulation of waste at the cells or at the MRF;
b) Contact with hazardous waste;
c) The movement and operation of heavy machinery, (especially reversing waste trucks);
d) Risk of explosion and fires linked to degradation of waste.
e) Slips or falls into leachate ponds.

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

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

a) The Operator will appoint an Environment, Health and Safety Officer who is a qualified engineer.
b) Access to site will be prevented through appropriate fencing, guarded entrances for all non-authorized personnel. All entrances will be recorded. Video cameras should also be put in place around the perimeter of the site.
c) Sufficient signage with health and safety warnings and information disclosure at the entrance to the site.
d) Education and awareness seminars for the operator staff on landfill-related hazards. A site safety program will be developed by the operator and workers shall be trained regularly.

e) The Environment, Health and Safety Officer will conduct daily toolbox meetings (safety briefings) for the staff.
f) An accident record book will be maintained where all major or minor accidents and incidents are recorded with actions taken.
g) Ensure that all workers and informal recyclers are equipped with and use the required Personal Protective Equipment.
h) Provision of lifebuoys at the leachate ponds.
i) Adequate first aid equipment will be made available on site for landfill operators and informal recyclers.
j) Fire-fighting equipment and a trained fire-fighting team shall be present on site.
k) The operator will set out an Emergency Response Plan.
l) 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.
m) Enforcement of a speed limit of 30 km/h for all waste trucks and other transport under the landfill operator's control.
n) Control that waste trucks only use the designated access road;
o) Conduct training of waste truck drivers on driving skills, traffic regulations, and emergency preparedness and response.

313. Potential impacts to workers in operation due to COVID-19 will be mitigated through the following measures[29]:

a) 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.
b) 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.
c) Conduct Risk communication, training, and education. Training of workers in infection prevention and control practices
d) Adopt engineering, organizational and administrative measures, plan work so employees can keep distance from each other and minimise contact.
e) Provide clear and visible guidelines on how to prevent infection at the work site and initiatives taken.
f) 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;

314. More specifically, measures implemented shall entail:

a) Daily checking temperature of staff and workers prior starting the works.
b) Staff and workers have to wear masks all the time and properly.
c) Do not share personal items or supplies such as phones, pens, notebooks, tools, etc.
d) Avoid common physical greetings, such as handshakes.

[29] 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

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

f) 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.

g) 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.

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

i) 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.

j) 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.

k) 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.

l) 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.

7. ANALYSIS OF ALTERNATIVES

7.1. Solid Waste Management Design and Technology Alternatives

315. Alternative technological solutions for waste management are considered in detail in the Feasibility Study Report, Engineering Designs. A summary is provided in this section.

316. Four options ranging from uncontrolled open dumping to a fully engineered sanitary landfill are available to 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 ongoing environmental impacts. This option also could not be supported.
- Option 3, a controlled landfill. This 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.

317. 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 subproject. 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) are put in place initially to protect the surrounding environment (including groundwater), as these systems cannot be retrofitted later on.

318. Option 4 is considered too expensive for the relatively small city 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.

8. INFORMATION DISCLOSURE AND PUBLIC CONSULTATIONS

8.1. Public Consultations During Project Preparation

319. During CTDP-4 Project Preparation, meetings were held with stakeholders to obtain views and opinions on the subproject, and this also assisted the project team with development of the subproject designs.

320. CTDP-4 Project Preparation. During the preparation of the first IEE and EMP of May 2018 for the subprojects, consultations took place within each subproject area. The consultations in Kratie are listed in ***Table 33*** and a summary of comments and concerns raised at the consultations are provided in **Annex 4**. In general, the consultations found the subproject to be welcomed for the positive benefits it will bring, however concerns were raised regarding impacts during implementation, arising primarily from construction. In Kratie, the issues of existing solid waste management system (limited collection, delayed waste collection, limited waste trucks, lack of capacity, unsanitary waste disposal, and lack of involvement from local communities). The existing dumpsite, environmental quality, odour, and sanitation.

Table 33: CTDP-4 Project Preparation Consultations

Location	Dates	Stakeholders or Groups Met
Kratie Town	06/09/2017	Sangkat Kratie Sangkat Kandal
Kratie Town	07/09/2017	Sangkat Krakor Sangkat Ou Russei

321. IEE and Detailed Engineering Stage Consultations. 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 the IEE; and (ii) site visit combined with consultations with provincial, commune and village authorities to obtain their comments and suggestions to the subproject, its design and operation. Minutes of the consultations are attached in ***Annex 2*** and a summary of key points are listed in ***Table 34.***

Table 34: IEE and Detailed Engineering Design Stage Consultations

Location	Dates	Stakeholders or Groups Met	Key Comments
Office of the individual Authorities	15/06/2020	Village and commune authorities in Kratie town including: O Rusey, Krakor, Kratie, and Rokar Kandal Commune/Sankat, Kratie Town and Dar and Kantuot communes, Chetr Borei district	- Waste management is a big problem in all areas and all parties fully support the subproject - Important to disseminate information to households about waste regulations and fees - Important to implement measures to mitigate malodour, pests and runoff/effluents - Waste collection at markets and from households needs to be improved - The project should regularly monitor the environmental quality
Dar Commune Office	02/09/2020	MoE Reviewing Team Provincial Authority Provincial Department of Public work and Transportation Provincial Department of Environment Kratie Town Authority Cheatr Borei District Authority Dar Commune Authority Kantuot Commune Authority PMC, Member	- Waste management in Kratie town is a problem. No proper landfill and lack of waste trucks and public involvement is limited. - The site is state land. There are no sensitive resources located in and near the proposed site. The site is covered by degraded-shrub forest land. - All concerning departments in Kratie province agree on the siting of the landfill. - The project should prevent discharge of polluted wastewater and runoff from the landfill. - Important to mitigate malodour and pests from the landfill.

322. The household socio-economic surveys are reported in the PPTA study report, 2018 and include questions relevant to environmental safeguards. The respondents' views and results of existing solid waste management in Kratie City are summed below:

- 51% had access to solid waste collection services.
- 62% had their waste collected every two days; 21%, daily; 14% every 3 days.
- 67.5% received waste collection service by a private company, 82% by self-employed waste collector, 17% by informal waste collector, 4% by provincial department, 2% by a district office.
- Waste collection fees ranged from KR 4,000 to 15,000.
- 97% indicated that sorting of waste was important.
- 80% indicated that they sorted waste before disposing.
- 60% used their organic waste as animal feed; 13% dumped the organic waste in their backyard; 12% disposed it with other waste, 14% dumped it on open spaces; and 1% composted the organic waste.

8.2. Public Consultations during Project Implementation

8.2.1. Consultations during Construction

323. The PIU Safeguard Focal Point (PIU-SFP) will undertake consultations following the finalisation of the detailed design, and will conduct consultation interviews within 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 for the subproject.

324. 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 waste & liquid waste, 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

325. 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 EMP.

8.2.2. Consultation during Operation

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

8.2.3. Information Disclosure

327. 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:

a) The EMP will be translated into Khmer and be available for review PDPWT offices;
b) The IEE will be disclosed on ADB's project website (www.adb.org);
c) Copies of the IEE are available upon request; and
d) 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

328. A grievance redress mechanism (GRM), consistent with the requirements of the ADB Safeguard Policy Statement (2009) has been established to prevent and address community concerns, reduce risks, and assist the project to maximize environmental and social benefits.

329. The GRM was officially established on 31 January 2019 and is fully operational.

330. 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 environmental issues of concern arising from the subproject; (ii) demonstrate concerns about community members and their environmental well-being; and (iii) prevent and mitigate any adverse environmental impacts on communities caused by subproject implementation and operations. The GRM is accessible to all members of the community.

331. The access points to the GRM are critical for ensuring it is useable for the affected people. The GRM access points include:

- The Contractor's camp and site office
- District and Commune Council Offices
- The PIU office/ Provincial Department of Public Works and Transport (PDWT).
- The PMU/ Ministry of Public Works and Transport and project consultants

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

10. ENVIRONMENTAL MANAGEMENT PLAN

333. A detailed EMP has been prepared for the Subproject. The EMP is a standalone separate document (dated July 2021). 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.

334. The overall responsibility for EMP implementation and compliance with loan assurances lies with the Executing Agency, the MPWT. The EA has established a Project Steering Committee (PSC) and PMU based in Phnom Penh, responsible for general project implementation. The Implementing Agency is the PDPWT in each town. The PDPWT has established a PIU in each province, comprising relevant provincial government representatives including the PDoE.

335. A summary of the key functions for project implementation and therefore environmental safeguards is presented in ***Table 35***.

Table 35: Key Roles for Project Implementation

Role	Abbreviation	Location	Summary of Overall Function
Ministry of Public Works and Transport	MPWT	Phnom Penh	Accountable towards the Royal Government of Cambodia and ADB for the implementation of the Subproject and for ensuring compliance with loan

Role	Abbreviation	Location	Summary of Overall Function
			covenants
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	-	Construction Site	Timely implementation of the construction work according to contract Preparation and implementation of the CEMP as approved by the PMU
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.
Ministry of Environment (MOE)/ Provincial Department of Environment (PDoE)	MoE/PDoE	Phnom Penh	Responsible for environmental protection and natural resources conservation. Collaborate with the project to provide policies, environmental standards and advise. Review and approve EIA/IESIA reports. Conduct environmental compliance monitoring of the project

11. CONCLUSIONS AND RECOMMENDATIONS

11.1. Conclusions

336. This IEE was undertaken to determine the environmental issues and concerns associated with the subproject activities, based on the Detailed Engineering Design. The assessment confirms that the subproject 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.

337. 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 subproject is both financially and environmentally sustainable and achieves anticipated outcomes.

338. 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 the EMP will be closely monitored and reported on by the relevant stakeholders in the project.

339. Overall, it is expected that the subproject will result in improved urban environmental services in Kratie City. The subproject is anticipated to bring environmental benefits to the populations of the project service area as it will serve to improve waste management in the city, reduce pollution impacts and provide long term urban environmental improvements, health benefits and promote sustainable city development.

340. The next step of Environmental Safeguards implementation is the preparation of the Contractor's Environmental Management Plan (CEMP), which is to be based on the EMP, but is expected to include more 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, spoil and borrow sites management, traffic management, etc.

341. When operations start, the operator shall develop an Environmental Management Plan specific to the operational phase.

342. The Subproject includes remediation and closure of the two waste dumpsites in Kratie City. The Existing dumpsite located at the new landfill site will be closed by relocating the waste in the new waste cell. For the other, old dumpsite, a final decision on remediation and closure awaits the results of additional physical site investigations.

343. A Grievance Redress Mechanism has been established, as outlined in the IEE and the EMP. The GRM will ensure that all unplanned impacts which cause grievances for affected people are managed and that a satisfactory outcome will be brought about swiftly.

11.2. Recommendations

344. During both construction and operation, it is important to continue informing and consulting with the local communities and affected people about the progress of work and any changes or unusual situations; and to receive feedback and recommendations that may help to alleviate nuisances and improve the performance of the systems.

345. The next step in implementation of the Environmental Safeguards is the preparation of the CEMP. The CEMP shall be based on the EMP, but with more detailed descriptions of the measures to be implemented by the Contractor. The CEMP will form the basis of the

Environmental Management System of the Contractor during the construction phase. The CEMP shall contain a number of subplans dealing with specific topics, such as spoil and borrow site management, solid and liquid waste management, management of incoming waste and relocation of existing waste, community and occupational health and safety, emergency response, COVID-19 prevention and response plan, and Construction workers camp management (if required). The Contractor is required to obtain approval of the CEMP from the PMU before starting any construction works.

346. It is further recommended, as soon as practicable, to undertake additional physical investigations of the old dumpsite as a basis for making a decision on the remediation and closure method.

347. For the operational phase of the subproject, it is crucial that the Operation and Maintenance Manual provides clear methods and procedures for all aspects of the landfill operations including leachate management, and monitoring of treated effluents and groundwater.

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.

Area	06:00-18:00 dB(A)	18:00-22:00 dB(A)	22:00-06:00 dB(A)
Quiet area (hospital, school)	45	40	5
Residential area	60	50	45
Commercial area	70	65	50
Area with factories mixed with housing	75	70	50

(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	°C	< 45	< 45
2	pH		6 – 9	5 - 9
3	BOD5 (5 days at 20 °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

No	Parameters	Unit	Allowable limits for pollutant substance discharging to	
			Protected public water area	Public water area and sewer
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

No	Parameters	Unit	Allowable limits for pollutant substance discharging to	
			Protected public water area	Public water area and sewer
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.

Annex 4 of Sub-decree on Water Pollution Control

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

Source: Sub-decree No. 27 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: Sub-decree No. 27 ANRK.BK on Water Pollution Control, MOE, 1999

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

Drinking Water Quality Standard

No	Parameter	Drinking Water Quality Standard	
		Unit	Value
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

No	Parameter	Drinking Water Quality Standard	
		Unit	Value
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 Coliform	MPN/100mlml	0

(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: Consultations and Site Visits DED Stage

Summary of Public Consultations 15 June 2020

The landfill subproject is located in Khsar village, Dar commune, Cheatr Borei district, Kratie province. Near the subproject site is Kantuot village, Kantuot commune.

On 15 June 2020, the study team of SAWAC conducted public consultations with village and commune authorities in Kratie town namely: O Rusey, Krakor, Kratie, and Rokar Kandal Commune/Sankat, Kratie Town and Dar and Kantuot communes, Chetr Borei district. The problems, feedbacks, comments, and questions is summed below.

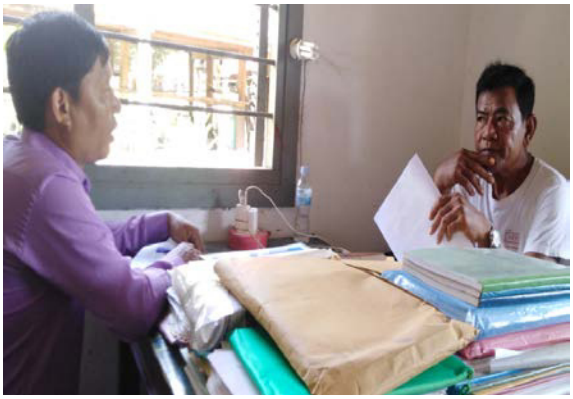
Summary of Key notes from consultation with village and commune authorities

Feedbacks and issues	Comments and questions
- O Russey commune is located in the Kratie town, we have problem of waste management in our area. The waste management and waste collection in town is not good (some wastes are still on the roads). - We support this subproject. Our town will have good landfill and clean-sanitation and good environment town for our healthy.	- Improve the waste trucks for collection of wastes. The waste truck must have cover to protect waste flow down and leach wastewater. - provide information to local town households of store and collecting waste in the town. - The project should be protected the odour from landfill that affect to nearest people. - Well manage the public health and safety, especially waste workers.
- Krakor commune locates in Karatie town. We support this subproject. - Now the waste management is not so good and sanitation and also the environment in the town is not good too. - Limited enforcement and waste collection system in the town, some people dispose wastes into public filed or steram. - We need this subproject and we want to live with our good environment, sanitation and health in our commune area as well as in the town.	- Project should provide awareness on regulations/policies of waste collection, disposal and sanitation in the town to local people and also waste collection fee. - Study on impacts on public health, safety, and sanitation for landfill operation and mitigation plan should be prepared for mitigate the negative impacts. - PDoE, should implement the penalty for someone who dispose waste into the public field, river or stream.
- Kratie commune is in Kratie town. We support the subproject for managing waste in our town, because this landfill is good landfill and sanitation. - We have existing waste duping site, but is not good, the waste dumps on the fields without protect the environment and social. - The waste is a problem in our town most in market areas, due of the delay of collecting out.	- Need public awareness to households on waste collection policies and regulations in the town, especially in market sites. - Awareness to local people on waste management. - Enforcement waste regulations.
- Rokar Kandal commune located in the Katie town. We support this landfill subproject in Dar Commune. - The Landfill is located out of the town far from our commune area, But the construction landfill should be considered the impact on communities are near the project site, such as: air pollution, odor from landfill, and public health of local people.	- Provide waste management and sanitation to key persons or FG in the commune. - Project should be improved the waste collection from households and markets. - Good collaboration with local authorities and communities. - During operation should regular monitoring and protection the water and wastewater flows or runoff from landfill site to outside. - The odour and flies from the landfill should be prevented.

- The landfill is located in Khsar village, Dar commune. But landfill site is far from village areas (residential areas). - We support this subproject, but the project should construct and operate with proper-good technical design for reduce the negative impacts on health and safety of local people. - Kantuot commune locates near the landfill site. The village is on the national road N.7. - We support this subproject for improve the waste management in Kratie town and our commune area too. - We see project study team collaborated and discussed with our people and authorities. - For construction landfill is not problem of any impacts, but during operation, we are worried of increasing odour, fly, air quality, and wastewater discharge or flow from landfill.	- Projection the wastewater and runoff from landfill site to outside field. - Project should be considered to protect and mitigate the impacts of landfill activities on public health and safety, especially people are near the landfill sites. - Protection the runoff and wastewater from landfill site flows or discharges to the canal or stream on the downstream side. - During operation landfill, should use good technical to protect and mitigate the public health of our people. - More study of odour from landfill to this area and prepare plans for reduce the impacts - Good communicate with local authorities and people. Monitor of the any impacts on local people - The project will collect the waste in Kantuot commune as same as in Chetr Borei district?

- Pictures

	
Consulted with Chief of O Russey commune	Consulted with Clerk of Krakor commune
	
consulted with Chief of Kratie commune	consulted with Deputy Chief of Rokar Kandal commune

Consulted with Khsar village and Dar commune authorities


Consulted with Kantut village and Kantuot commune authorities

- Participants

No	Name	Sex	Institution	Position
1	Hav Chheun	M	O Russey commune	Deputy commune chief
2	Sao Chanbopha	F	Krakoe commune	Commune Clerk
3	Chhin Leang Yi	M	Kratie commune	Commune chief
4	Keat Hout	M	Rokar Kandal commune	Deputy commune chief
5	Sou Sam Ath	M	Dar commune	Deputy commune chief
6	Van Bunthy	M	Khsar Village, Dar commune	Chief of village
7	Top Horn	M	Kantuot commune	Commune Chief
8	Chheng Chhun	M	Kantuot village, Kantuot	Chief of village

Kratie Solid Waste Management Subproject

Field visits and consultations with local Authorities and relevant Departments

Activity Report

Component	Site visit for Landfill Subproject CTDP4
Type of Activity	Site visit at Kratie city
Sub-project/s	Landfill in Dar commune, Chetrborei district, Kratie province
Start date	02-09-2020
End date	02-09-2020
Planned Activities	MoE reviewing team conducted site visit and consultation with PIU, Kratie town village and commune authorities.
Activities Carried Out	Summary of landfill subproject, discussion and received feedbacks, comments and questions from local authorities
Appendix 1: Participants	
Appendix 2: Pictures	
Noted by: Mr. Yim Chamnan National Environmental Specialist	

Consultation Meeting in Dar commune office, Cheatr Borei district

On 02 September 2020 at 8:30 pm, in Dar commune office, Cheatr Borei district, Kratie province.

The Participants come from MoE Reviewing Team, PDPWT/PIU Staffs, PDoE, Kratie provincial hall, Kratie town, Dar commune leaders, PMC, and SAWAC. The attended list is shown in Appendix 1.

The objectives were:

- Present the project location, work plan and activities to participants
- Identify key impacts on environment and social in the draft IESIA report
- Receive additional information from local communities or affected people
- Receive feedbacks (concerned issues, comments, and questions) for participants
- Analyze the feedbacks for prepare or update the IESIA report of Landfill subproject.

Meeting discussion:

The proposed consultation: Present the work plan and activities of building a control landfill subproject in Dar commune to provincial, district, commune authorities. Receive sensitive environmental and social receptor are setting in and near the project area.

On 01-02 September 2020, the MoE Reviewing Team is collaborated with SAWAC Team, PIU, and PMC conducted site visits of Landfill subproject site in Dar commune, Cheatr Borei district, Kratie province. During visit, the MoE team was consulted with provincial, district, village and commune authorities in Dar commune. The meeting is conducted on 02 September 2020. The key feedbacks, issues, and comment from consultation meeting are briefed bellow:

The key concerns, comments, and questions form participants

- The waste management in Kratie town is a problem in Kratie town, no landfill (is disposed dumping site), lack of waste trucks and public involvement for waste collection is limited.
- The provincial governor reserves this land site for landfill is public land. There are no sensitive resources located in and near the proposed site. The site is covered by degraded-shrub-regrowing forest land.
- During PPTA study all local authorities in Kratie province are agreed for landfill site section.

- The landfill site is located in Dar Commune and is bordered with Kantuot commune area
- The Small Stream is located Kantuot village, Kantuot commune is no the downstream are of landfill site. Some people use water from this Stream for irrigation farm and vegetable crops.

The considers:

- We proposed of 27.80 ha for build the control landfill for Kratie town is located in Dar commune, Cheatr Borei district. The proposed land site is public land.
- The Kantuot village, Kantout commune is located on the downstream area of landfill site.
- Impact on water quality in downstream area. Or Kantuot Stream is located about 0.5 km form landfill site on the downstream. So the design should be considered on impact of water quality of Stream in the downstream from landfill operation
- Flood and runoff control around the landfill site. So, the project should be ensured, there is no leaching wastewater and runoff (stormwater) from landfill site flows to downstream area.
- The fly will be increased and odor from landfill may be impacted to nearest people in village areas.
- Khsar village area, Dar commune is located on the National Road 7 is about 2 km from Landfill site, where are houses, school and pagoda. So during construction the affected from landfill on environmental and social resources are minor.

Conclusion

Generally, they support to the subproject for improvement of waste management system in Kartie town. They will support and collaborate with the project any time. But the protection on surface water quality of Or Kantuot Stream, flood, (runoff), and odour should be considered and provided proper mitigation measures. Some concerns and comments for this meeting SAWAC was noted and will update/revise in IESIA report.

Appendix 1: List of Participants

No	Name	Sex	Institution	Position	Phone
1	Chea Leng	M	IEA Department, MoE	Deputy director	012 249 798
2	Chhrin Narun	M	--	Chief office	086 266 629
3	Yim Sothan	M	--	Chief office	012 494 900
4	Sokhom S.Somaly	F	--	Officer	085 309 222
5	Samuth Luma	M	Kratie Province	Chief of Planning Office	012 917 592
6	Chhup Phaly	M	DPWT/PIU	Deputy director	012 831 295
7	Van Bunthy	M	Dar commune	Village Chief	097 262 6313
8	Eav Narun	M	Cheatr Borei district	Vice Governor	088 833 4351
9	Duong Savan	M	Kratie Town	Administration Chief	097 670 4247
10	Sou Sam Ath	M	Dar Commune	Deputy commune chief	097 718 7222
11	Kuon Sarun	M	Dar Commune	Commune Council	097 479 4416
12	Chheang Chhun	M	Kantuot Commune	Village chief	097 515 5195
13	Ly Lim	M	Kantuot Commune	Deputy commune chief	
14	Yim Chamnan	M	PMC	NES	012 945 546
15	Phean Sokmy	M	PDoE	Deputy director	071 277 1456
16	Than Chan Veasna	M	PDoE	Deputy of chief office	088 499 6771
17	Heng Kosal	M	Kratie Town	Officer	092 299 943
18	Oum Sereyvuth	M	SAWAC Team	Team Leader	012 360 743

Appendix 2: Pictures


The existing access road to landfill site and condition of forest/vegetation resources




The existing condition of natural resources in landfill site


Consultation meeting with provincial, district and commune authorities

Annex 3: Terms of Reference for Environmental Compliance Audit of Waste Dumpsites in Kratie City

Background

The Fourth Greater Mekong Subregion Corridor Towns Development Project (GMS4 or CTDP-4 Project) will support the Governments of Cambodia and the Lao People's Democratic Republic (PDR) in enhancing the competitiveness of selected towns located along the Central Mekong Economic Corridor in the Greater Mekong Subregion (GMS).

In Cambodia, the project will improve urban environmental services in Kampong Cham, Kratie and Stung Treng, three of Cambodia's provincial cities located on Mekong River. The project will also improve institutional effectiveness to provide sustainable services and support an improved policy and planning environment for wastewater and solid waste management

The project will construct controlled landfills in all three cities with sufficient volume capacity to accommodate waste from the existing dump sites as well as new waste for the next 10 years.

Purpose and requirement of Environmental Compliance Audit

There are two dumpsites in Kratie City (the old dumpsite and the existing dumpsite) which are considered *Existing Facilities*[30] of the wider CTDP-4 Project and the closure and remediation of the dumpsites require that an Environmental Compliance Audit (ECA) is conducted of the facilities pursuant to the SPS (2009), para 10 of Appendix 1 and para 12 of Appendix 4.

The closure and remediation of the dumpsites are part of the Kratie Solid Waste Management Subproject.

Scope of the ECA for the dumpsite

The ECA is divided into two phases, where phase 1 is an initial assessment of the risks, possible solutions and the need for immediate mitigation measures at the dumpsite to minimise any on-going pollution and risks to human health and the environment as much as practical until the long-term solution can be implemented. Phase 2 is an optional phase in case a permanent solution has not been found under the first phase. Phase 2 will then include more detailed site investigations and analyses as may be necessary to make a decision on the long-term solution and to provide information for the preparation of the detailed remediation design

Phase 1

Activities

Phase 1 includes the following activities:

1. Site visit(s) to identify existing activities or conditions that may cause or contribute to pollution or spread of infections:
    a. Current land use and vegetation cover of the dumpsite and surrounding areas
    b. Evidence of open burning
    c. Evidence of vectors (e.g. rats, insects, birds)
    d. Evidence of windblown waste
    e. Direct field assessment of odours
    f. Drainage and waterbodies
    g. Leachate seepage
    h. Mapping of waste piles (active and non-active) and the dumpsite boundary
    i. Inspect incoming waste or recently dumped waste to characterize the waste types
    j. Presence of informal recyclers
    k. Distance to sensitive receptors
    l. Review of any existing permits or authorizations for the dumpsite

[30] *Existing Facilities 12. For projects involving facilities and/or business activities that already exist or are under construction, 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.*

m. Documentation may include drone photos, videos, onsite photos, field observation notes, GPS tracks and waypoints.

2. Interviews with waste management personnel, government officials, informal recyclers, and farmers owning adjacent land:
    a. Date dumpsite was commissioned (became operational);
    b. Current operator and responsible authority of dumpsite
    c. Current disposal practices;
    d. Types of solid waste disposed in dumpsite (e.g. domestic, hospital, construction, industrial);
    e. Rate of solid waste disposal at dumpsite (tonne/day or tonne/month);
    f. Local water management, water use, flood risk;
    g. Existing groundwater wells;
    h. Relevant water quality data.

Site visits and interviews may be combined.

Analyses

Phase 1 includes the following analyses:

1. Analysis of historical Google Earth images to identify the approximate spatial extent of the dumpsite, changes in land use and land cover, proximity to water bodies, and residents, and other sensitive receptors.
2. Preparation of preliminary drawings and maps with Google Earth backdrop approximately to scale and elevations from onsite GPS data based on the above documentation identifying waste pits or trenches, waterbodies, vegetation, surrounding land use, sensitive receptors, and groundwater wells.
3. IBAT proximity assessment.
4. Rough estimation of the spatial extent of the waste dump and total volume of waste.
5. Identification of landownership
6. Analysis of applicable government laws and regulations (non-exhaustive list below, missing regulations will be identified and included in the analysis) to clarify whether the design and operation of the existing dumpsite is in compliance and to clarify requirements applicable to the closure of the dumpsite.
    a. Sub-decree on Water Pollution Control (Sub-decree No. 27 ANRK/BK) 2009;
    b. Guidance on Selection of Landfill Sites (2016);
    c. Sub-decree on Solid Waste Management (Sub-decree No. 36 ANK/BK) 1999;
    d. Environmental Guidelines on Solid Waste Management in Kingdom of Cambodia, Ministry of Environment, 2006.
7. Preliminary identification and assessment of existing pollution and other health risks and development of practical and affordable immediate actions to eliminate or minimise the risks including cost estimates for such actions.
8. Preparation of a simple Environmental Management Plan covering the immediate mitigation measures at the dumpsite.
9. Analysis of alternative long-term solutions and develop recommendations. If the results of the investigations are conclusive or if the most advantageous solution (environmental impacts, costs, future land use, landownership, technical feasibility) can reasonably be determined, then recommend the preferred remediation and closure method. If the results are inconclusive, then the critical information gaps should be identified, and Phase 2 investigations should be initiated.

Expected Results

Phase 1 is designed to provide the following results:

1. Legal requirements to dumpsite closure
2. Analysis of alternative long-term solutions, and either
    a. Determination of the preferred solution (if the findings are sufficiently conclusive); or
    b. Phase 2 investigation programme

The results will be documented and incorporated in the IEE and EMP.

Phase 2

The objectives of the Phase 2 investigations are to fill-in information gaps identified in Phase 1 and to determine the long-term solution to the remediation of the dumpsite and to provide information for the preparation of the detailed remediation design.

The scope of the Phase 2 investigations consists of the activities listed below and possibly additional activities as may have been determined in Phase 1.

Activities

1. Interviews (continued from Phase 1) with waste management personnel and government officials with knowledge about the dumpsite:
    a. Preferred future land use (ranking of alternatives)
    b. the number and depth of waste cells;
    c. underlying waste cell lining material if any;
    d. extent of active surface runoff collection and drainage;
    e. extent of leachate and gas collection and treatment;
    f. extent of septage disposal and management;
    g. waste recycling process used by local waste pickers; and
    h. scheduling of transport of solid waste to dumpsite.
2. Obtain existing data on groundwater quality near the dumpsites from PDoE (if available).
3. Obtain existing surface water quality data for potentially impacted water bodies.
4. Determine number of full-time and part-time informal recyclers that work (and live) at the dumpsite
5. Identify any other use of the dumpsite area.
6. Consult with the surrounding community and the informal recyclers to determine if there are past or present environmental, social, or human health issues associated with the operation of the existing dumpsite.
7. *Waste Surveys:* It is critical to determine the volume and nature of the waste on the site. A mapping exercise is required, which details the extent of waste coverage and depths of waste in different localities. This will require excavating pits into the waste piles in order to determine the depth of waste. It is also important to understand the typical waste density of the waste, which will help assess tonnages. This will require undertaking waste density tests in a number of locations (kilograms per square metre). It will also be useful to provide further details on the typical composition of the waste and the degree of degradation that has occurred (i.e., an estimation of the length of time the waste has been on-site and the degree of decomposition of organic material). The presence of any problem or hazardous waste (e.g., medical wastes) should be recorded, including details and locations of these wastes.
8. *Groundwater Quality Survey:* It is critical to determine the impact that the waste dump has on water quality in underlying groundwater. It is highly recommended that this is undertaken even if the waste is relocated, since it will be important to determine the legacy impacts of this dumpsite.
9. Following the completion of the above surveys, an economic feasibility assessment will be undertaken to determine the viability of transferring the old waste to the new landfill. If this option is deemed viable, then further geotechnical surveys are not required. If relocation of waste is not economically viable, then in-situ remediation will clearly be the only option, and in will then be necessary to undertake the geotechnical survey outlined below, and possibly also the hydrogeological survey, if the groundwater has been shown to be polluted.

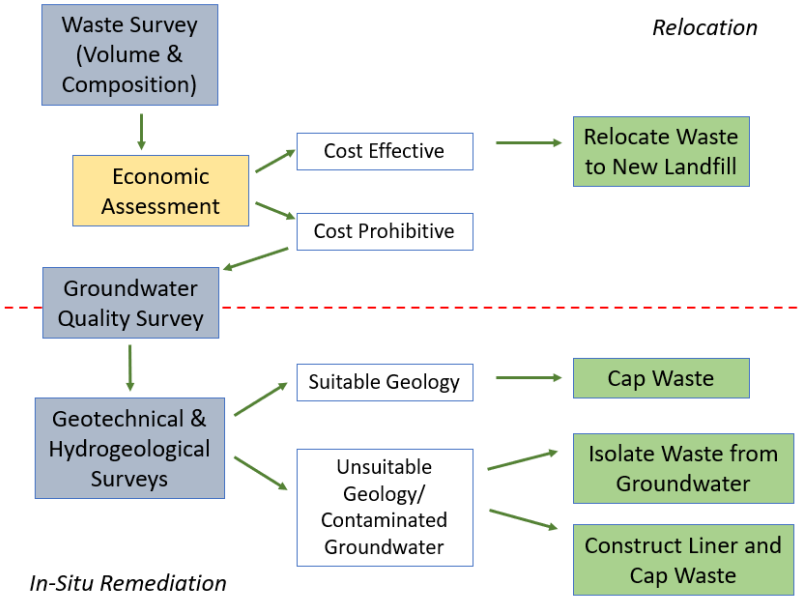
Additional Optional Activities

10. *Geotechnical and Hydrogeological Surveys:* For in-situ remediation measures, it will be critical to understand the site geology and hydrology. This will involve developing an understanding of the underlying geology, particularly in terms of permeability and the potential for transferring leachate into groundwater. Hydrogeological surveys will be necessary if water quality surveys show that the groundwater is polluted from the waste. This survey will involve an examination of groundwater flow and connectivity, in order to determine if polluted water is

being used by neighbouring activities, with particular concerns where it is being used as human or livestock drinking water sources.

11. The choice of in-situ remediation options will depend on the results of the surveys. The ideal and default option for in-situ remediation will be closure through capping the waste (see below for details). However, if there is existing pollution of groundwater and the geology is not suitable then more complex engineering options will need to be considered. This would include the construction of an engineered landfill cell, complete with an underlying liner; or may include other approaches that isolate the waste from the groundwater, such as cut-off barriers.
12. The overall decision tree for remediation options is detailed below:

Remediation Decision Approach



Expected Results

Phase 2 is designed to provide the following results:

1. Recommendations on the future land use of the remediated dumpsite
2. Analysis and ranking of alternative long-term solutions
3. The preferred long-term solution including monitoring and aftercare.
4. Cost estimate

The results will be documented in a concise report and presented to the PMU and ADB for their decisions on the recommended remediation and closure method.

Annex 4: Consultation During IEE Preparation

Public Consultation: Focus Group Discussion (FGD) and relevant agencies or departments

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?

There are 02 consultations conducted in the Kratie Town for 4 communes namely:

(i) FGD meeting is conducted for Kratie commune and Rokar Kandal commune. The meeting is conducted in Kratie Commune Office on 06 September 2017. (ii) FGD meeting is conducted for Krakor commune and Ou Russei commune. The meeting is conducted in Krakor Commune office on 07 September 2017 in morning. The key notes, feedbacks, comments, and questions are summed in table below.

Table: Key notes from consultations in Kratie Town

Issues/problems, feedbacks, comments and questions in Kratie Town	Response
- The Flood is an issue in the Kratie Town, during raining season the flash flood is flooded on some roads and village areas. - In Kratie Town as same as Krakor, Ou Ressei, Kratie, and Rokar Kandal Commune, all the wastewater is discharging to lowland and then flows directly to the Mekong River (not waste water treatment system). - Shallow river water in villages - My village always flood and bad smell, not flow two or three day, have more mosquitos and fly and affect by disease, the solid waste management not on time - No place for solid waste. - All men worry on the transportation, destroy the agriculture product - All women worry on traveling, disease, the children difficult go to school - The flood could be impacted to water use, community sanitation, and increased infective diseases (waterborne diseases). - The solid wastes will flow from upstream to downstream through runoff during the flood occurs in Kratie Town, is caused from lack of solid management. - Solid waste in Kratie town is collecting and transporting to dumping site by subcontractor. - The solid waste management is limited due to low capacity of subcontractor (waste collection 3 days/time), limited of enforcement laws and awareness, - Limited of public involvement in solid waste management. Some households of soe village in Kratie Town don't want to joint and pay for waste collection fee. - So the improving drainage system, WWTP, and solid waste dumping site are very important for our people in Kratie Town. - Now the population in Kratie Town is increasing time to time and the vehicles is increasing too. So the roadway in Kratie is limited and narrow road, there are some traffic accidents on the road section in Kratie Town. - Environmental problems associated with drainage and road construction (i.e., dust, noise, and air etc.) will be increased during construction stage. - Some trees might be affected or cut during road clearing and waste dumping site of clearing stage conducted by the contractors. - Some road sections are still laterite road (very dusty in dry season and muddy in raining season) and some part of is flooded during raining season some sections in Krakor Commun and Ou Russei commune. - The project will be improved sanitation, public health, and environmental quality management as well as Mekong River water. - Easy access to basic facilities and services; - Affordability of transport costs/services; - Easy access for students in going to schools especially on secondary and tertiary levels which are oftentimes located - outside the village/ commune. - Improving waste management system (solid and wastewater) in Kratie Town. Provide more waste trucks and rubbish tanks in markets areas. - The public awareness of waste management law and concerned regulations and sanitation shall be provided. - Strongly implementation and enforcement waste management law and concerned regulations, is including penalties.	- The engineers will study hydrology and install the culvert. - Now is study time, we don't know which subprojects will be selected yet. - We will report your ideas to MPWT, ADB, DPWT, and provincial Authority for decide.




The consultation meeting in Kratie and Rokar Kandal Commune




The consultation meeting in Krakor and Ou Russei Commune

Annex 5: Leachate Management Details

(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 60,000mg/L
- COD – 4 to 100,000mg/L
- Ammonia – 2 to 3,000mg/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 of the CTDP-4 project 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.

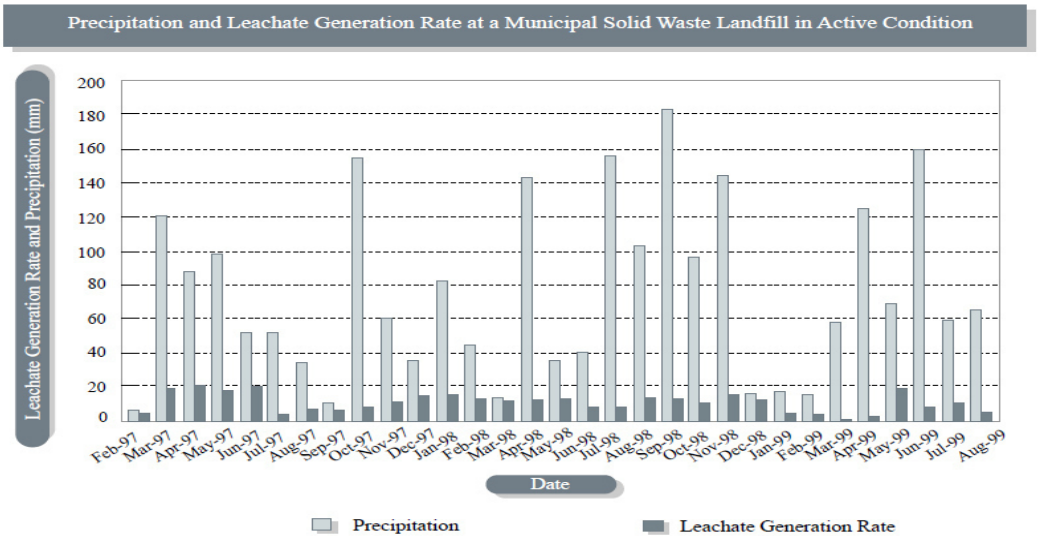
Leachate flow balance

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

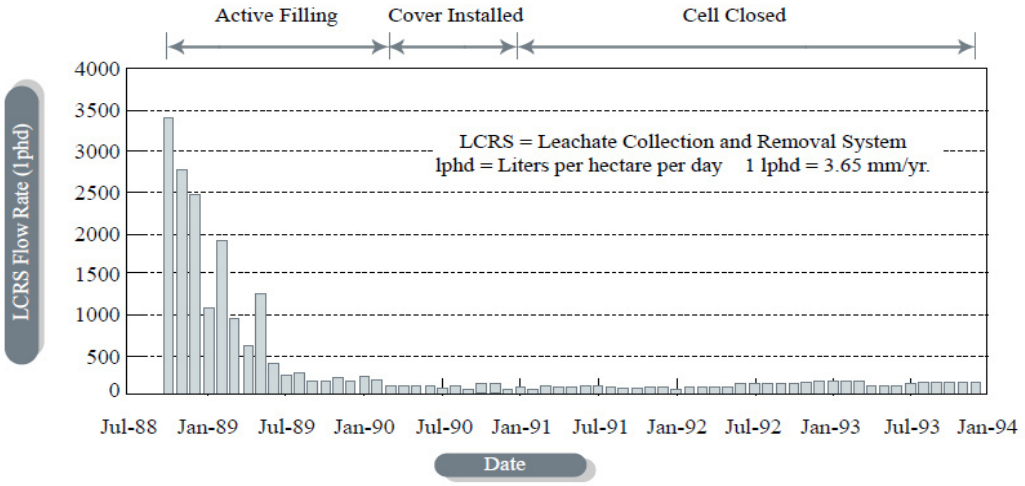


Ref: "Qian, X., R. M. Koerner, and D. H. Gray, "Geotechnical aspects of landfill design and construction, upper Saddle River, New Jersey". Prentice-Hall, 2002

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 1,306mm of annual rainfall over the final landfill area within the long-term period of this study (Stages 1 through 4) of approximately 16.0ha, 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 104,000m^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 45m^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** = 40,000m^2 x 1,306mm x 0.25 =>13,000 m^3/year

Evapotranspiration:

- 40,000m^2 x 1,540mm x 0.625 => 38,500m^3/yr. (for lush grass cover)
- 40,000m^2 x 1,540mm x 0.35 => 21,600m^3/yr. (for moderate grass)
- 40,000m^2 x 1,540mm x 0.15 => 8,200m^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 TS2 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

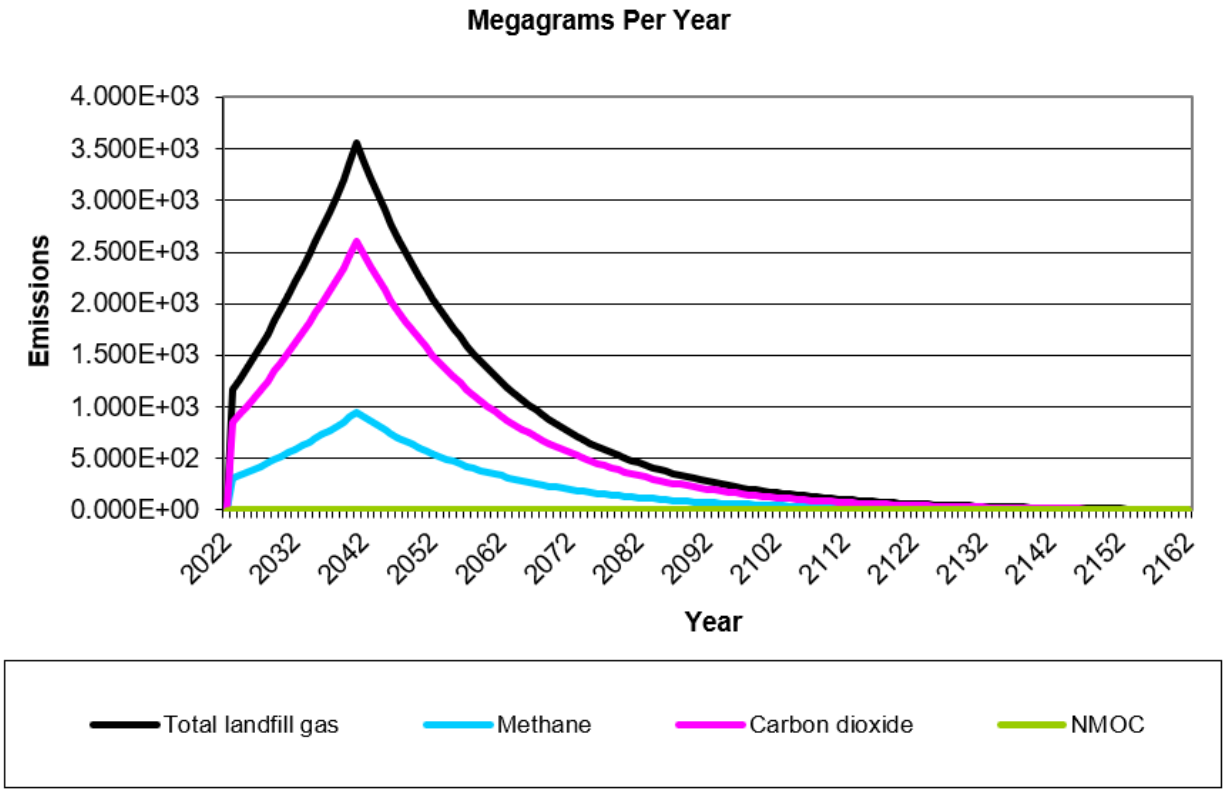
The mobility of selected heavy metals such as Cu, Pb, Zn, Cr, Fe and Mn depends not only on the permeability of the soil but also potential attachment sites such as those resulting from the soluble/exchangeable sites (cation exchange capacity), carbonates, Fe and Mn oxides, and organic matter fractions.
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.

Annex 6: Landfill Gas Estimates

The following calculations have been made using the USEPA's LandGEM model, which assumes 50%-50% split between carbon dioxide and methane.



	Total landfill gas		Methane		Carbon dioxide		Non methane organic compounds	
	(Tonnes/year)	*(m^3/year)*	*(Tonnes/year)*	*(m^3/year)*	*(Tonnes/year)*	*(m^3/year)*	*(Tonnes /year)*	*(m^3/year)*
2022	0	0	0	0	0	0	0	0
2023	1,168	934,956	312	467,478	856	467,478	2	561
2024	1,270	1,016,655	339	508,328	930	508,328	2	610
2025	1,375	1,100,888	367	550,444	1,008	550,444	2	661
2026	1,483	1,187,456	396	593,728	1,087	593,728	3	712
2027	1,595	1,277,066	426	638,533	1,169	638,533	3	766
2028	1,710	1,369,270	457	684,635	1,253	684,635	3	822
2029	1,830	1,464,992	489	732,496	1,341	732,496	3	879
2030	1,953	1,563,565	522	781,783	1,431	781,783	3	938
2031	2,081	1,666,016	556	833,008	1,525	833,008	4	1,000
2032	2,212	1,771,193	591	885,597	1,621	885,597	4	1,063
2033	2,344	1,877,188	626	938,594	1,718	938,594	4	1,126
2034	2,476	1,982,448	661	991,224	1,814	991,224	4	1,189
2035	2,610	2,090,057	697	1,045,029	1,913	1,045,029	4	1,254
2036	2,743	2,196,866	733	1,098,433	2,011	1,098,433	5	1,318
2037	2,884	2,309,430	770	1,154,715	2,114	1,154,715	5	1,386
2038	3,035	2,430,666	811	1,215,333	2,225	1,215,333	5	1,458

	Total landfill gas		Methane		Carbon dioxide		Non methane organic compounds	
	(Tonnes/year)	*(m^3/year)*	*(Tonnes/year)*	*(m^3/year)*	*(Tonnes/year)*	*(m^3/year)*	*(Tonnes /year)*	*(m^3/year)*
2039	3,195	2,558,199	853	1,279,099	2,341	1,279,099	6	1,535
2040	3,366	2,695,262	899	1,347,631	2,467	1,347,631	6	1,617
2041	3,551	2,843,270	948	1,421,635	2,602	1,421,635	6	1,706
2042	3,378	2,704,602	902	1,352,301	2,475	1,352,301	6	1,623
2043	3,213	2,572,697	858	1,286,349	2,355	1,286,349	6	1,544
2044	3,056	2,447,225	816	1,223,613	2,240	1,223,613	5	1,468
2045	2,907	2,327,873	777	1,163,936	2,131	1,163,936	5	1,397
2046	2,765	2,214,341	739	1,107,170	2,027	1,107,170	5	1,329
2047	2,630	2,106,346	703	1,053,173	1,928	1,053,173	5	1,264
2048	2,502	2,003,618	668	1,001,809	1,834	1,001,809	4	1,202
2049	2,380	1,905,901	636	952,950	1,744	952,950	4	1,144
2050	2,264	1,812,949	605	906,474	1,659	906,474	4	1,088
2051	2,154	1,724,530	575	862,265	1,578	862,265	4	1,035
2052	2,049	1,640,424	547	820,212	1,501	820,212	4	984
2053	1,949	1,560,420	521	780,210	1,428	780,210	3	936
2054	1,854	1,484,317	495	742,159	1,359	742,159	3	891
2055	1,763	1,411,926	471	705,963	1,292	705,963	3	847
2056	1,677	1,343,066	448	671,533	1,229	671,533	3	806
2057	1,595	1,277,564	426	638,782	1,169	638,782	3	767
2058	1,518	1,215,256	405	607,628	1,112	607,628	3	729
2059	1,444	1,155,987	386	577,994	1,058	577,994	2	694
2060	1,373	1,099,609	367	549,805	1,006	549,805	2	660
2061	1,306	1,045,981	349	522,990	957	522,990	2	628
2062	1,243	994,967	332	497,484	911	497,484	2	597
2063	1,182	946,442	316	473,221	866	473,221	2	568
2064	1,124	900,284	300	450,142	824	450,142	2	540
2065	1,069	856,376	286	428,188	784	428,188	2	514
2066	1,017	814,610	272	407,305	746	407,305	2	489
2067	968	774,881	258	387,441	709	387,441	2	465
2068	920	737,090	246	368,545	675	368,545	2	442
2069	876	701,142	234	350,571	642	350,571	2	421
2070	833	666,947	222	333,473	610	333,473	1	400
2071	792	634,419	212	317,210	581	317,210	1	381

Annex 7: IESIA Certificate

ព្រះរាជាណាចក្រកម្ពុជា
ជាតិ សាសនា ព្រះមហាក្សត្រ

ក្រសួងសាធារណការ និងដឹកជញ្ជូន
លេខ:...១៤៦.ប.ប.....សក.អកវ៤

គោរពជូន
ឯកឧត្តមរដ្ឋមន្ត្រីក្រសួងបរិស្ថាន

ម្ចាស់គម្រោង តំណាងដោយ **ឯកឧត្តមទេសរដ្ឋមន្ត្រី រដ្ឋមន្ត្រីក្រសួងសាធារណការ និងដឹកជញ្ជូន** មានអាសយដ្ឋាន ផ្លូវលេខ៥៩៨ សង្កាត់ច្រាំងចំរេះ២ ខណ្ឌឫស្សីកែវ រាជធានីភ្នំពេញ។

សូមធ្វើកិច្ចសន្យាការពារបរិស្ថាន

ដើម្បីរួមចំណែកធានានូវនិរន្តរភាពបរិស្ថានក្នុងកិច្ចដំណើរការអភិវឌ្ឍប្រទេសជាតិ ក្រសួងសាធារណការ និងដឹកជញ្ជូន(ម្ចាស់គម្រោង) សូមធ្វើកិច្ចសន្យាការពារបរិស្ថានចំពោះក្រសួងបរិស្ថាន សម្រាប់អនុគម្រោងសាងសង់ទីលានទុកដាក់សំរាមក្រុងក្រចេះ នៃគម្រោងអភិវឌ្ឍន៍ក្រុងរបៀងនៃមហាអនុតំបន់មេគង្គទី៤ លើផ្ទៃដីទំហំ ២៧,៨៥ហិកតា (ម្ភៃប្រាំពីរ ហិកតា និងប៉ែតសិបប្រាំអា) ដែលមានទីតាំងស្ថិតនៅក្នុងភូមិសាស្ត្រភូមិខ្សារ ឃុំដារ ស្រុកចិត្របុរី ខេត្តក្រចេះ តាមប្រការដូចខាងក្រោម៖

ប្រការ១..

ធានាទទួលខុសត្រូវ និងអនុវត្តនូវខ្លឹមសារដែលបានរៀបរាប់នៅក្នុងរបាយការណ៍វាយតម្លៃហេតុប៉ះពាល់បរិស្ថាន និងសង្គមដំបូង (IESIA) សម្រាប់អនុគម្រោងសាងសង់ទីលានទុកដាក់សំរាមក្រុងក្រចេះ នៃគម្រោងអភិវឌ្ឍន៍ក្រុងរបៀងនៃមហាអនុតំបន់មេគង្គទី៤ ដែលក្រសួងបរិស្ថានបានឯកភាព។

ប្រការ២..

ធានាផ្តល់របាយការណ៍អង្កេតតាមដានបរិស្ថាន (Environmental Monitoring Report) ០១ដង/ឆ្នាំ នៅក្នុងដំណាក់កាលសាងសង់ ០១ដង/ឆ្នាំ នៅដំណាក់កាលប្រតិបត្តិគម្រោងជូននាយកដ្ឋានវាយតម្លៃហេតុប៉ះពាល់បរិស្ថាននៃក្រសួងបរិស្ថាន ដើម្បីពិនិត្យ និងវាយតម្លៃ។

ប្រការ៣..

ធានាផ្តល់របាយការណ៍សង្ខេបនៃការសិក្សាលម្អិត (Summary Detailed Design Report) សម្រាប់អនុគម្រោងសាងសង់ទីលានទុកដាក់សំរាមក្រុងក្រចេះ នៃគម្រោងអភិវឌ្ឍន៍ក្រុងរបៀងនៃមហាអនុតំបន់មេគង្គទី៤ ដែលមិនបានលម្អិតនៅក្នុងរបាយការណ៍វាយតម្លៃហេតុប៉ះពាល់បរិស្ថាន និងសង្គមដំបូង (IESIA) ដើម្បីដាក់ជូនក្រសួងបរិស្ថានពិនិត្យ និងផ្តល់យោបល់។

ប្រការ៤..

ក្នុងករណីក្រសួងបរិស្ថាន តម្រូវឱ្យម្ចាស់គម្រោងធ្វើការកែប្រែនូវបច្ចេកទេសបរិស្ថានណាមួយ ដើម្បីឱ្យសមស្របទៅតាមគោលការណ៍ណែនាំ និងកម្រិតបទដ្ឋានបរិស្ថាន ម្ចាស់គម្រោងនឹងទទួលអនុវត្តទៅតាមគោលការណ៍ណែនាំនោះទាំងស្រុង។

ផ្លូវ៥៩៨ សង្កាត់ច្រាំងចំរេះ២ ខណ្ឌឫស្សីកែវ ភ្នំពេញ ទូរស័ព្ទ-ទូរសារ(៨៥៥)២៣ ៤២៦ ៦៤០, (៨៥៥) ២៣ ៤២៧ ៨៦២

ប្រការ៥..

ទៅថ្ងៃអនាគត បើម្ចាស់គម្រោងមានគម្រោងពង្រីកបន្ថែម ឬផ្លាស់ប្តូរ ឬកែសម្រួលរបាយការណ៍សិក្សាសមិទ្ធិលទ្ធភាព (Feasibility Study Report) ឬផ្ទាកសកម្មភាព ម្ចាស់គម្រោងនឹងរាយការណ៍ជូនក្រសួងបរិស្ថានឱ្យបានមុន០១ខែ។

ប្រការ៦..

អនុញ្ញាតឱ្យមន្ត្រីជំនាញពីក្រសួងបរិស្ថាន ឬមន្ទីរបរិស្ថានខេត្តក្រចេះ ដែលមានលិខិតបញ្ជាបេសកកម្មត្រឹមត្រូវ ដើម្បីធ្វើការត្រួតពិនិត្យនៅទីតាំងតំបន់គម្រោង។

ប្រការ៧..

ក្នុងករណីដែលម្ចាស់គម្រោងពុំបានគោរពតាមប្រការណាមួយ ឬអនុវត្តផ្ទុយពីកិច្ចសន្យានេះ ឬលិខិតបទដ្ឋានគតិយុត្តចូលជាធរមានផ្សេងៗទៀត ម្ចាស់គម្រោងនឹងទទួលខុសត្រូវចំពោះមុខច្បាប់ជាធរមាន។

ថ្ងៃអង្គារ ១៤កើត ខែពិសាខ ឆ្នាំឆ្លូវត្រីស័ក ព.ស.២៥៦៥
រាជធានីភ្នំពេញ ថ្ងៃទី ១១ ខែឧសភា ឆ្នាំ២០២១
ជ.រដ្ឋមន្ត្រីក្រសួងសាធារណការ និងដឹកជញ្ជូន
រដ្ឋលេខាធិការ

ស៊ុយ សាន

បានឃើញ និងគោរពជូន
ឯកឧត្តមរដ្ឋមន្ត្រីក្រសួងបរិស្ថាន មេត្តាពិនិត្យ និងសម្រេច
លេខ៖ ៦៣០ រ.ហ.ប.ស
ថ្ងៃពុធ ៨កើត ខែជេស្ឋ ឆ្នាំឆ្លូវ ត្រីស័ក ព.ស.២៥៦៥
រាជធានីភ្នំពេញ ថ្ងៃទី២៩ ខែឧសភា ឆ្នាំ២០២១
ប្រធាននាយកដ្ឋានវាយតម្លៃហេតុប៉ះពាល់បរិស្ថាន

ជា ញ៉ែ សេរី

បានឃើញ និងឯកភាព
ថ្ងៃព្រហស្បតិ៍ ៩កើត ខែជេស្ឋ ឆ្នាំឆ្លូវ ត្រីស័ក ព.ស.២៥៦៥
រាជធានីភ្នំពេញ ថ្ងៃទី ៣០ ខែឧសភា ឆ្នាំ២០២១
ជ.រដ្ឋមន្ត្រីក្រសួងបរិស្ថាន
រដ្ឋលេខាធិការ

ស្រ៊ុន ជារិទ្ធិ

ផ្លូវ៥៩៨ សង្កាត់ច្រាំងចំរេះ២ ខណ្ឌឫស្សីកែវ ភ្នំពេញ ទូរស័ព្ទ-ទូរសារ(៨៥៥)២៣ ៤២៦ ៦៤០, (៨៥៥) ២៣ ៤២៧ ៨៦២

ព្រះរាជាណាចក្រកម្ពុជា
ជាតិ សាសនា ព្រះមហាក្សត្រ

ក្រសួងបរិស្ថាន
លេខ: ៤៧៤..ស.ស.ន.ប.ស្ត

សូមគោរពជូន
ឯកឧត្តមទេសរដ្ឋមន្ត្រី រដ្ឋមន្ត្រីក្រសួងសាធារណការ និងដឹកជញ្ជូន

កម្មវត្ថុ ៖ ការពិនិត្យ និងផ្តល់យោបល់លើរបាយការណ៍វាយតម្លៃហេតុប៉ះពាល់បរិស្ថាន និងសង្គមដំបូង (IESIA) សម្រាប់អនុគម្រោងសាងសង់ទីលានទុកដាក់សំរាមក្រុងក្រចេះ នៃគម្រោងកែលម្អគ្រប់គ្រងបរិស្ថានក្រុងជុំវិញបឹងទន្លេសាបជំហាន២ របស់ក្រសួងសាធារណការ និងដឹកជញ្ជូន នៅខេត្តក្រចេះ

យោង ៖
- ព្រះរាជក្រមលេខ នស/រកម/១២៩៦/៣៦ ចុះថ្ងៃទី២៤ ខែធ្នូ ឆ្នាំ១៩៩៦ ដែលប្រកាសឱ្យប្រើច្បាប់ស្តីពីកិច្ចការពារបរិស្ថាន និងការគ្រប់គ្រងធនធានធម្មជាតិ
- អនុក្រឹត្យលេខ៧២ អនក្រ.បក ចុះថ្ងៃទី១១ ខែសីហា ឆ្នាំ១៩៩៩ ស្តីពីកិច្ចដំណើរការវាយតម្លៃហេតុប៉ះពាល់បរិស្ថាន
- លិខិតលេខ២៩៧១ សក.អករ៤ ចុះថ្ងៃទី១៤ ខែសីហា ឆ្នាំ២០២០ របស់ក្រសួងសាធារណការ និងដឹកជញ្ជូន
- លិខិតលេខ០៤១ សក.អករ៤ ចុះថ្ងៃទី១២ ខែមករា ឆ្នាំ២០២១ របស់ក្រសួងសាធារណការ និងដឹកជញ្ជូន
- លិខិតលេខ៨៧៥ សក.អករ៤ ចុះថ្ងៃទី១១ ខែមីនា ឆ្នាំ២០២១ របស់ក្រសួងសាធារណការ និងដឹកជញ្ជូន
- លិខិតលេខ៣៩៧ សជណ ប.ស្ត ចុះថ្ងៃទី២៥ ខែមីនា ឆ្នាំ២០២១ របស់ក្រសួងបរិស្ថាន
- លិខិតលេខ១៣៣៤ វ.ហ.ប.ស្ត ចុះថ្ងៃទី២៨ ខែកញ្ញា ឆ្នាំ២០២០ របស់នាយកដ្ឋានវាយតម្លៃហេតុប៉ះពាល់បរិស្ថាននៃក្រសួងបរិស្ថាន

សេចក្តីដូចមានចែងក្នុងកម្មវត្ថុ និងយោងខាងលើ ខ្ញុំសូមគោរពជម្រាបជូន **ឯកឧត្តមទេសរដ្ឋមន្ត្រី** មេត្តាជ្រាបថា ក្រសួងបរិស្ថានឯកភាពលើរបាយការណ៍វាយតម្លៃហេតុប៉ះពាល់បរិស្ថាន និងសង្គមដំបូង (IESIA) សម្រាប់អនុគម្រោងសាងសង់ទីលានទុកដាក់សំរាមក្រុងក្រចេះ នៃគម្រោងកែលម្អគ្រប់គ្រងបរិស្ថានក្រុងជុំវិញបឹងទន្លេសាបជំហាន២ លើផ្ទៃដីទំហំ ២៧,៨៥ហិកតា (ម្ភៃប្រាំពីរហិកតា និងប៉ែតសិបប្រាំអា) ដែលមានទីតាំងភូមិសាស្ត្រស្ថិតនៅក្នុងភូមិខ្សារ ឃុំដារ ស្រុកចិត្របុរី ខេត្តក្រចេះ របស់ក្រសួងសាធារណការ និងដឹកជញ្ជូន (ម្ចាស់គម្រោង) ដោយម្ចាស់គម្រោងត្រូវគោរពតាមកិច្ចសន្យាការពារបរិស្ថានលេខ១៤៦១ សក.អករ៤ ចុះថ្ងៃទី១១ ខែឧសភា ឆ្នាំ២០២១ របស់ក្រសួងសាធារណការ និងដឹកជញ្ជូន។

អាស្រ័យដូចបានគោរពជម្រាបជូនខាងលើ សូម **ឯកឧត្តមទេសរដ្ឋមន្ត្រី** មេត្តាអនុវត្ត និងចាត់ចែងដោយសេចក្តីអនុគ្រោះ។

សូម **ឯកឧត្តមទេសរដ្ឋមន្ត្រី** មេត្តាទទួលនូវសេចក្តីគោរពពីខ្ញុំ។

ថ្ងៃ[illegible] ខែ[illegible] ឆ្នាំឆ្លូវ ត្រីស័ក ព.ស. ២៥៦៥
រាជធានីភ្នំពេញ ថ្ងៃទី[illegible] ខែ ឧសភា ឆ្នាំ២០២១

រដ្ឋលេខាធិការ

ស្ត្រុន ដារិទ្ធិ

ចម្លងជូន៖
- ទីស្តីការគណៈរដ្ឋមន្ត្រី
- ក្រសួងសេដ្ឋកិច្ច និងហិរញ្ញវត្ថុ
- ក្រសួងរៀបចំដែនដី នគរូបនីយកម្ម និងសំណង់
- រដ្ឋបាលខេត្តក្រចេះ
- មន្ទីរបរិស្ថានខេត្តក្រចេះ
- ឯកសារ កាលប្បវត្តិ

KINGDOM OF CAMBODIA
Nation Religion King

(Logo)
Ministry of Public Works and Transport
No. 1461 MPWT/OKR4

Attention to

His Excellency Minister of Environment
Owner of the Project, represented by **His Excellency Senior Minister and Minister of Public Works and Transport**
Address: St 598, Sangkat Chrang Chamres II, Khan Russey Keo, Phnom Penh

It is committed to protecting the environment.

In order to contribute to ensuring environmental sustainability in the national development process, Ministry of Public Works and Transport is committed to protecting the environment for the Ministry of Environment in relation to the Solid Waste Management Sub-project in Kratie Town of the Fourth Great Mekong Sub-Region Corridor Towns Development project with area of 27,85ha located at Khsar Village, Dar Commune, Chetr Borei District, Kratie Province, under the following terms and conditions:

Article 1.-

It is guaranteed to responsibly comply with the content described in the Initial Environmental and Social Impact Assessment Report (IESIA) for the Solid Waste Management sub-project in Kratie Town of the Fourth Great Mekong Sub-Region Corridor Towns Development project, which was approved by the Ministry of Environment.

Article 2.-

It is further guaranteed to submit an Environmental Monitoring Report once a year during the phase of construction and once in the first year during the operational phase of the project to the Ministry of Environment for review and evaluation.

Article 3.-

It is further guaranteed to submit a Summary Detailed Design Report for the Solid Waste Management sub-project in Kratie Town of the Fourth Great Mekong Sub-Region Corridor Towns Development project, as not detailed in the Initial Environmental and Social Impact Assessment Report – IESIA, to the Ministry of Environment for review and comment.

Article 4.-

In the event that the Ministry of Environment requires the Project Owner to modify any particular environmental technical details to be consistent with the guidelines and environmental standards, the Project Owner will accept to fully comply with those guidelines.

Article 5.-

In the event that the Project Owner plans to expand the project, change or modify the Feasibility Study Report or suspend the activities in the future, the Project Owner will report the same to the Ministry of Environment within 01 month in advance.

Article 6.-

Permission will be given to expert officials from the Ministry of Environment or Kratie Provincial Department of Environment, holding a valid mission order, to carry out an inspection on the project site.

Article 7.-

In the event that the Project Owner fails to comply with any article herein or violates these commitments or any other applicable regulations, the former will assume responsibility before the applicable laws.

Phnom Penh, May 11, 2021
For Minister of Public Works and Transport
Secretary of State
(Signature and stamp)

SUY SAN

Seen and respectfully submitted to
His Excellency Minister of Environment
for review and approval.

No. 630 EIAD
Phnom Penh, May 19, 2021
Director of Environmental Impact Assessment Department
(Signature)

DANH SEREY

Seen and approved
Phnom Penh, May 20, 2021
For Minister of Environment
Secretary of State
(Signature and stamp)

SRUN DARITH

KINGDOM OF CAMBODIA
Nation Religion King

(Logo)
MINISTRY OF ENVIRONMENT
No. 672 S.Chh.N.MoE

Respectfully to
His Excellency Senior Minister and Minister of Public Works and Transport

Subject: Regarding the review and comment on the Initial Environmental and Social Impact Assessment - IESIA Report for the Solid Waste Management sub-project in Kratie Town, Kratie Province of the Fourth Great Mekong Sub-Region Corridor Towns Development project.

Ref.:
- Royal Code No. NS/KRM/1296/36, dated December 24, 1996, promulgating the Law on Environmental Protection and Management of Natural Resources,
- Sub-Decree No. 72 Ankr.Bk, dated August 11, 1999, concerning the Environmental Impact Assessment Process,
- Letter No 2971 SK/OKR4, dated August 14, 2020, of the Ministry of Public Works and Transport,
- Letter No. 041 SK/OKR4, dated January 12, 2021, of the Ministry of Public Works and Transport,
- Letter No. 875 SK/OKR4, dated March 11, 2021, of the Ministry of Public Works and Transport,
- Letter No. 397 S.C.N.MoE, dated March 25, 2021, of the Ministry of Environment,
- Letter No. 1334 V.H.MoE, dated September 28, 2020, of the Environmental Impact Assessment Department of Ministry of Environment,

With regard to the above mentioned subject and references, I would respectfully like to inform **Your Excellency Senior Minister** that the Ministry of Environment has approved the Initial Environmental and Social Impact Assessment Report for the Solid Waste Management sub-project in Kratie Town of the Fourth Great Mekong Sub-Region Corridor Towns Development project with area of 27, 85ha located at Khsar Village, Dar Commune, Chetr Borei District, Kratie Province, the project of the Ministry of Public Works and Transport (Principal) subject to the Principal's compliance with the Environmental Protection Commitment No. 1461 SK/OKR4, dated May 11, 2021 of the Ministry of Public Works and Transport.

In view of the foregoing, may **Your Excellency Senior Minister** follow the above instruction and take appropriate action accordingly.

Please accept **Your Excellency Senior Minister,** the assurances of my highest regards.

Phnom Penh, May 20, 2021
For Minister
Secretary of State
(Signature and stamp)

SRUN DARITH

CC:
- Office of the Council of Ministers
- Ministry of Economy and Finance
- Ministry of Land Management, Urban Planning and Construction
- Kratie Provincial Administration
- Kratie Provincial Department of Environment
- File – Archive

Morodok Techo Building, Lot 503, Tonle Bassac Riverfront Road, Tonle Bassac quarter, Chamkar Mon district, Phnom Penh, Tel: 023 235 004 / 023 235 006

Annex 8: IBAT Proximity Assessment

Integrated Biodiversity Assessment Tool

PROXIMITY REPORT
KRATIE LANDFILL

Country: Cambodia

Location: [12.5, 106.2]

Date of analysis: 07 June 2021 (GMT)

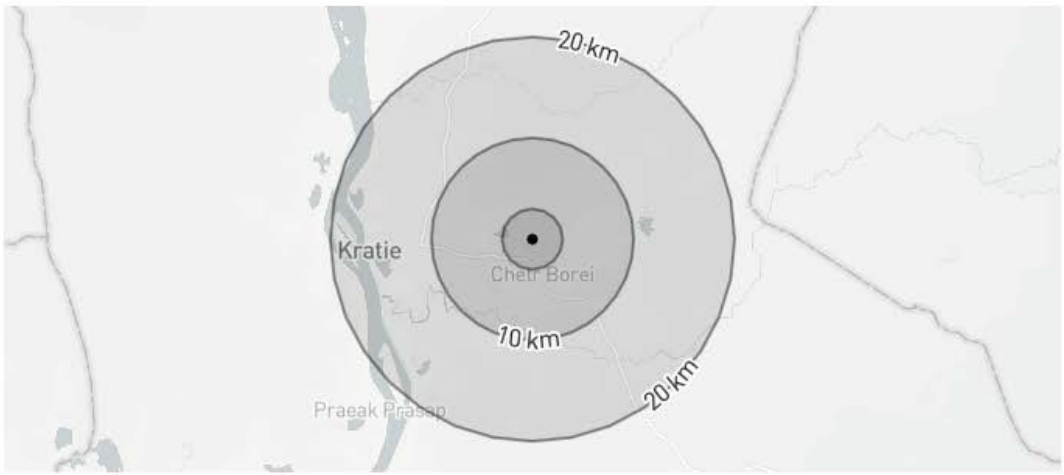
Buffers applied: 3 km | 10 km | 20 km

Generated by: Peter Gammelgaard Jensen

Organisation: ADB

Overlaps with:

Protected Areas	0
Key Biodiversity Areas	2
IUCN Red List	86



Displaying project location and buffers: 3 km, 10 km, 20 km

About this report

This report presents the results of [6690-17041] proximity analysis to identify the biodiversity features and species which are located within the following buffers: 3 km, 10 km, 20 km.

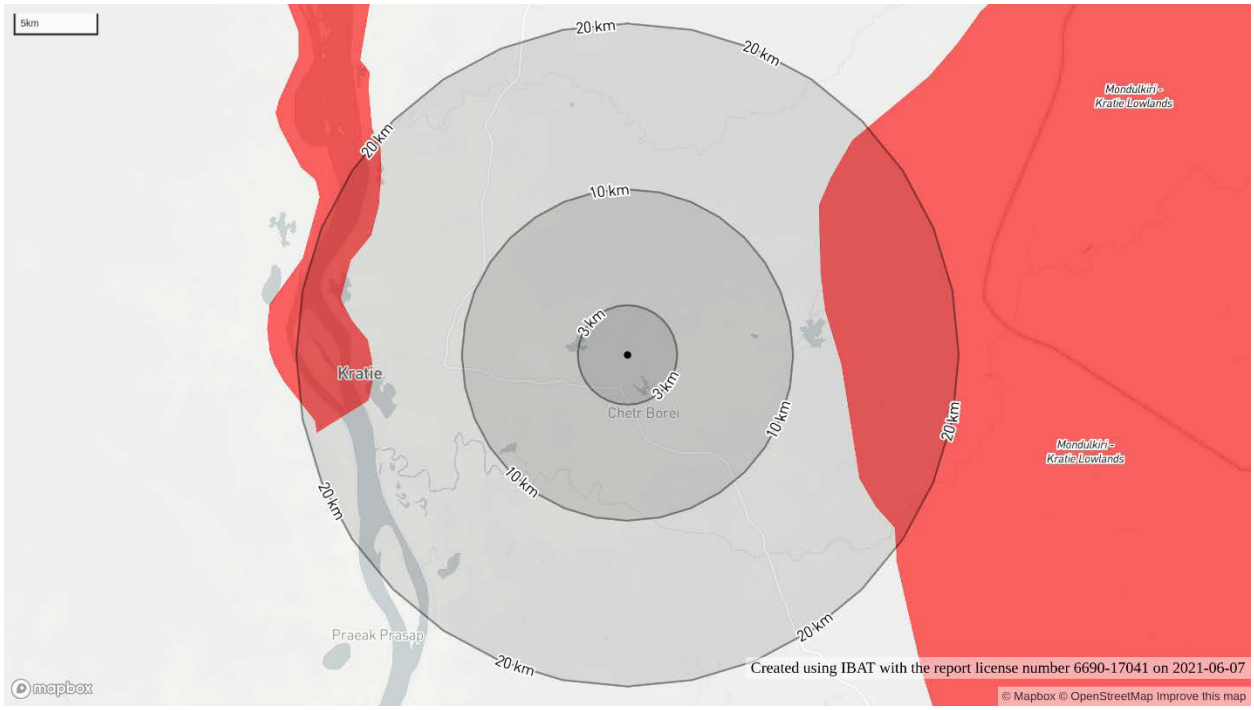
This report is one part of a package generated by IBAT on 07 June 2021 (GMT) that includes full list of all species, protected areas, Key Biodiversity Areas in CSV format, maps showing the area of interest in relation to these features, and a 'How to read IBAT reports' document.

WARNING: IBAT aims to provide the most up-to-date and accurate information available at the time of analysis. There is however a possibility of incomplete, incorrect or out-of-date information. All findings in this report must be supported by further desktop review, consultation with experts and/or on-the-ground field assessment. Please consult IBAT for any additional disclaimers or recommendations applicable to the information used to generate this report.

Please note, sensitive species data are currently not included in IBAT reports in line with the Sensitive Data Access Restrictions Policy for the IUCN Red List. This relates to sensitive Threatened species and KBAs triggered by sensitive species.

Data used to generate this report

- UNEP-WCMC and IUCN, 2021. Protected Planet: The World Database on Protected Areas (WDPA)[On-line], Cambridge, UK: UNEP-WCMC and IUCN. Available at: www.protectedplanet.net - June 2021.
- BirdLife International (on behalf of the KBA Partnership), 2021. Key Biodiversity Areas - April 2021.
- IUCN, 2021. IUCN Red List of Threatened Species - April 2021.


5km
20 km
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20 km
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3 km
3 km
10 km
10 km
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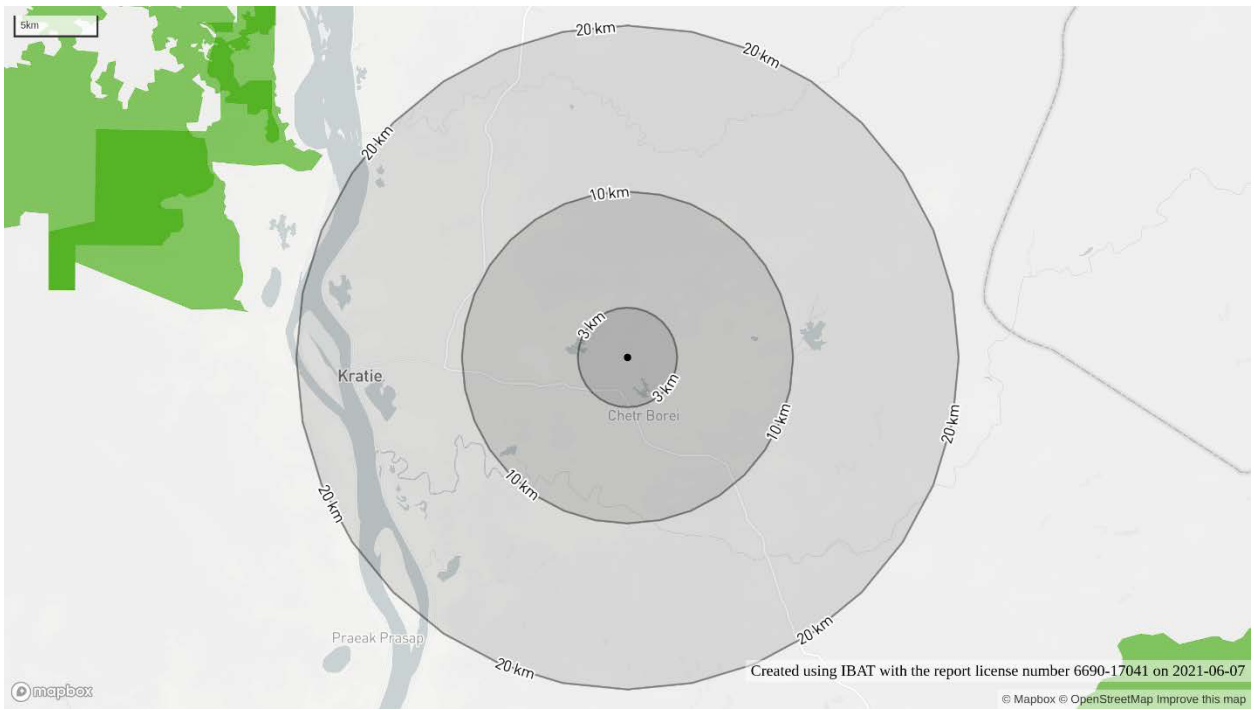
20 km
20 km
20 km
Kratie
Chetr Borei
Praeak Prasap
Mondulkiri - Kratie Lowlands
Mondulkiri - Kratie Lowlands
Created using IBAT with the report license number 6690-17041 on 2021-06-07
© Mapbox © OpenStreetMap Improve this map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20 km
20 km
20 km
Kratie
Chetr Borei
Praeak Prasap
Created using IBAT with the report license number 6690-17041 on 2021-06-07
© Mapbox © OpenStreetMap Improve this map

Integrated Biodiversity Assessment Tool

PROXIMITY REPORT
KRATIE OLD DUMPSITE

Country: Cambodia

Location: [12.5, 106.1]

Date of analysis: 07 June 2021 (GMT)

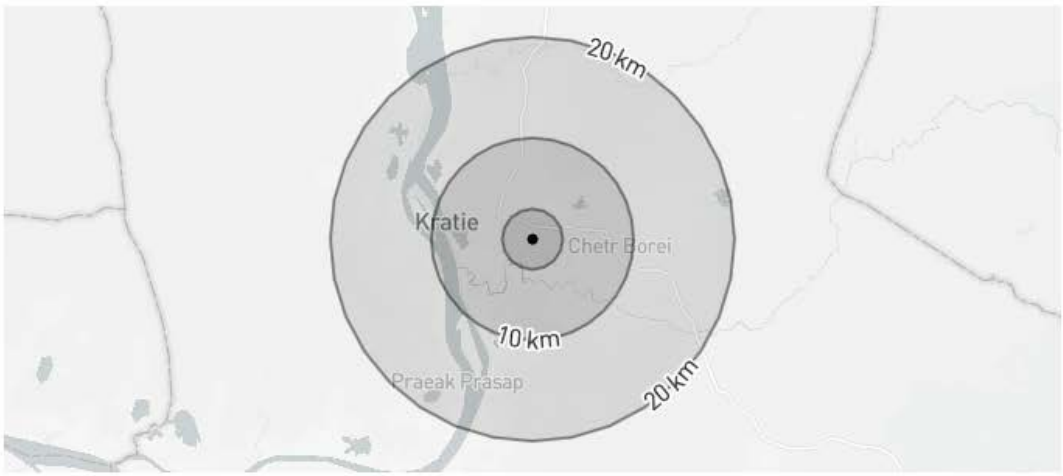
Buffers applied: 3 km | 10 km | 20 km

Generated by: Peter Gammelgaard Jensen

Organisation: ADB

Overlaps with:

Protected Areas	1
Key Biodiversity Areas	2
IUCN Red List	83



Displaying project location and buffers: 3 km, 10 km, 20 km

About this report

This report presents the results of [6690-17042] proximity analysis to identify the biodiversity features and species which are located within the following buffers: 3 km, 10 km, 20 km.

This report is one part of a package generated by IBAT on 07 June 2021 (GMT) that includes full list of all species, protected areas, Key Biodiversity Areas in CSV format, maps showing the area of interest in relation to these features, and a 'How to read IBAT reports' document.

WARNING: IBAT aims to provide the most up-to-date and accurate information available at the time of analysis. There is however a possibility of incomplete, incorrect or out-of-date information. All findings in this report must be supported by further desktop review, consultation with experts and/or on-the-ground field assessment. Please consult IBAT for any additional disclaimers or recommendations applicable to the information used to generate this report.

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Data used to generate this report

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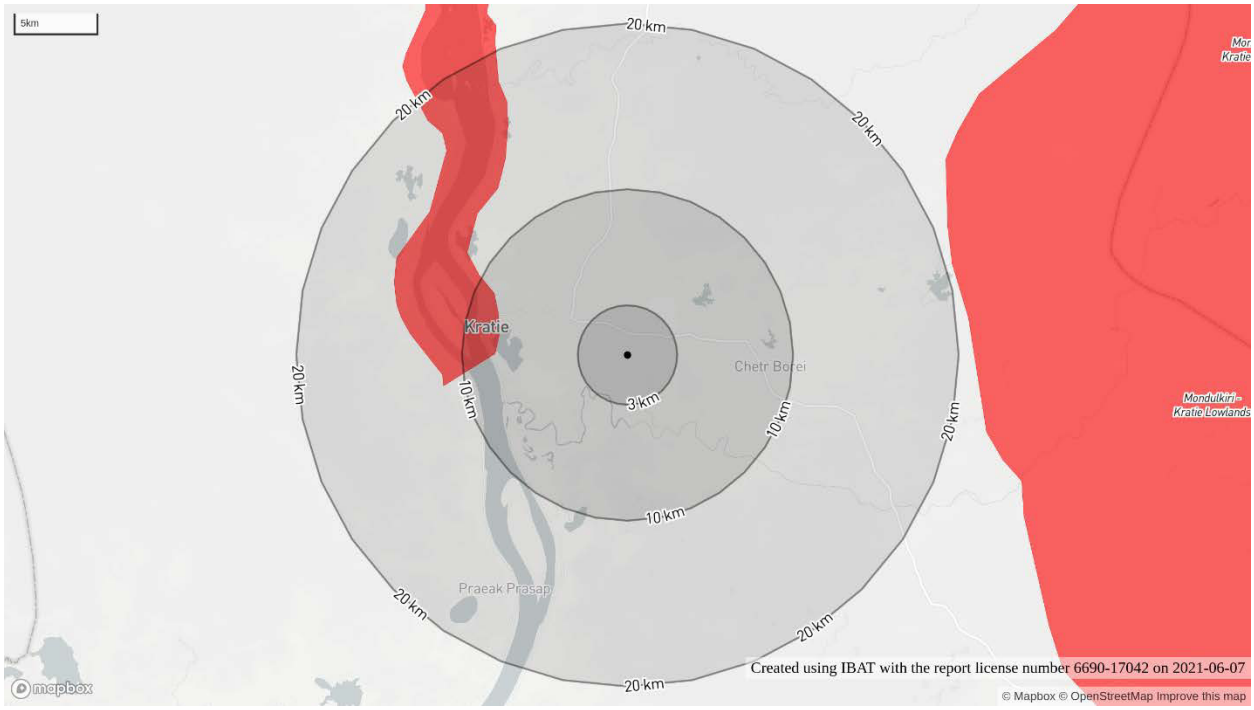
- BirdLife International (on behalf of the KBA Partnership), 2021. Key Biodiversity Areas - April 2021.
- IUCN, 2021. IUCN Red List of Threatened Species - April 2021.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Kratie
Chetr Borei
Praeak Prasap
Mondulkiri - Kratie Lowlands
Created using IBAT with the report license number 6690-17042 on 2021-06-07
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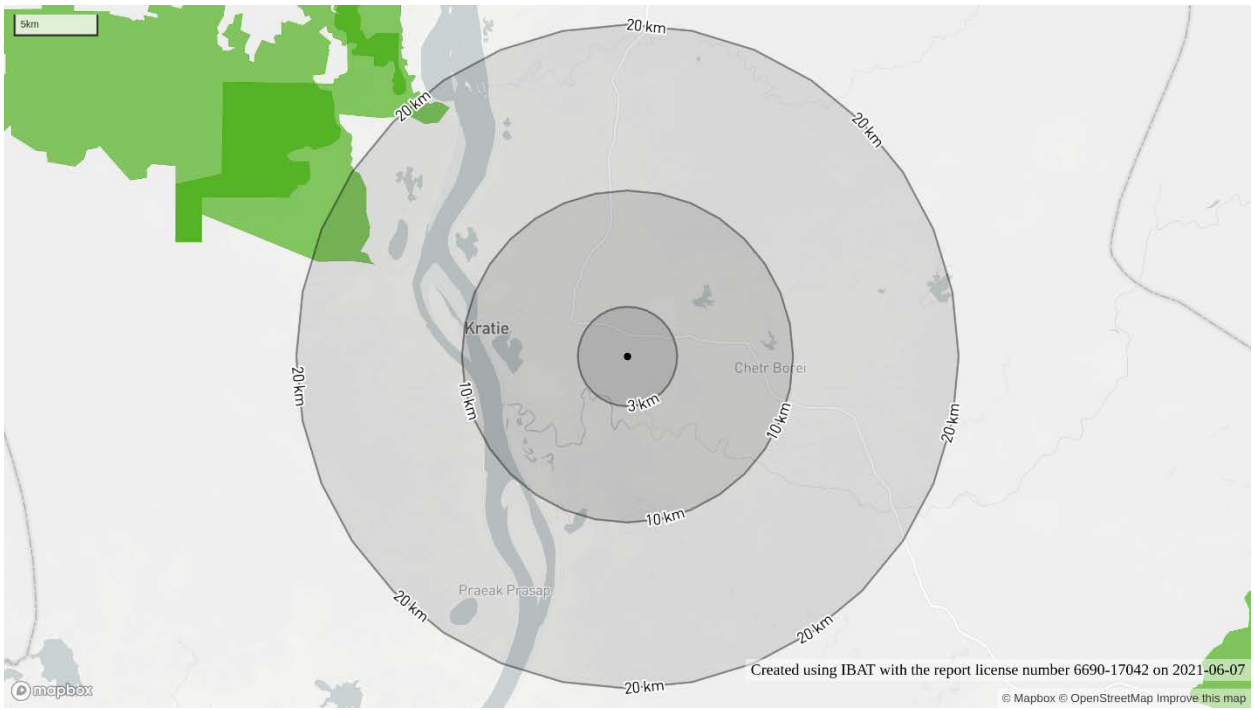
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Kratie
Chetr Borei
Praeak Prasap
Created using IBAT with the report license number 6690-17042 on 2021-06-07
© Mapbox © OpenStreetMap Improve this map

Annex 9: Water Balance in the Leachate Ponds

The modelling is based on average rainfall but has not taking recirculation into account

Source: Detailed Engineering Design, Kratie Landfill Subproject, May 2021

Year	Month	Rain mm/ month	Evaporation mm/ month	Leachate	Pond 1 (Anaerobic) 2,091 m^2; 5,112 m^3		Pond 2 (aerobic) 1,955 m^2; 1,825 m^3		Pond 3 (Wetland) 1,850 m^2; 1,937 m^3		Pond 4 (Treated Water) 1,747 m^2; 4,187 m^3	
					Water Balance	Cumulative water balance	Water Balance	Cumulative water balance	Water Balance	Cumulative water balance	Water Balance	Cumulative water balance
2022	October	158	125	0	135	135	126	126	119	119	113	113
2022	Novembe	105	130	0	17	152	16	142	15	15	14	127
2022	Decembe	19	130	0	-164	0	-153	0	-145	0	-137	0
2023	January	2	140	0	-215	0	-201	0	-191	0	-180	0
2023	February	4	140	0	-211	0	-197	0	-187	0	-176	0
2023	March	26	175	0	-220	0	-206	0	-195	0	-184	0
2023	April	82	160	0	-79	0	-74	0	-70	0	-66	0
2023	May	197	160	189	351	0	151	0	143	143	135	0
2023	June	217	140	189	424	36	220	0	208	208	196	0
2023	July	300	140	189	597	633	381	62	361	361	341	55
2023	August	221	135	189	439	1,072	234	296	221	221	209	264
2023	Septembe	288	120	189	603	1,675	387	683	367	367	346	610
2023	October	158	125	189	324	1,999	126	809	119	119	113	723
2023	Novembe	105	130	24	41	2,040	16	825	15	15	14	737
2023	Decembe	19	130	24	-140	1,900	-153	671	-145	0	-137	600
2024	January	2	140	24	-191	1,709	-201	470	-191	0	-180	420
2024	February	4	140	24	-187	1,522	-197	272	-187	0	-176	243
2024	March	26	175	24	-196	1,327	-206	67	-195	0	-184	60
2024	April	82	160	24	-55	1,272	-74	0	-70	0	-66	0
2024	May	127	160	220	235	1,507	14	7	13	13	13	6
2024	June	151	140	220	316	1,823	90	96	85	85	80	86
2024	July	190	140	220	399	2,222	167	263	158	158	149	235
2024	August	151	135	220	324	2,546	97	361	92	92	87	322
2024	Septembe	243	120	220	540	3,086	299	660	283	283	267	589
2024	October	198	125	220	439	3,524	205	864	194	194	183	772
2024	Novembe	36	130	29	-99	3,425	-120	744	-114	0	-107	665
2024	Decembe	22	130	29	-128	3,297	-148	596	-140	0	-132	533
2025	January	8	140	29	-173	3,124	-189	407	-179	0	-169	364
2025	February	18	140	29	-152	2,972	-169	238	-160	0	-151	213
2025	March	27	175	29	-188	2,784	-203	35	-192	0	-182	31

Year	Month	Rain mm/ month	Evaporation mm/ month	Leachate	Pond 1 (Anaerobic) 2,091 m^2; 5,112 m^3		Pond 2 (aerobic) 1,955 m^2; 1,825 m^3		Pond 3 (Wetland) 1,850 m^2; 1,937 m^3		Pond 4 (Treated Water) 1,747 m^2; 4,187 m^3	
					Water Balance	Cumulative water balance	Water Balance	Cumulative water balance	Water Balance	Cumulative water balance	Water Balance	Cumulative water balance
2025	April	65	160	29	-85	2,699	-107	0	-101	0	-96	0
2025	May	127	160	253	268	2,967	14	0	13	13	13	0
2025	June	151	140	253	349	3,315	90	32	85	85	80	28
2025	July	190	140	253	431	3,747	167	199	158	158	149	177
2025	August	151	135	253	357	4,103	97	296	92	92	87	264
2025	Septembe	243	120	253	572	4,676	299	595	283	283	267	532
2025	October	198	125	253	471	5,147	240	835	194	194	183	715
2025	Novembe	36	130	35	-94	5,053	-120	714	-114	0	-107	607
2025	Decembe	22	130	35	-123	4,930	-148	567	-140	0	-132	475
2026	January	8	140	35	-168	4,762	-189	378	-179	0	-169	306
2026	February	18	140	35	-146	4,616	-169	208	-160	0	-151	155
2026	March	27	175	35	-183	4,433	-203	5	-192	0	-182	0
2026	April	65	160	35	-80	4,353	-107	0	-101	0	-96	0
2026	May	127	160	287	302	4,655	14	0	13	13	13	0
2026	June	151	140	287	383	5,038	90	2	85	85	80	0
2026	July	190	140	287	466	5,504	559	560	158	158	149	120
2026	August	151	135	287	391	5,895	880	1,440	92	92	87	207
2026	Septembe	243	120	287	607	6,501	1,689	3,129	1,587	1,587	1,854	2,061
2026	October	198	125	287	506	7,007	2,100	5,229	3,597	3,597	3,780	5,841
2026	Novembe	36	130	40	-89	6,919	1,687	6,915	4,977	4,977	4,869	10,710
2026	Decembe	22	130	40	-118	6,801	1,541	8,457	6,492	6,492	6,360	17,070

Annex 10: Environmental Compliance Audit for the Solid Waste Dumpsites

Environmental Compliance Audit

Solid Waste Dumpsites

July 2021

CAM: Fourth Greater Mekong Sub-Region Corridor Towns Development Project

Solid Waste Management Subproject, Kratie City, Kratie Province

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

CURRENCY EQUIVALENTS

(as of 2021)

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

ABBREVIATIONS

ADB	–	Asian Development Bank
CEMP	–	Construction Environmental Management Plan
ECA	–	Environmental Compliance Audit
EMP	–	Environmental Management Plan
IEE	–	Initial Environmental Examination
MoE	–	Ministry of Environment
MPWT	–	Ministry of Public Works and Transport
TS-2	–	Second Tonle Sap Urban Environmental Management Project
WWTP	-	Wastewater Treatment Plant

Contents

1. Background

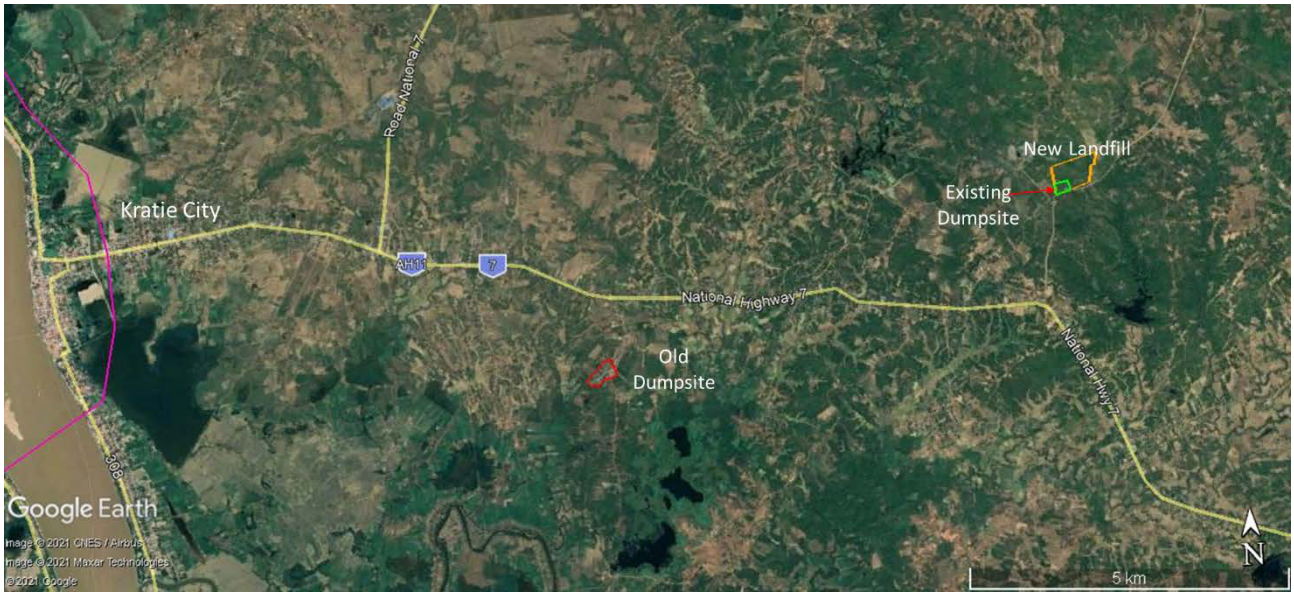
This document contains an environmental compliance audit of two solid waste dumpsites in Kratie City area. The audit has been prepared under the Fourth Greater Mekong Subregion Corridor Towns Development Project (GMS4 or CTDP-4 Project) financed by the Asian Development Bank (ADB).

The CTDP-4 Project is supporting the Governments of Cambodia and the Lao People's Democratic Republic (PDR) in enhancing the competitiveness of selected towns located along the Central Mekong Economic Corridor in the Greater Mekong Subregion (GMS).

In Cambodia, the Project is implemented by the Ministry of Public Works and Transport. The project will improve urban environmental services in Kampong Cham, Kratie and Stung Treng, three of Cambodia's provincial cities located on Mekong River. The Project is divided into a number of subprojects and for Kratie City, the Solid Waste Management Subproject includes construction of a controlled landfill. As part of the planned improvements to solid waste management, the Subproject will consider closure of old and/or existing dumpsites in the Subproject area.

There are two dumpsites in Kratie City (one known as the "old dumpsite" and the other known as "the existing dumpsite" – see ***Figure 1***). These dumpsites are considered *Existing Facilities*[1] of the wider CTDP-4 Project and according to the ADB Safeguard Statement (2009) para 10 of Appendix 1 and para 12 of Appendix 4, an Environmental Compliance Audit (ECA) shall be conducted of the facilities.

Figure 1: Overview Map of the Dumpsites and the New Landfill Site



1.1. Objective and Scope of the ECA

The ECA is divided into two phases, where phase 1 is an initial assessment with the objective to identify the main risks, and outline possible solutions including any need for immediate mitigation measures at the dumpsite to minimise any on-going pollution and risks to human health and the environment.

[1] *Existing Facilities: For projects involving facilities and/or business activities that already exist or are under construction, 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.*

Phase 2 is an optional phase in case a permanent solution has not been found under the first phase. Phase 2 will then include more detailed and physical site investigations and analyses as may be necessary to make a decision on the long-term solution and to provide information for the preparation of the detailed remediation design.

This document covers phase 1 of the ECA for both the old and the existing dumpsite.

2. The Existing Dumpsite

2.1. Salient Information

Salient information about the existing dumpsite is summarized in ***Table 1***.

Table 1: Salient Information on the Existing Dumpsite

Aspect	Description
Location	Khya Village, Dar commune, Cheatr Borei District, Kratie Province (see ***Figure 1*** and ***Figure 2***)
Land Ownership	The dumpsite is on State Land
Size	The dumpsite covers an area of approximately 3.6 ha in the southwestern corner of the 30 ha large future landfill site (see ***Figure 2***)
Management	The dumpsite is under the responsibility of Kratie Provincial Department of Public Works and Transport in collaboration with Kratie Provincial Department of Environment
Approvals	The dumpsite has been approved by Kratie Provincial Authorities
Waste collection and transport	Waste collection and transport to the dumpsite are carried out by a private company, Tuk Khun Company
Period of operation	Since 2015 (see ***Figure 2, Figure 3*** and ***Figure 4***)
Waste disposal rate	Approximately 14 tonnes per day (dry season) – rather uncertain
Total waste deposited	Estimated to 7,344 tonnes (see ***Section 2.2.1***)

Figure 2: Satellite Image of the Area for the Existing Dumpsite, December 2013

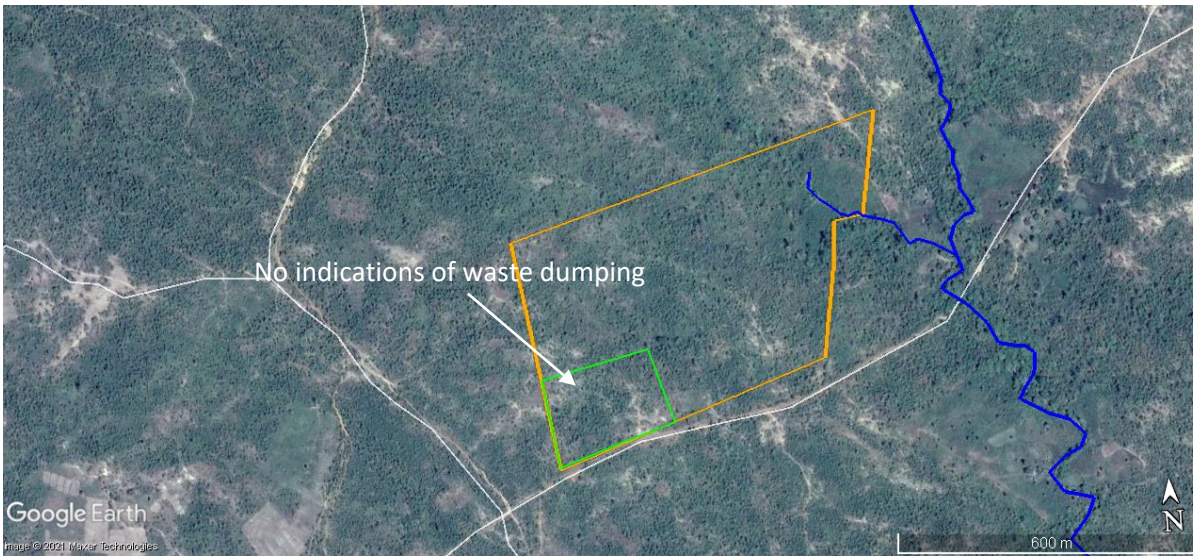


Figure 3: Satellite Image of the Existing Dumpsite, November 2015

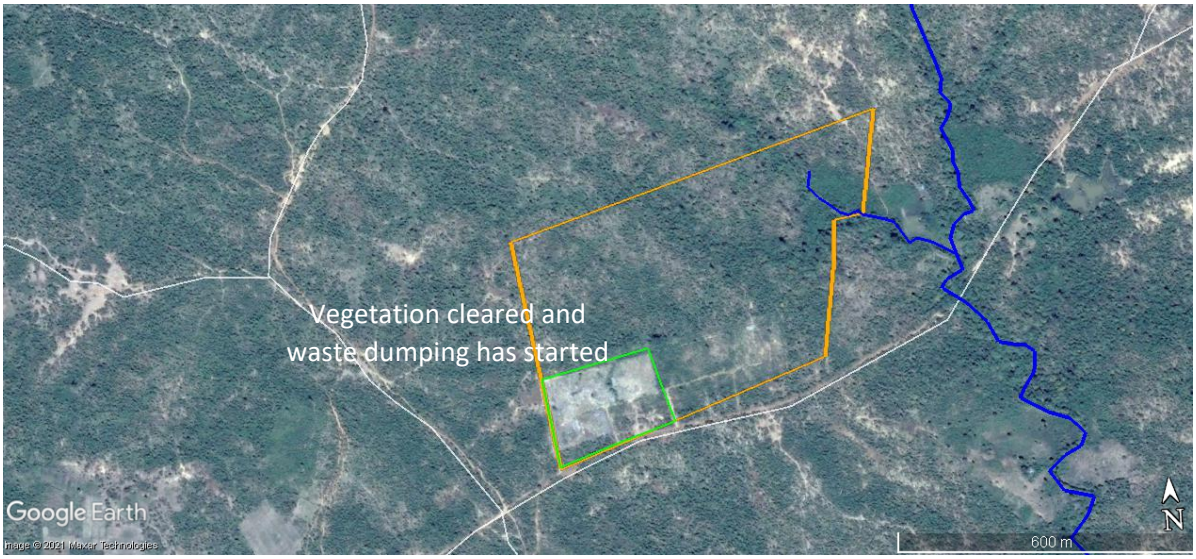


Figure 4: Satellite Image of the Existing Dumpsite, November 2018

2.2. Dumpsite Description

2.2.1. Physical Layout

The existing waste dump occupies the southwest corner of the 30-hectare large future landfill site. The dumpsite has a footprint of approximately 3.6 ha, although this area has not been entirely used for depositing waste. The dumpsite is comprised of four cells, which are neither lined nor have leachate collection systems. To date, only three of the cells have been utilised, with the bottom right cell so far unused entirely (this is the area where the landfill buildings will be located). As shown in ***Figure 5***, waste has been deposited to varying depths across this area, from 1 m to 2.5 m.

A small pond is located in the south-eastern corner of the dumpsite. This is probably a former borrow pit (see ***Figure 6***). No waste has been dumped in the pond.

Figure 5: **Existing Dumpsite Within the future Landfill Area**

Based on estimated depths and the area of the waste cells (noting that waste is not spread across the entire area of the cells), it has been very roughly calculated that the existing dumpsite contains 11,750 m^3 of waste.

According to ADB, with no compaction the waste density in a landfill will be 300 kg/m^3. Taking into account some subsequent settlement of the wastes, it has been calculated that the site may contain between 3,525 to 5,875 tonnes of waste, with the former figure accounting for settlement and using a rate of 500 kg/m^3. To take further into account uncertainties on the depths of the cells, a 25% additional contingency on the likely volume of waste has been applied. Therefore, it is assumed that there may be up to **7,344 tonnes** of waste in the dumpsite.

Table 2 Volume of Existing Waste

Cell	Location	Length (m)	Height (m)	Size (m2)	Waste Height (m)	Air Space (m3)	Tonnes of Waste	Tonnes of Waste with Settlement
1	SW	20	35	700	1.5	1,050	315	525
2	NW	70	20	1,400	2.5	3,500	1,050	1,750
3	NE	80	60	4,800	1.5	7,200	2,160	3,600
4	SE							
Total				**6,900**		**11,750**	**3,525**	**5,875**

Figure 6: Existing Dumpsite

Dumpsite in the southwestern corner of the landfill site

Pond at the existing dumpsite in the southwestern corner of the landfill. Probably former borrow pit

2.2.2. Waste Composition

The composition of the waste disposed at the existing dumpsite is unknown but based on various solid waste management studies in Cambodia, at the time of disposal, the waste is likely to have contained about 60% biodegradable components and the remaining 40% would include potentially recyclables and non-biodegradable waste. The biodegradable content has most likely already decomposed and only the most recently deposited waste will still contain biodegradable components. There are no major industries or other generators of any significant amounts of hazardous waste in Kratie City, and the content of hazardous substances in the dumpsite waste is therefore likely rather limited and will mainly include the types and amounts commonly found in waste from small-businesses and households in low-income areas. The possible content of infectious waste from health care facilities is unknown but cannot be ruled out. However, as pathogenic micro-organisms have a limited capacity of survival in the environment, these organisms are unlikely to have survived in waste that is older than 1-2 months.

Informal recyclers from eleven households occasionally collect waste for recycling at the site.[2]

[2] PMC Pre-screening Note, 28 January 2020

2.3. Assessment of Environmental and Social Impacts

2.3.1. Potential Impacts on Sensitive Receptors

The sensitive receptors of concern in terms of potential environmental and social impacts associated with the existing dumpsite are summarised in ***Table 3*** and the receptors in the immediate surroundings of the dumpsite are indicated in ***Figure 7***.

Table 3: The Existing Dumpsite and Sensitive Receptors

Surface Water Receptors	Socio-Economic & Cultural Receptors	Land Cover/ Ecological Receptors	Protected Area Status
- 600 m from Or Kantuot Stream which flows 2 km to a 16 ha irrigation reservoir - 500 m from a small ephemeral stream that connects to Or Kantuot Stream north-east of the dumpsite	- State Land - about 15 km for Kratie City and 17 km from Mekong River - 2 km from national road No. 7 - 2 km from Khsar village, Dar commune, with houses, schools, pagoda and other rural local utilities. - Primary school 1.7 km southwest of the site. - A stone quarry 350 m northwest of the site	- The site is covered with degraded forest and secondary shrub - Surrounding area is upland area with secondary forest/shrub and patches of agricultural land	- Mondulkiri - Kratie Lowlands Key Biodiversity Area located about 11 km to the east - the Mekong River Kratie to Lao Border Key Biodiversity Area about 15 km to the west

Source: Google Earth, IBAT proximity assessment, PMC site visits

The proximity of the dumpsite to Key Biodiversity Areas (KBI) and National Protected Areas, Ramsar Sites etc. has been analysed using the Integrated Biodiversity Assessment Tool (IBAT). The IBAT Proximity Report (attached in Appendix 1) shows that the nearest Key Biodiversity Area is the Mondulkiri - Kratie Lowlands Key Biodiversity Area located about 11 km to the east. The Mekong River Kratie to Lao Border Key Biodiversity Area is located about 15 km to the west. Based on the IBAT proximity assessment it can be concluded that the dumpsite is not located within any legally protected area or area that is internationally recognized for biodiversity.

Table 4 contains an assessment of compliance with the current landfill siting criteria as an indication of the potential environmental and social impacts on sensitive receptors. The assessment shows that the location of the dumpsite is basically consistent with the siting criteria, but it should also be taken into account that the siting criteria are meant to apply to a properly designed and operated landfill.

Inconsistencies with the siting criteria include:

- The dumpsite is 0.6 km from a water body where the siting criteria is 3 km. The siting complies with the criteria recommended by the World Bank (> 0.3 km to a perennial stream) but considering the dumpsite design and operation (see next section) the risk of water pollution is evident.
- The dumpsite is located 1.7 km from the nearest school where the siting criteria is 3 km. The siting complies with the criteria recommended by the World Bank (1 km to a socio-politically sensitive sites such as schools, places of worship).

Figure 7: Receptors in the Immediate Surroundings of the Existing Dumpsite

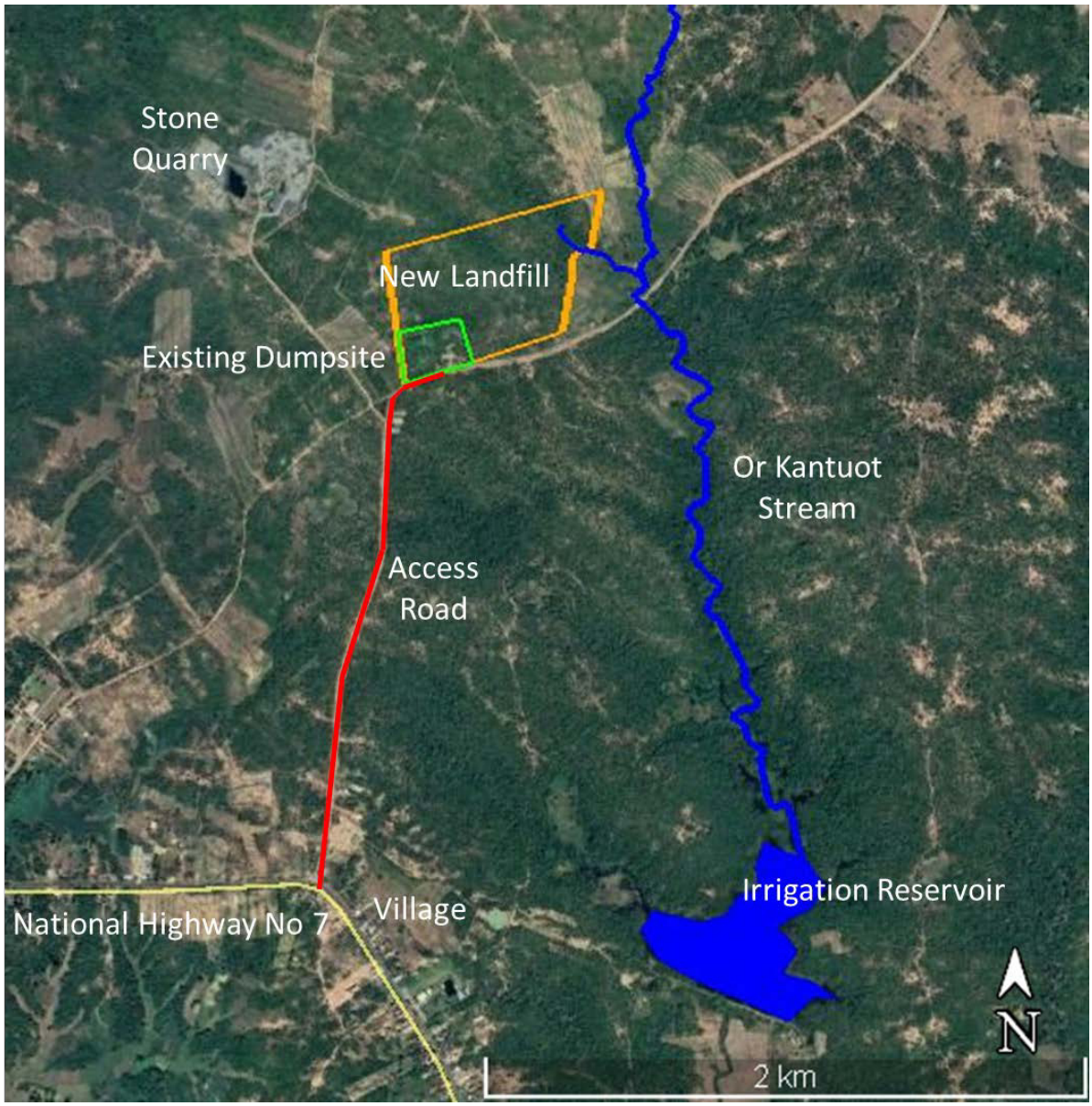


Table 4: Location of the Existing Dumpsite compared with the Current (2016) Siting Criteria

Landfill Siting Guidelines (2016)		Dumpsite Location
Minimum distances to Receptors	1 km from any residential property	- 2 km to residential area
	3 km from any school/health centre/natural resources/ water source	- 1.7 km to the nearest school - A small temporary stream that connects to Or Kantuot Stream 500 m from the dumpsite. - Or Kantuot Stream flows 2 km to a 16 ha irrigation reservoir
	5 km from any place of worship and resort	- 2.5 km to nearest pagoda
	8 km from an airport	- 15 km to the airport
	10 km from town centre	- 15 km to the city

Landfill Siting Guidelines (2016)		Dumpsite Location
	15 km from any heritage site	- No heritage site within a 20 km radius - Mondulkiri - Kratie Lowlands Key Biodiversity Area located about 11 km to the east - the Mekong River Kratie to Lao Border Key Biodiversity Area about 15 km to the west
Hydrology	Not in a flood prone area	- the landfill is not located in a flood prone area
	Depth to groundwater from the bottom of the cell > 3 m	- groundwater is at least 5 m below ground and the bottom of the dumpsite "cells" is likely max 2 m below ground - The local geology consists of compact sandstone which provide some protection against infiltration of polluted leachate

2.3.2. Potential Impacts Associated with the Dumpsite Design and Operations

The environmental and social risks associated with the dumpsite design and operation are elaborated in ***Table 5*** with point of departure in the measures required for a basic standard landfill according to the Environmental Guidelines on Solid Waste Management issued by the MoE (2006).

Table 5: Environmental and Social Risks Associated with the Dumpsite Design and Operation

Requirement	Dumpsite	Impact Assessment
Fencing	- No fence	- Risk of windblow waste to fields and open areas in the surroundings
Tree buffer	- No tree buffer planted but the site has secondary shrub and small trees	- Existing vegetation provides some protection against spread of windblow waste
Landfill liner	- No liner	- Increased risk of groundwater contamination with polluted leachate - Increased risk of soil contamination with heavy metals and other chemicals
All weather access road	- Dirt road – not all weather	- Access may be difficult in the rainy season - Generation of dust in the dry season
Management office	- No structures or management facilities on site	- Lack of daily management increases the likelihood of poor waste disposal practices
Cells for waste dumping	- Three are three waste pits but waste is also spread indiscriminately	- Spread of infectious diseases by vectors - Increased risk of polluted runoff
Waste compaction and soil cover	- No waste compaction and no soil cover	- Nuisance from generation of malodours - Spread of infectious diseases by vectors - Increased risk of polluted runoff
Leachate pond	- No leachate collection and no leachate pond	- Increased risk of polluted runoff - Increased risk of groundwater pollution
Registration of waste	- No registration of waste	- Risk of disposal of hazardous waste – although like small amounts
Control access of informal recyclers	- No access control - 11 households collect recyclables at the site	- The informal recyclers risk accidents, injuries and contracting infectious diseases

Requirement	Dumpsite	Impact Assessment
Prevention of open burning of waste	- Open burning occurs - No action to prevent open burning	- Air pollution with Persistent Organic Pollutants, particulate matter, sulphur dioxide, lead and other chemicals

2.3.3. Socio-Economic Impacts

Assuming that the existing dumpsite will be closed as part of the Subproject, the informal recyclers operating at the dumpsite will lose the site as a source of income and will thus be affected on their livelihood. Compensation and livelihood restoration measures need to be set out in the relevant social safeguard documents following consultations with the informal recyclers which will be carried out by the General Department of Resettlement with assistance from the Project's social safeguards specialist prior to start of construction work. The general livelihood options for consideration include one or a combination of the following measures (more options may be developed in the course of preparing the social safeguard documents):

- Continue recovering waste at the new landfill
- Opportunity to work for the landfill contractor during the construction phase
- Opportunity to work at the Materials Recovery Facility once the landfill starts operating
- Opportunity to be involved in livelihood improvement programmes
- Provide compensation.

At this stage, it is anticipated that the informal recyclers operating at the existing dumpsite will be allowed to collect recyclables from the dumpsite until the waste relocation work starts. During the relocation of waste, they should not be allowed to work at the dumpsite but should be allowed to recover recyclables at the new landfill cell 1 under strict safety rules. These recyclers should also be provided with appropriate PPE and be instructed in health and safety measures.

2.4. Conclusion

The existing dumpsite has originally been approved by Kratie Provincial Authorities for daily operation. However, the actual implementation and operation of the dumpsite are not consistent with the relevant regulations and guidelines (lack of daily management, lack of leachate control, lack of waste compaction and daily cover, indiscriminate dumping and spreading of waste, lack of fire control, lack of access control, no fencing – among others).

The type of potential impacts associated with the existing dumpsite mainly affect the surrounding environment, informal recyclers collecting and sorting waste at the site and the productive use of adjacent land. The key impacts associated with the dumpsite are summarized below:

- generation and discharge of leachate affecting surface water and possibly groundwater;
- contamination of land with decomposing waste and chemicals;
- air pollution including with toxic substances such as Persistent Organic Pollutants from open burning of waste;
- spread of infectious diseases by vectors.

Due to the relatively small amounts of waste so far deposited at the dumpsite and the general consistency with siting criteria, the overall environmental and social risks are considered moderate.

However, the site is located within the premises of the future controlled landfill for Kratie City and its presence is incompatible with the design and operation of the future landfill, and it would pose a high risk to workers, informal recyclers and other visitors.

It is therefore highly recommended that the dumpsite is remediated and closed.

2.5. Remediation and Closure

2.5.1. Objectives

The objectives of closing and remediating the dumpsite include to:

- create an area that can be safely used for the future landfill facilities;
- minimise the risk that leachate from the waste dump may infiltrate groundwater resources that are or may in the future be used as a source of drinking water;
- minimise the risk of contamination of nearby waterways;
- minimise the risk to public health from spread of infections;
- eliminate the generation of harmful air emissions from open burning of waste;
- eliminate generation and odour and windblown waste;
- improve the livelihoods and living conditions of informal recyclers.

2.5.2. Closure Options

The options[3] considered for the closure of the existing dumpsite include:

a) In-place closure by capping the waste,
b) Closure by upgrading into a controlled engineered landfill, or
c) Closure by removing the waste from the dump and disposing it at the new landfill.

It is recommended to implement option c) closure by removing the waste from the dump and disposing it at the new landfill on the following grounds:

a) Option b) is irrelevant;
b) The amount of waste (estimated to 7,344 tonnes) is relatively small, and it can easily be accommodated in the new landfill cell;
c) Option c) provides the best environmental protection;
d) Option c) is the least costly[4];
e) Option c) ensures that the dumpsite area can be used for landfill facilities.

2.5.3. Temporary Measures

Temporary measures will be implemented in preparation for the relocation of the waste and to mitigate any ongoing environmental impacts:

a) the dumpsite area will be fenced off;
b) any existing fires will be extinguished;
c) the vegetation will be cleared and removed without mixing it with waste;
d) water in the small pond will be tested and then reused for dust suppression or treated, if necessary, before being discharged to the environment;
e) the existing waste will be bulldozed into low waste cells, increasing compaction and waste density, and covered with soil to minimise nuisances;
f) narrow trenches may be excavated to determine the depth of the waste deposits;
g) incoming waste will be deposited and compacted into waste cells adjacent to existing waste and covered with soil;

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[3] A Roadmap for closing Waste Dumpsites, The World's most Polluted Places, ISWA, 2016, https://www.iswa.org/fileadmin/galleries/About%20ISWA/ISWA_Roadmap_Report.pdf

[4] The Detailed Engineering Design estimates the costs of option a) to 80,000 USD and option c) to 22,000 USD

h) if necessary, ditches and bunds will be constructed to control leachate and manage surface runoff;

i) if necessary, leachate will be conveyed to a small pond/tank for temporary storage until the leachate treatment system is ready to receive leachate;

j) the informal recyclers will be trained in health and safety precautions and provided with appropriate PPE;

k) a registration process will be established so only licensed adult recyclers will be allowed on site.

2.5.4. Remediation and Closure Measures

The closure and remediation measures for the existing dumpsite include to remove the existing waste including any later incoming waste and deposit it in the newly constructed waste cell 1 as soon as it is ready to receive waste.

The relocation of the waste will start as soon as cell 1 is ready to receive waste and may extent into the Contractor's three months operations and maintenance period during which the Contractor is required to train the Operation and Maintenance Operator. The work is estimated to require a total of 29 workdays and involve the use of an excavator and a small dump truck.

After all waste has been disposed at the new cell 1, the former dumpsite area will be rehabilitated. Voids will be backfilled with clean materials and the site will be shaped in accordance with the detailed engineering design.

This work could be undertaken using an 8-tonne dump truck and would require an estimated maximum of 918 trips. Assuming each load would take a maximum of 15 minutes to transfer, a total of 32 loads could be transferred across an 8-hour working day. This would require 29 days of total work, which could be completed within the first year of operations, depending on the amount of time available to undertake this work on top of normal operations. In theory, this would require no more capital or operational expenditure than what is required for normal operations, since the operation would require an excavator and a small dump truck, equipment that would be standard for daily operations. Conversely, this work could be undertaken under a contract. In the Bill of Quantities a budget has been included to cover this potential work, with an estimated cost of $22,000.

The alternative method of om-place capping the waste would involve aimed at preventing water infiltration and leachate accumulation within the waste mass, providing a barrier to the wastes for humans and other animals, achieving mechanical stability of the waste piles, as well as providing some controls for landfill gas. At a basic level this approach would require the addition of a final capping layer.

Using the following layers (although the final approach should also take into account the planned use of this area after remediation):

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

The costs of material to cover the waste are estimated at approximately $80,000. Landfill gas control measures will also be required. These will likely be in the form of passive vents and will likely cost approximately $2,000.

In addition to the material costs for remediation the approach of capping the current waste dump, as opposed to relocation of the wastes, will also result in lost opportunity costs. Following capping,

the land will have limited value for the ongoing operational site. The relocation of wastes would allow for the development of future lined landfill cells in this area.

3. The Old Dumpsite

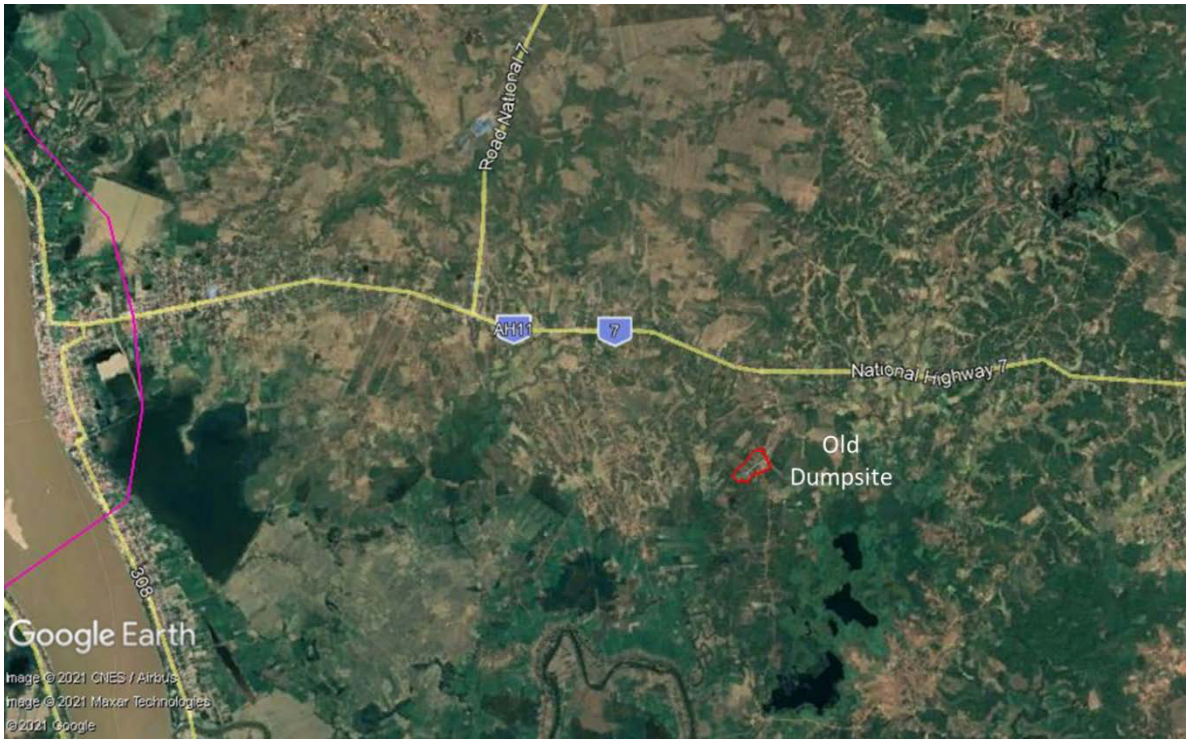
3.1. Salient Information

Salient information about the old dumpsite is summarized in ***Table 6***.

Table 6: Salient Information on the Old Dumpsite

Aspect	Description
Location	Kratie Province (see ***Figure 1*** and ***Figure 8***)
Land Ownership	The dumpsite is on State Land
Size	The dumpsite covers an area of approximately 10 ha (see ***Figure 12***)
Management	The dumpsite is under the responsibility of Kratie Provincial Department of Public Works and Transport in collaboration with Kratie Provincial Department of Environment
Approvals	The dumpsite has been approved by Kratie Provincial Authorities
Waste collection and transport	Waste collection and transport to the dumpsite are carried out by a private company, Tuk Khun Company
Period of operation	2006 to 2015 (see historical Google Earth images in ***Figure 10*** and ***Figure 11***) but disposal has continued after the site was officially closed in 2015
Waste disposal rate	Approximately 14 tonnes per day, rather uncertain
Total waste deposited	Estimated to 144,000 m^3 but not verified and very uncertain

Figure 8: The Old Dumpsite Location



3.2. Dumpsite Description

3.2.1. Physical Layout

The old dumpsite is currently only operating during the wet season. It is on State Land and managed by the provincial government, and there is some distribution of waste with bulldozer (see pictures in ***Figure 9***). The dumpsite is left open, without fence. The waste is transported by Tuk Khun Company. The total land size is approximately 10 ha.

Figure 9: Pictures of the Old Dumpsite, October 2020

The dumping operations at the old dumpsite site started in 2006, but officially closed in 2015 in response to requests from communities to have the dumping operations moved to another place. However, the dumpsite has continued to receive waste. Unverified information report that the dumpsite has one lined cell with leachate drains, with a dimension of 120 m x 120 m x 10 m (length, width, depth), and a capacity of 144,000 m^3.[5]

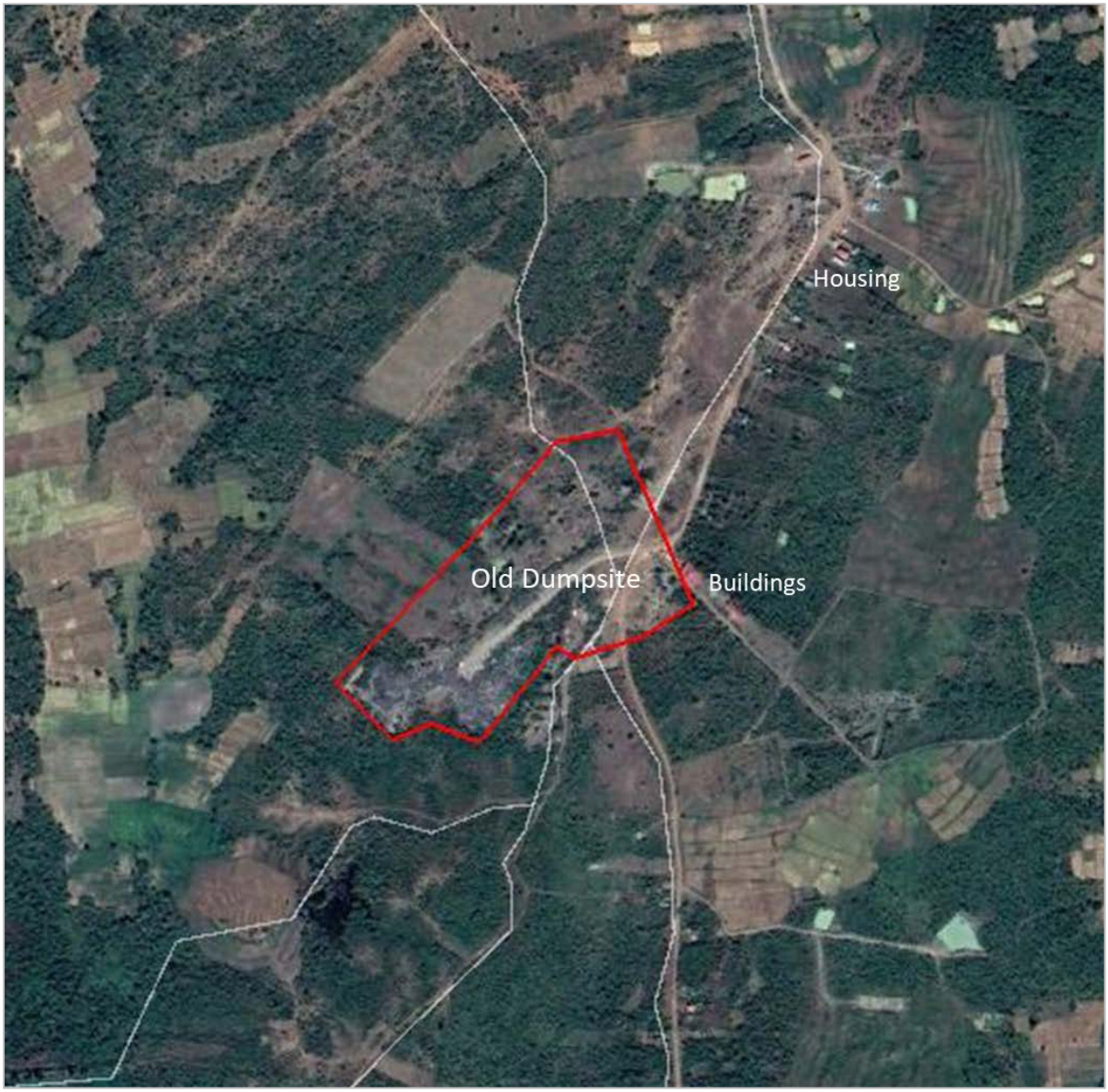
Figure 12 is a satellite image of the old dumpsite from November 2018. The demarcation on the image is only indicative and is not intended to show the boundary of any future clean-up and closure. The old dumpsite is located on slightly higher ground (elevation about 38 m asl. to 40 m asl. sloping toward the south) than the surrounding area. This is also visible from the pictures in ***Figure 9***.

Figure 10: Satellite Image of the Old Dumpsite, December 2010

[5] IEE, May 2018, CAM: Fourth Greater Mekong Subregion Corridor Towns Development Project Stung Treng Subproject Kratie Subproject Kampong Cham Subproject, Ministry of Public Works and Transport

Figure 11: Satellite Image of the Old Dumpsite, November 2015

Figure 12: Satellite Image of the Old Dumpsite, November 2018



3.2.2. Waste Composition

The composition of the waste disposed at the old dumpsite is unknown but based on various solid waste management studies in Cambodia, at the time of disposal, the waste is likely to have contained about 60% biodegradable components and the remaining 40% would include potentially recyclables and non-biodegradable waste. The biodegradable content has most likely already decomposed and only the most recently deposited waste will still contain biodegradable components. There are no major industries or other generators of any significant amounts of hazardous waste in Kratie City, and the content of hazardous substances in the dumpsite waste is therefore likely rather limited and will mainly include the types and amounts commonly found in waste from small-businesses and households in low-income areas. The possible content of infectious waste from health care facilities is unknown but cannot be ruled out. However, as pathogenic micro-organisms have a limited capacity of survival in the environment, these organisms are unlikely to have survived in waste that is older than 1-2 months.

The composition of the waste will be further studied in phase 2 of the ECA to enable more accurate estimations of waste types, waste densities and degree of decomposition.

3.3. Assessment of Environmental and Social Impacts

3.3.1. Potential Impacts on Sensitive Receptors

The sensitive receptors of concern in terms of potential environmental and social impacts associated with the old dumpsite are summarised in ***Table 7*** and the receptors in the immediate surroundings of the dumpsite are indicated in ***Figure 7***.

Table 7: The Old Dumpsite and Sensitive Receptors

Surface Water Receptors	Socio-Economic & Cultural Receptors	Land Cover/ Ecological Receptors	Protected Area Status
- Wetlands 1.3 km southeast and a small pond 0.3 km south of the site - 3 km from Prek Te River and within its catchment	- single houses/buildings next to the dumpsite and along the access road - 1.3 km to nearest village along National Highway No. 7 - big buddha statue along the dumpsite access road	- The site is covered with degraded forest and secondary shrub - Surrounding area is secondary forest/shrub in-between areas of agricultural land	- the Mekong River Kratie to Lao Border Key Biodiversity Area about 7.5 km to the west - Prek Prasab Protected Area 17 km to the northwest

Source: Google Earth, IBAT proximity assessment, PMC site visits

The dumpsite is about 4.5 km from the runway of Kratie Airport which is still operational. There are buildings next to the dumpsite and housing structures along the access road. The closest water body is a wetlands 1.3 km southeast and small pond 0.3 km south of the site. A big buddha statue is located near to the dumpsite access road. Surrounding the site are agricultural land with shrub/grasslands and forested areas in between.

The proximity of the old dumpsite to Key Biodiversity Areas (KBI) and National Protected Areas, Ramsar Sites etc. has been analysed using the Integrated Biodiversity Assessment Tool (IBAT). The IBAT Proximity Report (attached in Appendix 1) shows that the nearest Key Biodiversity Area is the Mekong River Kratie to Lao Border Key Biodiversity Area about 7.5 km to the west, and beyond this site is the Prek Prasab Protected Area about 17 km to the northwest.

Based on the IBAT proximity assessment it can be concluded that the old dumpsite is not located within any legally protected area or area that is internationally recognized for biodiversity.

The pictures in ***Figure 9*** indicate that the site is not managed and operated properly. There is open burning and waste is not covered with soil. It appears that waste is being pushed downslope.

Table 8 contains an assessment of compliance with the current landfill siting criteria as an indication of the potential environmental and social impacts on sensitive receptors. The assessment shows that the location of the dumpsite is inconsistent with most of the siting criteria, and adding to that it should also be taken into account that the siting criteria are meant to apply to a properly designed and operated landfill.

Table 8: Location of the Old Dumpsite compared with the Current (2016) Siting Criteria

Landfill Siting Guidelines (2016)		Dumpsite Location
Minimum distances to Receptors	1 km from any residential property	- single houses/buildings next to the dumpsite and along the access road - 1.3 km to nearest village
	3 km from any school/health centre/natural resources/ water source	- 1.3 km to the nearest school (assuming there is a school in the nearest village) - Wetlands 1.3 km southeast and a small pond 0.3 km south of the site - 3 km from Prek Te River and within its catchment
	5 km from any place of worship and resort	- big buddha statue is located near to the dumpsite access road
	8 km from an airport	- 4.5 km from the runway of Kratie Airport
	10 km from town centre	- 7.5 km to the city
	15 km from any heritage site	- No heritage site within a 20 km radius - the Mekong River Kratie to Lao Border Key Biodiversity Area about 7.5 km to the west - Prek Prasab Protected Area 17 km to the northwest
Hydrology	Not in a flood prone area	- the landfill is not located in a flood prone area
	Depth to groundwater from the bottom of the cell > 3 m	- unknown

3.3.2. Potential Impacts Associated with the Dumpsite Design and Operations

The environmental and social risks associated with the dumpsite design and operation are elaborated in ***Table 9*** with point of departure in the measures required for a basic standard landfill according to the Environmental Guidelines on Solid Waste Management issued by the MoE (2006).

Table 9: Environmental and Social Risks Associated with the Dumpsite Design and Operation

Requirement	Dumpsite	Impact Assessment
Fencing	- No fence	- Risk of windblow waste to fields and open areas in the surroundings
Tree buffer	- No tree buffer planted but the site is surrounded by secondary shrub and small trees	- Existing vegetation provides some protection against spread of windblow waste
Landfill liner	- No liner (although it has been reported that there is a	- Increased risk of groundwater contamination with polluted leachate

Requirement	Dumpsite	Impact Assessment
	cell with liner, this has not been verified and it is therefore assumed that there is no liner)	- Increased risk of soil contamination with heavy metals and other chemicals
All weather access road	- Dirt road – not all weather	- Access may be difficult in the rainy season - Generation of dust in the dry season
Management office	- No structures or management facilities on site	- Lack of daily management increases the likelihood of poor waste disposal practices
Cells for waste dumping	- Waste is spread indiscriminately - Some distribution of waste with bulldozer	- Spread of infectious diseases by vectors - Increased risk of polluted runoff
Waste compaction and soil cover	- No waste compaction and no soil cover	- Nuisance from generation of malodours - Spread of infectious diseases by vectors - Increased risk of polluted runoff
Leachate pond	- No leachate collection and no leachate pond	- Increased risk of polluted runoff - Increased risk of groundwater pollution
Registration of waste	- No registration of waste	- Risk of disposal of hazardous waste – although like small amounts
Control access of informal recyclers	- No access control - A number of households collect recyclables at the site	- The informal recyclers risk accidents, injuries and contracting infectious diseases
Prevention of open burning of waste	- Open burning occurs - No action to prevent open burning	- Air pollution with Persistent Organic Pollutants, particulate matter, sulphur dioxide, lead and other chemicals

3.3.3. Socio-Economic Impacts

A number of waste pickers operate at the old dumpsite as seen on the pictures in ***Figure 13***.

Figure 13: Waste Pickers at the Old Dumpsite, 2018

Assuming that the old dumpsite will be closed as part of the Subproject, the informal recyclers operating at the old dumpsite will lose the site as a source of income and will thus be affected on their livelihood. Compensation and livelihood restoration measures need to be set out in the relevant social safeguard documents following consultations with the informal recyclers which will be carried out by the General Department of Resettlement with assistance from the Project's social safeguards specialist prior to start of construction work. The general livelihood options for consideration include one or a combination of the following measures (more options may be developed in the course of preparing the social safeguard documents):

- Opportunity to work for the landfill contractor during the construction phase
- Opportunity to work at the Materials Recovery Facility at the new landfill site once the landfill starts operating
- Opportunity to be involved in livelihood improvement programmes
- Provide compensation.

It is anticipated that the informal recyclers at the old dumpsite will be allowed to continue recovering recyclables until the dumpsite remediation and closure activities kick-off. When the closure work starts, they will lose the site as a source of income. In the meantime, they should be provided with appropriate PPE and given training on health and safety to ensure safe working conditions.

3.4. Conclusion

The old dumpsite has originally been approved by Kratie Provincial Authorities for daily operation. Although the site was officially closed in 2015 in response to requests from communities to have the dumping operations moved to another place, dumping of waste has continued – presumably because of problems accessing the existing dumpsite located at the site for the future landfill.

The siting of the old dumpsite is not consistent with the current landfill siting criteria issued by MoE and the implementation and operation of the dumpsite are also not consistent with the relevant regulations and guidelines (lack of daily management, lack of leachate control, lack of waste compaction and daily cover, indiscriminate dumping and spreading of waste, lack of fire control, lack of access control, no fencing – among others).

The type of potential impacts associated with the old dumpsite mainly affect the residents in the immediate surroundings, informal recyclers collecting and sorting waste at the site and the productive use of adjacent land, and potentially groundwater and surface water resources. The key impacts associated with the dumpsite are summarized below:

- generation and discharge of leachate affecting surface water and possibly groundwater;
- contamination of land with decomposing waste and chemicals;
- air pollution including with toxic substances such as Persistent Organic Pollutants from open burning of waste;
- malodour nuisances;
- spread of infectious diseases by vectors.

In conclusion, it is highly recommended to remediate and close the old dumpsite. However, as discussed in ***Section 3.5.2***, there are still significant gaps and uncertainties in the information about the dumpsite, which will require additional investigations before a permanent solution can be developed.

3.5. Remediation and Closure

3.5.1. Objectives

The objectives of closing and remediating the dumpsite include to:

- create an area that can be safely used for the future landfill facilities;
- minimise the risk that leachate from the waste dump may infiltrate groundwater resources that are or may in the future be used as a source of drinking water;
- minimise the risk of contamination of nearby waterways;
- minimise the risk to public health from spread of infections;
- eliminate the generation of harmful air emissions from open burning of waste;
- eliminate generation and odour and windblown waste;
- improve the livelihoods and living conditions of informal recyclers.

3.5.2. Closure Options

The options under consideration for the closure of the old dumpsite include:

a) Closure by removing the waste from the dump and disposing it at the new landfill.
b) In-place closure by capping the waste,
c) Closure by upgrading into a controlled engineered landfill, or
d) Isolation of waste from groundwater, using drainage/ engineered containment.

There are still significant gaps and uncertainties in the information about the dumpsite, which will require additional investigations before a permanent solution can be developed.

The significant gaps and uncertainties in the information about the dumpsite include:

a) Amount of waste and size of the area with waste dumped
b) Potential risk to groundwater
c) Potential risk to surface water from runoff with polluted leachate
d) Planned future land use

In order to address these gaps and uncertainties it is essential that further survey work is undertaken before a final decision is made on the most suitable remediation approach. The necessary additional surveys are included in Phase 2 of the ECA as presented in ***Section 3.6.***

The closure options are discussed here below, with the first option involving relocation of wastes and the final three options remediation in-situ:

(i) **Closure by removing the waste from the dump and disposing it at the new landfill**. This alternative will be dependent on the economic feasibility assessment. The approach could be combined with sorting the waste for recyclable materials and separation of hazardous waste. In principle, deposition of the waste at the new landfill would inevitably reduce the design-life of the new landfill. It has been reported that the amount of waste could be as much as 144,000 m^3; however, the basis for this estimation has not been verified and must be taken with caution. Such an amount would occupy almost two waste cells (as designed for the new landfill). The excavated void should be backfilled with suitable locally available materials. This would in principle ensure that there would not be any land use restrictions and no need for monitoring and aftercare. However, if the groundwater underneath the waste dump has already been contaminated, there may be a need for additional mitigation measure and/or monitoring activities.

(ii) **In-place closure by capping the waste**. This preferred in-situ method includes a low permeability cap and a topsoil layer (typically comprised of 4 layers: (1) gas drainage, (2) low permeable clay layer, (3) soil drainage layer and (4) a topsoil layer). The final grading of the

closed dump should be designed to ensure slope stability and proper drainage that prevents ponding of water and which is not causing erosion. Seepage of polluted leachate on side slopes would have to be collected and treated. Installation of landfill gas vents would also be considered, retrofitted into the waste. The site would likely be suitable for sport activities, park or recreation, agriculture (cropland, plantation, grazing land), but not for buildings or installations or infrastructure that require good foundation.

Long-term aftercare and monitoring would be required, and this would likely include groundwater monitoring (monitoring wells would have to be established), monitoring of seepage /leachate, landfill gas monitoring. Aftercare would consist of regular cleaning and repairs as required to the leachate collection and disposal systems, reinstatement of eroded batters, replacement of soils that are eroded, replanting any vegetation that dies back, filling any depressions that occur on site due to differential settlement, reparation of access roads to allow access at all times, and repairs to the perimeter and internal fences as needed.

The remediation costs mainly depend on the size of the area as opposed to the total amount of waste. The area could potentially be reduced by bulldozing and compacting the waste to form one "cell".

The implementation of this option could be done independently of the new landfill construction.

(iii) **Closure by upgrading into a controlled engineered landfill**. If surveys show that there is contamination of groundwater and there is sufficient available space at the dumpsite, a controlled waste cell could be constructed at the site. The waste would be excavated and disposed in the cell with proper compaction of the waste in thin layers thereby potentially reducing the area or the footprint and thus also the generation of leachate. Ideally, the waste would be encapsulated in a cell with liner, leachate collection system, and landfill gas venting. The cell would be provided with a cap as in the 'in-place closure'. Leachate could be treated (possibly also recirculated) onsite or trucked to the new landfill or the future wastewater treatment plant for treatment. Segregating recyclable materials from the excavated waste could be part of the remediation. The future land use of the capped cell would be restricted similar to the 'in-place closure' alternative, but it may be possible to free-up some land that would be free of waste and that would not have any land use restrictions. The excavated void should be backfilled with suitable locally available materials. Monitoring and aftercare would likely be similar to the 'in-place closure' alternative.

The implementation of this option could be done independently of the new landfill construction.

(iv) **Isolation of waste from groundwater.** If waste is leading to the contamination of groundwater, it may be possible to isolate the waste without the need to construct a full controlled landfill cell, as per option iii. Depending on the results of the hydrogeological survey, it may be possible to construct engineered approaches to isolate the waste from the groundwater. These may include enhanced drainage, which relocates the groundwater flows and bypasses the waste area; or the use of vertical cut-off barriers of low permeability to prevent the lateral spread of contaminated groundwater beneath the base of the dumpsite.

In addition, it is recommended to implement the following temporary mitigation measures:

- Fencing off the dumpsite and controlling access
- Extinguishing fires
- Covering the waste with soil
- Temporary leachate management such as diversion of leachate to a temporary pit
- Training of informal recyclers and providing them with PPEs.

3.6. ECA Phase 2 Scope of Work

The objectives of the Phase 2 investigations are to fill-in information gaps identified in Phase 1 and to determine the long-term solution to the remediation of the dumpsite and to provide information for the preparation of the detailed remediation design.

The scope of the Phase 2 investigations consists of the activities listed below and possibly additional activities as may have been determined in Phase 1.

3.6.1. Activities

1. Interviews (continued from Phase 1) with waste management personnel and government officials with knowledge about the dumpsite:
    a. Preferred future land use (ranking of alternatives)
    b. the number and depth of waste cells;
    c. underlying waste cell lining material if any;
    d. extent of active surface runoff collection and drainage;
    e. extent of leachate and gas collection and treatment;
    f. extent of septage disposal and management;
    g. waste recycling process used by local waste pickers; and
    h. scheduling of transport of solid waste to dumpsite.
2. Obtain existing data on groundwater quality near the dumpsites from PDoE (if available).
3. Obtain existing surface water quality data for potentially impacted water bodies.
4. Determine number of full-time and part-time informal recyclers that work (and live) at the dumpsite
5. Identify any other use of the dumpsite area.
6. Consult with the surrounding community and the informal recyclers to determine if there are past or present environmental, social, or human health issues associated with the operation of the existing dumpsite.
7. Waste Surveys: It is critical to determine the volume and nature of the waste on the site. A mapping exercise is required, which details the extent of waste coverage and depths of waste in different localities. This will require excavating pits into the waste piles in order to determine the depth of waste. It is also important to understand the typical waste density of the waste, which will help assess tonnages. This will require undertaking waste density tests in a number of locations (kilograms per square metre). It will also be useful to provide further details on the typical composition of the waste and the degree of degradation that has occurred (i.e., an estimation of the length of time the waste has been on-site and the degree of decomposition of organic material). The presence of any problem or hazardous waste (e.g., medical wastes) should be recorded, including details and locations of these wastes.
8. Groundwater Quality Survey: It is critical to determine the impact that the waste dump has on water quality in underlying groundwater. It is highly recommended that this is undertaken even if the waste is relocated, since it will be important to determine the legacy impacts of this dumpsite.
9. Following the completion of the above surveys, an economic feasibility assessment will be undertaken to determine the viability of transferring the old waste to the new landfill. If this option is deemed viable, then further geotechnical surveys are not required. If relocation of waste is not economically viable, then in-situ remediation will clearly be the only option, and in will then be necessary to undertake the geotechnical survey outlined below, and possibly also the hydrogeological survey, if the groundwater has been shown to be polluted.

3.6.2. Additional Optional Activities

10. Geotechnical and Hydrogeological Surveys: For in-situ remediation measures, it will be critical to understand the site geology and hydrology. This will involve developing an understanding

of the underlying geology, particularly in terms of permeability and the potential for transferring leachate into groundwater. Hydrogeological surveys will be necessary if water quality surveys show that the groundwater is polluted from the waste. This survey will involve an examination of groundwater flow and connectivity, in order to determine if polluted water is being used by neighbouring activities, with particular concerns where it is being used as human or livestock drinking water sources.

11. The choice of in-situ remediation options will depend on the results of the surveys. The ideal and default option for in-situ remediation will be closure through capping the waste (see below for details). However, if there is existing pollution of groundwater and the geology is not suitable then more complex engineering options will need to be considered. This would include the construction of an engineered landfill cell, complete with an underlying liner; or may include other approaches that isolate the waste from the groundwater, such as cut-off barriers.

3.6.3. Expected Results

Phase 2 is designed to provide the following results:

1. Recommendations on the future land use of the remediated dumpsite
2. Analysis and ranking of alternative long-term solutions
3. The preferred long-term solution including monitoring and aftercare.
4. Cost estimate

The results will be documented in a concise report and presented to the PMU and ADB for their decisions on the recommended remediation and closure method.

APPENDIX 1: IBAT PROXIMITY ASSESSMENT

Integrated Biodiversity Assessment Tool

PROXIMITY REPORT
KRATIE LANDFILL

Country: Cambodia

Location: [12.5, 106.2]

Date of analysis: 07 June 2021 (GMT)

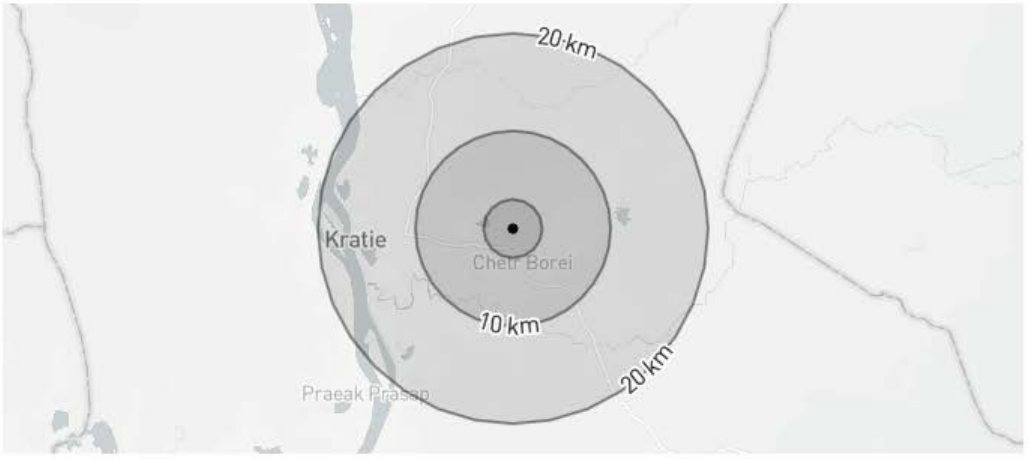
Buffers applied: 3 km | 10 km | 20 km

Generated by: Peter Gammelgaard Jensen

Organisation: ADB

Overlaps with:

Protected Areas	0
Key Biodiversity Areas	2
IUCN Red List	86



Displaying project location and buffers: 3 km, 10 km, 20 km

About this report

This report presents the results of [6690-17041] proximity analysis to identify the biodiversity features and species which are located within the following buffers: 3 km, 10 km, 20 km.

This report is one part of a package generated by IBAT on 07 June 2021 (GMT) that includes full list of all species, protected areas, Key Biodiversity Areas in CSV format, maps showing the area of interest in relation to these features, and a 'How to read IBAT reports' document.

WARNING: IBAT aims to provide the most up-to-date and accurate information available at the time of analysis. There is however a possibility of incomplete, incorrect or out-of-date information. All findings in this report must be supported by further desktop review, consultation with experts and/or on-the-ground field assessment. Please consult IBAT for any additional disclaimers or recommendations applicable to the information used to generate this report.

Please note, sensitive species data are currently not included in IBAT reports in line with the Sensitive Data Access Restrictions Policy for the IUCN Red List. This relates to sensitive Threatened species and KBAs triggered by sensitive species.

Data used to generate this report

- UNEP-WCMC and IUCN, 2021. Protected Planet: The World Database on Protected Areas (WDPA)[On-line], Cambridge, UK: UNEP-WCMC and IUCN. Available at: www.protectedplanet.net - June 2021.
- BirdLife International (on behalf of the KBA Partnership), 2021. Key Biodiversity Areas - April 2021.
- IUCN, 2021. IUCN Red List of Threatened Species - April 2021.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Integrated Biodiversity Assessment Tool

PROXIMITY REPORT
KRATIE OLD DUMPSITE

Country: Cambodia

Location: [12.5, 106.1]

Date of analysis: 07 June 2021 (GMT)

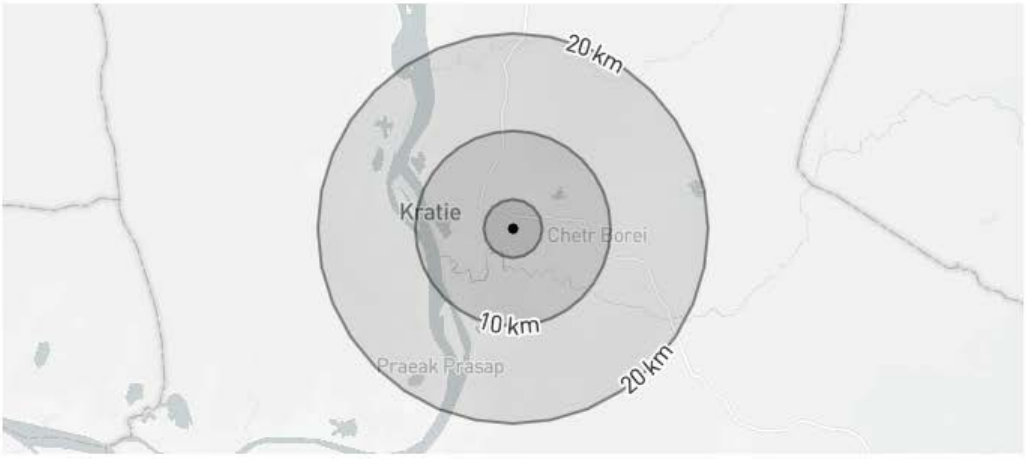
Buffers applied: 3 km | 10 km | 20 km

Generated by: Peter Gammelgaard Jensen

Organisation: ADB

Overlaps with:

Protected Areas	1
Key Biodiversity Areas	2
IUCN Red List	83



Displaying project location and buffers: 3 km, 10 km, 20 km

About this report

This report presents the results of [6690-17042] proximity analysis to identify the biodiversity features and species which are located within the following buffers: 3 km, 10 km, 20 km.

This report is one part of a package generated by IBAT on 07 June 2021 (GMT) that includes full list of all species, protected areas, Key Biodiversity Areas in CSV format, maps showing the area of interest in relation to these features, and a 'How to read IBAT reports' document.

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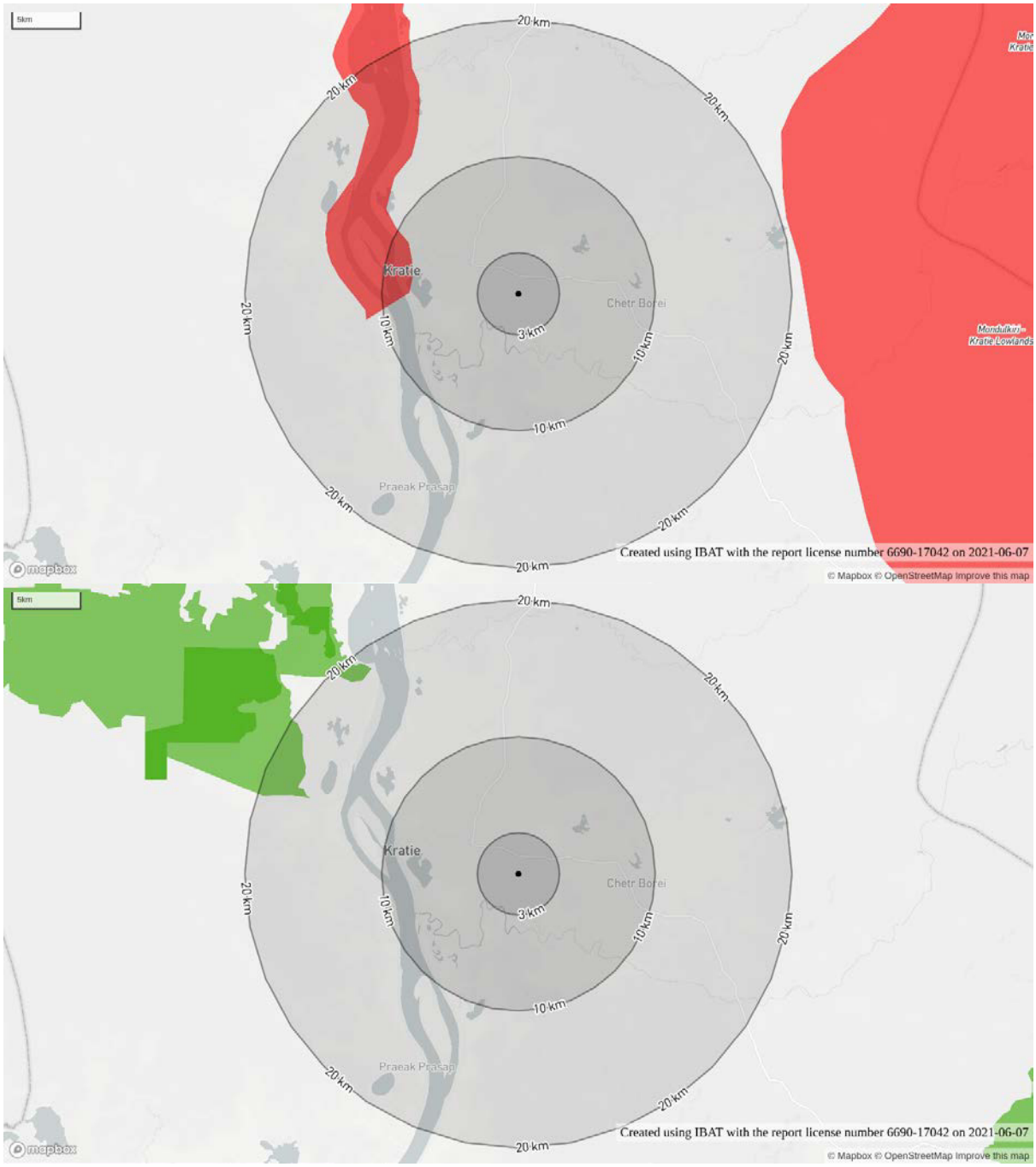
- BirdLife International (on behalf of the KBA Partnership), 2021. Key Biodiversity Areas - April 2021.
- IUCN, 2021. IUCN Red List of Threatened Species - April 2021.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