Initial Environmental Examination

September 2021

Cambodia: Fourth Greater Mekong Subregion Corridor Towns Development Project

Solid Waste Management Subproject, Stung Treng City, Stung Treng Province

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

TABLE OF CONTENTS

1. EXECUTIVE SUMMARY 9
1.1. Project Introduction 9
1.2. Key Findings 10
1.3. Environmental Management Plan 12
1.4. Conclusion 13
2. INTRODUCTION 14
2.1. Background and Location 14
2.2. Objectives of the IEE 16
2.3. ADB and National Environmental Due Diligence 17
2.4. Structure of This Report 17
3. LAW, POLICY, AND ADMINISTRATIVE FRAMEWORK 18
3.1. Environmental Assessment Requirements 18
3.2. National Environmental Policies and Legislations 20
3.3. International Agreements 27
4. DESCRIPTION OF THE PROJECT 28
4.1. Rationale 28
4.2. Project Impact, Outcome and Outputs 29
4.3. Existing Solid Waste Management 29
4.4. Landfill Design Basis 30
4.5. Landfill Design and Technology 36
4.6. Closure of the Existing Dumpsite 58
4.7. Construction Implementation 58
4.8. Associated and Existing Facilities 60
5. DESCRIPTION OF THE ENVIRONMENT 61
5.1. Project Area of Influence and Sensitive Receptors 61
5.2. Topography and Geology 63
5.3. Meteorology and Climate 64
5.4. Climate Change Projections 66
5.5. Surface Water and Ground Water Quality 68
5.6. Air Quality 72
5.7. Natural Disasters 74
5.8. Physical Cultural Resources 74
5.9. Ecological Resources 74
5.10. Socio-Economic Data 82
5.11. The Dumpsite Environment 83
6. ANTICIPATED IMPACTS AND MITIGATION MEASURES 88

6.1. Project Environmental Benefits 88
6.2. Environmental Impact Assessment Screening 88
6.3. Impacts Associated with Project Location, Planning and Design 90
6.4. Environmental Impact and Mitigation Measures During Construction 94
6.5. Closure of the Dumpsite 102
6.6. Environmental Impact and Mitigation Measures During Operation 106
7. ANALYSIS OF ALTERNATIVES 113
7.1. Solid Waste Management Design and Technology Alternatives 113
8. INFORMATION DISCLOSURE AND PUBLIC CONSULTATIONS 114
8.1. Public Consultations During Project Preparation 114
8.2. Public Consultations during Project Implementation 116
9. GRIEVANCE REDRESS MECHANISM 117
10. ENVIRONMENTAL MANAGEMENT PLAN 117
11. CONCLUSIONS AND RECOMMENDATIONS 118
11.1. Conclusions 118
11.2. Recommendations 119

List of tables

Table 1: Summary of CTDP-4 Sub-projects 9
Table 2: Summary of CTDP-4 Subprojects 14
Table 3: Relevant Laws, Regulations and Guidelines 21
Table 4: Comparison of Landfill Selection Criteria 25
Table 5: Key National and International Environmental Standards and Guidelines 26
Table 6: Estimated Population Growth and Service Coverage 34
Table 7: Waste Amount Forecast 35
Table 8: Physical Composition of Solid Waste in Cambodia 35
Table 9: Landfill Cell Capacity 38
Table 10: Depth to Groundwater Table 41
Table 11: Leachate Treatment System Details 47
Table 12: Estimated Leachate Volumes 49
Table 13: Preliminary Hazardous Waste Acceptance Guidelines 54
Table 14: Summary of Sensitive Receptors 62
Table 15: Impacts from Climate Change on Landfill Operations 68
Table 16: The surface water quality in Or Kantuot 69

Table 17 Surface Water Sampling Points *70*

Table 18: Groundwater Quality in nearby Water Well *71*

Table 19: Air Quality Data for the Subproject Area *72*

Table 20: Noise Levels at the Landfill Site *73*

Table 21: Tree and Shrub Species in Subproject Site *76*

Table 22: Bird Species in the Subproject Area *78*

Table 23: Reptile Species in the Subproject Area *80*

Table 24: Population Data for Communes Closest to the Landfill Site *82*

Table 25: Land use in Ou Rai and Thalabarivat commune *82*

Table 26: Distribution of the main household occupation *82*

Table 27: The Education Facilities *82*

Table 28: The health services *83*

Table 29: Diseases suffered by Villagers *83*

Table 30: Screening of Impacts for Stung Treng Landfill *89*

Table 31: Location of the Landfill compared with Siting Criteria *92*

Table 32: Borrow Pit and Spoil Disposal Site Selection Criteria *98*

Table 33: CTDP-4 Project Preparation Consultations *114*

Table 34: IEE and Detailed Engineering Design Stage Consultations *115*

Table 35: Key Roles for Project Implementation *118*

List of figures

Figure 1: Locations of Project Towns *15*

Figure 2: Stung Treng City Solid Waste Management Subproject *16*

Figure 3: Overview Map of the Existing Dumpsite and the New Landfill Site *30*

Figure 4: Stung Treng Landfill Site *31*

Figure 5: Stung Treng Landfill *32*

Figure 6: Waste Collection Service Area *33*

Figure 7 Possible Additional Settlements for Waste Collection *34*

Figure 8: Landfill Masterplan Layout *38*

Figure 9: Profile of Cell-1 ..... *39*

Figure 10: Landfill Cell Phasing 40
Figure 11: Typical Daily Cell 40
Figure 12: Ways of Representing the Gradient of a Site 41
Figure 13: Landfill Liner 42
Figure 14: Design of Leachate Collection System 43
Figure 15: Leachate Treatment System 44
Figure 16: Constructed Wetland 46
Figure 17: Connection System for Leachate Recirculation 48
Figure 18: Groundwater Monitoring Wells 51
Figure 19: Conceptual Design of the Groundwater Monitoring Wells 52
Figure 20: Potential Future Transition from Passive to Active System 53
Figure 21: Hazardous Waste Landfill Cell 55
Figure 22: Landfill Facilities Master Plan 56
Figure 23: Access Road Profile 56
Figure 24: Materials Recovery Facility Layout 57
Figure 25: Tentative Time Schedule for Construction 59
Figure 26: Receptors in the Immediate Surroundings of the Landfill 63
Figure 27: Pictures of the Landfill Site 64
Figure 28: Monthly Average Rainfall and Rainfall Days, Strung Treng (1991-2020) 65
Figure 29: Average Maximum and Minimum Monthly Temperatures 1909-2021, Strung Treng 66
Figure 30: Projected Change in Monthly Temperature for Cambodia for 2020-2039 67
Figure 31: Projected Change in Monthly Precipitation for Cambodia for 2020-2039 68
Figure 32: Tributary to The Mekong River, 4 km upstream the confluence with the Mekong River 69
Figure 33: Surface Water Sampling Points 70
Figure 34: Groundwater Well 71
Figure 35: Air Sampling Points 73
Figure 36: Landfill Site Vegetation 77
Figure 37: The Existing Dumpsite and Its Surroundings 84
Figure 38: The Dumpsite, September 2020 84

Figure 39: The Dumpsite, August 2021 ..... *85*

Figure 40: Proximity to Protected Areas and Key Biodiversity Areas *93*

List of Annexes

Annex 1: Environmental Quality Standards *121*

Annex 2: Consultation During Project Preparation *126*

Annex 3: Consultations at Detailed Engineering Design and IEE Stage *129*

Annex 4: Stung Treng Landfill and Dumpsite Site Visits *136*

Annex 5: Terms of Reference for Environmental Compliance Audit of Waste Dumpsites in Stung Treng City *143*

Annex 6: Leachate Management Details *147*

Annex 7: Landfill Gas Estimates *154*

Annex 8: IESIA Certificate *156*

Annex 9: IBAT Proximity Assessment *161*

Annex 10: Water Balance in the Leachate Ponds *169*

Annex 11: Environmental Compliance Audit for the Solid Waste Dumpsite *171*

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 Stung Treng 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 September 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 Ministry of Environment (MoE) on 30 June 2021 (***Annex 8***). The IEE and EMP will be further updated if necessary.

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

- Upgrading of 1,450 metres of external access road to the landfill site to be above flood levels.
- Construction of one controlled landfill cell out of a total of two 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 2,003 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 (separate to the landfill project).
- Closure of the existing 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 Anlong Svay village, Or Rai and Thala Barivat commune, Thala Barivat district, Stung Treng province. The site covers an area of 34.45 ha.

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

- about 5 km for Stung Treng City centre across the Mekong River.
- About 4 km by road from National Road No. 9
- about 3.5 km from the Mekong River.
- The nearest housing is a small cluster of houses/buildings 2.5 km southeast of the site close to National Road No. 9.
- The site is covered with shrub regrowth.
- The surrounding area in a 2.5 km radius is dominated by shrubland with patches of agricultural land
- The site is located just inside a Key Biodiversity Area.

1.2. Key Findings

8. 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

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

are dominated by secondary shrubs and patches of agricultural land. The site is located just inside the Thala Stung Treng Key Biodiversity Area, about 8.3 km southwest from Stung Treng Ramsar site, and 3 km west of the Mekong River from Kratie to Lao PDR Key Biodiversity Area.

1.2.1. Pre-construction

9. 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

10. 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.

11. The potential impacts caused by the dumpsite mainly affect the nearby residents, the productive use of adjacent land, informal recyclers collecting and sorting waste at the site, the surrounding environment including a nearby irrigation reservoir and possibly groundwater resources beneath the site.

12. The key objectives of closing and remediating the existing 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.

13. An Environmental Compliance Audit for the dumpsite has been undertaken (***Annex 11***). The audit considered and evaluated the following remediation and closure methods:

    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.

    The evaluation concludes that out of these four options, option (a) is both the most environmentally safe as well as the least costly method. It is therefore recommended to implement option (a) *Closure by removing the waste from the dump and disposing it at the new landfill*.

1.2.3. Operations

14. 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.

15. 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.

16. 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

17. 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

18. 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

19. 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

20. 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.

21. 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.

22. A Grievance Redress Mechanism (GRM) has been established on 18 January 2019 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

23. This IEE was undertaken to determine the environmental issues and concerns associated with the solid waste management subproject in Stung Treng 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.

24. 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.

25. The subproject is anticipated to bring environmental benefits to the population of Stung Treng 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.

26. As outlined in this IEE and the EMP, a Grievance Redress Mechanism has been established on 18 January 2019. 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

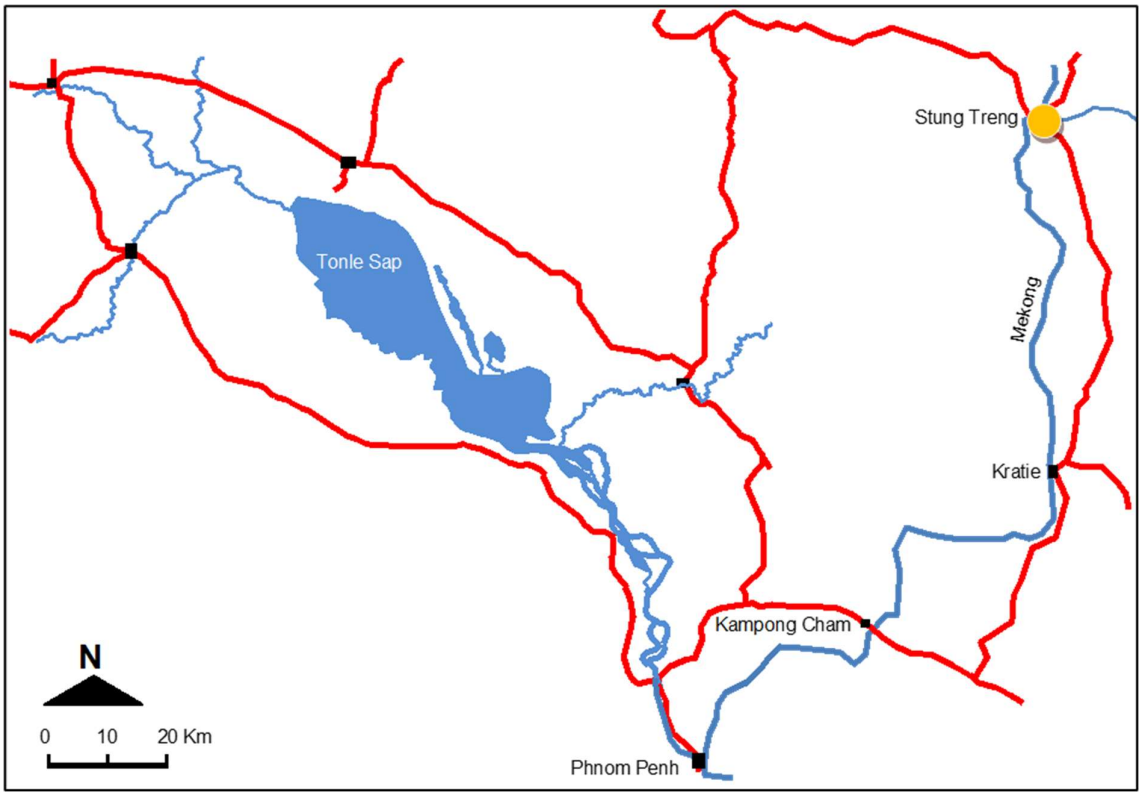
27. The Fourth Greater Mekong Subregion Corridor Towns Development Project (GMS4 or CTDP-4 Project) will support the Governments of Cambodia and the Lao People's Democratic Republic (PDR) in enhancing the competitiveness of selected towns located along the Central Mekong Economic Corridor in the Greater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

28. 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
Kampong Cham	5,000 m^3/day	137 km	4,3 km	436,208 m^3
Kratie	4,900 m^3/day	143 km	12 km	203,119 m^3
Stueng Treng	3.650 m^3/day	147 km	12 km	181,230 m^3

Figure 1: Locations of Project Towns



29. The Stung Treng City Solid Waste Management Subproject consists of the following works and components:

- Upgrading of 1,450 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 two 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 2,003 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 dumpsite.

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

31. The site for the controlled landfill is located on State Land in Anlong Svay Village, Or Rai and Thala Barivat Commune, Thala Barivat District, Stung Treng Province – see ***Figure 2***.

Figure 2: Stung Treng City Solid Waste Management Subproject

2.2. Objectives of the IEE

32. This IEE covering the Stung Treng 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 30 June 2021 (Certificate attached in ***Annex 8***).

33. 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

34. 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.

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

36. 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.

37. The requirements for Ministry of Environment (MoE) approvals under Cambodian law are set out in detail in ***Section 3.2.2***. As required, 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

38. 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.

39. 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.

40. 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

41. 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.

42. 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;

43. 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.

44. 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.

45. 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

46. 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.

47. 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).

48. 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.

49. A meeting[2] held between the MoE, Ministry of Public Works and Transport (MPWT) and consultant teams for ADB projects on 06 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.

The preparation of the IESIA for the Stung Treng Landfill started in August 2020 following approval by MOE of the terms of reference for the study. After submission of the first draft IESIA, MOE conducted a site visit and based on comments from the ministry, the second draft IESIA was submitted for consideration at an inter-ministerial meeting in April 2021. The final IESIA incorporating comments from the inter-ministerial meeting was approved by MOE on 30 June 2021.

3.2. National Environmental Policies and Legislations

3.2.1. Legal Framework for Environmental Management

50. 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).

51. 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.

52. 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

53. 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.

54. 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.

55. 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)

56. 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 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

Law/Regulation/Guideline	Year	Summary
		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 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

Law/Regulation/Guideline	Year	Summary
		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 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.

<table>
<tr><th>Law/Regulation/Guideline</th><th>Year</th><th>Summary</th></tr>
<tr><td></td><td></td><td>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 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="3">Cell Design</td><td>Gas collection (flaring)</td></tr>
<tr><td>Leachate collection system</td></tr>
<tr><td>Leachate treatment (lagoon)</td></tr>
</table></td></tr>
</table>

Law/Regulation/Guideline	Year	Summary
		Clay liner ≥ 1 m (first liner) HDPE liner (second liner) Permeable liner (third liner) Drainage system: Depth 1 m, width 0,6 m
Technical Guideline on Garbage and Urban Solid Waste Management	2016	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).
Prakas on Environmental Impact Assessment Classification for Development Projects No. 21 PRK.BST	2020	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

57. Landfill Site Guidance. A meeting was held at MoE[3] 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.

58. 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)[4]	- Not located in the immediate proximity of dwellings - Minimum buffer distance 500 m	- No distance given
ADB – Integrated SWM for Local	- No residential development	- The site must be located in an

[3] 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.

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

Source of Guidance	Residential Receptors	Water Receptors
Governments., A Practical Guide (2017)	within 250 m	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

59. 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 and Noise Disturbance, 2000	WHO Air Quality Guidelines, global update 2005
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

60. 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.

61. 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.

62. 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

63. 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.

64. 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).

65. 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

66. 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.

67. Stung Treng city is the capital of the Stung Treng Province in northeast Cambodia. It borders the provinces of Ratanakiri to the east, Mondulkiri and Kratie to the south and Kampong Thom and Preah Vihear to the west. The Province's northern boundary is Cambodia's international border with Laos. Stung Treng is located on the Sekong River, close its confluence with the Mekong River. The city is served by National Highways 7 and 64. Located along the GMS Inter-corridor Link, Stung Treng City is connected to Sihanoukville and Phnom Penh to the south, and to the north along National Highway No 7 to the border with the Lao PDR and from there on to Pakse and Savannakhet in the Lao PDR meeting the East–West Economic Corridor. Thus, Stung Treng City has geographical advantages and potential to benefit from and contribute to economic growth in the region and reduce regional development disparities.

68. Stung Treng District consists of four sangkats with a total population of just over 37,000 (2019). Compared with other districts in Cambodia, Stung Treng District has a high economic potential[5]. The most significant economic sector in the city economy is tourism, trade, transport, and government. Solid waste collection service currently extends to 3 of the 4 sangkats but it is estimated that only about 50% of the populations is served[6]. Solid waste is disposed of in an open dumpsite 14 km from the City.

69. As part of the Fourth Greater Mekong Subregion Corridor Towns Development Project (CTDP-4 Project), the Stung Treng Solid Waste Management Subproject will improve urban waste management services and thereby attract economic growth and promote Stung Treng City as a node in the regional economic corridors.

70. 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.

---

[5] Cambodia, Achieving the Potential of Urbanization, World Bank, August 2018

[6] Note that although the actual collection coverage is rather low, for forecasting purposes a higher percentage has been used to ensure that there is enough space in the landfill for incoming waste.

4.2. Project Impact, Outcome and Outputs

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

72. **Output 1: Improved urban waste management services in Stung Treng City:** The output includes establishment of a controlled landfill with a design capacity of 283,200 tonnes of waste. The landfill is estimated to receive a maximum of 185,151 tonnes of waste during the design life period, which means that the site will have capacity up until approximately 2045.

73. **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.

74. **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

4.3.1. The Existing Dumpsite

75. The existing dumpsite is about 14 km northeast of Stung Treng urban area in Sameakki Sangkat (see ***Figure 3***) and about 26 km by road from the new landfill site. The site began operating in 2011 and is managed by Stung Treng City Hall, with technical support provided by the Department of the Environment. The dumpsite has originally been approved by Stung Treng Provincial Authorities for daily operation. However, the siting of the dumpsite does not comply with the landfill siting criteria issued by the Ministry of Environment in 2016, and the actual implementation and operation of the dumpsite are not consistent with the current relevant regulations and guidelines. There are limited environmental controls, which are likely causing significant socio-environmental impacts, particularly as there is a residential area in the proximity. The site is about 3.5 km from the Stung Treng RAMSAR site, which is also a National Protected Area. The area currently being used as a dump is about 3 hectares in size with waste dumped here and there within this area and also being dumped alongside the access road. The waste has not been profiled, compacted or covered with soil, being simply left exposed and of then also burned.

76. Waste is collected by a private company, Sroy Raksmey Co., Ltd. The contract is renewed annually and covers only collection and dumping of solid waste[7]. The

[7] Verbal communication with Stung Treng Project Implementation Unit of the Stung Treng Provincial Department of Public Works and Transport. The waste collection contract itself has not been reviewed.

Company has 14 staff, two compactor trucks and two open-top trucks. A total of 2,998 households are covered by the waste collection services, but only 1,168 households are willing to pay for the collection service fee. There is no weighbridge facility to verify the amount of waste collected.

77. The dumpsite and surrounding environment are further described in ***Section 5.11.***

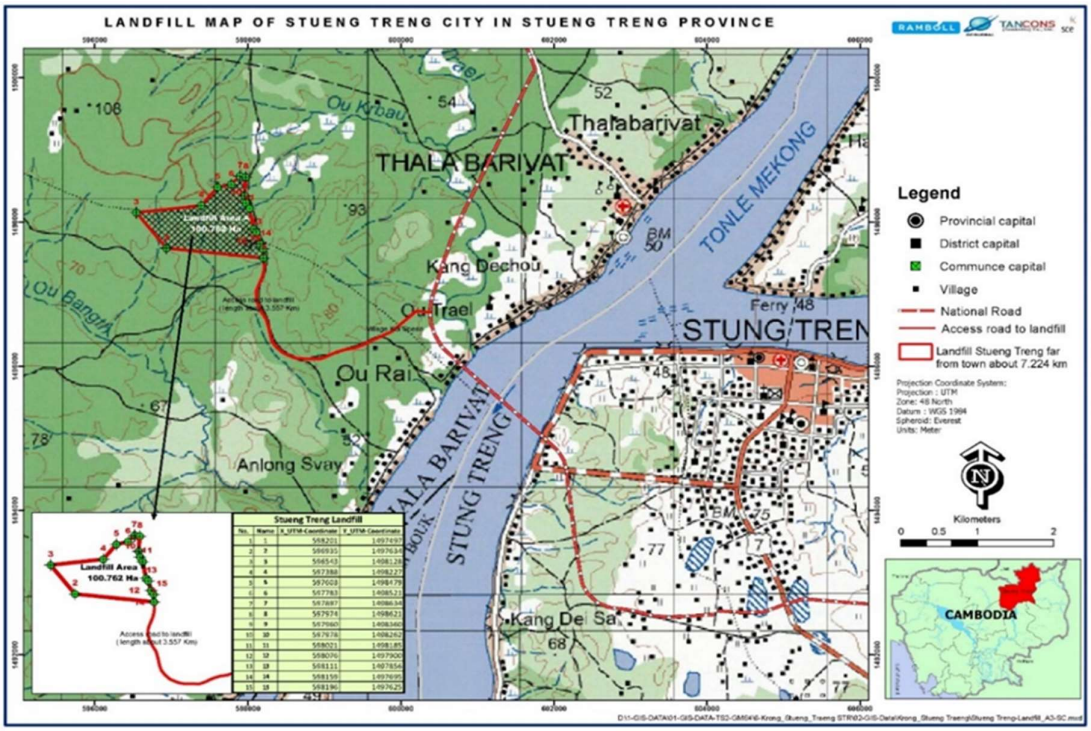
Figure 3: Overview Map of the Existing Dumpsite and the New Landfill Site

4.4. Landfill Design Basis

4.4.1. Location

78. The landfill site is on State Land in Anlong Svay village, Or Rai and Thala Barivat commune, Thala Barivat district, Stung Treng province (see ***Figure 4***). The landfill is approximately 5 km west of the urban area across the Mekong. The Provincial Government has an area of 100 hectares in this location of which an area of 34.45 hectares has been set aside for the landfill, contained within the north-eastern corner of the larger area. Initially an area of 25 hectares in the south-eastern corner had been selected, but to avoid impacting on cashew nut farms in that area, which could not be relocated, the Ministry of Public Works and Transport decided to move the location of the landfill to the north-eastern part of the land. The new landfill site is located 26 km by road from the existing dumpsite.

Figure 4: Stung Treng Landfill Site



4.4.2. Site Physical Characteristics

79. The site is located in upland hilly terrain with elevations of about 105 m asl. at hilltops located in the north-western part of the site sloping towards the southeast with elevations between 80 and 90 m asl in the lower areas. The landfill cells will be located on the higher ground so that leachate can be transferred to the leachate treatment system by gravity.

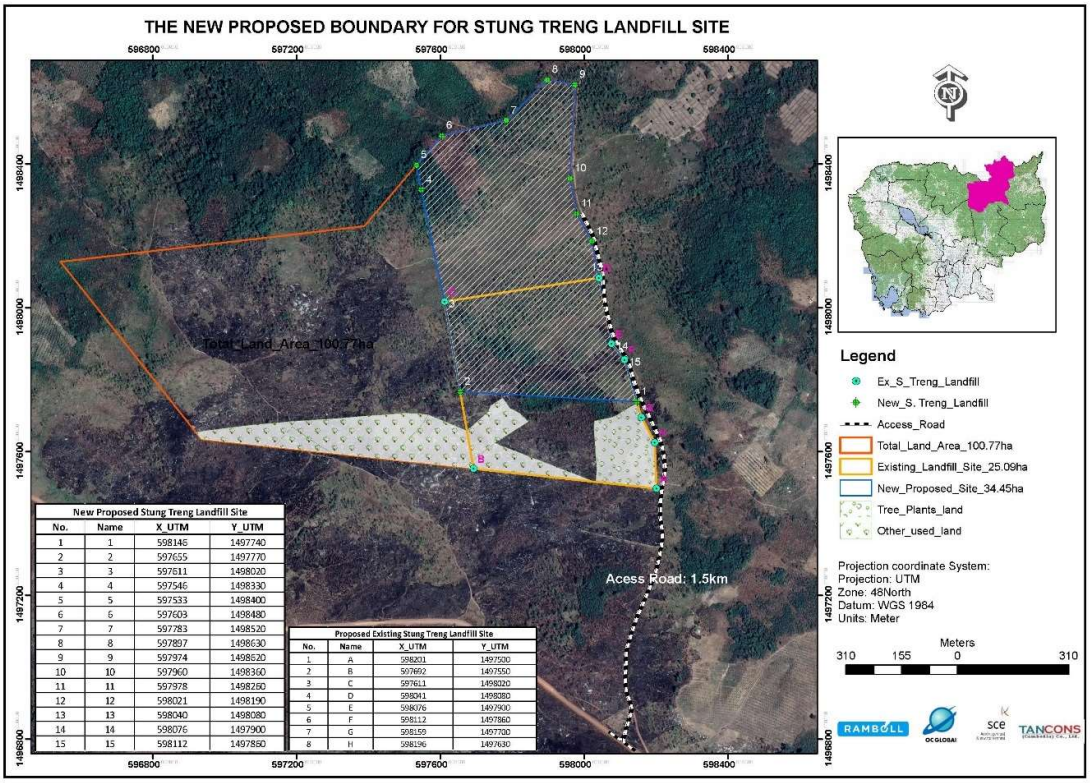
80. The site is covered by secondary shrub (***Figure 4***). The main land use in the immediate surroundings is agriculture, including cashew nut, cassava, mango and rice fields. There are patches of secondary forest, shrub and natural grasses, particularly on the hillsides. There are no sites of cultural significance in the area. The proximity to sensitive receptors is detailed in ***Section 5.1.2***.

81. There are no structures on the site.

82. There are no permanent waterbodies located within or near the site. However, there are some ephemeral streams that cross the site. It is likely that these will only contain water during periods or rain, transporting water down the hillsides to lower elevations. Consequently, the designs ensure that this water bypasses the landfill cell through drainage channels. Surface water draining towards the landfill area could potentially increase leachate and bring about local flooding during major rain events. The design has therefore incorporated peripheral drainage systems, which will divert water away from the landfill cells.

83. Geotechnical investigations at the site show that the underlying geology is comprised of various clays (including lean clay, sandy lean clay) and underlying sandstone, which is typically in the range of 8 to 14 m below the surface. It is envisaged that it will be possible to undertaken standard excavations on the site, due to the depth of compact geology. The groundwater is on average 4.7 m below the existing ground surface (dry season level). As such, the site will comply with the requirements for a 3-metre buffer between the landfill cells/ leachate ponds and underlying groundwater. The nearest groundwater well is located in a village, about 4-5 km from the site.

Figure 5: Stung Treng Landfill



New Proposed Stung Treng Landfill Site

No.	Name	X_UTM	Y_UTM
1	1	598148	1497740
2	2	597655	1497770
3	3	597611	1498020
4	4	597546	1498330
5	5	597533	1498400
6	6	597603	1498480
7	7	597783	1498520
8	8	597897	1498630
9	9	597974	1498620
10	10	597960	1498360
11	11	597978	1498260
12	12	598021	1498190
13	13	598040	1498080
14	14	598076	1497900
15	15	598112	1497850

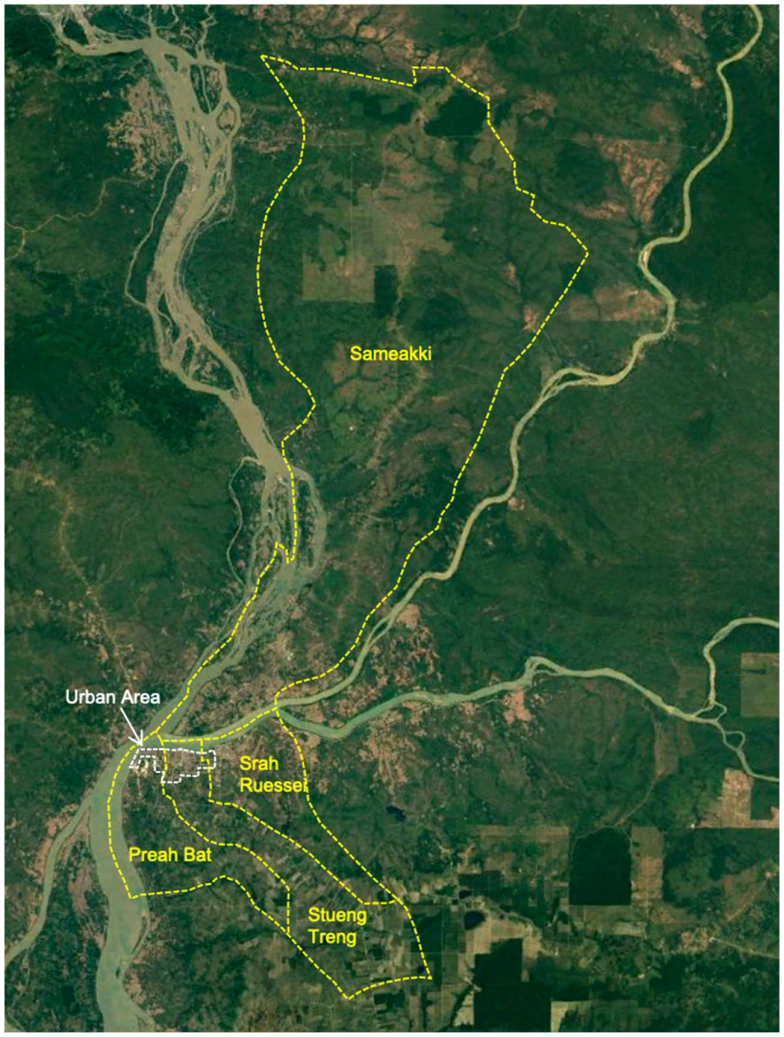
Proposed Existing Stung Treng Landfill Site

No.	Name	X_UTM	Y_UTM
1	A	598201	1497500
2	B	597692	1497550
3	C	597611	1498020
4	D	598041	1498080
5	E	598076	1497900
6	F	598112	1497860
7	G	598159	1497700
8	H	598196	1497630

4.4.3. Service Area and Population

84. The planning horizon for the project is until the year 2040, with initial construction of landfill cells to cover the period to 2030. The project is designed to cover the main urban areas of Stung Treng. There are four sangkats in the Stung Treng municipality, namely Stung Treng, Preah Bat, Srah Ruessei, and Sameakki. However, as Sameakki is a large rural sangkat it would not be practical to provide collection services for the whole of this area. The service in this Sangkat will only cover the two villages on the north side of the National Road No.7 bridge, namely Hang Ko Suon and Hang Ko Barn. The other three sangkats will be provided with collection services. The waste collection service area is displayed in ***Figure 6***.

Figure 6: Waste Collection Service Area



85. There may be scope to include some other settlement areas close to the route from the municipality to the landfill site. These are the villages on the western side of the Mekong in Thala Bharivat District, with access from National Road No.9, as shown in ***Figure 7.***

Figure 7 Possible Additional Settlements for Waste Collection

86. The population to be serviced by the Subproject over the period from 2023 to 2040 has been estimated under the Detailed Engineering Design based on a 2018 baseline population of 31,000 and using a medium annual average growth rate of 2% during the years 2020-2030 and 1.5% for the years 2031-2040. The estimated population growth and the gradual increase in service coverage until 2040 are tabulated in ***Table 6***. It should be noted that the baseline service coverage of 82% applied for the landfill design is likely higher than the actual collection coverage, which may be as low as 50%. This higher percentage in service coverage has been used in the forecasts to ensure that there is enough space in the landfill for incoming waste.

Table 6: Estimated Population Growth and Service Coverage

Year	Total Population	Serviced Population	Design Percentage of Total Population
2018	31,000	24,800	82%
2023	33,467	27,686	83%
2030	38,400	33,862	88%
2040	44,500	42,275	95%

Source: Detailed Engineering Design, Stung Treng Landfill Subproject, July 2021

4.4.4. Waste Forecasts

87. 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 82% 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 7: Waste Amount Forecast

Year	Residential Waste (tons/day)	Commercial Waste (tons/day)	Waste to Landfill (tons/day)
2019 (Baseline)	12	2	14
2023	16	2	18
2030	22	4	26
2040	36	6	43

Source: Detailed Engineering Design, Stung Treng Landfill Subproject, July 2021

88. 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. It must be recognized that there is a lack of credible area specific surveys and data on waste generation, and it is challenging to determine a precise rate. However, the baseline waste generation rate of 0.7 kg/cap/day is similar to rates estimated for waste generation in Battambang, Siem Reap and Kampong Cham in 2009 by other studies based on interviews with waste collection companies and local authorities[8]. While the applied increase in 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.

4.4.5. Waste Composition

89. A detailed composition study of the waste generated in Stung Treng has not been conducted. ***Table 8*** summarises results of various solid waste management studies in Cambodia which have formed the basis for the design of the Stung Treng 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 Stung Treng 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 8: 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%
Textiles	1-4%
Glass	1-8%
Metal	0.6-8%
Wood	-

[8] A guide for technology selection and implementation of urban organic waste utilisation projects in Cambodia, IGES Policy Report-2011-06

Waste Type	Percentage
Soil and Dirt	10-30%
Miscellaneous	2-8%

Source: Detailed Engineering Design, Stung Treng Landfill Subproject, July 2021

4.5. Landfill Design and Technology

4.5.1. Overview

90. The landfill will be designed, constructed and operated as a controlled landfill with sufficient capacity to accommodate the predicted waste flow until 2030. The landfill site and the design allow for development of additional landfill cell sufficient to serve the needs of Stung Treng City until 2040 (and likely until 2047).

91. This will be an area landfill, with waste deposited predominantly above ground. The recommended maximum height of waste in any landfill cell will be 25 m, with a 1:2.5 slope, which through settlement is likely to achieve a final slope of 1:3. The actual final heights of the waste cells are likely to be lower in the vicinity of 15-20 m.

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

- Upgrading of 1,450 metres of external access road to the landfill site to be above flood levels.
- Construction of one controlled landfill cell out of a total of two 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 2,003 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.
- Remediation and closure of the existing waste dump.

4.5.2. Climate Change Design Considerations

93. 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 have been designed to allow for future retrofitting active systems and flaring of gas, including methane, a powerful greenhouse gas.
- The incorporation 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.

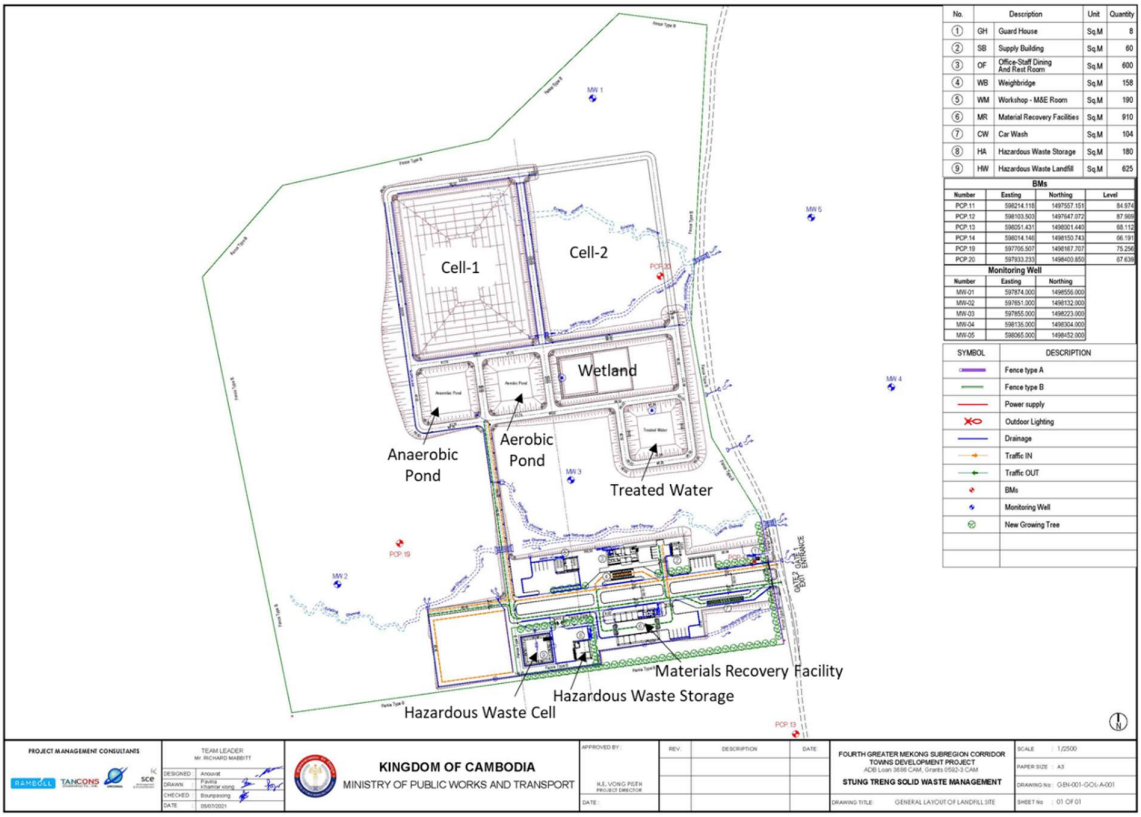
- Embankments and interceptor surface water drainage has been utilised around the landfill, providing protection against storm events.
- All sidewalls and roofs are designed to withstand high wind velocity and storms up to 260 km/hr.
- Concrete roads are introduced to avoid vehicle penetration in the ground.
- Leachate collection and treatment lagoons can take high volumes of wastewater in case of extreme events.
- Maximum rainfall has been considered towards the design of leachate collection, treatment and the stormwater discharge system.
- Cells have a single composite liner to avoid percolation of leachate into the ground water.
- To save landfill area, a percentage of waste diversion is envisaged (30% of waste by 2030).
- Staff and workers' restroom with bathing and toilet facilities are provided to provide comfort to the workers during extreme weather. Staff to have adequate PPE.

4.5.3. Landfill Masterplan

94. The landfill masterplan layout is presented in ***Figure 8***. The landfill site has a total area of 34.45 ha, of which 20.8 ha will be utilized for this phase of the landfill project with space for 2 identical landfill cells. The initial construction includes landfill cell-1, a 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.

95. The capacity of cell-1 and cell-2 is summarized in ***Table 9***. The cells have a total design airspace of 274,832 m^3 equivalent to 283,200 tonnes of settled waste, Cell-1 will provide capacity beyond 2030, potentially to 2037, The life span of this cell will also depend on any requirements to accommodate waste that is transferred from the existing waste dumpsite. Cell-2 will accommodate 43,551 tonnes of waste during the 2040 planning horizon, with room for approximately a further 100,000 tonnes.

Figure 8: Landfill Masterplan Layout



Source: Detailed Engineering Design, Stung Treng Landfill Subproject, July 2021

Table 9: Landfill Cell Capacity

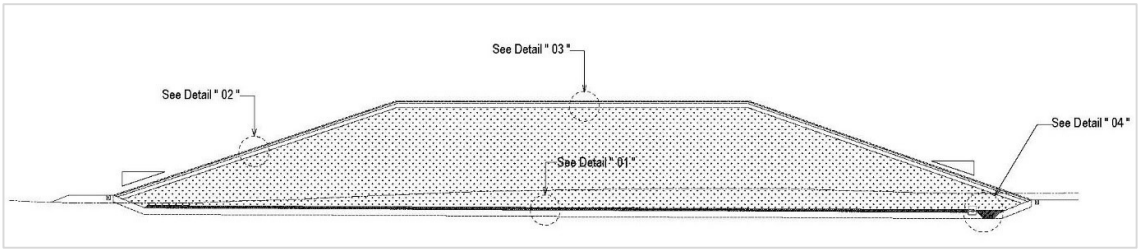
Cell Number	Predicted years covered	Total Base Area (m^2)	Total Space (m^3)	Tonnes of Waste[9]
Cell 1	2022-2035	15,976	137,416	141,600
Cell 2	2035-2045	15,976	137,416	141,600
Total		**31,951**	**274,832**	**283,200**

Source: Detailed Engineering Design, Stung Treng Landfill Subproject, July 2021

96. As mentioned in ***Para 91***, this will be an area landfill and as illustrated in ***Figure 9*** , the cells will practically be constructed on the existing ground involving minimal excavation.

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

Figure 9: Profile of Cell-1



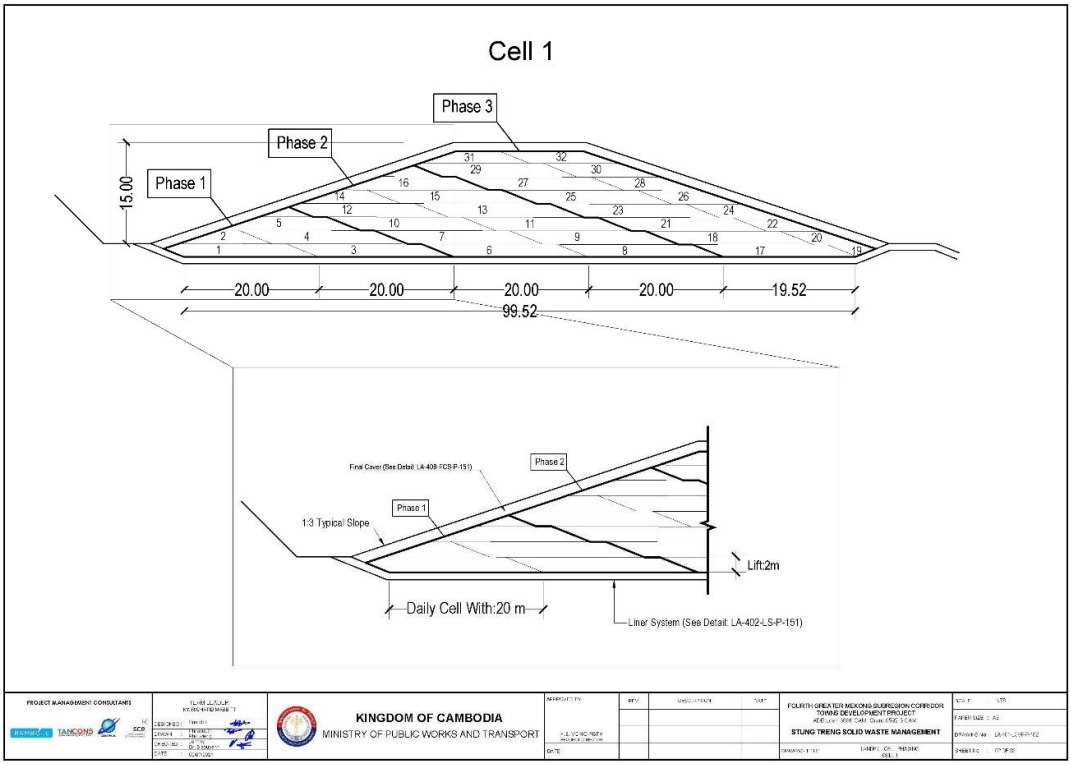
Source: Detailed Engineering Design, Stung Treng Landfill Subproject, July 2021

4.5.4. Cell Volumes and Phasing

97. 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.

98. As outlined in ***Figure 10,*** 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 recommended maximum height of any waste cell is 25 m, but the actual final heights are likely to be in the vicinity of 15-20 m.

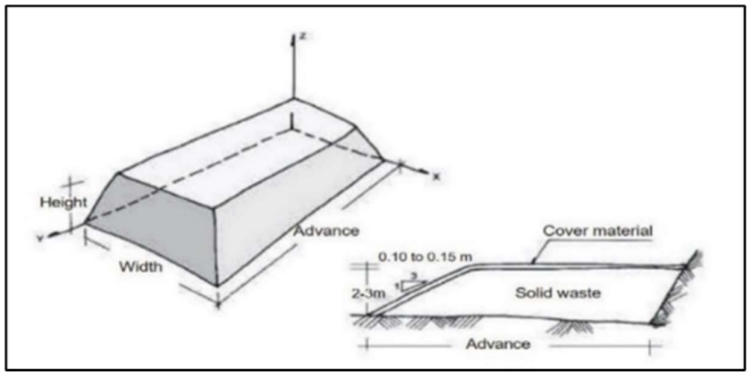
Figure 10: Landfill Cell Phasing



99. 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.

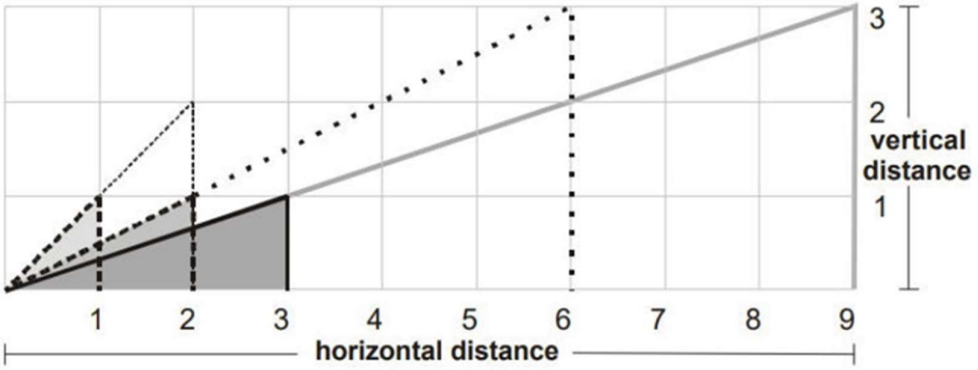
100. A bulldozer will subsequently spread the waste in thin layers of between 300 mm and 500 mm, depending on the quantity and nature of incoming wastes, which will be compacted by approximately six passes. Individual daily lifts may be between 2 to 3 m in height, as shown in ***Figure 11***, depending on the daily volume of refuse deposited. The maximum height of 3 m will allow for safe working practices.

Figure 11: Typical Daily Cell



101. 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 12***.

Figure 12: Ways of Representing the Gradient of a Site



102. 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

103. As shown in ***Table 10***, the groundwater table has been found at an average depth of 4.7 metres ranging from 3.05 m to 6.13 m below ground. This confirms that the design complies with the Cambodian Solid Waste Management Guidelines, specifying that the unsaturated zone must be a minimum of 3 m.

Table 10: Depth to Groundwater Table

Borehole	1	2	3	4	5	6	7	8	9	10	11	12
Depth to Groundwater (m)	3.1	3.3	5.3	6.1	3.0	4.9	4.5	5.	5.1	5.9	5.1	5.2

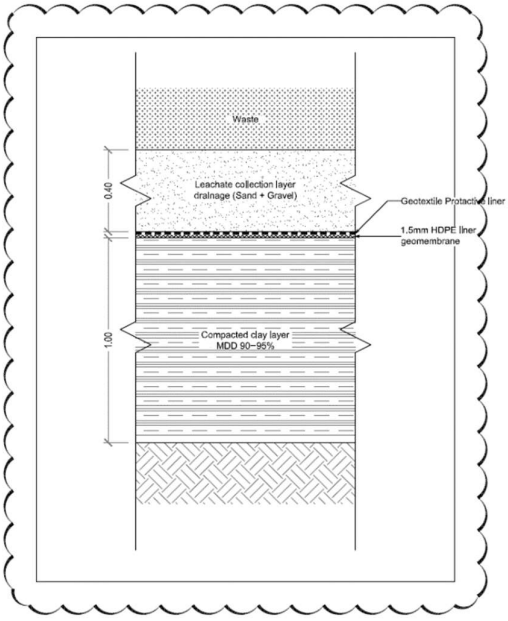
104. The sides of the landfill cell will be comprised of earth bunds, minimum 1 m in height, with an inner clay core that is connected to the underlying clay liner in order to prevent any lateral movement of leachate out of the landfill cell.

105. 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 13***):

- 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 13: Landfill Liner



106. 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.

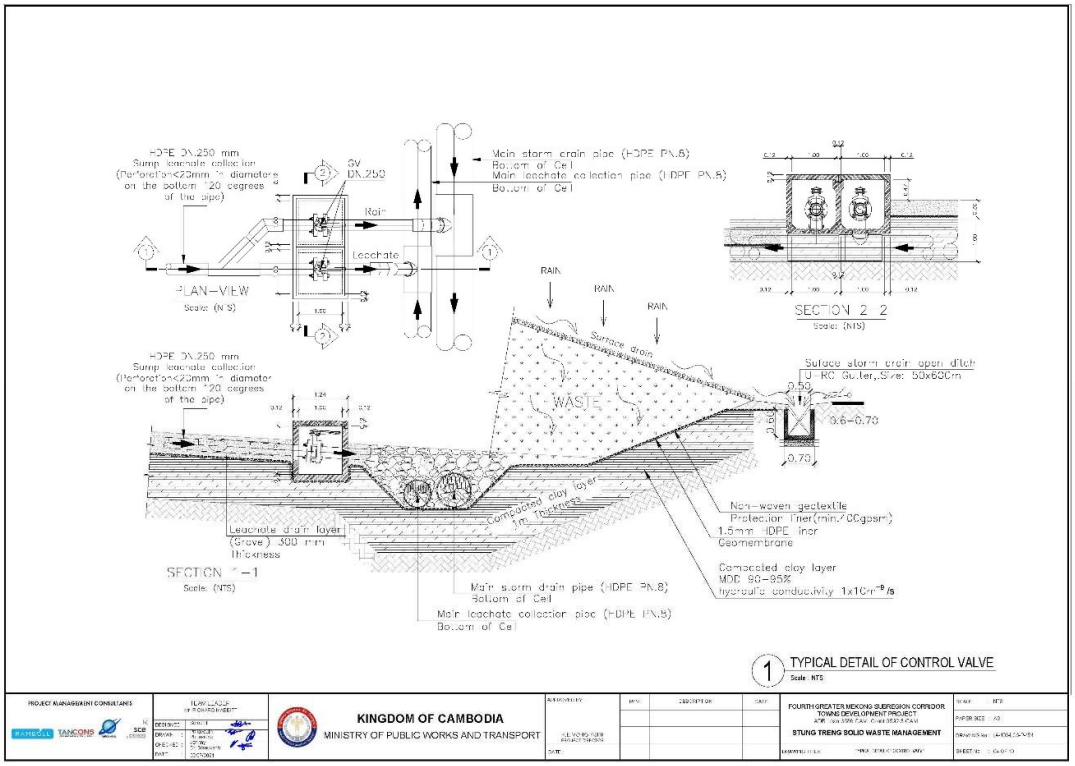
4.5.6. Leachate Collection

107. 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.

108. The leachate collection system, detailed in ***Figure 14***, 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 14: Design of Leachate Collection System



109. 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 0.5% 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.

110. 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.

111. 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.

112. 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).

113. 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.

114. 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.

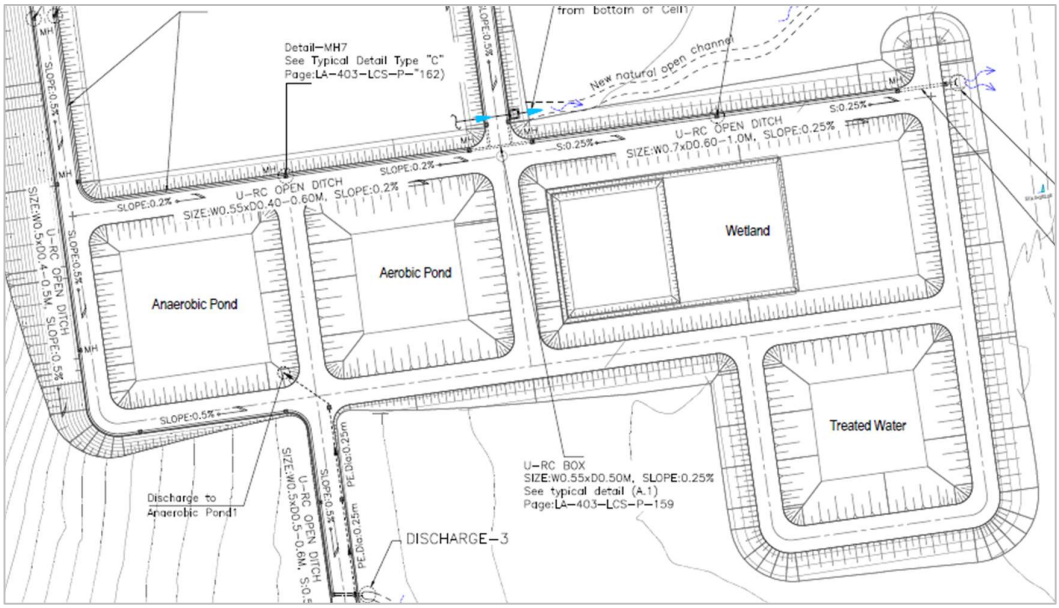
115. Due to the slopping nature of the site, leachate will be predominantly transported via gravity. These main leachate and storm water collection pipes will be manufactured from HDPE. The leachate pipes will have a diameter of 500 mm and the stormwater pipes will have a diameter of 600 mm. The diameter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

116. 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

117. 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 15***).

Figure 15: Leachate Treatment System



118. 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[10].

119. 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.

120. 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.

121. Due to the climate in Stung Treng, 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.

122. 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

123. 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.

124. *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.

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

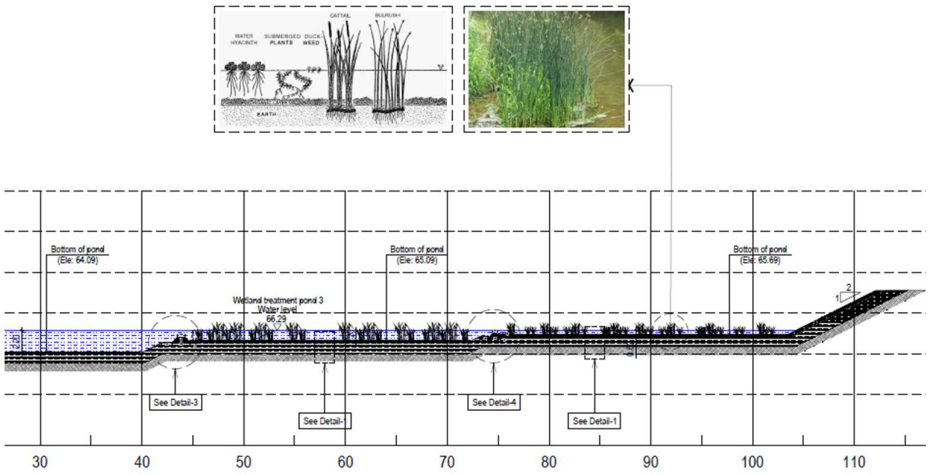
125. *Aerobic Lagoon:* The second lagoon's purpose is to remove biological degradable materials, some ammonia, plus achieve low BOD. This is achieved through an aeration process to diffuse and mix the water. In order to minimise operational costs and resources electric aerators will not be utilised. 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.

126. *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.

127. 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 16***, 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.

128. 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 16: Constructed Wetland



129. Treated Water Lagoon: This lagoon of 3 m metres depth will provide a holding area for treated water. As mentioned in ***Para 119***, 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.

130. 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.

131. 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.

132. This site does not require a stormwater pump to control water levels during periods of heavy rainfall. Any surplus water can drain out of the treated water pond by gravity.

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

134. Summary information on each treatment lagoon is outlined in ***Table 11***. The square metres refer to the maximum water limit and metres cubed refers to the maximum level of water.

Table 11: Leachate Treatment System Details

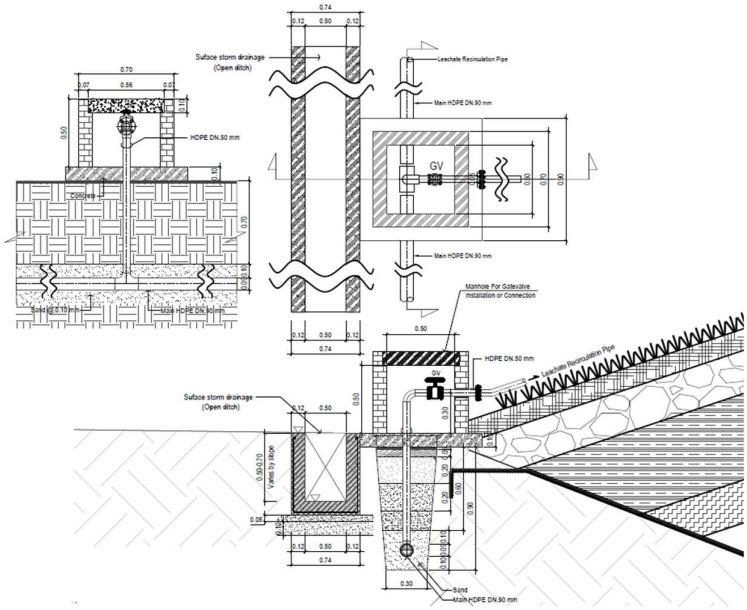
Lagoon	Square Metres	Metres Cubed	Depth Range	Retention Time
Anaerobic	1,200	2,540	3 m	20 Days
Aerobic	1,145	1,267	1.2 m	5 Days
Wetland	2,980	3,225	0.6 – 2.2 m	5 to 14 Days
Treated	1,110	2,136	(av. 1.5)	Unlimited
Total	**6,435**	**9,168**		

135. 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.

136. The recirculation system involves a portable pump, which will be used to pump leachate into a leachate distribution system around the landfill cells. An electric driven pump will have a capacity of 780 cubic metres per hour (a backup pump is also required). As this pump are portable, they will also be able to pump 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.

137. 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 17***, allow for the leachate to be distributed using either drip irrigation (trickle) or sprinkler irrigation. The drip irrigation will be administered via a 130 m long flexible HDPE pipe, with perforations across the final 30 m to achieve a broad distribution.

Figure 17: Connection System for Leachate Recirculation



138. 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

139. Leachate quantities will be minimised through landfill design and operations, including intercepting incoming surface water from upstream catchment areas through drains (***Para 145*** and ***147***); reducing ability for water to infiltrate wastes via heavy compaction of wastes (***Para 100***); building waste in phases as opposed to spread across the whole cell (***Para 97*** and ***98***); utilising intermediate cover to promote surface water run-off (***Para 102***); and completing main phases prior to the onset of the wet season (***Para 102***). 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 113***).

140. Calculations for volumes of leachate have been undertaken for each phase across cell 1 up until 2030, as shown in ***Table 12***. Calculations have been made based on average rainfalls only, since maximum rainfall data is unreliable. These calculations

take into account the level of exposed waste, level of intermediate cover being used, and adsorptive capacity of waste.

Table 12: Estimated Leachate Volumes

Year	Season	Average Rainfall Leachate produced (m^3)			
		Season	Month	Week	Day
2023	Dry	1	0	0	0
2023	Wet	222	37	9	1
2024	Dry	0	0	0	0
2024	Wet	301	50	13	2
2025	Dry	0	0	0	0
2025	Wet	386	64	16	2
2026	Dry	0	0	0	0
2026	Wet	476	79	20	3
2027	Dry	0	0	0	0
2027	Dry	0	0	0	0
2027	Wet	569	95	24	3
2028	Dry	0	0	0	0
2028	Wet	669	112	28	4
2029	Dry	0	0	0	0
2029	Wet	773	129	32	4
2030	Dry	0	0	0	0
2030	Wet	883	147	37	5

Calculation assumptions and limitations: Assumes average rainfall split across wet and dry seasons. No surface water run-off into cell. No intrusion into cell from groundwater. At any time 80% of the cell is assumed to be uncovered/ 20% covered. Infiltration rate in waste estimated at a high level of 90%, with 10% run-off out of cell. Infiltration rate in covered sections estimated at maximum level of 10%. Absorptive capacity of waste assumed to be 0.02 m3/m3. Calculations do not include water vapour from landfill gas, or amount of liquid reintroduced through recirculation

141. 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.

142. The water balance and flow in the ponds have been calculated (see ***Annex 10***) 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. Note, however, that recirculation of treated leachate has not been taken into account.

143. 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.

144. The calculations show that, based on average rainfalls and evaporation rates, the ponds will have adequate capacity to cope with average precipitation levels in leachate generation, with further capacity available during periods of rain that is higher than average.

4.5.9. Surface Water Drainage

145. 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.

146. Natural channels will be constructed across the site to facilitate the movement of water through the site from the surrounding hills. This will require box culverts under the access road.

147. 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.

148. 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

149. 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 18*** and in accordance with the conceptual design presented in ***Figure 19***. The exact depth will be determined during the drilling work.

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

Figure 18: Groundwater Monitoring Wells

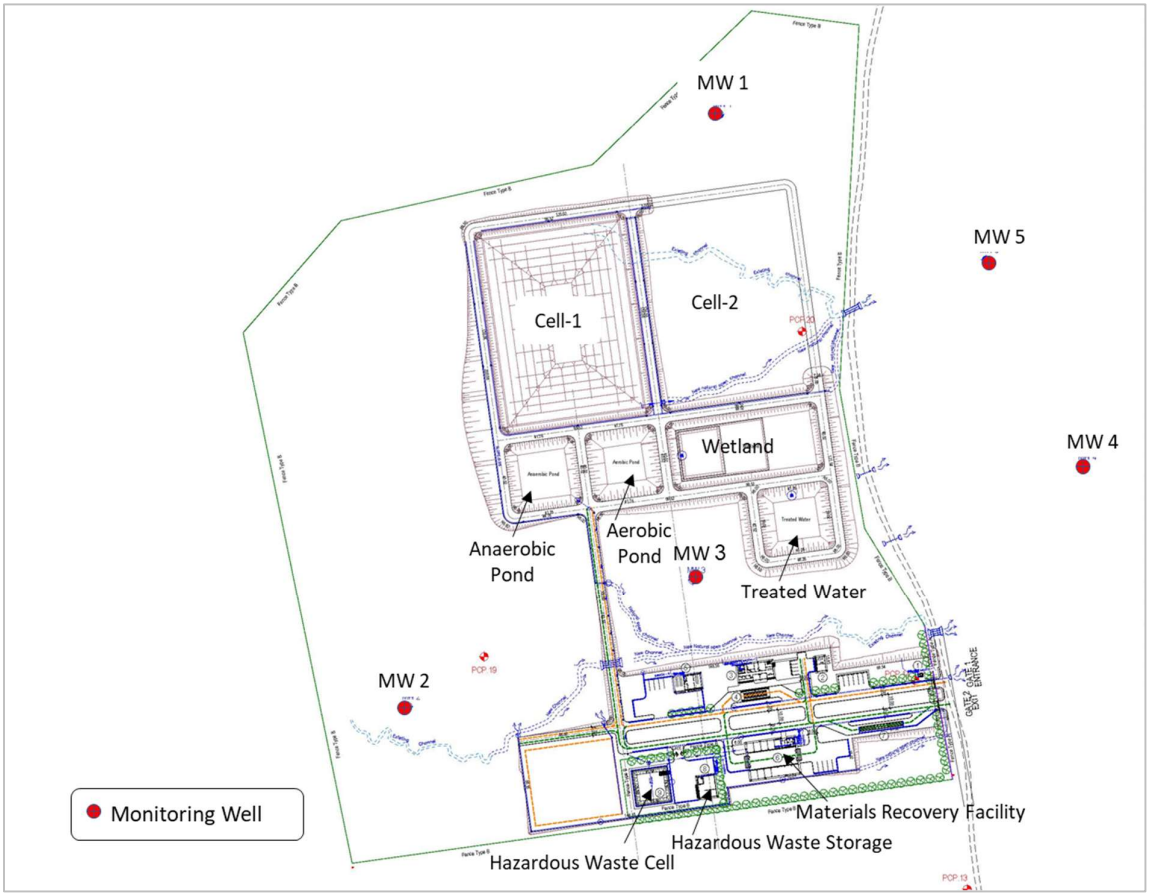
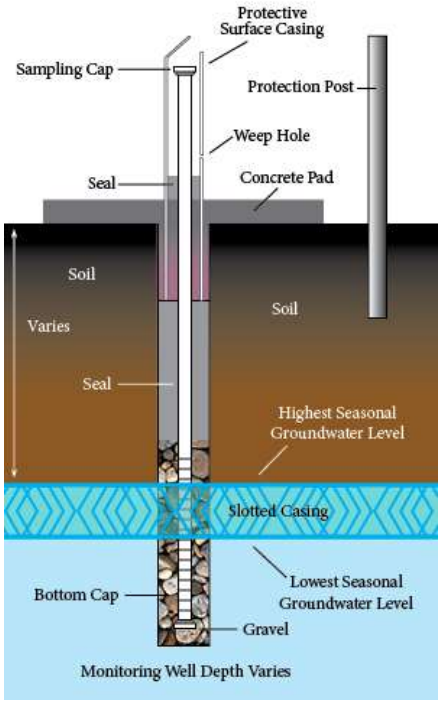


Figure 19: Conceptual Design of the Groundwater Monitoring Wells



4.5.11. Landfill Gas Control

151. 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 7***. 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.

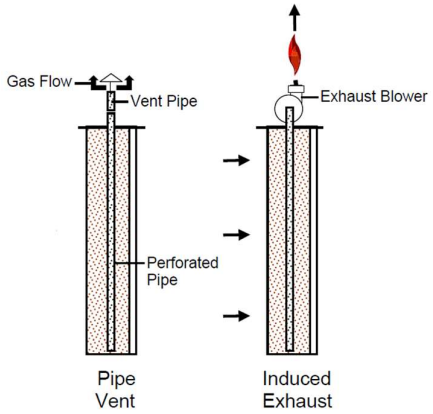
152. The approach to landfill gas management will be to utilise passive vents, using vertical wells, which use existing variations in landfill pressure and gas concentrations to vent landfill gas into the atmosphere. These vents are constructed using 2 m lengths of perforated/ slotted HDPE pipe, with 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.

153. 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.

154. As shown in ***Figure 20,*** the passive gas collection system can be converted to an active system, which includes an induced exhaust system and flaring.

Figure 20: Potential Future Transition from Passive to Active System



155. 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

156. 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).

157. *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.

158. *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.

159. *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.

160. *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).

161. 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

162. 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 13*** provides preliminary hazardous waste acceptance guidelines to be further elaborated and considered in the O&M manual.

163. 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 13: 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	• 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

Acceptable Hazardous Waste	Unacceptable Hazardous Waste
materials contaminated with hazardous chemicals	• Gas cylinders

164. The conceptual design of the hazardous landfill cell is displayed in ***Figure 21*** and the location is indicated in ***Figure 22***. 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).

165. 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).

166. 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 21: Hazardous Waste Landfill Cell

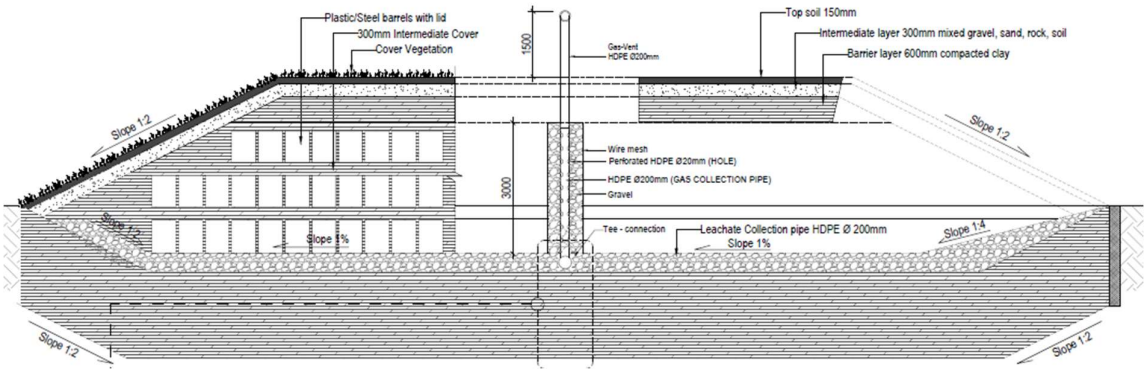
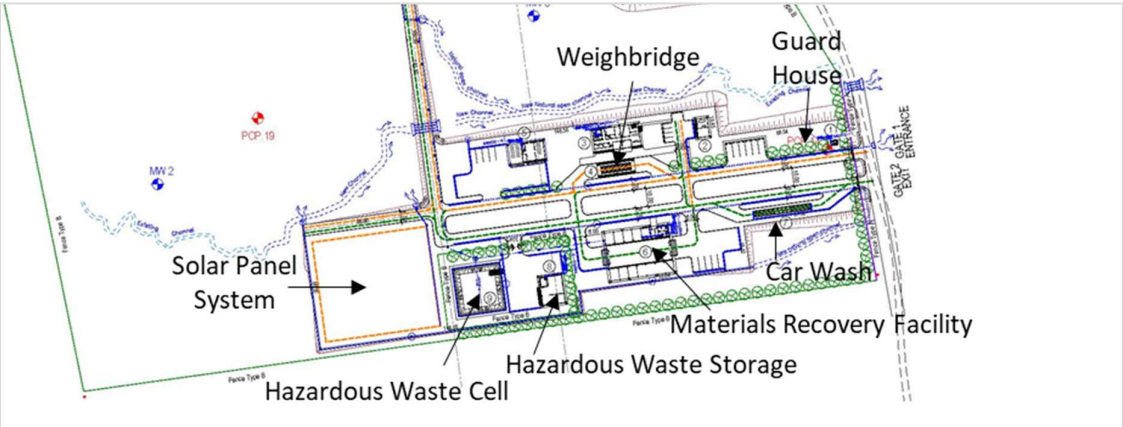


Figure 22: Landfill Facilities Master Plan

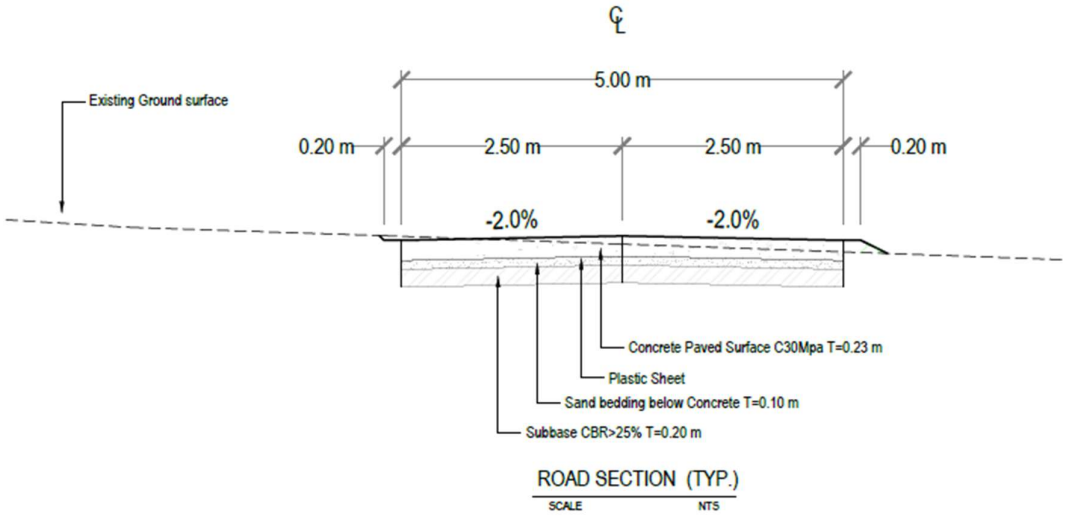


4.5.14. Landfill Facility Civil Works

167. The layout of the facilities is presented in ***Figure 22***. The layout and road system are designed to ensure that vehicle movements are efficient, and crossing is minimised.

168. **Access Roads:** 1.45 kilometres of access road to the site will be upgraded to a 5 m wide and 23 cm thick concrete construction with a load bearing capacity of 25 tons. There will be a 20 cm shoulder on each side of the road. This upgrade is based on the current width of the road - see ***Figure 23.***

Figure 23: Access Road Profile



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

170. **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.

171. **Workshop, Electrical, and Mechanical Room:** A workshop is provided to maintain all the vehicles within the facility. An electrical room is provided to maintain all electrical

components of the facility. The mechanical room is provided for maintaining all mechanical parts, such as fans, exhaust fans, pumps, and motors.

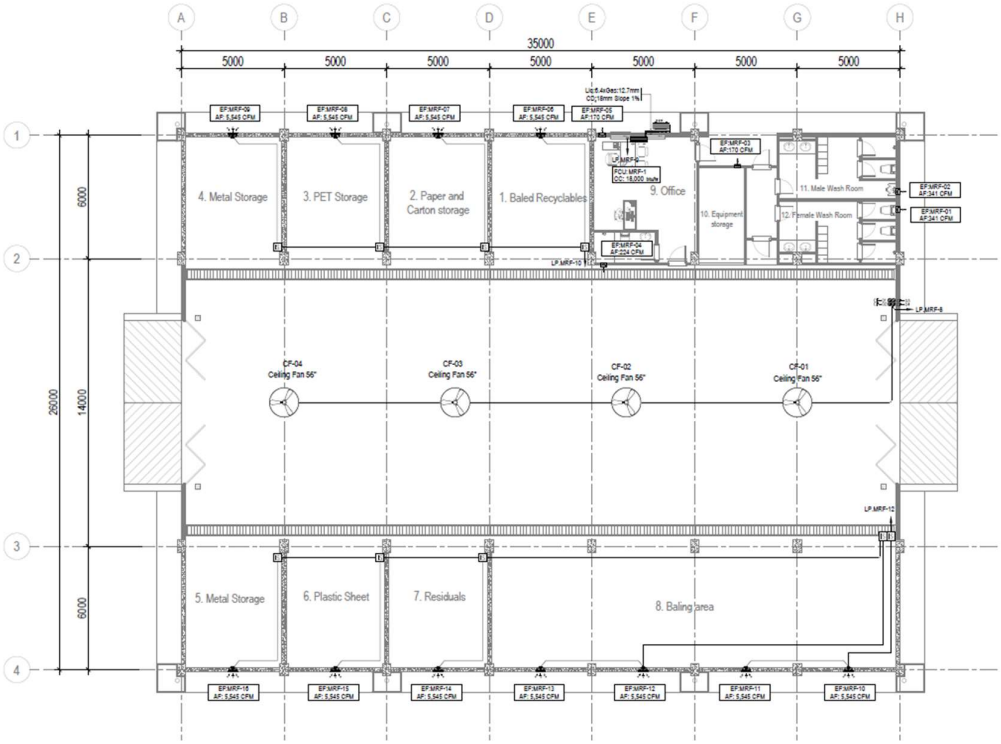
172. **Supply Room:** This small building will have two rooms a) Plumping technical room for the groundwater pump and supply; b) Electrical technical room for the generator and main distribution boards (MDB) for electricity supply.

173. **Material Recovery Facility (*Figure 24*):** This is a non-mechanical type material recovery facility, which will provide a covered building for the manual sorting of recyclable wastes. 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 18 tonnes per day.

174. 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.

175. 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.

Figure 24: Materials Recovery Facility Layout



176. **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.

177. 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.

178. 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.

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

180. **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 but are typically 5 metres wide, and the total length of these roads is 2,003 m in the initial construction. This initial construction does not involve the roads specifically associated with landfill cell 2.

181. **Fence and Wall**: 1,794 metres of two-metre high 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. Wire mesh is being utilised as it will also help capture wind-blown litter, intercepting it before it leaves the site. An additional 218 metres of fence will be installed around the hazardous waste facility (storage and landfill cell). A total of 100 metres of brick masonry wall will also be constructed around the entrance to the landfill site.

182. **Vegetation Screens**: Trees will be planted throughout the site to provide screens and minimise the spread of dust and odours.

183. **On-Site Drainage**: Drainage is provided in the form of reinforced concrete-lined open ditches, reinforced-concrete covered drains, and natural ditches. These drains will divert storm water away from roads, landfill cells, buildings and facilities.

184. **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 144.3 KW.

185. **Water Supply**: Water supply will come from a deep tube well on the site. An overhead HDPE tank will be installed for water storage. Water will then be supplied by gravity/booster pump to the buildings.

186. **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

187. The existing dumpsite is described in ***Section 4.3.1***. and in ***Section 5.11***. The closure options are discussed in ***Section 6.5***.

4.7. Construction Implementation

4.7.1. Construction Schedule

188. The construction is scheduled to be completed within 14 months as outlined in ***Figure 25***:. The schedule takes into account wet season constraints.

Figure 25: 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							■	■	■	■				
11	Access Road										■	■	■	■	■
12	Internal Roads	■	■								■	■	■	■	■
13	Entrance Gate with Security											■	■	■	■
14	Tree Planting													■	■
15	Groundwater Monitoring Wells			■											
16	Training of O&M staff														■
17	Quarterly Environmental Monitoring (air, noise)		■						■					■	
18	Groundwater Monitoring		■						■						■

4.7.2. Construction Activities

189. 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, 2 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, 1.45 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: Drilling of groundwater monitoring boreholes
- Activity 16: Training of O&M Staff
- Activity 17: Air and noise monitoring
- Activity 18: Groundwater monitoring

4.8. Associated and Existing Facilities

190. 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.

191. 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 current dumpsite is considered an existing facility under the wider CTDP4 Project and as such an Environmental Compliance Audit (ECA) is required for the dumpsite. An ECA for the dumpsite has been prepared and is attached in ***Annex 11***. 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

192. 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 centres will continue, leading to further developments around the sub-project areas.

193. 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.

194. 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 dB(A) (Outside; residential receptor, daytime limit)
- Construction Noise: Backhoe excavator 80 dB(A) at 15 m and concrete mixer 79 dB(A) at 15 m. Source: Construction Noise Handbook (www.fhwa.dot.gov), US Department of Transport.
- Noise attenuation factor: a conservative 6 dB(A) 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 dB(A) (WHO limit).

5.1.2. Sensitive Receptors

195. 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.

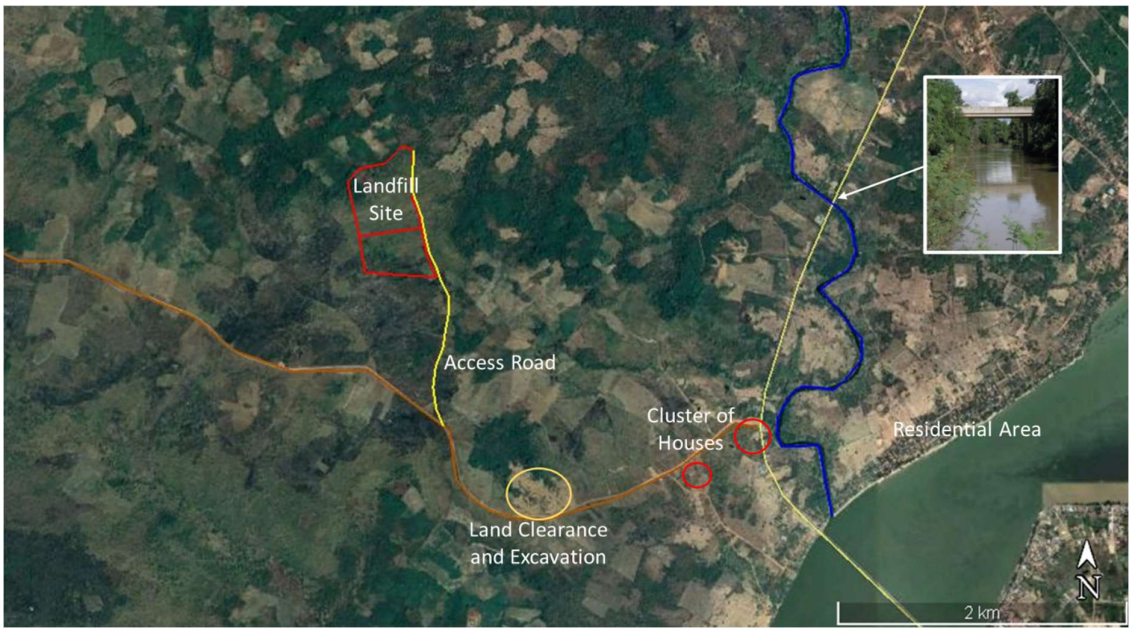
196. The identification and proximity of sensitive receptors is summarised in ***Table 14*** and the receptors in the immediate surroundings are displayed in ***Figure 26***.

Table 14: Summary of Sensitive Receptors

Project Component	Surface Water Receptors	Socioeconomic and Cultural Receptors	Land Cover and Ecological Receptors	Protected Areas
Landfill Site	- about 3.5 km from the Mekong River - About 2.7 km from a right-bank tributary to the Mekong River - Small ephemeral streams criss-cross the surrounding areas	- State Land - 5 km for Stung Treng City centre across the Mekong River. - The nearest housing is a small cluster of houses/buildings 2.5 km southeast of the site - 4 km from nearest villages Anglong Svay in Or Rai commune and Or Trail in Thala Barivat commune with houses, schools and other local utilities	- The site is in upland area, hilly terrain covered with degraded forest and secondary shrub - Surrounding area is upland area with secondary forest/shrub and patches of agricultural land including rice fields and cashew plantations	- 8.3 km southwest of the Stung Treng Ramsar Site which is a National Protected Area of Cambodia - Just inside the Thala Stung Treng freshwater Key Biodiversity Area - 3 km west of Mekong River from Kratie to the Lao PDR, Key Biodiversity Area - 3.5 km west of the Northeast Corridor of Protected Area
Dumpsite	- A 7 ha large reservoir/lake/wetl and is located about 800 m west of the dumpsite. The water is used for irrigation of paddy fields - Small irrigation canals connect reservoir to rice fields. - About 1 km northwest of the Sekong River	- 450 m from housing area along National Road No. 7 - 14 km northeast of Stung Treng urban area	- Laterite roads inside an area covered with degraded open forest and secondary shrub - Surrounding area is upland area with secondary shrub, grassland and patches of agricultural land	- 1 km northwest of the Sekong River Key Biodiversity Area - 3.5 km southeast of the Stung Treng Ramsar Site, which is a National Protected Area of Cambodia - 3.5 km southeast of Mekong River from Kratie to the Lao PDR, Key Biodiversity Area - 6 km west of the Northeast Corridor of Protected Area

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

Figure 26: Receptors in the Immediate Surroundings of the Landfill



5.2. Topography and Geology

197. The landfill is located in an upland area with hilly terrain with elevations generally between about 90-105 m asl. at the hilly north-western part of the site and around 80 m asl. at the lower lying areas.

198. Geotechnical investigations at the site show that the underlying geology is comprised of various clays (including lean clay, sandy lean clay) and underlying sandstone, which is typically in the range of 8 to 14 m below the surface. The groundwater is on average 4.7 m below the existing ground surface.

199. The main land use / land cover of the surrounding area consists of agriculture, including cashew nut, cassava, mango and rice fields with patches of secondary forest, shrub and natural grasses, particularly on the hillsides (see ***Figure 27***).

Figure 27: Pictures of the Landfill Site

5.3. Meteorology and Climate

200. The climate for Strung Treng Province is classified as tropical wet and dry climate (Aw) according to the Köppen-Geiger climate classification.

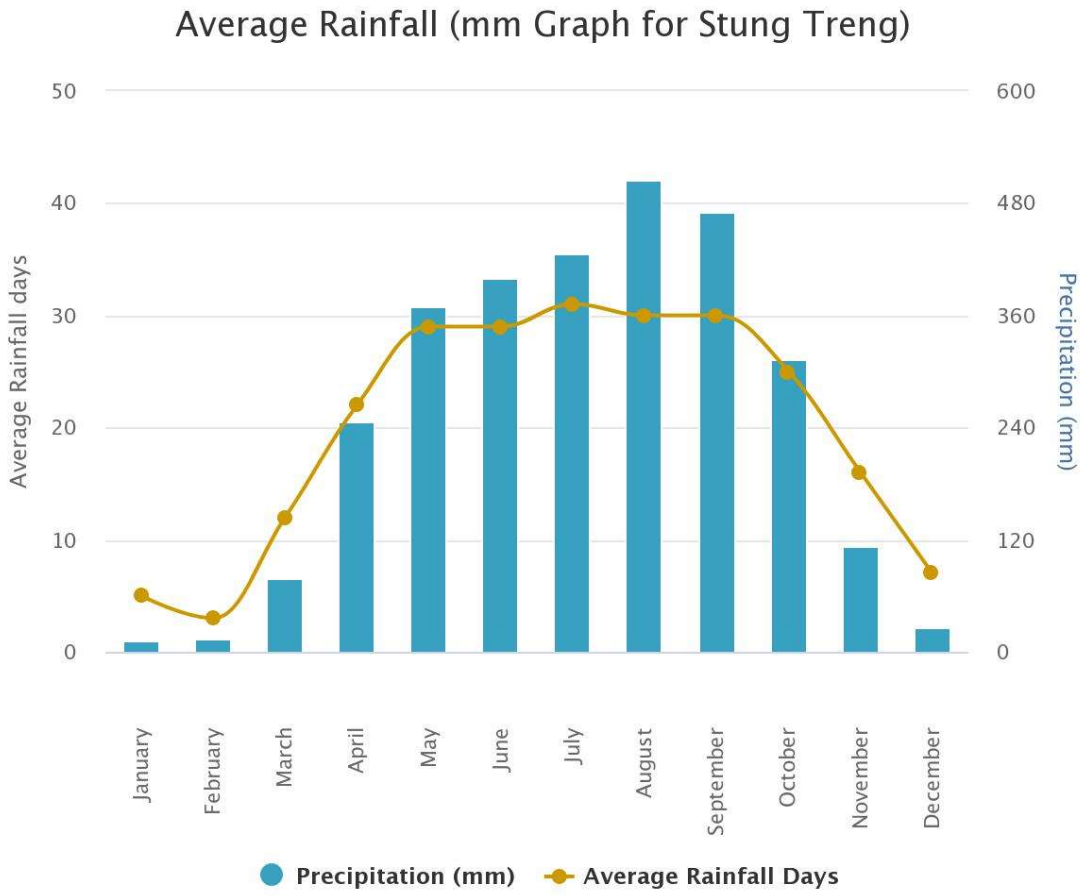
201. The average monthly rainfall (mm) and average rainfall days 1909-2021 is presented in ***Figure 28***.

202. The rainy season lasts 5.5 months, from May 1 to October 19, with a greater than 31% chance of a given day being a wet day. The chance of a wet day peaks at 60% on August 29.

203. The dry season lasts 6.5 months, from October 19 to May 1. The smallest chance of a wet day is 1% on January 1[11].

[11] https://weatherspark.com/ accessed on 21 July 2021

Figure 28: Monthly Average Rainfall and Rainfall Days, Strung Treng (1991-2020)



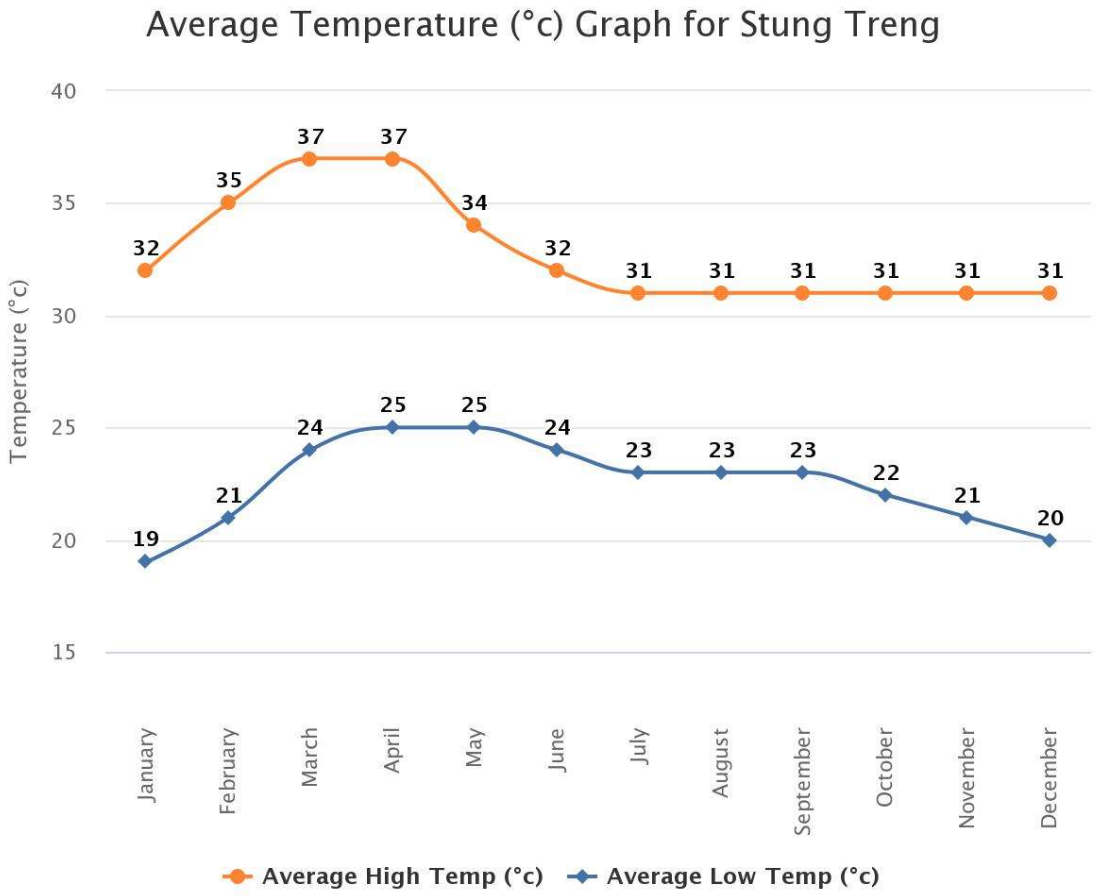
Source: https://www.worldweatheronline.com/stung-treng-weather-averages/stung-treng/kh.aspxaccessed on 21-July-2021

204. The average monthly maximum and minimum temperatures (1909-2021) are displayed on the chart in ***Figure 29.***

205. Over the course of the year, the temperature typically varies from 19°C to 38°C and is rarely below 16°C or above 41°C. The hot season lasts for 2.2 months, from February 27 to May 2, with an average daily high temperature above 37°C. The hottest day of the year is March 28, with an average high of 38°C and low of 25°C.

206. The cool season lasts for 6.5 months, from June 20 to January 6, with an average daily high temperature below 32°C.

Figure 29: Average Maximum and Minimum Monthly Temperatures 1909-2021, Strung Treng



Source: https://www.worldweatheronline.com/stung-treng-weather-averages/stung-treng/kh.aspxaccessed on 21-July-2021

207. The average hourly wind speed in Stung Treng is 1.2 m/s and only varies with +/- 0.2 m/s over the course of the year[12],

5.4. Climate Change Projections

208. 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,

[12] https://weatherspark.com/ accessed on 21 July 2021

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[13].

209. The key climate change predictions for Cambodia available in the World Bank's Climate Change Portal include that[14]:

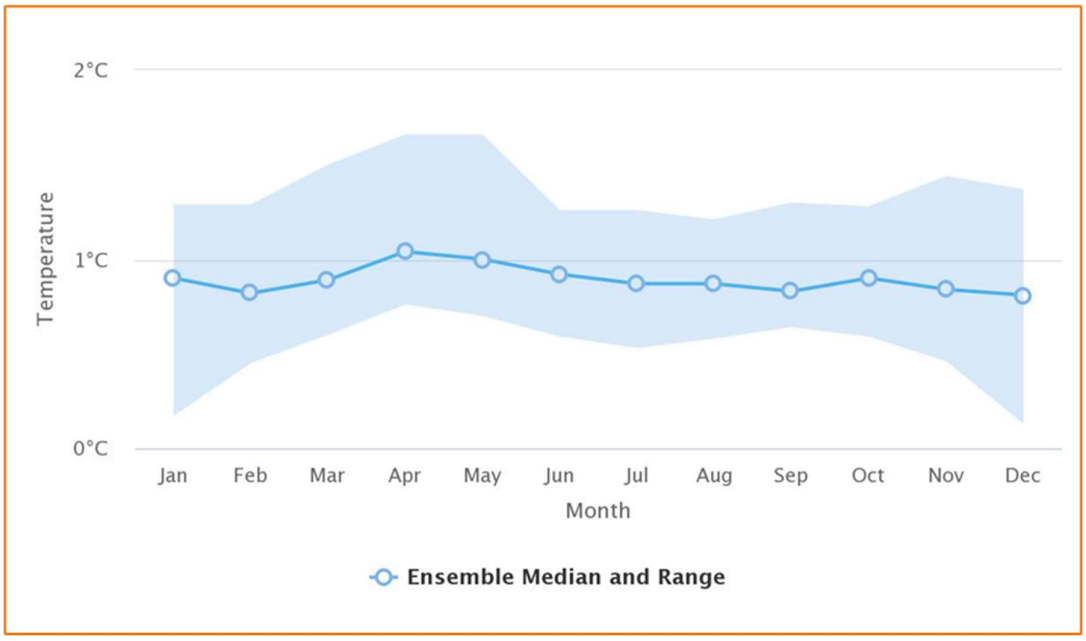
    a) mean annual temperature will rise by 1.54 °C (1.06 °C to 2.50 °C) in 2040-2059 (RCP[15] 8.5, Ensemble[16])

    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)

210. The projected change in monthly temperature for Cambodia is shown in ***Figure 30*** and the projected change in monthly precipitation is presented in ***Figure 31***. 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.

Figure 30: Projected Change in Monthly Temperature for Cambodia for 2020-2039



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

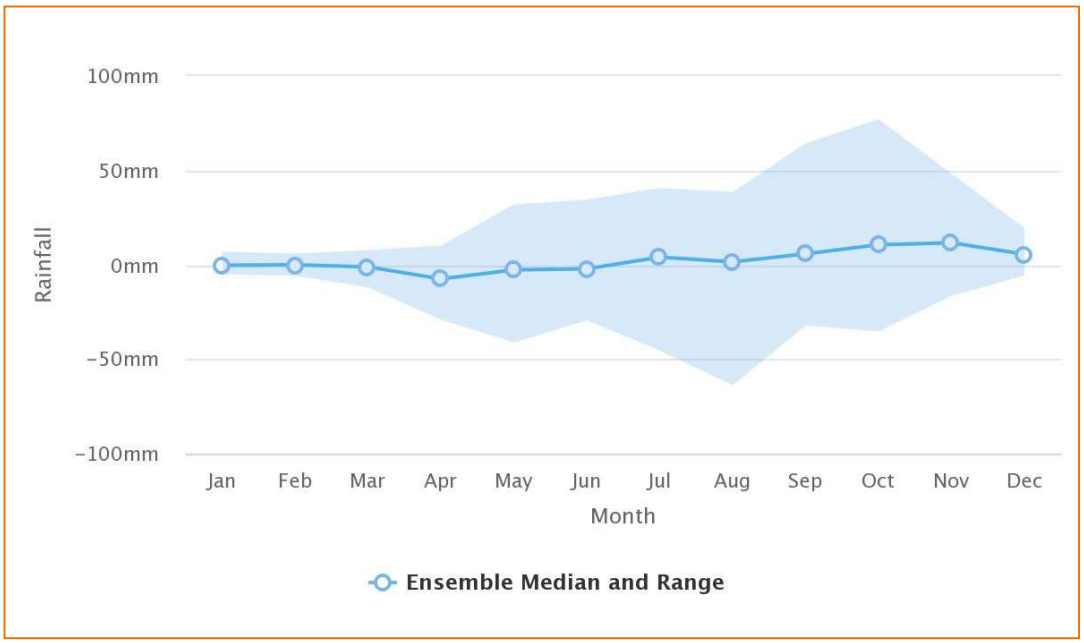
[13] https://climateknowledgeportal.worldbank.org/country/cambodia/climate-data-historical. Accessed on 01-May-2021

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

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

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

Figure 31: Projected Change in Monthly Precipitation for Cambodia for 2020-2039



211. ***Table 15*** 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 15: 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 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.

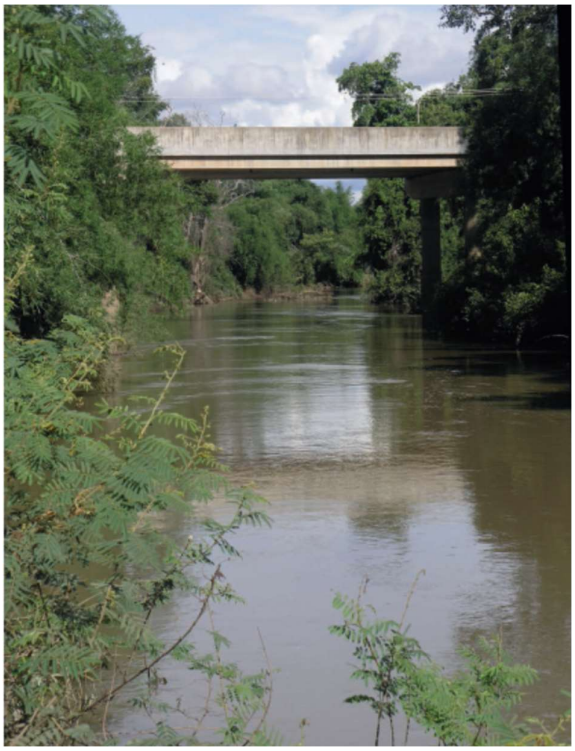
Source: PPTA 2018

5.5. Surface Water and Ground Water Quality

5.5.1. Surface Water

212. The catchment of the right-bank tributary to the Mekong River that is about 2.7 km east of the landfill site is considered a Key Biodiversity Area due to the presence of a freshwater molluscs (*Hydrorissoia munensis*) which is classified as Vulnerable on the IUCN Red List. The size of the catchment is about 42 ha and the river is about 15-20 m wide at the lower reaches of the river indicating a relatively high stream flow (see picture in ***Figure 32***). Judging from elevations on Google Earth, it appears that the landfill site is located just within this catchment. Although an accurate demarcation of the watershed has not been determined, for the purpose of this IEE, the landfill site is considered inside the catchment. Small ephemeral streams and diches running through thick low vegetation and along patches of farmland form the drainage of the catchment, however, there is no direct drainage line from the landfill site or its immediate surroundings to the tributary.

Figure 32: Tributary to The Mekong River, 4 km upstream the confluence with the Mekong River



Source: Kosterin, O. E., A short survey of Odonata in Stung Treng Province, in northern Cambodia in midsummer, 2016, International Dragonfly Fund Report, Journal of the International Dragonfly Fund, 07.03.2017

213. The IESIA study analysed the water quality of samples collected from a pond and three small streams in the surrounding area of the landfill site. The results are summarized in ***Table 16***. The sampling points are indicated in ***Figure 33*** and the coordinates are listed in ***Table 17***.

Table 16: The surface water quality in Or Kantuot

N.	Parameter	Unit	Standards (MoE)	Sample Location			
				SW-01	SW-02	SW-03	SW-04
1	T ºC	°C		28.2	27.1	30.2	31.5
2	PH	No	6.5-8.5	6.55	7.25	6.93	6.81
3	Total Dissolved Solid (TDS)	mg/l	< 1000	34.4	84.15	69.25	109.5
4	Total Suspended Solid) TSS)	mg/l	25-100	34	34	19	8
5	Dissolved Oxygen (DO)	mg/l	7.5-2.0	2.29	2.34	3.01	3.6
6	Biochemical Oxygen Demand (BOD_5	mg/l	1-10	2.6	2.8	1.06	0.8
7	Chemical Oxygen Demand) COD)Mn	mg/l	< 50	9.8	9.01	3.72	1.96
8	Oil and Grease	mg/l	< 5.0	**9.67**	1.2	**9.2**	1.93
9	Phosphate (PO_4	mg/l	NV	ND	ND	ND	ND
10	Sulphate (SO_4	mg/l	< 300	8	4	1	5
11	Total Nitrogen (TN)	mg/l	0.1-0.6	**0.71**	0.57	0.47	0.41
12	Total Phosphorus (TP)	mg/l	0.005-0.05	**0.07**	**0.09**	0.04	**0.08**
13	Nitrate (NO_3	mg/l	< 50	8.36	7.92	6.16	8.8
14	Arsenic (As)	mg/l	< 0.01	0.003	0.002	0.001	0.0006
15	Iron (Fe)	mg/l	< 1	0.74	0.44	0.54	0.47

N.	Parameter	Unit	Standards (MoE)	Sample Location			
				SW-01	SW-02	SW-03	SW-04
16	Mercury (Hg-Total)	mg/l	< 0.0005	0.0002	0.0001	0.0001	ND
17	Total Coliform	MPN/100 (ml)	< 5000	$4.3x10^3$	**$7.5x10^3$**	**$7.5x10^3$**	$9.2x10^2$

Source: IESIA report, SAWAC-MoE August 2020

Figure 33: Surface Water Sampling Points

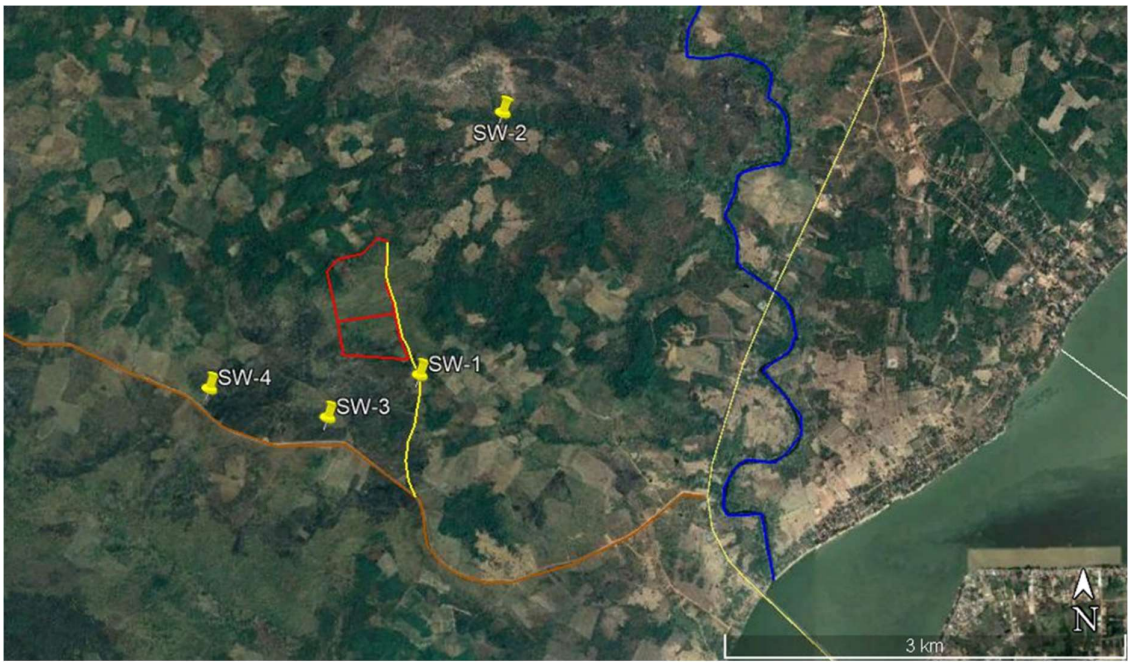


Table 17 Surface Water Sampling Points

Sampling Points	Coordinates (UTM)	
SW-1: Pond near the landfill site	X: 598192	Y: 1497528
SW-2: Prabaov Stream	X: 598806	Y: 1499481
SW-3: Andeik Stream	X: 597504	Y: 1497207
SW-4: Sragne	X: 596619	Y: 1497419

214. Sampling point SW-1 is a small pond near the landfill and not of much interest for this IEE. The results of the other sampling points provide some general indications of the water quality in the small slow-moving streams and ditches. The results show low levels of dissolved oxygen, elevated concentrations of oil and grease in one sample and high concentrations of coliform bacteria. These results are not unusual for a semi-agricultural landscape.

5.5.2. Groundwater

215. The nearest groundwater well for domestic water supply identified by the IESIA study is located about 2.5 km southeast of the landfill site – see ***Figure 34*** (X: 599997 and Y:1496642). The well 15-30 m deep. The groundwater quality was analysed under the IESIA study, and the results are summarized in ***Table 18***. The results indicate that the groundwater is contaminated with coliform bacteria including *E. Coli*, but otherwise the quality is within the relevant drinking water quality standards.

Table 18: Groundwater Quality in nearby Water Well

N.	Parameter	Unit	Standards	Sampling location (GW-01)
1	pH	-	6.5-8.5	7.49
2	Turbidity	NTU	5	**38**
3	Electrode Conductivity (EC)	NTU	500-1500	443
4	Total Dissolved Solid (TDS)	mg/l	800	221.5
5	Total Hardness (as $CaCO_3$	mg/l	300	130
6	Chloride (Cl^-	mg/l	250	27
7	Fluoride (F)	mg/l	1.5	0.36
8	Nitrate (NO_3	mg/l	50	9.24
9	Sulfate (SO_4	mg/l	250	13
10	Iron (Fe)	mg/l	0.3	0.22
11	Arsenic (As)	mg/l	0.05	0.005
12	Mercury (Hg-Total)	mg/l	0.001	ND
13	Chromium (Cr-Total)	mg/l	0.05	0.002
14	Manganese (Mn)	mg/l	0.1	**0.3**
15	Aluminum (Al)	mg/l	0.2	0.18
16	Cadmium (Cd)	mg/l	0.003	ND
17	Total Coliform	MPN/100ml	0	**$1.5x10^3$**
18	*E. coli*	MPN/100ml	0	**94**

Sources: MoE Laboratory. IESIA Report. SAWAC August 2020

Figure 34: Groundwater Well

5.6. Air Quality

216. Field observations indicate that air quality in the project sites is good, as the landfill site is located in a rural area without significant industrial/commercial activites that may cause air quality degradation. The IESIA study measured the air air quality at two locations in the Subproject area (see ***Figure 35***). The results compared with national standards are shown in ***Table 19***.

- Air sampling point 1: at the landfill site, Orei village, Thalabariwat commune, Thala Bariwat district, Stung Treng province. (X: 598132 and Y: 1497734).
- Air sampling point 2: Road junction in Orei village, Thala Bariwat commune, Thala Bariwat district, Stung Treng province (X: 600346 and Y: 1496749).

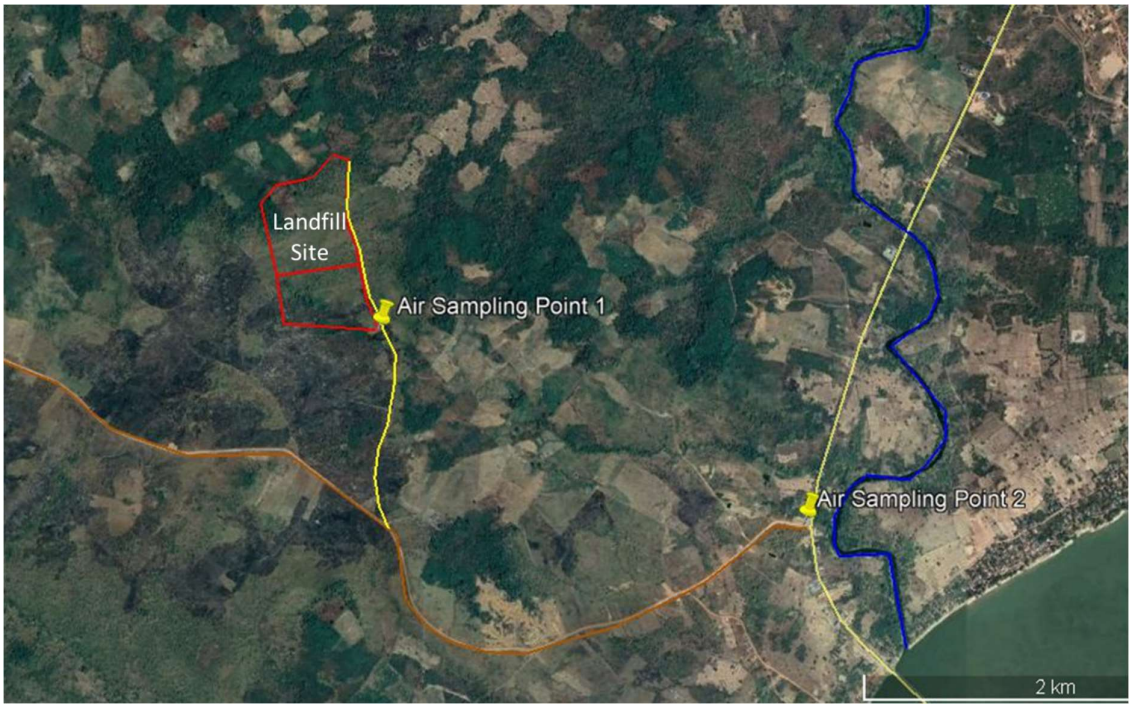
217. The results of the air quality measurements indicate that the air quality at the landfill site is within the National standards, but the PM10 and PM2.5 levels are slightly above the standard at the road junction 2.4 km southeast of the landfill.

Table 19: Air Quality Data for the Subproject Area

No	Parameter	Unit	Result (Point 1)	Result (Point 2)	Standards and Timing	Reference Method
1	Carbon Monoxide) CO)	mg/m^3	4.60	5.5	<20 (8 h)	Method Carbon Monoxide Passive Dositube
2	Nitrogen Dioxide (NO_2)	mg/m^3	0.039	0.044	<0.10 (24 h)	Method Saltzman [ISO 6768:1998(E)]
3	Sulfur Dioxide (SO_2)	mg/m^3	0.047	0.053	<0.30 (24 h)	Method Pararosaniline [ISO 6767:1990(E)]
4	Ozone (O_3)	mg/m^3	0.012	0.019	<0.2 (1 time)	Method Professional Gas Detector GT-901 03
5	Total Suspended Particles (TSP)	mg/m^3	0.063	0.112	<0.33 (24 h)	Method Weight Concentration Measuring
6	PM10	mg/m^3	0.033	**00.65**	<0.05 (24 h)	Method Weight Concentration Measuring
7	PM2.5	mg/m^3	0.017	**0.027**	<0.025 (24 h)	Method Weight Concentration Measuring
8	Lead (Pb)	mg/m^3	ND	0.002	<0.005 (24 h)	Method 3500-Pb C(HNo3, HCl Digestion)

Sources: MoE Laboratory. IESIA Report. SAWAC August 2020

Figure 35: Air Sampling Points



218. The noise levels at the landfill site were measured under the IESIA Study (Air Sampling Point 1). The results are summarised in ***Table 20***. The results indicate that the noise levels are within the noise standards for residential areas[17].

Table 20: Noise Levels at the Landfill Site

Time	Survey Period	Nosie Level dB (A)				Mean
		14 July 2020 (Rainy Season)				
		L_{aeq}	Standard L_{aeq}	L_{max}	L_{min}	
Day	6:00 - 7:00	52.1	60	63.8	41.4	51.75
	7:00 - 8:00	51.6		65.1	43.2	
	8:00 - 9:00	52.4		69.2	40.6	
	9:00 - 10:00	53.6		70.2	42	
	10:00 - 11:00	54.3		70.6	42.9	
	11:00 - 12:00	51.2		69.6	37.8	
	12:00 - 13:00	47.8		58.5	42.2	
	13:00 - 14:00	45.6		65	31.2	
	14:00 - 15:00	52.9		65.2	40.6	
	15:00 - 16:00	51.7		67.8	40.7	

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

Time	Survey Period	Nosie Level dB (A)				Mean
		14 July 2020 (Rainy Season)				
		L_{aeq}	Standard L_{aeq}	L_{max}	L_{min}	
	16:00 - 17:00	52		68.4	40.7	
	17:00 - 18:00	55.8		65.2	41.4	
Evening	18:00 - 19:00	51.2	**50**	60	38.5	**46.78**
	19:00 - 20:00	46.2		58.3	37.1	
	20:00 - 21:00	45.8		58.5	38.1	
	21:00 - 22:00	43.9		56.4	36.5	
Night	22:00 - 23:00	44.4	**45**	47.7	36.2	**45.29**
	23:00 - 00:00	43.3		46.8	34.7	
	00:00 - 1:00	43.7		45.3	37.1	
	1:00 - 2:00	48.2		44.4	37.1	
	2:00 - 3:00	44.6		45.5	38.8	
	3:00 - 4:00	47.2		41.4	38	
	4:00 - 5:00	45.4		48.5	37.3	
	5:00 - 6:00	45.5		47.7	38.4	
24 hours Average		**48.8**		**58.3**	**38.9**	

Sources: MoE Laboratory. IESIA Report. SAWAC August 2020

5.7. Natural Disasters

219. 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.

220. Stung Treng City experiences flooding every rainy season, usually after heavy rainfall and in combination with high flows of the Mekong River. However, the same rain causes the water level in the Mekong and Sekong rivers to rise, which prompts the town government to close the four sluice gates installed in the canals so that the water from the Mekong River and Sekong River combined will not enter the town. Having no more outlets, the flood water is then trapped in the town, resulting in inundation of residential and business areas, particularly in the lower parts. This flooding is recurrently almost every year. (PPTA report 2018).

221. The landfill site is not located in a flood prone area.

5.8. Physical Cultural Resources

222. 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

223. 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 9***) shows that the landfill site is located

- just within the Thala Stung Treng Key Biodiversity Area (KBA);
- 8.3 km southwest of the Stung Treng Ramsar Site which is a National Protected Area of Cambodia
- 3 km west of Mekong River from Kratie to the Lao PDR, Key Biodiversity Area; and
- 3.5 km west of the Northeast Corridor of Protected Area (overlaps with the Mekong River from Kratie to the Lao PDR Key Biodiversity Area.

224. The Stung Treng Ramsar Site has a diverse constellation of wetlands unique for the biogeographic region encompassing wide stretches of braided river, harbouring a mosaic of vegetated channel islands, rocky outcrops, sandbars and mudflats that can be subject to inundation or total submergence depending on season and water level. This channel-island type river system provides very localised habitat and is a unique feature of the Mekong River system. The site hosts a unique flora and fauna of high conservation value including at least 95 bird species including a breeding population of the Critically Endangered White-shouldered Ibis (*Pseudibis davisoni*) and the site provides important refuge and a food source for fish species including the critically endangered Giant Mekong Catfish (*Pangasianodon gigas*) and the vulnerable Irrawaddy Dolphin (*Orcaella brevirostris*)[18] [Ramsar 2021a, Ramsar 2021b].

225. The trigger species for the Thala Stueng Treng freshwater KBA is the molluscs *Hydrorissoia munensis* classified as Vulnerable in the IUCN Red List. The KBA is characterised by open marshland and irrigated agricultural land with remnant forest patches. The river channel includes a range of in-stream habitats such as riffles and sand banks. The downstream reaches and mouth of the river are potentially threatened by urbanisation and changes in land use such for agriculture[19].

226. The proposed landfill site is 3 km west of the Mekong River from Kratie to the Lao PDR KBA. The KBA comprises the Mekong River and associated riverine vegetation from Kratie town to the international border with Lao PDR. Along this stretch, the Mekong River is very varied with some wide sections and other braided sections with several channels and islands. Although much of the riverine forest is degraded, some areas of good condition mixed deciduous/semi-evergreen forest remain around the Kratie-Stung Treng provincial border. Many human settlements, with associated shifting cultivation, are located along the river. The KBA supports a large proportion of the global population of Mekong Wagtail *Motacilla samveasnae*, which is thought to be endemic to the Mekong River and its major tributaries. In addition, the KBA supports significant populations of a suite of riverine species that have declined severely throughout mainland South-east Asia[20].

---

[18] Quoted from: Information Sheet on Ramsar Wetlands (RIS) – 2009-2012 version, https://rsis.ramsar.org/RISapp/files/RISrep/KH999RIS.pdf, accessed on 30/03/2021
https://rsis.ramsar.org/ris/999 accessed on 30/03/2021

[19] IUCN 2019, Freshwater Key Biodiversity Areas in the Lower Mekong River Basin, Informing species conservation and investment planning in freshwater ecosystems, Freshwater Biodiversity Unit, IUCN Global Species Programme, June 2019.
Key Biodiversity Areas Partnership (2020) Key Biodiversity Areas factsheet: Thala Stueng Treng. Extracted from the World Database of Key Biodiversity Areas, http://www.keybiodiversityareas.org/ on 30/03/2021.

[20] Key Biodiversity Areas Partnership (2020) Key Biodiversity Areas factsheet: Mekong River from Kratie to Lao PDR, http://www.keybiodiversityareas.org/ on 30/03/2021.

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[21]. The results of the survey are summarized in ***Table 21***. The PMU and the PMC together with officials from Stung Treng Provincial Department of Public Works and Transport inspected the site on 30-Sep-2020. Pictures from this site inspection are shown in ***Figure 36***. Overall, the site surveys show that the site is covered with secondary degraded forest and shrub. The IESIA screening identified one Endangered species (No. 7 in the Table) and one Vulnerable species (No. 14).

Table 21: Tree and Shrub Species in Subproject Site

No	Local Name (Khmer)	Scientific Name	IUCN
1	Kakos	*Sindora cochinchinensis*	
2	Chhlich	*Terminalia tomantasa*	
3	Duong Chem	*Tarritiajavanica*	
4	Trasek	*Peltophorum ferrugineum*	
5	Phcheak	*Shorea obtusa*	
6	Popoul	*Vitex sp*	
7	Popel	*Hopea recopei / shoprea*	EN
8	Sokrom	*Xylia dolabriformis*	
9	Sralaov	*Lagerstroemia duperreana*	
10	Chramas	*Vatica astrotricha*	
11	Chheur Teal	*Dipterocarpus dyeri*	
12	Tbeng	*Dipterocarpus obtusifolius*	LC
13	Krabaov	*Hydnocarpus anthelmintica*	
14	Kray	*Xylopia pierrei*	VU
15	Pram Damleung	*Terminalia mucronata*	
16	Proul	*Garcinia ferra*	
17	Lngeang	*Cartoxylon orunifolium*	
18	Svay Prey	*Mangifera duperreana*	
19	Kdor Kamprok	*Goniothalamus tamirensis*	LC
20	Khchas	*Diospyros silvatica*	
21	Khtom Phnom		
22	Cham Bork	*Irvingia malayana*	LC
23	Chhke Sreng		
24	Chhun Luos	*Glycosmis cochinchinensis*	
25	Ngor Prey	*Morinda tomentosa*	
26	Treal	*Uvaria hahnii*	

[21] 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
27	Thlork	*Parinarium annainensis*	
28	Pramat	*Brucea javanica*	
29	Pongror	*Schleicher oleosa*	
30	Ponlear	*Pterospermum diversifoliom*	
31	Phlou	*Dilleniaovata*	
32	Mean Prey	*Euphori cambodiana*	
33	Ro Ka	*Bombax sp*	
34	Lvea Dei	*Ficus hirta*	
35	Sangke	*Combritum quarangulare*	
36	Savmaov Prey		
37	Angrung	*Zizyphus cambodiana*	

Source: IESIA Report. SAWAC August 2020

Figure 36: Landfill Site Vegetation

5.9.3. Fauna

228. The IESIA studies included interviews with local residents in Or Rai and Thala Barivat commune, Thala Barivat District and field investigations by the IESIA Study Team to identify wildlife species observed in the local area around the landfill site. It should be noted that the identification of species through interviews with local people is subject to considerable uncertainties and should not be understood as a scientific identification.

229. The bird species listed by local residents and/or identified by the IESIA Team are presented in ***Table 22.*** The list includes one Endangered species (No. 32), the green peafowl (*Pavo muticus*). This species is native to the tropical forests of Southeast Asia. It has been classified as Endangered because the global population has been declining rapidly and is severely fragmented due to loss of habitat[22]. The project will not cause any loss of tropical forest and will therefore not have any impact on this species.

[22] https://en.wikipedia.org/wiki/Green_peafowl

Table 22: Bird Species in the Subproject Area

Nº	Khmer Name	Scientific Name	English name	IUCN
1	Bakou	Upupa epops	Common Hoopoe	LC
2	Popich Kor Sar	Alophoixus ochraceus	Ochraceous Bulbul	LC
3	Popich slap Khmao	Hemixos flavala	Ashy Bulbul	LC
4	Popich Khnog Dea	Phylloscopus plumbeitarsus	Two-barred Wabler	
5	Popich Kbal Khmao	Pycnonotus aurigaster	Sooty-headed Bulbul	LC
6	Popich Mort Leung	Pycnonotus finlaysoni	Stripe-throated Bulbul	LC
7	Popich Kbal Kmao	Pycnonotus melanicterus	Black-crested Bulbul	LC
8	Popich Trocheak Chhnot	Pynonotus blanfordi	Streak-eared Bulbul	LC
9	Poplak Chouvit	Caprimulgus affinis	Savanna Nightjar	LC
10	Popoul Champous Thom	Treron curvirostra	Thick-billed Green Pigeon	LC
11	Popoul Troug Pleung	Treron bicincta	Orange-breasted Green Pigeon	LC
12	Chap Pouk Troung Chhnot	Ploceus manyar	Streaked Weaver	LC
13	Chap Changkrung	Lonchura punctulata	Scaly-breasted Munia	LC
14	Chap Doun Ta	Acrocephalus orientalis	Oriental Reed Wabler	
15	Chap Doun Ta Khmao	Acrocephalus bistrigiceps	Black-browed Reed Wabler	LC
16	Chap Tet	Orthotomus sutorius	Common Tailorbird	LC
17	Chap Kanlang	Nectarinia jugularis	Olive-backed Sunbird	LC
18	Chap Srok	Passer montanus	Eurasian Tree Sparrow	LC
19	Cap Phtas	Passer domesticus	House Sparrow	LC
20	Chap Kruoch	Pycnonotus goiavier	Yellow-vented Bulbul	LC
21	Chap Krok	Megalurus palustris	Striated Grassbird	LC
22	Kraleang Vek	Garrulax leucolophus	White-crested Laughingthrush	LC
23	Paol Tork Kbal Prolet	Megalaima lineata	Lineated Barbet	LC
24	Paol Tork Ambok	Megalaima haemacephala	Coppersmith Barbet	LC
25	Paot Tork Beytung	Megalaima faiostricta	Green-eared Barbet	LC
26	Paot Tork Tok Kralok	Megalaima incognita	Moustached Barbet	LC
27	Chekchao Slap Khmao Sar	Aegithina tiphia	Common Iora	LC
28	Chekchao Slap Khmao	Aegithina lafresnayei	Great Iora	LC
29	Chektomo Khbal Khmao	Oriolus xanthornus	Black-hooded Oriole	LC
30	Chekkhchey Phleung	Chloropsis aurifrons	Golden-fronted Leafbird	LC
31	Kheck	Corvus macrohynchos	Large-billed Crow	LC
32	Kngork Beitang	Pavo muticus	Green Peafowl	EN
33	Povaing	Aceros undulatus	Wreathed Hornbill	LC
34	Kenkang Thom	Buceros bicornis	Great Hornbill	NT
35	Kenkank Touch	Anthracoceros albirostris	Oriental Pied Hornbill	LC

Nº	Khmer Name	Scientific Name	English name	IUCN
36	Sek Ath	Psittacula roseata	Blossom-headed Parakeet	NT
37	Sek Kantoy Kheiv-Leung	Psittacula finschii	Grey-headed Parakeet	NT
38	Sek Krech	Loriculus vernalis	Vernal Hanging Parrot	LC
39	Anteap Khmao	Dicrurus aeneus	Bronzed Drongo	LC
40	Anteap Champous Kheck	Dicrurus annectans	Crow-billed Drongo	LC
41	Anteap Kampaoy	Dicrurus hottentottus	Spangled Drongo	LC
42	Anteap Praphas	Dicrurus leucophaeus	Ashy Drongo	LC
43	Anteap Rumyorl Phnom	Dicrurus remifer	Lesser Racket-tailed Drongo	LC
44	Ork Pous Prey	Spilornis cheela	Crested Serpent Eagle	LC
45	Ork Khmao	Aquila clanga	Greater Spotted Eagle	VU
46	Kardar Kheiv Sar	Todiramphus cholris	Collared Kingfisher	LC
47	Kardar Kbal Khmao	Halcyon pileata	Black-capped Kingfisher	LC
48	Kardar Troung Sar	Halcyon smymensis	White-throated Kingfisher	LC
49	Charchat Trocheak Kheiv	Alcedo meninting	Blue-eared Kingfisher	LC
50	Kok Kor	Bubulcus ibis	Cattle Egret	LC
51	Kok Mteastom	Ixobrychus cinnamomeus	Cinnamon Bittern	LC
52	Kok Krung Thom	Egretta alble	Great Egretta	
53	Kok Krung Mothyom	Egretta intermedia	Intermediate Egret	LC
54	Kok Krung Touch	Egretta garzetta	Little Egret	LC
55	Kok Khmao Andeuk	Dupetor flavicollis	Black Bittern	LC
56	Kok Krot Kbal Thnort	Ardeola bacchus	Javan Pond Heron	LC
57	Kok Sambark Trapaeng	Ixobrychus sinensis	Yellow Bittern	LC
58	Mann Teuk	Gallinula chloropus	White-breasted Waterhen	LC
59	Rneal Khmao	Ciconia episcopus	White-necked Stork	LC
60	Uot Thom	Centropus sinensis	Greater Coucal	LC
61	Uot Sbouy	Centropus bengalensis	Lesser Coucal	LC
62	Lolok Bay	Streptopelia chinensis	Spotted Dove	LC
63	Lolok Bay Thnort	Streptopelia orientalis	Oriental Turtle Dove	LC
64	Lolok Phnom	Macropygia unchall	Barred Cuckoo Dove	LC
65	Lolok Traing	Streptopelia tranquebarica	Red Collared Dove	LC
66	Lolok Dei	Geopelia striata	Zebra Dove	LC
67	Lveachek Prey	Copsychus malabaricus	White-rumped Shama	LC
68	Mann Prey	Gallus gallus	Red Junglefowl	LC
69	Krouch Eut	Turnix suscitator	Barred Buttonquail	LC
70	Tracheak Kam	Apus affinis	House Swift	LC
71	Tracheak Kam Khmao	Cypsiurus balasiensis	Asian Palm Swift	LC
72	Tradeav Kbal Thnort	Merops leschenaulti	Chestnut-headed Bee-eater	LC
73	Tradeav Touch	Merops orientailis	Green Bee-eater	LC

Nº	Khmer Name	Scientific Name	English name	IUCN
74	Tradeav Kbal Beytang	Merops philipinus	Blue-tailed Bee-eater	LC
75	Tradeavich Kbal Praphes	Vanellus cinereus	Grey-headed Lapwing	LC
76	Tradeavich Tonle	Vanellus duvaucelii	River Lapwing	NT
77	Trases Phleug Touch	Dinopium javanense	Common Flameback	LC
78	Trases Popeal Thnort	Meiglyptes jugularis	Black-and-buff Woodpecker	
79	Pramath Khla	Crypsirina temia	Racket-tailed Treepie	LC
80	Sarika Keo Kor	Acridotheres tristis	Common Myna	LC
81	Sarika Keo Krabei	Acridotheres javanicus	White-vented Myna	LC
82	Sarika Keo Vang	Gracula religiosa	Hill Myna	LC
83	Staing Slap Chhek	Accipiter badius	Shikra	LC
84	Staing Slap Chhek Khmao	Aviceda leuphotes	Black Baza	LC
85	Staing Lolonk	Elanus coeruleus	Black-shouldered Kite	LC
86	Staing Slap Srouch	Falco tinnunculus	Common Kestrel	LC
87	Tmath	yps bengalensis	White-rumped Vulture	CR
88	Tea Prey	Eurystomus orientalis	Dollarbird	LC
89	Tear Kheiv	Coracias benghalensis	Indian Roller	LC
90	Khngal Phmom	Otus spilocephalus	Mountain Scops Owl	LC
91	Meam Thom Kouk	Strix leptogrammica	Brown Wood Owl	LC
92	Keam Thom Vou	Strix seloputo	Spotted Wood Owl	LC
93	Totear Katta	Francolinus pintadeanus	Chinese Francokin	LC
94	Kok KaKou	Phaenicophaeus tristis	Green-billed Malkoha	LC
95	Khtobdei Leung Krom	Motacilla flava	Yellow Wagtail	LC
96	Yeung Yeung	Hypothymis azurea	Black-naped Monarch	LC
97	Chap Doun Ta chencheim Sar	Lanius cristatus	Brown Shrike	LC

Source: IESIA Report. SAWAC August 2020

230. The reptile species listed by local residents and/or identified by the IESIA Team are presented in ***Table 23***. The list includes one Endangered species, the elongated tortoise (*Indotestudo elongata*). This species is found in Southeast Asia and parts of the Indian Subcontinent, particularly Nepal. The elongated tortoise is in severe decline across its natural range. The principal threats to this species are mass harvesting of the remaining wild populations for the large and growing food markets. Other threats include habitat destruction and illegal collecting for the pet trade. In addition, the list includes four Vulnerable species.

Table 23: Reptile Species in the Subproject Area

Nº	Khmer Name	Scientific Name	English Name	IUCN
1	Bankouy Sounchbar	*Calotes versicolor*	Garden Fence Lizard	
2	Bankouy Kraham-Leung	*Draco taeniopterus*	Barred Gliding Lizard	LC
3	Pous Pralit	*Enhydris enhydris*	Rainbow Water Snake	LC
4	Pous Khse Kor	*Amphiesma stolata*	Striped Keelback	

Nº	Khmer Name	Scientific Name	English Name	IUCN
5	Pous Haknuman	*Boiga cyanea*	Green Cat Snake	
6	Pous Khse Kor Chhnot	*Dendrelaphis subocularis*	Mountain Bronzeback	LC
7	Pous Sna Ansong	*Elaphe radiata*	Radiated Ratsnake	
8	Pous Teuke	*Chrysopelea ornata*	Golden Tree Snake	
9	Pous Vek Dambok	*Naja siamensis*	Indochinese Spitting Cobra	VU
10	Pous Vek Roneam	*Ophiophagus hannah*	King Cobra	VU
11	Pous Prey Khmao	*Ptyas korros*	Indochinese Ratsnake	
12	Pous Sanseunr	*Ptyas mucosus*	Common Ratsnake	
13	Pous Thlan Thom	*Python reticulatus*	Reticulated Python	
14	Pous Samlap Kankep	*Xenochrophis piscator*	Chequered Keelred	
15	Pous Samlap Kankep Khmao	*Xenochrophis piscator*	Chequered Keelback	
16	Pous Preang	*Xenopeltis unicolor*	Sunbeam Snake	
17	Andeik Phnom	*Indotestudo elongata*	Elongated Tortoise	EN
18	Andeik Sre	*Malayemys subtrijuga*	Rice-field terrapin	VU
19	Toke	*Gekko gecko*	Tokay Gecko	
20	Chhing Chork	*Cosymbotus platyurus*	Flat-tailed Gecko	
21	Thlen Sbek Rolung	*Eutropis multifasciatus*	Common Sun Skink	
22	Thlen Sbek Ouch	*Scincella reevesii*	Speckled Leaf-litter Skink	
23	Chheas Krahorm	*Leiolepis belliana*	Common Butterfly Lizard	
24	Trokout	*Varanus bengalensis*	Common Indian Monitor	LC
25	Kigkouk	*Bufo melanosstictus*	Common Asian Toad	LC
26	Kigkouk Phnom	*Bufo macrotis*	Big-eared Toad	LC
27	Hing Chhor	*Kaloula pulchra*	Banded Bullfrog	LC
28	Hing Ankarm	*Calluela guttulata*		
29	Hing Ankarm Chhnot	*Kalophrynus interlineatus*	Striped sticky frog	LC
30	Hing Ankarm Prey	*Microhyla annamensis*	Rice Frog	VU
31	Hing Ankarm	*Microhyla berdmorei*	Rice Frog	LC
32	Hing Ankarm	*Microhyla fissipes*		LC
33	Hing Ankarm	*Microhyla butleri*	Tubercled Pygmy Frog	LC
34	Hing Ankarm	*Microhyla heymonsi*	Arcuate-spotted Pygmy Frog	LC
35	Hing Ankarm Krala	*Microhyla pulchra*	Beautiful Pygmy Frog	LC
36	Kankep Srov	*Micryletta inornata*	narrow-mouthed frog	LC
37	Kankep Ach Kor	*Fejervarya limnocharis*	Rice Field Frog	
38	Kankep Smao	*Fejervarya limnocharis*	Asian Grass Frog	
39	Kralorn Tonn Kbal Thom	*Limnonectes gyldenstolpei*	Gyldenstolpe's frog	LC
40	Kon Kaath	*Occidozyga lima*	Rough-skinned floating frog	

Source: IESIA Report. SAWAC August 2020

231. The Subproject is unlikely to pose any significant risk to fish biodiversity. Fish species likely present in the subproject area are therefore not listed here. However, the molluscs *Hydrorissoia munensis* which is classified as Vulnerable in the IUCN Red List is the trigger species for the recently delineated freshwater Key Biodiverstiy Area, Thala Stung Treng – see description in ***Para 212*** and ***Para225***.

5.10. Socio-Economic Data

232. The landfill site is located partly within Ou Rai and partly within Thala Barivat commune. These communes have villages closest to the landfill site. The socio-economic data presented in this Section provides an overall profile of Ou Rai and Thala Barivat communes.

233. Population data for the two communes closest to the landfill site Ou Rai and Thala Barivat is summarized in ***Table 24***.

Table 24: Population Data for Communes Closest to the Landfill Site

Commune name	Total Family	Population		Khmer family	Hhmer-Islam family	Vietnamese
		Population	Female			
Ou Rai	755	3330	1563	749	6	0
Thala Barivat	1240	5329	2677	1240	0	0

Source: Commune data, 2020

234. Land Use data is presented in ***Table 25.***

Table 25: Land use in Ou Rai and Thalabarivat commune

Commune name	Total Land (ha)	Rice field (ha)	Farm field (ha)	Village area (ha)	Other land (ha)
Ou Rai	17 357.04	421	2 562	30	14 344.04
Thala Barivat	8 846.66	1 345.2	357	346.8	6 797.66

Source: Commune data, 2020

235. Occupation data is summarized in ***Table 26.*** The data is based on a socioeconomic survey carried out under the IESIA study (2020) covering 96 households in Ou Rai and Thalabarivat commune.

Table 26: Distribution of the main household occupation

Commune Name	Government Job	Company or NGO	Farmer	Worker	Business	Handicraft	other	Total
Ou Rai	5	2	33	1	3	1	1	46
Thala Barivat	10		27	6	4	2	1	50
Total	15	2	60	7	7	3	2	96
%	16%	2%	63%	7%	7%	3%	2%	100%

Source: survey with households, SAWAC IESIA August 2020

Table 27: The Education Facilities

Commune	Pre-school			Primary school			Secondary school			Hight School		
	Buildi	Roo	Studen	Buildin	Roo	Studen	Buildin	Roo	Studen	Buildin	Roo	Studen

Commune	Pre-school			Primary school			Secondary school			Hight School		
	Buildi	Roo	Studen t	Buildin g	Roo	Studen t	Buildin g	Roo	Studen t	Buildin g	Roo	Studen t
Ou Rai	0	0	0	9	45	660	2	10	252	0	0	0
Thala Barivat	3	4	80	5	25	823	2	11	330	1	5	99
Total	3	4	80	14	70	1483	4	21	582	1	5	99

Source: Ou Rai and Thalabarivat Commune Leaders, 2020

236. **In 2018, the poverty rate** was 10% in Or Rai Commune and 11% in Thala Barivat Commune, (commune data 2018).

237. Data on health services are summarized in ***Table 28***

Table 28: The health services

No.	Commune	Health Post			Health Center		
		Building	Room	Staff	Building	Room	Staff
1	Or Rai	0	0	0	0	0	0
2	Thala Barivat	0	0	0	1	6	16
	Total	**0**	**0**	**0**	**1**	**6**	**16**

Source: commune book. IESIA report, August 2020

238. Diseases reported suffered by the interviewed households in Anglong Svay and Or Trail villages (2020) are summarized in ***Table 29***.

Table 29: Diseases suffered by Villagers

No	Type of diseases	Anglong Svay Village	Or Trail Village	Total	Percent
	Number interviewed households	46	50	96	
1	Dengue Fever	3	1	4	3
2	Malaria	0	1	1	1
3	fever	3	12	15	12
4	Diarrhea	13	16	29	24
5	Typhoid Fever	32	29	61	50
6	Skin Diseases	2	1	3	2
7	Respiratory Diseases	1	0	1	1
8	Others	3	6	9	7

Source: interviews with 96 households. IESIA report SAWAC August 2020

5.11. The Dumpsite Environment

239. The existing dumpsite is located in Sameakki Sangkat (see ***Figure 3***). The total land area of the dumpsite is approximately 10 ha, however as noted in ***Para 244***, the area where waste has been dumped is about 3 ha. A satellite image of the dumpsite (July 2019) is displayed in ***Figure 37.*** The demarcation on the image is only indicative and is not intended to show the boundary of any future clean-up and closure. Recent pictures of the dumpsite are shown in ***Figure 38*** and ***Figure 39***. Informal recyclers collecting waste for recycling at the site were observed during site visits on 30 September 2020 and on 08 August 2021. The wooden house seen on one of the pictures is just outside the dumpsite and is occupied by a caretaker assigned by the government. There are no structures within the dumpsite area.

Figure 37: The Existing Dumpsite and Its Surroundings

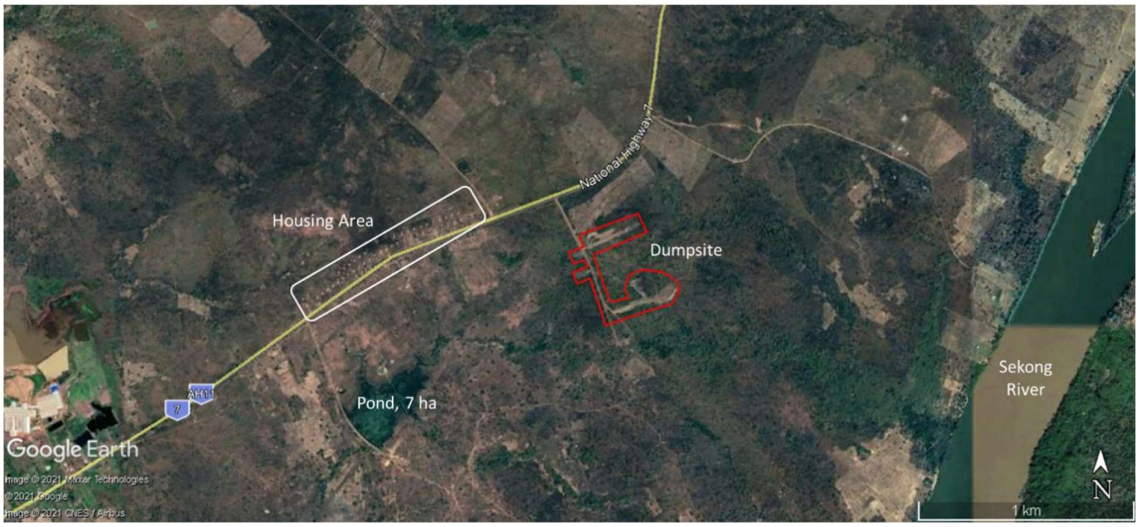


Figure 38: The Dumpsite, September 2020

Figure 39: The Dumpsite, August 2021

Informal recyclers at the dumpsite

 Area surrounding the dumpsite	 Area surrouding the dumpsite

240. As presented in ***Table 14***, sensitive receptors in the immediate surroundings include a housing area along National Road No. 7 about 450 m northwest of the dumpsite, and a 7 ha large reservoir/lake/wetland located about 800 m west of the dumpsite.

241. PMC conducted a site visit to the dumpsite in August 2021 and reported the following findings:

- There is no management of the waste. The waste is simply dumped without any compaction or soil cover.
- Open burning of waste at the dumpsite is common and extensive generating fumes and smoke harmful to human and animal health
- Birds and rats are scavenging the waste and pose a risk of infectious disease transmission
- Flies feeding on rotten waste is prevalent. Flies can carry bacteria and protozoans that cause many serious diseases
- Foul odour from decomposing and burning waste is rampant
- Polluted surface runoff is likely to reach the reservoir/lake about 800 m west of the dumpsite

242. 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 ***Annex 9***) shows that the dumpsite is located:

- 1 km northwest of the Sekong River Key Biodiversity Area
- 3.5 km southeast of the Stung Treng Ramsar Site, which is a National Protected Area of Cambodia
- 3.5 km southeast of Mekong River from Kratie to the Lao PDR, Key Biodiversity Area
- 6 km west of the Northeast Corridor of Protected Area.

243. Based on the IBAT proximity assessment (see ***Annex 9***), it can be concluded that the dumpsite is not located within any legally protected area or area that is internationally recognized for biodiversity.

244. The exact volume of waste on this site is unknown. Based on site observations and analysis of Google Earth images, the area where waste has been dumped over time is estimated to roughly 3 ha and assuming a waste thickness of 2 m and a density of 0.3 tonnes per cubic metre, then the total amount of waste would be 18,000 tonnes (30,000 m^2 * 2 m * 0.3 t/m^3 = 18,000 t). There are considerable uncertainties to this estimation. On the other end of the scale assuming a daily waste collection/dumping of 18 tonnes over a period of 10 years and a 30% reduction in waste due to burning and decomposition would give roughly 46,000 tonnes (18 t/day * 365 days/year * 10 years

* 0.7 = 45,990 tonnes). For the purpose of this IEE and the associated EMP, the area-based calculation is considered more realistic as it is based on field observations.

245. The composition of the waste disposed at the 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 Stung Treng 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[23]. To minimise the risk of exposure to hazardous waste (including infectious waste), and to ensure that such waste is safely disposed, the clean-up of the dumpsite will be undertaken under constant supervision by personnel trained in identifying hazardous waste. All workers will be provided with appropriate personal protective equipment and any hazardous waste discovered during clean-up of the dumpsite will be segregated and temporarily stored in 200 L drums under lid and placed on spill trays under cover. The drums will be labelled with the content and the appropriate danger signage. Upon completion of the clean-up, the drums containing hazardous waste acceptable at the new landfill will be transported to the landfill site for disposal in the hazardous waste cell once completed. Final disposal of hazardous waste that is unacceptable at the new landfill will be determined on a case-by-case basis.

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

6. ANTICIPATED IMPACTS AND MITIGATION MEASURES

6.1. Project Environmental Benefits

246. The project is anticipated to have significant localized environmental benefits. Field visits showed that the existing dumpsite is not properly managed and not provided with any environmental controls. The dumpsite poses 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.

247. 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.

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

6.2. Environmental Impact Assessment Screening

249. 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).

250. 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.

251.

252. ***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 Stung Treng Landfill

Impact	Source	Receptors
Construction		
Degradation of air quality	- Exhaust fumes from construction machinery and equipment, movement of haulage trucks - 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	- Populations near project sites - Workers
Impacts on water quality	- Discharge of contaminated stormwater (suspended material, spills) - Accidental spills - Waste / litter	- 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 - Transmission of the SARS-CoV-2 virus	- Communities - Workers
Operation		
Degradation of air quality	- Landfill biogas generation - Emissions from waste 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	- Odour from waste disposal and exposure of waste in waste cells - Dust from waste disposal and movement of vehicles	- Workers - Communities
Impacts on Health and Safety	- Movement of waste trucks and trucks for cover material - Accidental events such as fires and explosions - Use of equipment/maintenance of landfill - Presence of litter and pests around landfill - Non-compliant effluents - Spread of infectious diseases by vectors - Transmission of the SARS-CoV-2 virus	- Workers - Informal recyclers - Communities

6.3. Impacts Associated with Project Location, Planning and Design

253. 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.

254. 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 have been or will be initiated prior to start of construction:

a) Institutional set up and strengthening. (a) a Safeguards Focal Point has been appointed within the PIU (PIU-SFP) (b) an Environmental Safeguards Officer has been appointed in the PMU (PMU-ESO)[24]; and (c) international and national environmental specialists have been contracted under the Project Management Consultant (PMC- I/NES). Prior to the start of construction, an environmental capacity building and training program will be delivered by the PMC. 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, PMC site engineers and the contractor.
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 18 January 2019 and is fully operational. In accordance with the GRM (see the 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 PIU/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 numbers, PIU/PMU contact points email addresses) and local access points e.g. contractor's site office and district and commune offices.
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 implementation schedule, key construction activities (in particular those that may result in disturbances or nuisances), 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 survey, removal, 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.

[24] 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.

e) EMP in bidding documents. The EMP related to this IEE will be incorporated in the bid documents and construction contracts. The EMP will form the 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 final IEE and EMP cleared by ADB and submit it to the PMU/PMC for review and 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
- 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.
- Management of incoming solid waste (depending on coordinated timing of closure of the dumpsite and opening the new waste cell for waste disposal)

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 spoil 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***).
j) Environmental compliance audit. Audit of the existing dumpsite to inform detailed design of dumpsite closure. See ***Annex 5*** for Terms of Reference for the audit. The results of the audit have been incorporated into this IEE and the Environmental Compliance Audit Report is attached in ***Annex 11***.

6.3.1. Landfill Siting

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

Table 31: Location of the Landfill compared with Siting Criteria

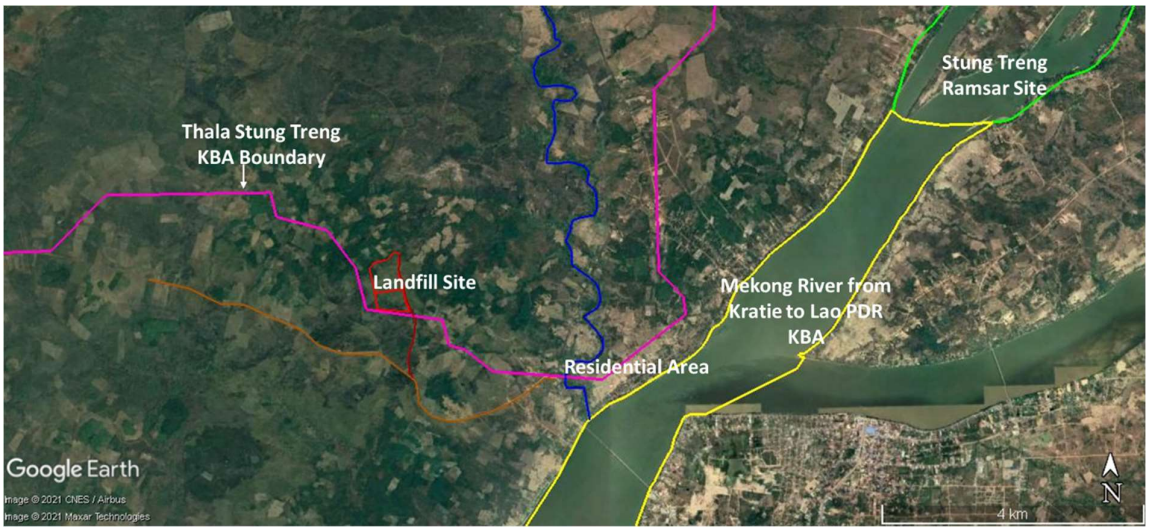
Landfill Siting Guidelines (2016)		Landfill Location
Minimum distances to Receptors	1 km from any residential property	- 4 km from nearest villages Anglong Svay Village and Or Trail Village
	3 km from any school/health centre/natural resources/ water source	- about 3.5 km from the Mekong River - About 2.7 km from a right-bank tributary to the Mekong River - 2.5 km from the nearest housing small cluster of houses/buildings southeast of the site - 4 km from nearest villages Anglong Svay in Or Rai commune and Or Trail in Thala Barivat commune with houses, schools
	5 km from any place of worship and resort	- 5 km to Stung Treng city with pagoda
	8 km from an airport	- There is no active airport in Stung Treng (closed in 2003)
	10 km from town centre	- 5 km to Stung Treng city
	15 km from any heritage site	- 8.3 km southwest of the Stung Treng Ramsar Site which is a National Protected Area of Cambodia
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	- The groundwater is on average 4.7 metres below the existing ground surface and the bottom of the cells will be at or close to ground level

256. As indicated in ***Table 31***, some of the minimum distance guidelines are not fully met (city centre, heritage site), however, as noted in ***Para 60***, the siting of project components (in this case the controlled landfill) is considered and approved through the IESIA review and approval process.

257. 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 under most rain events and any exceptional discharge of treated leachate will be applied on land either on the open area just south of the cell within the landfill site or through the culvers under the access road to the area east of the landfill site.

258. The proximity to Protected Area and Key Biodiversity Area has been assessed using the IBAT tool (***Para 223***) – see also ***Figure 40.*** The IBAT proximity assessment shows that the landfill is located 8.3 km southwest of the Stung Treng Ramsar Site, 3 km northwest of the Mekong River from Kratie to Lao PDR Key Biodiversity Area (which overlaps with the Northeast Corridor (biodiversity corridor of National Protected Areas), and that the landfill is just within the western boundary of Thala Stung Treng Key Biodiversity Area. This Key Biodiversity Area is not a designated protected area under Cambodian legislation and the location of the landfill therefore does not have any legal implications for the subproject under Cambodian Law. Based on the IBAT proximity assessment it can be concluded that the landfill site is not located within any legally protected area, but the landfill is – as mentioned - within the Thala Stung Treng Key Biodiversity Area.

Figure 40: Proximity to Protected Areas and Key Biodiversity Areas



259. The Thala Stung Treng Key Biodiversity Area Ramsar site is presented in ***Para 212*** and ***Para 225***. The main threats to biodiversity include land use changes for agriculture, water pollution and over harvesting[25]. The landfill is located 2.7 km from the river habitats of the KBA trigger species, the freshwater molluscs *Hydrorissoia munensis* classified as Vulnerable in the IUCN Red List. The footprint of the landfill site itself consists of upland degraded forest, shrub and open grassland (see ***Figure 36***). Neither the construction nor the operation of the proposed landfill poses any risk of direct disturbances to the biodiversity values of the KBA. Small ephemeral streams and diches running through thick low vegetation and along patches of farmland form the drainage of the catchment, however, there is no direct drainage line from the landfill site or its immediate surroundings to the river. Furthermore, the landfill is designed and will be operated as a zero-leachate-discharge facility under most rainfall events (***Section 4.5.7*** and ***Section 4.5.8***), and any exceptional discharge of treated leachate will be applied on land either on the open area just south of the cell within the landfill site or through the culvers under the access road to the area east of the landfill site. Such discharges are likely to be highly diluted with catchment runoff before possibly reaching river habitats. Therefore, the risk that the landfill construction or operation would cause pollution or otherwise disturb the habitats that the molluscs or any other aquatic biodiversity depend on is considered negligible.

260. The Stung Treng Ramsar site is presented in **Para 224**. The main threats to biodiversity at the Stung Treng Ramsar Site include loss of riverine forest due to encroachment for agriculture and illegal logging, frequent and widespread small fires, and wildlife hunting. Neither the construction nor the operation of the landfill poses any risk of direct disturbances to the Ramsar Site and its biodiversity values, 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 the Ramsar Site.

261. The Mekong River from Kratie to Lao PDR Key Biodiversity Area is described in ***Para 226***. The main threats to biodiversity include clearance of land for agriculture along the

[25] Key Biodiversity Areas Partnership (2020) Key Biodiversity Areas factsheet: Thala Stueng Treng. Extracted from the World Database of Key Biodiversity Areas, http://www.keybiodiversityareas.org/ on 30/03/2021

banks of the river, frequent and widespread small fires, wildlife hunting and egg collection, and illegal fishing. Neither the construction nor the operation of the proposed landfill poses any risk of direct disturbances to the KBA and its biodiversity values and will not cause nor contribute to any increase in threats to the KBA listed above.

6.4. Environmental Impact and Mitigation Measures During Construction

6.4.1. Air Quality

262. 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 and spoil disposal sites;

c) In the unlikely event that it is decided to close the existing dumpsite by moving waste from the dumpsite to the new landfill, this may generate fugitive dust, bioaerosols and odour.

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

263. Due to the absence of residences or businesses nearby the landfill, these impacts are mainly a concern for the construction workers and people living along the transport routes or borrow pits/spoil disposal sites (these sites have will be identified under the CEMP). Implementation of conventional measures will be fully adequate to mitigate these minor impacts:

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 from the nearest dwellings in order to reduce the impact of dust and fumes on humans. The silos will 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

264. 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. Due to the

absence of residences or businesses nearby the landfill, the noise impacts will mainly be a concern for construction workers and people living along the transport routes or borrow pits/spoil disposal sites. 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

265. As noted in ***Para 259***, the land cover at the landfill site consists of degraded forest, shrub and open grassland. 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 254g)***), 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 screens (see ***Para 182***).
b) Where possible, material from existing licensed borrow and quarry sites will be used. If new sites are needed, they will be proposed in the CEMP for review and approval by PMU/PMC and Stung Treng PDoE to ensure that sensitive habitats are avoided and that an appropriate restoration plan will be implemented by the contractor (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

266. The landfill construction work will take place within a 42 ha large catchment to a tributary to the Mekong River. The tributary is about 2.7 km from the landfill and the catchment is drained by small ephemeral streams and diches running through thick low vegetation and along patches of farmland. There is no direct drainage line from the landfill site or its immediate surroundings to the tributary. The likely potential impacts on surface water are listed below. These impacts are minor, temporary and localised:

    a) Uncontrolled vegetation clearance causing sediment-laden runoff during rain events to discharge into the ditches then on to agricultural land.
    b) Uncontrolled drainage of polluted runoff from the construction area into the ditches then on to agricultural land.
    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.

267. 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 sediment-laden runoff to sediment controls at the downslope perimeter of the site disturbances and discharge the stormwater onto a vegetated buffer area.
    b) To prevent erosion caused by the stormwater flows within the buffer, use devices that physically dissipate stormwater flows so that the discharge entering the buffer is spread out and slowed down. This will decrease the rate of stormwater flow, encourage infiltration and promote physical pollutant filtering functions of the buffer.
    c) Stockpiles and materials will be stored at least 50 m from surface waters with drainage directed away from canals or ditches.
    d) No washing or repair of machinery within 50 m of surface waters.
    e) Topsoil present on the construction site will be removed and stockpiled in labelled areas for later use in rehabilitation of the construction sites.
    f) Construction working areas will be clearly demarcated and encroachment onto adjacent areas prohibited.
    g) 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.
    h) Pit latrines and septic tanks shall be placed at least 2 m above the groundwater table and must be located at least 50 m from surface water bodies and water wells and in areas of suitable soil profiles.
    i) 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.
    j) 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.
    k) Refuelling of machineries by service vehicles will be conducted with measures preventing oil spillage during refuelling including placement of buckets under refuelling nozzles.

l) Stationary equipment such as motors, pumps, generators will be positioned over drip pans.

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

268. The groundwater resources under the site are found beneath various clay layers at an average depth of 4.7 m (see ***Para 198***). 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.

269. 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 267***).

6.4.6. Soil Erosion

270. 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

271. 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).

272. 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 267***). To the extent possible, a duly authorized waste company will be contracted to recycle hazardous waste. Any remaining hazardous waste that complies with the final hazardous waste acceptance guidelines (see also ***Para 163***) may be disposed of in the Hazardous Waste Cell once completed.

d) Non-hazardous, non-recyclable solid waste will be temporarily deposited on site and managed together with any incoming domestic waste once cell 1 is operational. Management of incoming waste includes waste relocated from the dumpsite - see also ***Section 6.5.3***.

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

273. 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.

274. ***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)	

275. 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 and local authorities;

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

276. 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.

277. 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) 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.

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

e) 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.

f) 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

278. Socio-economic impacts related to the Subproject are limited to potential impacts on the livelihood of informal recyclers operating at the existing dumpsite, 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.

279. It is anticipated that the informal recyclers at the 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. During the dumpsite remediation and closure, it will be considered to allow the informal recyclers to recover recyclables at the new landfill cell 1 under strict safety rules.

6.4.11. Occupational Health and Safety

280. The main occupational health and safety risks include (assuming that the contractor will have to manage incoming waste when the dumpsite closure starts):

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 incoming waste;
f) Noise and dust emissions from construction activities.

281. 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[26];

[26] 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;
f) provide fall protection when workers are exposed to unguarded platforms or walkways higher than 2 m;
g) ensure there are safe ways to enter and exit the excavation;
h) keep excavations dry;
i) provide safety precautions when using high voltage electric power tools;
j) carry out daily toolbox meetings (safety briefings);
k) maintain an accident record book where all major or minor accidents and incidents are recorded with actions taken;
l) educate the workers on construction hazards;
m) train drivers on safe driving skills;
n) appoint an Environment, Health and Safety Officer who is a qualified engineer;
o) make adequate first aid equipment available on site;
p) carry out training and awareness of the workers on HIV-AIDS prevention;
q) implement emergency preparedness and response procedures (to be incorporated in the CEMP).

282. 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[27].
c) Safety glasses (waste handling, crushing/grinding, cutting).
d) Welding hoods with clear safety glasses under (welding).

6.4.12. Labour Camp Impacts

283. 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.

284. 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.

---

[27] 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.

285. 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 Dumpsite

6.5.1. Incorporation of Environmental Compliance Audit Findings

286. The dumpsite is considered an existing facility under the wider CTDP4 Project and as such an Environmental Compliance Audit (ECA) is required for the dumpsite. An ECA for the dumpsite has been prepared and is attached in ***Annex 11***. 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 5***, 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.

287. As further explained in this Section, the ECA has been concluded based on the results of the phase 1 investigations recommending that the waste at the dumpsite is relocated to the new landfill once it is ready to receive waste.

288. The review of Cambodian legislation carried out for the preparation of this IEE has not identified any specific regulation that would require the project owner, MPWT to obtain an approval or permit from MOE to close the dumpsite or to implement a specific closure method. However, the IESIA does explain that the project includes closure of the dumpsite (though the closure method is not described), which means that by approving the IESIA, MOE has acknowledged that the closure of the dumpsite is part of the project.

6.5.2. Impacts and Closure Objectives

289. The existing dumpsite has originally been approved by Strung Treng Provincial Authorities for daily operation. However, the actual implementation and operation of the dumpsite is 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).

290. The potential impacts caused by the dumpsite mainly affect the nearby residents, the productive use of adjacent land, informal recyclers collecting and sorting waste at the site, the surrounding environment including a nearby irrigation reservoir and possibly groundwater resources beneath the site.

291. The key impacts and risks associated with the dumpsite 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 nuisance odour from decomposing waste and burning of waste.
e) spread of infectious diseases by vectors. Residents in the vicinity of the dumpsite at risk of exposure to health risks caused by houseflies and vermin
f) risk of injury or infections from collecting recyclables at the dumpsite.

292. The objectives of closing and remediating the dumpsite 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 of 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 Dumpsite

293. The options[28] under consideration for the closure of the dumpsite include:

a) Closure by removing the waste from the dumpsite and disposing it at the new landfill.

b) In-place closure by capping the waste,

c) Closure by upgrading the dumpsite into a controlled engineered landfill, or

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

294. The closure options are discussed here below. These options are all in line with the Cambodian Technical Guideline on Garbage and Urban Solid Waste Management, 2016 and with international dumpsite closure guidelines. Any of these options, when properly designed and implemented commensurate with the likely risks and impacts, would be consistent with ADB Safeguard Policies. The first option involves relocation of wastes and the other three options involve remediation in-situ.

(i) **Closure by removing the waste from the dump and disposing it at the new landfill**. The relocation of the waste would be combined with sorting the waste for recyclable materials and separating hazardous waste. In addition, to remove any potentially contaminated soil, the upper 0.3 m of the soil underneath the waste heaps should be excavated and removed together with the waste. In principle, deposition of the waste at the new landfill would inevitably reduce the design-life of the new landfill. The amount of waste at the dumpsite is estimated to 18,000 t (see ***Para 244***). This amount plus the excavated soil layer would roughly occupy 20% of cell 1. However, as cell 1 has a capacity beyond the design life of the cell (2030), potentially until 2037 (see ***Para 95***), the reduction in cell volume due to relocation of waste from the dumpsite would not have any significant implications on the engineering design or the economic considerations behind the landfill project. This option 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 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 and could be retrofitted into the waste. To protect the cap against damages, it may be necessary to fence off the site and prevent access by people and domestic animals. In any case, the site would only be suitable for sport activities, park or recreation, but not for buildings or installations or infrastructure that require good foundation.

[28] 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

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, and landfill gas monitoring. Aftercare would consist of regular cleaning and repairs as required of the leachate collection and disposal systems, reinstatement of eroded batters, replacement of soils that are eroded, replanting any vegetation that dies, 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. If this option is considered a potentially preferable option based on Phase 1 of the ECA, then Phase 2 of the ECA would be required to make a closer assessment of groundwater and surface water pollution risks.

(iii) **Closure by upgrading into a controlled engineered landfill**. If surveys show that there is contamination of groundwater, 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. Monitoring and aftercare would likely be similar to the 'in-place closure' alternative. If this option is considered a potentially preferable option based on Phase 1 of the ECA, then Phase 2 of the ECA would be required to make a closer assessment of groundwater and surface water pollution risks.

(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 in phase 2 of the ECA, it may be possible to combine option (ii) capping with 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. If this option is considered a potentially preferable option based on Phase 1 of the ECA, then Phase 2 of the ECA would be required to make a closer assessment of groundwater and surface water pollution risks.

295. Common for all the above options is that they would have to include management of incoming waste at the dumpsite until cell 1 is ready to receive waste and operational.

296. For any of the above options, it is recommended to implement the following temporary mitigation measures at the dumpsite:

- deploy a supervisor to manage and control the dumpsite
- fence off the dumpsite area;
- extinguish existing fires and stop open burning of waste;
- bulldoze the existing waste into low waste cells, increase compaction and waste density, and cover the waste with soil to minimise nuisances;
- deposit and compact incoming waste into waste cells adjacent to existing waste and cover the waste with soil;

- if necessary, construct ditches and bunds to control leachate and manage surface runoff;
- if necessary, convey leachate to a small pond/tank for temporary storage;
- train the informal recyclers in health and safety precautions and provide them with appropriate PPE;
- establish a registration procedure so only registered adult recyclers will be allowed on site.

6.5.4. Recommended Closure Options

297. As detailed in the attached ECA (***Annex 11,*** ECA Section 2.5.3), a ranking of the closure options according to the environmental and social protection that they would provide indicates that option (i) *Closure by removing the waste from the dumpsite and disposing it at the new landfill* provides the highest level of protection of the four options and that option (ii) *In-place closure by capping the waste* is at the other end of the scale providing a basic level of environmental protection. The ranking also shows that all the onsite options (ii, iii and iv) have the same drawback that future use of the site would be restricted.

298. Indicative cost estimates (see ***Annex 11,*** ECA Appendix 2) of option (i) *Closure by removing the waste from the dumpsite and disposing it at the new landfill* and option (ii) *In-place closure by capping the waste* show that in rounded figures, the cost of option (i) is about 140,000 US dollars and option (ii) is roughly 200,000 US dollars – not including subsequent monitoring and aftercare.

299. Considering that the costs of option (iii) and (iv) would surely be higher than the cost of option (b), it is concluded that out of the four options, option (i) is both the most environmentally and socially safe option and the least costly. It is therefore recommended to implement option (i).

6.6. Environmental Impact and Mitigation Measures During Operation

6.6.1. Overview

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

301. 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.

302. 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.

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

304. The informal recyclers at the dumpsite will be allowed to continue to operate at the new landfill using the Materials Recovery Facility for sorting and packaging

recyclables. The facility will have sanitation facilities and potable water supply, and the informal recyclers will be trained on health and safety and provided with PPE. This is further detailed in the separate Livelihood Restoration Plan for the subproject.

6.6.2. Landfill Gas

305. 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.

306. 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 7*** and shows that in the year with the maximum annual emission of greenhouse gasses (2025), the estimated amount of greenhouse gasses would include 731 tonnes methane and 2005 tonnes carbon dioxide, which converted to carbon dioxide equivalents (CO_2e) amount to 20,280 tonnes and thus well below the threshold.

307. 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.

308. The current level of greenhouse gas emissions at the dumpsite is unknown. However, it is likely that a significant portion of the organic waste has already (over the years) either been burned or has decomposed.

309. 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

310. 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.

311. The following mitigation measures will be implemented:

a) The site is located about 2.5 km from the nearest housing and 4 km from the nearest village, which is much farther away than the minimum distance of 500 m recommended by ISWA.[29]
b) Compaction of the waste daily and cover of waste regularly will significantly reduce odour problems and limit scavenging by pests (flies, 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.
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

312. 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.
313. 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.

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

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. Natural channels will be constructed across the site to facilitate the movement of water through the site from the surrounding hills and through box culverts under the road to the adjacent vegetated land that will function as a buffer.

c) To prevent erosion caused by discharge of stormwater into the buffer, devises will be installed to dissipate, spread out and slow down the stormwater flow. This will further increase infiltration and promote filtering of pollutants.

d) 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 to manage flow rates and accelerate uniform settlement of wastes.

e) 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.

f) 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 recipient. 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 the open buffer zone south of cell 1 and/or via the stormwater channel and applied on the land adjacent to the access road. This is a vegetated area that will function as a buffer and promote infiltration and filtering of pollutants. This area is 2.7 km from the nearest perennial waterway and, therefore, it is highly unlikely that a rare discharge of leachate would lead to any pollution of the river. In practical terms, considering the low leachate flow rates, and that the

effluents would be mixed and diluted with clean stormwater and applied on vegetated land, any rare discharge of treated leachate that may eventually drain into the river would be highly diluted and unlikely to pose any 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 standards[30].

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

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

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

6.6.5. Groundwater

314. 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 clay layers 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

315. Community risks come mainly from:

a) Unauthorized access to the landfill site;

b) Traffic risks linked to the increase of movement of waste collection trucks and movement of vehicles including trucks transporting cover material.

316. 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.

---

[30] 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

e) Slips or falls into leachate ponds.

317. 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).

318. 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.

319. Potential impacts to workers in operation due to COVID-19 will be mitigated through the following measures[31]:

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.

[31] 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

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;

320. 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.

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

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

322. Four options ranging from uncontrolled open dumping to a fully engineered sanitary landfill have been considered. 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. This option would not be permitted under Cambodian regulations and would be inconsistent with ADB Safeguards.
- 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. This option would not be permitted under Cambodian regulations and would be inconsistent with ADB Safeguards.
- 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. With proper design, construction and operation based on assessments of environmental and social impacts, this option would be permitted under Cambodian regulations and would be consistent with ADB Safeguards.
- 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.

  With proper design, construction and operation based on assessments of environmental and social impacts, this option would be permitted under Cambodian regulations and would be consistent with ADB Safeguards.

323. 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.

324. 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

325. 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.

326. 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 Stung Treng included focus group discussions as listed in ***Table 33*** and a summary of comments and concerns raised at the consultations are provided in **Annex 2**.

327. The main comments and concerns form the focus group participants include:

- the subproject is welcomed for the positive benefits it will bring
- In Stung Treng Town there is a lack of waste management with only 1 truck for solid waste collection, and collection frequency is 2 times/week
- The roles and responsibilities on solid waste management are unclear.
- Noise and air emissions from construction work are temporary and not a big issue.
- The improvements to the solid waste disposal site in Stung Treng Town is very important for the environment and for community health.
- Women need the solid waste container near their house and waste should be collected every day[32].

Table 33: CTDP-4 Project Preparation Consultations

Location	Dates	Stakeholders or Groups Met
Barchong Pagoda, Preah Bat Commune	05-Sep-2017	Stung Treng Sangkat Preah Bat Sangkat Representatives of communities, village chiefs/deputy village chiefs, commune chiefs/deputy commune chiefs and commune council members

328. As part of the preparation of the IESIA and in conjunction with the preparation of this IEE and the Detailed Engineering Design, further consultations were undertaken first in June 2020 (on 24, 27, and 28 June 2020) and again on 3 September 2020. The consultations involved village and commune authorities as well as provincial authorities of Stung Treng including the following:

- Ou Rai and Thala Barivat Commune, Thala Barivat District,
- Srah Ruessei, Sameakki, Stung Treng, and Preah Bat commune/sangkat, Stung Treng District

[32] Initial Environmental Examination, CAM: Fourth Greater Mekong Subregion Corridor Towns Development Project, Stung Treng Subproject, Kratie Subproject, Kampong Cham Subproject, the Ministry of Public Works and Transport for ADB, May 2018

329. Minutes of the consultations are attached in ***Annex 3*** and a summary of key points are listed in ***Table 34.***

Table 34: IEE and Detailed Engineering Design Stage Consultations

Location	Stakeholders or Groups Met	Key Comments	Response
Ou Rai Commune	Deputy Commune Chief Chief of Anlong Svay Village	- During construction and operation the project should consider how to protect or mitigate the impacts of project activities on our environment, especially on social resources near the landfill site. - The project should provide job opportunities for the commune population.	- Environmental and social protection are incorporated in the EMP and will be monitored to ensure compliance with requirements
Thala Barivat Commune	Deputy Commune Chief	- The project should avoid private land. - The project should start soon for improving our waste management. - During landfill operation, mitigation of odour impacts on local people should be provided. - Protect the outflow or runoff from the landfill site to water resources surrounding the landfill site.	- The landfill site is on state land - Mitigation of odour impacts is incorporated in the EMP and will be further detailed in the operations manual - Odour impacts will be monitored, however due to the location of the site several kilometres from the nearest residences, odour nuisances are unlikely - Protection against water pollution is incorporated in the design and operations of the landfill
Srah Reussei Commune	Commune Chief	- we need to improve waste management service and reasonable waste collection price - The landfill should be constructed as soon as possible. - The project should improve waste management, collection equipment and ensure safety for waste trucks.	- Provision of waste management equipment is part of the project
Sameakki Commune	Commune Chief	- we request the project to provide waste collection services in Sameakki commune too. - The project should provide technic to improve and manage the waste to create good environment and a clean town	- As Sameakki is a large rural sangkat it would not be practical to provide collection services for the whole of this area. The service in this Sangkat will only cover the two villages on the north side of the National Road No.7 bridge, namely Hang Ko Suon and Hang Ko Barn
Stung Treng Commune	Commune Chief	- The project should prepare a plan and provide good waste management services for the town. - Provide enough and proper waste trucks - Prove clean town to attract more tourists. - We need good waste collection service with reasonable price.	-
Preah Bat	Commune Chief	- Waste regulations should be enforced. - We want the controlled landfill to be constructed soon. - The project should have good waste management and create a	-

Location	Stakeholders or Groups Met	Key Comments	Response
		clean city to attract more tourists and provide public health and sanitation. - We need good waste management with reasonable waste collection fee. - The project should provide waste collection services to some areas surrounding the town	

8.2. Public Consultations during Project Implementation

8.2.1. Consultations during Construction

330. 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.

331. 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

332. 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

333. 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

334. Environmental information on the project, including the IEE, EMP 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 at 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;

d) Quarterly progress reports; and

e) Semi-annual environment monitoring reports on compliance with the Environmental Management Plan (EMP) and other necessary information will be available at www.adb.org.

9. GRIEVANCE REDRESS MECHANISM

335. 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.

336. The GRM was officially established on 18 January 2019 and is fully operational.

337. 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.

338. 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

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

10. ENVIRONMENTAL MANAGEMENT PLAN

340. A detailed EMP has been prepared for the Subproject. The EMP is a standalone separate document (dated September 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.

341. 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.

342. 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 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

343. 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. Proper implementation of the mitigation measures outlined in this IEE ensures effective prevention or minimisation of all the predicted potential adverse impacts during construction and operation of the subproject. These mitigation measures are further detailed in the EMP associated with this IEE together with monitoring programmes to check that the implementation is effective and appropriate.

344. 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.

345. The key parties responsible for implementation of the mitigation measures are the construction contractors and the operators. They will be supported by qualified national and international environmental consultants within the PMC. The implementation of the EMP will be closely monitored and reported on by the relevant stakeholders in the project.

346. Overall, it is expected that the subproject will result in improved urban environmental services in Stung Treng 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.

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

348. The Subproject includes remediation and closure of the waste dumpsite located about 14 km east of Stung Treng City. Based on the Environmental Compliance Audit for the dumpsite (the audit report is attached in ***Annex 11***), it is concluded that closure by removing the waste from the dump and disposing it at the new landfill would be the most environmentally safe as well as the least costly method.

349. 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

350. 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.

351. 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.

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

353. 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.

354. The Environmental Compliance Audit of the waste dumpsite considered and evaluated the following remediation and closure methods:

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.

The evaluation concludes that out of these four options, option (a) is both the most environmentally safe as well as the least costly method. It is therefore recommended to implement option (a) *Closure by removing the waste from the dump and disposing it at the new landfill*.

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	Aluminium (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: Consultation During Project Preparation

Focus Group Discussions on 05 September 2017

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?

Summary of the results of consultations

Focus Group Discussion Meetings in Stung Treng Town

There are 02 FGD meetings conducted in the Stung Treng Town of 03 communes namely:

1. FGD meeting is conducted for Stung Treng commune and Preah Bat commune. The meeting is conducted in Barchong Pagoda, Preah Bat Commune on 05 September 2017 in morning.
2. FGD meeting is conducted for Srach Russei commune. The meeting is conducted in Srach Russei Commune Office on 05 September 2017 in the afternoon. The issues, feedbacks, comments, and questions are summarized in table below.

The summary of Consultations

Issues, feedbacks, comments and questions in Stung Tren Town	Response
- Flood from runoff is a problem in Stung Treng Commune during the rainy season due to lack of drainage and old or damaged culverts/drainage. - The flood usually occurs in September during heavy rain. - Mothers worry about their children to school, disease affected to children, agriculture product, poultry, livestock - All men worry about daily livelihood destroy the infrastructure - All the wastewater is discharging into the Mekong River without treatment. - The floods affect road structures, fruit trees/vegetable, and education (school time is delayed) and local business activities. - Some section of road in Preah Bat commune is difficult travelling, muddy and potholes during wet season. - In Stung Treng Town as same as problems in Stung Treng, Preah Bat, and Srach Russei commune, there is a lack of waste management: (i) there is only 1 truck for solid waste collection, the collection frequency is 2 times/week (ii) Unclear role and responsible for solid waste management (Stung Treng Town and Subcontractor). (iii) some households don't use subcontractor collection system. - We are not concerned too much about impacts from project construction activities on natural and social environments. - Noise and air emissions from construction stage are temporary and not a big issue. - Some trees might be affected or cut during road clearing and waste dumping site of clearing stage conducted by the contractor. - So the improvements to the Solid Waste disposal site in Stung Treng Town is very important for the environment (Mekong River) and community health. - Improving sanitation, public health, and environmental quality management as well as Mekong River water. - Women need the solid waste container near their house and collected every day	- Environmental and social protection are incorporated in the EMP and will be monitored to ensure compliance with requirements

Pictures in Stung Treng Town

The FGD meeting activities in Stung Treng and Preah Bat Commune, Stung Treng Town

The FGD meeting activities in Srach Russei Commune, Stung Treng Town

Annex 3: Consultations at Detailed Engineering Design and IEE Stage

Consultations June 2020

The Landfill subproject in Stung Treng Town, Stung Treng province

The landfill subproject is located in Anlong Svay village, Ou Rai Commune and Treal village, Thala Barivat Commune, Thala Barivat District, Stung Treng Province.

On 24, 27, and 28 June 2020, the study team of SAWAC conducted public consultation with village and commune authorities of the following communes in Stung Treng and Thala Barivat districts:

- Ou Rai and Thala Barivat Commune, Thala Barivat District, Stung Treng Province.
- Srah Ruessei, Sameakki, Stung Treng, and Preah Bat commune/sankat, Stung Treng District, Stung Treng Province.

The concerns and recommendations raised by the consulted people are summarised in the table below.

Summary of Key Concerns and Recommendations from consultations with village and commune authorities

Feedbacks and Issues	Comments	Response
Ou Rai Commune - There is no waste collection service. - The people manage wastes by themselves, dumping in village area or field and by burning. - we support this subproject for improving our environment in town/our area with good health for local people. - we are aware of the subproject in our commune from provincial hall and provincial department of Land Management - The project should protect against odour and water pollution.	- There should be timely waste collection for all areas in the town, including our commune. - Sanitation should be provided for our health and safety. - The landfill should be constructed soon - During construction and operation the project should consider how to protect or mitigate the impacts of project activities on our environment, especially on social resources near the landfill site. - The project should provide job opportunities for the commune population.	- Environmental and social protection are incorporated in the EMP and will be monitored to ensure compliance with requirements and to minimise impacts on people and the environment
Thala Barivat Commune - This is a rural commune and there is no waste collection services. - The project should provide waste collection to the commune. - The people manage wastes by themselves, dumping in village area or field and by burning. - We support this subproject and we believe that the landfill will be good for our environment, sanitation, and public health. - The main impacts will be during the operation of the landfill.	- The project should avoid private land. - The project should start soon for improving our waste management. - During landfill operation, mitigation of odour impacts on local people should be provided. - Protect the outflow or runoff from the landfill site to water resources surrounding the landfill site. - We are worried about the odour and surface water pollution.	- The landfill site is on state land - Mitigation of odour impacts is incorporated in the EMP and will be further detailed in the operations manual - Odour impacts will be monitored, however due to the location of the site several kilometres from the nearest residences, odour nuisances are unlikely - Protection against water pollution is incorporated in the design and operations of the landfill
Anlong Svay - The village is in Orei commune and located near the landfill site about 4 km.	- The project should employ local people. - Provide plan and mitigate odour from the landfill during operation.	- The project will cover waste collection of the main urban areas of Stung Treng, namely

Feedbacks and Issues	Comments	Response
- We are aware of the landfill subproject from commune authority and the project study team. - We support this subproject, because provincial authority has plan to improve our provincial town with good environment. - The project should provide proper plan to protect and mitigated negative impacts on the environment and the communities.	- Provide mitigation measures to control the wastewater and runoff from landfill. - Provide the waste collection services to the entire Stung Treng District and affected communes (Ou Rai and Thala Barivat communes).	Stung Treng, Preah Bat, Srah Ruessei, and Sameakki communes. However, as Sameakki is a large rural sangkat it would not be practical to provide collection services for the whole of this area. The service in this Sangkat will only cover the two villages along National Road No.7
Srah Reussei Commune - The commune is located in the Stung Treng town - The waste management in our commune and in the town is very limited. - There is a lack of involvement from local people. - Some waste is dumped on the streets and in fields, There are not enough waste collection trucks, so the waste is kept a few days in the town or streets. - 2 times/week the waste truck comes to collect waste from households, but some time the collection is delayed. - we support this landfill subproject, it is good for our environment and sanitation in the town. - For our commune the environmental and social impacts of this project are not a problem.	- we need to improve waste management service and reasonable waste collection price. - The project should extend the waste collection areas to all communes in the town. This will also make the town more attractive to tourists. - The landfill should be constructed as soon as possible. - The project should improve waste management, collection equipment and ensure safety for waste trucks.	- The project will cover waste collection of the main urban areas of Stung Treng, namely Stung Treng, Preah Bat, Srah Ruessei, and Sameakki communes. However, as Sameakki is a large rural sangkat it would not be practical to provide collection services for the whole of this area. The service in this Sangkat will only cover the two villages along National Road No.7 - Provision of waste management equipment is part of the project
Sameakki Commune - The commune is located in town area far from the landfill site. - We are aware of the subproject since 2018 from provincial authority. - We support this project it is a good project for management of the environment in our area. - There is no waste collection service in our commune. - People dump and burn wastes and a few households dump waste in the existing dumpsite.	- The project should extend the waste collect areas to all the communes in the town. - we request the project to provide waste collection services in Sameakki commune too. - The project should provide technic to improve and manage the waste to create good environment and a clean town.	- Sameakki is a large rural sangkat and it would not be practical to provide collection services for the whole of this area. The service in this Sangkat will only cover the two villages on the north side of the National Road No.7 bridge, namely Hang Ko Suon and Hang Ko Barn - The landfill and the waste management are designed in accordance with requirements for a controlled landfill
Stung Treng Commune - The commune is located in urban town area. The commune has waste collection service. - The waste collection in the town is the as same as in Stung Treng commune and it is limited (the waste truck comes 2 times/week for household wastes). - Sometime the waste collection time is not regular.	- The project should prepare a plan and provide good waste management services for the town. - Provide enough and proper waster trucks - Prove clean town to attract more tourists. - We need good waste collection service with reasonable price. - The controlled landfill should be constructed soon.	- See above

Feedbacks and Issues	Comments	Response
- The negative effects from the project to our area is no problem. We will receive a good service from this landfill subproject.		
Preah Bat Commune - The commune is located in Stung Treng town. - The commune has no waste collection services. - People dump and burn waste and some people dump their waste at the dumpsite. - The waste collection service in the town is limited. There is a lack of equipment, limited number of waste trucks, resulting in delayed waste collection. - In the town area, the environmental and social impacts of the landfill subproject activities are probably not significant. The impacts to communes near the landfill site should be considered	- - The project should extend the waste collection areas to the entire town - Waste regulations should be enforced. - We want the controlled landfill to be constructed soon. - The project should have good waste management and create a clean city to attract more tourists and provide public health and sanitation. - We need good waste management with reasonable waste collection fee. - The project should provide waste collection services to some areas surrounding the town	- See above

Pictures

Consultation with Ou Rai Commune Authority

Consultation with Srah Ruessei Commune Authority

Consultation with Sameakki Commune Authority

	
Consultations with StungTreng Commune Authority	Consultations with Preah Bat Commune Authority

	
Consulted with chief Anlong Svay village, Ou Rai Commune	Consulted with chief of Treal village, Thala Barivat

Participants

No	Name	Sex	Institution	Position
1	Sath Chhel	M	Orei Commune	Deputy commune chief
2	Chan Dam	M	Thalaboravath Commune	Deputy commune chief
3	Den Phyrum	M	Sras Russey Coomune	Commune chief
4	Chea Maly	M	Samaky Commune	Commune chief
5	Chea Vanna	M	Stung Treng Commune	Commune chief
6	Seth Kimteng	M	Preah Bath Commune	Commune Chief
7	Bun Rin	M	Orei Commune	Chief of Anlong Svay Village

Consultations with relevant Agencies and Departments 03 September 2020

Component	Site visit for Landfill Subproject CTDP4
Type of Activity	Site visit at Stueng Treng city
Sub-project/s	Landfill in Ou Rai Commune, Thala Barivat District, Stung Treng Province
Start date	03-09-2020
End date	03-09-2020
Planned Activities	MoE team reviewed IESIA report and conducted site visit, and consulted with PIU, Provincial, District, Commune and Village authorities
Activities Carried Out	Summary of landfill subproject, discussion and received feedbacks, and comments from local authorities
Appendix 1: Participants	
Appendix 2: Pictures	

Noted by: Mr. Yim Chamnan National Environmental Specialist	

Consultation Meeting in Or Rei commune office, Thala Borivat district

On 03 September 2020 at 8:30 pm, in Ou Rai Commune office, Thala Barivat district, Stung Treng Province. The Participants come from MoE Reviewing Team, PDPWT/PIU Staffs, PDoE, provincial, town, commune authorities, PMC, and SAWAC Team. The list of attendees is shown in Appendix 1.

The objectives were:

- Brief the project location, work plan and activities of landfill subproject
- 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 comments or concerns for update the IESIA report.

Meeting discussion:

The proposed consultation: Present the work plan and activities of building a control landfill for Stung Treng town to relevant local authorities. Receive concerns or issues from filed visit concerning to sensitive environmental and social receptors near the project area.

On 02-03 September 2020, the MoE Reviewing Team collaborated with SAWAC Team, PIU, and PMC and conducted a site visit to the landfill subproject site in Ou Rai and Thala Commune, Thala Barivat District, Stung Treng Province. The consultation meeting was conducted on 03 September 2020. The key feedbacks, issues, and comment from consultation meeting are briefed bellow:

The key concerns, comments, and questions form participants

- The existing waste collection and management system in Stung Treng town
- The households involved in waste collection policy or declaration
- The environmental and social issues and impacts of existing waste generation
- From PPTA the provincial authorities supported for Landfill site selection in Ou Rai and Thala Barivat commune area (is public land).
- The proposed site is good: far from river, village areas and far from town. But now a few people encroach some land sites near the landfill site for farming.

The considers:

- There is 100 ha of public land in this location. The provincial authority allocates 25 ha for CTDP4 to build the controlled landfill.
- This site for landfill is far from Stung Treng Town
- The site is about 4 km from Mekong River, and about 4 km from the national road and Ou Rai and Thala Barivat commune areas.

- during construction and operation of the landfill, the impacts of landfill activities on social receptors are very small.
- But the local authorities are concerned about impacts from waste collection and waste transportation during operation stage. (waste collection is delayed, no safe waste trucks, and waste spilled or falling off trucks during transport).
- The landfill site is located in upland and sloped area, So the design should consider flood runoff protection. To ensure that the water, runoff and leachate from the landfill site do not flow out to downstream area and water sources downstream.
- The landfill operation will increase odour and flies, the project should mitigate and reduce the odour and flies.

Conclusion

Generally, all the participants from provincial, town, district and commune authorities support this subproject for improvement of waste management system in their areas/town. But during operation of the landfill the project owner should comply with design standards and provide proper mitigation measures to mitigate the effects on environmental quality and social receptors. The concerns and comments from the consultation meeting was noted and considered in the updated 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	Saren Sokhom Somaly	F	--	Officer	085 309 222
5	Sath Chhel	M	Or Rei Commune	Deputy commune chief	068 655 661
6	Long Sophat	M	--	Deputy commune chief	088 905 5528
7	Chan Lum	M	--	Commune Leader	097 856 1855
8	Thay Hy	M	Thala Commune	Commune Leader	097 287 1661
9	Nol Panharith	M	PDoE	Chief office	089 808 249
10	Bun Rin	M	Or Rei Commune	Village Chief	097 835 2247
11	Chan Dam	M	Thala Commune	Deputy commune chief	097 308 7155
12	Yet Run	M	PDoE	Deputy Director	097 761 8165
13	Kong Sothea	M	PDPWT	Deputy Director	012 609 735
14	Nou Vanna	M	--	Chief of Culver office	012 684 270
15	Duong Sam Ol	M	Stueng Treng Province	Chief Office	097 380 2111
16	Seng Virak	M	Stueng Treng Town	Chief Admin. Office	097 721 6684
17	Phork Sokheng	F	Or Rei Commune	Gender Unit	071 336 6095
18	Yim Chamnan	M	PMC (ADB-MPWT)	National Environment	012 945 546
19	Oum Sereyvuth	M	SAWAC Team	Team Leader	012 360 743
20	Chea Bunnara	M	SAWAC Team	Assistant	096 578 3396

Appendix 2: Pictures

The existing access road to landfill site. people encroached a few sites along the road	
	
The existing condition of natural resources in landfill site	
	
Consultation meeting with provincial, district and commune authorities in Or Rei Commune Office	

Annex 4: Stung Treng Landfill and Dumpsite Site Visits

Site Visit Report 30 September 2020

Component	Site visit for Subproject CTDP4
Type of Activity	Site visit at Stung Treng Town
Sub-project/s	Landfill in Anlung Svay village, Ou Rai commune, Thala Barivat District, Stung Treng Province
Start date	30-09-2020
End date	30-09-2020
Planned Activities	Meeting with PIU and Site visit landfill
Activities Carried Out	Introduction, Present of landfill subproject, Question from landfill situation, comments and questions from PIU
Appendix 1: Participants	
Appendix 2: Pictures	

Consultant Signature	Date
Mr. Richard Mabbitt Team Leader	
Consultant Signature	Date
Mr. Ly Nara Deputy Team Leader Mr. Yin Somean Solid Waste Engineer	

Meeting with PIU members

On 30 September 2020 at 2:30 pm, in Provincial Department of Public Work and Transport have a meeting discussion on the new subproject landfill and the current landfill. The participants are PDPWT/PIU members, PMU and PMC. Meeting Attendees are shown in Appendix 1.

The objectives

- Introduction on the type of new subproject landfill.
- Collect data and the important information for the technical detail design.
- Visit the situation of the current and the new landfill site location.

Meeting discussion and questions

Determine logistics of waste transportation and the engineering requirements for road access into the site and get an understanding of proximity to existing networks and determine the potential impact that the landfill may have on surrounding communities, livelihoods and the environment, understand water movements, drainage requirements and the impact that any unintentional discharge of leachate would have on the surrounding environment, understand the impact the construction and the operations may have in terms of wind-blown odors/ pollutants, understand the possible impact on surrounding ecology and also any existing nuisance problems, which the landfill is likely to exacerbate, understand the presence of any cultural/ spiritual sites within the site or close by, understand construction materials may be available in the wider vicinity, determine suitable locations for some of the site's facilities, determine past and current management and operations, nature and composition of wastes, the approach to deposition and management of wastes, the potential impact that the landfill is having on surrounding communities and pollution levels of environmental impact.

The key concerns and comments

- There are many types of vehicles run along the access road to the landfill especially agriculture crop harvest season, so it may have damage if not good operation and maintenance.
- No water network supply to the subproject site.
- The operations may have in terms of wind-blown odors/ pollutants and wastewater spill out of the cells to field and stream.
- Poor management on Operation and maintenance the subproject landfill after finish construction and handover to them to operate.

The considers

- Strictly manage the runoff and leachate from the landfill to avoid the impact on the groundwater and surface water quality.
- Use the technical or mitigation for reduce the wind odours, fly, and other insects out from the landfill.
- Strictly manage the waste collection and transportation by truck on the road passing through the residential area.

Conclusion

Generally, they support the project, but they are concerned during operation stage how to manage and control the landfill for avoid or mitigate the impacts on social and environment in and around the project site. Moreover, they are concern about next future using the landfill, due to it will be probably full in next 10 to 20 years, and the landfill will be limited. So, they have raised a question is “what is your plan to do when the landfill full all cells?”

Appendix 1: List of Participants

No	Name	Sex	Institution	Position	Phone
1	Kong Sothea	M	PDPWT	Deputy Director	012 609 735
2	Pich Ramy	M	Provincial Hall	Deputy municipal chief	012 402 944
3	Nou Vanna	M	PDPWT	Chief of Drainage and Sewage Office	097 899 0204
4	Doung Sam OL	M	Provincial Hall	Chief of Economic Office	097 380 2111
5	Nop Robert	M	PMU	Project Manager	011 624 626
6	Yin Somean	M	PMC	Solid Waste Engineer	078 794 042
7	Ly Nara	M	PMC	Deputy Team Leader	012 823 767
8	Seng Virak	M	Provincial Hall	Chief of Town Administrative Office	092 216 684
9	Yen Run	M	PDOE	Deputy Director	097 761 8165

Appendix 2: Pictures




Meeting with PIU and Site visit in the existing open dumpsite


	
Site visit the new landfill location	
	
	
Pipe culvert at the entrance where the point of connection between road number 2648 and new landfill access road. And onside open drain.	Landfill access road

Site Visit Report 08 February 2018

Stung Treng Landfill Site

On 8 February 2018, the ADB environmental specialist and national environmental specialist of TA-9192 project collaborated with local authorities and concerned departments of Stung Treng Province namely: Stung Treng Town, Department of Public Works and Transport (DPWT), Department of Environment (DOE), Department of Land Management Urban Planning and Construction (DLMUPC) and conducted a field visit to the proposed new landfill site.

The location of new dumping site:

- The proposed site is located in Thala and Ou Rai Commune, Thala Barevat District, Stung Treng Province.
- This proposed land belongs to the state (provincial land)
- About 4 km from national road 9. The rural road is access road to landfill site and the site is located about 0.7 km from the rural road
- The Thala Commune is located along the National Road 9 and Ou Rai Commune is located on Mekong Riverbank
- About 04 km from Mekong Bridge and Mekong River
- There are no sensitive resources located near the site (residents, pagoda, hospital, protected areas and archaeological/historical areas).
- It is upland area, not flood prone
- Degraded forest land area
- There a few small streams/ditches crossing the site. These steams/ditches only carry water in the rainy season. No water was observed in these streams/ditches during the visit (see pictures below).

B. Field Pictures

The existing condition of accessed rural road from NR-9 to proposed site

The existing forest resources and oxcart road in the proposed landfill site	
	
The team field visit of landfill site	

List of site visiting team

No	Name	Sex	Institution	Position	Phone
1	Mr. Ly Mina	M	ST Town	Vice town governor	097 200 2124
2	Mr. Pich Ramy	M	ST Town	Vice town governor	
3	Mr. Kao Chheun	M	ST Town	Chief solid waste	088 887 5787
4	Mr. Paha Viseth	M	DOE	Chief EP/EIA office	089 808 249
5	Mr. Nou Vanna	M	DPWT	Deputy chief office	012 684 270
6	Mr. Dem Sarin	M	DLMUPC	Official	
7	Ms. Genevieve O'Farrell	F	ADB	Environmental Specialist	
8	Mr. Yim Chamnan	M	PPTA-9192	National Environment	012 945 546

Annex 5: Terms of Reference for Environmental Compliance Audit of Waste Dumpsites in Stung Treng 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

The dumpsite in Stung Treng City is considered an *Existing Facility*[33] of the wider CTDP-4 Project and the closure and remediation of the dumpsite require that an Environmental Compliance Audit (ECA) is conducted of the facility pursuant to the SPS (2009), para 10 of Appendix 1 and para 12 of Appendix 4.

The closure and remediation of the dumpsite is part of the Strung Treng 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 and cost estimates 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

---

[33] *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.*

l. Review of any existing permits or authorizations for the dumpsite
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.

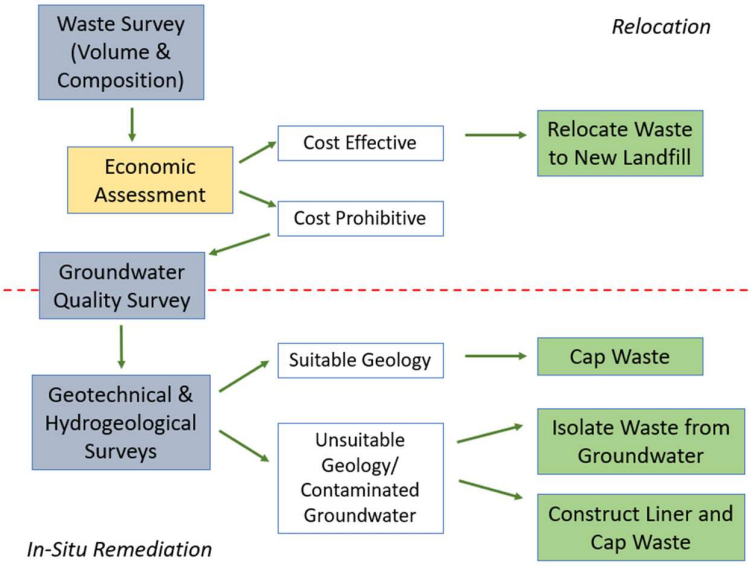
Additional Optional Activities

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 6: 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.

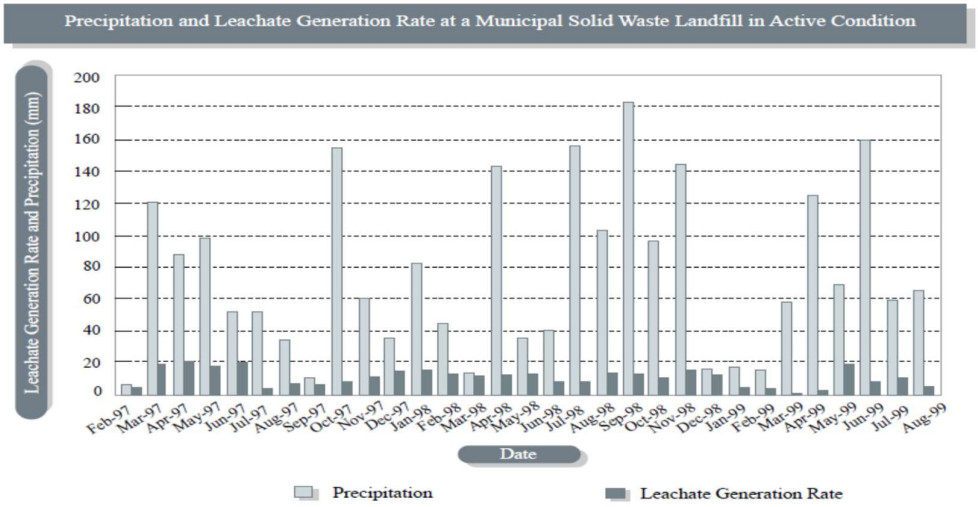
The degradation of the organic component of the waste mass produces a small quantity of liquid leachate and gaseous by-products. The leachate produced is partially absorbed into the dry waste mass and partially lost as vapour due to the heat of the biodegradation process. Under these conditions virtually 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

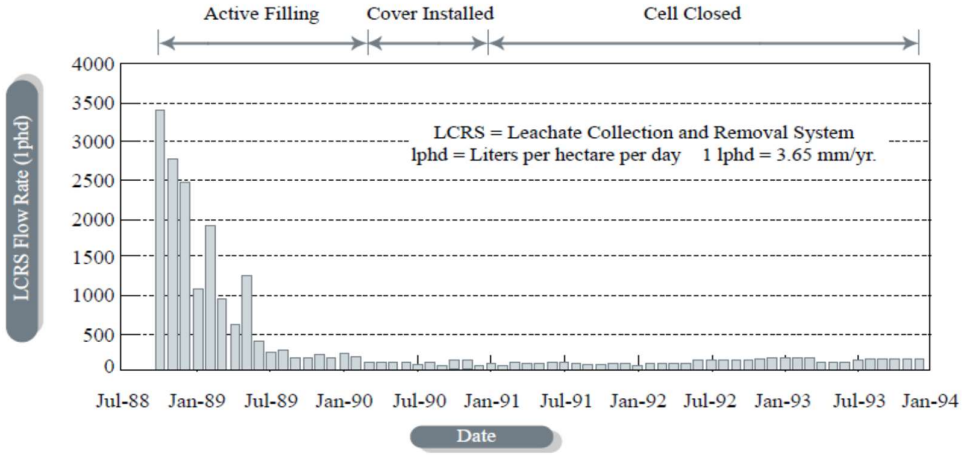


Ref: "Qian, X., R. M. Koerner, and D. H. Gray, "Geotechnical aspects of landfill design and construction, upper Saddle River, New Jersey". Prentice-Hall, 2002

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 7: 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)*
2023	0	0	0	0	0	0	0	0
2024	1,363	1,091,506	364	545,753	999	545,753	0	0
2025	2,736	2,190,484	731	1,095,242	2,005	1,095,242	0	0
2026	2,602	2,083,653	695	1,041,826	1,907	1,041,826	0	0
2027	2,475	1,982,032	661	991,016	1,814	991,016	0	0
2028	2,354	1,885,367	629	942,684	1,726	942,684	0	0
2029	2,240	1,793,417	598	896,708	1,641	896,708	0	0
2030	2,130	1,705,951	569	852,975	1,561	852,975	11	2,988
2031	2,027	1,622,751	541	811,375	1,485	811,375	21	5,996
2032	1,928	1,543,608	515	771,804	1,413	771,804	20	5,703
2033	1,834	1,468,325	490	734,163	1,344	734,163	19	5,425
2034	1,744	1,396,714	466	698,357	1,278	698,357	18	5,161
2035	1,659	1,328,596	443	664,298	1,216	664,298	18	4,909
2036	1,578	1,263,799	422	631,900	1,157	631,900	17	4,669
2037	1,501	1,202,163	401	601,082	1,100	601,082	16	4,442
2038	1,428	1,143,533	381	571,766	1,047	571,766	15	4,225
2039	1,358	1,087,762	363	543,881	996	543,881	14	4,019
2040	1,292	1,034,711	345	517,356	947	517,356	14	3,823
2041	1,229	984,248	328	492,124	901	492,124	13	3,637
2042	1,169	936,246	312	468,123	857	468,123	12	3,459
2043	1,112	890,584	297	445,292	815	445,292	12	3,290
2044	1,058	847,150	283	423,575	775	423,575	11	3,130
2045	1,006	805,834	269	402,917	738	402,917	11	2,977
2046	957	766,533	256	383,267	702	383,267	10	2,832
2047	911	729,149	243	364,574	667	364,574	10	2,694
2048	866	693,588	231	346,794	635	346,794	9	2,563
2049	824	659,761	220	329,881	604	329,881	9	2,438
2050	784	627,584	209	313,792	574	313,792	8	2,319
2051	746	596,977	199	298,488	546	298,488	8	2,206
2052	709	567,862	189	283,931	520	283,931	8	2,098
2053	675	540,167	180	270,083	494	270,083	7	1,996
2054	642	513,822	171	256,911	470	256,911	7	1,898
2055	610	488,763	163	244,382	447	244,382	6	1,806
2056	581	464,926	155	232,463	426	232,463	6	1,718
2057	552	442,251	148	221,126	405	221,126	6	1,634
2058	525	420,682	140	210,341	385	210,341	6	1,554
2059	500	400,165	133	200,083	366	200,083	5	1,479
2060	475	380,649	127	190,325	348	190,325	5	1,406
2061	452	362,085	121	181,042	331	181,042	5	1,338
2062	430	344,426	115	172,213	315	172,213	5	1,273
2063	409	327,628	109	163,814	300	163,814	4	1,211
2064	389	311,649	104	155,825	285	155,825	4	1,151
2065	370	296,450	99	148,225	271	148,225	4	1,095
2066	352	281,992	94	140,996	258	140,996	4	1,042
2067	335	268,239	89	134,119	246	134,119	4	991

	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)*
2068	319	255,157	85	127,578	234	127,578	3	943
2069	303	242,713	81	121,356	222	121,356	3	897
2070	288	230,875	77	115,438	211	115,438	3	853
2071	274	219,615	73	109,808	201	109,808	3	811
2072	0	0	0	0	0	0	0	0

Annex 8: IESIA Certificate

ព្រះរាជាណាចក្រកម្ពុជា
ជាតិ សាសនា ព្រះមហាក្សត្រ

ក្រសួងបរិស្ថាន
លេខ: ៥០៤៣/ស.ដ.ណ.ប.ស

ថ្ងៃ ៣ ខែ ៤ ឆ្នាំជូត ទោស័ក ព.ស.២៥៦៤
រាជធានីភ្នំពេញ ថ្ងៃទី ២៨ ខែ ឧសភា ឆ្នាំ២០២០

ជម្រាបជូន
លោកប្រធានក្រុមប្រឹក្សាតិចាលក្រុមហ៊ុនទីប្រឹក្សា សាវ៉ាក់ ខនសាល់ធេន (ខេមបូឌា)

កម្មវត្ថុ ៖ ករណីសំណើសុំការអនុញ្ញាតចុះសិក្សា និងពិគ្រោះយោបល់ជាសាធារណៈជាមួយស្ថាប័នពាក់ព័ន្ធ ដើម្បីរៀបចំរបាយការណ៍វាយតម្លៃហេតុប៉ះពាល់បរិស្ថាន និងសង្គមដំបូង សម្រាប់អនុគម្រោងបង្កើតទីលានចាក់សំរាមក្រុងស្ទឹងត្រែង នៃគម្រោងអភិវឌ្ឍន៍ក្រុងរបៀង ៤ នៃមហាអនុតំបន់មេគង្គ នៅខេត្តស្ទឹងត្រែង

យោង ៖ - ព្រះរាជក្រមលេខ នស/រកម/១២៩៦/៣៦ ចុះថ្ងៃទី២៤ ខែធ្នូ ឆ្នាំ១៩៩៦ ដែលប្រកាសឱ្យប្រើច្បាប់ស្តីពីកិច្ចការពារបរិស្ថាន និងការគ្រប់គ្រងធនធានធម្មជាតិ
- អនុក្រឹត្យលេខ ៧២ អនក្រ.បក ចុះថ្ងៃទី១១ ខែសីហា ឆ្នាំ១៩៩៩ ស្តីពីកិច្ចដំណើរការវាយតម្លៃហេតុប៉ះពាល់បរិស្ថាន
- ប្រកាសលេខ ២១៥ ប្រក.ប.ស ចុះថ្ងៃទី១៩ ខែឧសភា ឆ្នាំ២០១៤ ស្តីពីការចុះបញ្ជីក្រុមហ៊ុនទីប្រឹក្សាសម្រាប់ការសិក្សា និងរៀបចំរបាយការណ៍វាយតម្លៃហេតុប៉ះពាល់បរិស្ថាន និងសង្គម
- លិខិតលេខ ៨៣៥ រ.ហ.ប.ស្ត ចុះថ្ងៃទី១៦ ខែមិថុនា ឆ្នាំ២០២០ របស់នាយកដ្ឋានវាយតម្លៃហេតុប៉ះពាល់បរិស្ថាននៃក្រសួងបរិស្ថាន
- លិខិតលេខ SOC-05-11.02 ចុះថ្ងៃទី១១ ខែឧសភា ឆ្នាំ២០២០ របស់ក្រុមហ៊ុនទីប្រឹក្សាសាវ៉ាក់ ខនសាល់ធេន (ខេមបូឌា)

សេចក្តីដូចមានចែងក្នុងកម្មវត្ថុ និងយោងខាងលើ ខ្ញុំសូមជម្រាបជូន **លោកប្រធាន** ជ្រាបថាក្រសួងបរិស្ថានឯកភាពលើសំណើសុំការអនុញ្ញាតចុះសិក្សា និងពិគ្រោះយោបល់ជាសាធារណៈជាមួយស្ថាប័នពាក់ព័ន្ធ ដើម្បីរៀបចំរបាយការណ៍វាយតម្លៃហេតុប៉ះពាល់បរិស្ថាន និងសង្គមដំបូង សម្រាប់អនុគម្រោងបង្កើតទីលានចាក់សំរាមក្រុងស្ទឹងត្រែង នៃគម្រោងអភិវឌ្ឍន៍ក្រុងរបៀង ៤ នៃមហាអនុតំបន់មេគង្គ លើផ្ទៃដីទំហំ ១០០,៧៦ហិកតា (មួយរយហិកតា និងចិតសិបប្រាំមួយអា) ដែលមានទីតាំងស្ថិតនៅឃុំថាឡាបរីរ៉ាត់ និងឃុំអូររំរ៉ៃ ស្រុកថាឡាបរីរ៉ាត់ ខេត្តស្ទឹងត្រែង របស់ក្រសួងសាធារណការ និងដឹកជញ្ជូន (ម្ចាស់គម្រោង) ដោយគិតចាប់ពីថ្ងៃចុះហត្ថលេខានេះរហូតដល់ថ្ងៃទី២៨ ខែតុលា ឆ្នាំ២០២០ ដោយក្នុងនោះក្រុមហ៊ុនត្រូវ៖

- ធ្វើការសិក្សាដោយផ្អែកលើលក្ខខណ្ឌការងារ ដែលបានផ្តល់យោបល់ដោយនាយកដ្ឋានវាយតម្លៃហេតុប៉ះពាល់បរិស្ថាន
- ធ្វើការទំនាក់ទំនងជាមួយក្រសួង-ស្ថាប័នជំនាញពាក់ព័ន្ធ និងអាជ្ញាធរមូលដ្ឋាននៅក្នុងតំបន់គម្រោង
- មានការចូលរួមអង្កេតការណ៍លើការសិក្សារបស់ក្រុមហ៊ុនពីសំណាក់មន្ទីរបរិស្ថាន
- សិក្សាឱ្យបានចប់តាមពេលវេលាកំណត់ដើម្បីកុំឱ្យរាំងស្ទះដល់ដំណើរការវិនិយោគ។

អាស្រ័យដូចបានជម្រាបជូនខាងលើ សូម **លោកប្រធាន** អនុវត្ត និងចាត់ចែងតាមការគួរ។
សូម **លោកប្រធាន** ទទួលនូវសេចក្តីរាប់អានដ៏ស្មោះពីខ្ញុំ៕

ជ.រដ្ឋមន្ត្រី
រដ្ឋលេខាធិការ

ចម្លងជូន៖
- ក្រសួងសាធារណការ និងដឹកជញ្ជូន
- រដ្ឋបាលខេត្តស្ទឹងត្រែង
- មន្ទីរបរិស្ថានខេត្តស្ទឹងត្រែង
- ឯកសារ កាលប្បវត្តិ

អាគារមរតកតេជោ ដីឡូលេខ503 ផ្លូវកៅស៊ូអមមាត់ទន្លេបាសាក់ សង្កាត់ទន្លេបាសាក់ ខណ្ឌចំការមន ភ្នំពេញ ទូរស័ព្ទ: 023 235 004 / 023 235 006

KINGDOM OF CAMBODIA
Nation Religion King

(Logo)
MINISTRY OF ENVIRONMENT
No. 893 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 Stueng Treng Town, Stueng Treng 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 2970 SK/OKR4, dated August 14, 2020, of the Ministry of Public Works and Transport,
- Letter No. 287 SK/OKR4, dated February 02, 2021, of the Ministry of Public Works and Transport,
- Letter No. 1780 SK/OKR4, dated June 03, 2021, of the Ministry of Public Works and Transport,
- Letter No. 637 S.C.N.MoE, dated May 13, 2021, of the Ministry of Environment,
- Letter No. 1323 V.H.MoE, dated September 25, 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 Stueng Treng Town of the Fourth Great Mekong Sub-Region Corridor Towns Development project with area of 100,762ha located at Anlong Svay Village, Orey Commune, and Trel Village Thalaborivat Commune, Thalaborivat District, Stueng Treng Province, the project of the Ministry of Public Works and Transport (Principal) subject to the Principal's compliance with the Environmental Protection Commitment No. 2070 SK/OKR4, dated June 22, 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, June 30, 2021
For Minister
Secretary of State
(Signature and stamp)

SABOU OZANOU

CC:
- Office of the Council of Ministers
- Ministry of Economy and Finance
- Ministry of Land Management, Urban Planning and

Construction
- Stueng Treng Provincial Administration
- Stueng Treng 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

Kingdom of Cambodia

National Religion King

Ministry Public Works and Transport (MPWT)
No 2070

Respect to

His Excellency Minister of Environment

The project owner is 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.

The Contract on Environmental Protection

For collaboration to ensure of the sustainable environment in the country development process. I (MPWT) is committed the Contract on Environmental Protection to Ministry of Environment (MoE) for control landfill construction subproject of solid waste management in Stung Treng Town of the Fourth Great Mekong Sub-Region Corridor Towns Development Project with total area 100.76ha located in Anlong Svay Village, Orei Commune and Treal Village, Thalaborivath Commune, Thalaborivath District, Stung Treng Province.

Article 1:
Ensure for responsibility and comply/implement the contents are described in the Initial Environmental and Social Impact Assessment Report (IESIA) for control landfill construction subproject of solid waste management in Stung Treng Town of the Fourth Great Mekong Sub-Region Corridor Towns Development Project which approved by MoE.

Article 2:
Submit the Environmental Monitoring Report 01 time/year, during construction stage and 1 time in the first year of operation stage to Department of Environmental Impact Assessment, MoE for reviewing and evaluation.

Article 3:
Submit the Summary of Detailed Designing Report of the control landfill construction subproject for solid waste management in Stung Treng Town of the Fourth Great Mekong Sub-Region Corridor Towns Development Project, which is not detailed in the IESIA Report to the Ministry of Environment for review and comment.

Article 4:
In the case, MoE requires to the Project Owner to modify of correction whcih environmental technics for complying with guidelines and environmental standards, the Project Owner will operate and fully comply with those guidelines.

Article 5:
In the future, if the Project Owner has plan to expand the project, change or updated the the Feasibility Study Report or pause/project closure, the Project Owner should inform to MoE 01 month before.

Article 6:

Permit to environmental officials from Ministry of Environment or Provincial Environmental Department in Stung Treng, which official mission for conducting monitoring in subproject area.

Article 7:

In the case, the Project owner will not comply with which article or missing implementation of this contract or any other applicable regulations, the project owner will response to applicable laws.

Phnom Penh, on June 22 2021
Represented **Minister of MPWT**
Secretary of State

Suy San

Seen and submit to
HE. Minister of Environment
for review and approval
Phnom Penh June 2021
Director of EIA Department
Danh Serey

Seen and accepted
Phnom Penh June 2021
Represented **Minister of MoE**
Secretary of State

IBAT

Integrated Biodiversity Assessment Tool

PROXIMITY REPORT
STUNG TRENG NEW LANDFILL

Country: Cambodia

Location: [13.6, 105.9]

Date of analysis: 21 July 2021 (GMT)

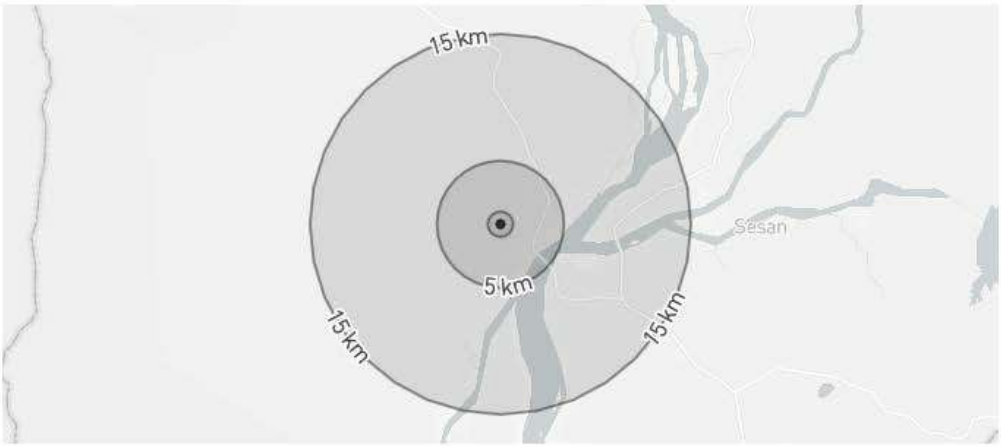
Buffers applied: 1 km | 5 km | 15 km

Generated by: Peter Gammelgaard Jensen

Organisation: ADB

Overlaps with:

Protected Areas	3
Key Biodiversity Areas	4
IUCN Red List	106



Displaying project location and buffers: 1 km, 5 km, 15 km

About this report

This report presents the results of [6690-19072] proximity analysis to identify the biodiversity features and species which are located within the following buffers: 1 km, 5 km, 15 km.

This report is one part of a package generated by IBAT on 21 July 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 - July 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.

Protected Areas

The following protected areas are found within 1 km, 5 km, 15 km of the area of interest.
For further details please refer to the associated csv file in the report folder.

Area name	Within buffer of
NorthEast Corridor	5 km
NorthWest Corridor	15 km
Stung Treng	15 km

Key Biodiversity Areas

The following key biodiversity areas are found within 1 km, 5 km, 15 km of the area of interest.
For further details please refer to the associated csv file in the report folder.

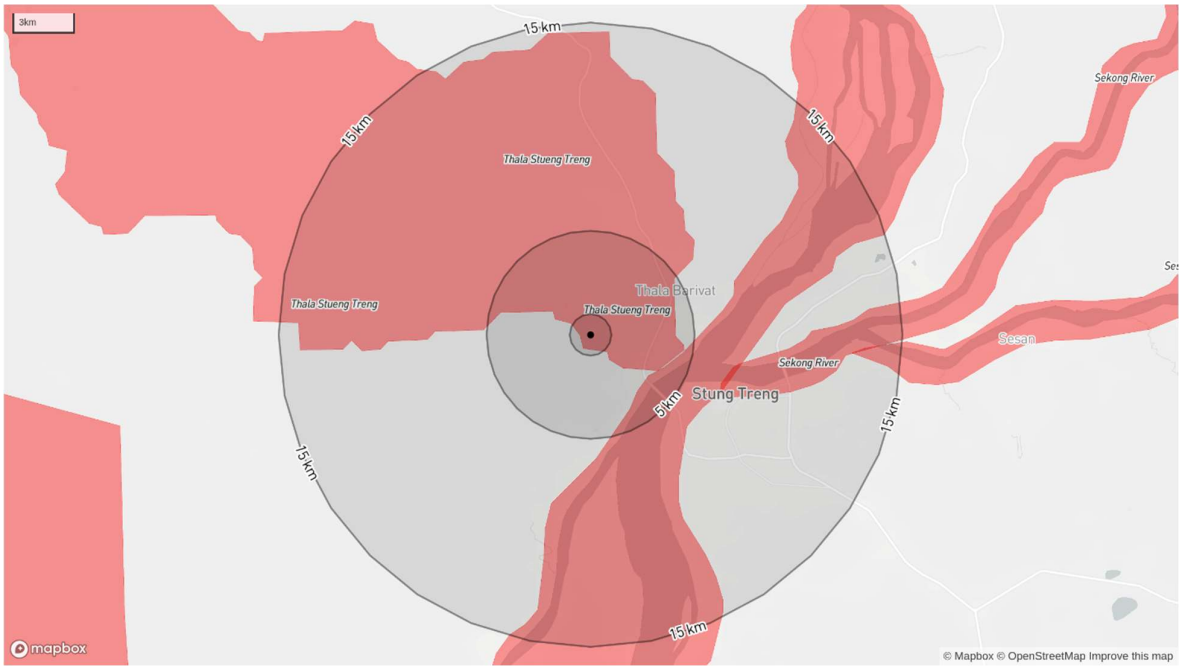
Area name	Distance
Thala Stueng Treng	1 km
Mekong River from Kratie to Lao PDR	5 km
Sekong River	15 km
Sesan River	15 km

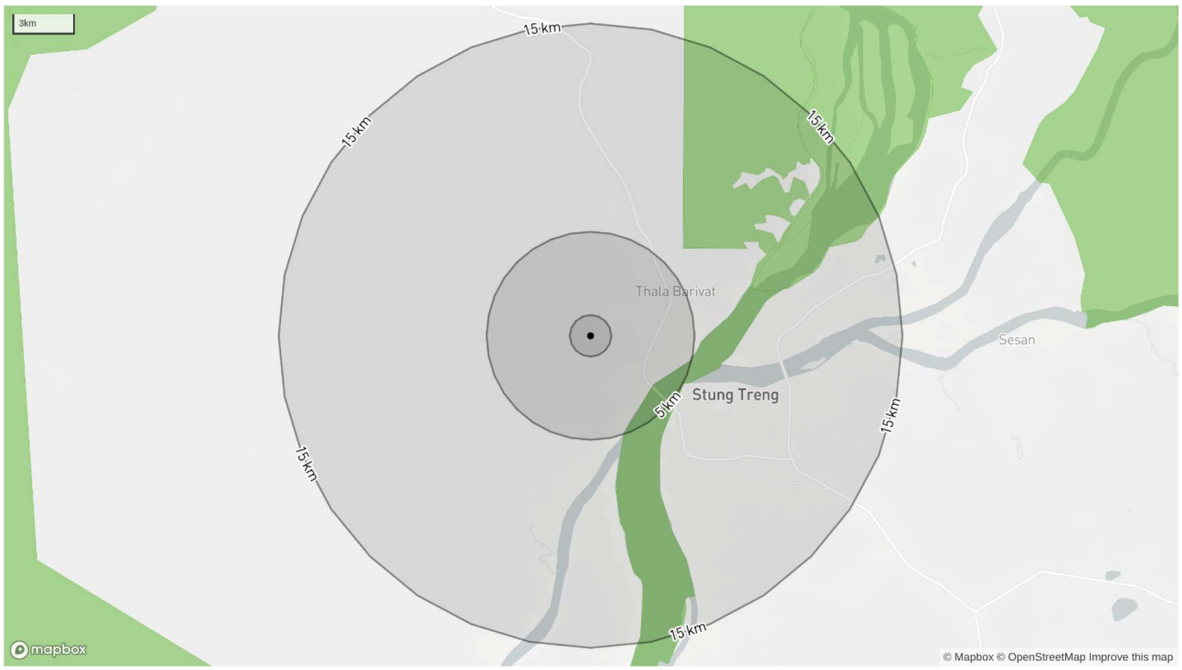
IUCN Red List of Threatened Species

The following threatened species are potentially found within 50km of the area of interest.

For the full IUCN Red List please refer to the associated csv in the report folder.

Species Name	Common Name	Taxonomic Group	IUCN Category	Population Trend	Biome


3km
15 km
15 km
15 km
15 km
15 km
5 km
Thala Stueng Treng
Thala Stueng Treng
Thala Stueng Treng
Thala Barivat
Stung Treng
Sekong River
Sekong River
Sesan
mapbox
© Mapbox © OpenStreetMap Improve this map


3km
15 km
15 km
15 km
15 km
15 km
5 km
Thala Barivat
Stung Treng
Sesan
mapbox
© Mapbox © OpenStreetMap Improve this map

Integrated Biodiversity Assessment Tool

PROXIMITY REPORT
STUNG TRENG EXISTING DUMPSITE

Country: Cambodia

Location: [13.6, 106.1]

Date of analysis: 21 July 2021 (GMT)

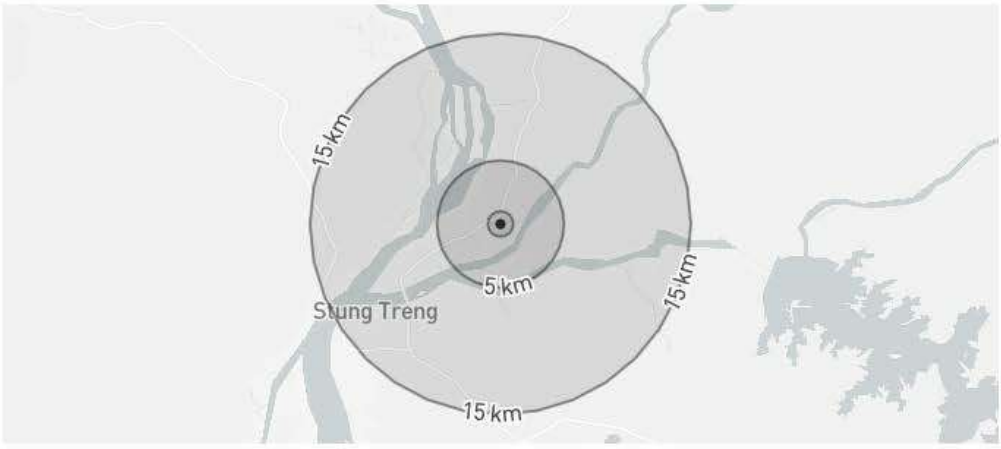
Buffers applied: 1 km | 5 km | 15 km

Generated by: Peter Gammelgaard Jensen

Organisation: ADB

Overlaps with:

Protected Areas	3
Key Biodiversity Areas	4
IUCN Red List	106



Displaying project location and buffers: 1 km, 5 km, 15 km

About this report

This report presents the results of [6690-19073] proximity analysis to identify the biodiversity features and species which are located within the following buffers: 1 km, 5 km, 15 km.

This report is one part of a package generated by IBAT on 21 July 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 - July 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.

Protected Areas

The following protected areas are found within 1 km, 5 km, 15 km of the area of interest.
For further details please refer to the associated csv file in the report folder.

Area name	Within buffer of
Stung Treng	5 km
NorthEast Corridor	15 km
NorthWest Corridor	15 km

Key Biodiversity Areas

The following key biodiversity areas are found within 1 km, 5 km, 15 km of the area of interest.
For further details please refer to the associated csv file in the report folder.

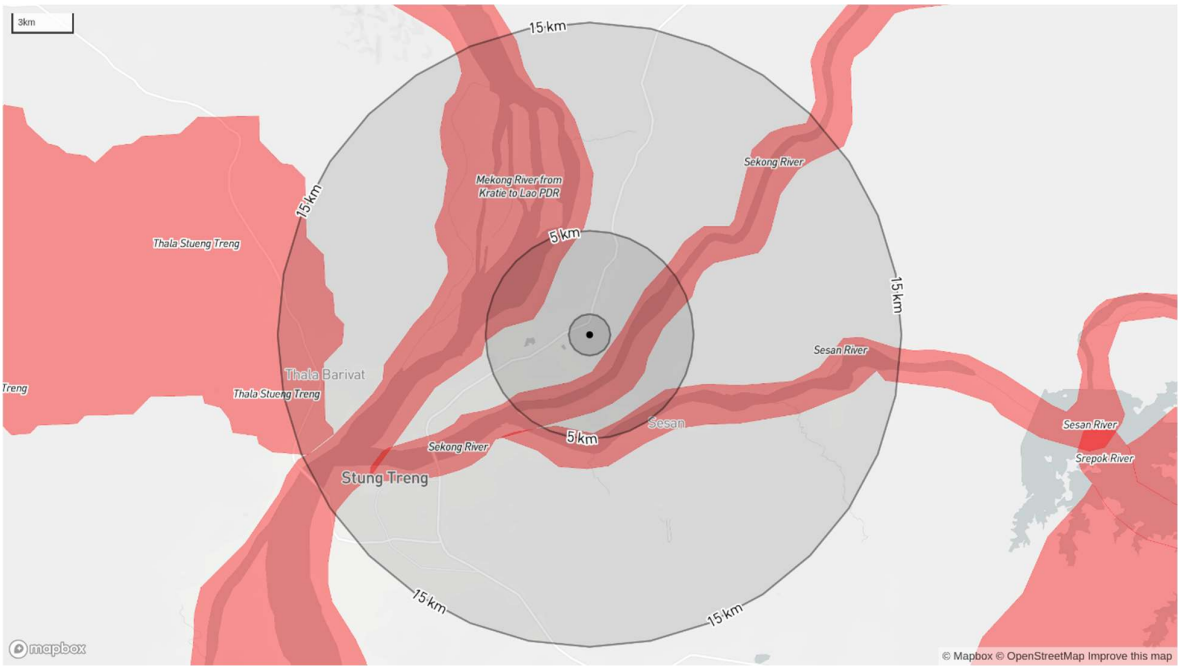
Area name	Distance
Mekong River from Kratie to Lao PDR	5 km
Sekong River	5 km
Sesan River	5 km
Thala Stueng Treng	15 km

IUCN Red List of Threatened Species

The following threatened species are potentially found within 50km of the area of interest.

For the full IUCN Red List please refer to the associated csv in the report folder.

Species Name	Common Name	Taxonomic Group	IUCN Category	Population Trend	Biome


3km
15 km
15 km
15 km
5 km
5 km
15 km
15 km
Mekong River from Kratie to Lao PDR
Sekong River
Thala Stueng Treng
Thala Barivat
Thala Stueng Treng
Treng
Sekong River
Stung Treng
Sesan River
Sesan
Sesan River
Srepok River
mapbox
© Mapbox © OpenStreetMap Improve this map


3km
15 km
15 km
15 km
5 km
5 km
15 km
15 km
Thala Barivat
Sesan
Stung Treng
mapbox
© Mapbox © OpenStreetMap Improve this map

Annex 10: Water Balance in the Leachate Ponds

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

Source: Detailed Engineering Design, Stung Treng Landfill Subproject, July 2021

Year	Month	Rain mm/ month	Evaporation mm/ month	Leachate	Pond 1 (Anaerobic) 1,200 m^2; 2,540 m^3		Pond 2 (aerobic) 1,145 m^2; 1,267 m^3		Pond 3 (Wetland) 2,980 m^2; 3,225 m^3		Pond 4 (Treated Water) 1,110 m^2; 2,136 m^3	
					Water Balance	Cumulative water balance	Water Balance	Cumulative water balance	Water Balance	Cumulative water balance	Water Balance	Cumulative water balance
2023	January	1	140	0	-125	-125	-119	-119	-310	-310	-115	-115
2023	February	3	140	0	-122	-247	-117	-236	-304	-304	-113	-229
2023	March	15	175	0	-139	-386	-133	-369	-346	-346	-129	-358
2023	April	43	160	0	-92	-478	-88	-457	-229	-229	-85	-443
2023	May	119	160	37	36	-443	-1	-458	-3	-3	-1	-444
2023	June	168	140	37	113	-330	72	-386	188	188	70	-374
2023	July	175	140	37	121	-209	80	-306	209	209	78	-297
2023	August	199	135	37	154	-55	112	-194	291	291	109	-188
2023	Septembe	153	120	37	113	58	72	-122	188	188	70	-118
2023	October	83	125	37	24	82	-12	-134	-32	-32	-12	-130
2023	November	21	130	37	-55	27	-88	-222	-228	-228	-85	-215
2023	December	5	130	37	-74	-47	-106	-328	-276	-276	-103	-318
2024	January	1	140	37	-88	-135	-119	-447	-310	-310	-115	-433
2024	February	3	125	0	-109	-244	-104	-551	-270	-270	-101	-534
2024	March	15	125	0	-95	-338	-90	-641	-235	-235	-87	-621
2024	April	43	125	0	-61	-399	-58	-699	-151	-151	-56	-678
2024	May	119	125	0	30	-369	29	-670	75	75	28	-650
2024	June	168	125	0	89	-280	85	-585	221	221	82	-567
2024	July	175	125	0	98	-182	93	-492	242	242	90	-477
2024	August	199	125	50	177	-6	121	-372	314	314	117	-360
2024	Septembe	153	125	50	121	116	68	-304	177	177	66	-294
2024	October	83	125	50	37	153	-12	-316	-32	-32	-12	-306
2024	November	21	125	50	-37	116	-83	-399	-217	-217	-81	-387
2024	December	153	125	50	121	237	68	-331	177	177	66	-321
2025	January	19	140	101	-2	3,200	562	3,639	2,116	2,116	2,020	3,882
2025	February	15	140	0	-108	3,092	449	4,088	2,552	2,552	2,452	6,334
2025	March	31	175	0	-120	2,972	317	4,404	2,839	2,839	2,727	9,061
2025	April	97	160	0	-28	2,944	377	4,782	3,446	3,446	3,420	12,481
2025	May	220	160	0	120	3,064	639	5,420	4,452	4,452	4,563	17,044

Year	Month	Rain mm/ month	Evaporation mm/ month	Leachate	Pond 1 (Anaerobic) 1,200 m^2; 2,540 m^3		Pond 2 (aerobic) 1,145 m^2; 1,267 m^3		Pond 3 (Wetland) 2,980 m^2; 3,225 m^3		Pond 4 (Treated Water) 1,110 m^2; 2,136 m^3	
					Water Balance	Cumulative water balance	Water Balance	Cumulative water balance	Water Balance	Cumulative water balance	Water Balance	Cumulative water balance
2025	June	243	140	0	165	3,230	847	6,268	5,412	5,412	5,565	22,609
2025	July	324	140	0	263	3,493	1,204	7,472	6,858	6,858	7,101	29,711
2025	August	331	135	127	402	3,895	1,617	9,089	8,505	8,505	8,760	38,471
2025	Septembe	325	120	127	409	4,304	2,033	11,122	10,555	10,555	10,816	49,286
2025	October	188	125	127	240	4,543	2,111	13,233	12,246	12,246	12,350	61,637
2025	November	71	130	127	95	4,639	2,069	15,301	13,956	13,956	13,927	75,564
2025	December	32	130	127	48	4,687	2,071	17,373	15,910	15,910	15,837	91,400
2026	January	19	140	127	24	4,710	2,072	19,444	17,921	17,921	17,826	109,226
2026	February	15	140	0	-108	4,602	1,959	21,403	19,868	19,868	19,768	128,994
2026	March	31	175	0	-120	4,482	1,827	23,231	21,665	21,665	21,554	150,548
2026	April	97	160	0	-28	4,454	1,888	25,118	23,782	23,782	23,757	174,304
2026	May	220	160	0	120	4,574	2,149	27,267	26,299	26,299	26,410	200,714
2026	June	243	140	0	165	4,740	2,358	29,625	28,769	28,769	28,922	229,636
2026	July	324	140	0	263	5,003	2,714	32,339	31,726	31,726	31,969	261,605
2026	August	331	135	155	430	5,433	3,155	35,495	34,911	34,911	35,166	296,771
2026	Septembe	325	120	155	437	5,869	3,598	39,093	38,526	38,526	38,787	335,558
2026	October	188	125	155	267	6,137	3,705	42,798	41,811	41,811	41,915	377,474
2026	November	71	130	155	123	6,260	3,690	46,488	45,143	45,143	45,113	422,587
2026	December	32	130	155	76	6,336	3,721	50,208	48,746	48,746	48,673	471,260
2027	January	19	140	155	52	6,387	3,749	53,957	52,434	52,434	52,339	523,599
2027	February	15	140	0	-108	6,279	3,636	57,593	56,058	56,058	55,958	579,556
2027	March	31	175	0	-120	6,159	3,504	61,097	59,532	59,532	59,421	638,977

Annex 11: Environmental Compliance Audit for the Solid Waste Dumpsite