

Environmental Management Plan

June 2012

CAM: Greater Mekong Subregion Southern Economic
Corridor Towns Development Project

Neak Loeung Subproject

CURRENCY EQUIVALENTS

(as of 2 June 2012)

Currency Unit	–	riel (KR)
KR1.00	=	\$0.00024
\$1.00	=	KR4,166

ABBREVIATIONS

ADB	–	Asian Development Bank
AH	–	affected household
BOD	–	biological oxygen demand
COD	–	chemical oxygen demand
CTDP	–	corridor towns development project
DDSC	–	detailed design and supervision consultant
EA	–	environmental assessment
ECO	–	environmental control officer
EIA	–	environmental impact assessment
EMP	–	environmental management plan
EERT	–	external emergency response team
ERT	–	emergency response team
ERTL	–	emergency response team leader
ESMU	–	environment and social management unit
ESO	–	environmental site officer
GMS	–	Greater Mekong Subregion
GoC	–	Government of Cambodia
IA	–	implementing agency
IEE	–	initial environmental examination
MoE	–	Ministry of Environment
MPWT	–	Ministry of Public Works and Transport
NGOs	–	nongovernment organization
O&M	–	operation and maintenance
PIU	–	project implementation unit
PMU	–	project management unit
PDPWT	–	Provincial Department of Public Works and Transport
WWTP	–	wastewater treatment plant
USD	–	United States dollar
UXO	–	unexploded ordnance

WEIGHTS AND MEASURES

km	–	kilometer
kg	–	kilogram
ha	–	hectare
mm	–	millimeter

NOTE

In this report, "\$" refers to US dollars.

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I. INTRODUCTION

1. The environmental management plan (EMP) provided herein is one of four EMPs that have been prepared for the four subprojects of the Corridor Towns Development Project in the towns of Bavet, Battambang, Neak Loeung, and Poipet, Cambodia. The EMP for Neak Loeung updates and reformats the original EMP that was prepared for the subproject. The parent Initial Environmental Evaluation (IEE) of the Neak Loeung subproject on which the EMP is based is provided under separate cover.

A. Subproject Components

2. The Neak Loeung subproject consists of flood control dike-roads in the urban area.

II. INSTITUTIONAL ARRANGEMENTS & RESPONSIBILITIES

3. At the feasibility stage the primary management framework overseeing the implementation of the environmental management plan (EMP) will be defined by the: 1) Ministry of Public Works and Transports (MPWT) who is the executing agency (EA) of the subproject; 2) the Provincial Department of Public Works and Transport (PDPWT) who will be the implementing agency (IA) of subproject; 3) a project management unit (PMU) formed by the EA who will oversee implementation of the subproject in Neak Loeung and the other three subprojects in Cambodia; and 4) the town of Neak Loeung who will be the project implementation agency (PIU) who will assist the PMU.

4. Along with the PMU an environmental control officer (ECO) will be identified. The ECO will form part of the environmental and social management unit (ESMU) for all four subprojects in Cambodia.

5. A Detailed Design and Supervision Consultant¹ (DDSC) will assist with detailed designs of the subproject, and will update the EMP to ensure EMP meets the final subproject designs. The ADB is responsible for monitoring to ensure subproject meets the environmental safeguards of the SPS (2009).

6. The responsibilities of the EA/PMU are summarized below:

1. Overall responsibility for subproject implementation and establishment of the subproject Management Unit (PMU);
2. Sign the subproject Agreement on behalf of the National Government;
3. Approve medium term and annual rolling plans for subproject implementation;
4. Ensure compliance of Loan Covenants;
5. Ensure Government counterpart fund allocation;
6. Establish and manage first generation impress accounts;
7. Submit disbursement projections and withdrawal applications to ADB;
8. Submit audited subproject accounts and audited financial statements to ADB;
9. Approve procurement plans, bidding documents, bid evaluation and contract awards;
10. Submit regular quarterly and annual subproject reports to ADB;
11. Submit updated resettlement plans for ADB concurrence prior to implementation;
12. Ensure compliance of subproject implementation with ADB's social and environmental policies and guidelines;

¹ DDSC to be defined.

13. Approve proposed actions in the event of adverse financial audits or monitoring and evaluation reports; and
14. Select Consultant for subproject Implementation Support and Capacity Development.

The PMU will hold overall accountability of the subproject implementation and operation on behalf of the EA and work as national subproject agency.

7. The responsibilities of the IA are summarized below:

1. Coordinate and monitor subproject activities of the PIU
2. Support PIU in carrying out the approved annual rolling plans;
3. Coordinate and provide capacity development program for PIU,
4. Obtain necessary approvals from respective departments prior to awarding of civil works contracts,
5. Support PIU in the implementation of EMPs,
6. Coordinate regular reporting of PIU to EA on EMP implementation,
7. Undertake regular quality control inspection of subproject facilities,
8. Manage the handover of subproject facilities to agencies responsible for operation and maintenance.

8. As the PIU, the town of Neak Loeung will oversee and coordinate the implementation of the subproject investments including the management of the institutional strengthening plan. It will also be responsible for coordinating subproject implementation with the participating agencies and institutions at the district and corridor town levels to ensure broad participation in subproject related activities and further enhance subproject ownership.

9. Responsibilities of the PIU are summarized:

1. Undertake day to day management of subproject activities;
2. Implement approved annual rolling work and financial plans;
3. Prepare and submit regular quarterly and annual subproject reports;
4. Establish and manage second generation impress accounts;
5. Undertake procurement of civil works and equipment;
6. Supervise civil works contractors;
7. Manage separate subproject financial records and account, and prepare financial reports for submission to EA and IA;
8. Prepare withdrawal application for submission to EA;
9. Ensure that EMPs are incorporated in the detailed designs and included in civil works contracts;
10. Ensure EMP implementation; submit regular monitoring reports to IA and EA; and
11. Monitor implementation of resettlement activities by the respective corridor towns and submit monitoring reports to IA and EA

10. The PMU, PIU, ESMU and ECO with assistance from the DDSC ensure that the EMP becomes part of the construction contract, that the EMP is implemented, and that the contractor(s) abide by the EMP. The ECO should undertake regular site inspections and the results should be recorded and submitted to the relevant authorities as part of progress reporting.

III. SUMMARY OF POTENTIAL IMPACTS

11. The potential impacts of the flood control dike-roads in Neak Loeung are summarized in Table 1. The IEE indicates that potential environmental impacts of the infrastructure developments are primarily construction related and can be mitigated.

Table 1. Summary of Potential Environmental Impacts of Neak Loeung Subproject

Pre-construction Phase
1) Land acquisition and unforeseen resettlement. Addressed by RAP. 2) Land clearing.
Construction Phase
1) Civil works (e.g., dust, air pollution, noise, solid & liquid waste, erosion, sedimentation, local flooding, land & surface water pollution) with specific reference to areas to be reclaimed in urban area. 2) Potential unforeseen impact on valued aquatic habitat, fauna & flora, and cultural property & values after dike site locations finalized at detailed designs. 3) Civil disturbance (e.g., increased traffic, reduced access, disrupted business & community activity, social issues from migrant workers, worker & public accidents). 4) Excavation of treatment lagoons of WWTP exposing water table & groundwater to potential pollution from WWTP lagoons.
Operation Phase
1) Increased traffic in urban area due to new dike roads leading to increased accidents & air pollution.

A. Public Consultation

12. The stakeholder communication strategy that was developed with the IEE will be continued with the start of the pre-construction phase of the subproject. The first step will be the disclosure of the IEE to the affected stakeholders identified in the IEE for their review and comment.

1. Follow-up Consultation

13. As indicated in the IEE, the primary concern of the public of the subproject in Neak Loeung centred on the disturbances during construction of any road developments, and the effects traffic, and traffic accidents. These issues plus any others will be reviewed during follow-up consultations throughout the pre-construction, construction, and operation of the completed subproject in Neak Loeung.

IV. MITIGATION PLAN

14. The mitigation measures of the EMP are presented in a comprehensive mitigation plan for the subproject which is summarized in Table 2. The plan includes the environmental issues and concerns raised at the stakeholder meetings. The plan identifies responsible parties, location, and timing. Indicative costs are tabled separately.

15. The mitigation plan combines the construction phase activities common to all components while highlighting activities and mitigations specific to a single component.

Table 2. Environmental Impact Mitigation Plan

Subproject Activity	Potential Environmental Impacts	Proposed Mitigation Measures	Location	Timing	Activity Reporting	Responsibility	
						Supervision	Implementation
<i>Pre-Construction, Detailed Design Completion Phase</i>							
Confirmation of required resettlement and temporary relocations	No negative environmental impacts	1. Affected persons well informed well ahead of subproject implementation.	Affected persons in subproject area	Before project implemented	See resettlement plans	IA/PMU	Resettlement committees
Disclosure, & engagement of community	No community impacts	2. Initiate Information Disclosure and Grievance process of IEE	For all construction sites.	Beginning of project	Quarterly	IA/PMU	IA
GoC approvals	No negative impact	3. Notify MoE of subproject initiation to complete EIA requirements, and obtain required project permits and certificates.	Entire subproject	Before construction	As required	MoE	MoE

Subproject Activity	Potential Environmental Impacts	Proposed Mitigation Measures	Location	Timing	Activity Reporting	Responsibility	
						Supervision	Implementation
Detailed designs of subproject,	Minimize negative environmental impacts	<p>4. Work with DDSC² to complete detailed designs of the flood control dike-roads and ensure the following measures are included:</p> <p>a) no disturbance or damage to culture property and values;</p> <p>b) minimal acquisition of agriculture and forested lands;</p> <p>c) locate aggregate borrow pits and rock supply areas away from human settlements with fencing and access barriers;</p> <p>d) no or minimal disruption to water supply, utilities, and electricity with contingency plans for unavoidable disruptions;</p> <p>e) no or minimal disruption to normal pedestrian and vehicle traffic along all road segments with contingency alternate routes;</p> <p>f) For urban areas include specific plan to notify & provide merchants and residents of construction activities & schedule to minimize disruption to normal commercial and residential activities.</p>	Final siting	Before construction initiated	Once with detailed designs documents	DDSC	IA/PMU

² DDSC is detailed design and supervision consultant

Subproject Activity	Potential Environmental Impacts	Proposed Mitigation Measures	Location	Timing	Activity Reporting	Responsibility	
						Supervision	Implementation
Update EMP	Positive environmental impacts	<p>5. Document baseline water quality of flooded area to be reclaimed and baseline air quality data at dike-road sites. (See Environmental Monitoring Plan below)</p> <p>6. Review final locations of all dike-road sites to determine presence of valued ecological or cultural resources. In particular aquatic resources & uses of flooded areas to be reclaimed.</p> <p>7. Identify any new potential impacts of subproject and include in EMP.</p> <p>8. Update mitigation measures and monitoring requirements of EMP where necessary to meet detailed designs, and affected environments.</p> <p>9. Submit updated EMP with new potential impacts to ADB to review.</p> <p>10. Develop individual management subplans for: a) Drainage; b) Erosion; c) Noise and Dust; d) Contaminated Spoil Disposal; e) Solid and Liquid Waste Disposal; f) Construction & Urban Traffic; g) Utility and Power Disruption; h) Worker and Public Safety; i) Tree and Vegetation Removal and Site Restoration; j) Construction Materials Acquisition, Transport, & Storage, and cultural chance finds.</p>	All sites	Before construction initiated	Once with detailed designs documents	DDSC	IA/PMU
UXO survey, & removal	Injured worker or public	<p>11. Ensure GoC is consulted and clears areas where necessary</p>	All construction sites.	Beginning of subproject	Once	EA/GoC	GoC
Develop bid documents	No negative environmental impact	<p>12. Ensure updated EMP is included in contractor tender documents, and that tender documents specify requirements of EMP must be budgeted.</p> <p>13. Specify in bid documents that contractor must have experience with implementing EMPs, or provide staff with the experience.</p>	All subproject areas	Before construction begins	Once for all tenders	DDSC	PMU
Capacity development	No negative environmental impact	<p>14. Develop and schedule training plan for PMU (PIU/ESMU/ECO) to be able to fully implement EMP, and to manage implementation of mitigation measures by contractors.</p> <p>15. Create awareness and training plan for contractors whom will implement mitigation measures.</p>	All subproject areas	Before construction begins	Initially, refresh later if needed	DDSC	DDSC

Subproject Activity	Potential Environmental Impacts	Proposed Mitigation Measures	Location	Timing	Activity Reporting	Responsibility	
						Supervision	Implementation
Recruitment of workers	Spread of sexually transmitted disease	16. Use local workers as much as possible, reducing #s of migrant worker	All work forces.	Throughout construction phase	Worker hiring stages	PMU/PIU	Contractor's bid documents
Construction Phase of Dike-roads							
Initiate EMP & subplans,	Prevent or minimize impacts	17. Initiate updated EMP including individual management subplans for different potential impact areas that are completed in pre-construction phase (see subplan guidance below).	For all construction sites	Beginning of construction	Once	DDSC	PMU/PIU & contractors
Obtain & activate permits and licenses	Prevent or minimize impacts	18. Contractors to comply with all statutory requirements set out by GoC for use of construction equipment, and operation construction plants such as concrete batching.	For all construction sites	Beginning of construction	Once	DDSC	PMU/PIU & contractors
Worker camps	Pollution and social problems	<p>19. Locate worker camps away from human settlements.</p> <p>20. Ensure adequate housing and waste disposal facilities including pit latrines and garbage cans.</p> <p>21. A solid waste collection program must be established and implemented that maintains a clean worker camps</p> <p>22. Locate separate pit latrines for male and female workers away from worker living and eating areas.</p> <p>23. A clean-out or infill schedule for pit latrines must be established and implemented to ensure working latrines are available at all times.</p> <p>24. Worker camps must have adequate drainage.</p> <p>25. Local food should be provided to worker camps. Guns and weapons not allowed in camps.</p> <p>26. Transient workers should not be allowed to interact with the local community. HIV Aids education should be given to workers.</p> <p>27. Camp areas must be restored to original condition after construction completed.</p>	All worker camps	Throughout construction phase	Monthly	DDSC/PMU	contractor

Subpr ject Activit y	Potential Environm ental Impacts	Proposed Mitigation Measures	Locati on	Timing	Activit y Report ing	Responsibility	
						Supervi sion	Implement ation
Training & capacity	Prevent of impacts through education	28. Implement training and awareness plan for PMU (PIU/ESMU/ECO) and contractors.	PMU/PI U offices, construc tion sites	Beginnin g of construc tion	After each event	DDSC	DDSC/PIU

Subproject Activity	Potential Environmental Impacts	Proposed Mitigation Measures	Location	Timing	Activity Reporting	Responsibility	
						Supervision	Implementation
Implement Construction materials acquisition, transport, and storage subplan	Pollution, injury, increased traffic, disrupted access	<p>29. All borrow pits and quarries should be approved by GoC.</p> <p>30. Select pits and quarries in areas with low gradient and as close as possible to construction sites.</p> <p>31. Required aggregate volumes must be carefully calculated prior to extraction to prevent wastage.</p> <p>32. Pits and quarries should not be located near surface waters, forested areas, critical habitat for wildlife, or cultural property or values.</p> <p>33. If aggregate mining from fluvial environments is required small streams and rivers should be used, and dry alluvial plains preferred.</p> <p>34. All topsoil and overburden removed should be stockpiled for later restoration.</p> <p>35. All borrow pits and quarries should have a fence perimeter with signage to keep public away.</p> <p>36. After use pits and quarries should be dewatered and permanent fences installed with signage to keep public out, and restored as much as possible using original overburden and topsoil.</p> <p>37. Unstable slope conditions in/adjacent to the quarry or pit caused by the extractions should be rectified with tree planting.</p> <p>38. Define & schedule how materials are extracted from borrow pits and rock quarries, transported, and handled & stored at sites.</p> <p>39. Define and schedule how fabricated materials such as steel, wood structures, and scaffolding will transported and handled.</p> <p>40. All aggregate loads on trucks should be covered.</p> <p>41. Piles of aggregates at sites should be used/or removed promptly, or covered and placed in non traffic areas.</p>	For all construction areas.	Throughout construction phase	Monthly	DDSC/P MU	contractor

Subproject Activity	Potential Environmental Impacts	Proposed Mitigation Measures	Location	Timing	Activity Reporting	Responsibility	
						Supervision	Implementation
Asphalt production, transport, and use	Air pollution, land and water contamination, and traffic & access problems,	<p>42. Locate asphalt plant well away from all human activity and settlements, and cultural (e.g., schools, hospitals), and ecological receptors. Bitumen production and handling areas should be isolated.</p> <p>43. Contractors must be well trained and experienced with the production, handling, and application of bitumen.</p> <p>44. All spills should be cleaned immediately and handled as per hazardous waste management plan, and according to GoC regulations.</p> <p>45. Bitumen should only be spread on designated road beds, not on other land, near or in any surface waters, or near any human activities.</p> <p>46. Bitumen should not be used a fuel.</p>	For all construction areas.	Throughout construction phase	Monthly	DDSC & PMU	contractor
Implement Spoil management subplan	Contamination of land and surface waters from excavated spoil, and construction waste	<p>47. Uncontaminated spoil to be disposed of in GoC-designated sites, which must never be in or adjacent surface waters. Designated sites must be clearly marked and identified.</p> <p>48. Spoil must not be disposed of on sloped land, near cultural property or values, ecologically important areas, or on/near any other culturally or ecologically sensitive feature.</p> <p>49. Where possible spoil should be used at other construction sites, or disposed in spent quarries or borrow pits.</p> <p>50. A record of type, estimated volume, and source of disposed spoil must be recorded.</p> <p>51. Contaminated spoil disposal must follow GoC regulations including handling, transport, treatment (if necessary), and disposal.</p> <p>52. Suspected contaminated soil must be tested, and disposed of in designated sites identified as per GoC regulations.</p> <p>53. Before treatment or disposal contaminated spoil must be covered with plastic and isolated from all human activity.</p>	All excavation areas	Throughout construction phase	Monthly	DDSC & PMU & MoE	contractor

Subproject Activity	Potential Environmental Impacts	Proposed Mitigation Measures	Location	Timing	Activity Reporting	Responsibility	
						Supervision	Implementation
Implement Solid and liquid construction waste subplan	Contamination of land and surface waters from construction waste	<p>54. Management of general solid and liquid waste of construction will follow GoC regulations, and will cover, collection, handling, transport, recycling, and disposal of waste created from construction activities and worker force.</p> <p>55. Areas of disposal of solid and liquid waste to be determined by GoC.</p> <p>56. Disposed of waste should be catalogued for type, estimated weight, and source.</p> <p>57. Construction sites should have large garbage bins.</p> <p>58. A schedule of solid and liquid waste pickup and disposal must be established and followed that ensures construction sites are as clean as possible.</p> <p>59. Solid waste should be separated and recyclables sold to buyers in community.</p> <p><u>Hazardous Waste</u></p> <p>60. Collection, storage, transport, and disposal of hazardous waste such as used oils, gasoline, paint, and other toxics must follow GoC regulations.</p> <p>61. Wastes should be separated (e.g., hydrocarbons, batteries, paints, organic solvents)</p> <p>62. Wastes must be stored above ground in closed, well labeled, ventilated plastic bins in good condition well away from construction activity areas, all surface water, water supplies, and cultural and ecological sensitive receptors.</p> <p>63. All spills must be cleaned up completely with all contaminated soil removed and handled with by contaminated spoil subplan.</p>	All construction sites and worker camps	Throughout construction phase	Monthly	DDSC & PMU & MoE	contractor

Subproject Activity	Potential Environmental Impacts	Proposed Mitigation Measures	Location	Timing	Activity Reporting	Responsibility	
						Supervision	Implementation
Implement Noise and dust subplan	Dust Noise	<p>64. Regularly apply wetting agents to exposed soil and construction roads.</p> <p>65. Cover or keep moist all stockpiles of construction aggregates, and all truck loads of aggregates.</p> <p>66. Minimize time that excavations and exposed soil are left open/exposed. Backfill asap.</p> <p>67. As much as possible restrict working time between 07:00 and 17:00. In particular are activities such as pile driving.</p> <p>68. Maintain equipment in proper working order</p> <p>69. Replace unnecessarily noisy vehicles and machinery.</p> <p>70. Vehicles and machinery to be turned off when not in use.</p> <p>71. Construct temporary noise barriers around excessively noisy activity areas where possible.</p>	All construction sites.	Fulltime	Monthly	DDSC & PMU	contractor
Implement Utility and power disruption subplan	Loss or disruption of utilities and services such as water supply and electricity	<p>72. Develop carefully a plan of days and locations where outages in utilities and services will occur, or are expected.</p> <p>73. Contact local utilities and services with schedule, and identify possible contingency back-up plans for outages.</p> <p>74. Contact affected community to inform them of planned outages.</p> <p>75. Try to schedule all outages during low use time such between 24:00 and 06:00.</p>	All construction sites.	Fulltime	Monthly	DDSC & PMU & Utility company	contractor
Implement Tree and vegetation removal, and site restoration subplan	Damage or loss of trees, vegetation, and landscape	<p>76. Contact MAFF for advice on how to minimize damage to trees and vegetation.</p> <p>77. Restrict tree and vegetation removal to within RoWs.</p> <p>78. Within RoWs minimize removals, and install protective physical barriers around trees that do not need to be removed.</p> <p>79. All RoWs to be re-vegetated and landscaped after construction completed. Consult MAFF to determine the most successful restoration strategy and techniques.</p>	All construction sites.	Beginning and end of subproject	Monthly	DDSC & PMU	contractor

Subproject Activity	Potential Environmental Impacts	Proposed Mitigation Measures	Location	Timing	Activity Reporting	Responsibility	
						Supervision	Implementation
Implement Erosion control subplan	Land erosion	<p>80. Berms, and plastic sheet fencing should be placed around all excavations and earthwork areas.</p> <p>81. Earthworks should be conducted during dry periods.</p> <p>82. Maintain a stockpile of topsoil for immediate site restoration following backfilling.</p> <p>83. Protect exposed or cut slopes with planted vegetation, and have a slope stabilization protocol ready.</p> <p>84. Re-vegetate all soil exposure areas asap.</p>	All construction sites	Throughout construction phase	Monthly	DDSC & PMU	contractor

Subproject Activity	Potential Environmental Impacts	Proposed Mitigation Measures	Location	Timing	Activity Reporting	Responsibility	
						Supervision	Implementation
Implement worker and public safety subplan	Public and worker injury, and health	<p>85. Proper fencing, protective barriers, and buffer zones should be provided around all construction sites.</p> <p>86. Sufficient signage and information disclosure, and site supervisors and night guards should be placed at all sites.</p> <p>87. Worker and public safety guidelines GoC should be followed.</p> <p>88. Population near blast areas should be notified 24 hrs ahead, and evacuated well before operation. Accepted GoC blast procedures and safety measures implemented.</p> <p>89. Speed limits should be imposed on all roads used by construction vehicles.</p> <p>90. Standing water suitable for disease vector breeding should be filled in.</p> <p>91. Worker education and awareness seminars for construction hazards should be given. A construction site safety program should be developed and distributed to workers.</p> <p>92. Appropriate safety clothing and footwear should be mandatory for all construction workers.</p> <p>93. Adequate medical services must be on site or nearby all construction sites.</p> <p>94. Drinking water must be provided at all construction sites.</p> <p>95. Sufficient lighting used during necessary night work.</p> <p>96. All construction sites should be examined daily to ensure unsafe conditions are removed.</p>	All construction sites.	Fulltime	Monthly	DDSC & PMU	contractor

Subproject Activity	Potential Environmental Impacts	Proposed Mitigation Measures	Location	Timing	Activity Reporting	Responsibility	
						Supervision	Implementation
Civil works	Degradation of water quality & aquatic resources	<p>97. Protective coffer dams, berms, plastic sheet fencing, or silt curtains should be placed between all earthworks and surface waters.</p> <p>98. Erosion channels must be built around aggregate stockpile areas to contain rain-induced erosion.</p> <p>99. Earthworks should be conducted during dry periods.</p> <p>100. All construction fluids such as oils, and fuels should be stored and handled well away from surface waters.</p> <p>101. No waste of any kind is to be thrown in surface waters.</p> <p>102. No washing or repair of machinery near surface waters.</p> <p>103. Pit latrines to be located well away from surface waters.</p> <p>104. No unnecessary earthworks in or adjacent to water courses.</p> <p>105. No aggregate mining from rivers or lakes.</p> <p>106. All irrigation canals and channels to be protected the same way as rivers, streams, and lakes</p>	All construction sites	Throughout construction phase	Monthly	DDSC & PMU	contractor
Civil works	Degradation of terrestrial resources	<p>107. All construction sites should be located away forested or all plantation areas as much as possible.</p> <p>108. No unnecessary cutting of trees.</p> <p>109. All construction fluids such as oils, and fuels should be stored and handled well away from forested and plantation areas.</p> <p>110. No waste of any kind is to be discarded on land or in forests/plantations.</p>	All construction sites	Throughout construction phase	Monthly	DDSC & PMU	contractor

Subproject Activity	Potential Environmental Impacts	Proposed Mitigation Measures	Location	Timing	Activity Reporting	Responsibility	
						Supervision	Implementation
Implement Construction and urban traffic subplan	Traffic disruption, accidents, public injury	<p>111. Schedule construction vehicle activity during light traffic periods. Create adequate traffic detours, and sufficient signage & warning lights.</p> <p>112. Post speed limits, and create dedicated construction vehicle roads or lanes.</p> <p>113. Inform community of location of construction traffic areas, and provide them with directions on how to best co-exist with construction vehicles on their roads.</p> <p>114. Increase the number of pedestrian crossings away from construction areas.</p> <p>115. Increase road and walkway lighting.</p>	All construction sites	Fulltime	Monthly	DDSC & PMU	contractor
Implement Construction Drainage subplan	Loss of drainage & flood storage	<p>116. Provide adequate short-term drainage away from construction sites to prevent ponding and flooding.</p> <p>117. Manage to not allow borrow pits and quarries to fill with water. Pump periodically to land infiltration or nearby water courses.</p> <p>118. Install temporary storm drains or ditches for construction sites</p> <p>119. Ensure connections among surface waters (ponds, streams) are maintained or enhanced to sustain existing stormwater storage capacity.</p> <p>120. Protect surface waters from silt and eroded soil.</p>	All areas with surface waters	Design & construction phases	Monthly	DDSC & PMU	contractor
Civil works	Damage to cultural property or values, and chance finds	<p>121. As per detailed designs all civil works should be located away from all cultural property and values.</p> <p>122. Chance finds of valued relics and cultural values should be anticipated by contractors. Site supervisors should be on the watch for finds.</p> <p>123. Upon a chance find all work stops immediately, find left untouched, and PMU notified. If find deemed valuable, provincial cultural authorities must be notified.</p> <p>124. Work at find site will remain stopped until authorities allow work to continue.</p>	All construction sites	At the start, and throughout construction phase	Monthly	DDSC & PMU	contractor
<i>Post-construction Operation of Dike-roads</i>							

Subproject Activity	Potential Environmental Impacts	Proposed Mitigation Measures	Location	Timing	Activity Reporting	Responsibility	
						Supervision	Implementation
Operation of new & upgraded roads	Increased risk of accident or injury.	125. Enforce well marked speed limits, provide guard rails along road, and educate public on new road safety.	Upgraded / new roads to MRF, & WWTP	Fulltime	Biannual	PDPWT	
Operation of new & upgraded roads	Increased air pollution & noise	126. Enforce speed limits, ensure vehicles maintained in proper working condition	Upgraded / new roads to MRF, & WWTP	Periodic checks	Biannual	PDPWT	

V. MONITORING PLAN

16. The environmental monitoring plan for the EMP is provided in Table 3. The monitoring plan focuses on all three phases (pre-construction, construction, post-construction operation) of the dike-road flood control structures and consists of environmental indicators, the sampling locations & frequency, method of data collection, and responsible parties. Estimated costs are tabled separately.

The purpose of the monitoring plan is to determine the effectiveness of the impact mitigations, and to document any unexpected positive or negative environmental impacts of the subproject.

17. The regulatory framework including standards for environmental quality is not well developed in Cambodia. The key available environmental standards are for allowable industrial effluent discharges, and ambient water quality for biodiversity conservation and human health which are found in Annexes 2, 4 & 5 of the GoC Subdecree on Water Pollution Control (1999). There are no standards for groundwater quality. The standards are reproduced in Appendix A. The environmental standards provided by the Environmental, Health and Safety Guidelines of the World Bank (2007) (e.g., ambient air quality & noise) should be followed to supplement standards not provided by the GoC.

18. An independent environmental monitoring consultant (EMC) will be required to implement the environmental monitoring program. The PMU/PIU will provide logistical support to the EMC where necessary for the implementation of environmental monitoring plan.

19. After the construction phase is completed and the effects of the operation of the dike roads on traffic patterns, frequency of accidents, and overall urban development should be monitored by the EA.

20. Monitoring the success of the resettlement the few households that have to be moved, and the temporary relocation of secondary structures will be undertaken as part of the separate RAP prepared for the subproject.

A. Performance Monitoring

21. Performance monitoring is required to assess the overall performance of the EMP. A performance monitoring system is normally developed by the EA for the entire subproject. Select indicators of major components of the environment that will be affected primarily by the construction phase are drawn from the mitigation and monitoring plans and summarized in Table 4.

VI. REPORTING

22. Regular reporting on the implementation of mitigation measures, and on monitoring activities during construction phase of the subproject is required. Reporting is the responsibility of PMU and should be conducted in conjunction with the regular meetings with stakeholders as part of the stakeholder communication strategy. The mitigation and monitoring plans (Tables 2 and 3) summarize proposed timing of reporting. Environmental monitoring reports will be prepared quarterly for the EA by the PMU/PIUs and sent to the MoE and ADB. The reports will table all indicators measured with the monitoring plan of EMP including performance monitoring indicators (Table 4), and will include relevant GoC environmental quality standards and criteria.

Table 3. Environmental Monitoring Plan

ENVIRONMENTAL EFFECTS MONITORING						
Environmental Indicators	Location	Means of Monitoring	Frequency	Reporting	Responsibility	
					Supervision	Implementation
<i>Pre-construction Phase – Update Baseline Conditions</i>						
Update baseline on sensitive receptors (e.g., cultural property & values, new schools or hospitals, rare/endangered species, critical habitat), and aquatic resources and human uses of affected urban area to be reclaimed.	Near dike-road sites	Original field work, community consultations	Once	Once	EA/PMU	Environmental Monitoring Consultant
A) Air quality: dust, CO, NOx, SOx, noise, wind, temperature, and vibration levels B) Surface water quality: TSS, heavy metals (As, Cd, Pb,) oil and grease,	A): At construction sites B): At dike-road sites, inside & outside dikes	Using field and analytical methods approved by MoE.	(A & B): One day and one night measurement during rainy & dry	One baseline supplement report before construction phase	PMU	Environmental Monitoring Consultant

ENVIRONMENTAL EFFECTS MONITORING						
Environmental Indicators	Location	Means of Monitoring	Frequency	Reporting	Responsibility	
					Supervision	Implementation
total & faecal coliform, pH, DO, COD, BOD ₅ , temperature, TDS, NH ₃ , NH ₄ , other nutrient forms of N & P, sulphides, surfactants.			seasons	starts		
Inventory of present and past land uses that could cause contaminated soil.	Possible contaminated lands at all excavation sites	Using field and analytical methods approved by MoE.	Once	Once	PMU	Environmental Monitoring Consultant
Construction of Dike-roads						
Analysis of soil quality (heavy metals (As, Cd, Pb, oil & grease, hydrocarbons).	Possible contaminated lands at excavation sites	Using field and analytical methods approved by MoE.	D): Once if needed	Once	PMU	Environmental Monitoring Consultant
A) Air quality: dust, CO, NO _x , SO _x , noise, wind, temperature, and vibration levels B) Surface water quality: TSS, heavy metals (As, Cd, Pb,) oil and grease, total & faecal coliform, pH, DO, COD, BOD ₅ , temperature, NH ₃ , and other nutrient forms of N & P. C) Analysis of soil quality (heavy metals (As, Cd, Pb, Hg, Mn), hydrocarbons. D) Domestic (worker) and construction solid waste inside & outside construction sites including worker camps. E) Public comments and complaints	A & B): Baseline sites of pre-construction phase. C) At sites where contaminated soil is suspected. D) All construction sites and worker camps E) Using hotline number placed at construction areas F) At all construction areas	A – C : Using field and analytical methods approved by MoE. Include visual observations of dust and noise from contractor & public reports . D) Visual observation E) Information transferred by telephone hotline number posted at all construction sites. F) regular reporting by contractors/PMU	(A – B): Quarterly during construction periods Daily visual records C) Once at start of excavations D) Monthly E) Continuous public input F)	Monthly	(A - D): PMU E & F) & daily observations: EA/PMU	Environmental Monitoring Consultant contractor

ENVIRONMENTAL EFFECTS MONITORING						
Environmental Indicators	Location	Means of Monitoring	Frequency	Reporting	Responsibility	
					Supervision	Implementation
F) Incidence of worker or public accident or injury			Continuous			
Operation of Dike-roads						
Air quality: dust, CO, NOx, SOx, noise and vibration levels	Baseline sites of pre-construction phase.	Using field and analytical methods approved by MoE.	Quarterly for 5 years	Biannual	PDPWT	
Traffic accidents	Along dike-roads roads & urban area fed by roads.	Regular record keeping.	Continuously	For each event	PDPWT	
Incidence of flooding	Area reclaimed, & outside dikes	Surveys, public complaints	Seasonal for 5 years	Seasonal	PDPWT	

Table 4. Performance Monitoring Indicators

Major Environmental Component	Key Indicator	Performance Objective	Data Source
Pre-construction Phase			
Public Consultation & Disclosure	Affected public & stakeholders	Meeting with stakeholders contacted during IEE & new stakeholders convened for follow-up consultation & to introduce grievance mechanism	Minutes of meeting, and participants list
EMP	Updated EMP	All stakeholders contacted during IEE re-contacted for follow-up consultation	EMP
Bid Documents	Requirements of EMP (CEMP ³)	EMP appended to bidding documents with clear instructions to bidders for CEMP	Bid documents
Training of PMU/PIU/ECO	Training course(s) & schedule	By end of P-C phase, required course(s) that will be delivered are designed and scheduled	Course(s) outline, participants, and schedule
Construction of Dike-roads			
All subproject areas	Critical habitat, rare or endangered species if present	All critical habitat and R & E species unchanged, and unharmed	Monitoring by EMC ⁴
Water quality outside dikes	TSS, DO, BOD, COD, pH, oil & grease, nutrient forms of T & N, metals (Pb, Fe, As)	GoC environmental standards & criteria	Monitoring by EMC
Air quality	SOx, NOx, dust, , CO, noise, vibration	Levels never exceed pre-construction baseline levels	EMC & contractor monitoring reports,
Soil quality	Solid & liquid waste	Rigorous program of procedures & rules to collect and store all waste from construction camps and sites practiced.	Contractor and EMC monitoring reports
Hazardous materials & waste	Oil, gasoline, grease, alum, chlorine, soda	Rigorous program of procedures to manage and store all waste from construction camps and sites practiced.	Contractor and EMC monitoring reports
Public & worker safety	Frequency of injuries	Adherence to GoC policy and site-specific procedures to	Contractor reports

³ Contractor Environmental Management Plan developed from EMP in contractor bidding document

⁴ Environmental Monitoring Consultant hired to implement Environmental Monitoring Plan

Major Environmental Component	Key Indicator	Performance Objective	Data Source
		prevent accidents	
Cultural property	Incidence of damage, or complaints	No valued cultural property, or unearthed valuable relic is harmed in any way	Public input, contractor reports, public input, EMC reports
Traffic	Frequency of disruptions & blocked roadways	Disruptions, stoppages, or detours are managed to absolute minimum.	Public input, contractor reports, EMC reports
<i>Operation Phase of Dike-roads</i>			
Flooding	Incidence of flooded inner urban area	Subproject design specification	PDPWT
Traffic safety	Frequency of accidents	No increase in pre-construction frequency	PDPWT

VII. ESTIMATED COST OF EMP

23. The marginal costs for implementing the EMP are primarily for environmental monitoring because the costs for implementing impact mitigation measures are included with the construction costs in contractor bid documents.

24. The preliminary cost for the implementation of the EMP for the flood control dike-roads in Neak Loeng is USD\$113,025 (Table 5).

25. An estimated budget of USD\$11,000., is required for capacity building for environmental management. The costs will need to be updated by the DDSC in conjunction with the PMU during the pre-construction phase.

Table 5. Preliminary Cost Estimation of EMP for Flood Control Dikes

Activity	Indicative Cost (USD)			
	Integrated in to Construction and O&M Contract	Integrated in to Detailed Design Contract	Integrated in to PMU/PIU Budget	Training, Technical Assistance & Services Budget
Environmental Mitigation				
A. Pre-Construction Phase				
A.1 Engineering mitigation measures		Design cost		
A.2 Preparation of GoC IEE		Design cost	ESMU cost	17500
A.3 EA application		Design cost	ESMU cost	1500
A.4 Community awareness campaign			ESMU cost	7000
A.5 Resettlement, compensation activities			ESMU cost	6000
B. Construction Phase				
B.1 Implementation of construction engineering best practice as mitigation	Subproject cost			
C. Operation Phase				
C.1 Implementation of mitigation measures in design	Subproject cost			
C.2 Implementation of operational practices as mitigation measures	Subproject cost			
Environmental Effects Monitoring				
A. Pre-Construction Phase				
A.1 Establishment of baseline environmental data			ESMU cost	5800
B. Construction Phase				
B.1 Monitoring of air, noise, vibration, water			ESMU cost	9750
B.2 Monitoring of community & workers' health and safety			ESMU cost	9000
C. Operation Phase				
C.1 Monitoring of air, noise, water (2 years)			ESMU cost	7200
C.2 Monitoring of community health and safety (2 years)			ESMU cost	10000
Sub-Total (USD)				
D. Performance Monitoring				
D.1 ESMU Audits				4000
D.2 Project Audits			ESMU Cost	20000
Miscellaneous & Contingency				
Seminars/Workshops				5000
Transport (use of vehicle)			ESMU Cost	
Equipment & Supplies	Subproject cost		ESMU Cost	
Sub-Total (USD)				102750
Contingency at 10%				10275
Total (USD)				113,025

VIII. EMERGENCY RESPONSE PLAN

26. The Contractor must develop emergency or incident response procedures during construction. In the operational phase the operator/civil authorities will have responsibility for any emergencies or serious incidents. The construction phase should ensure:

- i) Emergency Response Team (ERT) of the Contractor as initial responder;
- ii) the District and City fire and police departments, emergency medical service, the Department of Public Health (DPH), collectively referred to as the External Emergency Response Team (EERT), as ultimate responders.

27. The Contractor will provide and sustain the required technical, human and financial resources for quick response during construction.

Table 6. Roles and Responsibilities in Emergency Incident Response

Entity	Responsibilities
Contractor Team (ERT)	<ul style="list-style-type: none"> - Communicates / alerts the EERT. - Prepares the emergency site to facilitate the response action of the EERT, e.g., vacating, clearing, restricting site. - When necessary & requested by the EERT, lends support / provides assistance during EERT's response operations.
External Emergency Response Team (EERT)	<ul style="list-style-type: none"> - Solves the emergency/incident
Contractor Resources	<ul style="list-style-type: none"> - Provide and sustain the people, equipment, tools & funds necessary to ensure Subproject's quick response to emergency situations. - Maintain good communication lines with the EERT to ensure prompt help response & adequate protection, by keeping them informed of Subproject progress.

28. The ERT will be led by the senior Contractor engineer (designated ERTL) on site with a suitably trained foreman or junior engineer as deputy. Trained first-aiders and security crew will be the core members of the ERT.

29. The Contractor will ensure that ERT members are physically, technically and psychologically fit for their emergency response roles and responsibilities.

30. Prior to the mobilization of civil works, the Contractor, through its Construction Manager, ERTL, in coordination with the PMU/PCU, will meet with the ultimate response institutions to discuss the overall construction process, including, but not limited to:

- i) Subproject sites;
- ii) construction time frame and phasing;
- iii) any special construction techniques and equipment that will be used; i
- iv) any hazardous materials that will be brought to and stored in the construction premise and details on their applications and handling/management system;
- v) the Contractor's Emergency Management Plan
- vi) names and contact details of the ERT members

31. The objective of this meeting is to provide the ultimate response institutions the context for:

- i) their comments on the adequacy of the respective Emergency Management Plans
- ii) their own assessment of what types, likely magnitude and likely incidence rate of potential hazards are anticipated
- iii) the arrangements for coordination and collaboration.

32. To ensure effective emergency response, prior to mobilization of civil works, the Contractor will:

- i) set up the ERT;
- ii) set up all support equipment and facilities in working condition
- iii) made arrangements with the EERT;
- iv) conducted proper training of ERT members, and encouraged and trained volunteers from the work force; v) conducted orientation to all construction workers on the emergency response procedures and facilities, particularly evacuation procedures, evacuation routes, evacuation assembly points, and self-first response, among others; and vi) conducted drills for different possible situations.

33. To sustain effective emergency response throughout Subproject implementation an adequate budget shall be provided to sustain the capabilities and efficiency of the emergency response mechanism, the emergency response equipment, tools, facilities and supplies. Drills and reminders will take place regularly, the former at least every two months and the latter at least every month.

A. Alert Procedures

34. Means of communicating, reporting and alerting an emergency situation may be any combination of the following: i) audible alarm (siren, bell or gong); ii) visual alarm (blinking/rotating red light or orange safety flag); iii) telephone (landline); iv) mobile phone; v) two-way radio; and vi) public address system/loud speakers. Some rules relative to communicating/alerting will be:

- (i) Whoever detects an emergency situation first shall immediately :
 - call the attention of other people in the emergency site,
 - sound the nearest alarm, and/or
 - report/communicate the emergency situation to the ERT.

- (ii) Only the ERTL and, if ERTL is not available, the Deputy ERTL are authorized to communicate with the EERT. Exceptional cases to this rule may be necessary and should be defined in the Emergency Management Plans.
- (iii) When communicating/alerting an emergency to the EERT, it is important to provide them with at least: i) the type of emergency situation; ii) correct location of the emergency; iii) estimated magnitude of the situation; iv) estimated persons harmed; v) time it happened; vi) in case of a spill, which hazardous substance spilled; and vi) in case of fire and explosion, what caused it. Such details would allow the EERT to prepare for the appropriate response actions.

For an effective reporting/alerting of an emergency situation:

- (i) The names and contact details of the relevant persons and institutions should be readily available in, or near to, all forms of communication equipment, and strategically posted (at legible size) in all Subproject sites and vehicles:
 - Most relevant construction/operations staffs namely, the ERTL, Deputy ERTL, first-aiders, supervising engineers, foremen
 - EERT institutions/organizations
 - Concerned village authorities
 - PMU Office, ESMU
- (ii) All Subproject sites should have good access to any combination of audible and visual alarms, landline phones, mobile phones and two-way radio communication at all times.
- (iii) Contractor's construction vehicles should also be equipped with the appropriate communication facilities.

B. Emergency Response Situations

The following tables suggest general procedures that will be refined in the final EMP during detailed design, and described in more detail in the Emergency Management Plans of the Contractor.

Table 7. Evacuation Procedure

Procedure	Remarks
<ul style="list-style-type: none"> ▪ Move out as quickly as possible as a group, but avoid panic. 	<ul style="list-style-type: none"> ▪ All workers/staff, sub-contractors, site visitors to move out, guided by the ERT.
<ul style="list-style-type: none"> ▪ Evacuate through the directed evacuation route. 	<ul style="list-style-type: none"> ▪ The safe evacuation shall have been determined fast by the ERTL/Deputy ERTL & immediately communicated to ERT members.
<ul style="list-style-type: none"> ▪ Keep moving until everyone is safely away from the emergency site and its influence area. 	<ul style="list-style-type: none"> ▪ A restricted area must be established outside the emergency site, all to stay beyond the restricted area.
<ul style="list-style-type: none"> ▪ Once outside, conduct head counts. 	<ul style="list-style-type: none"> ▪ Foremen to do head counts of their sub-groups; ERTL/Deputy ERTL of the ERT.
<ul style="list-style-type: none"> ▪ Report missing persons to EERT 	<ul style="list-style-type: none"> ▪ ERTL/Deputy ERTL to communicate

Procedure	Remarks
immediately.	with the EERT.
<ul style="list-style-type: none"> ▪ Assist the injured in evacuation & hand them over to the ERT first-aiders or EERT medical group 	<ul style="list-style-type: none"> ▪ ERT to manage injured persons to ensure proper handling.
<ul style="list-style-type: none"> ▪ If injury warrants special care, DO NOT MOVE them, unless necessary & instructed/directed by the EERT. 	<ul style="list-style-type: none"> ▪ ERTL/Deputy ERTL communicates with EERT to get instructions/directions in handling the injured.

Table 8. Response Procedure During Medical Emergency

Procedure	Remarks
<ul style="list-style-type: none"> ▪ Administer First Aid regardless of severity immediately. 	<ul style="list-style-type: none"> ▪ Fundamentals when giving First Aid: <ul style="list-style-type: none"> - Safety first of both the rescuer and the victim. - Do not move an injured person unless: <ul style="list-style-type: none"> - victim is exposed to more danger when left where they are, e.g., during fire, chemical spill - it would be impossible for EERT to aid victims in their locations, e.g., under a collapsed structure - instructed or directed by the EERT. ▪ First AID to be conducted only by a person who has been properly trained in giving First Aid.
<ul style="list-style-type: none"> ▪ Call the EERT emergency medical services &/or nearest hospital. 	<ul style="list-style-type: none"> ▪ ERTL/Deputy ERTL or authorized on-site emergency communicator
<ul style="list-style-type: none"> ▪ Facilitate leading the EERT to the emergency site. 	<ul style="list-style-type: none"> ▪ ERTL/Deputy ERTL to instruct: <ul style="list-style-type: none"> - an ERT member on-site to meet EERT in access road/strategic location. He/she shall hold orange safety flag to get their attention & lead them to site. - Other ERT members to clear access road for smooth passage of the EERT.
<ul style="list-style-type: none"> ▪ If applicable, vacate site & influence area at once, restrict site, suspend work until further notice. 	<ul style="list-style-type: none"> ▪ Follow evacuation procedure.

Table 9. Response Procedure in Case of Fire

Procedure	Remarks
<ul style="list-style-type: none"> ▪ Alert a fire situation. 	<ul style="list-style-type: none"> ▪ Whoever detects the fire shall immediately: <ul style="list-style-type: none"> - call the attention of other people in the site, - sound the nearest alarm, and/or - Foreman or any ERT member among the construction sub-group contacts the

Procedure	Remarks
	fire department (in this case it should be agreed on that it is alright for any ERT member in the sub-group to alert the fire department) - report/communicate the emergency situation to the ERTL/Deputy ERTL.
<ul style="list-style-type: none"> ▪ Stop all activities/operations and evacuate. 	<ul style="list-style-type: none"> ▪ All (non-ERT) workers/staff sub-contractors, site visitors and concerned public to move out to safe grounds following the evacuation procedure.
<ul style="list-style-type: none"> ▪ Activate ERT to contain fire/control fire from spreading. 	<ul style="list-style-type: none"> ▪ Guided by the training they undertook, ERT members assigned to mitigate the fire shall assess their own safety situation first before attempting to control fire spread.
<ul style="list-style-type: none"> ▪ Call the nearest fire & police stations &, if applicable, emergency medical services. 	<ul style="list-style-type: none"> ▪ When alerting the EERT, ERTL will give the location, cause of fire, estimated fire alarm rating, any injuries.
<ul style="list-style-type: none"> ▪ Facilitate leading the EERT to the emergency site. 	<ul style="list-style-type: none"> ▪ ERTL/Deputy ERTL to instruct: <ul style="list-style-type: none"> - an ERT member to meet the EERT in the access road or strategic location and lead them to the site. He/she shall hold the orange safety flag to get their attention and lead them to the site. - some ERT members to stop traffic in, & clear, the access road to facilitate passage of the EERT.
<ul style="list-style-type: none"> ▪ ERT to vacate the site as soon as their safety is assessed as in danger. 	<ul style="list-style-type: none"> ▪ Follow appropriate evacuation procedure.

IX. INSTITUTIONAL CAPACITY REVIEW AND NEEDS

35. Currently there is little capacity for environmental assessment and management amongst subproject staff (e.g., PMU/PIU) in Neak Loeung. The DDSC with assistance from the designated ESMU and ECO of the subproject will develop and deliver training courses to the PIU/PMU staff. The purpose of the courses is to strengthen the ability of the PIU/PMU to oversee implementation of the EMP by construction contractors, and EMC

36. The ECO who may be the only full-time environmental member of the ESMU should attend training courses as required. Costs for training should be included with costs for implementation of the EMP. Training also must include the operation and maintenance of the new dike-roads.

37. Training on the implementation of an EMP should focus on two thematic areas. The first area should be principles environmental management focused on the potential impacts of infrastructure development on the natural and social environment. The second area should be environmental safeguard requirements of the ADB and GoC with specific focus on the EMP.

X. APPENDIX A: ENVIRONMENTAL STANDARDS FOR CAMBODIA

Annex 2
Effluent standard for pollution sources
discharging wastewater to public water areas or sewer

N ^o	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	BOD ₅ (5 days at 200 C)	mg/l	< 30	< 80
4	COD	mg/l	< 50	< 100
5	Total Suspended Solids	mg/l	< 50	< 80
6	Total Dissolved Solids	mg/l	< 1000	< 2000
7	Grease and Oil	mg/l	< 5.0	< 15
8	Detergents	mg/l	< 5.0	< 15
9	Phenols	mg/l	< 0.1	< 1.2
10	Nitrate (NO ₃)	mg/l	< 10	< 20
11	Chlorine (free)	mg/l	< 1.0	< 2.0
12	Chloride (ion)	mg/l	< 500	< 700
13	Sulphate (as SO ₄)	mg/l	< 300	< 500
14	Sulphide (as Sulphur)	mg/l	< 0.2	< 1.0
15	Phosphate (PO ₄)	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 (NH ₃)	mg/l	< 5.0	< 7.0
35	DO	mg/l	>2.0	>1.0
36	Polychlorinated Byphenyl	mg/l	<0.003	<0.003
37	Calcium	mg/l	<150	<200
38	Magnesium	mg/l	<150	<200
39	Carbon tetrachloride	mg/l	<3	<3
40	Hexachloro benzene	mg/l	<2	<2
41	DTT	mg/l	<1.3	<1.3
42	Endrin	mg/l	<0.01	<0.01
43	Dieldrin	mg/l	<0.01	<0.01
44	Aldrin	mg/l	<0.01	<0.01
45	Isodrin	mg/l	<0.01	<0.01
46	Perchloro ethylene	mg/l	<2.5	<2.5
47	Hexachloro butadiene	mg/l	<3	<3
48	Chloroform	mg/l	<1	<1
49	1,2 Dichloro ethylene	mg/l	<2.5	<2.5
50	Trichloro ethylene	mg/l	<1	<1
51	Trichloro benzene	mg/l	<2	<2
52	Hexaxhloro cyclohexene	mg/l	<2	<2

Remark: The Ministry of Environment and the Ministry of Agriculture, Forestry and Fishery shall collaborate to set up the standard of pesticides which discharged from pollution sources.

Annex 4
Water Quality Standard in public water areas
for bio-diversity conservation

1- River

No	Parameter	Unit	Standard Val
1	pH	mg/l	6.5 – 8.5
2	BOD ₅	mg/l	1 – 10
3	Suspended Solid	mg/l	25 – 100
4	Dissolved Oxygen	mg/l	2.0 - 7.5
5	Coliform	MPN/100ml	< 5000

2- Lakes and Reservoirs

No	Parameter	Unit	Standard Value
1	pH	mg/l	6.5 – 8.5
2	COD	mg/l	1 – 8
3	Suspended Solid	mg/l	1 – 15
4	Dissolved Oxygen	mg/l	2.0 - 7.5
5	Coliform	MPN/100ml	< 1000
6	Total Nitrogen	mg/l	1.0 – 0.6
7	Total Phosphorus	mg/l	0.005 – 0.05

3- Coastal water

No	Parameter	Unit	Standard Value
1	pH	mg/l	7.0 – 8.3
2	COD	mg/l	2 – 8
4	Dissolved Oxygen	mg/l	2 - 7.5
5	Coliform	MPN/100ml	< 1000
5	Oil content	mg/l	0
6	Total Nitrogen	mg/l	1– 1.0
7	Total Phosphorus	mg/l	0.02 – 0.09

Annex 5

Water Quality Standard in public water areas
for public health protection

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	Dieldrin	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