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## PART III

### ENVIRONMENTAL AND SOCIAL ASSESSMENT REPORT

#### PROPOSED INTERVENTIONS IN THE COASTAL AREAS OF THE MONROVIA METROPOLITAN AREA (MMA) IN LIBERIA

GOVERNMENT OF LIBERIA – ENVIRONMENTAL PROTECTION AGENCY

UNITED NATIONS DEVELOPMENT PROGRAMME (UNDP)

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## ABBREVIATIONS AND ACRONYMS

%	Percent
°C	Degree Celsius
µg	Microgram
ACHPR	African Charter on Human and Peoples' Rights
ACRWC	African Charter on the Rights and Welfare of the Child
AFL	Armed Forces of Liberia
AIDS	Acquired Immunodeficiency Syndrome
AMA	American Medical Association
AME	African Methodist Episcopal Church
AU	African Union
BNF	Bureau of National Fisheries
BOD	Biological Oxygen Demand
BPPS	Bureau for Policy and Programme Support
BTC	Barclay Training Center
CAT	Convention against Torture and Other Cruel, Inhuman or Degrading Treatment or Punishment
CBD	Convention on Biological Diversity
CBO	Community Based Organisation
CEDAW	Convention on the Elimination of all forms of Discrimination Against Women
CH <sub>4</sub>	Methane
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CMA	Collective Management Associations
CMS	Convention on the Conservation of Migratory Species
CO	Carbon Monoxide
CO <sub>2</sub>	Carbon Dioxide
COD	Chemical Oxygen Demand
CO <sub>x</sub>	Carbon Oxides
CRC	Convention on the Rights of the Child
CRPD	Convention on the Rights of Persons with Disabilities
d	Day(s)
dB (A)	A-weighted Decibel
dB (C)	C-weighted Decibel
DO	Dissolved Oxygen
e.g.	For example
ECMWF	European Centre for Medium-Range Weather Forecasts
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
EIS	Environmental Impact Statement
EJF	Environmental Justice Foundation
EPA	Environmental Protection Agency
EPH	Extractable Petroleum Hydrocarbon
EPML	Environment Protection and Management Law
ERM	Environmental Resource Management

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ESAR	Environmental and Social Assessment Report
ESIA	Environmental and Social Impact Assessment
ESMMM	Environmental and Social Management and Mitigation Matrix
ESMP	Environmental and Social Management Plan
ESS	Environmental and Social Safeguards
FAO	Food and Agriculture Organisation
FDA	Forestry Development Authority
FGM	Female Genital Mutilation
FPIC	Free Prior Informed Consent
GCF	Green Climate Fund
GHG	Greenhouse Gas
GoL	Government of Liberia
GRM	Grievance Redress Mechanism
GRO	Gasoline Range Organics
h	Hour (s)
ha	Hectares
HC	Hydrocarbons
HIES	Household Income and Expenditure Survey
HIV	Human Immunodeficiency Virus
HP	Horsepower
ICCPR	International Covenant on Civil and Political Rights
ICESCR	The International Covenant on Economic, Social and Cultural Rights
ICZM	Integrated Coastal Zone Management
IDP	Internally Displaced Person
ILO	International Labour Organization
IMO	International Maritime Organization
IPCC	International Panel on Climate Change
IRRF	Integrated Results and Resources Framework
ITTA	International Tropical Timber Agreement
IUCN	International Union for Conservation of Nature
IUU	Illegal, Unreported and Unregulated
km	Kilometre
km <sup>2</sup>	Square kilometre
KW	Kilowatt
L	Litre
LAT	Lowest Astronomical Tide
LCG	Liberian Coast Guard
LCG	Liberian Coast Guard
LEC	Liberia Electricity Corporation
Leq	Equivalent Continuous Sound Level
LFS	Liberia Labour Force
LGS	Liberian Hydrological Services
LHS	Liberian Hydrological Services
LISGIS	Liberia Institute of Statistics and Geo-Information Services
LMA	Liberia Maritime Authority
Lmax	Maximum Sound Level

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LRD	Liberian Dollar
LWSC	Liberia Water and Sewer Corporation
m	Metre
m <sup>2</sup>	Square Metre
m <sup>3</sup>	Cubic metre
ma	Mega annum
MARPOL	International Convention for the Prevention of Pollution from Ships
MCC	Monrovia City Corporation
mg	Milligram
MGCSP	Ministry of Gender, Children and Social Protection
MLME	Ministry of Lands, Mines and Energy
mm	Millimetre
MMA	Monrovia Metropolitan Area
MOA	Ministry of Agriculture
MOHSW	Ministry of Health and Social Welfare
MPEA	Ministry of Planning and Economic Affairs
MPN	Most Probable Number
MPW	Ministry of Public Works
MSL	Mean Sea Level
n	Count
N.A.	Not Applicable
n.d.	Non Detectable
NAFAA	National Fisheries and Aquaculture Authority
NBSAP	National Biodiversity Strategy and Action Plan
NGO	Non-Governmental Organization
NIP	National Implementing Partner
NM	Nautical Mile
NOAA	National Oceanic and Atmospheric Administration
NO <sub>x</sub>	Nitrogen Oxides
NTU	Nephelometric Turbidity Unit
OAI	Office of Audit and Investigation
OPRC	International Convention on Oil Pollution Preparedness, Response and Co-operation
OSRP	Oil Spill Response Plan
PAH	Polycyclic aromatic hydrocarbon
PCC	Paynesville City Corporation
PHP	Public Health Pond
PITST	Project Implementation Support Team
PM	Particulate Matter
PMU	Project Management Unit
ppb	Parts per billion
ppm	Parts per Million
PTSD	Post-traumatic Stress Disorder
PUC	People United Community
RAP	Resettlement Action Plan
RPM	Respirable Particulate Matter (<10 µm)

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RSLR	Relative Sea Level Rise
s	Second
SAMFU	Save My Future Foundation
SCNL	Society of Conservation of Nature in Liberia
SDI	Social Development Initiatives
SEP	Stakeholder Engagement Plan
SES	Social and Environmental Standards
SESP	Environmental Screening Procedure
SGBV	Sexual and Gender Based Violence
SGBVU	Sexual and Gender Based Violence Unit
SHC	Saturated hydrocarbons
SO <sub>2</sub>	Sulphur Dioxide
SOLAS	International Convention for the Safety of Life at Sea
SO <sub>x</sub>	Sulphur Oxides
SPM	Suspended Particulate Matter
SRM	Stakeholder Response Mechanism
SRM	Stakeholder Response Mechanism
STW	Sea Turtle Watch
t	Ton
TDS	Total Dissolved Solids
TED	Turtle Excluder Device
TOC	Total organic carbon
TPH	Total Petroleum Hydrocarbon
TSS	Total Suspended Solids
UN	United Nations
UNCCD	<b>UN Convention to Combat Desertification</b>
UNCLOS	United Nations Convention on the Law of the Sea
UNDP	United Nations Development Program
UNEP	United Nations Environment Program
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
UNMIL	United Nations Mission in Liberia
UPR	Universal Periodic Review
USD	United States Dollar
UXO	Unexploded Ordnance
VOC	Volatile Organic Compounds
WHO	World Health Organization
y	Year
YMCA	Young Men's Christian Association

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## GLOSSARY

<b>Absolute poverty line</b>	Line below which individuals cannot meet their food and non-food minimum needs.
<b>Crew</b>	The number of people who regularly fish together in the same canoe.
<b>Extreme poverty line</b>	Line below which individuals' total food and non-food consumption falls below the minimum food requirements.
<b>Fishmonger</b>	A person who receives, processes and markets fish.
<b>Food poverty line</b>	Line below which individuals cannot meet their basic food needs.
<b>Slum</b>	Informal, high population density, low income communities, lacking in planning, usually as squatters on public land and not privately owned.

<p><b>Exchange Rate</b></p>
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<p><b>USD 1 = Liberian Dollar (LRD) 162 (March 2, 2019)</b></p>
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<p><b>Source: <a href="http://www.oanda.com">www.oanda.com</a></b></p>
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## EXECUTIVE SUMMARY

### A. INTRODUCTION

Climate change has been generating higher sea levels since at least the start of the current century and appears to be set to accelerate over the coming years. More intense storm-driven waves are already pushing the marginal shorelines of the Monrovia Metropolitan Area (MMA) out of equilibrium. The rising sea levels, with high tides becoming ever higher, coupled with storm waves of increasing intensity, is leading to flooding, the collapse of buildings and housing, salt intrusion into wells, and pollution from disrupted sewerage and city drains. There will be consequent impacts on the poor coastal communities which include large communities of artisanal fisherfolk, as houses, small businesses, markets and people are progressively forced to move elsewhere. Food security will deteriorate markedly as the fishery collapses because the fishermen can no longer live on the shores from which it is accessible.

Ensuring the survival of this fishery is key to the maintenance of a sustainable food source for a large city, through methods that are very low in carbon emissions. Keeping the industry operational on a low carbon basis requires a number of adaptations in the ways that the industry itself and the land of the coastal fringe are managed. It also needs some protection against the threat of increased inundation.

The project proposes solutions based on management interventions and ecologically sound control measures. These use nature-based techniques to control the encroaching sea, with “soft” engineering measures added where necessary. A key aspect of the project will be to protect the low-lying land occupied by the fisherfolk and their neighbouring communities. Other actions will address the health of the mangroves, making space for their survival as sea level rises. These management-based activities will focus on improving land use planning and reducing encroachment into the large, highly biodiverse mangrove-filled inlets close to Monrovia. Coastal management capacity will be enhanced to encompass improved governance and protection of these inland but tidal zones, where the forests are important carbon sequestration sites. Ensuring the long term health of the mangroves is itself a nature-based solution to low energy food security, since these areas are the breeding grounds for the

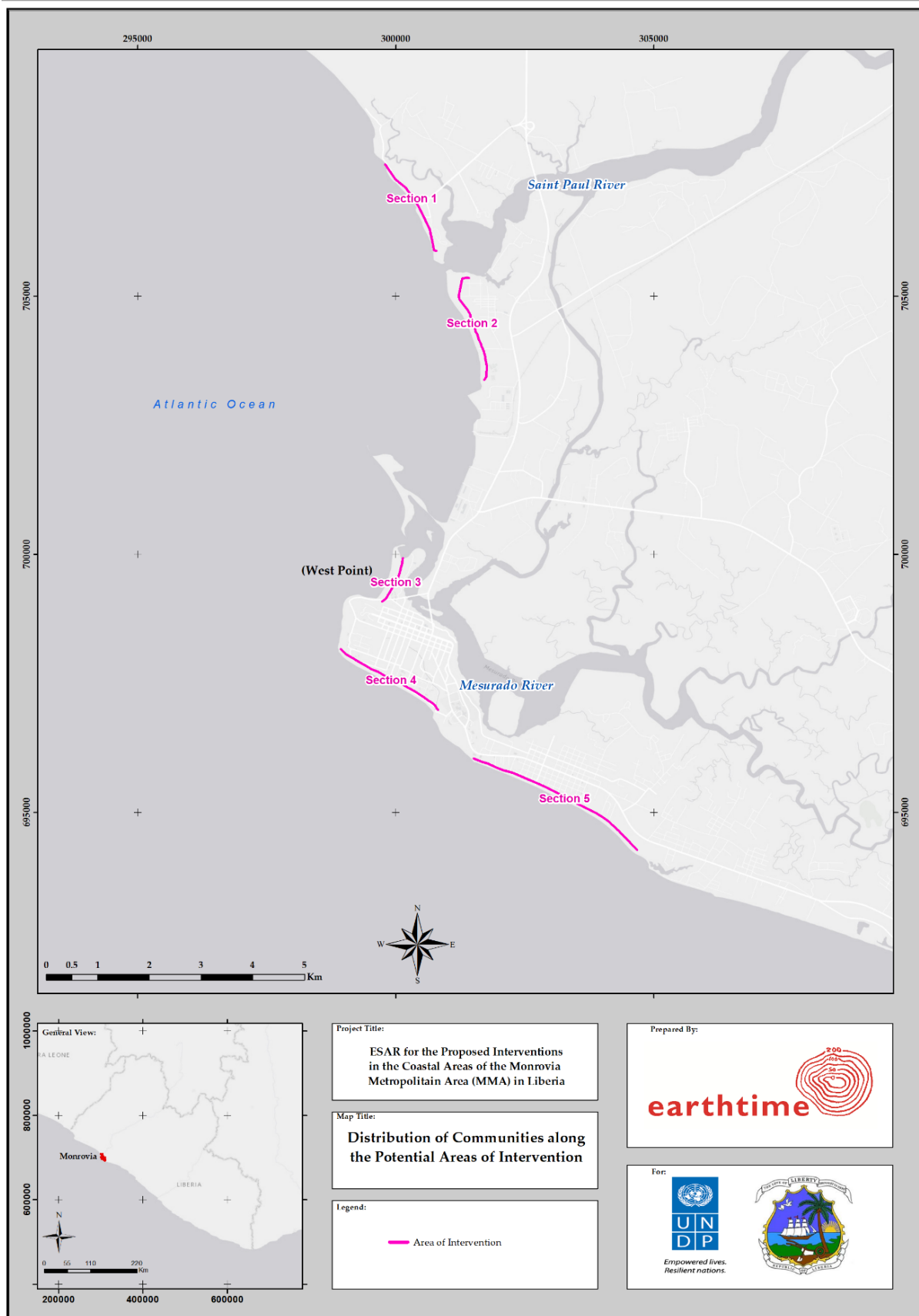
inshore fish and crustaceans that keep the artisanal fishery both highly productive and sustainable. Hence this strategy is central to sustaining the fishery and keeping Monrovia food secure while minimising carbon emissions – and thereby its contribution to the drivers of climate change.

This document, an Environmental and Social Assessment Report (ESAR), has been developed to safeguard the environment and society through the implementation of the project and beyond. It follows the requirements laid out in the United Nations Development Programme's (UNDP) 2014 Social and Environmental Screening Procedure (SESP) and Social and Environmental Standards (SES). The approach followed has been as holistic as possible. Although the project is designed to focus on the immediate zone of the ocean shore threatened by sea level rise and intense storm energy, the potential impacts on both the environment and society will extend well beyond this line. The complicated range of measures envisaged at the frontier of sea and land leads to the need for a comprehensive environmental and social management system to ensure that the safeguards meet the requirements of both the Environmental Protection Agency (EPA) and the UNDP, and to avoid the situation where an essentially pro-environment project actually causes more harm.

The ESAR report is an interim provision covering the requirements for a Project Brief, in addition to providing an Environmental and Social Monitoring Plan (ESMP). However, a full Environmental and Social Impact Assessment (ESIA) is required for this project in order to meet the requirements of the EPA.

## **B. PROJECT DESCRIPTION**

The project reviewed five coastal sections in Monrovia, as shown in the figure and table below. These coastal sections represent areas that are all experiencing coastal retreat and where fishing activities are prominent, since some of their sandy beaches offer suitable locations for the safe landing of the wooden canoes used by the artisanal fishermen.



55

56

Project location map

57 Name and length of project location sections

Coastal section	Common Name	Length (m)
Coastal section 1	Hotel Africa	2,200
Coastal section 2	New Kru Town to the Port	2,400
Coastal section 3	West Point	1,500
Coastal section 4	American Embassy to the Military Base	2,600
Coastal section 5	Military Base to Bernard Beach (JFK Hospital)	4,700
<b>Total</b>		<b>13,400</b>

58 Following detailed analysis, it was established that the only location with expected impacts  
59 that are very clearly attributable to the effects of climate change was that at West Point. For  
60 this reason, it is only at West Point that physical interventions are proposed under the project.  
61 However, a range of adaptive interventions are proposed that will have wider effectiveness.

62 The project aims at providing a climate-resilient strategy for Monrovia by:

- 63 • Minimising contributions to the drivers of climate change;
- 64 • Reducing vulnerability and making society climate resilient;
- 65 • Protecting and enhancing livelihoods;
- 66 • Upholding human rights;
- 67 • Safeguarding food security; and
- 68 • Enhancing ecosystems.

69 In order to achieve these objectives, the project proposes a two-fold approach that must be  
70 implemented together:

- 71 • The first category is a group of proposed interventions that are adaptive measures,  
72 aiming at aiding society to minimize the drivers of climate change. These are listed  
73 below.
  - 74 ○ Increase the capacity of the institutions responsible for integrated coastal  
75 zone management (ICZM); and
  - 76 ○ Increase awareness of the importance of addressing climate change issues  
77 among the affected society.
  - 78 ○ Address the management of fishing, catches, and fish processing and  
79 storage;
  - 80 ○ Understand the biological resource and ensure its protection as necessary  
81 to sustain catch volumes; and



- Understand and manage the pollution that threatens the biological resource in the urban proximity.
- There are also two adaptive measures that will help to reduce the impacts of climate change.
  - Alternative sources of construction sand; and
  - Options for climate-resilient infrastructure in coastal areas.
- The second category covers protective interventions, aiming at mitigating the impacts of climate change, particularly rising sea level and the damaging effects of waves from higher-energy storm events. The proposed interventions are at Coastal Section 3, West Point, where two options were examined, from which the most environmentally sound was chosen. This is the construction of a revetment wall. The other option included the use of a groyne with beach nourishment, which would have a potentially significant environmental impact through the need for dredged sand.

## C. PROJECT ALTERNATIVES

Alternatives to the project are few and have clear disadvantages. Resettlement in coastal sections 2 and 3 would seriously affect the coastal communities who rely on proximity to the beach for their livelihoods. It would also almost certainly lead to a more carbon-dependent economy for the people involved: supporting an increasing industrialization of the fishery would lead to a higher consumption of fossil-fuel energy, the displacement of many workers and potentially the over-exploitation of the fishery.

Other types of engineering solutions to protect against coastal retreat are either not technically feasible or not deemed acceptable by the stakeholders. Some are also very costly to construct and to maintain (groynes and beach nourishments) or have significant environmental impacts because of the need for offshore dredging (beach nourishments). In some areas of the project, the impact of climate change could not be clearly set as the main driver for the coastal retreat and therefore the options of building protective structures in these areas have to be dropped because they cannot fit in the project rationale (coastal sections 2 and 4). Although the Do Nothing alternative does not have any foreseen direct impacts on the environment, it will

generate significant harmful socio-economic impacts on the communities living along the coast, rendering it an unsupportable proposition.

It is clear that there is a strong need for the project, and that none of the possible alternatives are suitable.

## **D. LEGAL AND INSTITUTIONAL FRAMEWORK**

### **Environmental Protection Agency (EPA) Requirements**

All projects and activities identified in Annex I of the Environmental Protection and Management Law of Liberia (EPML) are required to conduct an environmental impact assessment. The proposed project includes building structures for erosion control, which falls under the “Land Reclamation and Land Development” category in Annex I of the EPML. This project must therefore present an Environmental and Social Impact Assessment report (ESIA) to the EPA and obtain a permit before the commencement of activities.

### **Green Climate Fund (GCF) Requirements**

The proposed project falls under Category B of the GCF Environmental and Social Policy: Activities with potential limited adverse environmental or social risks and impacts that individually or cumulatively, are few, generally site-specific, largely reversible, and readily addressed through mitigation measures..

### **United Nations Development Programme (UNDP) Requirements**

The ESAR is developed and presented in a manner that meets the SESP and Stakeholder Response Mechanism (SRM) requirements and objectives. Standard 5 (Displacement and Resettlement) and Standard 6 (Indigenous Peoples) of the Social and Environmental Standards (SES) were not considered to be relevant in this context, as the resettlement of people and impacts on indigenous groups are not anticipated (although these matters need to be confirmed in the project’s ESIA). Standards 1, 2, 3, 4 and 7 are to be met by the project.

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## E. DESCRIPTION OF THE OVERALL ENVIRONMENT

### Physical Environment

The project location lies on the coastal plains of Monrovia, characterized by relatively flat sandy beaches interspersed with sand bar-enclosed lagoons, mangrove swamps, and a few rocky cliffs. The bathymetric topography of coastal sections 1 and 2 is characterized by gentle slopes, while coastal sections 3, 4 and 5 have steeper slopes.

Monrovia's shoreline experiences a semi-diurnal tide, which reportedly influences wetlands and rivers to about 10 km inland. Liberia's wave regime is largely dominated by long period swell waves which are highly energetic and relatively uniform in direction and in height. Offshore wave heights have a seasonal variation, showing higher waves and a larger wave height distribution in the rainy season, when there are stronger onshore winds.

In the project area, the coastal waters are mainly influenced by inputs from the Mesurado River, the St. Paul River, and to a lesser extent by the Farmington River (southeast of coastal section 5). On the other hand, several sewer channels discharge raw wastewater into the ocean. These are mostly found in coastal sections 4 and 5.

Spot sampling was carried out in the Atlantic Ocean and in the estuarine areas of the St. Paul River and the Mesurado River, with a total of 21 samples. The results show a high TSS concentration in surface and coastal waters, which is an indication of pollution by anthropogenic activities. Chemical oxygen demand (COD) content increases downstream along the Mesurado River, and becomes diluted in the estuarine area. Samples collected from the St. Paul estuarine area clearly show a salinity gradient that increases with proximity to the ocean, as the St. Paul River's fresh water mixes with the ocean's saline water. The salinity in samples collected from the Mesurado estuarine area is comparable with that of seawater, demonstrating that this estuary is more influenced by the coastal waters than by the inland surface water. The implication is that impacts on coastal water quality may reach deeper inside the Mesurado estuary than they would in the St. Paul estuary where freshwater flows dominate the hydrology. Traces of heavy metals were detected in some samples, while cyanide, nitrite, petroleum hydrocarbons and phenols were not detected in any of the samples.

Sediment analysis onshore and offshore of the five coastal sections revealed that the samples are coarse, containing more than 85 percent of sand. Onshore samples have no silt or clay content, while offshore samples generally contain no gravel.

In the project area, the major continuous sources and sinks affecting the sediment budget are:

- St. Paul River, a source, located between coastal sections 1 and 2;
- Mesurado River, a sink, located between coastal sections 2 and 3; and
- Farmington River and its tributary Junk River, sources, located southeast of coastal section 5.

The average global sea level has been rising since at least the beginning of the twentieth century, as a result of global warming. Although the rise to date might look marginal (approximately 7 cm since 2000), projections show that sea level rise will continue, even for the most optimistic projection (i.e. currently the IPCC's Representative Concentration Pathway, RCP 4.5 scenario). This will subsequently cause a worsening of the effects of climate change that are already noticeable: intensified waves, more intense and frequent storms, and a change in the sediment balance of the nearshore ocean system. All these effects will contribute to coastal retreat.

## Biological Environment

The Monrovia coastal belt contains significant areas of swamp-related vegetation, which includes mangrove forests and savannah woodland-related vegetation. The mangrove forests provide nutritional inputs to adjacent shallow lagoons and lakes that are the primary habitat, as well as the main spawning and breeding grounds for many aquatic and marine species. The marine environment also plays a significant ecosystem services role, exerting influence over local processes such as the absorption of atmospheric carbon dioxide.

Mangrove forests are the most important flora in the coastal area. Also common in the coastal zones are palm trees, mango trees, papaya trees, other fruit trees and some ornamental plants. Minor seagrass growth may occur, especially in lagoons and wetland areas such as the Mesurado Wetland.

The wetland ecosystems of Monrovia support a very diverse assemblage of faunal species, some of which have high biological, conservational or economical values. In contrast, the faunal diversity of sandy beaches along the coast is relatively very low.

Published information on seaweed species diversity in Liberia revealed about 90 different algal species, but this number may be underestimated. Different seaweed species are expected to occur on rocky areas in the inter-tidal and subtidal zones of Monrovia's shore.

Detailed surveys of marine invertebrates in Liberia are lacking. However, the nearshore zone has well developed crustacean and mollusc populations, including commercially valued species. The benthic macrofaunal populations have not been studied in detail.

Terns and most importantly black terns (*Chlidonias niger*) pass through the offshore waters of Liberia, mainly in the spring when food stocks are high. Other marine birds identified in previous studies include juvenile gannets, skuas and white-fronted petrels.

Specific records of marine mammal occurrences in Liberian waters are scarce. A marine mammal fauna list consisting of 29 confirmed and potential species was identified for Liberia, comprising baleen whales, sperm whales, beaked whales, delphinid species and a single species of Sirenia (sea cows and manatees). Of these, two species are of particular conservation importance in the region, the Atlantic Humpback Dolphin and the West African Manatee.

At least four species of sea turtles are present in Liberian waters and nest in Liberia. No information could be located regarding their distribution at sea, although it can be expected that most - if not all - of the sea turtle species use both coastal and pelagic waters in Liberia's Exclusive Economic Zone (EEZ) for foraging and migrating, and are present in these habitats throughout the year.

Cassava Croakers, West African Ilisha, Sardine and Barracuda are the most abundant fish species in the coastal waters of Monrovia. Other fish commonly present are Groupers, Snappers and the Lesser African Threadfin. Tuna species, Wahoos, Marlins and Sailfish, Sharks and Rays are more common in the offshore waters beyond six nautical miles. The fishing season extends usually from October to May. June to September is considered to be a

low season for net fishing but the high season for hook and line fishing, which targets mostly Snappers on rocky bottoms.

## **Socio-economic Environment**

A rapid appraisal of the fishing-based communities was carried out along the beaches potentially affected by sea level changes and the possible locations of coastal interventions. Twenty-one focus group discussions were carried out as part of the ESAR, out of which six were fishing communities. None of these communities have groups that could be identifiable as “indigenous” using the international definition of the term by the UNDP.

The concerns that were voiced in relation to the project are loss of access to the beaches, loss of livelihood, relocation, and loss of the beach as a recreational area. In addition, security of land tenure is a serious concern for the communities in the project area. With the project’s protection of the coast, the values of land will be raised. Many members of the coastal communities do not have formal title to the land they occupy, having settled there either with customary rights allocated by a traditional Chief, or because of displacement during the civil wars. Many communities have been in place for at least 40 years and believe they have “squatters’ rights” via “adverse possession”.

In general, the fishing communities are either Kru, Fanti or Popo (a minority) and identify as such. In these artisanal fishing communities, the actual fishing is primarily undertaken by men and the processing and sale of the fish (fish mongering) are undertaken by their wives and female relatives. It is generally thought that up to three women will process and sell the catch of each man from each canoe.

## **F. STAKEHOLDER ENGAGEMENT AND PUBLIC PARTICIPATION**

### **Public Consultation and Environmental and Social Disclosure**

The ESAR includes public consultation as part of the ongoing stakeholder engagement plan for the project. The project was discussed with a wide range of stakeholders including relevant government departments, industry groups, NGOs, and individual community members. It is essential that consultation with any affected communities will continue. It is anticipated that

based on the communities' expressed views, the project will be fully accepted, provided that communities can stay where they are and are protected from eviction.

The Project Management Unit's (PMU) Safeguards Officer will be required to develop and release updates on the project on a regular basis to provide interested stakeholders with information on project status in line with the Stakeholder Engagement Plan for the project. All enquiries, concerns, complaints and grievances will be recorded on a register and the appropriate manager will be informed. All material must be published in English, which appears to be spoken by all occupants of the area; however, it might also be necessary to publish in Fanti (an old Ghanaian dialect), since some of this community mainly use this language in their homes.

## **Community Consultation**

An extensive community consultation exercise was undertaken for the ESAR over a three-week period in February 2019. In total, twenty communities were visited, in addition to a Community Based Organisation (CBO) located in West Point. Communities all report loss of lives, loss of structures (homes and workplaces), disruption to means of gaining a livelihood, increased uncertainty and a lack of anywhere else to go. Both fishing and non-fishing communities depend on their location for their livelihoods, and fears of loss of land, of inundation, forced relocation and lack of access to plots utilised for decades are deeply disturbing for all.

The majority of the inhabitants of the coastal communities are squatters and tenants of squatter households. The communities have all experienced the impacts of sea flooding, which has led to damage of their canoes and homes, displacement, and loss of livelihoods. Consequently they welcome the idea of coastal protection, while having some concerns. A major concern raised regarding the project was an appeal for residents to stay where they are as relocation means loss of livelihoods, loss of beach space for recreational use, and the breaking up of communities. The communities feel that they have a right to live in these areas especially as they feel they have looked after the coastline. Another concern was fear of being forced out by wealthier people if the land was protected. On the other hand, communities welcomed the idea of coastal protection.



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## 273 **Grievance Redress Mechanism**

274 The Grievance Redress Mechanism (GRM) recommended is a system proven to work in poor  
275 communities in Liberia, is compliant with UNDP's Social Safeguards, follows customary  
276 norms and fits into the statutory administrative process of the Government of Liberia.

277 A GRM allows internal and external stakeholders to ask questions and raise issues, with the  
278 knowledge that they will be handled properly. It is clear proof of the commitment to deal  
279 quickly and carefully with all reasonable concerns and queries that people bring. All  
280 grievances must be recorded, effectively processed and reported through the proper channels.

281 The practical process for resolving a complaint has a number of tiers. At all levels, the  
282 complainant can include witnesses, traditional authorities, a non-governmental organisation  
283 (NGO) or other civil society representative to assist and support them.

## 284 **G. ENVIRONMENTAL AND SOCIAL RISK ASSESSMENT AND MITIGATION**

285 As this project is supported by UNDP in its role as a GCF Accredited Entity, it has been  
286 screened against UNDP's SESP of 2016 under the SES of 2014. These comply with the  
287 requirements of the GCF's Environmental and Social Policy as adopted in March 2018.

288 Based on the Social and Environmental Screening, the project was deemed to be a moderate  
289 risk (Category B) project.

290 The methodology adopted in this ESAR uses the UNDP's general, international risk  
291 assessment procedure, but enhanced by Earthtime's risk assessment system, which has been  
292 developed for use specifically in Liberia. This means that it covers both the higher level,  
293 general risks faced by all development projects, and the project activity-specific risks likely to  
294 be encountered locally. Risks related to the project are identified and assessed for significance  
295 of impact and likelihood of occurrence. In addition, an outline of the risk mitigation is  
296 presented, followed by the residual risk remaining if appropriate mitigation measures are  
297 implemented to agreed standards. Finally, the linkages between the risk assessment matrix  
298 and the impacts in the Environmental and Social Management and Monitoring Matrix  
299 (ESMMM) are shown.

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## H. PLAN FOR ENVIRONMENTAL AND SOCIAL MANAGEMENT AND MITIGATION

The ESMMM is the key tool used in the Environmental and Social Management and Mitigation Plan to ensure that the impacts of project activities on the environment and society are minimized and that both will be safeguarded during the implementation of the proposed project, in compliance with all technical, regulatory, and institutional requirements. Rather than have separate plans for managing health and safety, gender and social inclusion, biodiversity, hazardous materials, etc., the ESMMM encompasses all of these aspects. The disadvantage of numerous sub-plans is the risk of contradiction, duplication and omission where topic areas overlap. The strength of a single, encompassing plan is that actions, standards to be achieved and responsibilities are clearly defined and can be easily monitored to ensure effectiveness.

In order to make it possible to manage the identified adverse environmental and social impacts in a structured way, they are disaggregated within areas of risk. This led to the following safeguard categories and impact mitigation headings that are used as the basis of the overall ESMMM.

1. General Environmental Protection
2. Community Protection Measures, including Gender and Social Inclusion
3. Environmental Health and Safety
4. Occupational Health and Safety
5. Labour and Working Conditions
6. Water Resources Management
7. Coastal Sediment Resources Management
8. Soil and Land Resources Management
9. Dust and Air Quality Management
10. Flora and Fauna Protection
11. Archaeology and Cultural Sites Management
12. Waste Management
13. Hazardous Materials Management

Through these categories, the ESMMM lays out the management system to ensure that all of the safeguards required by the Government of Liberia and UNDP are addressed to adequate, defined standards, and that this can be ascertained through monitoring. Most of the ESMMM content is given over to practical actions in all project activities, and guidelines to support these actions in meeting national and international standards.

The ESMMM has identified additional surveys and management plans that must be conducted before any activities take place, in addition to the ESIA. These are:

1. Detailed ESIA Surveys

1.1. Marine and Estuarine Biological Survey

1.2. Marine and Estuarine Sediment Survey

1.3. Household Survey of Affected Communities

1.4. Fish Landing Survey (linked to 1.1 and 1.3 above)

2. Detailed Sub-plans

2.1. Contractors' Oil Spill Response Plan for land

2.2. Contractors' Oil Spill Response Plan for sea, including a Marine Spill Contingency Plan

2.3. Contractors' Emergency Response Plan

2.4. Contractors' Rock Quarry Management Plan, including Blasting Plan

2.5. Resettlement Action Plan for Affected Livelihoods

2.6. Grievance Redress Mechanism

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## 1 INTRODUCTION

### 1.1 PROJECT BASIS

Climate change has been generating higher sea levels since at least the start of twentieth century and has been accelerating over the years. More intense storm-driven waves are pushing the marginal shorelines of the Monrovia Metropolitan Area (MMA) out of equilibrium. This will lead to the disintegration of a number of poor communities that form perhaps 20 percent of the city's population. They include large communities of artisanal fisherfolk from three main ethnic groups, who utilise the rich inshore fishing grounds of the coast. This fishery is key to the food security of the greater Monrovia area, as well as underpinning the livelihoods of many other people engaged in micro-enterprises. The fishery is sustainable, very low energy and resilient. The position of the fishing communities on the low-lying shores is essential to the operation of this livelihood, as their canoes are launched from the beaches and the catches are marketed close by in the city. However, the rising sea levels, with high tides becoming ever higher, coupled with storm waves of increasing intensity, is leading to flooding, the collapsing of buildings and housing, salt intrusion into wells, and pollution from disrupted sewerage and city drains. There will be consequent impacts on small businesses and markets as people are progressively forced to move elsewhere. Food security will deteriorate markedly as the fishery collapses because the fishermen are no longer there.

Yet, as long as it can be continued from the beaches, this fishery is a resilient industry that is minimalist in its contributions to the drivers of climate change. Ensuring its survival is also key to the maintenance of a sustainable food source for a large city, through methods that are very low in carbon emissions. It lies at each end of the climate change spectrum: it barely contributes to the causes of global warming, but it is a victim of its growing effects through rising sea level and intensifying storms. Keeping the industry operational on a low carbon basis requires a number of adaptations in the ways that the industry itself and the land of the coastal fringe are managed, as well as providing protection against the threat of increased inundation.

The project proposes solutions based on management interventions and ecologically sound control measures. These use nature-based techniques to control the encroaching sea, with soft engineering measures added where necessary. A key aspect of the project will be to protect the low-lying land occupied by the fisherfolk and their neighbouring communities. Other actions will address the health of the mangroves, making space for their survival as sea level rises. These management-based activities will focus on improving land use planning and reducing encroachment into the large, highly biodiverse mangrove-filled inlets close to Monrovia. Coastal management capacity will be expanded to encompass improved governance and protection of these inland but tidal zones, where the forests are important carbon sequestration sites. Ensuring the long term health of the mangroves is itself a nature-based solution to low energy food security, since these areas are the breeding grounds for the inshore fish and crustaceans that keep the artisanal fishery both highly productive and sustainable. Hence this strategy is central to sustaining the fishery.

## 1.2 ENVIRONMENTAL AND SOCIAL ASSESSMENT REPORT

Earthtime, working with CDR International, has developed this Environmental and Social Assessment Report (ESAR) to safeguard the environment and society through the implementation of the project and beyond. It follows the requirements laid out in the United Nations Development Programme's (UNDP) 2014 Social and Environmental Screening Procedure (SESP) and Social and Environmental Standards (SES). In particular, it incorporates the current template for the SESP: this focusses mainly on risks, and is provided in Chapter 7 of this ESAR.

Our approach is to place the SESP into context, so that there are statements describing the proposed project, the legal and institutional framework within which it is set, the existing environmental conditions and the approach to stakeholder consultation. In the light of this information, the risk assessment follows both the general template of UNDP's SESP and our own additional identification of project-specific risks in the local setting. Derived from this is a detailed Environmental and Social Management Plan (ESMP), which states how potential impacts derived from some of the risks can be addressed so as to ensure that the project does not affect the environment and society without due mitigation. Our approach to an ESMP includes a statement of the standards that must be achieved to make certain of this, and these

are provided along with extensive guidelines for areas not currently covered by gazetted standards.

Both the risk assessment – the SESP – and the ESMP are written as self-standing documents that can be extracted from the ESAR for separate use if required. However, they are also linked, with the ESMP specifically addressing the risks identified in the SESP as requiring specific action.

In summary, the purposes of this document are therefore as follows.

- a) To provide a description and review (from the environmental and social perspectives) of the proposed project interventions.
- b) To provide an initial overview of the environment as it currently exists and will be affected by the project. We have covered all aspects of the physical, biological and socio-economic environments.
- c) To engage with stakeholders and incorporate their views in the process.
- d) To assess the environmental and social risks associated with the project, and ways in which they must be mitigated.
- e) To define the screening process for individual project treatments to ensure that they comply with the requirements of the UNDP, the Green Climate Fund (GCF) and the Environmental Protection Agency (EPA) as the regulatory entity for the Government of Liberia (GoL), for which it is defined by the Environment Protection and Management Law 2003 (EPML).
- f) To describe the process to be followed in complying with the EPML 2003 during project implementation.
- g) To provide an overall ESMP, which includes the mitigation measures.
- h) To set the scene for a full Environmental and Social Impact Assessment (ESIA) of project components, since it has been determined that this level of investigation is required under the EPML 2003.

Our approach has been as holistic as possible. Although the project is designed to focus on the immediate zone of the ocean shore threatened by sea level rise and intense storm energy, the potential impacts on both the environment and society will extend well beyond this line. At sea it will have potential implications on the biological resources, especially the tidal mangrove swamps and the fish, sources of sand from the sea bed, and the physical and chemical quality of the inshore waters. On the land it will have impacts on the beaches, the urban residential and business areas behind them, and on sources of construction materials further inland in the bush, with consequent impacts on both soil and freshwater resources. The complicated range of measures envisaged at the frontier of sea and land leads to the need for a comprehensive environmental and social management system to ensure that the safeguards meet the requirements of both the EPA and the UNDP, and to avoid the situation where an essentially pro-environment project actually causes more harm.

### 1.3 STRUCTURE OF THE ESAR

The ESAR has been organized in eight chapters covering all the items required by the UNDP's 2014 Environmental Screening Procedure (SESP) and Social and Environmental Standards (SES). The ESAR structure is summarized in Table 1-1.

Table 1-1 ESAR structure

Chapter	Content
Chapter 1 – Introduction	Presents a brief background to the project, and the purpose and structure of the report.
Chapter 2 – Description of the Overall Project	Describes the project location, interventions and activities.
Chapter 3 – Project Alternatives	Describes the various alternatives that were assessed for the project.
Chapter 4 – Legal and Institutional Framework for Environmental and Social Matters	Describes the legal and policy requirements as well as the administrative framework relevant to the project.
Chapter 5 – Description of the Overall Environment	Provides a detailed baseline assessment of the receiving physical, biological and socio-economic environment.
Chapter 6 – Stakeholder Engagement and Public Participation	Summarises stakeholder engagement activities.
Chapter 7 – Environmental and Social Risk Assessment and Mitigation	Provides an assessment of the risks associated with the project, as well as an outline for mitigating these risks.
Chapter 8 – Environmental and Social Impact Management and Mitigation Plan	Presents the impacts associated with the project on the physical, biological and socio-economic environment. It also provides the approach to mitigating these impacts and the procedures for effective monitoring of environmental and social mitigation and management measures.

## 2 DESCRIPTION OF THE OVERALL PROJECT

### 2.1 PROJECT LOCATION

Liberia is located on the southwest corner of West Africa. Positioned on the Atlantic coastline, it lies between longitudes 7°30' and 11°30' west and latitudes 4°18' and 8°30' north and has a total surface area of 111,370 km<sup>2</sup>. Liberia is bordered by Guinea on the north, Sierra Leone on the west and Ivory Coast on the east. The capital, Monrovia, is the country's largest city.

The major part of the Monrovia coastline is a straight, sandy and wave-dominated coastline. The beach is relatively steep with coarse sediment. The project covers five coastal sections in Monrovia, as shown in Table 2-1 and Figure 2-1. These coastal sections represent areas that are all experiencing coastal retreat and where fishing activities are prominent, since some of their sandy beaches offer suitable locations for the safe landing of the wooden canoes used by the artisanal fishermen.

Table 2-1 Name and length of project location sections

Coastal section	Common Name	Length (m)
Coastal section 1	Hotel Africa	2,200
Coastal section 2	New Kru Town to the Port	2,400
Coastal section 3	West Point	1,500
Coastal section 4	American Embassy to the Military Base	2,600
Coastal section 5	Military Base to Bernard Beach (JFK Hospital)	4,700
<b>Total</b>		<b>13,400</b>

Coastal section 1 (Figure 2-2a) is located north of the St. Paul River mouth. The main landmark in this stretch is Hotel Africa, an abandoned hotel that has historical value for Monrovia society. Some communities reside around Hotel Africa, but the region is not densely populated. North of Hotel Africa lies Banjor Beach, a community that solely relies on fishing for their livelihoods. Coastal section 2 (Figure 2-2b) is a densely populated area that lies south of the St. Paul River mouth and north of the Free Port of Monrovia. Coastal section 3 (Figure 2-2c), where physical engineering interventions are proposed as part of the project in addition to the adaptive interventions (see below), is located on a large sand spit on the western fringe of the Mesurado estuary, bordered by the Cape of Monrovia to the southwest. Coastal sections 4 (Figure 2-2d) and 5 (Figure 2-2e) are located southeast of the Cape of Monrovia and are both relatively exposed to the Atlantic Ocean.



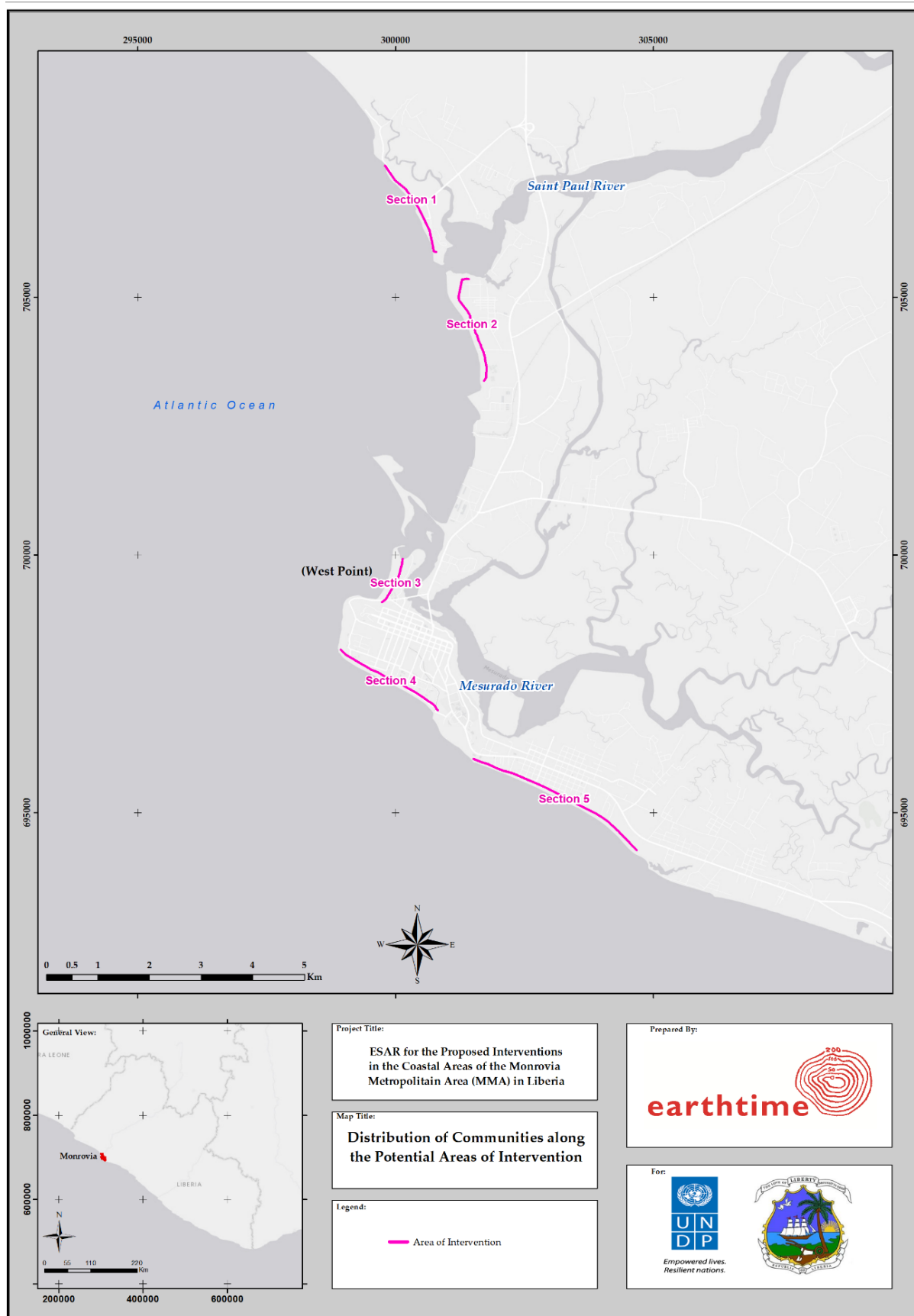


Figure 2-1 Project location map



(a)



(b)



(c)



(d)



(e)

Figure 2-2 Coastal sections (a) 1 – Hotel Africa; (b) 2 – New Kru Town to the Port (looking south); (c) 3 – West Point (looking north); (d) 4 – American Embassy to the Military Base (looking west); (e) 5 – Military Base to Bernard Beach and JFK Hospital (looking west).

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## 2.2 PROPOSED INTERVENTIONS

The project aims at providing a climate-resilient strategy for Monrovia by:

- Minimising contributions to the drivers of climate change;
- Reducing vulnerability and making society climate resilient;
- Protecting and enhancing livelihoods;
- Upholding human rights;
- Safeguarding food security; and
- Enhancing ecosystems.

In order to achieve these objectives, the project proposes a two-fold approach:

- The first category of proposed interventions are a groups of adaptive measures, aiming at aiding society to minimize the drivers of climate change. These interventions mostly consist of improvements in awareness and capacity, in order to develop the climate resiliency of the communities and relevant institutions, nature and assets. They cover all five of the exposed coastal areas, as well as the estuaries and mangroves where there are geomorphological and ecological dependencies.
- The second category are protective interventions, aiming at mitigating the impacts of climate change, particularly rising sea level and the damaging effects of waves from higher-energy storm events. These interventions consist of engineering measures coupled with green elements to protect the most vulnerable coastal sections from erosion and storm hazards. These measures will cover the physical protection of the landing beaches and the settlements behind them at West Point.

The intention is therefore that the activities of the adaptive interventions must go hand in hand with each other, and with the protective measures at West Point. A detailed description of the proposed interventions is presented in the sections below.

In implementing all interventions, the project will follow national and international principles of human rights, particularly the promotion of gender equality and women's empowerment. It will also focus special attention on youth and vulnerable groups, to help promote social justice in the Liberian context. These groups are among the project's primary beneficiaries.

## 2.2.1 Adaptive Interventions

Adaptive interventions in the project are predominantly measures to help minimise the drivers of climate change. These exploit opportunities to safeguard currently sustainable livelihoods that are low consumers of carbon energy, and which consequently promise to give Liberia “green” living approaches for both the current and future generations. The project focuses largely on the inshore artisanal fishery of Monrovia, which contributes significantly to the city’s food security with very low carbon emissions; however, a number of interventions are required to ensure that the environment supporting this will continue to sustain it as climatic conditions change, and impacts increase as a result of higher sea levels and stronger storms. The adaptive interventions will be implemented in all five of the locations along the Monrovia coast that are shown in Figure 2-1 and Figure 2-2. Some of the interventions will also focus specifically on the mangrove forests in the Mesurado River and St Paul River estuaries, as well as in other smaller inlets in this part of the coast. The capacity building interventions are also intended to enable government staff to address coastal zone management in a more integrated manner, which will help to ensure that climate change-related coastal issues are better addressed nationally, but particularly in the other vulnerable urban locations at Buchanan and Greenville.

A total of seven adaptive interventions are proposed in the project, under three groupings as follows.

- Strengthening governance:
  - Increase the capacity of the institutions responsible for integrated coastal zone management (ICZM); and
  - Increase awareness of the importance of addressing climate change issues among the affected society.
- Adaptation of livelihoods and the environment:
  - Address the management of fishing, catches, and fish processing and storage;
  - Understand the biological resource and ensure its protection as necessary to sustain catch volumes; and
  - Understand and manage the pollution that threatens the biological resource in the urban proximity.

- Adaptation of infrastructure:
  - Alternative sources of construction sand; and
  - Options for climate-resilient infrastructure in coastal areas.

The adaptive measures involve research, resource management, awareness raising in society and the building of capacity in administrative institutions. There are few direct impacts on the environment, although the indirect impacts are addressed in the risk assessment (chapter 0) and the ESMP (chapter 8) later in this ESAR.

### 2.2.2 Protective Interventions

The proposed protective interventions will ensure that Monrovia's most vulnerable coastal communities are protected from the impacts of climate change-induced impacts (sea level rise and increased storm wave energy).

The project proposes protective interventions at coastal section 3, the communities at West Point. These consist of a revetment wall with additional structures to ensure the sustainability of fish landing beaches.

A description of these interventions is provided below, since they will have direct environmental impacts.

A revetment wall (Figure 2-3) is a protective structure capable of resisting local hydraulic forces. It stabilizes the shoreline and protects its slope by preventing further erosion. In order to avoid additional erosion in front of the revetment wall, it must be constructed at the expected scouring depth. In addition, a resilient toe structure or a falling apron must be included in the design.

The revetment wall at West Point is designed to meet the following guidelines:

- *The Rock Manual: The use of rock in hydraulic engineering (Vol. 683)* (Construction Industry Research, Information Association, Civieltechnisch Centrum Uitvoering Research en Regelgeving (Netherlands) and Centre d'études maritimes et fluviales (France), 2007);
- *The Coastal Engineering Manual* (Washington, D.C.: U.S. Army Corps of Engineers, 2006); and



- *The Manual on Wave Overtopping of Sea Defences and Related Structures* (Van der Meer et al, 2016).

One of the inconveniences of a revetment wall is that it reduces the accessibility to the beach. This will affect the fishermen who use the beach for canoe landing and the local communities who use the beach as a leisure area. For this reason there must be breaks in the revetment wall, with additional structures to safeguard landing areas.



Figure 2-3 Examples of rip-rap revetment walls

## 2.3 PROJECT ACTIVITIES

### 2.3.1 Adaptive Interventions

A detailed description of the activities that will take place as part of the adaptive interventions is presented in Table 2-2. These activities will take place in all five of the sections of coast studied by the project, as well as in the environments related to them. In particular, the mangrove forests in the Mesurado River and St Paul River estuaries, as well as in other smaller inlets in this part of the coast, will be target areas for the interventions that aim to conserve biological resources and curb unplanned encroachment and pollution. The capacity building interventions will help enable government staff to undertake integrated coastal zone management, thereby increasing their effectiveness of coping with coastal issues nationally in relation to the available means of minimising Liberia's contribution to the drivers of climate change, and increasing resilience to change-induced impacts. As well as improving national-level abilities to aid small communities all along the coast, the other main vulnerable urban locations at Buchanan and Greenville will benefit from the increased capabilities in urban coastal management.

138 Table 2-2 Activities planned for each adaptive intervention

Adaptive intervention	Aims	Activities
Strengthening governance		
1. Capacity building of national and metropolitan institutions in integrated coastal zone management (ICZM) and land use planning	<ul style="list-style-type: none"><li>• To develop and maintain a sustainable coast in Liberia by sound coastal zone management policies and land planning.</li><li>• To improve the capacity of and coordination between the relevant institutions responsible for ICZM in Liberia.</li></ul>	<b>Component 1.1: Capacity building ICZM</b> <ul style="list-style-type: none"><li>• Trainings, workshops and (international) study and site visits</li><li>• Providing support to develop ICZM policies, regulations, funding mechanisms and project development</li><li>• Establishing structures</li><li>• Development of ICZM tools</li></ul>
		<b>Component 1.2: Strengthening coordination between institutions</b> <ul style="list-style-type: none"><li>• Establishing an inter-agency ICZM working group and defining roles and responsibilities</li><li>• Organizing awareness and learning and discussion workshops</li></ul>
		<b>Component 1.3: Improvement of land use planning and enforcement</b> <ul style="list-style-type: none"><li>• Providing support to develop regulations, land registry systems and enforcement policies</li><li>• Training and on-the-job support to stop illegal activities</li><li>• Dispute resolution support and training</li></ul>
2. Strengthening of community awareness and management of coastal zone risks and solutions	<ul style="list-style-type: none"><li>• To strengthen community resilience for climate change.</li><li>• To create awareness of coastal zone vulnerability (coastal retreat due to erosion and climate change) and environmental issues for communities.</li></ul>	<b>Component 2.1: Investigations</b> <ul style="list-style-type: none"><li>• Identification and selection of the most vulnerable coastal zones in Liberia (next to these in Monrovia)</li><li>• Identification of the specific target groups in the selected coastal areas</li><li>• Development of awareness and information strategy (including information materials and methods)</li><li>• Development of awareness and capacity building programme and materials</li></ul>
		<b>Component 2.2: Implementation</b> <ul style="list-style-type: none"><li>• Implementation of the awareness and capacity building strategy and program</li><li>• Evaluation, lessons learned and follow-up recommendations</li></ul>
Adaptation of livelihoods and the environment		
3. Sustainable fisheries management	<ul style="list-style-type: none"><li>• To ensure that the current low energy artisanal fishery can continue to function, using low carbon emission methods to supply affordable protein to the local urban market.</li></ul>	<b>Component 3.1: Investigations</b> <ul style="list-style-type: none"><li>• Study of catch volumes and species targeted by Kru, Fanti and Popo fishermen</li><li>• Survey of the marine biological resources and assessment of their sustainable offtake capacity</li><li>• Study of low energy options for improvement of fish processing and storage facilities</li></ul>
		<b>Component 3.2: Implementation</b> <ul style="list-style-type: none"><li>• Institutional development and capacity building support to the Liberian Artisanal Fishermen’s Association</li><li>• Institutional development and capacity building support to branches of the Monrovia Fishmongers’ Association</li><li>• Inshore 6 nautical mile zone enforced for artisanal fishing and sustainable offtake monitored.</li></ul>

Adaptive intervention	Aims	Activities
4. Management of the biological resources.	<ul style="list-style-type: none"><li>To sustain the low energy fishery through protected marine and mangrove areas.</li></ul>	<b>Component 4.1: Investigations</b> <ul style="list-style-type: none"><li>Study of the marine and estuarine biological environment</li></ul>
		<b>Component 4.2: Implementation</b> <ul style="list-style-type: none"><li>Determination of areas where protected area status is justified</li><li>Consultation on the proposed protected areas; local and national agreements; preparation of management plans</li><li>Support to the Forestry Development Authority (FDA) or another agency to draft the appropriate legal instruments to designate defined marine or estuarine areas as protected areas</li><li>Support to the start-up of the management of the protected areas</li></ul>
5. Management of urban pollution in coastal areas.	<ul style="list-style-type: none"><li>To sustain the low energy fishery through effective urban pollution control and waste management in coastal waters.</li></ul>	<b>Component 5.1: Investigations</b> <ul style="list-style-type: none"><li>Survey of water quality in the creeks, estuaries and nearshore ocean that might affect mangroves and other sensitive habitats</li><li>Survey of housing areas and sewerage systems within 1 km of tidal water</li><li>Survey of businesses and industries within 1 km of tidal waters</li><li>Review of the urban waste management system</li></ul>
		<b>Component 5.2: Implementation</b> <ul style="list-style-type: none"><li>Development of improved strategies for the waste management and pollution control agencies, including capacity development</li><li>Design of major waste management or pollution control interventions, if required, for separate financing by government</li><li>Monitoring of the effectiveness of the improved waste management or pollution control systems in terms of reducing damage to ecosystems and habitats in tidal waters</li></ul>
Adaptation of infrastructure		
6. Sustainable sand extraction.	<ul style="list-style-type: none"><li>To establish environmentally sound terrestrial sources of construction sand.</li><li>To stop sand extraction from present-day beaches.</li></ul>	<b>Component 6.1: Investigations</b> <ul style="list-style-type: none"><li>Prospecting of potential inland sources of sand within a 2-hour haulage distance from central Monrovia</li><li>Review of the impacts on livelihoods in poor coastal communities of the strict enforcement of a ban on sand extraction from present-day active beaches</li><li>Review of the formal and informal construction industries, and the economic consequences of sand extraction from only inland sources</li></ul>
		<b>Component 6.2: Implementation</b> <ul style="list-style-type: none"><li>Preparation of a strategy on inland sourcing of construction sand</li><li>Development of a planning framework within which inland construction sand will be permitted from designated areas</li><li>Support to government agencies to uphold strict enforcement of a ban on the extraction of sand from present-day active beaches</li></ul>



Adaptive intervention	Aims	Activities
7. Climate resilient community roads and other critical infrastructures	<ul style="list-style-type: none"> <li>• To enhance the resilience of road infrastructure.</li> <li>• To improve the capacity of relevant authorities to respond promptly in an emergency.</li> </ul>	<b>Component 1: Developing knowledge on the vulnerability and potential resiliency options for infrastructure</b> <ul style="list-style-type: none"> <li>• Vulnerability assessment of infrastructure and roads in selected coastal areas</li> <li>• Conducting a feasibility study and plan</li> <li>• Providing recommendations</li> </ul>
		<b>Component 2: Capacity building in resilient road infrastructure for relevant authorities</b> <ul style="list-style-type: none"> <li>• Developing a climate resilient policy mainstreaming framework</li> <li>• Preparing a training curriculum</li> <li>• On-the-job support to relevant staff in implementing agencies</li> <li>• Organizing trainings, workshops and field and study visits on climate resiliency of roads and waste, water and energy facilities</li> </ul>

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### 2.3.2 Protective Interventions

Before implementing the protective interventions, a preparatory phase will take place. It will be followed by the construction of the protective interventions sequentially at West Point. The main activities that will take place as part of the protective interventions are described below.

#### Preparation Phase

- Mobilization;
- Setting up of the construction yard
  - Maintenance equipment;
  - Water use (sanitation and concrete mixing);
  - Waste treatment (chemicals, solid waste, etc.);
  - Fuel storage and fuelling facilities;
  - Offices;
  - Concrete mixing;
  - Casting and construction of concrete elements; and
- Stockpiling of rocks and other materials for construction.

#### Construction of the Revetment Wall at West Point

- Stockpiling of armour rock;
- Construction of bund;
- Excavation;
- Disposal / stockpiling of excavated material;
- Placement of geotextile;
- Placement of underlayer;
- Placement of armour;
- Backfilling;
- Reshaping the base layer / bund of the promenade;
- Possible installation of drainage;
- Addition of the top layer of the promenade; and
- Planting of trees and other vegetation on the promenade.

Along the major part of the West Point coastline, a revetment is proposed that will fix the coastline position and thereby protect against coastal retreat. The revetment should be stable enough to withstand extreme scenarios as specified in the design requirements and conditions given in the Feasibility Study and still subject to detailed design. The beach will be kept more or the less as it is, as the sand excavated for the construction of the revetment will be placed on the beach. However, in the future the beach will retreat and eventually disappear. This means that the depth in front of the revetment will increase until an equilibrium is reached. A typical cross-section is shown in Figure 2-4: note that the toe of the structure extends to five metres below mean sea level to ensure that it stays intact as the beach retreats.

At the northern part of West Point, at the river mouth of the Mesurado River, it is expected that erosion will also continue gradually. To prevent scour development and potential backwashing in this area, a lighter revetment running towards the north is included in the design.

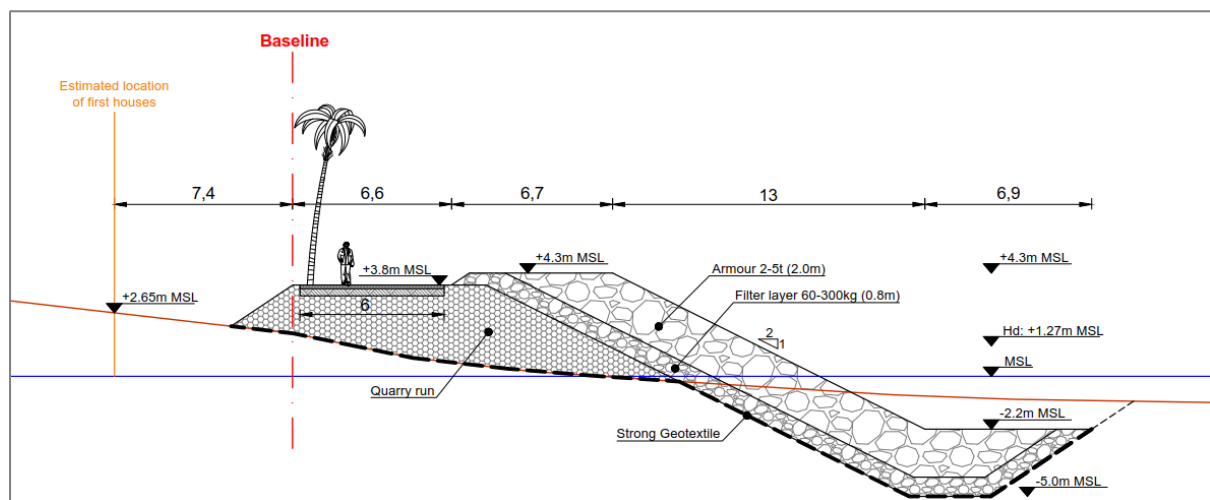


Figure 2-4 Typical cross-section of the proposed revetment at West Point.

Fishing landing sites are accommodated at two locations. For these, a small beach is needed, protected by hard structures to prevent further erosion and serious overtopping. At the middle part of the revetment, an existing bend in the coastline is a very suitable location for a fishing landing site as it minimizes the need for large amounts of rock. By extending part of the southern revetment into sea, like a parallel groyne, a small bay is formed which can be used to create a small beach and accommodate the fishing canoes. Figure 2-5 shows an overview of the revetment and the landing site. The parallel groyne will be approximately

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189 40 metres long. At the most southern end of West Point, the wave action is lower due to  
190 sheltering by Mamba Point. This creates a suitable location for another fishing landing site,  
191 and so a small beach is allowed for in the design.

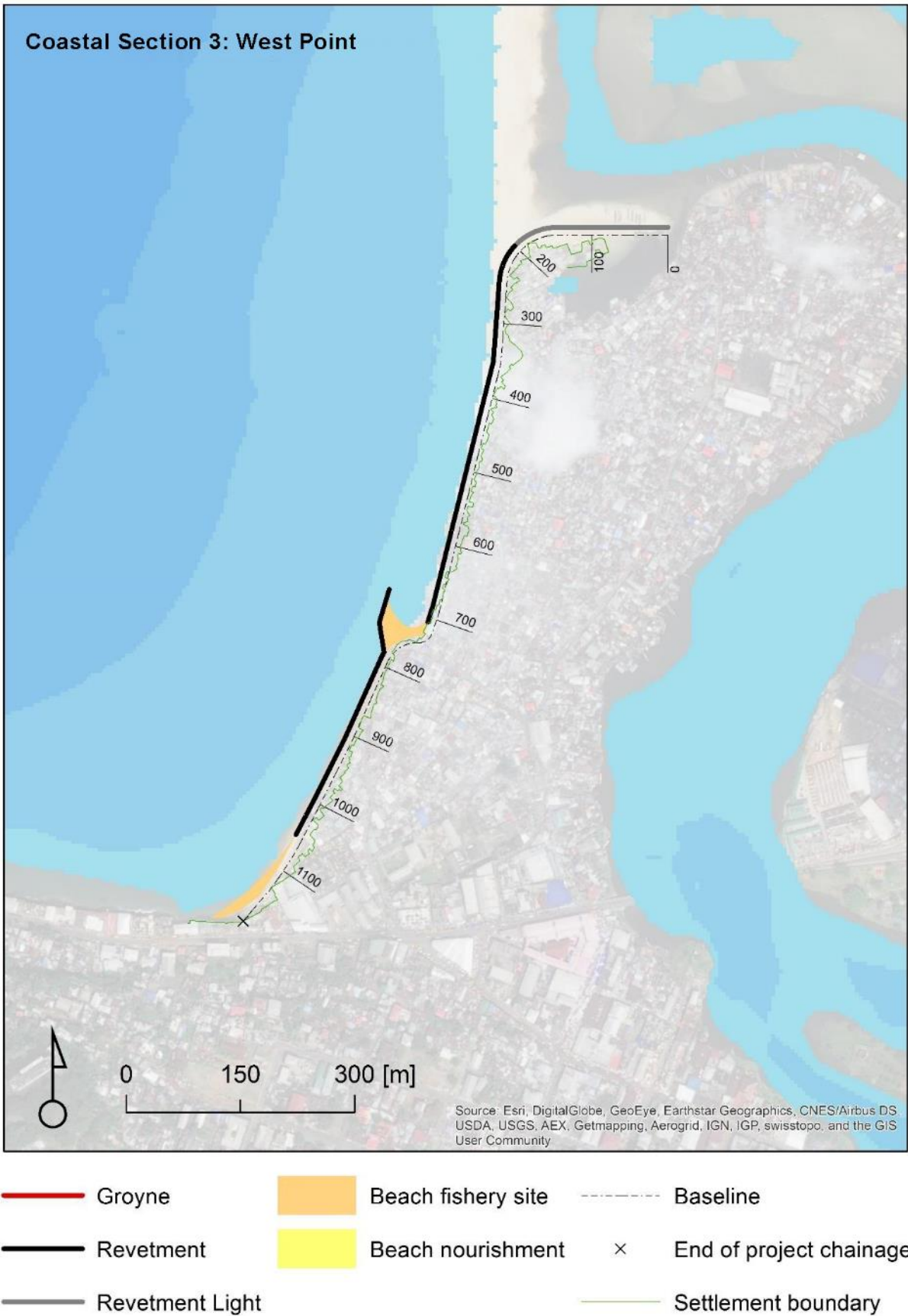


Figure 2-5 Overview of the proposed West Point protective structures and fishing landing beaches (adapted from CDR International, 2019b)

## 2.4 EQUIPMENT

Types and estimated numbers of construction equipment that will be used are described in Table 2-3. Most of these will be hired from international companies and shipped to Liberia during the mobilization phase, along with spare parts, lubricants and oil.

Table 2-3 Construction equipment

Equipment type and characteristics	Minimum no. required
Caterpillar (CAT) 390 long-reach excavator with GPS, rock buckets, skeleton buckets and grapples	2
Caterpillar (CAT) 330 excavator with bucket and excavation bucket	1
Caterpillar (CAT) 980 wheel loader with forks, bucket and skeleton bucket	1
Caterpillar (CAT) 740 dump truck	2
Caterpillar (CAT) D6 bulldozer	2
Water bowser	1
Diesel bowser	1
Car	1
Workshop	1
First aid materials	-
Personal protective equipment and site safety items	-

## 2.5 MATERIALS

The following is a preliminary list of materials that will be used for the protective interventions. Most of these will be sourced locally, unless they are not available. This list will be updated once the detailed designs have been finalized.

- Rock (for underlayer, scour protection, armour, rubble, quarry run);
- Aggregates;
- Geotextile;
- Drainage culverts or open drain components for existing discharge points;
- Diesel fuel, oil and lubricants; and
- Seedlings and planting stocks of trees, shrubs and grasses.

Rocks required for the revetment wall can be sourced at existing quarries in Liberia. A map showing the locations of these quarries along with the lines of access roads between these quarries and West Point is presented in Figure 2-6.

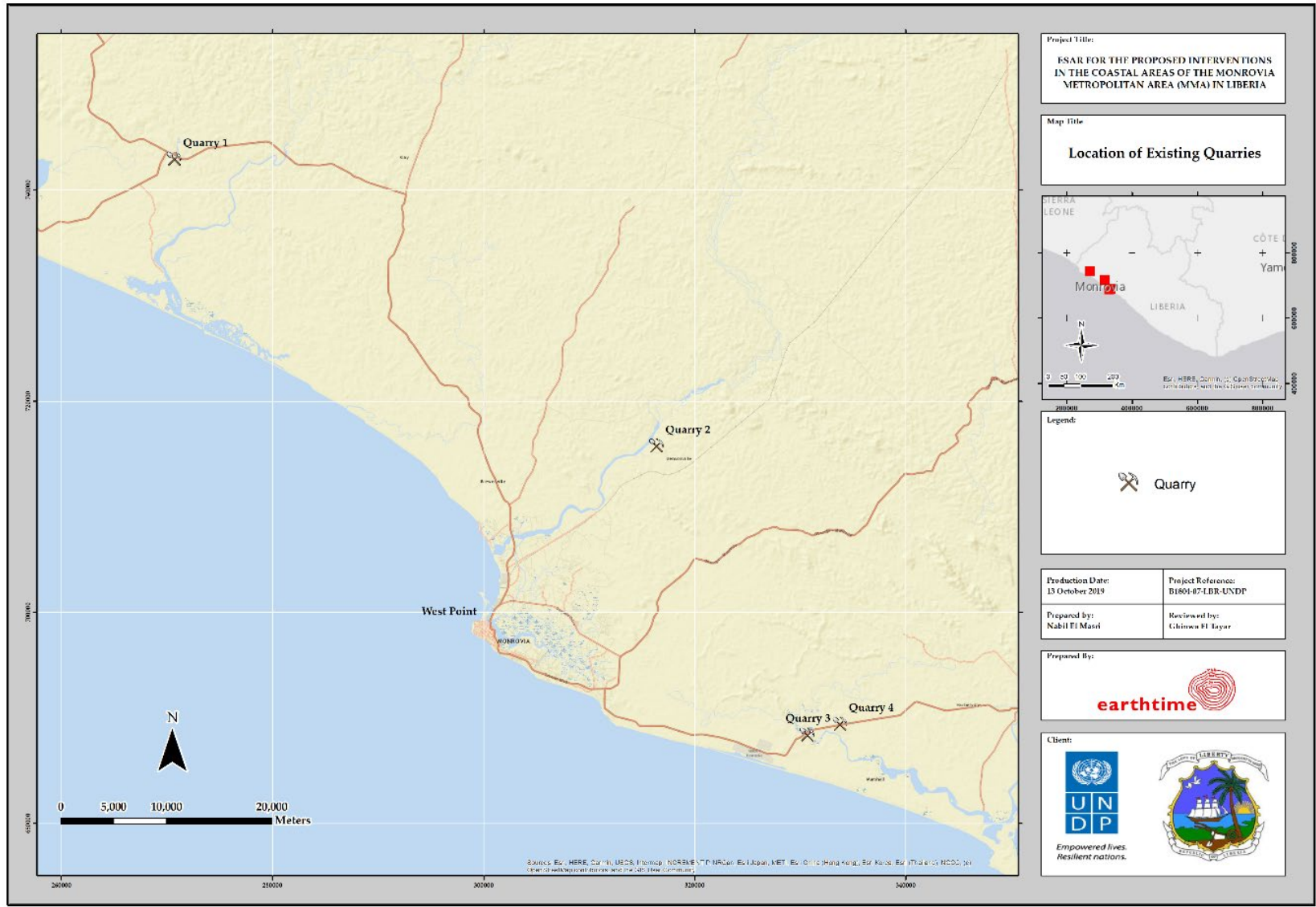


Figure 2-6 Quarries and access roads for potential sourcing of rocks for the revetment in West Point

## 2.6 WASTE

Information on the types of waste expected to result from the different activities of this project, as well as the disposal measures planned are described in Table 2-4.

Table 2-4 Types of waste expected to result from the project and planned disposal measures

Type of waste	Planned disposal measure
Municipal waste	Solid waste will be collected by a solid waste collector certified by the EPA.
Construction and demolition waste	Waste arising due to construction activity will be reused as fill or on temporary roads as much as possible. Remaining material will be disposed of safely through authorized recyclers.
Hazardous waste	Used oil and lubricants from machine sets will be stored in drums on an impermeable surface. Once the project is completed, they will be shipped back with the machines to the hiring company in compliance with the Basel Convention.
Medical waste	Medical waste resulting from the site infirmary will be collected by a solid waste collector certified by the EPA.

## 2.7 EMPLOYMENT

Employment opportunities will be available in the short term during project activities. Priority will be given to skilled and unskilled workers from the local communities. However, where the availability of skilled labour is low, there is potential for an influx of non-local labour.

Employment will include equal opportunities for both men and women. A written statement in all service providers' contracts will include commitment to equality, social inclusion and adherence to the prohibition of child labour according to the ILO Minimum Age Convention, 1973 (no 138), which sets the general minimum age for admission to employment or work at 15 years (13 years for light work) and minimum age for hazardous work at 18 years (16 years under certain strict conditions).

It is expected that the construction of the protective interventions will employ around 7 expatriates and 20 to 25 skilled local staff, plus a larger number of unskilled local workers. The minimum key staff will include managers, supervisors, surveyors, mechanics, machine operators, drivers, safety officers and security officers. Expatriate workers will be housed in one or two rented apartments, while local workers will find their own accommodation space in the urban areas close to the work sites.



### 3 PROJECT ALTERNATIVES

This chapter considers and discusses practicable alternatives that could promote the elimination of the negative environmental impacts identified. It is a critical consideration in determining the ideal project interventions with minimal environmental disturbance.

#### 3.1 DO NOTHING ALTERNATIVE

This alternative allows nature to take its course and evaluates the state of the original environment without any project intervention.

In the event that the project were not to occur (“Do Nothing”), coastal retreat and coastal erosion will continue to take place and become significantly worse due to the impacts of climate change. This can be clearly seen in the vulnerability maps presented in Appendix A which show the impacts of the least conservative climate change scenario (IPCC RCP 8.5) on the current map and assets in Monrovia. These maps were generated by CDR International (2019) and used the fifth assessment report of International Panel on Climate Change (IPCC - AR5 2014) as a basis for assessing the climate change impact. In the vulnerability maps, the hazard “lines” (blue, yellow, orange and red) show that the coastline position will shift to the east as a result of coastal retreat caused by sea level rise and increasingly intense storm erosion. Different scenarios are presented (shown by the various line colours), and the results are summarized in Table 3-1. Although all coastal sections will be affected, sections 2 and 3 will suffer the most.

Table 3-1 Projected coastline retreat due to climate change impacts for RCP 8.5 with respect to its 2020 position (adapted from CDR International, 2019a)

Coastal section	Projected coastline retreat with respect to the 2020 position (m)		
	Year 2020	Year 2050	Year 2050
	Storm with 100 year return period	No storm	Storm with 100 year return period
1	45	20	69
2	52	107	161
3	21	229	252
4	25	35	63
5	27	6	35

The Do Nothing alternative does not have any foreseen direct impacts on the environment, although there may be localised marine pollution as structures are washed away. However, it will generate significant harmful socio-economic impacts on the communities living along the

coast. If erosion control measures are not put in place, people will be forced to leave their homes, as well as their formal and informal workplaces and businesses. Most of these communities are fishermen, fishmongers or associated service providers, all of whose livelihoods depend on proximity to the beaches. Their physical displacement therefore also means loss of livelihood and trading income. With fisheries collapsing due to the lack of access by the fishermen, food security of the greater Monrovia area will deteriorate markedly because the source is no longer exploited.

The Do Nothing alternative is therefore not a supportable proposition.

### 3.2 ALTERNATIVE LOCATIONS

The five coastal sections that were selected for this project represent coastal areas where fishing activities are prominent. Their sandy beaches offer suitable locations for the safe landing of the wooden canoes used by the artisanal fishermen. These sections are all exposed to coastal retreat.

Alternative locations within the Monrovia Metropolitan area are:

- The Cape of Monrovia, a rocky peninsula located north of Mamba Point, between sections 3 and 4; and
- The Free Port area, between sections 2 and 3, which is protected by two breakwaters.

Because of their rocky or artificially protected nature, and the greater shoreline terrain elevations, both of these locations are less prone to coastal retreat. They are therefore locations where the interventions intended to be implemented under this project are unsuitable.

Coastal sections 2 and 3 were selected for inclusion in the project because they are densely populated on very low-lying ground that is particularly susceptible to inundation as sea level rises. Section 3 was selected because it is also seriously at risk of significant property loss and damage. By contrast, section 1, north of the mouth of the St. Paul River, was not selected because although it is likely that the steep beach will suffer erosion as a result of climate change-induced impacts, the consequences will not be so large. The population is much lower in this area and there is space for adaptation that does not justify major project investment. One fishing community may need to move as the beach evolves, but it is likely that an

alternative location will develop nearby. Another small village may also need to move inland. The ruined Hotel Africa may be affected, losing more of its derelict lodges and threatening the swimming pool and garden; but although this has historic value as the location of the 1979 conference of the Organisation of African Unity, its protection is hard to justify against the needs of the large communities living in much more risky locations in sections 2 and 3.

Coastal section 4 was selected because a large number of residential properties will be lost under the Do Nothing approach. Coastal section 5 (Barclay Training Center to Bernard Beach) is not predicted to have so much coastal retreat because of the nature of the shore, and less property and infrastructure will be affected. For this reason it was not considered to be a hotspot in the same category as sections 2, 3 and 4, and it is proposed to omit it from the project. Interventions here could be justified in the future, but the urgency is not as great as for sections 2, 3 and 4.

### 3.3 ALTERNATIVE INTERVENTIONS

This section discusses alternative interventions. The first group of these are adaptive — mostly improvements in capacity and management to ensure the sustainability of livelihoods, and the security of food supply. These mainly work to enhance activities that minimise contributing to the drivers of climate change. The second group are protective interventions, which are typically hard engineering approaches in a strategy of direct defence against the impacts of climate change.

#### 3.3.1 Adaptive Interventions

The project proposes a number of adaptive interventions that will help to alleviate the drivers of climate change. These will take direct action to help mitigate reliance on economic activities with higher carbon emissions, and to safeguard the estuarine mangroves that are important carbon stores and biodiversity resources. These measures therefore have strong environmental credentials. The alternatives that were considered were less sound for a number of reasons.

One alternative for coastal sections 2 and 3 (New Kru Town and West Point) in particular was to arrange the evacuation and resettlement of the areas where inundation is inevitable without protective interventions. This would be part of the retreat strategy described below. Its impact

would be the construction of settlement areas inland and the development of new livelihoods for the affected communities. Apart from the corresponding conversion of land from agriculture or bush to housing areas, resettlement would almost certainly lead to a more carbon-dependent economy for the people involved. Displaced from the easy access to the resource which they manage sustainably, they would find alternative livelihoods most likely to be urban-based and “developed” in character.

An alternative adaptation strategy might be to support an increasing industrialisation of the fishery as a way to increase resilience against the impacts of climate change. Kru, Fanti and Popoh wooden canoes could be replaced by small trawlers built of steel and powered by diesel engines, kept in newly constructed harbours in the Mesurado basin. Fishermen could live inland, in areas that are not at risk from rising sea level, and commute to the harbours by car. Catches could be processed in refrigerated facilities near the harbours. Such a development might look like the best way of increasing resilience, prosperity and food security. Yet it would consume much more fossil-fuel energy, displace many workers through the processes of mechanisation and potentially lead to the over-exploitation of the fishery through the rapid introduction of more efficient fishing methods. For all of these reasons, it appeared to be far less advantageous an alternative to that of ensuring the continuation of the existing sustainable, low energy artisanal fishery.

### 3.3.2 Protective Interventions

#### 3.3.2.1 Retreat Strategy

The retreat management strategy relies on (a) accepting the changes that take place in the coastal system, and (b) retreating from vulnerable coastal zones. Consequently, a setback line is defined and the area prone to coastal hazards is vacated (Figure 3-1). Residents and businesses need to be relocated, and new developments are not allowed within this area.

The successful implementation of a setback line is achievable through the use of permits, laws, law enforcement and political policies. It is also of paramount importance that there is no disturbance to the original livelihood and socio-economic dependencies on the coastal resources (particularly access to the beaches and the sea).

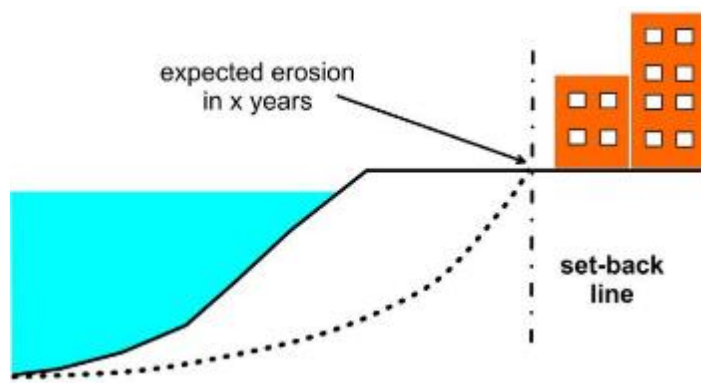


Figure 3-1 Example showing a setback line

A large number of communities living along the coast in Liberia are artisanal fishermen, who utilise the rich inshore fishing grounds of the coast. The position of the fishing communities on the low-lying shores is essential to the operation of their livelihood, as their canoes are launched from the beaches and the catches are marketed close by in the city.

If people are forced to move elsewhere, the fishermen will be unable to continue their livelihood because they will not have the ready access to the lading sites, and will be forced to take up alternative inland occupations. This will have a domino effect on the fish mongers, small businesses and markets. Food security will deteriorate markedly as the fishery collapses because the fishermen are no longer there.

In addition, a retreat strategy was previously implemented at West Point, but failed. A large majority of the residents who were relocated eventually came back to West Point, because proximity to the beach is vital for them to maintain their livelihoods.

Therefore, retreat is a complex trade-off strategy between benefits and threats. Although it is relatively cheap, requires no maintenance, and does not interfere with nature, retreat is practically very difficult to implement. It will cause the displacement of a large number of residents, loss of assets and living space. It will also have severe repercussions on the livelihoods of the fishing communities, as well as on food security in Monrovia. A setback line is therefore not considered feasible.

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### 3.3.2.2 Physical Adapt Strategy

The management strategy of physically adapting infrastructure accepts the changing coastal system and adapts the current coastal functions to it, in order to reduce vulnerability to coastal hazards. Structures can be adapted by rebuilding them on stilts or higher platforms, or by laying strong pile foundations under buildings. Another option would be to integrate the first line of buildings on the shore into a strong seawall that would ensure shoreline protection. However, all these options are technically not feasible (CDR International, 2019a).

### 3.3.2.3 Defend Strategy

The defend strategy requires a physical intervention in the natural coastal system to maintain and safeguard current functions behind the coastline.

This strategy means physically protecting a certain area against coastal hazards, to create or maintain safe living conditions behind the line of defence. From an environmental point of view, this strategy is less favourable than retreat or adapt, since it causes alteration to the existing environment. However, for urban areas, defending is quite often the most feasible option due to the number of buildings on a relatively small piece of land, and the sheer cost of accepting retreat or physically adapting them.

The defend strategy can include various types of interventions, many of which are not feasible as shown below.

- Adding sediment using a sand engine, or by constructing sand groynes are not feasible because the hydraulic conditions are too harsh on Monrovia's Atlantic coast.
- Blocking longshore sediment transport by constructing timber groynes could be technically feasible but does not mitigate cross-shore erosion. In addition, there is relatively poor scientific knowledge regarding the lifetime and efficiency of such an intervention.
- Dissipating wave energy by implementing purely ecosystem-based solutions is not feasible for the reasons described below.
  - Although bamboos are ideal for erosion control and slope stabilization on land, they cannot grow in saline conditions;
  - Coral reefs are not feasible due to the high turbidity in the water;

- Oyster reefs and seagrass beds are not feasible due to the harsh hydraulic conditions; and
- Mangrove forests and salt marshes are not feasible due to the harsh hydraulic conditions and the lack of space.
- Fixing the shoreline with a vertical seawall is an expensive solution that has a relatively high risk of failure without warning. It also causes wave reflection and eventually causes elimination of the beach.

In addition, based on the stakeholder consultation organized on January 30, 2019 in Monrovia, beach nourishment as an intervention on its own is not favoured, due to the need for continuous maintenance, and the potential risks regarding funding and implementation of regular maintenance (CDR International, 2019a).

Technically feasible solutions are not always viable for all locations, for example:

- A groyne or breakwater are considered less effective for coastal section 2 due to the presence of the dynamic St. Paul River mouth, and because cross-shore erosive processes are significant.
- An offshore breakwater will have a very limited effect at coastal section 3 and is therefore not considered sustainable.
- Although offshore (reef) breakwaters combined with beach nourishments would be feasible at coastal section 4, large structures are needed because of the steepness of the shoreface, making it a very expensive solution.
- Because of the highly energetic wave attack, a revetment wall is not feasible for coastal section 4.

### 3.4 DESIGN ALTERNATIVES

The project also studied the construction of a long groyne backed by beach nourishments as another option for physically protecting the beach from coastal retreat at West Point. This option would require heavy construction works as well as the sourcing of sand for nourishments from offshore locations using dredgers. This could result in much higher environmental impacts on the coastal and offshore marine physical and biological environments, particularly due to the dredging activities. It is also a costlier option on both

the implementation and maintenance levels, and was not favoured by stakeholders during consultations. It was therefore dropped from the project.

The implementation of protective measures in coastal sections 2 and 4 were also studied. A revetment wall with a beach promenade was designed by the CDR team to ensure the protection of the beach at coastal section 2. However, the plan was dropped because it was judged that the coastal retreat in this area was not clearly attributable to the impacts of climate change. Nevertheless, there already exists a revetment wall which was previously built by the government to protect existing structures on this coastline, and which was being reinforced and managed to better standards by the government at the time of this study. The team also designed physical solutions for the coastal section 4. The physical design option that was adopted as the most convenient and feasible in this section was the construction of a groyne along with nourishments on the beach. This option was also abandoned from the project for two main reasons:

1. The high cost of the dredging and nourishments on both the environmental level and the economic level.
2. The coastal retreat in this section could not be strongly attributed to climate change and, therefore, does not fit in the justification of the project.



## 4 LEGAL AND INSTITUTIONAL FRAMEWORK FOR ENVIRONMENTAL AND SOCIAL MATTERS

### 4.1 NATIONAL LEGISLATION, POLICIES AND REGULATIONS

The main categories of legislation in Liberia are described in Table 4-1. A summary of the Liberian legislation relevant to the project is presented in Table 4-2, while a summary of the relevant national policies, strategies, guidelines, codes and plans is provided in Table 4-3. Details from selected relevant national legislation are described in sections 4.1.1 through 4.1.3.

Table 4-1 Categories of legislation in Liberia

Category	Description
<b>Law</b>	Laws are passed by the National Legislature of Liberia, comprising the Senate and the House of Representatives. Any citizen or group of citizens, Cabinet Ministers, Managing Directors of public corporations or agencies can propose a bill to the National Legislature for enactment. The draft bill is first passed over to the appropriate Steering Committee of the Legislature. In the case of environmental bills, this committee is generally the Committee on Natural Resources, Energy and the Environment. The Committee reviews, assesses and presents the bill to the Legislative Plenary with appropriate amendments for debate, public hearing and subsequent enactment by the Legislature.
<b>Executive order</b>	The Executive Branch of government headed by the President, is charged with the duty to either approve those bills or reject them. If the President signs a bill into law; it goes immediately into effect unless there is another effective date noted. Equally, the President can issue Executive Orders without the approval of the National Legislature. The Executive orders have the power of a law provided that they do not contravene the existing law. The power of such orders has a limited time of existence.
<b>Regulation</b>	The national Legislature has empowered Cabinet Ministers and Managing Directors of public corporations and agencies to issue regulations for their respective functionaries without legislative approval or supervision, provided that such regulations are consistent with the statutory laws and the constitution of Liberia.

9 Table 4-2 Relevant national laws

Category	Title	Year	Description
<b>General</b>	Constitution of the Republic of Liberia	1986	The 1986 Constitution is the main legal framework which provides for the rights, equal treatment, and protection of all Liberian citizens and those residing within the borders of Liberia. It ensures that no citizen is discriminated against on the basis of sex, age, ethnic background, religious belief, political affiliation, social and economic status.
<b>Environment</b>	The Environment Protection Agency (EPA) Act	2003	The Act provides the EPA with the authority of government for the protection and management of the environment in Liberia. It provides for an Environmental Administrative Court to hear from aggrieved parties and requires that an Environmental and Social Impact Assessment (ESIA) be carried out for all activities and projects likely to have an adverse impact on the environment.
	The Environment Protection and Management Law (EPML)	2003	The law enables the EPA to protect the environment through the implementation of the Law. It arranges the rules, regulations, and procedures for the conduct of ESIA's and establishes regulations for environmental quality standards, pollution control and licensing, among others.
<b>Forestry</b>	Conservation of the Forests of the Republic of Liberia	1953	This Act provided for the establishment of the Bureau of Forest Conservation within the Department of Agriculture and Commerce and described the basic legal framework for forest and wildlife management in Liberia.
	Supplementary Act for the Conservation of Forests	1957	This supplementary Law also provides the framework for the use of forest and wildlife resources and allows for the creation of government reserves, native authority reserves, commercial forests, national parks and wildlife refuges.
	The Acts that created the Forestry Development Authority (FDA)	1976	These two acts established the FDA and defined its responsibilities, outlined forest offences and penalties, made provisions for an Advisory Conservation Committee and specified powers of forest officers with regard to trees in reserve areas. They gave the FDA the power to establish Government Forest Reserves, Native Authority Forest Reserves, Communal Forests and National Parks. They provided a framework for the drafting, negotiation and execution of forest products and utilization agreements between the Government and prospective forest users.
	Amendment to the FDA Act	1988	
	National Forestry Law	2000	This Act makes provision for the management and conservation of forest resources of Liberia, defines ownership rights and other rights in forests, provides for the protection of the environment and wildlife in forests, regulates the trade in forest products and provides for various other matters relative to forestry and wildlife. The act requires the FDA to "Protect and conserve the wetlands ecosystem for the benefit of the people".

Category	Title	Year	Description
	National New Forestry Reform Law	2006	This Act amends the national forestry law of 2000 and the act creating the FDA. The administration of this Act provides for the FDA to exercise power under the law to ensure sustainable management of the Republic's forestland, conservation of the forest resources, and protection of the environment. It also has provisions for sustainable economic development with the participation of and for the benefit of all Liberians to contribute to poverty alleviation in the country. The act also requires the FDA to identify and protect wetlands.
	Act to Establish the Community Rights Law with respect to Forest Lands	2009	The Law creates a legal framework that defines and supports community rights in the management and use of community and traditional lands and forest resources.
<b>Biodiversity conservation</b>	The Natural Resources Law of Liberia	1979	This Law includes chapters on forests, fish, and wildlife, soil, water, and minerals.
	Wildlife and National Parks Act	1988	The Act identifies a number of protected areas and specifies policies and objectives regarding wildlife and conservation in the country.
	Protected Forest Areas Network Law	2003	The Act for the Establishment of a Protected Forest Areas Network required a biologically representative network of protected areas to be established covering at least 30 percent of the existing forest area, comprising about 1.5 million hectares.
	FDA Draft Hunting Regulations	Undated	These regulations include a list of "Fully Protected Animals of Liberia".
	National Wildlife Conservation and Protected Areas Management Act	2014	The Law updates the 1988 law on wildlife and national parks. It includes a number of important provisions relating to biodiversity and protected areas.
<b>Fisheries</b>	Laws on Marine Fisheries (Title 24 of the Liberian Code of Laws)	1976	The Law applies to fishing in salt and fresh water. It addresses fishing licenses and registration of fishing vessels and gear.
	New Fisheries Regulations	2010	These Regulations implement the Laws on Marine Fisheries, 1976. They provide rules for the marine fisheries sector, including fisheries conservation and management; fishing and operating of fishing vessels; requirements and procedures for licenses and authorizations, and conditions and requirements for fishing, transshipment and the use of ports.
<b>Water resources</b>	Water Quality Regulations of Liberia	2018	These Regulations prohibit the pollution of water resources, including coastal and marine waters. They also provide measures for compliance, enforcement and offences.
	Water Resources (Wetlands, Rivers, Lakes, Groundwater and Sea Shore) Management Regulations	2009	These Regulations are pursuant of the provisions of the EPML (2003) and apply to all water resources and water bodies in Liberia.

Category	Title	Year	Description
<b>Mining and quarrying</b>	Act Adopting a New Minerals and Mining Law	2000	The Act lays out the ownership and rights to minerals in Liberia and the requirements to explore and to operate mines and quarries.
	Draft Mining Act	2014	The Act is aimed at establishing a framework for granting and regulating mineral titles
<b>Occupational health and safety</b>	Work Act of Liberia	2015	The Act repealed Title 18 of the Executive Law, Labour Practices of 1956. This is the most important piece of legislation on occupational health and safety in Liberia. Part VI of the Act provides the legal framework for occupational health and safety and outlines the general duties of employers and employees with respect to occupational health, safety and welfare in the workplace.
<b>Public health and safety</b>	Public Health Law	1976	This Law provides a framework for the management of public health and health systems in Liberia.
	Public Health Law, Revised.	2017	This law is the revised version of the 1976 public health law. It provides to a wide array of matters concerning public health, including, among other things, animal diseases, communicable diseases, veterinary drugs, environmental sanitation, hygiene in food establishments, control of parasites and mosquitoes, placing on the market of food, freshwater pollution and drinking water.
<b>Land rights</b>	Aborigines Law	1956	The Act states that each tribe is entitled to the use of as much of the public land in the area inhabited by the tribe, as is required for farming and other enterprises essential to tribal necessities. It shall have the possession of such land as against any other person. It goes further to say that the omission of a tribe to have its territory so delimited shall not however, affect in any way its right to the use of the land. While this Act allows tribal people to own and use the land for living and productive activities, it does not allow the individuals or groups using the land to transfer the land to another user.
	Property Law	1976	This Law established the conditions under which a Liberian can own real property and dispose of. It states that one must hold title document for such land and when transferring same, it shall be done by title, duly registered. Land acquired under this law allows the owner to convey or transfer it to another person(s) or entity through legal process.
	Rules and Regulations Governing the Hinterland of Liberia, Revised	2001	These Rules are a successor to the earlier law and regulations on the hinterland. These rules apply not only to the hinterland, but also to land in other counties, under the customary land tenure system. Articles 66 and 67 of the rules grant tribal people in the rural area the right to utilize land in their locale. Any stranger wishing to utilize such land as against their usage shall compensate for the use of the land.

Category	Title	Year	Description
	Liberia Land Commission Act	2009	The objective of this Act is to propose, advocate and coordinate reforms of land policy, laws and programs in Liberia. It does not have adjudicatory or implementation role. The goal of the commission is “to develop comprehensive national land tenure and land use system that will provide equitable access to land and security of tenure so as to facilitate inclusive sustained growth and development, ensure peace and security and provide sustainable management of the environment”.
	Land Right Act	2018	The Act is part of the recent land reform process in Liberia. The objectives of this act are i) to define the different categories of land ownership and rights in Liberia; ii) to prescribe the means by which each of the categories of land may be acquired, used, transferred and otherwise managed; iii) to ensure that all communities, families, individuals and legal entities enjoy secure land rights and iv) to ensure equal access and equal protection with respect to land ownership, use and management, including ensuring that Customary Land is given protection equal to Private Land and that land ownership is permitted for all Liberians.

10 Table 4-3 Relevant national policies, strategies, guidelines, codes and plans

Title	Year	Description
<b>National Environmental Policy</b>	2003	The policy provides a systematic and logical framework by which to address environmental issues. Section 4.7 of the policy calls for an ESIA on all major developmental, socioeconomic and land use activities in any form that may have adverse effects/impacts on the environment to one degree or another.
<b>National Biodiversity Strategy and Action Plan</b>	2004	The policy implements the United Nations Convention on Biological Diversity, of which Liberia is a member, on the national level.
<b>National Forestry Policy</b>	2006	The policy describes the main directions for the future of forestry development in Liberia, and updates earlier policies so they take into account the new Forestry Reform Law. Section 7.2 of the policy defines a strategy for the management of wetlands and mangroves.
<b>National Forest Management Strategy</b>	2007	The strategy summarizes the FDA's approach to managing the national forest endowment. It includes objectives, goals, and management actions in pursuit of the overall aim to "conserve and sustainably manage all forest areas so that they will continue to produce a complete range of goods and services for the benefit of all Liberians and contribute to poverty alleviation in the nation" (FDA 2007, 4).
<b>National Integrated Water Resources Management Policy</b>	2007	The Policy is intended to assist decision-makers and resource users in determining the roles in water resources management, "who does what and how", and in making priorities at the national level as well as at the private sector, local community and individual levels.
<b>National Gender Policy</b>	2009	The Policy is intended to eradicate and eliminate all gender related problems in Liberia.
<b>Mineral Policy of Liberia</b>	2010	The Policy provides key principles for mining and addresses quarrying (including sand mining).
<b>National Health Policy and National Health Plan</b>	2011	The document is a framework for health sector reforms in Liberia. The goal of the policy is to make health care delivery services throughout the country effective and efficient, thereby enhancing the quality of life of the population.
<b>Land Rights Policy</b>	2013	The policy provides recommendations for land rights in Liberia, centred on four basic types of rights: Public Land, Government Land, Customary Land and Private Land. The policy also fosters equal protection of all relative to all land matters. The policy recognizes that since the founding of Liberia, the lands of customary communities have been less secure than private lands. This must end such that land under customary practice and norms are given protection equal to that of private lands i.e. the land right of men and women.
<b>Fisheries and Aquaculture Policy and Strategy</b>	2014	This document provides guidance for the management and development of the fisheries sector.
<b>Environmental and Social Impact Assessment (ESIA) Procedural Guidelines</b>	2017	The ESIA Procedural Guidelines provides administrative procedures for the preparation of ESIA to ensure effective environmental governance.
<b>Code of Forest Harvesting Practices</b>	2017	This Code provides a set of guidelines to forest operators for carrying out sustainable and improved harvesting operations. It applies to all harvesting operations within Liberia's natural forests. It includes among other things, environmental and social performance requirements for timber logging and post-harvesting activities.

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#### 4.1.1 Constitution of the Republic of Liberia

The 1986 Constitution is the main legal framework which provides for the rights, equal treatment, and protection of all Liberian citizens and those residing within the borders of Liberia. It ensures that no citizen is discriminated against on the basis of sex, age, ethnic background, religious belief, political affiliation, social and economic status.

Article 7 of the 1986 Constitution of the Republic of Liberia sets the fundamental basis for the constitutional, legislative, and institutional frameworks for the protection and management of the environment. It also encourages public participation in the protection and management of the environment and the natural resources in Liberia.

Article 8 of the Constitution states that the Republic shall direct its policy toward ensuring for all citizens, without discrimination, opportunities for employment and livelihood under just humane conditions, and towards promoting safety, health and welfare facilities in employment.

Article 22 (a) provides that every person shall have the right to own property alone as well as in association with others; provided that only Liberian citizens shall have the right to own real property within the Republic.

#### 4.1.2 The Environmental Protection Agency Act

“An Act to establish a monitoring, coordinating and supervisory authority for the sustainable management of the environment in partnership with regulated Ministries and organizations and in a close and responsive relationship with the people of Liberia; and to provide high quality information and advice on the state of the environment and for matters connected therewith”.

Thus, the Environmental Protection Agency of Liberia (EPA) was created by the Act creating the Environment Protection Agency of the Republic of Liberia, known as the Environment Protection Agency Act. The Act was approved on November 26, 2002 and published on April 30, 2003. The establishment of the EPA marked a significant step forward in the protection and management of the environment of Liberia.

Section 5 of the Act designates the EPA as the principal Liberian authority for environmental management which shall co-ordinate, monitor, supervise, and consult with relevant stakeholders on all the activities for environmental protection and the sustainable use of natural resources. Section 6 (b) of the Act stipulates that the EPA should propose environmental policies and strategies to the Policy Council and ensure the integration of environmental concerns in the overall national planning. Moreover, the EPA is empowered to carry out, among other things, the following aspects of environmental protection and management in Liberia:

- Establish environmental criteria, guidelines, specifications, and standards for production processes and the sustainable use of natural resources for the health and welfare of the present generation, and in order to prevent environmental degradation for the welfare of the future generations;
- Identify projects, activities, and programs for which environmental impact assessment must be conducted under this Law
- Review and approve environmental impact statements (EIS) and environmental impact assessment (EIA) submitted in accordance with this Act;
- Monitor and assess projects, programs, and policies including activities being carried out by relevant ministries and bodies to ensure that the environment is not degraded by such activities and that environmental management objectives are adhered to and adequate early warning and monitoring on impending environmental emergencies is given;
- Review sectoral environmental laws and regulations and recommend for amendments and to initiate proposals for the enactment of environmental legislations in accordance with this Act or any other Act;
- Encourage the use of appropriate environmentally sound technologies and renewable sources of energy and natural resources;
- Function as the national clearinghouse for all activities relating to regional and international environment-related conventions, treaties and agreements, and as national liaison with the secretariat for all such regional and international instruments.



### 4.1.3 Act Adopting the Environment Protection and Management Law of the Republic of Liberia

The Environment Protection and Management Law (EPML) is the principal piece of legislation covering environmental protection and management in Liberia in parallel to the EPA Act. This Act provides the legal framework for the sustainable development, management and protection of the environment by the EPA in partnership with relevant ministries, autonomous agencies and organizations. It also stresses inter-sectoral coordination while allowing for sector specific statutes.

The EPML defines the specific requirements for performing an Environmental and Social Impact Assessment (ESIA) and other measures required to protect the environment in Liberia. Further details of the ESIA process are included in section 0.

A summary of the key sections of the EPML are presented in Table 4-4.

Table 4-4 Key sections of the EPML

Category	Description
Section 6	Requires an ESIA license or permit for the commencement of projects that have the potential to impact the environment. An ESIA is required for some specific types of projects (defined in Annex I of the EPML), while the need for an ESIA for other projects may be determined on a case-by-case basis.
Section 12	Requires environmental review for projects or activities that may have significant impact on the environment. Project proponent shall submit to the EPA their plans for improving environmental performance, including: <ul style="list-style-type: none"> <li>• Identification of the major environmental effects; and</li> <li>• A comprehensive mitigation plan in accordance with Section 15 of this law.</li> </ul>
Section 13	Requires the preparation of an environmental impact study.
Section 15	Business investors should present an environmental mitigation plan to the EPA, which should include the following sections: <ul style="list-style-type: none"> <li>• Objectives;</li> <li>• Description of activities to be carried out by the project to mitigate any adverse effects on the environment;</li> <li>• Period within which the mitigation measures shall be implemented; and</li> <li>• Proven effectiveness of the mitigation measures by indicating their experimental nature.</li> </ul>
Section 24	The EPA should ensure that projects comply with their environmental mitigation plans through monitoring of their operations. Where evidence of non-compliance occurs, the EPA shall impose remedial measures and may bring action before the Environmental Court or through the Ministry of Justice to enforce compliance.
Section 25	The EPA is responsible for carrying out periodic environmental audits of activities or projects likely to have adverse effects on the environment.
Section 58	An “Effluent Discharge License” must be obtained from the EPA for any type of discharge into the sewage system, also in case of operation of a sewage system. This license does not exceed one year.

Category	Description
<b>Section 64</b>	Requires project proponents to acquire a “Solid and Hazardous Waste Disposal License” in case of generation, storage, handling, transport or disposal of hazardous waste, or else ownership or operation of a waste disposal site. The EPA provides this license for a period of not more than one year. This license obliges the party who is generating the waste to take up waste management measures such as treatment, determination or recycling and remediation.
<b>Section 71</b>	Requires a “Pollution Emission License” for any project or activity which is likely to pollute the environment in excess of any standards or guidelines issued under this Law (the EPML). The EPA provides this license for a period of not more than one year.
<b>Section 74</b>	The EPA may prescribe general or specific guidelines for the management of rivers, lakes or wetlands. Those of specific relevance to the project include: <ul style="list-style-type: none"> <li>• Measures for the prevention or control of soil erosion;</li> <li>• The conservation of any vegetation growing in and around a river, lake or wetland;</li> <li>• The contingency plan for the prevention and control of any deliberate or accidental discharge which is likely to pollute the river, wetland or lake; and</li> <li>• The control measures to be taken in harvesting minerals including the strategies for the restoration of mining sites.</li> </ul>
<b>Section 75</b>	Prohibits the activities below in relation with any river, lake or wetland declared as protected areas by the EPA. These activities include: <ul style="list-style-type: none"> <li>• Using, erecting, constructing, placing, altering, extending, removing or demolishing any structure in, on, under, or over the bed;</li> <li>• Excavating, drilling, tunnelling or disturbing the bed otherwise;</li> <li>• Introducing or planting any part of a plant, plant specimen or organism whether alien or indigenous, dead or alive in a river, lake or wetland;</li> <li>• Introducing any animal or microorganism whether alien or indigenous, dead or alive in a river, lake or wetland;</li> <li>• Depositing any substance in a river, lake, or wetland or in or under its bed, which is likely to have adverse environmental effects on the river, lake or wetland;</li> <li>• Directing or blocking a river, lake or wetland from its natural and normal course; and</li> <li>• Draining any river, lake or wetland.</li> </ul>
<b>Section 80</b>	Provides an outline framework for the Protection of Wild Animals and Birds and includes conservation areas. It differentiates wildlife protected areas in section 80 (4) – national park, wildlife reserve, and nature reserve – from wildlife management areas in section 80 (5) – wildlife sanctuary, and community wildlife area – while also stating that the Line Ministry can designate any other area as either as it sees fit.
<b>Sections 83-85</b>	Provide the enabling environment for the conservation of biodiversity, charging the EPA with responsibility for a wide range of measures from preparing national conservation strategies to selecting and managing buffer zones to protected areas, to issuing guidelines for botanical gardens.
<b>Section 91</b>	The EPA may impose on the party that has caused or is likely to cause harm to the environment an “Environmental Restoration Order,” requiring it to remedy/prevent the harm within 21 days of the service of the order.
<b>Section 92</b>	Allows the party to request the Agency to reconsider that order (Section 91) by giving reasons in writing within the same period.
<b>Section 107</b>	States that non-compliance with the restoration order convicts the responsible party to imprisonment and/or a fine.

80 The project considered in this report includes building structures for erosion control, which  
81 falls under the “Land Reclamation and Land Development” category in Annex I of the EPML,  
82 and therefore is required to get a permit from the EPA before commencement of activities.  
83 This permit can be obtained by following the ESIA process defined in section 4.3 of this  
84 chapter.

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## 4.2 NATIONAL ENVIRONMENTAL ADMINISTRATIVE FRAMEWORK

The main institutional framework through which citizens' rights, liberty, safety, and the right to own property are protected is the Government Administrative Structure – the Central and Local Government Administration.

### 4.2.1 The Administrative Sub-Divisions of Liberia

The governance structure of Liberia is divided into the following four administrative subdivisions:

- national level;
- county level;
- district level; and
- clan level.

#### 4.2.1.1 Role of National Level Authorities

National level governance consists of three separate but equal branches - the Executive Branch which is headed by the President, the Legislative Branch which is headed by the Speaker, and the Judiciary Branch which is headed by the Chief Justice. The Legislative Branch makes and passes laws, acts, bills and budgets, and holds the Executive accountable for their implementation; the Executive plans and executes all projects and programs aimed at promoting the social, economic and political development of the country; and the Judiciary interprets the laws, conducts hearings into and adjudicates disputes.

As the head of the Government, the President ensures through close coordination with the other two branches that law and order prevail and the rights, liberty and safety of every citizen and resident is protected under the law. The President also ensures that socio-economic opportunities are created and made accessible to everyone without any form of discrimination.

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#### 4.2.1.2 Role of County Level Authorities

Liberia is divided into 15 counties. As the first tier of the local administration, the county level governance structure is headed by the Superintendent who is appointed by the President of the Republic to administer the social, economic, political and cultural affairs of the county on behalf of the President. Supported by the Assistant Superintendent for Development and the County Inspector, the Superintendent oversees the day-to-day activities of the county including ensuring that everyone under his or her jurisdiction is treated fairly and humanely, and the amicable resolution of disputes or conflicts wherever and whenever they occur within the county.

#### 4.2.1.3 Role of District Level Authorities

Counties are subdivided into a variable number of districts. As the second tier of the local administration, the district level governance structure is headed by the Commissioner. His or her team (including the Township Commissioner, the City Mayor, and the Paramount Chief) has the primary responsibility to ensure law and order in the district, as well as overseeing socio-economic development activities across the district. They also have the important responsibility of ensuring that the rights, freedom and safety of all citizens and residents within the district are protected and that no one is discriminated against based on gender, age, religious belief, etc. Like the national and county levels, the district authorities ensure that laws are enforced, and justice is served without discrimination.

#### 4.2.1.4 Role of Clan Level Authorities

As the last tier in the governance structure, the clan level administration is headed by the Clan Chief. At this level, the Clan Chief, with support from the General Town Chief and the traditional council of elders, ensures peace, security and the protection of the rights of each citizen and resident within the clan. The Clan and General Town Chief, with the guidance and advice of the traditional council, investigate and adjudicate dispute cases brought before them, foster peaceful co-existence and social cohesion through conflict mediation and resolution between and amongst citizens and residents in the clan.

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## 4.2.2 Environmental and Social Institutional Framework

The environmental and social governance in Liberia is divided between the EPA and some other ministries and national authorities, at the national level, and the Environmental and Social Committees, at the local level.

### 4.2.2.1 National Level

The EPA is the main agency and principal authority in Liberia for environmental management. In addition to the EPA, other organizations involved in environmental protection and management include the Ministry of Lands, Mines and Energy (MLME), the Ministry of Agriculture (MOA), the Forestry Development Authority (FDA). Waste management is under the Ministry of Public Works (MPW). Organizations involved in social protection and management include the Ministry of Gender, Children and Social Protection (MGCSP), the Ministry of Justice and the Ministry of Labor. Other organisations relative to the marine and maritime environment are the National Fisheries and Aquaculture Authority (NAFAA) (formerly the Bureau of National Fisheries (BNF)), the Liberia Maritime Authority (LMA) and the Liberian Coast Guard (LCG).

Table 4-5 summarizes the key functions of the EPA and other institutions relevant to environmental and social governance in the country.

153 Table 4-5 Key functions of the national institutions governing the environmental and social issues

Institution	Key Functions
<b>Environmental Protection Agency (EPA)</b>	<ul style="list-style-type: none"> <li>• To “coordinate, monitor, supervise and consult with relevant stakeholders on all activities in the protection of the environment and sustainable use of natural resources” (GoL, 2003a, s. 5);</li> <li>• Has executive authority for all environmental activities and programs relating to environmental management in Liberia (GoL, 2003a, s.5);</li> <li>• Responsible for issuing environmental impact assessment licenses; and</li> <li>• Responsible for compliance monitoring relating to environmental regulations and standards.</li> </ul>
<b>Ministry of Lands, Mines and Energy (MLME)</b>	<ul style="list-style-type: none"> <li>• Responsible for the development of mineral, water and energy resources in Liberia;</li> <li>• In charge of land surveys;</li> <li>• Coordinates, administers and regulates the use of public and private lands in Liberia, including mineral resources through granting of operation licenses, and regulates beach sand mining;</li> <li>• Conducts training and research on land rehabilitation together with the Ministry of Agriculture and the University of Liberia;</li> <li>• Manages the energy provision through the National Energy Committee; and</li> <li>• Manages water resources through the Liberian Hydrological Services (LHS).</li> </ul>
<b>Ministry of Public Works (MPW)</b>	<ul style="list-style-type: none"> <li>• Is responsible for the design, construction and maintenance of roads and highways, bridges, storm sewers, public buildings and other civil works in the country</li> <li>• Is responsible for the administration of urban and town planning, as well as provision of architectural and engineering services for all government ministries and agencies.</li> <li>• Is responsible for the installation and maintenance of the entire infrastructure required for waste management delivery services, including the construction of sanitary landfill facilities.</li> </ul>
<b>Ministry of Agriculture (MOA)</b>	<ul style="list-style-type: none"> <li>• Regulates forestry in relation to plant quarantine, agro-forestry and food crop related plantations, fishery and agriculture sectors;</li> <li>• Has specific responsibilities for soil conservation; and</li> <li>• Plans, executes, administers, manages and supervises agriculture programs and provides extension services, trains local farmers in improved cultural practices, and supplies farm inputs to enhance food security.</li> </ul>
<b>Forestry Development Authority (FDA)</b>	<ul style="list-style-type: none"> <li>• Is responsible for the protection, management and conservation of government-owned forests and wildlife on a sustainable basis;</li> <li>• Manages commercial, conservation and community use of Liberia’s forest estate;</li> <li>• Provides long- and mid-range planning in the forestry sector;</li> <li>• Prepares forestry policy, law and administration;</li> <li>• Controls the commercial use of state-owned forests: grants the concessions, supervises the adherence to the forest legislation and the concession agreements, calculates and determines forestry fees, evaluates investment proposals, executes reforestation and forest research and training and monitors activities of timber companies; and</li> <li>• Is responsible for the development and management of protected areas and wildlife through the Department of Conservation which is made up of the Division of National Parks and the Division of Wildlife.</li> </ul>

Institution	Key Functions
<b>Ministry of Gender, Children and Social Protection (MGCSP)</b>	<ul style="list-style-type: none"> <li>• Serves as the main central government institution for promoting gender equality and the elimination of all forms of discrimination against women and girls;</li> <li>• Through its National Gender Policy and National Gender Action Plan, the Ministry seeks to ensure gender equality across the spectrum of the social, economic, political and cultural life of the nation; and</li> <li>• Has a Sexual and Gender Based Violence Unit (SGBVU) mandated to monitor and report on cases of Sexual and Gender Based Violence (SGBV) throughout the country.</li> </ul>
<b>Ministry of Justice Sexual and Gender Based Violence Unit (SGBVU)</b>	<ul style="list-style-type: none"> <li>• Shares information with the Ministry of Justice to recommend cases for prosecution;</li> <li>• Serves as the secretariat for the Gender-Based Violence Inter-Agency Task Force, which brings together UN, government, and local and international NGOs to address pressing gender-based violence issues in the country; and</li> <li>• Oversees the prosecution of sexual offenses at Criminal Court “E” and at the regional justice and security hubs.</li> </ul>
<b>The Ministry of Labour</b>	<ul style="list-style-type: none"> <li>• Is the central government institution established to advance safe, fair and harmonious workplace practices that are essential to the social and economic wellbeing of citizens and residents;</li> <li>• Is responsible to set, communicate and enforce workplace standards; and</li> <li>• Develops, coordinate and implement strategies to prevent workplace injuries and illnesses through training and dissemination of health and safety information.</li> </ul>
<b>National Fisheries and Aquaculture Authority (NAFAA)</b>	<ul style="list-style-type: none"> <li>• Manages and regulates all fisheries and aquaculture activities in the Liberian waters.</li> </ul>
<b>Liberian Coast Guard (LCG)</b>	<ul style="list-style-type: none"> <li>• Is responsible to enforce the laws related to the Liberian coastline and Exclusive Economic Zone (EEZ);</li> <li>• Carries on inquiries, examinations, inspections, searches, seizures, and arrests upon the high seas as may be necessary; and</li> <li>• Provides assistance to distressed persons, vessels and aircrafts on the high seas and in Liberian waters.</li> </ul>

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#### 4.2.2.2 Local Level

To decentralize environmental management, the Environment Protection Agency Act authorizes the establishment of County and District Environmental Committees and directs the National Environmental Policy Council to provide guidelines for their establishment. Each County Committee is composed of county and district officials, traditional leaders, private citizens, and two local representatives to the national legislature. The Committee is staffed by a County Environment Officer, hired by the EPA, but responsible to the County Committee.

The District Environment Committees are to be established by and report to the relevant County Environment Committee. They are charged with promoting environmental awareness and mobilizing the public to manage and monitor activities within the district to ensure that they do not have any significant impact on the environment. The District Committees are composed of district officials, mayors, chiefs, and private citizens and are staffed by a District Environment Officer hired by the EPA.

In addition to assisting the County and District Committees in the fulfilment of their responsibilities, the County and District Environment Officers are responsible for compiling reports to the EPA, promoting environmental awareness, and conducting public hearings on environmental impact assessment in the County and the District.

At present, two County Environmental Committees have been established; One in Sinoe County and another in Nimba County. However, EPA has established outstation offices in ten counties, including Montserrado County. The offices are staffed by Environmental Inspectors. As the County Environment Committees are established, some of the Inspectors may be reassigned as County Environment Officers.

#### 4.2.3 **Environmental Inspectors and Courts**

For the enforcement of environmental requirements and standards, the Environment Protection Agency Act provides for the appointment of Environmental Inspectors and the establishment of an Environmental Court system.



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#### 4.2.3.1 Environmental Inspectors

The EPA Act authorizes the EPA to “designate its officers and duly qualified public officers/civil servants [...] to be environmental inspectors within such Counties and District limits.” Thus, Environmental Inspectors do not have to be EPA employees, but can also be designated officers or civil servants in other branches of the government. Environmental Inspectors are authorized to enter premises, inspect activities, take samples, and review records to ensure compliance with environmental rules and regulations. The exact nature of the inspector’s enforcement authority is not defined in the Act, but the Act does state that the EPA is to “[...] establish the conditions, rules and regulations governing the qualifications, performance, powers and duties of the Environmental Inspectors.” The EPML confirms that Environmental Inspectors can write Restoration Orders to correct an activity deemed to be noncompliant with environmental rules and regulations. Currently, the EPA has inspectors deployed in all the counties and districts of Liberia.

#### 4.2.3.2 Environmental Courts

The Environmental Protection Agency Act defines a two-tiered court system to hear and rule on compliance with environmental rules and regulations. The first tier is the Environmental Administrative Court. The complaints may concern the actions or decisions of the EPA or an Environmental Inspector, or may be brought by a member of the public to stop activities they believe are damaging the environment. The second tier is an Environmental Appeals Court, established at the Judicial Circuit level. At present, the Environmental Court system has not been formally established.

### 4.3 ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT PROCESS IN LIBERIA

An ESIA Process Flow Chart has been included as Figure 4-1. This process is applied prior to issuance of environment permits. The main steps in the process are (EPA, 2017):

- *Application for ESIA permit* – A formal request, in the form of a letter, is made to the EPA prior to the commencement of project activities.
- *Submission of Project Brief* – Following a response from the EPA, the project proponent is advised to proceed with the Project Brief.
- *Screening* – Screening is a process that is undertaken by the EPA to determine whether a proposal should be subject to an ESIA and if so, to what extent. If it is determined that the project does not require a full ESIA, the permit is issued or denied at this stage. In the case of this coastal protection project, an ESIA will certainly be required because it includes building structures for erosion control, which falls under the “Land Reclamation and Land Development” category in Annex I (Section 6) of the EPML, which defines activities that require a mandatory ESIA.
- *Notice of Intent* – If the project, following screening, is subject to a full ESIA, a notification is made through the media describing the proponent’s intention to engage in an undertaking.
- *Scoping* – Scoping is undertaken to identify the issues and impacts that are likely to be important and to establish the terms of reference for an ESIA study. This is largely a public consultation exercise. The findings are submitted as a separate report for EPA approval.
- *ESIA preparation* – This involves a number of distinct activities leading to the preparation of the ESIA in the form of a self-standing report for submission to the EPA. It must follow the terms of reference defined in Scoping.
  - Baseline determination – Data are collected on the relevant aspects of the physical, biological and socio-economic environments to define the current situation.
  - Impact analysis – Impact analysis is the process that will identify and predict the likely effects of the proposal on the current environmental, social and other related conditions.

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- Evaluation of significance – This is required to determine the relative importance and acceptability of residual impacts (i.e. impacts that cannot be mitigated).
  - Mitigation and impact management – To establish the measures that are necessary to avoid, minimize or offset predicted adverse impacts and incorporate them into an environmental and social management plan or system.
  - Preparation of an environmental impact statement (EIS) or report – To document, clearly and impartially, the impacts of the proposal, the proposed measures for mitigation, the significance of effects, and the concerns of the interested public and the communities affected by the proposal.
  - *Review of the EIS* – The EPA reviews the report to determine whether it meets its terms of reference, provides a satisfactory assessment of the proposal and contains the information required for decision making.
  - *Decision making* – To approve or reject the proposal and to establish the terms and conditions for its implementation.
  - *Follow up* – To ensure that the terms and conditions of approval are met; to monitor the impacts of development and the effectiveness of mitigation measures; to strengthen future ESIA applications and mitigation measures and where required, to undertake environmental audit and process evaluation to optimize environmental management.

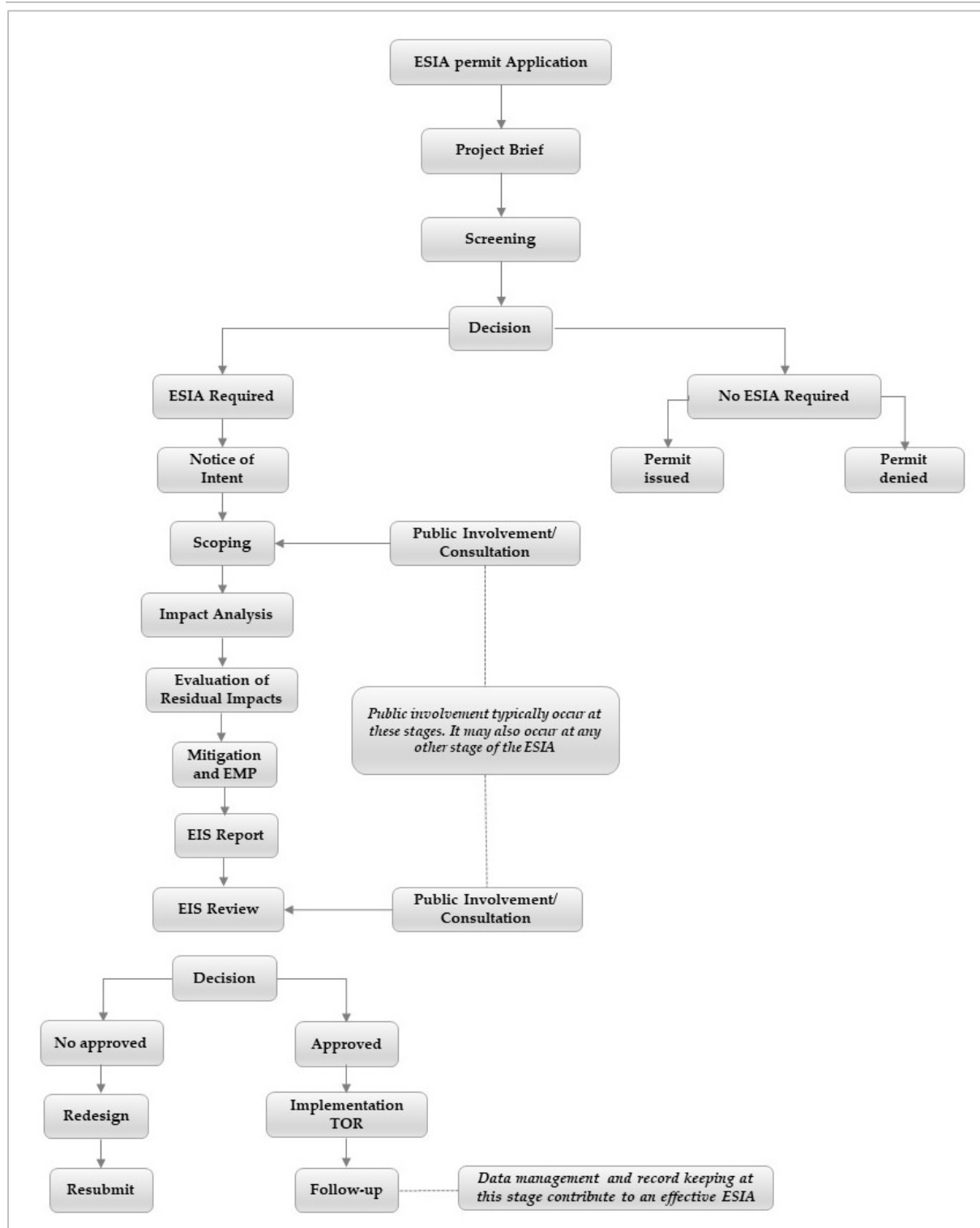


Figure 4-1 ESIA process in Liberia

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#### 4.3.1 Public Consultation Requirements of the ESIA Process

Involvement of the public in the ESIA commences with the launch of the ESIA process and continues throughout its course. Detailed below are the different requirements of the public involvement throughout the ESIA process:

1. After the submission of an application for an environmental impact assessment permit, the project proponent should publish a “notice of intent” that states the information that may be necessary to allow the stakeholders or any interested party to identify their interest in the proposed project or activity. This information should include: the nature of the project, its related activities, its timeframe and its site of operation and the area that may be impacted.
2. Before preparing the ESIA document, the project proponent should conduct public consultations with the potential affected stakeholders. This procedure is called the “scoping process” which aims to: 1) inform the stakeholders about the project’s details, its potential impacts on the physical, biological and socio-economic environments, and the mitigation measures that can be taken in order to minimize these impacts, and 2) get the stakeholders’ input on the various related issues. By achieving this, the scoping process is also a guiding tool for the project proponent and its consultants. It helps them in identifying the project’s impacts, mitigation measures and alternatives, which will form the essential part of the ESIA document. The scoping process consists of publishing the project’s details in the affected district’s media, holding public meetings to consult directly with the affected communities and stakeholders, and incorporating the views of these stakeholders in the scoping report which is submitted to the EPA.
3. On the completion of the ESIA study report, the public is invited again to participate in the ESIA review through public consultation meetings. The public’s views on the ESIA are taken into consideration by the EPA, when deciding about approving or rejecting the project.
4. In some cases, the EPA also decides to hold a public hearing about the project in order to fortify the public participation. These cases include but are not limited to: requests by the public for a public hearing, controversy about the project or expiry of the period stipulated for receipt of comments.

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## 4.4 TERMS OF REFERENCE FOR ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT REPORTS IN LIBERIA

According to the ESIA procedural guidelines for Liberia (EPA, 2017), the components of any ESIA report submitted to the EPA shall be as follows:

- Executive summary
- Introduction or overview of the project
- Policy, legal and administrative framework
- Detailed project description
- Description of the potentially affected environment including specific information necessary for identifying and assessing the environmental effect of the proposed project of activities
- Impact prediction and evaluation
- Socio-economic analysis of project impacts
- Economic information regarding the project
- Environmental management plan and mitigation measures
- Identification of alternatives
- Environmental management and training
- Monitoring program
- Public participation
- A statement of the degree of irreversible damage and an explanation
- A description of the best available technology
- An emergency response plan
- An indication of any difficulty encountered in the EIA
- Conclusion and recommendations
- List of references
- Annexes

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## 4.5 NATIONAL ENVIRONMENTAL QUALITY STANDARDS

Several environmental quality standards are partly prepared by the EPA. Some of these environmental quality standards likely to be relevant for aspects of this project are: 1) Air Quality Standards; 2) Water Quality Standards; 3) Noise Level Standards; and 4) Waste Management Standards.

Air quality standards are not complete for ambient air. They specify the tolerance limits of air pollutants in industrial areas, residential, rural and other areas, and controlled areas for different time durations (e.g. annual average, monthly average, daily average, one-hour peak, instant peak, etc.). The pollutants covered are sulphur oxides (SO<sub>x</sub>), nitrogen oxides (NO<sub>x</sub>), nitrogen dioxide, suspended particulate matter (SPM), respirable particulate matter (RPM), lead (Pb), carbon monoxide (CO)/ carbon dioxide (CO<sub>2</sub>), and ozone. Residential, rural and other area tolerance limits are almost fully specified for all pollutants, while those for industrial areas and controlled areas are still incomplete. In addition, tolerance limits for hydrocarbons (HC) and volatile organic compounds (VOC) are missing for all three areas. Existing ambient air quality standards are given in Table 4-6.

The primary water quality standards for coastal marine outfalls, class SWII (water used for bathing, contact water sports and commercial fishing) are presented in Table 4-7. In addition, the Ministry of Health and Social Welfare water standards for class II waters are presented in Table 4-8. Class II is for water used for fisheries, cultivated fisheries, organised public baths and recreational water sports, and can therefore be considered as a standard for this Project.

Noise level standards are complete for many environments. Relevant noise standards are presented in Table 4-9, Table 4-10, Table 4-11, Table 4-12, Table 4-13 and Table 4-14. Other noise standards and pollution control measures can be found in the Environment Protection and Management Law - Noise Pollution Control and Standards Regulations, 2017.

Table 4-6 Ambient air quality tolerance limits (adapted from EPML- Air Quality and Standards Regulations, 2009)

Pollutant	Time weighted average	Industrial area	Residential, rural and other area	Controlled areas***
Sulphur oxides (SO <sub>x</sub> )	Annual average*	80 µg/m <sup>3</sup>	60 µg/m <sup>3</sup>	15 µg/m <sup>3</sup>
	24 hours**	120 µg/m <sup>3</sup>	80 µg/m <sup>3</sup>	30 µg/m <sup>3</sup>
	Annual average		0.019 ppm/50 µg/m <sup>3</sup>	
	Monthly average			
	24 hours		0.048 ppm /125 µg/m <sup>3</sup>	
	One hour			
	Instant peak		500 µg/m <sup>3</sup>	
	Instant peak (10 min)		0.191 ppm	
Nitrogen oxides (NO <sub>x</sub> )	Annual average*	80 µg/m <sup>3</sup>	60 µg/m <sup>3</sup>	15 µg/m <sup>3</sup>
	24 hours**	120 µg/m <sup>3</sup>	80 µg/m <sup>3</sup>	30 µg/m <sup>3</sup>
	8 hours			
	Annual average		0.2 ppm	
	Monthly average		0.3 ppm	
	24 hours		0.4 ppm	
	One hour		0.8 ppm	
	Instant peak		1.4 ppm	
Nitrogen dioxide	Annual average		0.05 ppm	
	Monthly average		0.08 ppm	
	24 hours		0.1 ppm	
	One hour		0.2 ppm	
	Instant peak		0.5 ppm	
Suspended particulate matter (SPM)	Annual average*	360 µg/m <sup>3</sup>	140 µg/m <sup>3</sup>	70 µg/m <sup>3</sup>
	24 hours**	500 µg/m <sup>3</sup>	200 µg/m <sup>3</sup>	100 µg/m <sup>3</sup>
	Annual Average****		100 µg/m <sup>3</sup>	
	24 hours***		180 µg/m <sup>3</sup>	
Respirable particulate matter (<10 µm) (RPM)	Annual average*	120 µg/m <sup>3</sup>	60 µg/m <sup>3</sup>	50 µg/m <sup>3</sup>
	24 hours**	150 µg/m <sup>3</sup>	100 µg/m <sup>3</sup>	75 µg/m <sup>3</sup>
Lead (Pb)	Annual average*	1.0 µg/m <sup>3</sup>	0.75 µg/m <sup>3</sup>	0.50 µg/m <sup>3</sup>
	24 hours**	1.5 µg/m <sup>3</sup>	1.00 µg/m <sup>3</sup>	0.75 µg/m <sup>3</sup>
	Monthly average		2.5	
Carbon monoxide (CO)/ carbon dioxide (CO <sub>2</sub> )	8 hours**	5.0 mg/m <sup>3</sup>	2.0 mg/m <sup>3</sup>	1.0 mg/m <sup>3</sup>
	1 hour	10.0 mg/m <sup>3</sup>	4.0 mg/m <sup>3</sup>	2.0 mg/m <sup>3</sup>
Hydrocarbons (HC)	24 hours**			
Volatile organic compounds (VOC)	24 hours**			
Ozone	One hour		0.12 ppm	
	Instant peak		1.25 ppm	
<p>* Annual arithmetic mean of minimum 104 measurements in a year taken twice a week 24 hourly at uniform interval.</p> <p>** 24 hourly/8 hourly values should be met 98% of the time in a year. However, 2% of the time, it may exceed but not on two consecutive days. The 24-hour limit may not be exceeded more than three times in one year.</p> <p>*** Not to be exceeded more than once per year average concentration.</p> <p>Whenever and wherever two consecutive values exceed the limit specified above for the respective category, it would be considered adequate reason to institute regular/continuous monitoring and further investigations.</p>				



333 Table 4-7 Liberian primary water quality standards for coastal water marine outfalls, class SW-II (EPML – Water  
334 Quality Control and Standards Regulations, 2009)

Parameter	Range
pH	6.5 – 8.5
Dissolved oxygen (DO)	4.0 mg/L or 50% saturation value, whichever is higher
Colour and odour	No noticeable colour or offensive odour
Floating matters	Nothing obnoxious or detrimental for purpose of use
Turbidity	30 NTU (Nephelometric Turbidity Unit)
Faecal coliform	100/100 mL (MPN)
Biochemical oxygen demand (BOD) (3 days at 27°C)	3 mg/L
Class SW-II: water used for bathing, contact water sports and commercial fishing	

335 Table 4-8 Liberian water quality standards for Class II waters (Ministry of Health and Social Welfare, 1987)

Parameter	Unit	Range
pH	-logH	6.0 - 9.0
Chloride	mg Cl/L	≤ 350.0
Sulphate	mg SO <sub>4</sub> /L	≤ 200.0
Hardness	CaCO <sub>3</sub> mg/L	≤ 300.0
Iron Total	Fe mg/L	≤ 1.5
Manganese	Mn mg/L	≤ 0.3
Zinc Total	Zn mg/L	≤ 2.0
Coliform Bacteria	n/mL	0
Bacteria Total	n/mL	≤ 10
Dissolved Substance	mg/L	≤ 1000.0
Suspended Solids	mg/L	≤ 30.0
Ammonia	mg NH <sub>4</sub> /L	≤ 3.0
Nitrate	mg NO <sub>3</sub> /L	≤ 60.0
Nitrite	mg NO <sub>2</sub> /L	≤ 0.5
Phosphate	mg PO <sub>4</sub> /L	≤ 0.02
Phenols	mg/L	≤ 0.02
Detergents	mg/L	≤ 2.0
Fluoride	F mg/L	≤ 1.5
Cyanide	Cn mg/L	≤ 0.02
Lead	Pb mg/L	≤ 0.1
Mercury	Hg mg/L	≤ 0.005
Copper	Cu mg/L	≤ 0.01
Cadmium	Cd mg/L	≤ 0.001
Chromium Trivalent	Cr mg/L	≤ 0.5
Chromium Hexavalent	Cr mg/L	≤ 0.1
Nickel	Ni mg/L	≤ 1.0
Silver	Ag mg/L	≤ 0.01
Vanadium	V mg/L	≤ 1.0
Boron	B mg/L	≤ 1.0
Arsenic	As mg/L	≤ 0.05
<b>Key</b> mg Milligram L Litre mL Millilitre n Count n.d. Non detectable		Class II: water used for fisheries, cultivated fisheries, organized public bath, recreational water sports
Prepared for the Government of Liberia by UN Department of Technical Cooperation for UNDP New York 1987		

Table 4-9 Maximum permissible noise levels for general environment (EPML - Noise Pollution Control and Standards Regulations, 2017)

Facility	Noise Limits dB (A) (Leq)	
	Day	Night
Any building used as hospital, convalescence home, home for the aged, sanatorium and institutes of higher learning, conference rooms, public library, environmental or recreational sites	45	35
Residential buildings	50	35
Mixed residential (with some commercial and entertainment)	55	45
Residential + industry or small-scale production + commerce	60	50
Industrial	70	60
<i>Time Frame:</i> <i>Day: 6.00 a.m. to 10.00 p.m.</i> <i>Night: 10.00 p.m. to 6.00 a.m.</i> <i>The time frame takes into consideration human activity</i>		

Table 4-10 Maximum permissible noise levels (continuous or intermittent noise) from a factory or workshop (EPML - Noise Pollution Control and Standards Regulations, 2017)

Leq dB (A)	Duration (daily)	Duration (weekly)
85	8 hours	40 hours
88	4 hours	20 hours
91	2 hours	10 hours
94	1 hour	5 hours
97	30 minutes	2.5 hours
100	15 minutes	1.25 hours
103	7.5 minutes	37.5 minutes
106	3.75 minutes	18.75 minutes
109	1.875 minutes	9.375 minutes
<i>Noise Levels shall not exceed a Leq of -</i> <i>(i) Factory/Workshops 85 dB (A)</i> <i>(ii) Offices 50 dB (A)</i> <i>(iii) Factory/Workshop Compound 75 dB (A)</i>		

Table 4-11 Maximum permissible noise levels for impact or impulsive noise (EPML - Noise Pollution Control and Standards Regulations, 2017)

Sound Level dB (A) (Lmax)	Permitted number of Impulses or Impacts per Day
140	100
130	1,000
120	10,000

Table 4-12 Maximum permissible noise levels for construction sites (EPML - Noise Pollution Control and Standards Regulations, 2017)

Noise Control Zone	Sound Level dB (A) (Leq)	
	Day	Night
Residential Area	60	40
Commercial Area	75	50
Industrial Area	85	65
<i>Time Frame:</i> <i>Day: 6.00 a.m. to 10.00 p.m.</i> <i>Night: 10.00 p.m. to 6.00 a.m.</i> <i>The time frame takes into consideration human activity</i>		

Table 4-13 Maximum permissible noise levels for accelerating vehicles (adapted from EPML - Noise Pollution Control and Standards Regulations, 2017)

Vehicle type		Sound Level dB(A) (Leq)
Vehicles intended for carriage of passengers and equipped with not more than nine seats, including the driver's seat		78
Vehicles intended for carriage of passengers, and equipped with not more than nine seats, including the driver's seat and having maximum permissible mass of more than 3.5 tonnes	a) - with an engine power of more than 150 KW	80
	b) - with an engine power of less than 150 KW	83
Vehicles intended for carriage of passengers and equipped with more than nine seats including the driver's seat: vehicles intended for carriage of goods	a) - with a maximum permissible mass not exceeding 2 tonnes	79
	b) - with a maximum permissible mass exceeding 2 tonnes but not exceeding 3.5 tonnes	80
Vehicles intended for the carriage of goods and having a maximum permissible mass exceeding 3.5 tonnes	a) -with an engine power of less than 75 KW	81
	b) -with an engine power of not less than 75 KW but less than 150KW	83
	c) -with an engine power of not less than 150 KW	84

Table 4-14 Maximum permissible noise levels for residential and commercial areas (EPML - Noise Pollution Control and Standards Regulations, 2017)

Facility	Limit Value in dB(C)
For any building used as a hospital, school, convalescent home, old age home or residential building.	109 dB (C)
For any building in an area used for residential and one or more of the following purposes: Commerce, small-scale production, entertainment, or any residential apartment in an area that is used for purposes of industry, commerce or small-scale production, or any building used for the purpose of industry, commerce or small-scale production.	114 dB (C)

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## 4.6 MULTILATERAL AGREEMENTS AND BIODIVERSITY PROTOCOLS

Relevant international treaties, conventions and protocols to which Liberia is a signatory are presented in Table 4-15. The table includes all international maritime conventions ratified by Liberia because the project may involve the operation of ships to transport equipment and materials to Liberia and return of these from Liberia, possibly along with hazardous waste that may result from the project. Shipping activities must also be conducted according to the following:

- International Maritime Organization's Manual on Oil Pollution (2011 Edition).
- International Maritime Organization's Field Guide for Oil Spill Response in Tropical Waters, 1997.
- International Chamber of Shipping (Oil Companies International Marine Forum) Ship to Ship Transfer Guide for Petroleum (4th Edition), 2005.
- International Ship and Port Facility Security Code, 2002 (ISPS).

361 Table 4-15 Environmental multi-lateral agreements

Category	Name of Convention	Liberia Date of Ratification	Relevance to the Project
Biodiversity conservation	Convention on Biological Diversity (CBD) (UN, 1992)	8 November 2000	The project takes place near areas with biodiversity importance.
	Cartagena Protocol on Biosafety (UN, 2000)	15 February 2002	
	Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) (Switzerland, 1973)	9 June 1981	CITES species can occur in the project location.
	Convention on the Conservation of Migratory Species of Wild Animals (CMS/Bonn Convention) (Germany, 1979)	2 September 2004	Potential occurrence of terrestrial, avian and piscine migratory species within the project area.
	Memorandum of Understanding concerning Conservation Measures for Marine Turtles of the Atlantic Coast of Africa (CMS/UNEP, 2000)	24 November 2005	
	Memorandum of Understanding concerning the Conservation of the Manatee and small Cetaceans of Western Africa and Macaronesia (CMS, 2008)	3 October 2008	
	Memorandum of Understanding on the Conservation of Migratory Sharks (CMS, 2010)	12 February 2010	
	International Convention for the Conservation of Atlantic Tunas (FAO, 1966)	14 February 2014	
	Revised African Convention on the Conservation of Nature and Natural Resources (Maputo Convention) (AU, 2003)	23 February 2014	The project will take place near parts of Liberia with conservation value.
	Convention on Fishing and Conservation of the Living Resources of the High Seas (UN, 1958)	27 May 1958 (Simple signature)	The main stakeholders of the project are fishermen and fish mongers.
	Convention for Co-operation in the Protection and Development of the Marine and Coastal Environment of the West and Central African Region (Côte d'Ivoire, 1981)	22 March 2005	Project activities will take place in the marine environment, coastal zones and related internal waters falling within the jurisdiction of Liberia.
	Protocol concerning Co-operation in combating Pollution in cases of Emergency (Côte d'Ivoire, 1981)	23 March 2005	
Wetlands	Convention on Wetlands of International Importance especially as Waterfowl Habitat (Ramsar) (UNESCO, 1971)	2 July 2003	The project takes place in proximity to the Mesurado Wetland.
	Protocol to amend the Convention on Wetlands of International Importance especially as Waterfowl Habitat (UNESCO, 1982)	2 July 2004	

Category	Name of Convention	Liberia Date of Ratification	Relevance to the Project
<b>Air quality</b>	Convention for the Protection of the Ozone Layer (Vienna Convention) (UN, 1985)	15 January 1996	Project activities will result in emissions that deplete the ozone layer.
	Montreal Protocol on Substances that Deplete the Ozone Layer	15 January 1996	
	Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer	30 November 2004	
<b>Climate change</b>	United Nations Framework Convention on Climate Change (UNFCCC) (UN, 1992)	5 November 2002	Project activities will result in increased traffic in the area and therefore increased greenhouse gas emissions.
	Kyoto Protocol (UN, 1997)	5 November 2002	
	Doha Amendment to the Kyoto Protocol (UN, 2012)	17 August 2015	
	Paris Agreement (UN, 2018)	27 August 2018	
<b>Waste transport</b>	Bamako Convention on the Ban of the Import into Africa and the Control of Transboundary Movement and Management of Hazardous Wastes within Africa (AU, 1991)	16 December 2013	The Convention governs transboundary movement of hazardous wastes and applies if offshore activities include disposal of hazardous wastes in African countries outside of Liberia
	Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (UN, 1989)	22 September 2004	The Convention governs transboundary movement of hazardous wastes and is applicable when offshore activities include disposal of hazardous wastes outside of Liberia.
	Amendment to the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (UN, 1995)	16 September 2005	
	Basel Protocol on Liability and Compensation for Damage Resulting from Transboundary Movements of Hazardous Wastes and their Disposal (UN, 1999)	16 September 2005	
<b>Socio-cultural</b>	Convention Concerning the Protection of the World's Cultural and Natural Heritage (UNESCO, 1972)	23 March 2002	Potential occurrence of culturally important resources in areas of vegetation clearing and material sourcing.
	International Covenant on Economic, Social and Cultural Rights (ICESCR) (UN, 1976)	22 September 2004	The project is expected to affect the livelihoods of local communities as well as a good amount of local labour force.

Category	Name of Convention	Liberia Date of Ratification	Relevance to the Project
Maritime	Agreement for the Implementation of the Provisions of the UN Convention on the Law of the Sea of 10 December 1982 relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks (UN, 1995)	16 September 2005	Project activities will take place at or near the sea and may involve the operation and use of ships and fuel tankers.
	United Nations Convention on the Law of the Sea (UNCLOS) (UN, 1982)	25 September 2008	
	International Convention on Oil Pollution Preparedness, Response and Co-operation (OPRC) (IMO, 1990)	5 October 2005	
	Protocol on Preparedness, Response and Co-operation to Pollution Incidents by Hazardous and Noxious Substances	18 September 2008	
	International Convention for the Safety of Life at Sea (SOLAS) (IMO, 1974)	29 November 1983	
	Protocol of 1988 relating to the International Convention for the Safety of Life at Sea, 1974 (IMO, 1988)	26 February 1997	
	International Convention for the Control and Management of Ships' Ballast Water and Sediments (BWM 2004) (IMO, 2004)	18 September 2008	
	International Convention for the Prevention of Pollution from Ships (MARPOL), 1973, as modified by the Protocol of 1978 (MARPOL 73/78), including Annexes I-VI (IMO, 1978)	28 October 1980	
Other	Stockholm Convention on Persistent Organic Pollutants (UNEP, 2001)	23 May 2002	Potential use of insecticides and pesticides during the project activities.
	African Convention on the Conservation of Nature and Natural Resources (Algiers Convention) (AU, 1968)	22 November 1978	The project will use natural resources.
	African Convention on the Conservation of Nature and Natural Resources, Revised Version (AU, 2003)	Simple signature: 16 December 2003	
	UN Convention to Combat Desertification (UNCCD) (UN, 1996)	2 March 1998	Vegetation clearing is anticipated for the project.
	International Tropical Timber Agreement, 1994 (ITTA) (UN, 1994)	9 December 1994	Project materials could include timber.

## 4.7 GENDER EQUALITY FRAMEWORK IN LIBERIA

Liberia has ratified or acceded to the core international human rights treaties. It is a party to the major regional human rights instrument which obliged states to respect, protect and fulfil human rights of all persons within the territory and subject to the jurisdiction of the state, without discrimination. As a state party to the Convention on the Elimination of all forms of Discrimination Against Women (CEDAW) and the Protocol to the African Charter on Human and Peoples' Rights on the Rights of Women in Africa (the "Maputo Protocol"), Liberia has made legally binding commitments to exercise due diligence to combat gender-based violence and discrimination. Table 4-16 presents the legal and safeguard provisions that are in place to address this issue.

**Table 4-16 Provisions related to human rights and anti-gender-based discrimination and violence in Liberia**

Category	Provisions
<b>Inter-national treaties</b>	<ul style="list-style-type: none"> <li>• The International Covenant on Civil and Political Rights (ICCPR) (2004)</li> <li>• The International Covenant on Economic, Social and Cultural Rights (ICESCR) (2004)</li> <li>• The Convention against Torture and Other Cruel, Inhuman or Degrading Treatment or Punishment (CAT) (1993)</li> <li>• The Convention on the Elimination of All Forms of Discrimination against Women (CEDAW) (1984)</li> <li>• The Convention on the Rights of the Child (CRC) (1990)</li> <li>• The Convention on the Rights of Persons with Disabilities (CRPD) (2012)</li> <li>• The International Convention on the Elimination of All Forms of Racial Discrimination (1976)</li> </ul>
<b>Regional treaties</b>	<ul style="list-style-type: none"> <li>• The African Charter on Human and Peoples' Rights (ACHPR) (1982)</li> <li>• The African Charter on the Rights and Welfare of the Child (ACRWC) (2007)</li> <li>• The Protocol to the ACHPR on the Rights of Women in Africa (the "Maputo Protocol") (2007)</li> </ul>
<b>National policies</b>	<ul style="list-style-type: none"> <li>• The National Action Plan for the Implementation of United Nations Security Council Resolution 1325 (2009)</li> <li>• The National Sexual and Reproductive Health Policy (2010), providing for access to quality health services for survivors of sexual violence and the establishment of a reporting mechanism to facilitate intra-governmental coordination in the management of SGBV cases (MOHSW, 2010)</li> <li>• The National Plan of Action for the Prevention and Management of Gender Based Violence in Liberia (2011-2015)</li> <li>• The Reconciliation Roadmap (2012), incorporating recommendations of the Truth and Reconciliation Commission to enhance women's psychosocial recovery and economic empowerment as a form of redress for sexual violence (Republic of Liberia, 2012)</li> <li>• The Agenda for Transformation (2012), which includes provisions to address gender-based violence and empower women in multiple sectors and to enhance the protection of children from violence and abuse (MPEA, 2012)</li> <li>• The National Human Rights Action Plan of Liberia (2013), which incorporates recommendations regarding SGBV received during the Universal Periodic Review (UPR) process</li> <li>• The third Joint Program of the Government of Liberia and the United Nations on SGBV and harmful traditional practices, launched in 2016</li> <li>• Revised National Gender Policy (2018-2022)</li> <li>• European Union – United Nations Spotlight Initiative (2019-2022)</li> </ul>



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## 4.8 GCF AND UNDP ENVIRONMENTAL AND SOCIAL REQUIREMENTS

### 4.8.1 GCF Environmental and Social Policy

The policy reflects the broad consensus on GCF commitments to achieve environmental and social benefits and avoid harm in all the activities undertaken and supported, and the importance of conveying these clearly to stakeholders and communities. It articulates how GCF integrates environmental and social considerations into its decision-making and operations to effectively manage environmental and social risks and impacts, and improve outcomes. This policy presents the commitments of GCF and articulates the principles and standards to which GCF will hold itself accountable.

The policy requires that all GCF-supported activities will commit to:

- Avoid, and where avoidance is impossible, mitigate adverse impacts to people and the environment;
- Enhance equitable access to development benefits; and
- Give due consideration to vulnerable populations, groups, and individuals (including women, children, and people with disabilities, and people marginalised by virtue of their sexual orientation or gender identity), local communities, indigenous peoples, and other marginalised groups of people and individuals that are affected or potentially affected by GCF-financed activities.

The policy requires that GCF's accredited entities, including financial intermediaries, establish an environmental and social management system to assess, mitigate and manage the environmental and social risks and impacts of the supported activities. GCF will require accredited entities to assign the appropriate environmental and social risk categories to activities in a manner consistent with the accreditation framework of GCF. The categories are as follows:

- Category A. Activities with potential significant adverse environmental and/or social risks and impacts that, individually or cumulatively, are diverse, irreversible, or unprecedented;

- Category B. Activities with potential limited adverse environmental and/or social risks and impacts that individually or cumulatively, are few, generally site-specific, largely reversible, and readily addressed through mitigation measures; and
- Category C. Activities with minimal or no adverse environmental and/or social risks and/or impacts.

As this ESAR shows (section 7), this project is deemed to fall into Category B of environmental and social risk.

#### 4.8.2 UNDP Social and Environmental Standards

UNDP's Social and Environmental Standards (SES) underpin UNDP's commitment to mainstream social and environmental sustainability in its programmes and projects to support sustainable development. The objectives of the SES are to:

- Strengthen the social and environmental outcomes of UNDP Programmes and Projects
- Avoid adverse impacts to people and the environment
- Minimize, mitigate, and manage adverse impacts where avoidance is not possible
- Strengthen UNDP and partner capacities for managing social and environmental risks
- Ensure full and effective stakeholder engagement, including through a mechanism to respond to complaints from project-affected people

The SES document clarifies that UNDP will not support activities that do not comply with national law and obligations under international law, whichever is the higher standard.

UNDP applies the following three principles to the development and implementation of country, regional and global programmes:

- human rights-based approach to development programming;
- gender equality; and
- environmental sustainability.

UNDP screens and reviews its activities to identify opportunities to advance these principles and to identify potential risks that may require measures to avoid, minimize, and/or mitigate potential impacts.

The SES are comprised of 7 standards:

- Standard 1: Biodiversity Conservation and Sustainable Natural;
- Standard 2: Climate Change Mitigation and Adaptation;
- Standard 3: Community Health, Safety and Working Conditions;
- Standard 4: Cultural Heritage;
- Standard 5: Displacement and Resettlement;
- Standard 6: Indigenous Peoples; and
- Standard 7: Pollution Prevention and Resource Efficiency.

Application of these seven standards is ensured by UNDP through its Social and Environmental Screening Procedure (SESP). The SESP is a requirement for all proposed projects with a budget of US\$500,000 or more, and seeks to:

- integrate the SES overarching principles;
- identify potential social and environmental risks and their significance;
- determine the project's risk category (Low, Moderate, High); and
- determine the level of social and environmental assessment and management required to address potential risks and impacts.

The standards are also supported by an Accountability Mechanism with two key functions:

- A Stakeholder Response Mechanism (SRM) that ensures individuals, peoples, and communities affected by UNDP projects have access to appropriate procedures for hearing and addressing project-related grievances; and
- A Compliance Review process to respond to claims that UNDP is not in compliance with UNDP's social and environmental policies.

*This report is developed and presented in a manner that meets the SESP and SRM requirements and objectives. Standard 5 (Displacement and Resettlement) and Standard 6 (Indigenous Peoples) were not considered to be relevant in this context, as discussed elsewhere in this report, as the resettlement of people and impacts on indigenous groups are not anticipated (although these matters need to be confirmed in the project's ESIA). Standards 1, 2, 3, 4 and 7 are to be met by the project.*

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## 5 DESCRIPTION OF THE OVERALL ENVIRONMENT

This chapter presents a description of the overall environment in the project area, namely the physical, biological, and socio-economic environments. The data presented is largely from secondary sources, but some primary baseline data was also collected, including the collection and analysis of water, sand and sediment samples, the collection of data on marine faunal biodiversity, as well as the collection and analysis of socio-economic data. Findings of these surveys are included within the relevant baseline sections below.

### 5.1 PHYSICAL ENVIRONMENT

Liberia is located on the southwest corner of West Africa. Positioned on the Atlantic coastline, it lies between longitudes 7°30' and 11°30' west and latitudes 4°18' and 8°30' north and has a total surface area of 111,370 km<sup>2</sup>. Liberia is bordered by Guinea on the north, Sierra Leone on the west and Ivory Coast on the east. The capital, Monrovia, is the country's largest city.

Liberia has a 560 km long coastline and claims an exclusive economic zone (EEZ) of 200 nautical miles and a territorial sea of 13 nautical miles (USAID, 2008). The Liberian coast is characterized by low, flat and sandy unbroken beaches, with a few bays, many coastal inlets and lagoons (Ssentongo, 1987). The dominant vegetation is swamp-related, including mangrove forests that extend up to 40 km inland (USAID, 2008 and Republic of Liberia, 2017).

The project location lies on the coastal plains of Monrovia, characterized by relatively flat sandy beaches interspersed with sand bar-enclosed lagoons, mangrove swamps, and a few rocky cliffs.

#### 5.1.1 Existing Climate

The climate of Liberia is highly influenced by its equatorial position in the Inter-Tropical Convergence Zone, an area encircling the equator where winds originating in the northern and southern hemispheres come together. In Liberia, the Inter-Tropical Convergence Zone is primarily influenced by the interaction of low and high pressure belts along the African continent and the Atlantic Ocean. Liberia typically has a fairly warm temperature throughout the year, with high humidity (UNDP, 2006).

#### 5.1.1.1 Temperature

The Atlantic Ocean influences the temperature along the coast with maximum annual and daily variations (UNDP, 2006). Diurnal temperature variation is minimal, with temperatures ranging between 27 and 32°C during the day and between 21 and 24°C at night (Ssentongo, 1987). The average annual temperatures along the coast range from 24 to 30°C. The highest temperatures occur between January and April, while the lowest occur between August and September (UNDP, 2006).

#### 5.1.1.2 Precipitation

Liberia has two seasons – a dry season, which usually runs from November to April, and a rainy season, which generally runs from May to October. The annual precipitation in Monrovia is around 4,600 mm. The heaviest rainfall generally falls in June, July and September. The average rainfall per month recorded between 1944 and 1973 in Monrovia are presented in Figure 5-1. Precipitation in Monrovia is typically intense and of short duration, called convective rainfall. Its diurnal distribution generally shows that two-thirds of the rain falls during the night between 6:00 pm and 7:00 am (UNDP, 2006; Brandolini and Tigani, 2006).

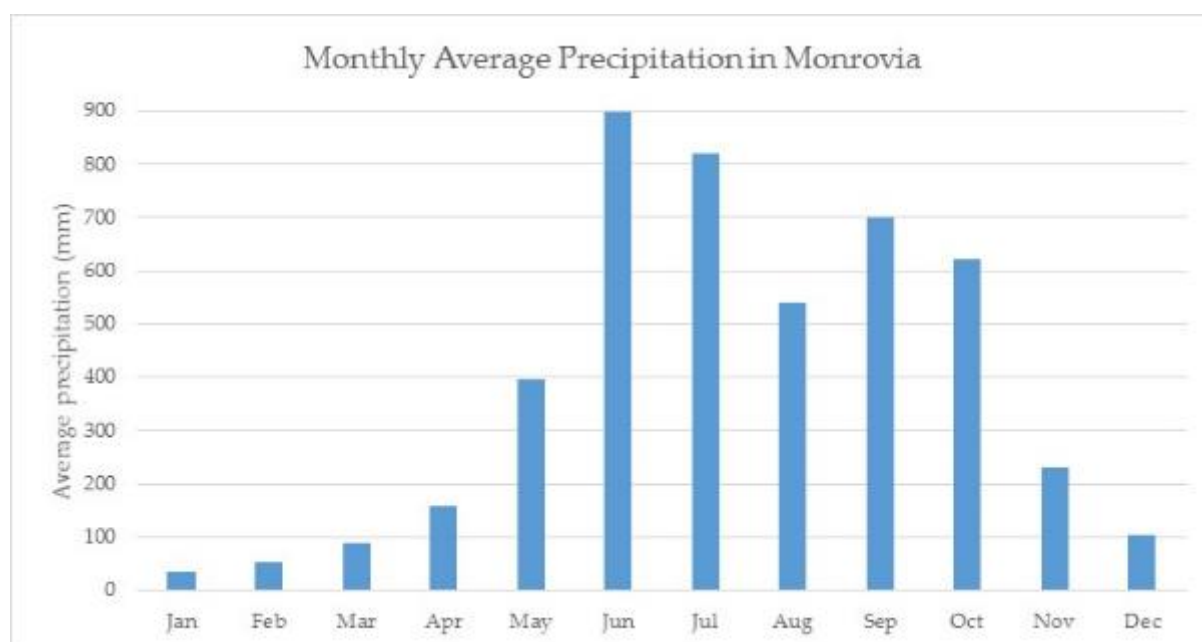


Figure 5-1 Monthly average precipitation in Monrovia between 1944 and 1973 (mm) (adapted from LHS, 1980)

### 5.1.1.3 Wind

The seasons in Liberia mainly result from the movement of air masses. The Inter-tropical Convergence Zone (ITCZ) follows the sun to move north of the Equator and the coast in the northern hemisphere summer, drawing relatively cool but moist air from the South Atlantic Ocean on to the land. When the ITCZ shifts south of the Equator in the southern hemisphere summer, the warm, dry continental air mass flows across Liberia and offshore (UNDP, 2006). However, while these general seasonal patterns explain the wet and dry seasons, more localised atmospheric pressure variations mean that onshore winds can occur at any time of year, and offshore winds can also be experienced during the northern hemisphere summer.

Onshore wind data recorded at Robertsfield Airport between 2000 and 2006 show that although wind direction slightly changes throughout the months, the dominant direction is southeast, and the second dominant direction is south (Figure 5-2). The highest monthly mean wind speed occurs in August at 10.3 km/h, while the lowest occurs in January at 7.1 km/h (JICA, 2009). Along the coast, the average annual wind speed is approximately 30 km/h (Brandolini and Tigani, 2006).

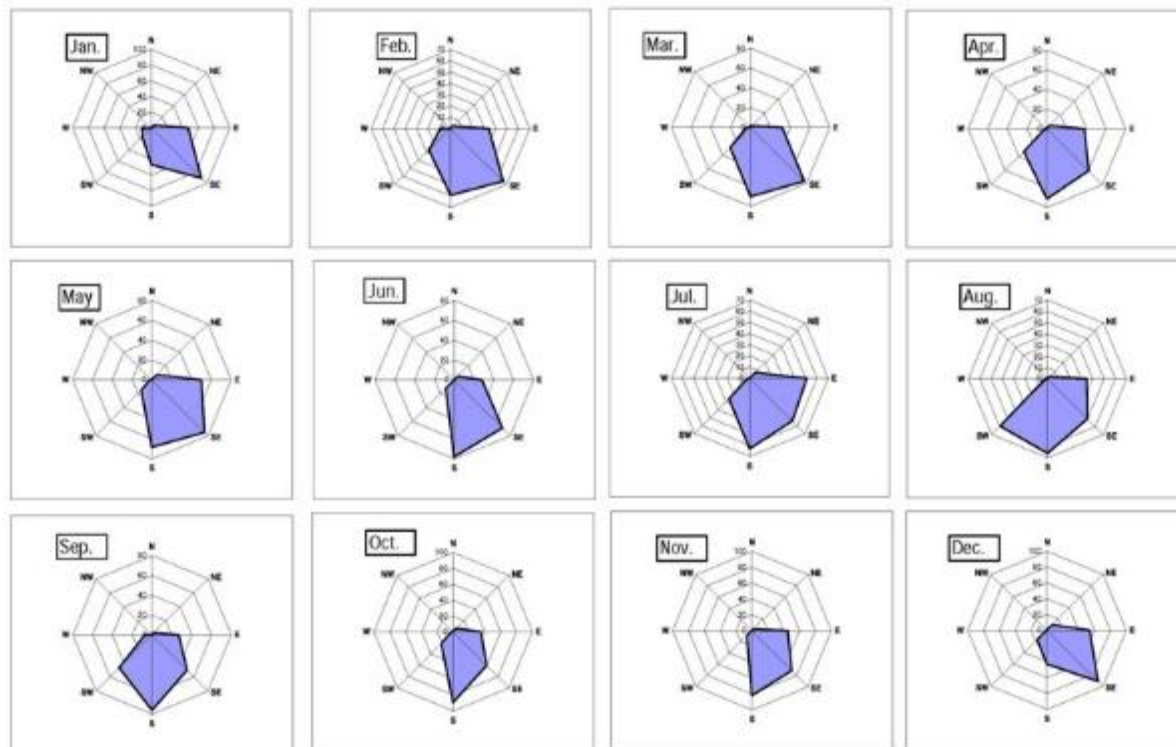


Figure 5-2 Monthly frequency of onshore wind direction at Robertsfield between 2000 and 2006 (JICA, 2009). Note that these diagrams show the direction of source of wind.

Offshore winds originate from the north and northeast. Wind speed varies between 0 to 10 m/s, creating a calm to moderate wind climate in Monrovia (Figure 5-3). While these are gentler than the onshore winds, they can include the very dry and dust-laden Harmattan.

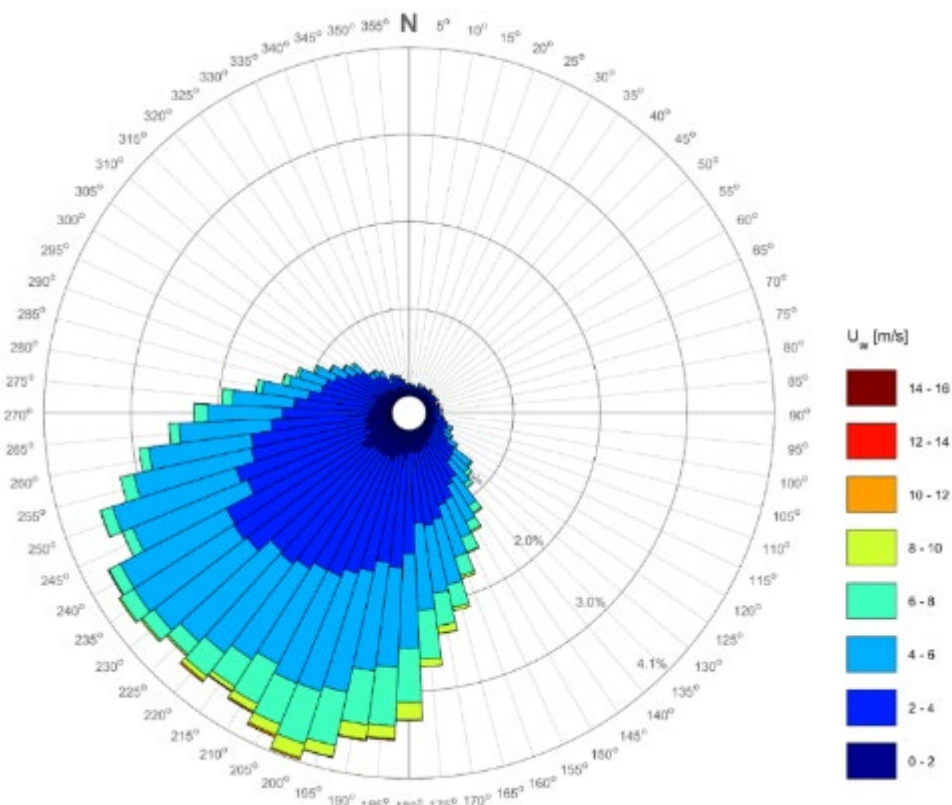


Figure 5-3 Rose diagram of offshore winds (CDR International, 2019a). Note that this diagram shows the direction of flow of the wind, the opposite to Figure 5-2.

#### 5.1.1.4 Relative Humidity

Relative humidity is generally high throughout the year. During the rainy season, it is common for relative humidity to range between 90 and 100%, while it can be as low as 65% during the dry season (UNDP, 2006). Data collected by the Liberian Hydrological Services (LHS) between 2000 and 2006 at Robertsfield Airport shows that August was the month with the highest relative humidity (92.4%) and February with the lowest (88.6%) (JICA, 2009).

Daily variation observed in Monrovia during the dry season show that relative humidity decreases to 80-85% during the day, and can even reach 65% during January and February, the driest months of the year. At night and in the early mornings, relative humidity reaches 90-100%, regardless of the season (Schulze, 1973).

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## 5.1.2 Geology, Coastal Topography and Bathymetry

### 5.1.2.1 Geology

The NW-SE orientation of the Liberian coast has been largely controlled by lineaments of Pan-African age (550 ma) along which rifting of the West African margin occurred during the Mesozoic (Anthony, 1991; Jones; Mgbatogu, 1982). The Liberian coast consists of a series of swash-aligned barrier beaches and enclosed lagoons, multiple prograded beach ridge plains and rocky headlands (Anthony, 1995; Bird, 2010).

Most of Monrovia's coastal area consists of lagoonal and beach deposits belonging to the Quaternary period, with the exception of a diabase rock formation at the Cape of Monrovia (north of Mamba point, between sections 3 and 4) belonging to the Jurassic period. This formation occurs as sill-like bodies in the coastal areas near Monrovia, and primarily consists of calcic plagioclase and clinopyroxene with minor amounts of magnetite and ilmenite. Its composition renders it more resistant to erosion, compared to the areas surrounding it.

Fluvial and deltaic deposits are found a little further inland all along the coast, underlying a terrain of very low relief. These deposits consist of buff silt and sand deposits, and could include some beach sands. The geology of the project area is shown in Figure 5-4.



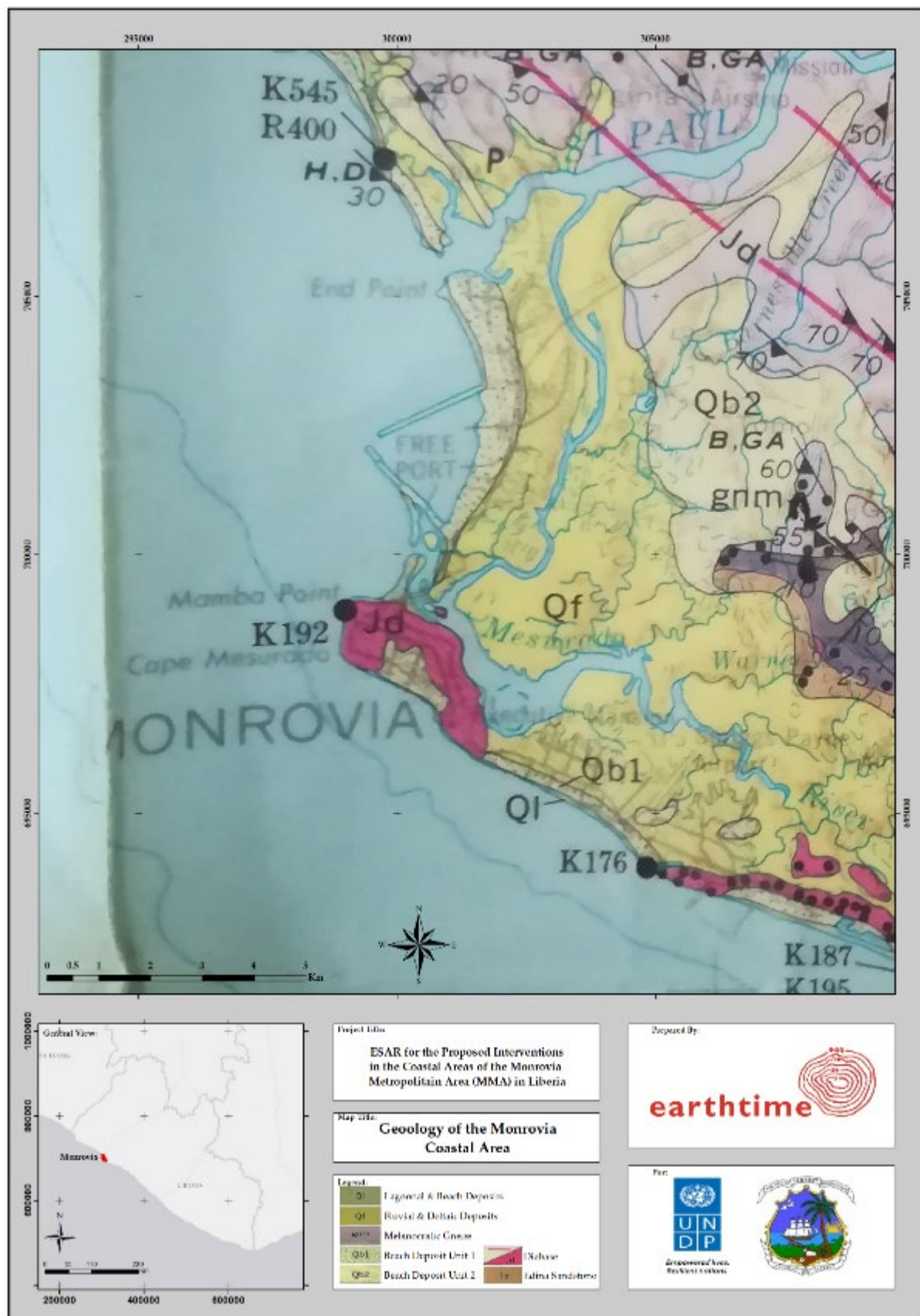


Figure 5-4 Geological map of the project area

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#### 5.1.2.2 Coastal Topography and Bathymetry - General

Liberia can be divided into three distinct topographical areas:

- A *flat coastal plain* which extends up to 80 km inland and is characterised by the abundance of creeks, lagoons, and mangrove swamps;
- An area of *broken, forested hills* with altitudes from 180 to 370 m, which covers most of the country; and
- An area of *mountains* in the northern highlands, with elevations reaching 1,384 m.

The project area falls within the flat coastal plain area in Monrovia. Coastal sections 1, 2 and 3 are relatively flat, low-lying lands that have an average terrain elevation of 0 to 10 m +MSL. The Cape of Monrovia, southwest of Coastal section 3, is a hill that reaches up to 80 m +MSL in elevation, making it the highest point in Monrovia. Coastal sections 4 and 5 have an average terrain elevation that ranges between 0 and 20 m +MSL, with occasional points that can reach up to 30 m +MSL (Figure 5-5).

Liberia's coastline is approximately 560 km long. The continental shelf is relatively narrow, ranging from 16 to 56 km wide, with water depths of around 80 to 100 m at the shelf edge (Wiles, 2005; Brandolini et al., 20016). The continental shelf off Monrovia is relatively flat and narrow (Robb et al., 1973; Villegas and Garcia, 1983). The shelf is reported to have a discontinuous sediment cover, with areas of exposed basement rock (McMaster et al., 1975). In the northwest of Liberia, the continental slope starts at 300 m depth, whereas it starts at approximately 100–120 m in the southeast. Beyond this depth, the sea floor has canyons and rocky outbreaks. A fossil coral bank lies parallel to the coast at between 80 and 200 m (Martos et al., 1991; Villegas and Garcia, 1983)

In the project area, the bathymetric topography of coastal sections 1 and 2 is characterized by gentle slopes, while coastal sections 3, 4 and 5 have steeper slopes, as can be seen in Figure 5-5. For example, at a distance of 5,000 m from the shore, the depth ranges between 15 and 20 m below MSL for coastal sections 1 and 2, while it ranges between 20 and 25 m below MSL for coastal section 3, and between 30 and 35 m below MSL for coastal sections 4 and 5.

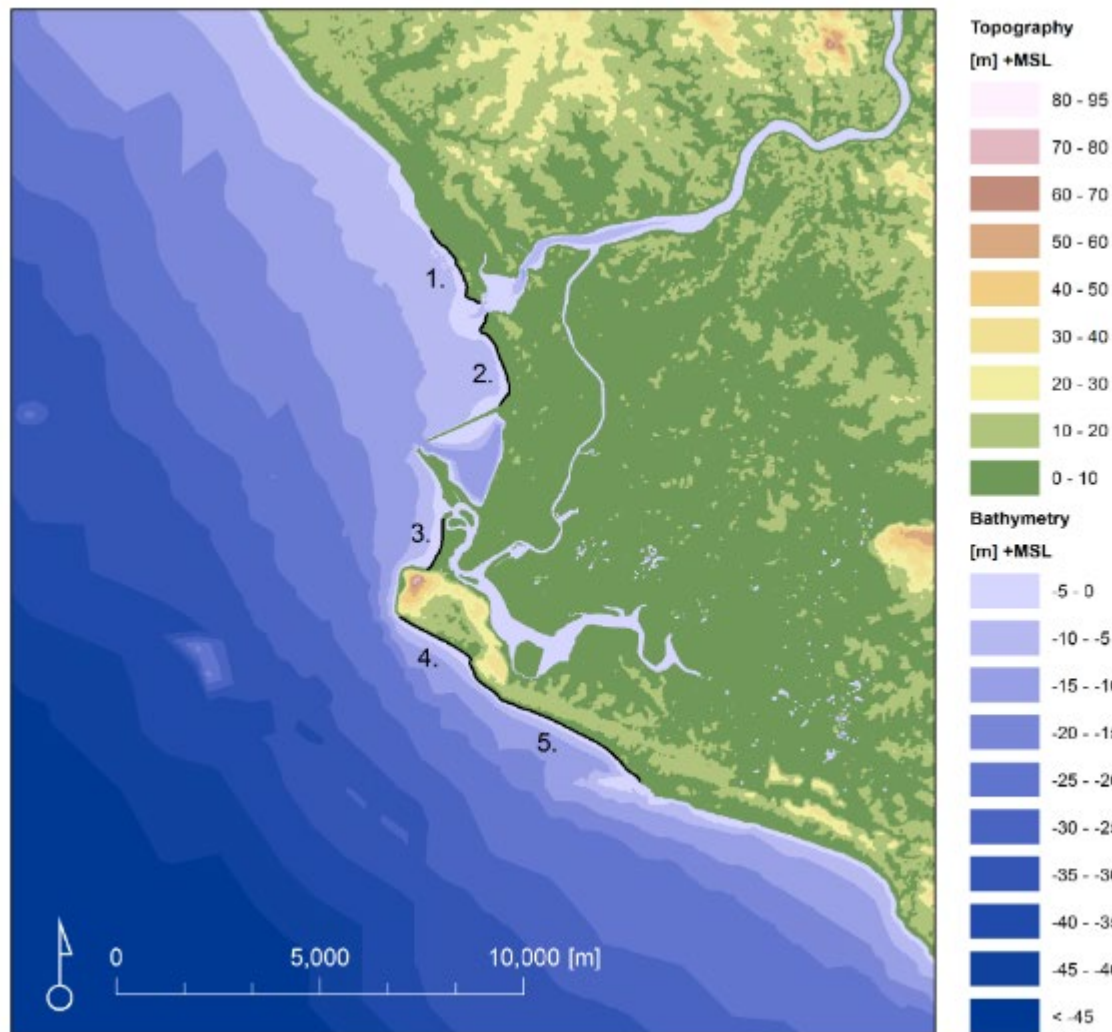


Figure 5-5 Bathymetric and topographic map of the project area (CDR International, 2018)

### 5.1.2.3 Coastal Topography and Bathymetry - West Point

Although the bathymetry for coastal area 3 (West Point) shows that the sea bed shelves relatively steeply in comparison with the near-shore zone further north, it is still quite a gentle slope. Figure 5-6 shows a profile for the West Point area. In this, the bay effect is very visible, with shallow water extending further offshore than is the case around Mamba Point to the south. At West Point, the water does not reach a depth of 8 metres until it is about 500 metres offshore. The sea bed here appears to be sandy and silty, with an even slope and no rock outcrops.





Figure 5-6 Coastal profile of the West Point area. Marine contours are at 2-metre intervals.

### 5.1.3 Seismicity

Liberia falls within the Western-Central Africa geotectonically stable zone (Meghraoui et al., 2016) (Figure 5-7). As a result, there is a very minimal risk of seismic activity in the project area.

Liberian news feeds are found about an earthquake that occurred in Guinea, with shocks that were felt in parts of Liberia without causing any damages (1983). More recent articles describe an earthquake with a magnitude of 7.1 on the Richter scale that occurred in 2017 about 1,050 km off of the coast of Monrovia at a depth of 10 km in the Atlantic Ocean (Best, 2017; Giahvue, 2016). This earthquake also did not form a threat for the Liberian society or neighbouring countries.

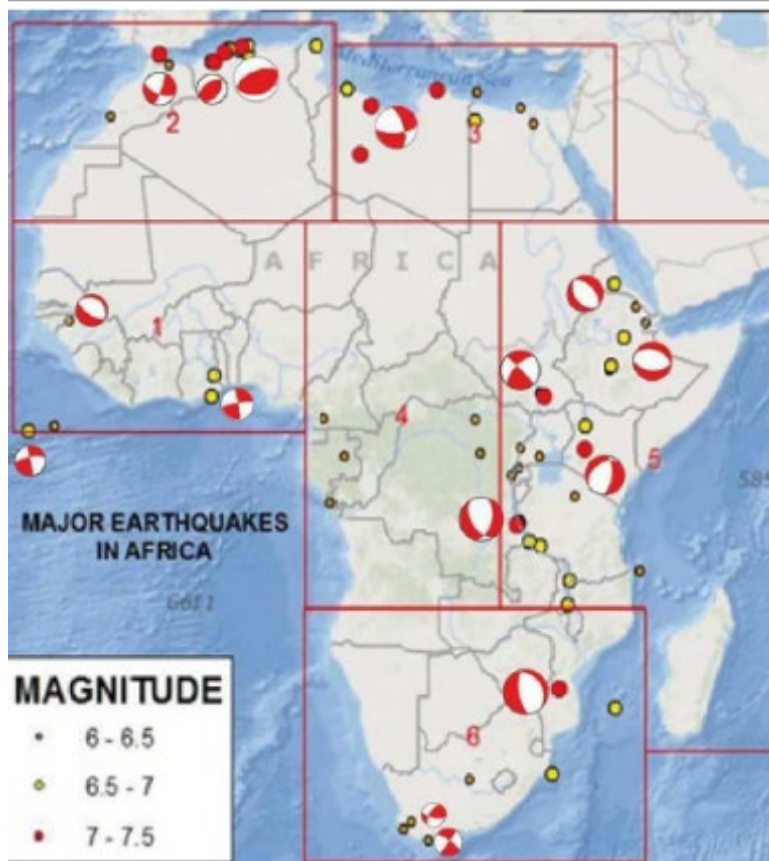


Figure 5-7 Seismotectonic provinces and major earthquakes in Africa (Meghraoui et al., 2016)

## 5.1.4 Currents, Tides and Wave Regimes

### 5.1.4.1 Currents

Liberian waters lie between two major upwelling areas of West Africa. One area is associated with the Canary Current to the northwest and the other is associated with the Benguela Current to the east. The Equatorial Counter Current is an eastward current embedded between the North and South Equatorial Currents. The North Equatorial Counter Current and the cold Canary Current contribute to the Guinea Current which runs along the West African coast from Senegal to the Bight of Biafra (Nigeria) (Ssentongo 1987). Waters offshore Liberia are primarily influenced by the Guinea Current, as shown in Figure 5-8.

The seasonal instability of the North Equatorial Counter Current and the Canary Current can influence the seasonal variability of the Guinea Current, which experiences minimum speeds during the winter (November through February) and maximum speeds during the summer (May through September) (Longhurst, 1962; Ingham, 1970; Colin, 1988). The phenomenon of

reversal of current is more marked in the coastal areas lying between Senegal and Liberia (Ssentongo, 1987).

The Guinea Current is characterized by areas of upwelling and increased biological productivity (Bakun, 1978; Binet, 1997). Beneath the Guinea Current flows the Guinea Undercurrent (also referred to as the Ivorian Undercurrent) in a westerly direction (Binet and Marchal, 1995; Gyory et al., 2008).

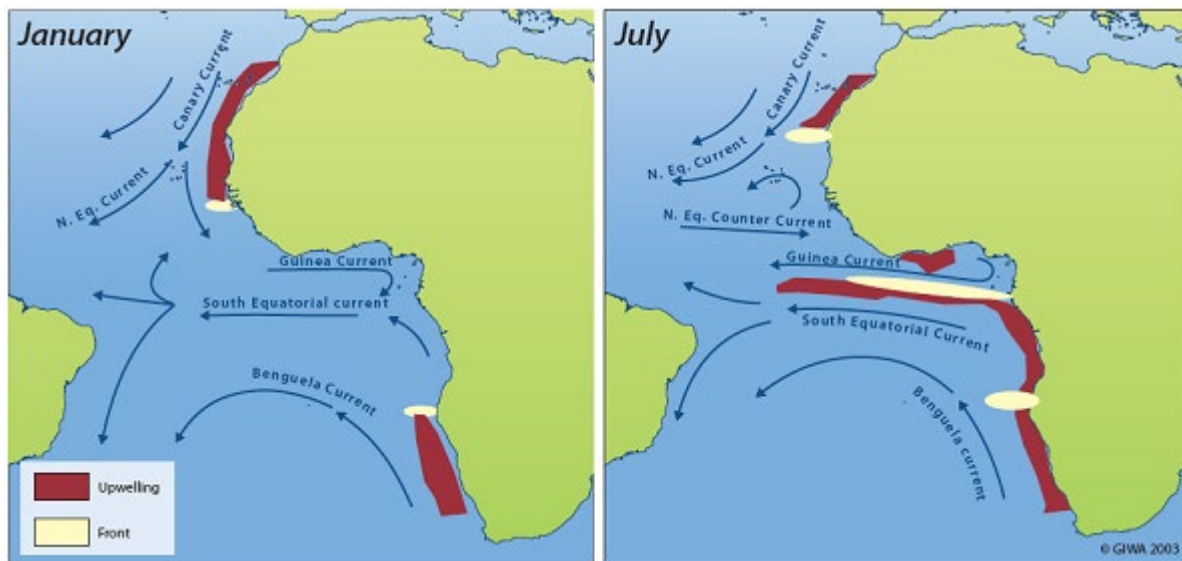


Figure 5-8 Current system of the central Atlantic Ocean (Abe et al., 2003)

#### 5.1.4.2 Tides

Monrovia's shoreline experiences a semi-diurnal tide (two high tides and two low tides daily). The first tide usually occurs between 12:00 AM and 6:00 AM, the second between 6:00 AM and 12:00 PM, the third between 12:00 PM and 6:00 PM, and the fourth between 6:00 PM and 12:00 AM. An example of the daily tidal variation for March 4, 2019 is provided in Figure 5-9.

Table 5-1 shows the resulting tidal levels with respect to mean sea level (MSL) and lowest astronomical tide (LAT). These values are considered to be with respect to the sea levels in the year 2000.

It is reported that tidal influence extends inland in wetlands and rivers to about 10 km (Gatter, 1997).

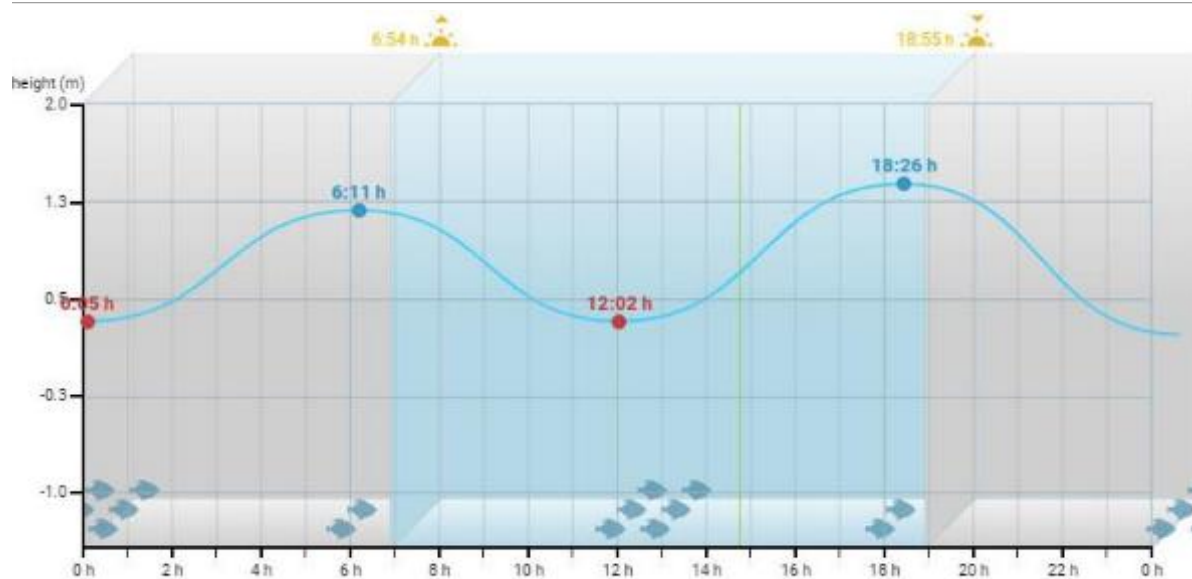


Figure 5-9 High tides and low tides in Monrovia on March 4, 2019 (Tides4Fishing, 2019)

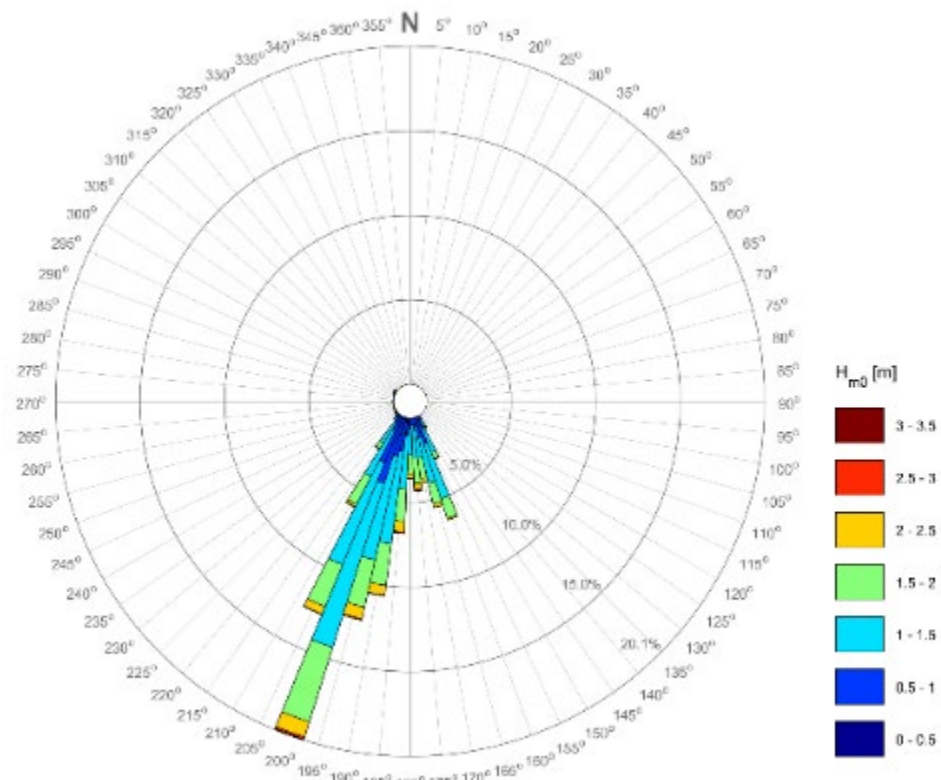
Table 5-1: Tidal data for Monrovia in the year 2000 (CDR International, 2019a)

Datum	Tidal level with respect to mean sea level (m +MSL)	Tidal level with respect to lowest astronomical tide (m +LAT)
Highest astronomical tide (HAT)	0.78	1.54
Mean high water springs (MHWS)	0.62	1.38
Mean higher high water (MHHW)	0.49	1.25
Mean high water (MHW)	0.42	1.18
Mean sea level (MSL)	0.00	0.76
Mean low water (MLW)	- 0.44	0.32
Mean lower low water (MLLW)	- 0.49	0.27
Mean low water springs (MLWS)	- 0.63	0.13
Lowest astronomical tide (LAT)	- 0.76	0.00

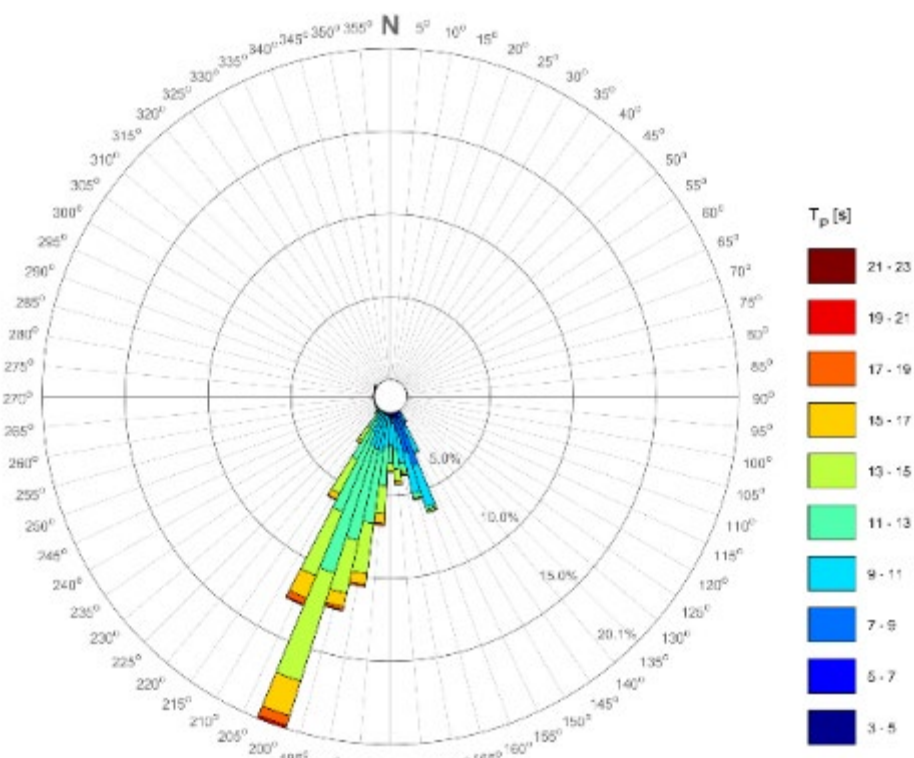
#### 5.1.4.3 Waves

The wave regime of Liberia's coastline is largely dominated by long period swell waves (average: 12 s, but can go up to 23 s) generated by distant storms in the South Atlantic Ocean. These swell waves are highly energetic, leading to strong wave breaking onto the shoreline, and are relatively uniform in direction and in height, as can be seen in Figure 5-10. Two main distinct systems can be observed: the dominant swell system originating from the SSW (~200°N), and another system originating from the SSE (~160°N). It is possible for both systems to occur simultaneously. A third system can be distinguished which originates from the WNW (~300°N), but is considered very weak (CDR International, 2019a).





(a)



(b)

Figure 5-10 Rose diagrams showing (a) offshore wave height and (b) peak period of offshore waves at 6°N 11°W (approximately 40 km offshore SSW of Monrovia) (CDR International, 2019a)



Wave heights have a seasonal variation and generally range between 0.5 and 2 m (PhysE, 2010). Offshore waves are higher between June and September (rainy season), compared to other months, as can be seen in Figure 5-11. The average offshore wave height is 1.75 m during the rainy season and 1 m during the dry season. In addition, the wave height distribution is wide in the rainy season, compared to a more uniform one in the dry season. The most extreme waves occur during the rainy season.

During the rainy season (June-Sept), some locally generated wind waves can be observed. These are usually very low (<0.25 m) but can reach up to 1 m. Nevertheless, they are considered very small compared to the dominant swell waves (CDR International, 2018).

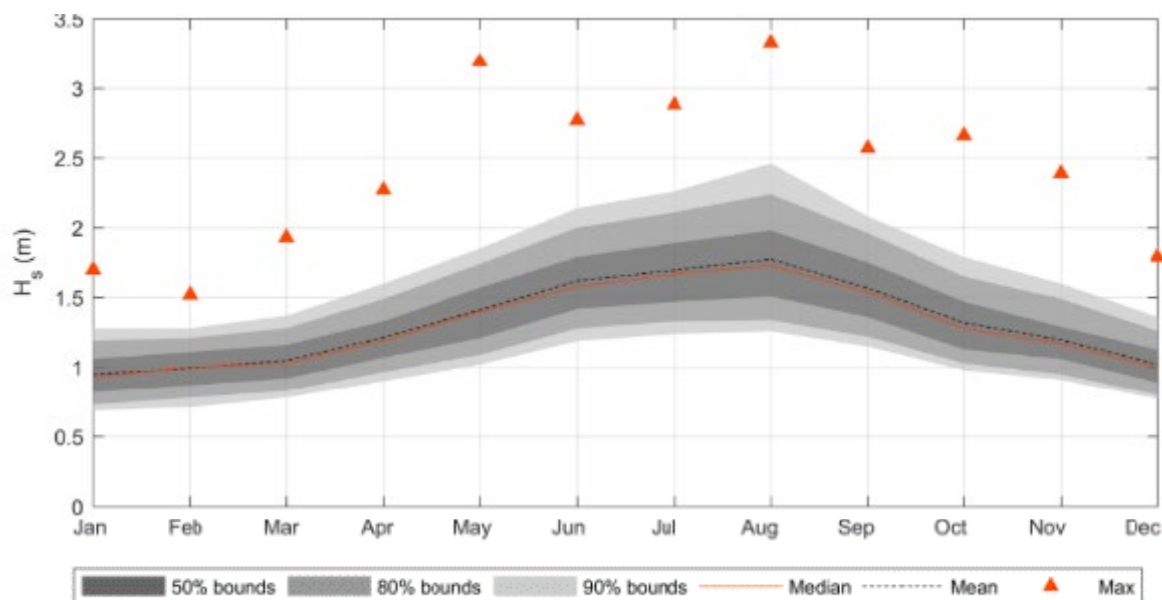


Figure 5-11 Monthly distribution of the height of the offshore significant wave (CDR International, 2019a)

The simulated nearshore wave field for average offshore wave conditions is shown in Figure 5-12. The colours indicate the significant wave height, the arrows show the mean wave direction and the contour lines show the imposed bathymetry. As can be seen, the significant wave height generally ranges between 1.1 and 1.3 m, with occasional locations where wave height is as high as 1.8 m. The predominant wave direction is SSW.

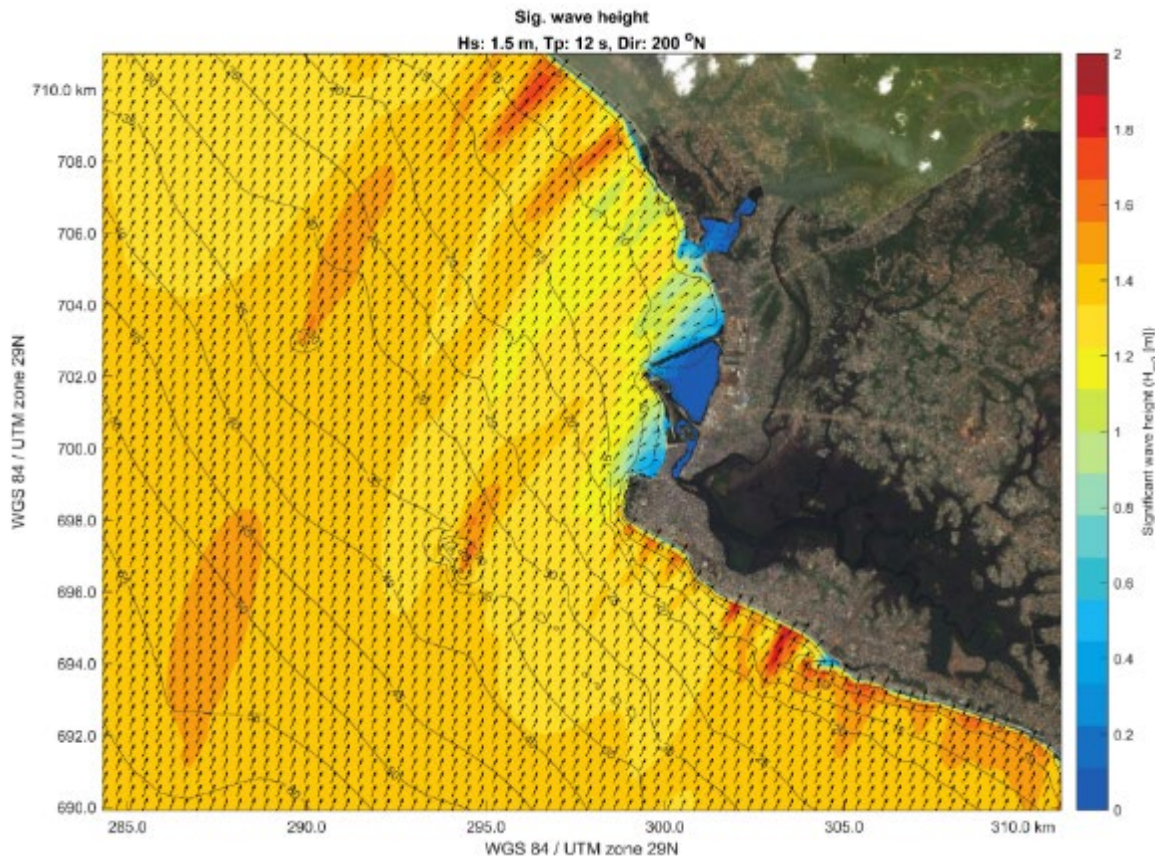


Figure 5-12 Simulated nearshore wave field for average offshore wave conditions (CDR International, 2018)

## 5.1.5 Ocean Water

### 5.1.5.1 Ocean Water in Liberia

Liberian waters are uniformly warm (26-28°C) and generally characterized by a hydrographic system that accounts for a relatively stable, shallow thermocline lying at mid-shelf. The average depth of the thermocline is between 20 and 35 m in most areas of West Africa (Williams, 1969), but in Liberia, the thermocline can be as shallow as 12–14 m. As a consequence, there is lack of renewal of water, low productivity, and dominance of river influence as opposed to upwelling (Longhurst, 1963).

Studies conducted in 2013 in Exxon Mobil's Block LB-13, located 50 to 80 km offshore between Monrovia and Buchanan (water depths: 1,181 m to 2,904 m), detected a steep thermocline from approximately 20 m from the water surface to about 40 m. Temperature profiles ranged between 3.43°C in the bottom water to 26.98°C at the surface (TDI Brooks Intl. and InterAct PMTI, 2013). There is seasonal oscillation of the thermocline and nutrients according to the oscillation of the equatorial undercurrent (Acorn Intl. and Earthtime Inc., 2014).

Because of the heavy rainfall and the high river discharge, Liberian surface waters tend to have low salinity, generally less than 32 parts per thousand (‰) (Longhurst, 1963). The highest river discharge occurs between June and November, which coincides with the rainy season (Ssentongo, 1987). Water sampling and profiling in Block LB-13 recorded a salinity range of 33.7 to 35.7‰ and detected a shallow lens of lower salinity water at the surface, attributed to significant rainfall and/or river discharge in the Inter-Tropical Convergence Zone even in the dry season. In addition, a strong salinity gradient was depicted at 30 to 40 m, which affects the density of water at this depth. It is highly probable that this gradient limits the influx of nutrients into surface waters from below this mixed layer (Acorn Intl. and Earthtime Inc., 2014; TDI Brooks Intl. and InterAct PMTI, 2013).

In the project area, the coastal waters are mainly influenced by inputs from the Mesurado River (north of coastal section 3) and the St. Paul River (between coastal sections 1 and 2) (see section 5.1.6.1), and to a lesser extent by inputs from the Farmington River (southeast of coastal section 5). On the other hand, several sewer channels discharge raw wastewater into the ocean. These are mostly found in coastal sections 4 and 5 (Figure 5-13).



Figure 5-13 Sewer outlet in coastal section 5 discharging raw wastewater in the Atlantic Ocean



### 5.1.5.2 Baseline Water Quality Collection in the Project Area

A spot sampling was carried out in the Atlantic Ocean and in the estuarine areas of the St. Paul River and the Mesurado River. The sampling took place on February 9<sup>th</sup> and 19<sup>th</sup>, 2019, using a boat and a canoe, respectively (sampling photos are shown in Figure 5-14). In total, 21 samples were collected from approximately 1 m below the water surface.

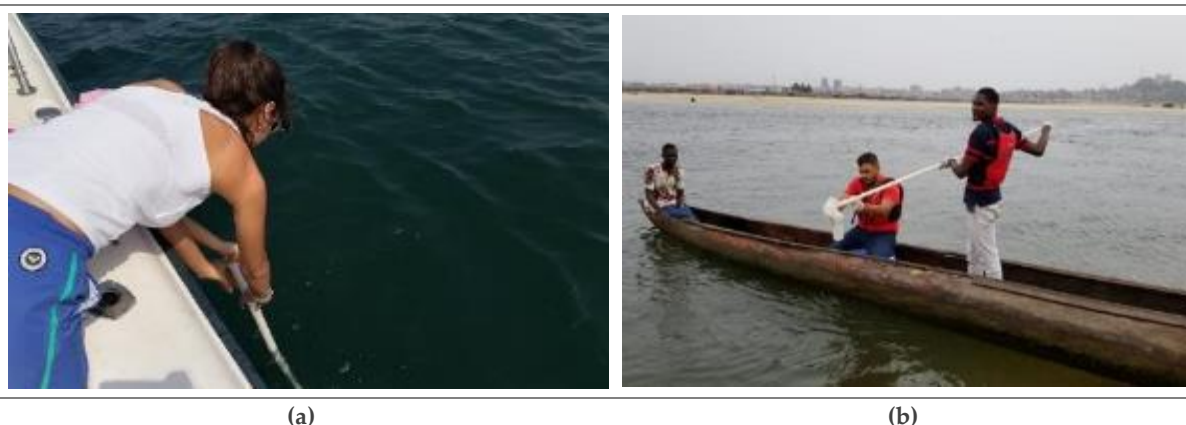


Figure 5-14 (a) Atlantic Ocean water sampling; (b) Mesurado estuary water sampling

Sampling locations are presented in Table 5-2 and Figure 5-15.

Table 5-2 Details of water sampling locations (Coordinate System: WGS 1984 UTM Zone 29N)

Sampling code	Sampling date	Coordinates		Location	Distance from coast
		Northing	Easting		
1b	9-Feb-19	708736.82	297844.87	Downdrift of coastal section 1	1.1 km
2a	9-Feb-19	706631.42	299895.86	Facing coastal section 1	425 m
2b	9-Feb-19	706098.85	299614.42	Facing coastal section 1	930 m
SP	9-Feb-19	706084.97	301859.87	St. Paul River mouth	N/A
3a	9-Feb-19	705582.85	300998.79	St. Paul River mouth	N/A
3b	9-Feb-19	705323.98	300708.09	Facing the St. Paul River mouth	200 m
3c	9-Feb-19	704830.22	300076.48	Facing the St. Paul River mouth	1 km
4a	9-Feb-19	704126.55	301060.74	Facing coastal section 2	450 m
4b	9-Feb-19	703608.99	300471.23	Facing coastal section 2	1.2 km
5	9-Feb-19	702469.83	299363.13	Facing the Monrovia Freeport outlet	N/A
6a	19-Feb-19	700631.00	300301.00	Mesurado River mouth	N/A
6b	9-Feb-19	700419.76	299744.34	Facing the Mesurado River mouth	300 m
MR1	19-Feb-19	700322.55	300647.59	Mesurado estuary, near mangrove island	N/A
MR2	19-Feb-19	698983.91	300665.08	Mesurado estuary, near Providence Island	N/A
MR3	19-Feb-19	698238.87	301609.3	Mesurado estuary, near wetlands	N/A
7a	9-Feb-19	699700.54	299608.08	Facing coastal section 3	360 m
7b	9-Feb-19	699833.45	298926.03	Facing coastal section 3	1 km
8a	9-Feb-19	696807.58	300265.44	Facing coastal section 4	400 m
8b	9-Feb-19	696268.06	299909.43	Facing coastal section 4	1 km
9a	9-Feb-19	694715.26	303535.67	Facing coastal section 5	310 m
9b	9-Feb-19	693967.01	303182.02	Facing coastal section 5	1.1 km

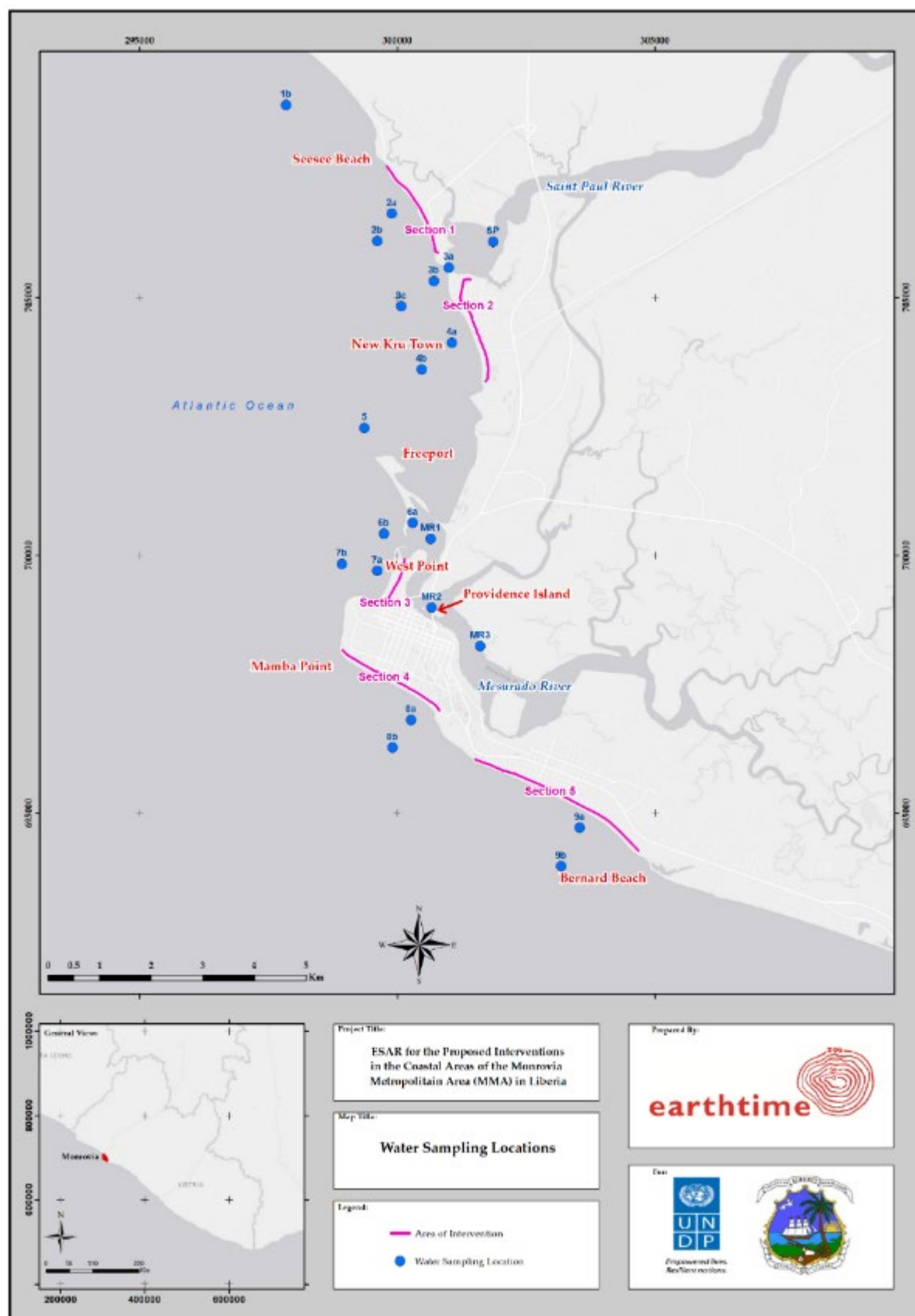


Figure 5-15 Water sampling locations

Sampling locations were selected to give a representative picture of the water quality in the project area, as explained below.

- During high tide, two samples were collected facing each coastal stretch: one at approximately 300-400 m from the coast (samples 2a, 4a, 7a, 8a, 9a) and one at approximately 1 km from the coast (samples 2b, 4b, 7b, 8b, 9b). Nearshore sampling locations were adjusted on-site to avoid possible damage to the boat by occasional nearshore rocks. The distances of 500 m and 1 km are still within the coastal environment (not offshore). They were chosen because project activities will take place at or near the coast, and impacts resulting from these activities are expected to be confined to a maximum of 1 km distance from the shore.
- During low tide, two samples were collected from the St. Paul River mouth (samples SP and 3a) and two samples at distances of 200 m (sample 3b) and 1 km (sample 3c) from the coastal waters facing the St. Paul River mouth.
- During low tide, one sample was collected from the Mesurado River mouth (sample 6a), three samples from the Mesurado River estuarine area (samples MR1, MR2 and MR3), and one at 300 m from the coast facing the Mesurado River mouth (sample 6b).
- Samples were also collected from points of interest such as the outlet of Monrovia's Freeport (sample 5), and downdrift of coastal section 1 (sample 1b).

Prior to sampling, ALS Laboratories in the UK were contacted to provide adequate and sterile sampling bottles for the requested tests. For each sampling location, 7 different sampling bottles were filled. These were:

- One plastic bottle (1 L);
- One glass bottle (500 mL);
- One plastic bottle containing HNO<sub>3</sub> preservative (sample filtered using syringes and filters provided by the Laboratory);
- One plastic bottle containing H<sub>2</sub>SO<sub>4</sub> preservative;
- One plastic bottle containing NaOH preservative; and
- Two glass vials (40 mL).

Water samples were collected as per the following procedure.

1. Sterile gloves were used to keep hands safe and to make sure the sampling bottles were not contaminated.
2. Collecting the sample:
  - a. A dipper sampler was filled with ocean water at approximately 1 m depth.
  - b. Water was poured from the dipper sampler into the sampling bottles, ensuring no overflow for the bottles containing a liquid preservative.
  - c. The sampling bottles were capped while avoiding trapped air bubbles.
  - d. If the sampling bottle required filtering; a syringe provided by ALS was used to withdraw water from the dipper sampler, then attached to a filter and emptied into the bottle containing the liquid preservative.
3. All sampling bottles were labelled carefully with the sample ID and the sampling date.
4. Sampling bottles were stored in a cool box containing ice for cool and dark conditions.

Upon return to Monrovia, the sampling bottles were inspected to ensure correct labelling. The Chain of Custody and shipping documents provided by the Laboratory were completed. The samples were packed in new coolers containing ice for shipping. The coolers were sealed and a copy of the Chain of Custody was attached to each cooler.

The samples were then shipped to ALS Laboratory in the UK for analysis.

#### **5.1.5.3 Laboratory Results and Analysis**

Water quality results, along with standard values, are presented in Table 5-3, Table 5-4 and Table 5-5. The original laboratory report is included in Appendix B.

Test results are compared to two Liberian standards which were previously presented in Section 4.4:

- The Liberian water quality standards for coastal waters marine outfall, class SW-II which includes “water used for bathing, contact sports and commercial fishing” (Environmental Protection Management Law, 2009); and
- The Ministry of Health drinking water quality standard for class II waters which includes “water used for fisheries, cultivated fisheries, organized public bath, recreational water sports” (Ministry of Health and Social Welfare, 1987).

In general, water sample results were within the above-mentioned standards except for:

- Total dissolved solids (TDS), which exceeded the Ministry of Health standard in all sampling locations; and
- Total suspended solids (TSS), which exceeded the Ministry of Health standard in 16 sampling locations out of 21 (1b, 2a, 3c, 4a, 4b, 5, 6a, 6b, MR1, MR2, MR3, 7a, 7b, 8a, 9a and 9b).

TDS values exceeding the Ministry of Health standard in all samples can be attributed to the fact that the water sampled is mostly saline (brackish in a few samples), while the Ministry of Health standard is for freshwaters: brackish and saline water have much higher levels of dissolved solids than freshwater. High TSS concentration in surface and coastal waters is an indication of pollution by anthropogenic activities such as agriculture, deforestation, sewage, etc. TSS values were the highest (>65 mg/l) in samples 6a, 8a and 9a. Samples 8a and 9a were taken at short distances from raw sewage outlets in coastal sections 4 and 5, while sample 6a was drawn at a short distance from the public toilets of the West Point community. Higher TSS values in these locations can be linked to the high organic pollution of these locations by fecal matter. During the rainy season, nearshore and estuarine waters are expected to have higher TSS concentrations and lower TDS values as a result of an increase in river and storm-water runoff (freshwater carrying more suspended solids from inland sources) as well as higher dilution rates.

COD values detected in samples collected from the Atlantic Ocean were in the order of 450 to 650 mg/L. In the St. Paul estuarine area, COD values increased as the fresh water mixed with ocean water, with COD values ranging between 86 in sample SP and 330 mg/L in sample 3c. On the other hand, COD ranged between 27 and 1,030 mg/L in the Mesurado estuarine area. COD values increased from 433 to 608 and 1,030 mg/L at MR3, MR2 and MR1, respectively. As the Mesurado River water flows down from the wetlands towards the ocean, it carries with it oxidisable pollutants, namely faecal matter. The water downstream therefore has a higher COD content than the water upstream. As the Mesurado River water mixes with ocean water, pollutants become diluted, resulting in lower COD content in samples 6a and 6b of 512 and 27 mg/L, respectively. Nitrites and Nitrates were mostly below detectable limits. Total organic carbon (TOC) was detected in 8 samples out of 21.



Salinity in the samples collected from the Atlantic Ocean ranged between 29 and 35‰. Samples collected from the St. Paul estuarine area clearly show a salinity gradient that increases with proximity to the ocean, as the St. Paul River's fresh water mixes with the ocean's saline water: sample SP has the lowest salinity of 5‰, while sample 3c has the highest salinity of 23‰. The salinity in samples collected from the Mesurado estuarine area (samples MR1, MR2 and MR3) ranged between 33.2 and 33.8‰. These values are those of saline waters, which means that the Mesurado Estuary is saline even during low tide (sampling took place during low tide). This demonstrates that this estuary is more influenced by the coastal waters than by the inland surface water, presumably because there is no large river flowing into it (like the nearby St. Paul). The implication is that impacts on coastal water quality may reach deeper inside the Mesurado estuary than they would in the St. Paul estuary where freshwater flows dominate the hydrology.

With regards to heavy metals, the following observations were made:

- Arsenic was detected in 20 out of 21 sampling locations (only sample 3a had an arsenic concentration below detection limit). Arsenic could result from gold mining, which is a prevalent industry in Liberia.
- Cadmium was detected in samples SP, 4b, 6b, MR2, 7a, 8a and 9a, and ranged between 0.00408 and 0.0583 µg/L. These concentrations are considered minimal. Sources of cadmium could be the use of fertilizers, sewage water, and wastewater or runoff from batteries and paint industries.
- Iron was detected in samples 1b, SP, 6a, MR1, MR2 and MR3, and ranged between 0.00524 and 0.0101 µg/L. Iron occurrence in surface water in Liberia is usually linked to the high level of irons naturally occurring in the Liberian soils.
- Lead was detected in samples SP and 4b, and ranged between 0.0169 and 0.0918 µg/L. Lead could result from a variety of sources, such as deposits of lead-containing dust from the atmosphere, industrial wastewater and urban runoff, but none can be identified.
- Mercury was not detected in any of the samples.

Cyanide, nitrite, petroleum hydrocarbons (GRO, EPH and TPH CWG) and phenols were not detected in any of the samples.

369 Table 5-3 Water sampling test results (1b, 2a, 2b, SP, 3a, 3b and 3c)

Parameter	Unit	Standard		Sample Code						
		EPML 2009 (SW-II Waters)	MoH (Class II)	1b	2a	2b	SP	3a	3b	3c
Inorganics										
Ammoniacal Nitrogen as N	mg/L	N/A	3	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
COD, unfiltered	mg/L	N/A	N/A	608	572	492	85.5	161	298	330
Conductivity at 20°C	mS/cm	N/A	N/A	46	46	40.3	8.67	15.6	25.9	33.1
Cyanide as CN	mg/L	N/A	0.02	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Cyanide Complex as CN	mg/L	N/A	N/A	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Cyanide Free as CN	mg/L	N/A	N/A	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Dissolved solids, Total (gravimetric)	mg/L	N/A	1,000	38,300	38,300	30,800	5,750	10,900	19,000	27,400
Nitrite as NO2	mg/L	N/A	1	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
pH	-	6.5-8.5	6.0 - 9.0	8.17	8.11	8.17	7.5	7.69	7.9	8.05
Saline Nitrate as NO3	mg/L	N/A	60	<0.3	0.367	<0.3	<0.3	<0.3	0.549	<0.3
Saline TON as NO3	mg/L	N/A	N/A	<0.3	0.383	<0.3	0.303	<0.3	0.58	<0.3
Salinity	‰	N/A	N/A	33.6	33.6	29	5.49	10.3	17.8	23.3
Suspended solids, Total	mg/L	N/A	30	51	68	17.5	6.5	15.5	7	46
TOC (Saline)	mg/L	N/A	N/A	3.13	3.38	2.6	<2.5	2.51	<2.5	<2.5
Turbidity	ntu	30	N/A	1.02	0.857	0.642	2.79	1.17	1.59	0.942
Gasoline Range Organics (GRO)										
EPH (C6-C10)	µg/L	N/A	N/A	<100	<100	<100	<100	<100	<100	<100
GRO >C5-C10	µg/L	N/A	N/A	<10	<10	<10	<10	<10	<10	<10
EPH (Extractable Petroleum Hydrocarbons)										
EPH Range >C10 - C40 (aq)	µg/L	N/A	N/A	<100	<100	<100	<100	<100	<100	<100
TPH Criteria Working Group (TPH CWG)										
Benzene	µg/L	N/A	N/A	<7	<7	<7	<7	<7	<7	<7
Ethylbenzene	µg/L	N/A	N/A	<5	<5	<5	<5	<5	<5	<5
m,p-Xylene	µg/L	N/A	N/A	<8	<8	<8	<8	<8	<8	<8
Methyl tertiary butyl ether (MTBE)	µg/L	N/A	N/A	<3	<3	<3	<3	<3	<3	<3
o-Xylene	µg/L	N/A	N/A	<3	<3	<3	<3	<3	<3	<3
Sum of detected BTEX	µg/L	N/A	N/A	<28	<28	<28	<28	<28	<28	<28
Toluene	µg/L	N/A	N/A	<4	<4	<4	<4	<4	<4	<4
Total EPH (C6-C40) (aq)	µg/L	N/A	N/A	<100	<100	<100	<100	<100	<100	<100
Metals										
Arsenic, Dissolved	µg/L	N/A	50	2.61	1.38	1.8	0.343	<0.5	1.21	1.62

Parameter	Unit	Standard		Sample Code						
		EPML 2009 (SW-II Waters)	MoH (Class II)	1b	2a	2b	SP	3a	3b	3c
Cadmium, Dissolved	µg/L	N/A	1	<0.05	<0.05	<0.05	0.00408	<0.05	<0.05	<0.05
Iron, Dissolved	µg/L	N/A	1,500	0.00851	<0.004	<0.004	0.00758	<0.004	<0.004	<0.004
Lead, Dissolved	µg/L	N/A	100	<0.3	<0.3	<0.3	0.0169	<0.3	<0.3	<0.3
Mercury, Dissolved	µg/L	N/A	5	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
<b>Color Code</b>										- = Test not performed
Exceeds or outside of range of MoH standard for Class II										N/A = Not Available

370 Table 5-4 Water sampling test results (4a, 4b, 5, 6a, 6b, MR1 and MR2)

Parameter	Unit	Standard		Sample Code						
		EPML 2009 (SW-II Waters)	MoH (Class II)	4a	4b	5	6a	6b	MR1	MR2
Inorganics										
Ammoniacal Nitrogen as N	mg/L	N/A	3	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
COD, unfiltered	mg/L	N/A	N/A	614	636	438	512	27.3	1030	608
Conductivity at 20°C	mS/cm	N/A	N/A	43.5	43.3	44	46.1	46.6	45.9	46.3
Cyanide as CN	mg/L	N/A	0.02	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Cyanide Complex as CN	mg/L	N/A	N/A	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Cyanide Free as CN	mg/L	N/A	N/A	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.005
Dissolved solids, Total (gravimetric)	mg/L	N/A	1,000	36,700	35,500	34,700	41,000	37,500	40,000	39,200
Nitrite as NO2	mg/L	N/A	1	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
pH	-	6.5-8.5	6.0 - 9.0	8.12	8.06	7.95	8.11	7.98	8.04	8.08
Saline Nitrate as NO3	mg/L	N/A	60	<0.3	<0.3	<0.3	<0.3	0.694	0.669	<0.3
Saline TON as NO3	mg/L	N/A	N/A	<0.3	0.301	<0.3	<0.3	0.707	0.691	<0.3
Salinity	‰	N/A	N/A	31.6	31.4	32	33.7	34.1	33.5	33.8
Suspended solids, Total	mg/L	N/A	30	56.5	53	42.5	73	59.5	53.5	56
TOC (Saline)	mg/L	N/A	N/A	<2.5	<2.5	<2.5	4.74	2.58	3.21	<2.5
Turbidity	ntu	30	N/A	0.679	0.607	1.09	2.49	0.999	3.79	4.41
Gasoline Range Organics (GRO)										
EPH (C6-C10)	µg/L	N/A	N/A	<100	<100	<100	<100	<100	<100	<100
GRO >C5-C10	µg/L	N/A	N/A	<10	<10	<10	<10	<10	<10	<10
EPH (Extractable Petroleum Hydrocarbons)										
EPH Range >C10 - C40 (aq)	µg/L	N/A	N/A	<100	<100	<100	<100	<100	<100	<100

Parameter	Unit	Standard		Sample Code						
		EPML 2009 (SW-II Waters)	MoH (Class II)	4a	4b	5	6a	6b	MR1	MR2
TPH Criteria Working Group (TPH CWG)										
Benzene	µg/L	N/A	N/A	<7	<7	<7	<7	<7	<7	<7
Ethylbenzene	µg/L	N/A	N/A	<5	<5	<5	<5	<5	<5	<5
m,p-Xylene	µg/L	N/A	N/A	<8	<8	<8	<8	<8	<8	<8
Methyl tertiary butyl ether (MTBE)	µg/L	N/A	N/A	<3	<3	<3	<3	<3	<3	<3
o-Xylene	µg/L	N/A	N/A	<3	<3	<3	<3	<3	<3	<3
Sum of detected BTEX	µg/L	N/A	N/A	<28	<28	<28	<28	<28	<28	<28
Toluene	µg/L	N/A	N/A	<4	<4	<4	<4	<4	<4	<4
Total EPH (C6-C40) (aq)	µg/L	N/A	N/A	<100	<100	<100	<100	<100	<100	<100
Metals										
Arsenic, Dissolved	µg/L	N/A	50	1.61	2.53	1.75	0.624	2.82	1.58	1.07
Cadmium, Dissolved	µg/L	N/A	1	<0.02	0.0176	<0.05	<0.05	0.0109	<0.05	0.0583
Iron, Dissolved	µg/L	N/A	1,500	<0.004	<0.002	<0.004	0.0101	<0.002	0.00564	0.00806
Lead, Dissolved	µg/L	N/A	100	<0.1	0.0918	<0.3	<0.3	<0.05	<0.3	<0.3
Mercury, Dissolved	µg/L	N/A	5	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Color Code										
	Exceeds or outside of range of MoH standard for Class II								- = Test not performed N/A = Not Available	

371 Table 5-5 Water sampling test results (MR3, 7a, 7b, 8a, 8b, 9a and 9b)

Parameter	Unit	Standard		Sample Code						
		EPML 2009 (SW-II Waters)	MoH (Class II)	MR3	7a	7b	8a	8b	9a	9b
Inorganics										
Ammoniacal Nitrogen as N	mg/L	N/A	3	<0.2	<0.2	<0.2	<0.2	<0.2	6.12	<0.2
COD, unfiltered	mg/L	N/A	N/A	433	464	444	476	490	500	628
Conductivity at 20°C	mS/cm	N/A	N/A	45.5	45.5	45.8	47.5	47.4	47.8	46.2
Cyanide as CN	mg/L	N/A	0.02	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Cyanide Complex as CN	mg/L	N/A	N/A	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Cyanide Free as CN	mg/L	N/A	N/A	<0.005	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Dissolved solids, Total (gravimetric)	mg/L	N/A	1,000	39,300	37,000	36,200	39,100	38,100	38,200	38,600
Nitrite as NO2	mg/L	N/A	1	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
pH	-	6.5-8.5	6.0 - 9.0	8.01	7.96	7.97	8.04	8.06	8.13	8.23
Saline Nitrate as NO3	mg/L	N/A	60	<0.3	0.351	<0.3	<0.3	<0.3	<0.3	<0.3

Parameter	Unit	Standard		Sample Code						
		EPML 2009 (SW-II Waters)	MoH (Class II)	MR3	7a	7b	8a	8b	9a	9b
Saline TON as NO3	mg/L	N/A	N/A	<0.3	0.365	<0.3	<0.3	<0.3	<0.3	<0.3
Salinity	‰	N/A	N/A	33.2	33.2	33.4	34.8	34.7	35.1	33.8
Suspended solids, Total	mg/L	N/A	30	49	51.5	46	70.5	20	66.5	63.5
TOC (Saline)	mg/L	N/A	N/A	<2.5	<2.5	<2.5	<2.5	<2.5	2.76	<2.5
Turbidity	ntu	30		4.55	0.951	0.641	0.607	0.561	0.632	0.676
<b>Gasoline Range Organics (GRO)</b>										
EPH (C6-C10)	µg/L	N/A	N/A	<100	<100	<100	<100	<100	<100	<100
GRO >C5-C10	µg/L	N/A	N/A	<10	<10	<10	<10	<10	<10	<10
<b>EPH (Extractable Petroleum Hydrocarbons)</b>										
EPH Range >C10 - C40 (aq)	µg/L	N/A	N/A	<100	<100	<100	<100	<100	<100	<100
<b>TPH Criteria Working Group (TPH CWG)</b>										
Benzene	µg/L	N/A	N/A	<7	<7	<7	<7	<7	<7	<7
Ethylbenzene	µg/L	N/A	N/A	<5	<5	<5	<5	<5	<5	<5
m,p-Xylene	µg/L	N/A	N/A	<8	<8	<8	<8	<8	<8	<8
Methyl tertiary butyl ether (MTBE)	µg/L	N/A	N/A	<3	<3	<3	<3	<3	<3	<3
o-Xylene	µg/L	N/A	N/A	<3	<3	<3	<3	<3	<3	<3
Sum of detected BTEX	µg/L	N/A	N/A	<28	<28	<28	<28	<28	<28	<28
Toluene	µg/L	N/A	N/A	<4	<4	<4	<4	<4	<4	<4
Total EPH (C6-C40) (aq)	µg/L	N/A	N/A	<100	<100	<100	<100	<100	<100	<100
<b>Metals</b>										
Arsenic, Dissolved	µg/L	N/A	50	1.43	2.89	1.83	2.03	1.95	2.43	1.82
Cadmium, Dissolved	µg/L	N/A	1	<0.05	0.0127	<0.02	0.0105	<0.02	0.0115	<0.02
Iron, Dissolved	µg/L	N/A	1,500	0.00524	<0.002	<0.004	<0.002	<0.004	<0.002	<0.004
Lead, Dissolved	µg/L	N/A	100	<0.3	<0.05	<0.1	<0.05	<0.1	<0.05	<0.1
Mercury, Dissolved	µg/L	N/A	5	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
<b>Color Code</b>										
<div></div> Exceeds or outside of range of MoH standard for Class II										
<div></div> - = Test not performed N/A = Not Available										

## 5.1.6 Terrestrial Surface and Ground Water

### 5.1.6.1 Surface Water

Coastal sections 1 and 2 are separated by the mouth of the St. Paul River (Figure 5-16), the second longest river in Liberia. The St. Paul's headwaters originate in Guinea, and its water provides the bulk of the water for Monrovia. Like most of the major rivers in Liberia, it flows in a northeast to southwest direction, perpendicular to the coast, until it reaches the Atlantic Ocean. The St. Paul River has a length of 495 km, an annual flow of 442 m<sup>3</sup>/s and a sediment load of 1,920 t/y (LHS, 1988; LHS and NVE, 2016; LHS, 2016). Its water is not navigable and therefore does not support water transport or industrial fishing. Instead, the water of the St. Paul River is used for artisanal fishing, washing, bathing, irrigation and in rare cases, when there is a groundwater shortage during the dry season, for drinking.



Figure 5-16 Mouth of the St. Paul River

The mouth of the Mesurado River borders coastal section 3 to the north (Figure 5-17a). The Mesurado is a small river that originates in the Mesurado Wetland inside Monrovia and drains in the Atlantic Ocean (Figure 5-17b). It is considered to be the most polluted waterbody in Liberia. Sources of pollution include the informal dumping of municipal solid waste in the Mesurado River (Figure 5-17c) and the direct discharge of human feces from public toilets built on stilts in the River (Figure 5-17d). In addition, blast fishing is sometimes practiced in the Mesurado River, either through the use of ammonium nitrate mixed with fuel oil (also known as ANFO), or through the use of carbide and water. Explosions generated by ammonium nitrate and fuel oil produce nitrates which are highly soluble and, if present in excess, can cause eutrophication of water bodies. Explosions generated by carbide and water produce calcium hydroxide, commonly known as hydrated lime, which can cause the pH of the water body to become alkaline.



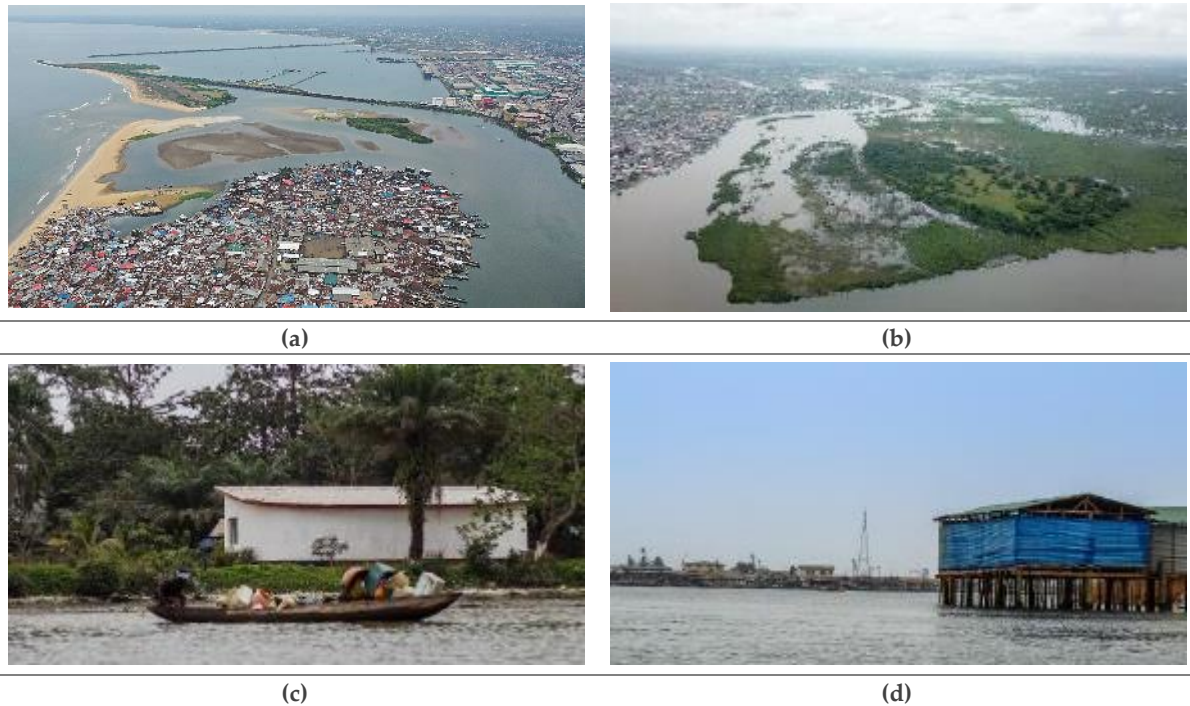


Figure 5-17 (a) Mouth of the Mesurado River ; (b) Part of the Mesurado Wetland; (c) A man collecting solid waste from the Mesurado River; (d) Public toilet built on stilts in the Mesurado River

The Mesurado River and the St. Paul River are linked through Stockton Creek (Figure 5-18), which defines the eastern border of Bushrod Island. It is approximately 1.5 km long and generally extends in a north-to-south direction. Water level in Stockton Creek changes on a daily basis due to tidal variations. Depending on tidal activities, water in this Creek flows either towards the south to pour in the Mesurado River, or towards the north to pour in the St. Paul River.



Figure 5-18 Stockton Creek linking the St. Paul River to the Mesurado River

Seasonal precipitation causes considerable fluctuations in waterbody levels, often resulting in rivers and streams overflowing their banks along the coastal plains during the rainy season.

River waters are often contaminated due to:

- The unregulated and uncontrolled disposal of waste and the lack of hazardous waste disposal facilities; and
- The uncontrolled use of chemicals in agriculture, mining (particularly artisanal gold mining) and other industries; and
- The lack of proper sanitation means in Liberia: open defecation and use of unimproved sanitation were reported in 2015 for 58% of households on a national level (WHO and UNICEF, 2017). As a result, fecal and total coliform are often detected in river waters, including the St. Paul River (Earthtime Inc., 2009).

#### 5.1.6.2 Groundwater

The Quaternary deposits (beach, lagoonal, fluvial and deltaic deposits) in the area are known to possibly be good aquifers for shallow wells. Groundwater depth in Monrovia varies from 1.5 m to 2.5 m between the rainy and dry seasons, respectively: this is a general figure and not specific to the immediate coastal areas. The unconsolidated sediments in the study area are mainly recharged by heavy rainfall. During the peak of the wet season, when water levels are at their highest, discharge from the aquifer can reach up to 30-40 mm per day. Most people tap this source by using shallow wells (Earthtime Inc., 2015).

The nature of the area and aquifer results in a water table that is affected by salt water intrusion from the ocean and brackish water from the Stockton Creek and the Mesurado River system. This aquifer is also affected by the tidal variation of the ocean.

Generally, the groundwater in Bushrod Island naturally contains contaminants like sulfide and sulfate. This is mainly due to the high decaying organic matter present in the unconsolidated material (Earthtime Inc., 2015).



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## 5.1.7 Coastal and Benthic Sediments

### 5.1.7.1 Coastal and Benthic Sediments in Liberia

Studies conducted in 2013 on sediments collected from Exxon Mobil's Block LB-13, located 50 to 80 km offshore between Monrovia and Buchanan at depths of 1,181 m to 2,904 m, showed the following (TDI Brooks Intl. and InterAct PMTI, 2013).

- TOC in sediment ranged from 1.52 to 2.88% dry weight, which is characteristic of depositional sediment.
- Ten metals were detected: arsenic, barium, cadmium, chromium, copper, lead, mercury, nickel, vanadium and zinc.
  - Arsenic and mercury are by-products of artisanal gold mining, which is prevalent in Liberia. Arsenic and mercury detected in the sediment most probably originate from mines and have been transported by rivers into the ocean.
  - Chromium was found in natural deposits of heavy mineral sands, which are found along the coast of Liberia.
  - Iron in sediment is typically attributed to natural sources in the earth's crust, and is especially common in Liberia due to its widespread iron formations.
- Minor concentrations of petroleum-related hydrocarbons were found. Analysis of the types of analytes present indicated that the biogenic material (i.e. natural material, not combustion-related compounds) are the primary source of the low levels of hydrocarbons detected.

### 5.1.7.2 Baseline Coastal and Benthic Sediments in the Project Area

CDR International conducted a spot sediment sampling between October 12 and 27, 2018. Sediment samples were collected from the beach and the seabed using a Van Veen Grab Sampler (Figure 5-19). Sampling was conducted onshore and offshore of the five coastal sections, and in the estuarine areas of the St. Paul and Mesurado rivers. Onshore samples were collected from the highest end of the beach and the lower end of the swash zone (where waves are active). Sampling locations are presented in Table 5-6 and Figure 5-20. In total, 13 sediment samples were collected (CDR International, 2019a).



Figure 5-19 (a) Van Veen grab sampler; (b) Sediment samples collected in plastic bags

Table 5-6 Details of sediment sampling locations (Coordinate System: WGS 1984 UTM Zone 29N)

Sampling code	Coordinates		Location	Description
	Northing	Easting		
Beach 1 - High	707160.52	300027.18	Coastal section 1, onshore	Highest end of the beach
Beach 1 - Low	707160.52	300027.18	Coastal section 1, onshore	Lowest end of the beach
Beach 5 - High	695159.34	303430.21	Coastal section 5, onshore	Highest end of the beach
Beach 5 - Low	695159.34	303430.21	Coastal section 5, onshore	Lowest end of the beach
Beach 1	706662.57	299840.26	Facing coastal section 1, offshore	Distance from coast: 450 m
Beach 2	704537.61	301152.75	Facing coastal section 2, offshore	Distance from coast: 200 m
Beach 3	699442.05	299478.25	Facing coastal section 3, offshore	Distance from coast: 350 m
Beach 4	697275.07	299746.91	Facing coastal section 4, offshore	Distance from coast: 250 m
Beach 5	694632.16	303488.91	Facing coastal section 5, offshore	Distance from coast: 420 m
Mesurado 1	700627.83	300321.44	Mesurado estuary	Mesurado River mouth
Mesurado 2	697850.46	301670.71	Mesurado estuary	Near Mesurado wetlands
St. Paul 1	705370.09	300922.50	St. Paul River	St. Paul River mouth
St. Paul 3	707112.94	302589.79	St. Paul River	Under the St. Paul bridge

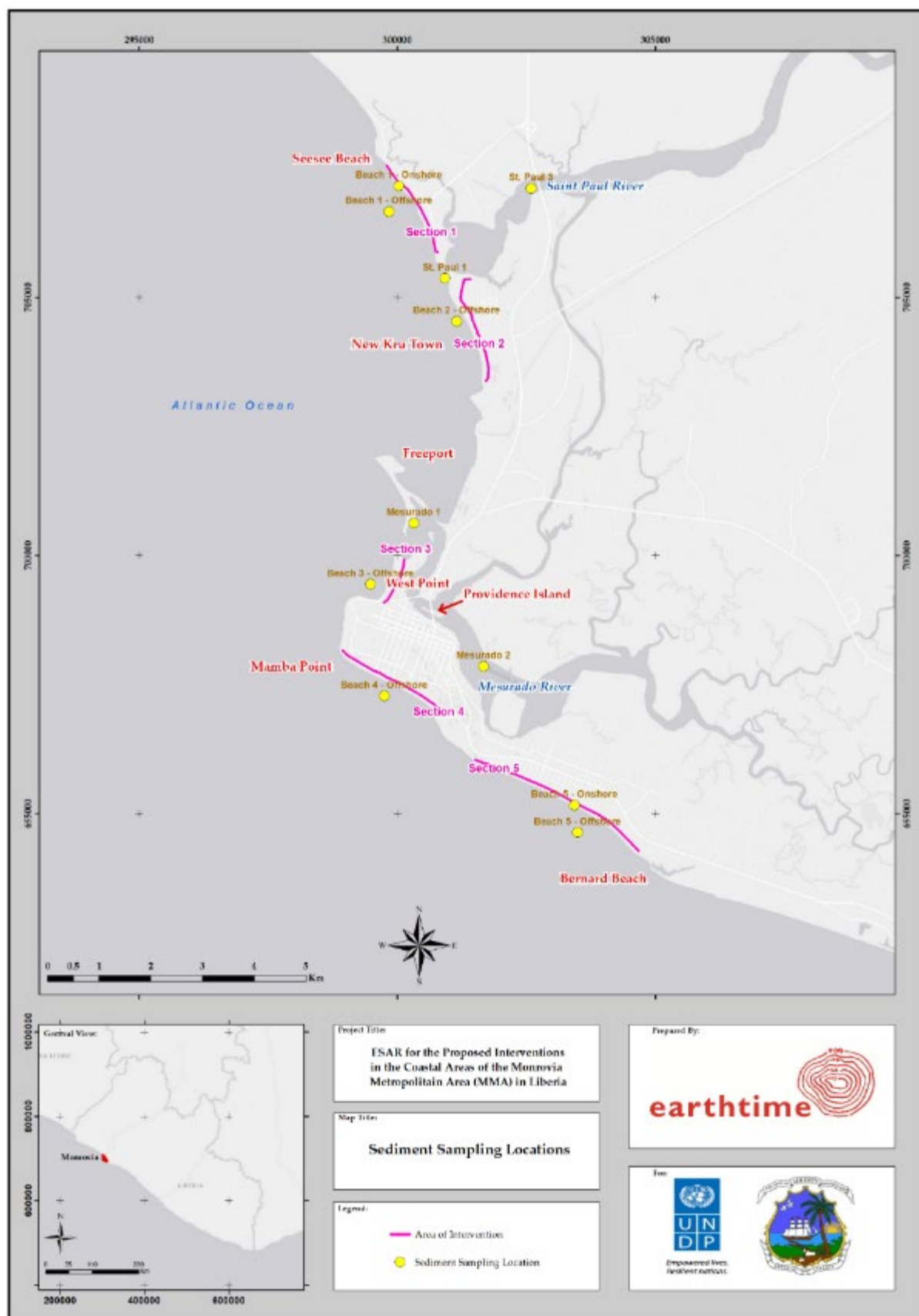


Figure 5-20 Sediment sampling locations

Sediment samples were analysed for grain size. Results are presented in Table 5-7. The grain size of the sediment is important for understanding the dynamics of benthic communities, correlation with various physical characteristics of the seabed environment and how contaminants may behave in the seabed environment, if released. Grain sizes can include gravel (> 2 mm), sand (0.063 – 2 mm), silt (0.002 - 0.063 mm) and clay (< 0.002 mm).

Table 5-7 Particle size distribution for sediment samples (adapted from CDR International, 2019a)

	Gravel (> 2 mm)	Sand (0.063 - 2 mm)	Silt (0.002 - 0.063 mm)	Clay (< 0.002 mm)
Onshore samples				
Beach 1 - High	1.6%	98.4%	-	-
Beach 1 - Low	0.1%	99.9%	-	-
Beach 5 - High	0.8%	99.2%	-	-
Beach 5 - Low	1.2%	98.8%	-	-
Offshore samples				
Beach 1	-	96.9%	0.1%	3.0%
Beach 2	-	96.9%	0.1%	3.0%
Beach 3	-	97.5%	0.1%	2.4%
Beach 4	0.1%	98.4%	0.6%	1.0%
Beach 5	0.0%	95.5%	1.5%	3.0%
Mesurado estuary samples				
Mesurado 1	-	93.5%	1.5%	5.0%
Mesurado 2	-	100.0%	-	-
St. Paul River samples				
St. Paul 1	14.5%	85.5%	-	-
St. Paul 3	4.7%	95.3%	-	-

All sediment samples collected contained more than 85% of sand. The following observations can be made.

- Onshore samples have no silt or clay content. Coarse sand is found at the higher end of the beach, while medium-coarse sand is found at the lower part;
- Offshore samples contain no gravel, with the exception of the offshore sample collected at Beach 4 which contained 0.1% gravel. Offshore samples mostly consist of sand particles (more than 95%), but also contain fine sediments. Sediment types of offshore samples were consistent across the five beaches;
- Mesurado estuary samples contain no gravel and mostly consist of fine sediments; and
- Samples collected from the mouth of the St. Paul River have no silt or clay content. They consist of coarse sediments.

### 5.1.7.3 Sediment Budget in the Project Area

The coastal system around Monrovia is relatively complex as it includes interactions with multiple coastal processes (Figure 5-21). The major part of the Monrovia coastline is a straight, sandy and wave-dominated coastline. The beach is relatively steep with relatively coarse sediment, which is typical of a reflective coastline. The Monrovia coast is mainly subject to long period swell waves (see section 5.1.4.3) which induce an alongshore sediment transport along the coast. The direction of the net alongshore sediment transport is to the northwest (CDR International, 2018).

In coastal sections 1, 2 and 3, sediment transport always occurs in the north-western direction. However, sediment transport in coastal sections 4 and 5 occurs both in the north-western and south-eastern directions, resulting in a coastline that is more or less in equilibrium (CDR International, 2019a).



Figure 5-21 Coastal processes in Greater Monrovia (adapted from CDR International, 2018)

Continuous sources and sinks of sediment in a coastal system include for example tidal inlets, estuaries, river mouths, canyons, etc. They are continuously either feeding the coast with sediment or demanding sediment from the coastline. Examples of temporary or discontinuous sources and sinks are sand mining and artificial nourishments (CDR International, 2019a). Sand mining occurs frequently in Liberia. In the project area, sand miners use their canoes to



collect sand from the beach along all the coastal sections and from the sand bars located near coastal section 3 (Figure 5-22). The sand collected is sold and used for construction.



Figure 5-22 Sand miners transporting sand in their canoes in the Mesurado River

In the project area, the major continuous sources and sinks affecting the sediment budget are:

- St. Paul River, a source, located between coastal sections 1 and 2;
- Mesurado River, a sink, located between coastal sections 2 and 3; and
- Farmington River and its tributary Junk River, sources, located southeast of coastal section 5.

Over the years, the supply of sediment originating from the St. Paul River and the Farmington River has decreased due to the construction of dams at the Mt. Coffee hydropower plant and the Firestone hydropower plant. An estimation of current sediment fluxes of the sources and sinks are presented in Table 5-8, where positive values represent a source and negative values represent a sink (CDR International, 2018).

Table 5-8 Baseline sources and sinks (CDR International, 2019a)

Source / Sink	Baseline sediment flux (m <sup>3</sup> /year)
St. Paul River	20,000
Mesurado River	-30,000
Farmington River	275,000

The beach of coastal section 1 is mainly fed by sand from the St. Paul River, which is largely transported in a north-western direction. The outgoing sediment is larger than the incoming sediment. This deficit has led to erosion of the sandy stretches in coastal section 1 (CDR International, 2019a).

The sediment supply to coastal section 2 is currently nil because all sediment transport is blocked by the port breakwaters. Any possible future increase of sediment supply from the St. Paul River will be mainly transported northwards to coastal section 1. Because there is a significant outgoing sediment drift with no sediment input, coastal section 2 is currently being eroded (CDR International, 2019a).

There is no incoming sediment from the southern part of coastal section 3, because this coastal section is isolated. Sediment originating from coastal section 3 is transported into the Mesurado basin where it sinks onto the growing sand spit around the southern breakwater of the port, or is lost offshore. As such, the beach in coastal section 3 is subjected to serious erosion (CDR International, 2019a).

The beaches and shoreface of section 4 are steep, because energetic waves approach this stretch in a nearly perpendicular direction. The net alongshore sediment transport is relatively limited, because the incoming and outgoing sediment transport are relatively similar. However, sand material transported from the western part of the section is considered lost because it settles to the west of the Cape of Monrovia, outside the active zone of the beach. Current coastline retreat is therefore limited but can be expected to increase in the future (CDR International, 2019a).

The incoming and outgoing sediment transport in coastal section 5 are fairly similar, resulting in a coastline that is relatively in equilibrium (CDR International, 2019a).

#### 5.1.8 Air Quality

Historic data on air quality levels in Monrovia are not available. Fuel combustion is a key source of air pollutants in Monrovia, primarily generating carbon dioxide (CO<sub>2</sub>), nitrogen oxides (NO<sub>x</sub>), sulphur dioxide (SO<sub>2</sub>), particulate matter (PM) and volatile organic compounds (VOCs). Fuel combustion takes place at the Liberia Electricity Corporation (LEC), located on Bushrod Island between coastal sections 2 and 3, as well as in small scale electrical generators used in the absence of electrical supply across all five coastal sections. Small-scale industries also release similar pollutants. Fuels used for combustion in diesel electrical generators are rarely high-quality fuels, such as low sulfur diesel, and often consist of leaded gasoline and high sulfur diesel.

As the project falls within an area with a dominant urban character, the entire project area is subject to emissions from vehicular traffic (dust and exhaust emissions) traveling on local roads. Vehicle exhaust emissions are mainly volatile organic compounds (VOCs), nitrogen oxides (NO<sub>x</sub>), particulate matter (PM), and carbon monoxide (CO), which are released from the tailpipe while a vehicle is operating.

Artisanal fishermen use either non-motorized wooden canoes, or 40 HP-motorized canoe-shaped vessels. The latter mainly releases sulphur dioxide (SO<sub>2</sub>), nitrogen oxides (NO<sub>x</sub>) and particulate matter (PM).

Emissions from domestic cooking may also represent important but localized sources of dust and pollutant emissions. Another source of dust is the Harmattan, the dry dusty trade wind that blows from the Sahara during the dry season, as well as vehicular traffic on unpaved roads, especially during the dry season.

In addition, occasional open burning of municipal solid waste generates gaseous pollutants such as nitrogen oxides (NO<sub>x</sub>), carbon oxides (CO<sub>x</sub>), sulphur oxides (SO<sub>x</sub>), particulate matter (PM), methane (CH<sub>4</sub>), ammonia in addition to dioxins/furans, volatile organic compounds (VOCs), polycyclic aromatic hydrocarbons (PAHs) and odorous compounds that can disperse to as far as 200m beyond the burning site (Rushbrook and Pugh, 1999).

### 5.1.9 Ambient Light

The sun is overhead, or within a few degrees of it, at noon throughout the year, giving rise to intense insolation in all parts of the country. The days with the longest hours of sunshine occur between December and March, while those with the shortest hours of sunshine fall between July and September (MPEA, 1983) (Table 5-9). Due to Liberia's high rainfall climate, annual insolation along the coast is lower than inland (Brandolini, 2006).

Table 5-9 Sunshine hours recorded at the Robertsfield metrological station (adapted from LHS, 1988)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual mean
1977	5.6	4.8	4.8	4.7	4.9	3.9	1.7	1.5	1.4	3.3	4.1	3.5	3.7
1978	5.4	4.5	4.5	3.2	3.7	3.9	2.5	2.1	2.2	3.3	3.6	3.8	3.6
1979	4	4.3	4.3	3.3	3.9	3.6	3.9	1.8	3.6	3	4.5	3.7	3.7
1980	4.5	4.9	4.5	4.8	3.8	2.5	1.2	2.6	1.7	2.3	3.4	3.8	3.3
1981	5.1	5.1	3.4	4.3	3.7	4	1.6	2.1	1.9	4.4	4.6	3.4	3.6
1982	4.8	6	5.6	4.4	4.3	1.5	3.9	2.5	2.3	3.3	4.3	3.6	3.9
Monthly mean	4.9	4.9	4.5	4.1	4.1	3.2	2.5	2.1	2.2	3.3	4.1	3.6	3.6



### 5.1.10 Ambient Noise

Background noise in the project area is dominated by waves crashing on the shore constantly throughout the day and night. Other sources of constant noise in the project vicinity during the day are related to vehicular traffic along the highways and traffic congestion. The U.N. Drive highway (coastal sections 1, 2 and 3), which later becomes the Tubman Boulevard highway (coastal sections 4 and 5), is used by all sorts of vehicles and transportation means. It is the major and only access road leading to the Freeport of Monrovia, and is frequently used by heavy vehicles such as trucks transporting containers to and from the Port.

Other sources of noise include industries and craft work, market cycles, and activities from nearby residential and commercial areas particularly the noise generated by small scale private electrical generators that power the nearby shops, residential structures and industries. The noise can be described as high and constant during day hours. The passage of motorized canoes also generates noise, which is of short duration.

Baseline noise measurements conducted by Environmental Resource Management (ERM) at the Free Port of Monrovia in October 2012 showed that day and night-time noise levels are comparable inside the port (WCL Port Facilities Area) in an area where human activity is limited, and are mostly affected by noise from the sea (Table 5-10). The results were well below the Liberian standards for industrial areas. On the other hand, noise levels recorded at Gate 3, a community area near the U.N. Drive highway, were typical for urban areas with busy roads, as day and night-time noise levels differing by  $\pm 10$  dBA (Western Cluster Limited, 2013). Results at Gate 3 were higher than the Liberian standards for industrial areas, and for areas with a mix of residential, industrial, small scale production and commerce activities.

Table 5-10 Baseline noise measurement conducted by ERM in October 2012 (adapted from Western Cluster Limited, 2013)

Site Description	Site Type	Day-time		Night-time	
		LAeq (dBA)	LA90 (dBA)	LAeq (dBA)	LA90 (dBA)
Liberian Standard (EPML, 2017; see Table 4-9)	Industrial	70	-	60	-
	Residential + industry or small-scale production + commerce	60	-	50	-
WCL Port Facilities Area	Industrial	47.3	45	48.1	45.1
Gate 3	Residential + industry or small-scale production + commerce	73.8	67.6	67.4	62.5

### 5.1.11 Visual Amenity

Coastal section 1 (Figure 5-23a) mainly consists of long stretches of steep, sandy beaches and a gently-sloping shoreface with several rock outcrops located nearshore and along the coastline. The main landmark in Coastal section 1 is Hotel Africa, an abandoned hotel that has historical value for the Monrovia society (Figure 5-23b). Within the premises of Hotel Africa are a number of abandoned huts which previously housed the United Nations Mission in Liberia (UNMIL) (Figure 5-23c). Remnants of an old revetment wall and collapsed buildings are present along the coast (Figure 5-23d). North of Hotel Africa are a few entertainment beaches that are mostly visited by beach-goers during the weekends and holidays. These entertainment beaches are bordered by bamboo fences and have parasols mostly made of coconut or palm tree branches (Figure 5-23e). Further north of the entertainment beaches is Banjor Beach Community, whose residents solely rely on fishing for their livelihoods (Figure 5-23f). Some communities reside around Hotel Africa, but the region is not densely populated.



(a)



(b)



(c)



(d)



(e)





(f)

Figure 5-23 Coastal section 1: (a) Overview; (b) Hotel Africa; (c) Abandoned huts; (d) Remnants of an old  
revetment wall and collapsed buildings; (e) Entertainment beaches; (f) Banjor Beach Community

Coastal section 2 (Figure 5-24a) is bordered by a rip-rap revetment wall that is currently under construction to protect this region against further erosion (Figure 5-24b). The revetment wall has created a sort of corniche used as a pedestrian road and along which people gather for recreational activities during the evenings and weekends (Figure 5-24c). The district behind coastal section 2 is densely populated, mostly consisting of housing units (Figure 5-24d), but also including small shops and a school (Figure 5-24e). Fishing communities that live in the area of coastal section 2 use the sandy shore as a landing site for their canoes (Figure 5-24f).





(a)



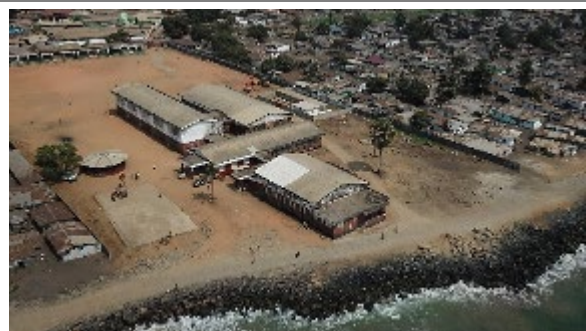
(b)



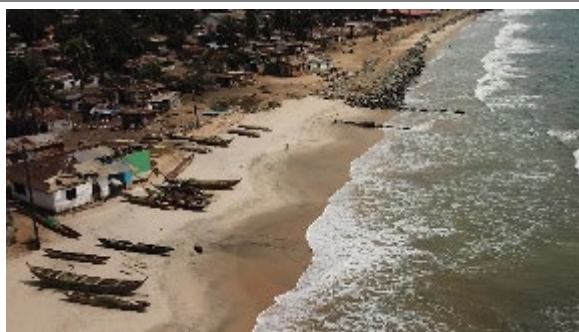
(c)



(d)



(e)



(f)



618 Figure 5-24 Coastal section 2: (a) Overview; (b) Revetment wall under construction; (c) Corniche along the  
619 revetment wall; (d) Housing units; (e) School; (f) Canoe landing sites



Coastal sections 2 and 3 are separated by the Freeport of Monrovia, which is the largest port in Liberia. The harbor encircles a basin of 300 ha of secure water and is protected by two breakwaters (Figure 5-25).

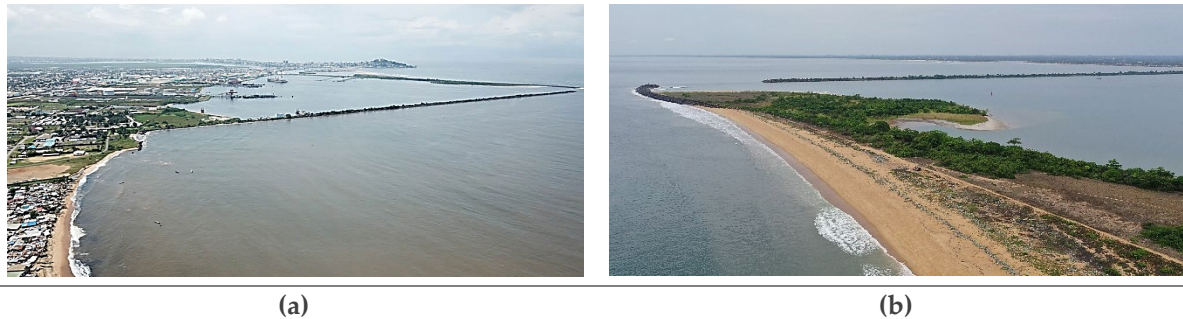


Figure 5-25 Breakwaters of the Freeport of Monrovia seen from (a) the north and (b) the south

Coastal section 3 is located in front of West Point, one of the most densely populated areas of Monrovia, principally consisting of informal, temporary housing units (Figure 5-26a). This district is built on a dynamic sand spit between the ocean and the Mesurado River. The mouth of the Mesurado River is a dynamic zone that includes tidal flats, bars and channels. The sandy coast of section 3 is bordered by the protruding diabase rock formation of the Cape of Monrovia to the southwest, on which buildings are constructed. The coast of section 3 is used for canoe landing, fish drying, and recreational activities (Figure 5-26b). Some fishermen also anchor their boats in the inner part of the Mesurado estuary (Figure 5-26c).





Figure 5-26 Coastal section 3: (a) Overview; (b) Canoe landing site on the coast; (c) Boats anchored in the inner part of the Mesurady estuary

Coastal section 4 (Figure 5-27a) is located at the south of an important economic district of Monrovia. It has a steep beach and shoreface. The western part of this coastal stretch (Figure 5-27b) mostly consists of shanties, permanent housing buildings, hotels and shops. Some residents have installed make shift, low cost wave protection in front of their dwellings to protect them from the waves (Figure 5-27c). The beach on the eastern part is bordered by a road that runs parallel to the coast, next to which is the Barclay Training Center, a military base known as BTC (Figure 5-27d). The beach in coastal section 4 is often used by locals for sports activities (mainly football) and recreation. A sewer discharges raw wastewater onto the beach at the eastern end of the coastal section (Figure 5-27e).





(a)



(b)



(c)



(d)



(e)





(f)

643 Figure 5-27 Coastal section 4: (a) Overview; (b) Western part; (c) Low cost wave protection on dwellings; (d)  
644 Eastern part; (e) Beach used for sports and recreational activities; (f) Wastewater discharge onto the beach

645 Coastal section 5 (Figure 5-28a) has similar characteristics to coastal section 4, since it is its  
646 eastern extension. The most prominent landmark is JFK Hospital. Parallel to the shore are  
647 shanties (Figure 5-28b), permanent housing buildings and shops. West of JFK Hospital, a  
648 sewer discharges raw wastewater onto the beach (Figure 5-28c).





(a)



(b)



(c)

Figure 5-28 Coastal section 5: (a) Overview; (b) Shanties; (c) Wastewater discharge onto the beach

### 5.1.12 Unexploded Ordnance

Fighting in Liberia during the two civil wars between 1990 and 2003 left a small (by global standards) but unknown amount of unexploded ordnance (UXO) hidden in the soil and waterways. This may still include the Monrovia area and the nearshore environment, although it was more common in the hinterland. Between 2003 and 2016, the United Nations Mission in Liberia (UNMIL) and other international agencies defused or detonated a considerable number of items of UXO, particularly in the Monrovia metropolitan area. UNMIL also trained units in the Armed Forces of Liberia to undertake safe disposal, and handed over full responsibility in mid-2016. Landmines were reportedly used in some areas during the first civil war (1990 to 1997) but apparently not in the second civil war (1999 to

2003) (Landmine and Cluster Munition Monitor, 2014). Cluster bombs appear not to have been used in Liberia.

The residual presence of UXO in the project area is therefore expected to be very low. Nevertheless, it is possible that munitions remain in the marine environment, where detection has not been systematic. For this reason, basic provisions are proposed in the Environmental and Social Management and Mitigation Matrix (ESMMM) to check for the presence of UXO in advance of any civil engineering works. This includes hand-held metal detection for shorelines and magnetic surveys at sea before starting foundation excavations. These are standard global practices, and must be written into any relevant contracts to ensure the full safety of workers.

### 5.1.13 Climate Change and Projected Effects

This section describes the foreseen impact of climate change on the coast of Monrovia, using the information from the Revised Interim Report (CDR International, 2019a) as a main reference. CDR International used the fifth assessment report of International Panel on Climate Change (IPCC - AR5 2014) as a basis for assessing the climate change impact. The most and least conservative climate change scenarios of IPCC have been used: RCP 4.5 and RCP 8.5, in order to show the bounds of the climate change effects.

Sea level rise, changing wave impact and change in sediment exchange of rivers and estuaries all contribute towards:

- A shift in the equilibrium profile due to sea level rise (called the 'Bruun Effect');
- Chronical erosion due to sediment deficit caused by long-shore sediment transport and sediment exchange with rivers and estuaries; and
- Storm erosion.

Coastal retreat occurs as a consequence of these processes.

The subsections below describe the projected sea level rise, as well as the change in wave climate, storms and storm erosion, and sediment exchange with rivers and estuaries. As a result of these changes, the projected coastal retreat is explained.

### 5.1.13.1 Sea Level Rise

The average global sea level has been rising since at least the beginning of the twentieth century, as a result of global warming. Relative sea level rise (RSLR) is the sum of two major components: global-mean sea-level change, and regional (local) spatial variations in sea-level change and land movement (uplift and subsidence). As stated in this project's appraisal and design reports, because the latter component is negligible in Liberia, it is not taken into consideration.

Figure 5-29a shows the resulting relative sea level rise projections for the two RCP scenarios for the period of 2000 to 2100. The least conservative scenario (RCP 8.5) shows a projected relative sea level rise of almost 75 cm for the year 2100. When comparing the projected relative sea level rise over the last two decades (2000-2018) to the observed sea level rise, it is clear that the sea level rise is very comparable to the projections and the present sea level rise is mostly between the least and most conservative scenarios (Figure 5-29b).

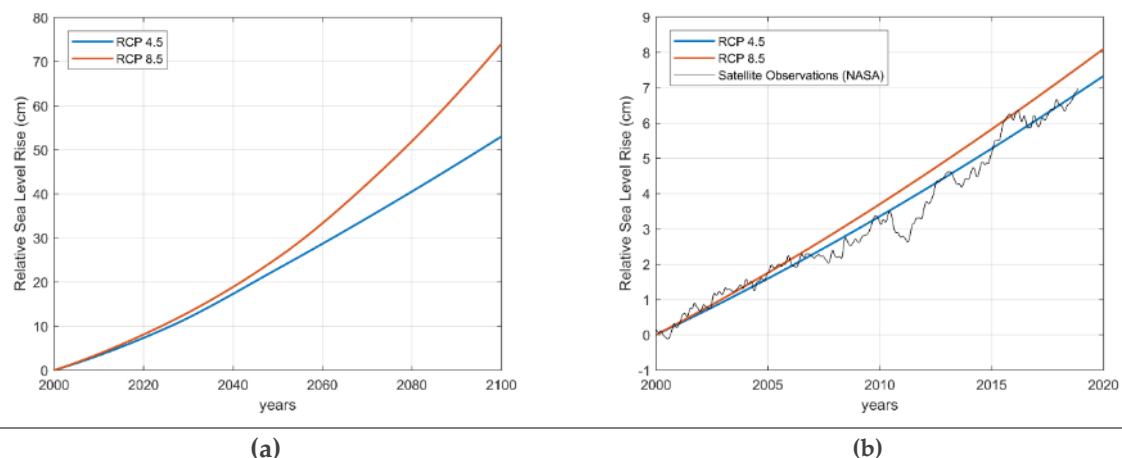


Figure 5-29 Projected relative sea level rise for RCP 4.5 and RCP 8.5 for the years 2000 to 2100; (b) Comparison between projected sea level rise and observed sea level rise for the years 2000 to 2020 (CDR International, 2019a)

### 5.1.13.2 Change in Wave Climate

Over the last decade, the wave climate in Liberia has changed, as can be seen in Figure 5-30. Due to climate change, the wave height distribution has changed between the periods of 1979-2000 and 2000-2018, with the higher waves (especially the 10% highest waves) becoming higher and increasing up to 3 to 5%.

As climate change continues, it is expected for wave heights to increase, for wave periods to increase, and for the wave direction to change.



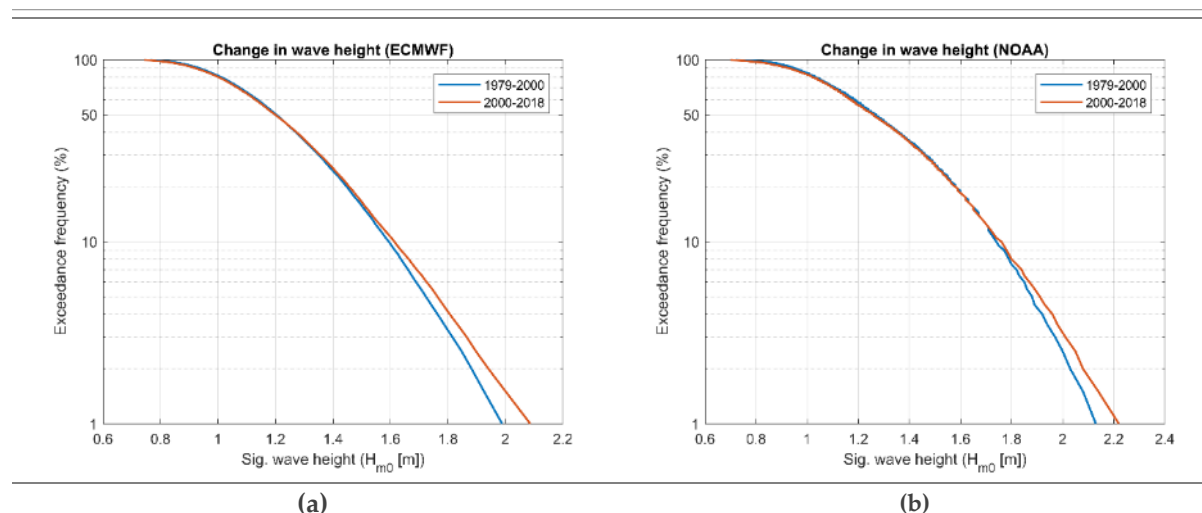


Figure 5-30 Change in wave height between 1979-2000 and 2000-2018 based on hindcast data from (a) the European Centre for Medium-Range Weather Forecasts (ECMWF) and (b) the National Oceanic and Atmospheric Administration (NOAA) (CDR International, 2019a)

### 5.1.13.3 Change in Storms and Storm Erosion

Projections for the year 2100 show that climate change will cause an increase in the significant wave height of extreme waves. This also means that a storm with a 100-year return period in the year 2000 will have a smaller return period in 2100 due to climate change. Thus, storms will occur more frequently.

Due to climate change, the 100 year wave height will have a return period of approximately 40 years with RCP 4.5 and 25 years with RCP 8.5 in 2100. In other words, storms will occur twice more often with RCP 4.5, and four times more often with RCP 8.5.

The additional coastal retreat due to storms (storm erosion) is shown in Table 5-11. For all coastal sections, coastal retreat will significantly increase due to climate change. Coastal sections 1 and 2 will suffer the most from storm erosion, mostly because of their relatively gentle profile combined with heavy wave attack.

Table 5-11: Additional coastal retreat (storm erosion) due to storms with a return period of 100 years for the RCP 8.5 scenario (CDR International, 2019a)

Coastal Section	Additional coastal retreat (m)			
	2020	2050	2070	2100
1	45	49	52	59
2	52	54	59	66
3	21	23	26	28
4	25	28	29	33
5	27	29	30	33

#### 5.1.13.4 Change in Sediment Exchange with Rivers and Estuaries

The sediment balance of the coastal system of Monrovia is highly dependent on the sediment exchange of the rivers and estuaries with the ocean. As described in section 5.1.7.3, the main sources of sediment in the project area are the St. Paul River and the Farmington and Junk Rivers, while the main sink is the Mesurado River.

Projections taking into account the combined effects of anthropogenic drivers and climate change (considered for both RCP scenarios) show that:

- The sediment import of the St. Paul River will increase by 12% and 18% in the year 2100 for RCP 4.5 and RCP 8.5, respectively. This will primarily be caused by the high contribution of anthropogenic effects, such as expected deforestation and change in land-use.
- Similarly, the sediment import of the Farmington River will increase by 10% and 12% in the year 2100 for RCP 4.5 and RCP 8.5, respectively. This will also mainly be caused by the high contribution of anthropogenic effects, such as expected deforestation and change in land-use.
- The sediment demand of the Mesurado River will significantly increase due to climate change.

#### 5.1.13.5 Coastal Retreat

For the last decade, coastal retreat has posed the most pronounced environmental threat on the coast of Monrovia, leading to loss of land, valuable assets and recreational beaches. The average coastal retreat along the coastal sections between 2008 and 2018 is shown in Table 5-12. Coastal sections 2 and 3 have been the most impacted, while coastal section 5 has been the least impacted.

Table 5-12 Average coastal retreat along the coastal sections between 2008 and 2018 (CDR International, 2019a)

Coastal Section	Average coastal retreat between 2008 and 2018 (m)
1	6.5
2	37
3	33
4	10
5	2.5

Coastal retreat has been caused by natural processes (shift in the equilibrium profile due to sea level rise, chronical erosion and storm erosion) and amplified due to climate change. Since the effect of climate change will accelerate during the next decades, coastal retreat and subsequent damage is expected to worsen significantly over the coming decades (up to 2 times in 2100). This is illustrated in Figure 5-31, where the dashed line shows the coastal retreat without climate change and the continuous line the coastal retreat with climate change, based on the RCP 8.5 scenario. It is evident that coastal retreat becomes significantly worse due to climate change for all sections, and that coastal sections 2 and 3 will suffer the most from coastal retreat.

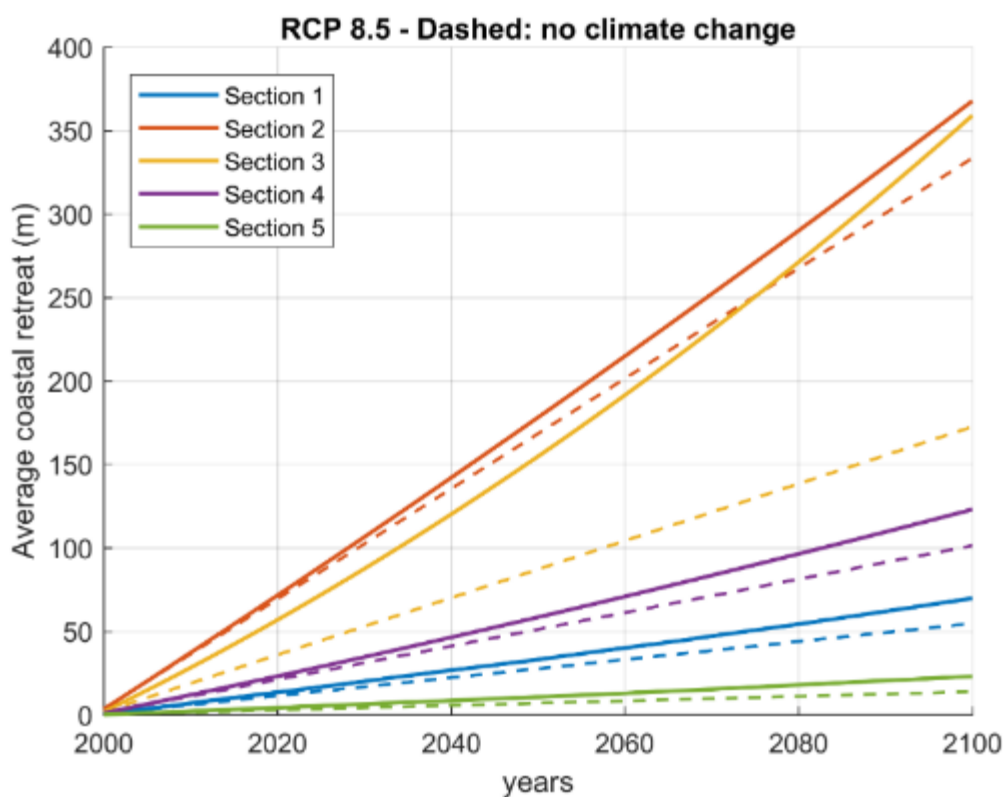


Figure 5-31 Average coastal retreat with (continuous line) and without (dashed line) climate change (CDR International, 2019a)

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## 5.2 BIOLOGICAL ENVIRONMENT

Data presented in this section is largely from secondary sources, but some primary baseline data was also collected. Data on marine faunal biodiversity is mostly focused on the local fisheries. It was collected through interviews with fishermen of the different fishing communities in Monrovia. These interviews aimed at collecting both biological and socio-economic data at the same time. The detailed methodology of the bio-socio-economic data collection is described in Section 0. Questionnaires used are presented in Appendix C. Biological findings of this survey are presented throughout this chapter.

In addition, some biological information presented below were collected or validated through:

- field visits to the affected coastal areas;
- meetings with the National Fisheries and Aquaculture Authority (NAFAA);
- direct photography;
- drone footage; and
- land cover mapping.

### 5.2.1 Coastal and Marine Ecosystems

The coastal zone of Liberia has enormous resources that are both biologically and socio-economically significant. With a coastline of about 560 km, a continental shelf of about 159,200 km<sup>2</sup> and territorial seas of up to about 14,894 km<sup>2</sup>, Liberia annually produces about 7,616 metric tonnes of fish and about 126 metric tonnes of molluscs and crustaceans (Republic of Liberia, 2017). The coastal belt contains significant areas of swamp-related vegetation, which includes mangrove forests and savannah woodland-related vegetation that extend up to 40 km inland (USAID, 2008 and Republic of Liberia, 2017). The mangrove forests provide nutritional inputs to adjacent shallow lagoons and lakes that are the primary habitat, as well as the main spawning and breeding grounds for many aquatic and marine species. The marine environment also plays a significant ecosystem services role, exerting influence over local processes such as the absorption of atmospheric carbon dioxide. The coastal area and marine environments are subject to a variety of pressures, including:



- beach erosion which is due to sea level rise as well as anthropogenic causes such as sand mining;
- anthropogenic pollution: solid waste dumping, sewage dumping, pollution of rivers;
- urban development and population increase;
- intensive and illegal fishing; and
- shipping and related impacts.

The overall marine and coastal database in Liberia is limited, with little published information about the presence of coral reefs or seagrass beds in West Africa. While no major coral reefs or seagrass beds are known, it is likely that these do occur sporadically along the coast.

The various coastal and marine ecosystems found in Liberia in general, and in Monrovia particularly, are presented in Sections 5.2.1.1 through 5.2.1.6 below.

#### **5.2.1.1 Beaches**

About 90% of the Liberian coastline consists of a narrow sand beach interspersed with lagoons, estuaries, bays and brackish wetlands (USAID, 2008). Monrovia's coast is not an exception. Sandy beaches are found all along the coast of Monrovia and are only interrupted by minor rocky areas such as the Mamba Point area known as the Cape of Monrovia, some lagoon areas and two main estuaries: the St. Paul River Estuary and the Mesurado River Estuary.

Sandy beaches are difficult habitats for marine organisms as they are unstable and constantly change with the movements of waves, tides and currents. In Monrovia, the sandy beaches are under pressure by the impacts of sand mining, solid waste pollution (Figure 5-32), sewage pollution (Figure 5-33), human traffic and the expansion of the city among other causes. Coconut trees usually grow on these beaches, along with plant and grass species that are tolerant to salt and sand. These beaches are inhabited by few species of crabs, molluscs, and insects, in addition to sea birds that feed on these organisms. Sea turtles are reported to nest along the beaches in Liberia, but no mass nesting sites were identified (Section 5.2.3.2- Marine Reptiles). Sea turtles do not nest on beaches of Monrovia due to increased human traffic (day and night) and pollution on these beaches.



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Figure 5-32 Beach vegetation and solid waste pollution near Hotel Africa (coastal section 1)



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Figure 5-33 Main sewage outlet of Monrovia (down centre of the photo) discharging raw wastewater to the south of the Barclay Training Center beach (coastal section 4)

#### 5.2.1.2 Coastal Savannah

The coastal savannah consists of low grasses with scattered low trees. It also contains palm and coconut trees along with mangrove and *Raphia* palms (Wiles, 2005). Coastal savannah is mostly found in southeastern Liberia, from Rivercess to Maryland counties, and more pronounced in Grand Kru County (UNDP, 2006). It provides a refuge for a variety of birds as well as some species of small mammals and reptiles.

The propagation of the city of Monrovia towards its coast did not allow stretches of coastal savannah to grow. These are only found to the northern coast of Monrovia (Figure 5-34), separating the sandy beach from the wetland that lies in this area.



Figure 5-34 A stretch of coastal savannah fringing the beach at the northern coast of Monrovia (coastal section 1)

#### 5.2.1.3 Coastal Wetlands

Liberia is endowed with wetlands that provide both subsistence and economic benefits to its many inhabitants. Besides being important reservoirs of biological diversity, these habitats provide spawning and breeding grounds for many fish, including transboundary species and shellfish in the region, and therefore are the basis of the regenerative capacity of the region's fisheries (Ukwe et al., 2001).

Eight major wetlands have been identified in Liberia. Among these, five are coastal wetlands. These are: Lake Piso, Marshall, Mesurado, Bafu Bay and Lake Shepherd Wetlands. Coastal wetlands in Liberia mostly consist of mangrove forests which are either lagoonal, occurring in lagoons behind barrier islands that extend parallel to the beach, or deltaic, located in estuaries.



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## **The Mangrove Ecosystem**

Mangroves are coastal forests that grow where ocean, freshwater, and land meet. They are among the most productive and complex ecosystems on the planet, thriving in salty and brackish conditions that would kill most other plants. Their capacity to protect against storms and even sea level rise make them indispensable for coastal communities in their fight against climate change (Wetlands International, 2019). They have evolved clever mechanisms to enable them to cope with high salinities and the regular inundation of their root systems by incoming tides (Corcoran et al., 2007). Mangrove forests provide the following benefits to the environment:

- They offer spawning grounds and nurseries for many fish, crabs, shrimps, molluscs and other forms of marine life;
- They provide a habitat for many endangered species of manatees, crocodiles, turtles, and migratory birds;
- They have a high carbon storage capacity through accumulation in living biomass and through burial in sediment deposits;
- They provide protection and shelter against extreme weather events, such as storm winds and floods, as well as tsunamis by dispersing tidal surges associated with these events;
- They protect the coastline by reducing erosion from storm surges, currents, waves, and tides; and
- They deliver wood and non-wood forest products to the surrounding communities.

In Liberia, mangroves are mainly found around estuaries, at the edges of river banks and lagoons, and in wetland areas (Figure 5-35). With the exception of a few places in the central part of Liberia, primary mangrove forests have been replaced by secondary stands of mangroves. Much of the destruction appears to be concentrated along the edges of creeks, river estuaries and lagoons, with particularly widespread destruction around the major coastal towns and cities, such as Monrovia, Buchanan, Greenville, Robertsport and Harper. Mangroves are historically exploited for their wood which is burned as fuelwood or used for construction purposes. Recently, another product of economic importance, a gastropod species called “Kissmeat”, is being extracted from mangrove forests and sold in the markets

for food consumption. The biggest threat to Liberia's mangroves is urban expansion and landfills, particularly in Monrovia. This expansion began during the civil conflict when many displaced people established landfills in Mesurado and Marshall Mangrove wetlands, causing large areas of mangroves to be destroyed and to be used as dumps or as sewage disposal sites (USAID, 2008). In addition, mangrove deforestation is also caused by intensive cutting for wood, fuelwood and charcoal production.



Figure 5-35 Mangrove trees at the St. Paul River Estuary

### Mesurado Wetland

The Mesurado Wetland is situated in the heart of the city of Monrovia (Figure 5-36). This estuarine wetland of 6,670 hectares is one of the five designated Wetlands of International Importance in Liberia. This site has a high ecological value, mainly due to three mangrove species (*Rhizophora harrisonii*, *R. mangle* and *Avicennia africana*) which are threatened by intense charcoal burning and fuel wood collection (The Ramsar Sites Information Service, 2006). The site provides a favorable habitat and feeding ground for several species of birds such as the African Spoonbill (*Platalea alba*), the Common Pratincole (*Glareola nuchaltis*) and the Curlew (*Numenius arquata*). The site hosts three reptile species. These are: the African Dwarf Crocodile (*Osteolaemus tetraspis*) which is classified as vulnerable by the IUCN Redlist, the critically endangered African Sharp-Nosed Crocodile (*Crocodylus cataphractus*), and the Nile Crocodile (*Crocodylus niloticus*) which is included in the CITES Appendix I for protection against over-

exploitation through international trade. It also hosts the endangered Upper Guinea Red Colobus monkey (*Procolobus badius*), and the Water Chevrotain (*Hyemoschus aquaticus*) which has a declining population (IUCN, 2019). These species are among the list of fully protected animals in Liberia.

The Mesurado Wetland is currently under pressure mainly due to the following reasons:

- cutting of mangrove trees for fuel wood, construction material, medicinal use, etc.;
- disposal of solid waste in the wetland and trapping of solid debris carried by the Mesurado River and the Stockton Creek (Figure 5-37); and
- urban encroachment and construction of infrastructure in the wetland (Figure 5-38).

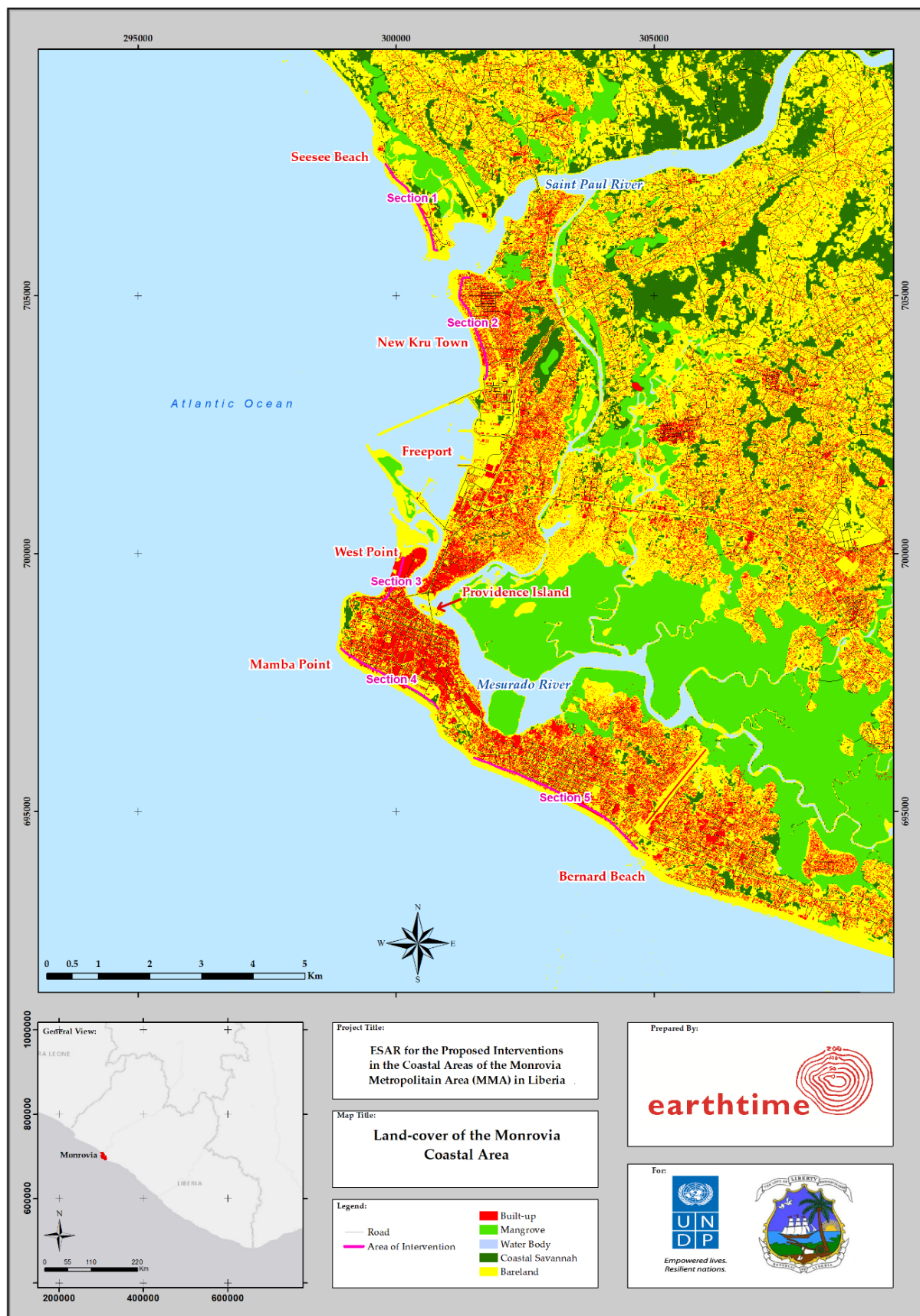


Figure 5-36 Land cover map of the project area





Figure 5-37 Mangrove trees trapping solid waste at the Mesurado Wetland



Figure 5-38 Expansion of the city at the expense of the Mesurado Wetland

### Other Coastal Wetland Areas in Monrovia

Apart from the Mesurado Wetland which covers a big part of the city, the coast of Monrovia harbours smaller wetland areas which provide ecological benefits to the coast. An estuarine mangrove area is found in the St. Paul River Estuary at the northern bank of the St. Paul River mouth (Figure 5-39). In addition, the Bernard Beach lagoon of about 9 acres lies parallel to the



coast to the east of coastal section 5 (Figure 5-40). It is separated from the ocean by a strip of sandy beach.

Lagoons and estuaries are known to be highly biodiverse due to the variety of habitats they can house (de Wit, 2011; Kennish and Paerl, 2010). Lagoons and estuaries and their associated habitats provide nurseries and feeding grounds for many commercially important species of fish and shellfish (Kathiresan and Bingham, 2001; Kennish and Paerl, 2010) as well as birds. In addition, lagoons can be rich in benthic plants such as algae and seagrass because they are shallow and allow the sunlight to penetrate to their bottom (Kennish and Paerl, 2010).



Figure 5-39 Mangrove area lying parallel to the beach at the northern bank of the St. Paul River Mouth (coastal section 1)



Figure 5-40 Bernard Beach lagoon lying parallel to the coast to the east of coastal section 5

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#### 5.2.1.4 Seagrass Beds

There is very limited available information on the occurrence, location, densities and species composition of seagrass in West Africa in general, and in Liberia in particular. It is likely that seagrass beds are found sporadically in Liberia in the intertidal and near shore waters. No large seagrass concentrations are yet identified (Green and Short, 2003).

In general, sea grasses prefer sheltered lagoons or bays with low wave action. Lake Piso has a strong potential for seagrass development. In addition, seagrass constitute the diet of the West African Manatee, which have been recorded from the St. Paul and Mesurado rivers, as well as the St. John and the Cavalla rivers in the south. Therefore, these areas are potential locations where seagrass occurs in Liberia. (Aaron Lobo, Personal Communication, February 12, 2019).

#### 5.2.1.5 Shelf Habitats

Specific information on the shelf habitats of Liberia is still very primitive. The continental shelf of Liberia is dominated by soft sediments. Mud and sand, in differing proportions, extend in parallel strips all along the coast. Also parallel to the coast, between 80 and 200 m, are fossil coral banks from the Holocene age (Martos et al., 1991; Villegas and Garcia, 1983). Rocky areas are minimal (Martos et al., 1991; Villegas and Garcia, 1983). Coral reef development is also negligible (Villegas and Garcia, 1983).

It is known that the majority of soft-bottoms lack significant amounts of seaweeds and seagrasses (Castro and Huber, 2005). They are therefore known as unvegetated communities. The main primary producer is phytoplankton. Nutrients are largely land-sourced from estuaries and mangrove areas. Another source would be the marine detritus (feces, dead organisms, etc.). Faunal communities that predominate in these habitats are the animals that dig or burrow in the sediment: the Infauna (worms, snails, clams, etc.). Adding to these are the Epifauna animals, such as anemones, shrimps and crabs, which live on top of the sediment. Sessile forms are very rare due to the soft character of the sediments (Castro and Huber, 2005). Some fish species such as skates, rays and soles, among others, can also be found foraging over the soft sediments. The biodiversity and productivity of soft bottom habitats depend upon a variety of factors such as depth, light exposure, temperature, sediment grain size and abundance of microalgae and bacteria. Different communities' assemblages can be found in different conditions.

Rocky areas, however, provide for a wider variety of marine organisms. Rocky areas provide stability for the development of seaweeds in the shallow waters and other sessile organisms such as barnacles, anemones, sponges, etc. They offer a place of shelter and food for a multitude of fish and invertebrate species and their juveniles. Seabed rocks in Liberia are usually the extensions of the coastal sharp rocks that intersect with the long sandy beaches. These extensions can widen to cover the sea floor to depths of up to 80 m off Cape Palmas in the southeast of Liberia (Martos et al., 1991). They are targeted by the hook and line Kru fishermen for specific commercially important fish species such as snappers and groupers.

#### 5.2.1.6 Coral Reefs

Coral reefs are rare along Africa's west coast and there is little literature available on the abundance and composition of coral reef communities present in Liberia.

A study by Laborel in 1974 on the West African Corals revealed the following information on warm water coral reefs occurrence in West Africa:

- Two oculinid corals, *Schizoculina africana* and *Schizoculina fissipara*, are endemic to the region and have adapted to Guinean waters and very low salinities.
- Colonial shallow water dendrophyllids are among the most abundant corals in West Africa, covering vertical rocky surfaces. Their taxonomy is still confused and it is not clear how many species are restricted to the area.
- The genus *Astrangia* is well represented.
- *Millepora* and *hermatypic* corals are found mainly around the islands where some of them are endemic, and the more tolerant species also occur in low salinity mainland littoral waters.
- *Madracis pharensis* seems to be abundant everywhere in the tropical and subtropical Atlantic.
- The taxonomy of *Siderastrea* still needs clarification. *S. Sidera*, a form similar to *S. Stellato*, and *S. Radians* are found in the islands of the Gulf of Guinea.
- There are three species of *Porites*: *P. Astreoides*, *P. Porites* and *P. Bernardi*. *P. Bernardi* is endemic to West Africa and is found from Liberia to Gabon.

The above-cited warm water coral species may potentially be found in Liberia, however their occurrence is still not confirmed. On the other hand, one of the significant deep-sea coral species, *Lophelia pertusa*, has been found off the coast of West Africa in several locations, including in or near Liberian waters (IUCN, 2004; Hoeksema and Cairns, 2019). This species is typically found at depths between 200 and 1,000 m (NOAA, 2010).

## 5.2.2 Coastal Biodiversity

### 5.2.2.1 Coastal Flora

Mangrove forests are the most important flora in the coastal area. The most common mangrove species in Liberia is *Rhizophora racemosa*, but three other species are abundant in the country. These are *Rhizophora harrisonii*, *Rhizophora mangle* and *Avicennia germinans*, which are believed to occur in the Mesurado Wetland (The Ramsar Sites Information Service, 2006).

According to the most recent National Biodiversity Strategy and Action Plan submitted by the Government of Liberia to the Convention on Biological Diversity, a fifth species (*Conocarpus erectus*) may also occur in the country; its presence is yet to be confirmed (Republic of Liberia, 2017). Although the occurrence of *Conocarpus erectus* was stated in many references, Adam (1970), Spalding et al. (1997) and Corcoran et al. (2007) describe *C. erectus* to be the dominant mangrove species around Cape Palmas in southeastern Liberia and to occur in the central coast of Liberia. They also refer to the presence of *Acrostichum aureum* in the Cape Palmas area.

Also common in the coastal zones are palm trees such as the coconut tree (*Cocos nucifera*), the African oil palm (*Elaies guineensis*) and the raphia palms (*Raphia palma-pinus*, *Raphia vinifera* and *Raphia hookeri*). Mango trees (*Magnifera indica*), papaya trees (*Carica papaya*) and other fruit trees as well as some ornamental plants are also common in the coastal area.

Minor seagrass growth may occur in the coastal areas of Monrovia, especially in lagoons and wetland areas such as the Mesurado Wetland. Published data verifying their existence and taxonomy is not available. Liberia has only three recorded species of seagrass (*Cymodocea nodosa*, *Ruppia maritima* and *Halodule wrightii*), the most common being *Halodule wrightii* (Dr. Aaron Lobo, Personal Communication, February 12, 2019).

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#### 5.2.2.2 Coastal Fauna

The wetland ecosystems of Monrovia support a very diverse assemblage of faunal species, some of which have high biological, conservational or economical values. Important faunal species of the Mesurado Wetland are listed in Table 5-13. The listing is extracted from the Ramsar site designation documents (2006). Detailed information on the diversity, structure and species abundance of these assemblages is not available.

Although not mentioned in the Ramsar documents, the West African Manatee *Trichechus senegalensis* (IUCN status: Vulnerable) was recorded in the Mesurado Wetland as well as in the St. Paul River Estuary (Dr. Aaron Lobo, Personal Communication, February, 12, 2019). Other mammals that are expected to occur in the coastal wetland areas of Monrovia are rats, mice, bats, duikers and antelopes species.

Apart from the crocodile species listed in Table 5-13, reptiles expected to exist in these wetlands are water snakes, lizards, skinks as well as turtles. In addition, a multitude of birds, molluscs, fish, crabs and shrimps are found in the wetlands. Nonetheless no published data about the exact taxonomy of these faunal species is available. Adult marine turtles may also be encountered nesting in sheltered wetland areas. Their juveniles may be found traversing the coastal estuaries while reaching to the ocean.

In contrast, the faunal diversity of sandy beaches along the coast is relatively very low. It is limited to some crab (Figure 5-41a), lizard, mollusc and insect species as well as birds. Birds commonly found resting or feeding on sandy beaches in Liberia are terns, herons (Figure 5-41b) and waders (Gatter, 1997). It is not likely that sea turtles nest on beaches of Monrovia because of the relatively high human traffic on these beaches. Surveys carried out by Earthtime's social team among the different fishermen communities of Monrovia did confirm that turtles do not nest on the city's beaches. However, numerous records of turtle nesting activities are reported for the southeast beaches of Liberia up to Grand Bassa County (see section 5.2.3.2 - Marine Reptiles).



Table 5-13 Important mammal, reptile and bird species of the Mesurado Wetland (adapted from The Ramsar Sites Information Service, 2006)

Class	English name	Scientific name	IUCN Red List Category*
Mammals	Water Chevrotain	<i>Hyemoschus aquaticus</i>	LC
	Red Colobbus Monkey	<i>Procolobus badius</i>	EN
Reptiles	African Dwarf Crocodile	<i>Osteolaemus tetraspis</i>	VU
	Nile Crocodile	<i>Crocodylus niloticus</i>	LC
	African Sharp-Nosed Crocodile	<i>Crocodylus cataphractus</i>	CR
Birds	Reef Heron	<i>Egretta gularis</i>	LC
	African Spoonbill	<i>Platalea alba</i>	LC
	Water Thick-knee	<i>Burhinus vermiculatus</i>	LC
	Common Pratincole	<i>Glareola pratincola</i>	LC
	Kentish Plover	<i>Charadrius alexandrinus</i>	LC
	Grey Plover	<i>Pluvialis squatarola</i>	LC
	Senegal Plover	<i>Vanellus lugubris</i>	LC
	Spur-winged Plover	<i>Vanellus spinosus</i>	LC
	Curlew	<i>Numenius arquata</i>	NT
	Whimbrel	<i>Numenius phaeopus</i>	LC
	Spotted Redshank	<i>Tringa erythropus</i>	LC
	Marsh Sandpiper	<i>Tringa stagnatilis</i>	LC
	Redshank	<i>Tringa totanus</i>	LC
	Turnstone	<i>Arenaria interpres</i>	LC
	Sanderling	<i>Calidris alba</i>	LC
	Knot	<i>Calidris canutus</i>	NT
	Curlew Sandpiper	<i>Calidris ferruginea</i>	NT
	Little Tern	<i>Sterna albifrons</i>	LC
	Damara Tern	<i>Sterna balaenarum</i>	VU
	Roseate Tern	<i>Sterna dougallii</i>	LC
	Common Tern	<i>Sterna hirundo</i>	LC
	Black Tern	<i>Sterna nigra</i>	LC
	Arctic Tern	<i>Sterna paradisaea</i>	LC
	Royal Tern	<i>Sterna maxima</i>	LC
	Sandwich Tern	<i>Sterna sandvicensis</i>	LC
	Caspian Tern	<i>Sterna tschegrava</i>	LC
	Little Bee-eater	<i>Merops pusillus</i>	LC
	Bar-breasted Fire-Finch	<i>Lagonosticta rufopicta</i>	LC

\* CR = critically endangered; EN = endangered; VU = vulnerable (IUCN, 2019)



(a)



(b)

Figure 5-41 Ghost Crab foraging on a beach in the southeast of Monrovia in March 2019; (b) Herons near the beach in Monrovia

1045 The biodiversity and abundance of species on rocky outcrops in the area is greater than on the  
1046 sandy beaches. This is common on naturally occurring rocks intersecting the sandy beaches  
1047 of Monrovia, as well as on solid structures added by developments (port breakwaters, existing  
1048 revetments, etc). Rocky outcrops are characterized by an assemblage of barnacles and  
1049 molluscs of unknown taxonomy (Figure 5-42). They also provide niches for crustaceans and  
1050 juvenile fish (Figure 5-43). Marine birds, mainly terns, and land birds such as the Red-eyed  
1051 Dove (*Streptopelia semitorquata*), the Rock Pratincole (*Glareola nuchalis*) and the Orange Weaver  
1052 (*Ploceus aurantius*), are common visitors of these rocks during the summer season (Gatter,  
1053 1997).



(a)



(b)

1054 Figure 5-42 Life on coastal rocks showing gastropods (a, b), barnacles and algae (b)





Figure 5-43 Crustacean community developed on the Buchanan Port southern breakwater.

### 5.2.3 Marine Biodiversity

#### 5.2.3.1 Marine Flora

West Africa's algal species diversity is low compared to that of other marine regions. This is due to many contributing factors such as the seasonal upwelling, the seasonal inflow of turbid, silt-laden water, the seasonally lowered inshore salinity, the absence of suitable shallow water substrata, as well as the low habitat diversity and heterogeneity (Bolton et al., 2013).

Published information on seaweed species diversity in Liberia revealed about 90 different algal species (Table 5-14). This number may be underestimated because Liberia's seaweed diversity is under-investigated; as it is based on collecting visits of less than one week (Bolton et al., 2013). For example, neighbouring Sierra-Leone, which was more intensively studied for algal diversity, has 112 recorded seaweed species. However, Sierra-Leone has more rocky shore areas, allowing more algal growth than Liberia.

Some of the identified (i.e. listed) and other unidentified seaweed species are expected to occur on rocky areas in the inter-tidal and subtidal zones of Monrovia's shore.

1071 Table 5-14 Seaweed species identified in Liberia (adapted from John et al., 2004)

Green Algae (Chlorophyta)	Brown Algae (Phaeophyta)	Red Algae (Rhodophyta)		
<i>Acetabularia pusilla</i>	<i>Asteronema breviarticulatus</i>	<i>Acrochaetium dasyae</i>	<i>Erythrocladia irregularis</i>	<i>Jania adhaerens</i>
<i>Bryopsis pennata</i>	<i>Bachelotia antillarum</i>	<i>Acrochaetium daviesii</i>	<i>Erythrotrichia carnea</i>	<i>Jania verrucosa</i>
<i>Bryopsis plumosa</i>	<i>Basispora Africana</i>	<i>Amphiroa beauvoisii</i>	<i>Galaxaura marginata</i>	<i>Laurencia galtsoffii</i>
<i>Caulerpa racemosa</i>	<i>Chnoospora minima</i>	<i>Amphiroa peruana</i>	<i>Gelidiopsis planicaulis</i>	<i>Laurencia nidifica</i>
<i>Caulerpella ambigua</i>	<i>Colpomenia peregrine</i>	<i>Asparagopsis taxiformis</i>	<i>Gelidiopsis variabilis</i>	<i>Laurencia tenera</i>
<i>Chaetomorpha antennina</i>	<i>Dictyopteris delicatula</i>	<i>Bostrychia moritziana</i>	<i>Gelidium corneum</i>	<i>Polysiphonia ferulacea</i>
<i>Chaetomorpha linum</i>	<i>Dictyota bartayresiana</i>	<i>Bostrychia radicans</i>	<i>Gelidium crinale</i>	<i>Polysiphonia subtileissima</i>
<i>Cladophora coelothrix</i>	<i>Dictyota cervicornis</i>	<i>Bostrychia tenella</i>	<i>Gelidium pusillum</i>	<i>Pterocladia capillacea</i>
<i>Cladophora montagneana</i>	<i>Dictyota ciliolate</i>	<i>Bryocladia cuspidate</i>	<i>Gracilaria gracilis</i>	<i>Taenioma perpusillum</i>
<i>Cladophora prolifera</i>	<i>Dictyota dichotoma</i>	<i>Bryocladia thyrsgera</i>	<i>Gracilaria rangiferina</i>	<i>Tricleocarpa fragilis</i>
<i>Cladophora socialis</i>	<i>Hincksia mitchelliae</i>	<i>Callithamniella tingitana</i>	<i>Grateloupia filicina</i>	<i>Wrangelia argus</i>
<i>Cladophora vagabunda</i>	<i>Hincksia rallsiae</i>	<i>Callithamnion granulatum</i>	<i>Grateloupia turuturu</i>	
<i>Phyllocladon anastomosans</i>	<i>Lobophora variegata</i>	<i>Caloglossa leprieurii</i>	<i>Gymnogongrus nigricans</i>	
<i>Ulva clathrata</i>	<i>Padina antillarum</i>	<i>Catenella caespitosa</i>	<i>Gymnogongrus tenuis</i>	
<i>Ulva fasciata</i>	<i>Padina durvillaei</i>	<i>Centroceras clavulatum</i>	<i>Haliptilon subulatum</i>	
<i>Ulva flexuosa</i>	<i>Padina gymnospora</i>	<i>Ceramium flaccidum</i>	<i>Herposiphonia guineensis</i>	
<i>Ulva lactuca</i>	<i>Ralfsia expansa</i>	<i>Ceramium ledermannii</i>	<i>Herposiphonia secunda</i>	
<i>Ulva rigida</i>	<i>Sargassum vulgare</i>	<i>Chondracanthus acicularis</i>	<i>Hildenbrandia rubra</i>	
	<i>Sphacelaria fusca</i>	<i>Chondrophycus intermedius</i>	<i>Hypnea flagelliformis</i>	
	<i>Sphacelaria rigidula</i>	<i>Corallina pilulifera</i>	<i>Hypnea musciformis</i>	
	<i>Sphacelaria tribuloides</i>	<i>Cryptonemia seminervis</i>	<i>Hypnea spinella</i>	

### 5.2.3.2 Marine Fauna

#### Marine Invertebrates

Detailed surveys of marine invertebrates in Liberia are lacking. However, the nearshore zone has well developed crustacean and mollusc populations, including commercially valued species. Crustaceans include penaeid shrimps and crabs; molluscs include oysters, cones, conches, arcs, and volutes.

A list presented in Liberia's first National Biodiversity Strategy and Action Plan (NBSAP) in 2003 defined marine invertebrates for the locations of ELWA, Banjor and West Point (in Montserrado County) and Marshall (in Margibi County) (Table 5-15). It included species of different habitats, ranging from pelagic to benthic. No information on the exact methods of data collection was provided (GoL, 2003b). However, the listed species can be considered to be commonly found in the project area. One of these species, the Portuguese Man of War, is shown in Figure 5-44.

Table 5-15 Marine invertebrates of ELWA, Banjor, Marshall and West Point (GoL, 2003b)

Phylum	Scientific Name	Common Name	Habitat
Cnidaria	<i>Physalia pelagica</i>	Portuguese Man of War	Pelagic
	<i>Chironex fleckeri</i>	Sea jelly fish	Pelagic
	<i>Metridium senile</i>	Sea anemone	Benthic
Mollusca	<i>Hatitot tuberculata</i>	Abalone	Benthic
	<i>Scaphander punctostriatus</i>	Sea snail	Moderately deep water
	<i>Tonna galea</i>	Tuna shell	Moderately deep water
	<i>Phalium granulatum</i>	Scotch bonnet	Shallow water
	<i>Murex tryoni</i>	Rock / dye shell	Deep water
	<i>Purpura patula</i>	Rock shell / dog winkie	Intertidal
	<i>Ventricolaria</i>	Venus clam	Shallow water
	<i>Crassostrea virginica</i>	Sea oyster	Shallow water
	<i>Pecten raveneli</i>	Scallop	Shallow water
	<i>Liogo pealii</i>	Squid	Pelagic
	<i>Octopus vulgaris</i>	Octopus	Benthic
Annelida	<i>Neanttes (Nereis) virens</i>	Clam worm	Benthic
Arthropoda	<i>Panulirus argus</i>	Spiny lobster	Benthic
	<i>Scyllarides</i>	Shovel-nose lobster	Benthic
	<i>Callinectes sapidus</i>	Blue crab	Benthic
	<i>Callappa flammea</i>	Box crab	Benthic
	<i>Oxypode quadrata</i>	Ghost crab	Sandy beach
	<i>Eupagurus bernhardus</i>	Hermit crab	Benthic
	<i>Squilla mantis</i>	Mantis shrimp	Benthic
	<i>Balanus balanoides</i>	Barnacle	Benthic
Echinodermata	<i>Astropecten irregularis</i>	Starfish/sea star	Benthic
	<i>Arabica puntulata</i>	Sea urchin	Benthic





Figure 5-44 A *Physalia physalis* (Portuguese Man o' War) washed up on the beach at the southeast of Monrovia in March 2018

The benthic macrofaunal populations have not been described in detail. Le Loeuff and von Cosel (1998) sampled sedimentary macrofauna of northwestern Africa on the shelf, to a depth of 200 m. The dominant fauna at all depths sampled were Polychaete worms. The study found that the Liberian fauna was reduced in numbers. This was explained to be due to a diminished effect of nutrient upwelling and primary productivity compared with the Guinea coast to the north and Ivory Coast, inside the Gulf of Guinea, to the south. The benthos composition of the Liberian continental slope is still unknown. On a global scale, these communities, residing at uniformly low temperatures, contain a high proportion of cosmopolitan species numerically dominated by polychaete worms, bivalve molluscs, and pericarid crustaceans (Gage and Tyler, 1991). On the other hand, only one study (Longhurst, 1959) described the benthos of the deeper shelf and upper slopes of West Africa. Densities of organisms from depths exceeding 50 m were all below 100 per m<sup>2</sup>.

In 2013, benthic sampling was carried out for Exxon Mobil's Block 13 Exploratory Drilling ESIA. The sampling took place in Block 13, located approximately 50 to 80 km offshore central Liberia, at depths between 1181 and 2904 m. The survey recorded 99 families of macrofauna. The abundance was observed to be less than typical abundance reported from continental slope sediments worldwide (TDI Brooks Intl. and InterAct PMTI, 2013). Crustaceans were the numerically dominant group (34%), followed by annelid (primarily polychaete) worms (31%),

and then molluscs (23%), collectively comprising 88% of the macrofauna. Other higher order taxa collectively making up 12% of the total abundance included echinoderms, sipunculans (peanut worms), nematodes (round worms), nemertean (ribbon worms), enteropneusts (acorn worms), platyhelminths (flatworms), hydroids, sea anemones, and bryozoans. Table 5-16 presents the abundance and types of macrofauna recorded in the study area. Of the 99 families identified, nine were most common and these made up more than 50% of the total abundance (Table 5-17). Dominant families were typical cosmopolitan inhabitants of shelf and slope sediments worldwide (TDI Brooks Intl. and Interact PMTI, 2013). These included spionid, cirratulid, paraonid polychaetes, phoxocephalid amphipods and thyasirid and nuculanid (bivalve) molluscs.

**Table 5-16 Macrofauna abundance and types in Exxon Mobil's Block 13 (Acorn Intl. and Earthtime Inc., 2014)**

Phylum/Subphylum	Mean abundance per square metre	Comments
Crustacea	236	Most abundant were tanaidaceans, isopods, amphipods, ostracods and cumaceans
Mollusca	161	Most common included pelecypods (bivalves), gastropods (snails), scaphopods (tusk shells) and chaetodermatids.
Polychaeta worms	219	Most common were Paraonidae, Cirratulidae, Spionidae and Capitellidae
Other, including echinoderms, sipunculans (peanut worms), nematodes (round worms), nemertean (ribbon worms), enteropneusts (acorn worms), platyhelminths (flatworms), hydroids, sea anemones and bryozoans.	65	Of these, round worms were most abundant followed by peanut worms, ribbon worms, acorn worms and flat worms. Sea anemones, sea-stars and sea cucumbers were also identified.

**Table 5-17 Dominant families of macrofauna in Exxon Mobil's Block 13 (TDI Brooks Intl. and Interact PMTI, 2013)**

Family	Major Taxon
Thyasiridae	Bivalve Mollusc
Nuculidae	
Paraonidae	Polychaete
Cirratulidae	
Spionidae	
Colletteidae	Tanaid Crustacean
Desmosomatidae	Isopod Crustacean
Phoxocephalidae	Amphipod Crustacean
Nematoda	Nematode

## Marine Birds

In general, terns and most importantly black terns (*Chlidonias niger*) pass through the offshore waters of Liberia, mainly in the spring when food stocks are high (Gatter, 1997). A survey of the pelagic resources and marine ecosystems off West Africa undertaken by R/V Dr. Dridjtof Nansen in 2017 revealed an abundance of Arctic and comic terns offshore Liberia. The survey also identified a juvenile gannet, a skua and a white-fronted petrel (Boyer et al., 2017). Birdlife International's database lists 19 species of seabirds for Liberia (Table 5-18).

Table 5-18 Seabirds of Liberia (Birdlife international, 2019)

Scientific name	English name	Family	IUCN Red List Category*
<i>Hydrobates leucorhous</i>	Leach's Storm-petrel	Hydrobatidae (Northern Storm-petrels)	VU
<i>Oceanites oceanicus</i>	Wilson's Storm-petrel	Oceanitidae (Southern Storm-petrels)	LC
<i>Calonectris diomedea</i>	Scopoli's Shearwater	Procellariidae (Petrels, Shearwaters)	LC
<i>Calonectris borealis</i>	Cory's Shearwater	Procellariidae (Petrels, Shearwaters)	LC
<i>Puffinus puffinus</i>	Manx Shearwater	Procellariidae (Petrels, Shearwaters)	LC
<i>Sula leucogaster</i>	Brown Booby	Sulidae (Gannets, Boobies)	LC
<i>Xema sabini</i>	Sabine's Gull	Laridae (Gulls, Terns, Skimmers)	LC
<i>Larus fuscus</i>	Lesser Black-backed Gull	Laridae (Gulls, Terns, Skimmers)	LC
<i>Onychoprion fuscatus</i>	Sooty Tern	Laridae (Gulls, Terns, Skimmers)	LC
<i>Sternula albifrons</i>	Little Tern	Laridae (Gulls, Terns, Skimmers)	LC
<i>Gelochelidon nilotica</i>	Common Gull-billed Tern	Laridae (Gulls, Terns, Skimmers)	LC
<i>Hydroprogne caspia</i>	Caspian Tern	Laridae (Gulls, Terns, Skimmers)	LC
<i>Chlidonias niger</i>	Black Tern	Laridae (Gulls, Terns, Skimmers)	LC
<i>Sterna hirundo</i>	Common Tern	Laridae (Gulls, Terns, Skimmers)	LC
<i>Sterna paradisaea</i>	Arctic Tern	Laridae (Gulls, Terns, Skimmers)	LC
<i>Thalasseus sandwicensis</i>	Sandwich Tern	Laridae (Gulls, Terns, Skimmers)	LC
<i>Thalasseus maximus</i>	Royal Tern	Laridae (Gulls, Terns, Skimmers)	LC
<i>Stercorarius parasiticus</i>	Arctic Jaeger	Stercorariidae (Skuas)	LC
<i>Stercorarius pomarinus</i>	Pomarine Jaeger	Stercorariidae (Skuas)	LC

\*CR = critically endangered; EN = endangered; VU = vulnerable

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## Marine Mammals

Specific records of marine mammal occurrences in Liberian waters are scarce. The most comprehensive data source on marine mammals in Liberia is the result of a focused literature review on the occurrence of both marine mammals and sea turtles, which was undertaken by Dr. Caroline R. Weir in 2013 as part of the ESIA for Exxon Mobil's Block LB-13 Exploratory Drilling Program. The literature review was able to locate reliable records for the confirmed occurrence of nine marine mammal species within the Liberian EEZ. These are:

- the Bryde's Whale;
- the Humpback Whale;
- the Sperm Whale;
- the Killer Whale;
- the Short-Finned Pilot Whale;
- the Pantropical Spotted Dolphin;
- the Spinner Dolphin, the Clymene Dolphin; and
- the West African Manatee (Weir, 2013).

A further 19 marine mammal species were confirmed to occur within the wider study area examined in the literature review and are considered very likely to occur in Liberian waters on an occasional or regular basis. These are: the Blue Whale, the Fin Whale, the Sei Whale, the Common Minke Whale, the Dwarf Sperm Whale, the Pygmy Sperm Whale, Cuvier's Beaked Whale, Gervais' Beaked Whale, the False Killer Whale, the Melon-Headed Whale, the Pygmy Killer Whale, the Atlantic Humpback Dolphin, the Rough-Toothed Dolphin, Risso's Dolphin, the Bottlenose Dolphin, the Atlantic Spotted Dolphin, the Striped Dolphin, the Common Dolphin and Fraser's Dolphin. One further species, the Blainville's Beaked Whale, has not been documented within the study area but is expected to occur in the region based on its worldwide distribution (Weir, 2013).

Consequently, a marine mammal fauna list consisting of 29 confirmed and potential species was identified for Liberia, comprising six baleen whale species, three sperm whale species, three beaked whale species, 16 delphinid species (Figure 5-45) and a single species of Sirenia (sea cows and manatees). Of these, two species are of particular conservation importance in the region, the Atlantic Humpback Dolphin and the West African Manatee, as both are



endemic to the tropical Atlantic coast of Africa and both are on the IUCN Red List of threatened species (Table 5-19). Both species inhabit nearshore coastal waters and estuaries (and freshwater rivers and lakes in the case of the manatee) and are therefore very vulnerable to human impacts such as by-catch, hunting, and habitat loss (Acorn Intl. and Earthtime Inc., 2014).



Figure 5-45 Dolphins 15 km off Monrovia (Extreme Fishing Charters, undated)

Table 5-19 Threatened and endangered marine mammal species found offshore Liberia

Scientific name	Common name	IUCN Red List Category*
<i>Sousa teuszii</i>	Atlantic Humpback Dolphin	CR
<i>Balaenoptera borealis</i>	Sei Whale	EN
<i>Balaenoptera musculus</i>	Blue Whale	EN
<i>Balaenoptera physalus</i>	Fin Whale	VU
<i>Physeter macrocephalus</i>	Sperm Whale	VU
<i>Trichechus senegalensis</i>	West African Manatee	VU

\*CR = critically endangered; EN = endangered; VU = vulnerable (IUCN, 2019)

Interviews with local fishermen in Monrovia revealed a good level of awareness regarding endangered marine mammal species. All interviewed fishermen groups stated that they do not catch marine mammals. The meeting with NAFAA also confirmed that catching marine mammals is prohibited and that the enforcement is strong regarding this matter. However, it is very likely that marine mammals are still being caught, sold and/or consumed by the local fishing communities, given the fact that they are poor and in need of any money they can acquire (see section 5.3.11.11).

## Marine Reptiles

Accessible material in terms of specific records of sea turtle occurrence in Liberian waters and coastal areas is very limited. The focused literature review on the occurrence of both marine mammals and sea turtles in the area, which was undertaken by Dr. Caroline R. Weir in 2013 as part of the ESIA for Exxon Mobil's Block LB-13 Exploratory Drilling Program, concluded that information available on sea turtles in Liberian waters is largely generic and anecdotal, and refers predominantly to -mostly dead- sea turtles encountered during opportunistic surveys and unverified reports from fishermen (Acorn Intl. and Earthtime Inc., 2014).

However, the review did confirm that four species of sea turtles are present in Liberian waters and nest in Liberia: the Olive Ridley, Leatherback, Green and Hawksbill turtles (Table 5-20). Anecdotal references to the occurrence of nesting Loggerhead turtles did not seem to be supported by verified records, although it should be expected that foraging loggerhead turtles do occur at sea within the Liberian EEZ (Weir, 2013). Satellite-tracked Loggerhead turtles from the Cape Verde population travelled at least as far south as Sierra Leone on foraging excursions (Hawkes et al., 2006) and may be expected to also venture into Liberian waters.

Table 5-20 Sea turtles of Liberia

Scientific name	Common name	IUCN Red List Category*
<i>Lepidochelys olivacea</i>	Olive Ridley	VU
<i>Dermochelis choriacea</i>	Leatherback Turtle	CR
<i>Chelonia mydas</i>	Green Turtle	EN
<i>Eretmochelys imbricata</i>	Hawksbill Turtle	CR
*CR = critically endangered; EN = endangered; VU = vulnerable (IUCN, 2019)		

Basic information on sea turtles nesting in Liberia cover only the southeastern part of Liberia. Information relating to the northern part of Liberia could not be located. In 2003, the Save My Future Foundation (SAMFU) published data on turtle nesting on beaches of Sinoe, Grand-Kru and Maryland County. More recently (since 2013), the Sea Turtle Watch (STW), another local non-governmental organisation (NGO), has been doing some work on sea turtle conservation in the Grand Bassa and Rivercess counties. Findings of both the SAMFU and the STW show that the Olive Ridley and Leatherback turtles (Figure 5-46) are the most abundant species in Liberia, followed by the Hawksbill and Green turtles.

On the other hand, no information could be located regarding the distribution of these animals at sea, although it can be expected that most - if not all - of the sea turtle species recorded use

both coastal and pelagic waters in Liberia's EEZ for foraging and migrating, and are present in these habitats throughout the year (Weir, 2013). Furthermore, anecdotal information suggests a nesting period from September to March, which corresponds with the documented nesting seasonality of Green, Leatherback and Olive Ridley turtles in nearby countries. It should also be considered that males, non-breeding females and immature turtles may occupy foraging habitat year-round, and that seasonality of nesting behaviour is only a small - although crucial with regards to population longevity - part of the overall picture (Weir, 2013).



Figure 5-46 A Leatherback sea turtle (*Dermochelys coriacea*) being released at the Samuel Brown Town beach - District #1, Grand Bassa. (Reuben Chinney, February 2016)

Despite national and international initiatives to protect these endangered species, sea turtles are still hunted for food throughout Liberia. Their eggs are also collected by humans, destroyed by dogs and pigs on the beaches, and occasionally caught by artisanal fishermen in nets. However, lately, a better level of awareness with regards to sea turtle conservation is observed among coastal communities. This was noticed during Earthtime's recent interviews with the local fishermen communities. All interviewed fishermen reported that they do not catch or kill sea turtles. However, as it is the case for marine mammals, it is very unlikely that the by-caught sea turtles are returned to sea, given the high poverty level of the fishermen communities.

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1218 **Marine Fish**

1219 Information on fish diversity and abundance in Liberia is relatively more available when  
1220 compared to other marine faunal groups. Fisheries of Liberia are rich and diverse, and the  
1221 fisheries sector is rather developed. The sector provided about 16,500<sup>1</sup> metric tonnes of fish in  
1222 2018. Research on fisheries is ongoing and the sector is progressing continuously. The NAFAA  
1223 is working with partners such as the Food and Agriculture Organization (FAO), the European  
1224 Union and the World Bank to improve the sector. However, the sector is still lacking  
1225 information on the biology and distribution of fish species.

1226 A list of the fish species encountered in the Liberian waters is presented in Table 5-21. Data  
1227 presented in this table is extracted from the following main reports:

- 1228 • Arcelor Mittal Liberia, 2013. Environmental Appraisal of the Transshipment of Iron Ore  
1229 Offshore from the Port of Buchanan.
- 1230 • Psomadakis, 2013. Important coastal fishery species of Liberia. A pocket Guide. FAO  
1231 FishFinder Programme. Rome, FAO.

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<sup>1</sup> The number is the sum of artisanal and industrial fishing production of 2018 as extrapolated from the NAFAA Research and Statistic Division Report of 2018.

1232

Table 5-21 Marine fish species of Liberia

Family	Latin name	English name	Liberian name	IUCN red List Category*
Albulidae	<i>Albula vulpes</i>	Bonefish	Bonita	NT
Ariidae	<i>Arius latiscutatus</i>	Rough-Head Sea Catfish	Catfish	DD
Ariidea	<i>Ablennes hians</i>	Flat Needlefish	Gar Fish, Silver Gar Fish	LC
Batrachoididae	<i>Perulibatrachus elminensis</i>	Guinean Toadfish	Sea Frog, Satan Fish	LC
Belonidae	<i>Tylosurus crocodilus</i>	Hound Needlefish	Susuah, Gar Fish	LC
Carangidae	<i>Alectis alexandrina</i>	Alexandria Pompano	Sand Cavalla, Pojoe, Bohead	LC
Carangidae	<i>Alectis ciliaris</i>	African Pomano	Bonsweah, Antaya	LC
Carangidae	<i>Caranx crysos</i>	Blue Runner	Short Trouser	LC
Carangidae	<i>Caranx fischeri</i>	Longfin Crevalle Jack	Cavalla	LC
Carangidae	<i>Caranx hippos</i>	Common Jack, Black Or Yellow Cavalli	Yellow Cavalli	LC
Carangidae	<i>Caranx senegallus</i>	None	Pelepe	LC
Carangidae	<i>Chloroscombrus chrysurus</i>	Atlantic Bumper	Pojoe, Petepe, Yewon	LC
Carangidae	<i>Selar crumenophthalmus</i>	Bigeye Scad	Zipper	LC
Carangidae	<i>Selene dorsalis</i>	African Moonfish	Wai-Wai	LC
Carangidae	<i>Seriola carpenteri</i>	Guinean Amberjack	Pojoe, Siayea, Blaffo, Tomleh	LC
Carangidae	<i>Trachinotus goreensis</i>	Longfin Pompano	Sand Cavalla, Small Cavalla, Camoge	LC
Carangidae	<i>Trachinotus ovatus</i>	Pompano, Silver Fish	Kangba Chi, White Silverfish	LC
Carcharhinidae	<i>Prionace glauca</i>	Blue Shark	Blue Shark	NT
Carcharhinidae	<i>Rhizoprionodon acutus</i>	Milk Shark	Shark, Won	LC
Centracanthidae	<i>Spicara nigricauda</i>	Blacktail Picarel	Tanny, Tunny	LC
Clupeidae	<i>Ethmalosa fimbriata</i>	Bonga Shad	Bonga	LC
Clupeidae	<i>Sardinella aurita</i>	Round Sardinella	Bonny	LC
Clupeidae	<i>Sardinella maderensis</i>	Mediterranean Sardine	Bonny	VU
Coryphaenidae	<i>Coryphaena equiselis</i>	Pompano Dolphinfin	Forbor	LC
Coryphaenidae	<i>Coryphaena hippurus</i>	Mahi Mahi, Dorado, Common Dolphinfin	Forbor	LC
Cynoglossidae	<i>Cynoglossus browni</i>	Nigerian Tonguesole	Yellow Solefish	DD
Cynoglossidae	<i>Cynoglossus monodi</i>	Guinean Tonguefish	Brown Solefish	NT
Dasyatidae	<i>Dasyatis margarita</i>	Daisy Stingray	Stinger	EN
Drepaneidae	<i>Drepane africana</i>	African Sickletail	Punkin, Pumpkin Fish	LC
Echeneidae	<i>Echeneis naucrates</i>	Live Sharksucker Or Suckerfish	Washboard Fish	LC
Elopidae	<i>Elops lacerta</i>	Bony Fish	Ten-Pound	LC
Elopidae	<i>Elops senegalensis</i>	Senegalese Ladyfish	Ten-Pound	Not evaluated

Family	Latin name	English name	Liberian name	IUCN red List Category*
Epinephelidae	<i>Epinephelus aeneus</i>	White Grouper	Rock Fish	NT
Glaucostegidae	<i>Glaucostegus Cemiculus</i>	Blackchin Guitarfish	Shovelnose Stinger	EN
Gymnuridae	<i>Gymnura altavela</i>	Spiny Butterfly Ray	Sea Bat, Stinger	VU
Haemulidae	<i>Brachydeuterus auritus</i>	Bigeye Grunt	Grunta, Boie-Boie	NT
Haemulidae	<i>Pomadasys jubelini</i>	Somapt Grunt	White Grunta	LC
Hemigaleidae	<i>Paragaleus pectoralis</i>	Atlantic Weasel Shark	Little Tiger Shark	DD
Hemiramphidae	<i>Hemiramphus brasiliensis</i>	Ballyhoo, Ballyhoo Halfbeak	Pentan	LC
Istiophoridae	<i>Istiophorus albicans</i>	Atlantic Sailfish	Napley, Diawoo	Not evaluated
Istiophoridae	<i>Istiophorus platypterus</i>	Sailfish	Napleh, Black Napleh	LC
Istiophoridae	<i>Makaira nigricans</i>	Blue Marlin	Dawu, Blue Napleh	VU
Labridae	<i>Bodianus speciosus</i>	Blackbar Hogfish	Unknown	DD
Lethrinidae	<i>Lethrinus atlanticus</i>	Atlantic Emperor	Grouper	LC
Lobotidae	<i>Lobotes surinamensis</i>	Atlantic Tripletail	Sea Bougar	LC
Lutjanidae	<i>Lutjanus agennes</i>	African Red Snapper	Red Snapper	DD
Lutjanidae	<i>Lutjanus dentatus</i>	African Brown Snapper	Black Gripper	DD
Lutjanidae	<i>Lutjanus fulgens</i>	Golden African Snapper	Red Grouper, Snapper	LC
Lutjanidae	<i>Lutjanus goreensis</i>	Gorean Snapper	Grouper	DD
Megalopidae	<i>Megalops atlanticus</i>	Tarpon	Tarpon	VU
Mugilida	<i>Mugil bananensis</i>	Banana Mullet	Molly Fish	LC
Mullidae	<i>Pseudupeneus prayensis</i>	West African Goatfish	Chicken Soup Fish	VU
Muraenesocidae	<i>Cynoponticus ferox</i>	Guinea Pike Conger	Silver Snakefish	LC
Muraenidae	<i>Echidna peli</i>	Pebbletooth Moray	Snakefish	LC
Muraenidae	<i>Enchelycore nigricans</i>	Viper Moray	Snakefish	LC
Muraenidae	<i>Gymnothorax vicinus</i>	Brown Conger, Purple Mouthed Moray	Brown Snakefish	LC
Muraenidae	<i>Muraena helena</i>	Mediterranean Moray	Snakefish	LC
Muraenidae	<i>Muraena robusta</i>	Stout Moray	Snakefish	LC
Ophichthidae	<i>Ophichthus ophis</i>	Spotted Snake Eel	Snakefish	LC
Polynemidae	<i>Galeoides decadactylus</i>	Lesser African Threadfin	Butternose	NT
Polynemidae	<i>Pentanemus quinquarius</i>	Royal Threadfin	Bear-Bear, Gbukar	VU
Pomacentridae	<i>Abudefduf saxatilis</i>	Sergeant Major, Damsel Fish, Five Finger	Bear-Bear, Gbukar	LC
Priacanthidae	<i>Priacanthus arenatus</i>	Atlantic Bigeye	Snapper Old Lady, Chicken Soup Fish, Loton	LC
Pristigasteridae	<i>Ilisha Africana</i>	West African Ilisha	Gbapele	LC
Psettodidae	<i>Psettodes belcheri</i>	Spottail Spiny Turbot	Black Solefish	DD
Rajidae	<i>Raja miraletus</i>	Brown Skate, Twineye Skate	Stinger	LC

Family	Latin name	English name	Liberian name	IUCN red List Category*
Rhinobatidae	<i>Rhinobatos irvinei</i>	Spineback Guitarfish	Shovelnose Stinger	VU
Sciaenidae	<i>Pseudolithus elongatus</i>	Bobo Croaker	Rock Head Cassava	LC
Sciaenidae	<i>Pseudolithus epipercus</i>	Guinea Croaker	Black Cassava Fish	LC
Sciaenidae	<i>Pseudolithus moorii</i>	Cameroon Croaker	Cassava	LC
Sciaenidae	<i>Pseudolithus senegalensis</i>	Cassava Croaker	Shortneck Cassava Fish	EN
Sciaenidae	<i>Pseudolithus senegallus</i>	Law Croaker	Short Neck Cassava Fish	VU
Sciaenidae	<i>Pseudolithus typus</i>	Bar, Croaker, Long Neck Croaker	Long Neck Cassava Fish	LC
Scianidae	<i>Petroscion peli</i>	Boe Drum	Cassava	LC
Scombridae	<i>Euthynnus alletteratus</i>	Little Tunny	Round Blood Fish	LC
Scombridae	<i>Katsuwonus pelamis</i>	Skipjack Tuna	Yanwien, Blood Fish	LC
Scombridae	<i>Scomberomorus tritor</i>	West African Spanish Mackerel	Mackerel	LC
Scombridae	<i>Thunnus alalunga</i>	Albacore Tuna	Kpasea, Blood Fish	NT
Scombridae	<i>Thunnus albacares</i>	Yellowfin Tuna	Kpasea, Yellowfin	NT
Scombridae	<i>Thunnus obesus</i>	Bigeye Tuna	Bigeye Tuna	VU
Serranidae	<i>Cephalopholis nigri</i>	Niger Hind	Unknown	LC
Serranidae	<i>Cephalopholis taeniops</i>	Bluespotted Seabass	Chicken Soup Fish, Kru-Kru	LC
Soleidae	<i>Synaptura cadenati</i>	Guinean Sole	Solefish	Not evaluated
Sparidae	<i>Dentex gibbosus</i>	Pink Dentex	Grunter	LC
Sparidae	<i>Dentex macrophthalmus</i>	Large Eyed Dentex	Red Snapper	LC
Sparidae	<i>Dentex maroccanus</i>	Morocco Dentex	Snapper	LC
Sparidae	<i>Pagellus acarne</i>	Axillary Seabream, Quayantee	Snapper	NT
Sparidae	<i>Pagrus caeruleostictus</i>	Blue Spotted Sea Bream	White Snapper	LC
Sphyrnidae	<i>Sphyrna afra</i>	Guinean Barracuda	Pipe Fish, Cuta	LC
Sphyrnidae	<i>Sphyrna lewini</i>	Scalloped Hammerhead Shark	Airplane Shark	EN
Sphyrnidae	<i>Sphyrna mokarran</i>	Great Hammerhead Shark	Airplane Shark	EN
Squatinae	<i>Squatina oculata</i>	Smoothback Angelshark	Frog Stinger	CR
Stromateidae	<i>Stromateus fiatola</i>	Blue Butterfish	Marry Fish	LC
Tetraodontidae	<i>Ephippion guttifer</i>	Prickly Puffer	Ewray	LC
Tetraodontidae	<i>Lagocephalus laevigatus</i>	Smooth Puffer	Ewray Poison Fish	LC
Triakidae	<i>Mustelus mustelus</i>	Common Smoothhound	Shark	VU
Trichiuridae	<i>Trichiurus lepturus</i>	Largehead Hairtail	Silverfish	LC
Xiphiidae	<i>Xiphias gladius</i>	Swordfish	Unknown	LC

\* CR = critically endangered; EN = endangered; VU = vulnerable (IUCN, 2019)



For the aim of this project, an effort to gather information on the common fish species and fishing grounds in the Monrovia area was made one of the emphases of the interviews held by Earthtime's social team with the local fishermen communities of Monrovia. This part of the interviews aimed at identifying:

- the most common fish in the area;
- the seasonal variations in fishing, which gives an idea on the seasonal patterns of fish occurrence in the area;
- the common fishing grounds; and
- the catches of sharks and rays.

The results of these interviews, described in detail in section 5.3.11.5 (Table 5-31), showed that Cassava Croakers (Cassava Fish), West African Ilisha (Gbapele), Sardine (Bonny) and Barracuda (Pipe fish) are the most abundant in the coastal waters of Monrovia, up to 6 Nautical Miles (NM). Cassava Croakers seem to be mostly abundant at 2-3 NM offshore. Other fish commonly present are Groupers, Snappers and the Lesser African Threadfin (Butternose). Tuna species (Figure 5-47), Wahoos, Marlins and Sailfish (all three are locally called Napleh), Sharks and Rays are more common in the offshore waters beyond 6 NM. The fishing season extends usually from October to May. June to September is considered to be a low season for net fishing (Cassava, Sardine, Barracuda, Ilisha, etc.) but the high season for hook and line fishing, which targets mostly Snappers on rocky bottoms. This means that the fish is mostly abundant from October to May (examples shown in Figure 5-48), except for fish foraging on rocky bottoms, such as Snappers, which are frequent between June and September.



Figure 5-47 Yellowfin Tuna at sea off Monrovia (Extreme Fishing Charters, 2018)



Figure 5-48 Fish caught at West Point in February 2019 (a) Cassava Fish (*Pseudolithus* sp), Pipefish (*Sphyrna* sp) and Snakefish (*Muraenidae* family); (b) Cassava Fish (*Pseudolithus* sp), Pipefish (*Sphyrna* sp) and Pojoe (*Carangidae* family); (c) Forbor (*Corypheana* sp); (d) Red snapper (*Lutjanus* sp)

Recently, some effort, albeit still primitive, has been carried out by the NAFAA and the World Bank for the mapping of artisanal fishing grounds as well as the coupling of fishing tracks with landings data. A data collection system was setup in 2018 in few selected fishing communities of Monrovia and Robertsport in Grand Cape Mount County. This pilot project aimed at linking vessel tracking system technology with mobile phone technology which combines information on fishing effort with information on the fish landed from tracked fishing trips. Some fishing tracks recorded by Fanti and Kru canoes from West Point and the Mesurado Pier Communities in Monrovia are presented in Figure 5-49. The figure provides an example of the usual fishing grounds locations of these communities. The furthest reaching canoes are Fanti canoes, since they are typically much longer and broader than those of the Kru and powered by outboard motors.

To identify the linkages between landings data and the trip where fish were caught, landings were recorded from canoes fitted with trackers. An example of this is shown in Figure 5-50. This kind of data has the potential to provide improved information on the fishing locations and seasonal variations of the fishing effort of the coastal fishing communities of Monrovia. As a result, it will be possible to better quantify the project impacts pertaining to fish distribution, abundance and diversity, as well as the underlying impacts on local coastal fisheries.



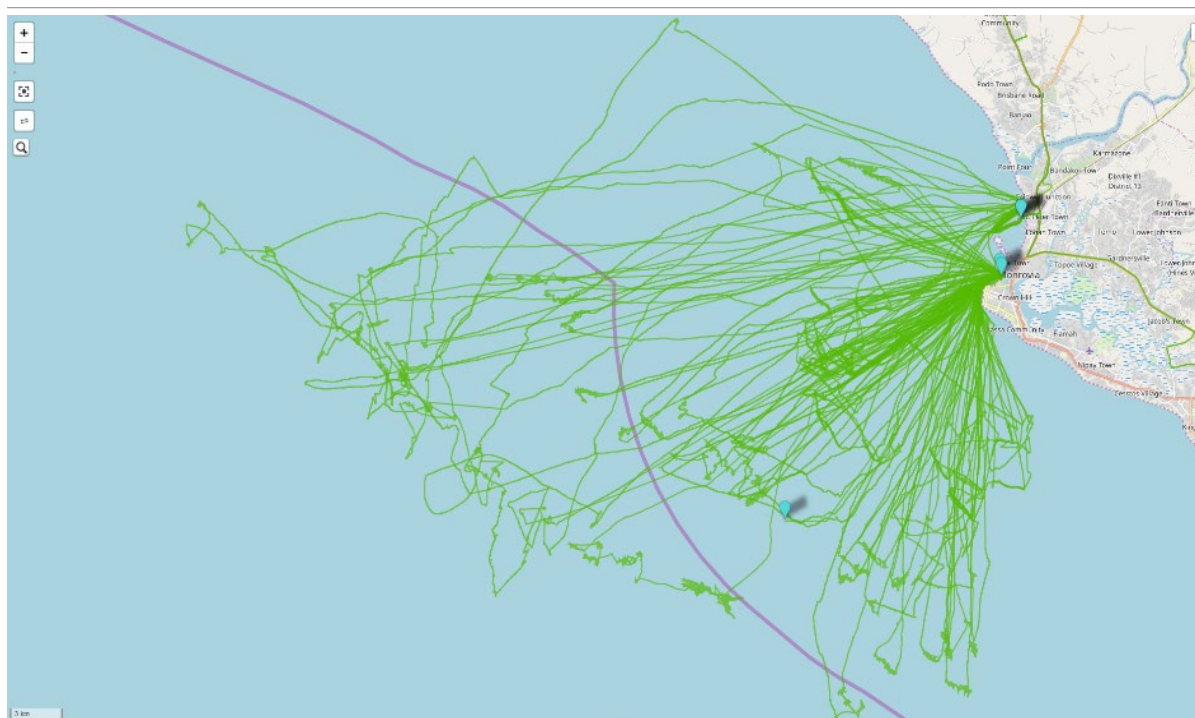


Figure 5-49 Recorded vessel tracks (green lines) in Monrovia in relation to the 12 nautical mile limit (purple line) (NAFAA, World Bank and MacAllister Elliott & Partners, 2018)

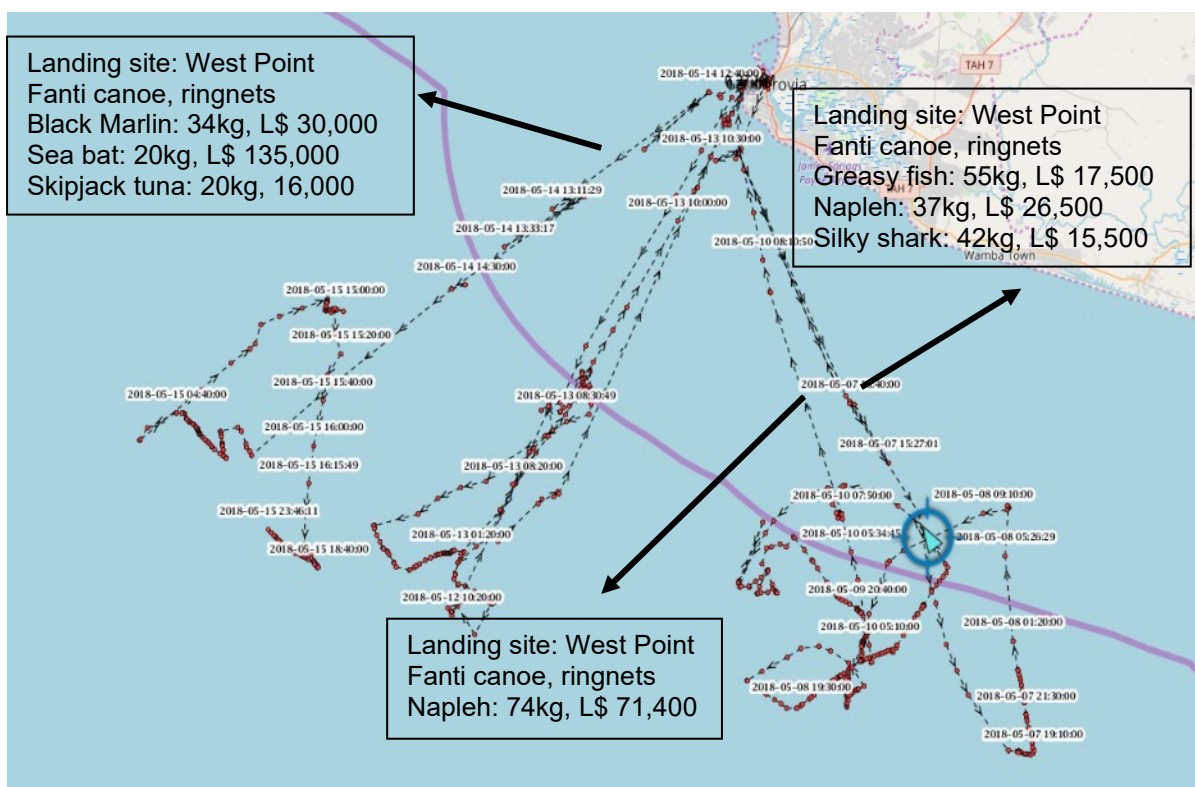


Figure 5-50 Tracks and landings of a Fanti canoe from West Point between the 7th and the 15th of May, 2018 - landings of 3 out of 5 fishing trips were recorded and shown on the picture (NAFAA, World Bank and MacAllister Elliott & Partners, 2018)

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## 5.2.4 The Biological Environment in West Point

In coastal section 3 (West Point), where the construction of a revetment wall is planned, the beach is narrow and sandy and is home to a few species of crabs, molluscs, lizards and birds as elsewhere in the altered littoral fringe habitats close to Monrovia. Data on the biological diversity found on this beach are not available. The biological value is expected to be low as this is a beach which is constantly frequented by the fishermen and local community of West Point. It is polluted by solid waste and is widely used by the West Point community for defecation, due to the lack of toilets available in the township. The coastal savannah that usually fringes beaches in Liberia is not present on the geomorphological formation underlying West Point, which is an unconsolidated sand spit: built structures start immediately above the active inter-tidal beach (Figure 5-51). Also, there is no mangrove development along the beach, because of the exposure to strong waves. However, a small patch of mangroves is found on the little island located behind the northern end of the beach at the outlet of the Mesurado River. Some mangrove trees, as well as some coastal savannah species, are also observed on the small beach created by the sand deposits south of the northern breakwater of the Monrovia port (Figure 5-52). On the northern end of West Point also, nested behind the beach, is a small lagoon that is surrounded by built structures and is being filled with solid waste and old tires to make space for new structures. It is heavily polluted by this waste and does not appear to harbour any important biological life (Figure 5-53).

Data on the continental shelf biodiversity in front of the West Point beach are also not available. However, it is expected that the usual soft bottom-dwelling (infauna and epifauna) species described earlier are found. Interviews with the West Point Kru fishermen, who fish in the nearshore waters of West Point, revealed that the most commonly fished species are Barracuda (Pipe Fish), Cassava Croakers (Cassava Fish) and Snappers. The high proportion of Snappers in the landings suggests that there are patches of rocky sea bed offshore from West Point because these species are usually caught over rocky bottoms.

The biological data on the ecology and biodiversity of the West Point beach and continental shelf presented here are anecdotal. Validated data on the habitats and species of this coastline

1314 should be obtained as part of the ESIA prior to the commencement of construction works at  
1315 West Point.



1316  
1317 Figure 5-51 Drone image showing the West Point Beach



1318  
1319 Figure 5-52 Drone image of the northern end of West Point showing the Mesurado River mouth, the mangrove  
1320 island and the vegetation on the beach south of the Freeport's southern breakwater





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Figure 5-53 Drone image showing the lagoon nested behind the northern end of West Point's beach; the picture shows the dumping of solid waste around the lagoon



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### 5.3 SOCIO-ECONOMIC ENVIRONMENT

Monrovia is situated in the District of Greater Monrovia in Montserrado County, central coastal Liberia. Municipally, Greater Monrovia District is subdivided into two city corporations and ten other local authorities (nine townships and one borough). Established by law in 1973 and operational since 1976, the Monrovia City Corporation (MCC) is responsible for the city's administration. The Paynesville City Corporation (PCC) is responsible for services in their area to the east of central Monrovia. The MCC also provides urban services to the townships and borough through a revenue-sharing arrangement, but has no zoning or enforcement jurisdiction in them. Administratively, instead of being divided into clans like other districts of Liberia, Greater Monrovia is divided into 16 "zones". Like clans in rural areas, these zones are subdivided into 161 "communities".

Monrovia lies along the Cape Mesurado peninsula, between the Atlantic Ocean and the Mesurado River, whose mouth forms a large natural harbour and was the historical reason for the location of the town at this point. The city of Monrovia is spread across the Mesurado peninsula, with the greater Metropolitan area encircling the marshy Mesurado River's mouth. The historic downtown, centred on Broad Street, is at the very end of the peninsula, with the major market district, Waterside, immediately to the north, facing the city's large natural harbour. Around the centre are a number of low-income informal communities built on low-lying, frequently flooded land that was less attractive for development because of the flooding. These communities are vital for the continued success of Monrovia.

Northwest of Waterside is the large, low-income West Point community which is both a zone and a township. Further east down the peninsula is the Sinkor section of Monrovia which has several informal communities along the beach front.

The St. Paul River lies directly north of the city and forms the northern boundary of Bushrod Island, which is reached by crossing the "New Bridge" from downtown Monrovia.

On Bushrod Island, north of central Monrovia is the New Kru Town zone and Borough. Further north of Bushrod Island are newer communities growing around the site of the former Hotel Africa.

The Multi-stakeholder Analysis Report (Mayson, 2018) identified 15 low income communities living and working on the coastline in Monrovia exposed to flooding. This number was increased to 20 during the community consultation period for this study as communities defined their own boundaries (Table 5-22). All these communities lie in the sea flooding areas; their geographical distribution is shown in Figure 5-54.

**Table 5-22 List of low-income communities affected by sea flooding and climate change; fishing communities are shaded**

Coastal section	Area name	Community name	Community population estimate*
1	Hotel Africa	1. Hotel New Community	630
		2. Blessing Road Community	1,000
		3. Fanti Town / Banjor Beach	3,870 (LISGIS, 2009)
2	New Kru Town (Borough)	4. New Kru Town / Popo Beach	25,000+
		5. Coast Guard Base	
		6. Fundaye	
		7. Lagoon Community	
3	West Point	8. Kru Beach	21,000+
		9. Fanti Town	
		10. White Flour	
		11. New West Point	
4	US Embassy to Barclay Training Center	12. Coconut Plantation	5,600+
		13. Public Health Pond (PHP)	6,000+
5	Barclay Training Center to Bernard Beach	14. People United Community (PUC) 19-24 Street	25,000
		15. Old GSA	5,000+
		16. Wisdom Town	2,500+
		17. People Community School	7,350
		18. Kpelle Town and surrounding area	200
		19. Bernard Beach / Small Town	1,487
	ELWA	20. King Gray Town	25,000

\* Based on an estimate given by the community chairman, unless stated otherwise.

Official statistical population data for the low-income communities affected by sea flooding and climate change is not available at the individual community level or even at zone / town / ward level inside each of the administrative areas. Data offered in this socio-economic section has been drawn from the most recent, available data but often refers to the whole of Monrovia or the Montserrado County in which Monrovia is located. The data presented are fully referenced and the applicability of each datum to the study area noted.

A Community Consultation exercise for this ESAR collected information from within the communities on activities and facilities which is presented in this section.

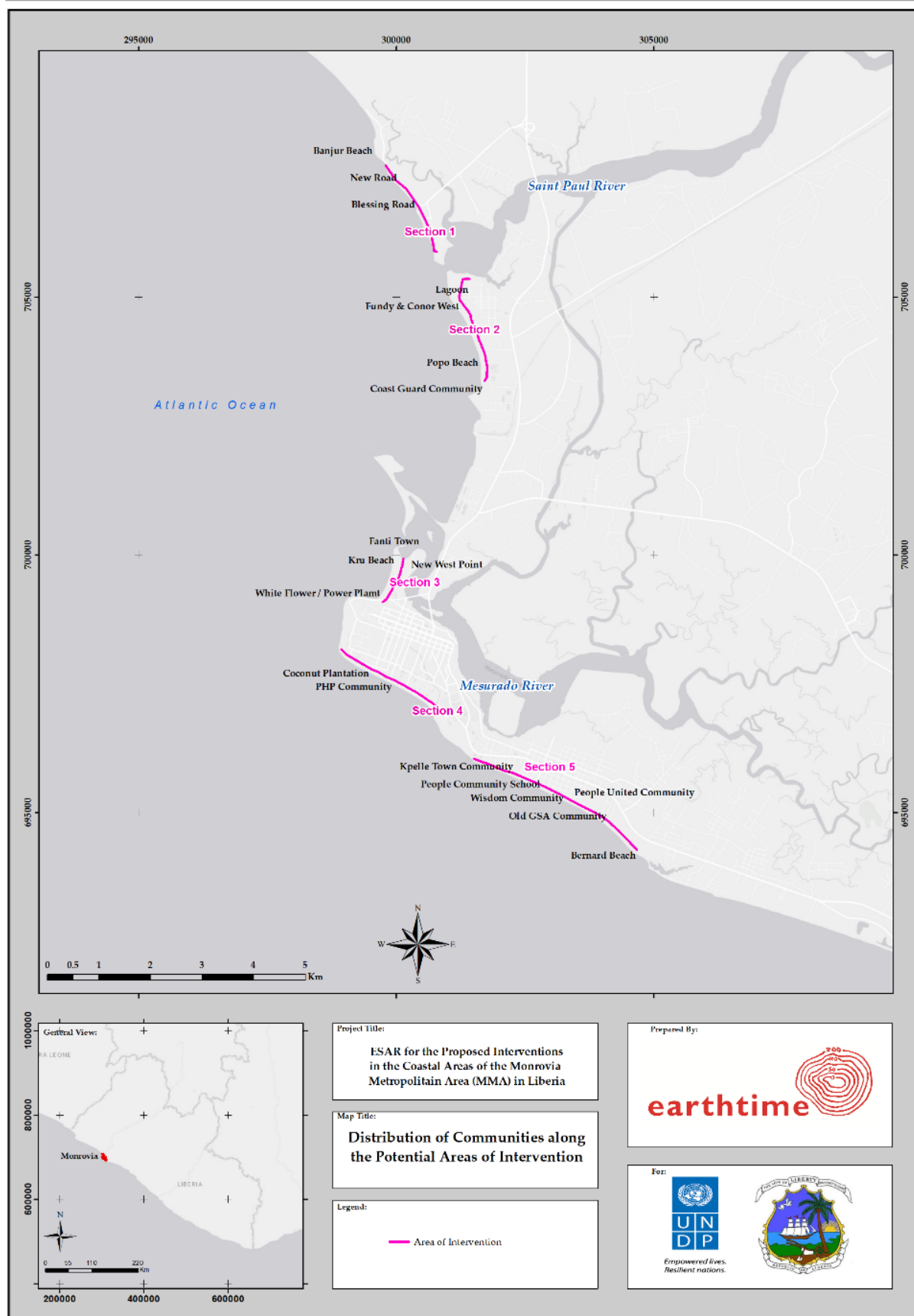


Figure 5-54 Map showing the communities that were visited as part of the ESAR social investigation

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### 5.3.1 Methodology for Social Investigations

The requirements of the UNDP ESAR are:

1. The collection of secondary data to outline the communities affected by the proposed project,
2. Rapid appraisal of social fishing livelihoods issues upon which little or no available data is available and which it is vital that the project must be informed about during the design process.
3. A community consultation to ensure all affected communities are aware of and kept informed about the project and that their views are incorporated in project design.

Secondary data from census and other official statistical material published by the Liberia Institute of Statistics and Geo-Information Services (LISGIS) were gathered from online sources and followed up where possible in Monrovia. However, the last census was conducted in 2008 (LISGIS, 2009) and the extraction of data to enumeration areas covering the affected communities was not possible. Secondary data presented here has been extracted to the smallest effective and appropriate level consistent with confidence in the material.

The second area for data collection was for a rapid appraisal of the fishing-based communities along the beaches potentially affected by sea level changes and the possible locations of coastal interventions. The aim of the appraisal was to collect background information about fishing and fish processing / selling (mongering) activities to inform the environmental investigations as well as help define the scope and nature of social impacts of the project. This data was collected through a series of focus group discussions with fishermen and fishmongers.

The key assumption for rapid appraisal data collection is that the answers are deemed to be true as there is no opportunity to triangulate the data collected through rapid survey techniques. The aim of the investigation is to gather background information into how fishermen communities operate, how and where they fish, the equipment used, frequency of fishing, type of catch and an outline of the economy of fishing and its role in Monrovia's life and that of Liberia as a whole. Similarly, the background information into fish mongering activities covered buying, processing and selling the different types of fish and the variety of marketing opportunities available to fishing communities.

Focus group discussions (FGDs) were chosen as the data collection process for this topic. For the small length of time available for the ESAR, focus groups maximise the collection of data from a wider spectrum of affected people in a short amount of time. Collective information gathered in such groups tends towards greater accuracy and more balanced replies as the answers recorded are a collective agreement. The focus group discussion topics for both fishermen and fishmongers were developed out of discussions with the environmentalists and economists on the team, as well as our knowledge and experience of how low income communities in Monrovia operate and a need to collect community impact material as rapidly as possible.

A list of topics was drawn up and discussed before piloting the FGD formats in the field. The topics were reviewed and revised after two FGDs to each target group to include more in-depth investigation into community management and interactions with the MCC, PCC and Borough / Township Authorities. The FGD proformas for both fishermen and fish mongering groups are included in Appendix C.1 and Appendix C.2.

The FGDs were conducted by a senior Liberian Social Consultant and a female Liberian Interviewer assisted by an environmental trainee who surveyed the GPS coordinates for each community to enable accurate plotting on a map (Figure 5-55). The discussions were organized in advance through contact by the team with the voluntary Community Chairmen for the community and the Fishing Chairmen and Fish mongering Chairs – usually female. The team requested a time to meet the community to come and discuss the fishing livelihoods in the community and to explore community views on impacts. The communities have to have some time to organize such meetings so that sufficient and representative community members are available to participate. Discussion notes and attendance records were kept of all meetings.

The fishing livelihoods FGDs were only administered to fishing communities. However there are a number of non-fishing communities also affected by flooding from the sea, potential sea level changes and loss of homes and livelihoods through flooding. All affected communities have to be consulted throughout the planning and implementation phases to ensure all impacts are identified and that concerns are addressed and unfortunate, unforeseen impacts are not created by the project. To this end all communities were invited to meet the team to

discuss possible impacts and the nature of the impact these may have on the project. A focus group proforma was drawn up to discuss these issues with both fishing and non-fishing communities (Appendix C.3).



Figure 5-55 Focus group discussions at West Point

The communities were listed on the basis of a Multi-stakeholder Analysis Report (Mayson, 2018) which had identified 15 low income communities living and working on the coastline in Monrovia exposed to flooding. This number was increased to 20 during the community consultation period for this study as communities defined their own boundaries. All these communities lie in the sea flooding areas and include fishing and non-fishing communities. A further meeting (making 21 in total) was held with the Disaster Victims Association, a Monrovia NGO based in West Point with the aim of supporting communities in need. The NGO was set up in 2015 after the major West African Ebola epidemic and has helped flooded community members gain some help. A list of the locations where stakeholder meetings were held is presented in Table 5-23.

The Community Consultation exercise for this ESAR also collected information from within the communities on activities and facilities which is presented in this section. This information adds to the understanding of how communities are affected by flooding and how mitigation measures, particularly this which would involve resettlement, would affect these communities livelihoods and survival.

1447 Table 5-23 List of communities where consultation meetings were held

Community name	Consultation Target Group	Date	Attendees			
			Youth	Men	Women	Total
1. Hotel New Community	Affected community	16 February 2019	9	37	19	65
2. Blessing Road Community	Affected community	16 February 2019	3	26	14	43
3. Fanti Town / Banjor Beach	Fishermen	18 February 2019	0	16	0	45
	Fishmongers	18 February 2019	0	9	20	
4. New Kru Town / Popo Beach	Fishermen	19 February 2019	0	19	0	45
	Fishmongers	19 February 2019	0	2	24	
5. Coast Guard Base	Affected community	15 February 2019	8	15	9	32
6. Fundaye	Affected community	15 February 2019	8	15	6	29
7. Lagoon Community	Affected community	15 February 2019	0	5	2	7
8. Kru Beach	Fishermen	21 February 2019	0	22	0	68
	Fishmongers	21 February 2019	0	0	46	
9. Fanti Town	Fishermen	20 February 2019	0	6	0	32
	Fishmongers	20 February 2019	0	9	17	
10. White Flour	Affected community	22 February 2019	0	26	28	54
11. New West Point	Affected community	22 February 2019	0	27	31	58
12. Coconut Plantation	Affected community	25 February 2019	0	23	11	34
13. Public Health Pond (PHP)	Affected community	25 February 2019	0	5	0	5
14. People United Community (PUC)	Affected community	26 February 2019	0	18	6	24
15. Old GSA	Affected community	1 March 2019	0	3	0	3
16. Wisdom Town	Affected community	27 February 2019	0	12	15	27
17. People Community School	Affected community	28 February 2019	0	14	8	22
18. Kpelle Town and surrounding area	Affected community	28 February 2019	0	14	6	20
19. Bernard Beach / Small Town	Fishermen	2 March 2019	0	8	0	17
	Fishmongers	2 March 2019	0	0	9	
20. King Gray Town	Fishermen	1 March 2019	0	5	0	11
	Fishmongers	1 March 2019	0	0	6	
21. Disaster Victims Association	Local NGO	22 February 2019	0	7	1	8



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### 5.3.2 Population

The 2008 census (LISGIS, 2009) recorded the population of Monrovia as 1.01 million people with the wards in the slum community areas recording a population of 127,243 people – approximately a quarter of Monrovia’s population. By 2015, Monrovia’s population had risen to 1.28 million (LISGIS, 2016) but there are no further up to date estimates for population levels in the slum communities from LISGIS. Cities Alliance, a global partner of UN-Habitat estimates that by 2016, almost a quarter of Liberians – approximately 1 million - live in the slums of greater Monrovia and face the challenge of living in poor housing with inadequate water supply and very little sanitation, including poorly constructed housing, lack of basic social services, infrastructure, lack of finance and severe overcrowding (Front Page Africa, 2017).

These communities contribute to the economy of Monrovia by providing goods and services needed by the population. The coastal communities provide sustainable fish supplies to feed the city and a myriad set of services catering for both fishing and non-fishing communities - canoe/ boat and net repairs, small scale metal work, other food supplies, building supplies, transport, health and education services – that feed into and support the lives of Monrovia residents.

These communities need to live and work in the areas to ensure survival. Relocation disrupts livelihood strategies and systems, and these are difficult to replace as the nature of the interdependence of home and work is so complex and access to the sea so vital. This social assessment concentrates on the 20 low-income communities in the areas potentially affected – positively and negatively – by the proposed interventions. Table 5-24 indicates the income earning activities by community.

1471 **Table 5-24 Income earning activities by community derived from this survey's FGDs**

Community name	Economic activities
1. Hotel New Community	Agriculture, petty trading, formal employment, some fishing, construction
2. Blessing Road Community	Agriculture, petty trading
3. Fanti Town / Banjor Beach	Fishing, processing and selling fish, petty trading
4. New Kru Town/ Popo Beach	Fishing, processing and selling fish, petty trading
5. Coast Guard Base	Petty trading, food processing and sales, business
6. Fundaye	Petty trading, food processing and sales, business, some fishing, fish processing
7. Lagoon Community	Petty trading, food processing and sales, business, some fishing, fish processing, selling fish, selling sand from beach
8. Kru Beach	Fishing, fish processing, selling fish, petty trading, food processing and sales, business
9. Fanti Town	Fishing, fish processing, selling fish, petty trading, food processing and sales
10. White Flour 11. New West Point	Petty trading, selling fish, water, construction,, security work, some employment
12. Coconut Plantation	Petty trading, tea shops, cold storage, sand mining, brick making, car washing
13. Public Health Pond (PHP)	Petty trading, self-employment, some formal employment by government
14. People United Community (PUC)	Petty trading, self-employment, some formal employment by Government – sand mining
15. Old GSA	Petty trading, some employment outside the community, sand mining
16. Wisdom Town	High unemployment, petty business, sand mining, self-employment, some formal employment
17. People Community School	Petty business, security jobs, motorcycle taxis, sell processed food and water, bars and entertainment areas
18. Kpelle Town and surrounding area	Petty trading, sand mining and bricks making
19. Bernard Beach/ Small Town	Fishing, sand mining, petty trading
20. King Gray Town	Fishing, sand mining, petty trading

### 1472 5.3.3 Ethnicity

1473 The 20 project affected communities contain representation of all 17 ethnic groups in Liberia  
1474 Of the official 17 ethnic groups that make up Liberia's indigenous African population, making  
1475 up maybe 95% of the total, all are found in the low-income communities, some in segregated  
1476 areas, other communities are intermixed. The proportions of ethnic Liberians by group is  
1477 listed in Table 5-25; the breakdown is based on an analysis of the 2008 census material (LISGIS,  
1478 2009), reported in the World Factbook, section on Liberia (CIA, 2018).

1479 Table 5-25 Ethnic groups in Liberia (adapted from CIA, 2018)

Ethnic Group	Percentage of Population
Kpelle	20.3%
Other	20.1%
Bassa	13.4%
Grebo	10%
Gio	8%
Mano	7.9%
Kru	6%
Lorma	5.1%
Gola	5.1%
Kissi	4.8%

1480 The Kpelle form the largest group; the Bassa, Gio, Kru are often fishermen; the Grebo,  
1481 Mandingo, are often in trade and transport, the Mano, Krahn, Gola, Gbandi, Loma, Kissi, Vai,  
1482 Belleh, Mende and Dey are originally agriculturalists.

1483 There are also more or less nomadic non-Liberian groups like the Fula, who engage mostly in  
1484 trade and are from drier areas in the Sahel, and the Fanti, who are often fishermen or traders  
1485 of fish, usually from Ghana, living seasonally and more and more often permanently in  
1486 Liberia. A small group of Popo(h) fishermen are also found originally from Togo. Additionally  
1487 there are Americo-Liberians, who are descendants of free-born and formerly enslaved African  
1488 Americans who arrived in Liberia from 1822 onward and Congo People (descendants of  
1489 immigrants from the Caribbean), making up an estimated 5% of the population. They used to  
1490 dominate political life in Liberia and still have a lot of influence (WPR, 2019).

1491 The Fanti are originally ethnic Ghanaians who moved up the coast in the 1920's to take  
1492 advantage of the fishing opportunities off Liberia. They became so numerous that they were  
1493 included as an ethnic group in the 1984 census of Liberia. Many are third or fourth generation,  
1494 married into Liberian ethnic groups. Many have Liberian documents. Whilst some Fanti  
1495 returned to Ghana during the civil war, many stayed, provisioning Monrovia throughout. The  
1496 Fanti live primarily in Fanti town in the West Point area, in parts of New Kru Town and  
1497 around the Africa hotel complex (EJF, 2012).

1498 The second major single low-income community in Monrovia is of the Kru people, many of  
1499 which live in New Kru town community on Bushrod Island. Originally the Kru came from  
1500 Grand Kru Territory in Maryland County and Sinoe County and are ethnic Liberians. The Kru  
1501 is the third largest indigenous group and comprise 7% of the population and it is also one of

the main languages spoken. The Kru are one of the three main indigenous group players in Liberia's socio-political activities along with the Krahn and Mano people.

It should be emphasized that all ethnic groups are found in most communities and whilst fishing is mainly the preserve of the Fanti, Kru and former Popo, that other tribes, particularly the Bassa are involved in fishing in Liberia and are often found in Monrovia as crew or mongers.

#### 5.3.4 Poverty

The Liberia 2014/2015 Household Income and Expenditure Survey (HIES) gives the most recent demographic statistics for Liberia (LISGIS, 2016). This data is aggregated to County level and therefore is difficult to use to describe only the low-income communities in Monrovia but it is all there is. Montserrado County which contains the District of Monrovia is reported as a unit. This survey found that approximately a third of all Liberians live in Montserrado County (32%). Unless stated otherwise, the data presented in this section is drawn from the HIES study.

In 2014/15, there were an estimated 938,383 households in Liberia, with an average household size of 4.26 persons per household; households were larger in urban areas (4.37) than rural areas (4.16). Out of a population of approximately 4 million persons, 48.5% are male and 51.5% female. Liberia has a young population with almost one in three Liberians being less than ten years of age. 52.7% of the population are of working age (between 15 and 65), and only 2.6% are 65 years old or older. The HIES survey reported an average household size of 4.0 persons in Montserrado County, lower than the national average. Montserrado had a lower than the national average proportion of 0-14 years and higher than national average of those aged 15-64. This reflects the pattern of families sending members to Monrovia to generate a home base, gain employment and support other members.

The HIES survey calculated three poverty lines: the food poverty line, defined as the line below which individuals cannot meet their basic food needs; the absolute poverty line, defined as the line below which individuals cannot meet their food and non-food minimum needs, and the extreme poverty line, defined as the line below which individuals' total food and non-food consumption falls below the minimum food requirements.

The headcount absolute poverty figure for the country is 54.1%. Rural poverty affects 70.0% of the population and urban absolute poverty is 43.3%. Regional absolute poverty was lowest in Montserrado County at 31.6% households reflecting greater employment and income generation potential. In Montserrado, the food poverty level was marginally higher than the absolute poverty level, 32.5% compared to 31.6%. This indicates that even though some households have sufficient expenditures that they are above the absolute poverty line, non-food spending consumes a greater share of total resources, crowding out food spending. Extreme poverty in Liberia affects 12.2% households, the level by county was the lowest for Montserrado at 6.6%. These figures show that poverty is lowest in the capital area but this generalisation hides the great variation in household incomes and access to basic life support. The low-income communities tend to have the highest poverty indicators in the County – high levels of unemployment, underemployment, greater reliance on the informal sector work, alongside higher income communities where formal sector employment is more common and where wages can buy essentials.

Nationally 65.5% of total spending is on food, including the equivalent market value of home production, and 34.5% on non-food, including estimated rent for those that own their homes and the estimated use value of household assets. The share of food is higher in rural areas, 73.2%, compared to urban areas, 60.2%. This is consistent with rural areas being generally poorer than urban areas, therefore devoting a larger share of the budget to food spending, and to the larger number of necessary non-food expenditure in urban areas, including rent, and transportation. Montserrado has the lowest share of food spending to total spending, 55.4%. In Montserrado, less than 2% of total food spending comes from home production compared to 20% nationally. Spending on education was highest in Montserrado at 16.3% of non-food spending compared with 12% nationally but health spending was close to the national average at 2.2%.

The highest levels of poverty are found among household heads under age 20, 71.0%, but these represent less than 0.5% of total household heads. The lowest poverty rate, 45.8%, is found for household heads between age 20 and 29. The poverty rate for households' head between age 30 and 39 is 51.2%, 55.9% for age 40 to 49, 59.3% for age 50 to 59, and 58.5% for household heads above age 60.

The highest levels of poverty are found in households in which the head has no formal education, 69.3%, compared to 59.6% for heads with at least some primary education, 47.0% for heads with at least some secondary education, and 23.6% for heads with post-secondary education. In terms of food poverty, a larger percentage of those with secondary education are in food poverty than in poverty overall, which is consistent with most individuals with post-secondary education residing in Montserrado. The difference, however, is more extreme than was found between Montserrado and other areas, indicating that in particular those with higher education are more likely to forego food consumption in favour of non-food spending as the costs of living other than on food expenditure is so high. Finally, there is almost no difference in extreme poverty between those with no education and primary education.

Investigations into incomes from the project affected areas by this survey indicate that incomes from fishing is around USD 3-7 per person per day and that incomes from non-fishing can be a little higher. This data is anecdotal and is only indicative. What should be emphasized is the variation in income earning potential from all low income activities. Income earning can be zero one day and USD 10 the next dependent on the availability of work, the weather, fish stocks and general unpredictability of life. Low income communities surveyed prioritise spending on food and water, followed by school fees, rental payments and health expenditure, reflecting the realities of life.

### 5.3.5 Language and Religion

The native languages can be grouped in four language families: Mande, Kru, Mel, and the divergent language Gola and about 30 dialects. Most tribal/ ethnic groups in Liberia have a language specific to their group although the official language is English.

According to the 2008 National Census, 85.5% of Liberia's population practices Christianity. Muslims comprise 12.2% of the population, largely coming from the Mandingo and Vai ethnic groups. The vast majority of Muslims are Malikite Sunni, with sizeable Shia and Ahmadiyya minorities. Traditional indigenous religions are practiced by 0.5% of the population, while 0.4% subscribe to no religion (LISGIS, 2009).

Christian denominations include the Lutheran, Baptist, Episcopal, Presbyterian, Roman Catholic, United Methodist, African Methodist Episcopal (AME) and AME Zion denominations, and a variety of Pentecostal churches. Some of the Pentecostal movements are affiliated with churches outside the country, while others are independent. There are also members of the Church of Jesus Christ of Latter Day Saints (Mormons) and Seventh-day Adventists. Christians live throughout the country.

In a religious context, the term *kwi* connotes a style of worship of a particular Christian church which is marked by formality and decorum. Kwi is a Liberian term used to connote Westernization. Services in churches considered to be non-kwi have more outward spiritualist expression, with dancing and even street processions in colourful costumes as key elements. Non-kwi churches also have self-proclaimed prophets who interpret dreams and visions, and prioritize a direct experience with the Holy Spirit. Liberia's educated elite have historically regarded the apostolic churches as churches of the uneducated and thus non-kwi.

Vai Muslims live predominantly in the west of Liberia while Mandingo Muslims, originally from the Sahel, reside throughout the country.

Regardless of public statements of identification with Christianity, a "vast majority" of Liberians believe a supernatural world of ancestral and bush spirits that impact daily life. Ethnic groups in some regions of Liberia participate in the traditional religious practices of the Poro and Sande secret societies, with the exception of the Krahn ethnic group, who have their own secret society (Olukoji, 2006).

"Liberian religious culture is characterised by a predisposition towards secrecy (encapsulated in the concept of *ifa mo* - "do not speak it") and an ingrained belief in the intervention of mysterious forces in human affairs". "Both elite and non-elite Liberians usually attribute events to the activities of secret powers and forces". "Beliefs include the conviction that there are deep and hidden things about an individual that only diviners, priests, and other qualified persons can unravel. This presupposes that whatever exists or happens in the physical realm has foundations in the spirit world" (Olukoji, 2006).

All religions are found in the low income communities – the 2008 census estimates 85% of Montserrado County citizens are from a wide variety of Christian religions with approximately 12.5% Muslim. Less than 1% claimed other religious beliefs. Traditional Poro /



Sande systems are not present in the slums. Christian churches were found in all communities whilst Muslims tend to attend mosques located outside the low income communities (LISGIS, 2009).

### 5.3.6 Indigenous Peoples, Minorities and Social Inclusion

None of the ethnic, tribal or language groups forms a distinctive majority, see Table 5-25. The ethnic mix of Liberian societies does not have groups that could be more identifiable than others as “indigenous” using the international definition of the term by the UNDP (UNDG, 2009) and other agencies (IFC, 2012a; IFC, 2012b). International usage refers to communities with separate languages, culture, livelihoods very distinct from the main stream groups in a country such that they incur additional disadvantage or require different approaches for engagement.

While each ethnic group / tribe in Liberia has its own language and customs, these are not sufficiently distinct to entitle any group to special status. Historically the greatest division was between the descendants of returned former slaves – the Americo-Liberian / Congo people – and those tribes originally resident. The laws enshrining separate rights have been dismantled and no group is additionally disadvantaged by law or practice to warrant separate consideration. In mixed communities, most people are similarly poor and lack access to services and ways of improving livelihood. No communities in the study area are differently disadvantaged and all are equally vulnerable.

No Liberian group is sufficiently small to be termed a minority, the previously Togolese Popo fishing group could have been regarded as a minority as could the small groups of Cote Ivorian and Senegalese fishermen occasionally found in Liberia, not necessarily in Monrovia. However, these groups are integrating rapidly through proximity and intermarriage such that designation as a minority is not useful.

The main causes of social exclusion in these low income communities are the twin problems of poverty and lack of opportunities. The legacy of the 20 years’ civil war is of the failure of educational opportunities, limited learning and lack of study skills and knowledge is such that job opportunities for the illiterate or low levels of literacy and low skilled are limited, further skills cannot be easily acquired without education and advancement is restricted.

People are immensely resourceful in finding ways to generate income and work hard to make a living. Goods are sold from wheelbarrows, from pitches along the roads or door to door. Households often have a micro workshop making small quantities of industrial products or a food processing capability or a repair shop as part of their house structure. Transportation of goods and people in low-income communities is provided by vehicle taxis, tuk-tuks / kekeh, motorcycle and bicycle taxis, handcarts, human portage as well as busses and trucks. Such activities require large inputs of time and deflect energies from advancement.

Exclusion arises through:

- Lack of understanding, not comprehending or analysing information;
- Lack of the School Leaving Certificate needed to access further training;
- Lack of a sufficient English vocabulary, of reading and writing skills;
- Not owning a radio;
- Not joining unions of workers or traders;
- Lack of time to attend meetings because of work in the home or to gain income; and
- In some areas, prejudice against women's participation or involvement.

Inclusion requires:

- Ensuring that all elements of the community have access to meetings and information by using radio and local languages;
- Investigating community membership and seeking out and removing barriers to participation;
- Ensuring that questions are fully answered and comprehended as often as required;
- Transmitting information using a variety of media;
- Repeating consultation exercises in sufficient numbers to ensure maximum coverage;
- Ensuring that the Administrative system and the Chiefdom systems are informed and that information is passed down through the community; and
- Enabling all voices to be heard at decision making times.

No group living in the affected communities is socially excluded by factors such as tribal origin, language spoken, historical or cultural influences.

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### 5.3.7 Gender Dynamics

Using the HIES survey to compare poverty levels by the gender of the household head, there is no difference in poverty between male and female-headed households nationally (LISGIS, 2016).

There appears to be a gender split of roles and income generation within Liberian low-income communities with both men and women needing to gain income to survive. Fewer women-headed households are found, indicating a generally lower status, less influence in decision-making and less access to property and resources. Most of the women who head households are divorced or widowed, with the result that they have reduced livelihoods options.

In most parts of Liberia, including the proposed project target areas, women are still generally the carers and providers for their families especially children but usually need to have their own income generation activities. These may be co-dependent on the activity of their men or be independent and own their own businesses or at least have their own income earning strategies. Women's businesses generally need to be located near to their homes so as to maximise sales and income as well as care for families, whereas men tend to undertake hawking or work further afield. A survey undertaken by ArcelorMittal in 2013 as part of its ESIA showed that, when holding other variables constant, being female had led to a significant decrease in individual income by on average US\$266 over the year prior to the survey, with an effect of between US\$498 and US\$34 in individual income for females. This was in a sample of 1019 individuals, where the average annual income per capita (total income recorded divided by number of individuals in the sample) was US\$498. However, high variation was found in incomes with the highest annual income recorded at US\$24,792 and the lowest at US \$8 (URS, 2013).

In artisanal fishing communities, the actual fishing is primarily undertaken by men and the processing and sale of the fish (fish mongering) are undertaken by their wives and female relatives. It is generally thought that up to three women will process and sell the catch of each man from each canoe or boat. The women buy the catch from the boat owner on the beach and clean the fish nearby. Some fish is then sold on to hawkers or suppliers further in town whilst other fish is taken to smoke. Fish smoking is undertaken by both men and women and both sell the produce. These are often a separate group from the fishermen and the

fishmongers. Catching, processing and selling the fish is therefore an extended family activity and supports entire households. One fisherman's catch may support 5-12 persons. Fish mongering offers women independent income generation, a direct means of support for the children close to the home and to the means of sales (EJF, 2012). The section on fisheries describes these activities in greater detail (Section 5.3.10).

As these communities are largely based on an essentially informal economy, they are also somewhat affected by social difficulties resulting from an underlying insecurity. While unemployment and drug abuse affect both sexes, women can be particularly vulnerable to exploitation by disadvantaged men frustrated by their inability to make significant headway in society. This tends to lead to high rates of teenage pregnancies and the driving of women into prostitution. Hence it is clear that poverty in the coastal urban communities affects everyone, but its implications are experienced disproportionately more by women.

### 5.3.8 Health

Liberia is one of the poorest countries in the world. Civil wars 1980-2003 killed around 250,000 people and displaced many more and destroyed most of the country's healthcare facilities. World Health Organisation (WHO) statistics (WHO, 2019) show that life expectancy in Liberia has risen from 47 post war to 63 years but is still much lower than the world average and other West African countries. Communicable diseases such as malaria, HIV/AIDS, tuberculosis, and meningitis are widespread (IHME, 2017). In 2008, Liberia had only one doctor and 27 nurses per 100,000 people (UNFPA, 2012).

Liberia was ill-equipped to handle the outbreak of Ebola in 2014 -2015. The Ebola epidemic hit the Monrovia slum communities very hard. Ebola was first reported in Liberia in Lofa and Nimba Counties in late March 2014 but spread rapidly and was carried quickly to Monrovia communities. The cramped and overcrowded living conditions in the slums and traditional methods of caring for the sick and dead created a situation whereby Ebola rapidly spread and was a major problem in areas like West Point where overcrowding and care traditions for the sick and dead caused an Ebola epidemic that was devastating to the community as widely reported in Frontline Africa, 2014-2015 and other Liberian newspapers and media.

A considerable amount of the population still suffers from mental illnesses or were mentally or physically traumatized, due to 14 years of intense civil conflict. A study by the American Medical Association (AMA) in 2008 had showed that a staggering 40% of adults had shown symptoms of major depressive disorders. 44% of adults also had symptoms of post-traumatic stress disorder (PTSD) (Johnson et al., 2008).

HIV/AIDS is one of the biggest diseases that has affected and is affecting Liberia to date. At any given time, 33,000 people are living with HIV in Liberia of whom nearly 60% are female. Due to Liberia's incapability to treat this disease, only about 1.2% of those affected survive the disease. The youth in Liberia is one of the biggest contributors to the extensive post-conflict HIV/AIDS problem. This is due to the risky high rate of unprotected sex among adolescents. Malnutrition is widespread in Liberia, particularly in low-income communities: Nationally, 40% of children have unnatural stunted growth and 7% of Liberia's population have highly acute malnutrition (LISGIS, 2013).

It is estimated that around half of all girls in Liberia have been subject to female genital mutilation (FGM), which is culturally ingrained in society. It is seen as an important precursor to marriage, to ensure a girl's purity. It causes numerous health problems and can sometimes be fatal. Reuters reported in 2016 that Liberia's parliament removed a ban on female genital mutilation from a new domestic violence law. The law listed it as a criminal offense, when it was first submitted to lawmakers in September 2015. Opposition from several politicians in April led to the FGM provision being removed from the bill (Reuters press release, 2016).

It is estimated that the water production rate in Monrovia post war is only 10 percent of the production rate of 1990 and that many communities cannot access clean drinking water. Additionally, the Liberia Water and Sewer Corporation (LWSC) and private pumpers have become more dependent on groundwater wells, however very few of the wells are believed to be free of contamination. The LWSC still requires significant subsidies from outside donors even though service is reduced to only a small part of Monrovia. The populations outside the supplied areas have to rely on purchasing water from vendors, spring water, untreated surface water and community operated wells in poor states of maintenance (USAID, 2010).

Finally, all sewerage systems have broken down. In Monrovia, the government and donors have relied on pumper trucks and septic tanks to remove wastewater and sewerage that has

collected in low spots in the old system pipes since lift station pumps and the wastewater treatment plant have been inoperable for the duration of the civil war and since. As a result, most Liberians have come to rely on pit latrines or onsite septic tanks. In those areas where sewerage or sanitation facilities are not available or completely inoperable, residents have resorted to open defecation (USAID, 2010). The situation has not improved to date for the communities interviewed for this study – the communities report that the beaches are commonly used as open defecation sites for low-income communities.

### 5.3.9 Education

Education service delivery in Liberia was severely affected by the First Liberian Civil War and Second Liberian Civil War; between 1989 and 2003 and literacy levels plummeted. Education in Liberia is allegedly free for primary students attending a government school, but most of these schools lack adequate learning facilities and extra funds are requested from parents.

Liberia's education sector is hampered by inadequate schools and supplies, as well as a lack of qualified teachers and corruption. A Primary School Certificate is achieved at the end of six years primary education and a Liberia Junior High School Certificate Examination (after three years) and a Liberia Senior High School Certificate (a further three years) can be achieved.

Higher education is provided by a number of public and private universities. The University of Liberia is the country's largest and oldest university. Located in Monrovia, the university opened in 1862 and today has six colleges. Other universities and colleges, most faith-based, have opened in the country since the end of the civil war.

Education: An estimated 66.7% of Liberians are able to read and write. Urban residents are more likely to be literate (76.0%) than rural residents (50.1%). A larger gap exists between gender literacy rates, with 80.6% of males reported as literate and just 54.8% of females. Majority of students are enrolled in government institutions (47.7%), private non-religious schools are the second most common provider (29.3%), followed by religious entities. (LISGIS, 2017).

The 2016 HIES survey reported regional differences in literacy, with a lower literacy rate of 41.9% in Grand Cape Mount County and a relatively high rate of 82.1% in Montserrado County. From the data based on consumption quintiles, it can be seen that literacy is highly

correlated with poverty. Poorer residents are less likely to be literate (42.9%). Most students (49.2%) take between 10 and 30 minutes to reach school on foot. Nearly all students reach school within 60 minutes, however 6.6% take longer. Textbooks used by students are predominantly borrowed from school or owned by the household (47.4% and 33.4% respectively). However, in urban areas, the proportion that owns a textbook is higher (42%), while in rural areas, those who borrow from schools is much higher (74.3%) (LISGIS, 2017).

### 5.3.10 Fisheries

The marine fishery resources of Liberia are exploited by two types of fisheries:

- The artisanal canoe fishery operating in estuaries and shallow inshore waters and extending from the shoreline to a depth of 20-40 m;
- The industrial trawl fishery supposedly operating in open deeper waters, and targeting finfish or shrimp. It is illegal to trawl inside 6 nautical miles from the coast.

There are three types of artisanal fishing units: small Kru canoes, medium Kru canoes and large Fanti canoes. These are shown in Figure 5-56 and described in Table 5-26.



Figure 5-56 (a) Typical Kru canoes; (b) Typical Fanti canoes

The Environmental Justice Foundation (EJF) is a NGO working with fishing communities in Liberia and Sierra Leone in partnership with the Society of Conservation of Nature in Liberia (SCNL). The aim is to engage with fishing communities, build capacity with local partners, develop Collaborative Management Associations to safeguard sustainable fishing and protect marine diversity. The EJF report on Liberian Fishing Communities looked at the challenges and problems faced by fishing communities and stated that whilst communities develop and



1814 enforce rules within their communities, they do not feel able to manage serious issues such as  
1815 illegal nets. Communities usually have both an elected Town Chief and an elected Fishing  
1816 Chief to manage civil and fishing related community problems. There appears to be interest  
1817 in collaborative management of fisheries to ensure sustainable fishing levels (EJF, 2012).

1818 There is a strong gender split in the Liberian artisanal fisheries. Fishermen are almost  
1819 exclusively male, while fish mongering is dominated by women. This is an important fact in  
1820 a country where gender equality is not assured, especially as the distribution of labour means  
1821 that it is the women who are placed in the most powerful economic position as the receivers  
1822 of revenue at the point of sale. Consequent on this is the fact that the fishery supports the  
1823 communities in a relatively equitable manner.

1824 The West Point and New Kru Town fisheries have proven their resilience and sustainability.  
1825 Through the political turmoil and disruption of the civil wars between 1980 and 2003, the  
1826 fishing industry kept functioning because it was self-sufficient and did not require the external  
1827 inputs that caused many industries to stagnate or collapse. The survival of the city through  
1828 this period is owing to a considerable extent on the food supply from the fishery (CDR  
1829 International, 2019a).

1830 Table 5-26 Fishing equipment used in the project area

Canoe type	Operated by	Capacity	Size	Mechanism	Fishing time	Fishing gear	Target species
Kru	Mainly Liberians (Kru) Some Togolese (Popo)	1-3 men	Small (< 6 m)	Hand-dug tree trunks with a moulded depth of about 60 cm, with or without sails.	Depart in the morning with an offshore wind and return in the afternoon with the onshore wind. A minority stays out overnight and returns the next morning.	Hook and line; occasionally gillnets	Mostly demersal
	Liberians (Kru)	3-5 men	Medium (> 6 m)	Propelled by sails or paddles, some powered by 7 horse power outboard engines.			
Fanti	Ghanaians (Fanti)	12-20 men	Large (10-15 m)	Dug-out or planked, powered by 10-40 horse power outboard engines	Up to 4 days at sea	Ring nets, purse nets, large gillnets specifically adapted for different species	Mostly small pelagic

### 5.3.11 Survey of Fishing Communities in Monrovia

A survey of the low-income fishing communities in Monrovia was commissioned as part of this ESAR. The survey was undertaken in February 2019 with the aim of discussing how fishing communities operate. The data on fishing techniques is needed for the environmental inputs to the ESAR whilst information on how these communities survive is needed for the social assessment part of the ESAR. The methodology for these surveys is presented in section 5.3.1. The consultations with fishermen and fishmongers included the affected community impact agenda.

#### 5.3.11.1 Location

The fishing communities are located on the Atlantic Coast of Monrovia at a number of locations where they have access to beaches sufficiently smooth enough to beach load canoes. As Monrovia has expanded these communities have become more crowded, pressures on housing become more intense and these areas have become slums. By this term we mean, informal, high population density, low income communities, lacking in planning, usually as squatters on public land and not owned privately. Building materials vary from mats and straw through corrugated iron sheets in various states of disintegration to buildings of permanent materials. These communities usually lack road access and basic services. Many communities have been in place for at least 40 years and believe they have “squatters’ rights” via “adverse possession”.

Six fishing communities are identified along the Monrovia Coastline:

- Banjor Beach near Hotel Africa
- Popo beach – New Kru Town
- Kru Beach – West Point
- Fanti Town – West Point
- King Gray Town - ELWA
- Bernard Beach – Paynesville.

Each community has an unpaid, elected Community Chairman who reports to and is in contact with the City administration. Each fishing community has a Fishing Association with a Fishing Chairman to manage fishing interests and disputes in the community. Each community has a community Fish Mongering Association to assist the selling of catches with a Chairwoman to manage any disputes. “Associations” to manage groups of people in an industry or local sector are a very common feature of Liberian community organisation. The Association manages entry to the activity, draws a small monthly contribution from members, regulates activities and manages disputes.

Fishing communities require immediate access to gently sloping beaches which can allow the beaching of the loaded canoes for selling the fish, repairing nets and other equipment and canoe and net storage when the sea is too rough to go out, as shown in Figure 5-57. Access to beaches is vital for storage and associated processing works as without such spaces fishing cannot be undertaken. Coastal space is very limited and needs to be protected for fishermen to continue their vital role in feeding Monrovia and the rest of Liberia. Reducing beach access and utilising beaches for rock / building material storage etc. will negatively impact fishing communities. Depending on the size of the fishing community, each community will have one to three 3 beaches / landing stages that they use, as shown in Table 5-28. More than one community can use a beach and there are places where Fanti and Kru crewed canoes beach alongside.



(a)



(b)



(c)

(d)

Figure 5-57 (a) Fishermen landing their canoes at King Gray; (b) Fishermen taking the fish out of their nets in order to sell them at West Point; (c) Fishermen repairing their nets at West Point Fanti Town; (d) Storage of nets on the beach in West Point Fanti Town

Table 5-27 Fishing beaches by community

Location	Fishing community	Name of landing beach
North of Africa Hotel	Banjor Beach	Banjor Beach
North end of New Kru Town, New Kru Town in Borough of New Kru Town	Popo Beach	Popo Beach
	New Kru Town West (also known as members of the Cape Mount / Bomi Collective Management Association (CMA))	New Kru Town West
West Point – Township within the Monrovia City Council	Kru Beach	Power Plant
		Du Side
		Kru Beach
	Fanti Town, Association called “God Sees You Fish”	West Point
		Doe Community Beach
	White Flour/ Power plant	Clara / Vai Town Beach
Bernard Beach	Bernard Beach	Power Plant
King Gray Town	King Gray Beach	Bernard Beach
		King Gray

### 5.3.11.2 Ethnicity

In general, the fishing communities are either Kru, Fanti or Popo and identify as such. Kru people are ethnic Liberians originally from Maryland in south east Liberia. They have a traditional fishing style and customs but post-civil war have intermarried with other ethnic Liberian groups. They are renowned for their maritime skills and work as crews internationally.

Fanti fishermen were originally from Ghana but have lived and fished in Liberia since the 1920's. In the 1984 population census the Fanti were included as a population group despite not being citizens. Some Fanti have intermarried and have Liberian citizenship papers. This group are the most populous fishing group in Monrovia, have bigger boats and fish in

different areas to the Kru. The Fanti fishermen are settled at various fishing locations along the Liberian coast, e.g., Bassa, Cape Palmas, Cape Mount and Sinoe (Ssentongo, 1987).

Popo fishermen were originally Togolese and migrated west in the twentieth century and settled in small communities in Monrovia and elsewhere in Liberia. They are gradually integrating and intermarrying with other Liberians. Some have Liberian citizenship.

Bassa fishermen are found on the south Monrovia beaches.

Communities are not solely one ethnic group. The Fanti and Popo often live and fish alongside each other and both Popo and Kru live in West Point. Community disputes are usually handled by the Fishing Chairman, Fish mongering Chairlady or the Community Chairman/ woman. Only if such mediation is unsuccessful is the dispute escalated to the Borough Governor/ Township Commissioner's Office.

#### **5.3.11.3 Fishing Equipment**

The fishing equipment used by fishermen's groups at the different fishing communities is presented in Table 5-28.

#### **5.3.11.4 Costs**

- A fishing licence is required per boat and is issued by the National Fisheries and Aquaculture Authority (NAFAA) at LRD 10,000 = approximately USD 62 for a Kru canoe owned by a Liberian. Licences for larger boats vary and permits for non-Liberians are much higher. The NAFAA has recently started collecting the licence using mobile money collection through the phone networks.
- The Kru canoes are all built in Liberia, while some of the bigger Fanti canoes are built in Ghana. One respondent said that the hollowed tree hulls of the Fanti canoe were often brought up from Ghana and the planked superstructure built in Liberia.
  - A motorised canoe 10-15 m long costs USD 1,500 to 2,000, some report USD 5,000; whereas
  - A Kru paddle canoe costs USD 150-400.
- Hooks – LRD 200 - 1,000 per packet.
- Lines – LRD 200 - 1,200 per roll.

1918 Table 5-28 Fishing equipment by community

Fishing community	Number of crews / boats	Population (2008 census)	Canoe type	Nets used <sup>◇</sup>	Crew
Banjor Beach	57	Men 1,905 Women 1,965 Total 3,870	Motorised canoes (Kru)	2, 3, 4 and 5 finger sized nets (gillnets) to catch Tunny (tuna) and Cassava Fish (cassava croakers)	1-6 persons
			Paddling Canoes (Kru), 6-13 m in length	Draw-way nets (seine nets) to catch Cassava Fish (cassava croakers), Bonny (sardines) and Gbapele (West African Ilisha) fish	1-2 persons
Popo Beach / New Kru Town	180-250	Men 3,871 Women 4,018 Total 7,889	50 motorised canoes (some Fanti, some Popo, a few smaller motorised canoes owned by Kru)	Shark net (gillnets to catch larger fish)	1-6 persons
			292 Paddling Canoes (Kru), 6-13 m in length	Hook and line Draw-way (seine nets)	1-2 persons
Kru Beach, West Point*	236-387	Men 7,130 Women 4,966 Total 14,096	Motorised canoes	2, 3, 4 and 5 finger sized nets (gillnets)	2-5 persons
			Paddling Canoes (Kru), 6-13 m in length		1-3 persons
Fanti Town, West Point	105	Men 2,708 Women 2,721 Total 5,429	Motorised canoes 40 HP (some made in Ghana)	Bonny net – Gbapele nets (gillnets) Use GPS and compass	4-15 persons
			Paddling canoes 6-15 m in length	Life jackets	1-3 persons
Bernard Beach	46	No census data available. Community chairman estimate: 1,487	Motorised canoe 40 HP	2 and 4 finger nets (gillnets)	4-5 persons
			Paddling canoes 5 m in length – some canoes built in Cape Mount, Sinoe and River Cess	2 and 4 finger nets (gillnets)	2-3 persons
King Gray Town	Not available	No census data available. Community chairman estimate: 25,000+	Paddling canoes 5 m in length	2 and 3 finger nets (gillnets)	1-2 persons
			Motorised canoes 40 HP (some made in Ghana), 6 m+	2 and 5 finger nets (gillnets) Hook and line	2-4 persons
◇ English name in parentheses * Called Lagoon East and West in census ** Called Fish Town in census					

1919



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#### 5.3.11.5 Fishing Activity

Fishing activities are dominated by men. However, a very few women own canoes, employ a crew and market their own fish catch.

From the survey, it is clear that motorised canoes are generally bigger, have bigger crews, undertake longer voyages and catch a greater variety of fish. The Fanti Town, West Point community travel the furthest, going all the way north up the coast on trips of up to 4 days. Some crews will sell fish to other communities north of Monrovia to fund their return journey and if the catch may go off owing to bad weather. This group are more likely to be in dispute with Senegalese fisher crews over access to northern Liberian fishing zones.

Paddled canoes are mostly operated by the Kru and Popo communities. These are smaller than the usual motorised canoe, travel less far and are less used in the rainy season when seas are rougher. The Kru fishing communities in Monrovia tend to have a daily schedule returning the same day to sell their catch. Those that stay out overnight return the next morning. Sharks and occasional rays are caught only by the bigger canoes travelling furthest.

Details on the fishing activities of communities in the project area are shown in Table 5-29.

One major issue arises of the impact that illegal fishing is having on the supply of fish in Liberian coastal waters and in disputes with other nationals' boats. Currently individual Fanti boats from Senegal travel down to Northern Liberian coastal waters to fish and land the fish to sell in Liberia. Recently permission was granted for up to 300 boats to enter Liberian waters which would have a serious impact on fish stocks that Liberians depend on. This may be revoked soon.

The NAFAA report that they have observed larger, cold storage boats coming down from Senegal carrying a number of Fanti type motorised canoes and crews on board. The canoes are deployed to fish from the boat which collects and stores the catch before returning to Senegal.

1945 Table 5-29 Fishing activities of communities in the project area

Community	Type	Fishing trip duration	Seasonal variation of catch		Fishing location	Usual fish species in catch (local names)	Shark and ray catches
			High season	Low Season			
Banjor Beach	Fanti and Kru	<ul style="list-style-type: none"> <li>• Around 6 hours usually</li> <li>• Sometime 24 hours-trips (am-am)</li> </ul>	October to April	May to September, rely on petty trading in low season	1-6 NM offshore	<ul style="list-style-type: none"> <li>• Cassava Fish</li> <li>• Bonny</li> <li>• Gbapele</li> </ul>	None
Popo Beach, New Kru Town	Kru	1-9 hours depending on catch	October to March	April to September	1-6 NM offshore	<ul style="list-style-type: none"> <li>• Cassava Fish</li> <li>• Gbapele</li> <li>• Grunta</li> <li>• Butternose</li> <li>• Snappers</li> <li>• Bonny</li> <li>• Napleh</li> </ul>	None
Kru Beach, West Point	Kru	<ul style="list-style-type: none"> <li>• Up to one day</li> <li>• They usually go out in the morning and come back when ready</li> </ul>	<ul style="list-style-type: none"> <li>• For nets: October to January and March to May</li> <li>• For hook and line: June to September</li> </ul>	For nets: June to September	1-4 NM offshore	<ul style="list-style-type: none"> <li>• Pipefish</li> <li>• Cassava Fish</li> <li>• Snappers</li> </ul>	Sharks, <i>only occasionally</i>
Fanti town, West Point	Fanti	1-4 days at sea	October to May	June to September	Travel all the way up the coast to Cape Mount	<ul style="list-style-type: none"> <li>• Bonny</li> <li>• Tuna</li> <li>• Napleh</li> <li>• Pipe Fish</li> <li>• Cassava Fish</li> <li>• Pojoe</li> <li>• Michel</li> <li>• Shark</li> <li>• Grunta</li> </ul>	Sharks and rays
Bernard Beach	Kru	8-12 hours	October to May	June to September	<ul style="list-style-type: none"> <li>• 2-3 NM offshore for Cassava Fish</li> <li>• 1-2 NM offshore for other fish</li> </ul>	<ul style="list-style-type: none"> <li>• Gbapele</li> <li>• Cassava Fish</li> <li>• Karngbay</li> </ul>	None
King Gray Township	Kru	12-24 hours	October to May	-	Usually at 2 NM (motorized canoes go up to 5 NM)	<ul style="list-style-type: none"> <li>• Cassava Fish</li> <li>• Kuda</li> <li>• Grouper</li> <li>• Gbapele</li> <li>• Simon</li> <li>• Bonny</li> <li>• Karngbay</li> </ul>	None

Further illegal fishing has been documented by the Sea Shepherd Global INGO of European and Chinese trawlers fishing in Liberian waters. In February 2017, Sea Shepherd Global launched a campaign in partnership with the Liberian Ministry of National Defence to fight illegal, unreported and unregulated (IUU) fishing in the West African coastal waters of Liberia. Developing countries are particularly vulnerable to IUU fishing, which accounts for up to 40% of the fish caught in West African waters. The resources of the Liberian Coast Guard to monitor, control and survey all of Liberia's sovereign waters are stretched. Sea Shepherd's mission is to assist them in identifying and arresting the unlicensed foreign industrial vessels operating in its waters, and to protect the six nautical miles closest to shore reserved for subsistence, artisanal and semi-artisanal fishing, an industry which employs 33,000 Liberians. In its first three months, *Operation Sola Stella* resulted in the arrest of five illegal fishing vessels committing over 50 violations of Liberian laws and maritime regulations, including fishing without permits, operating without vessel documentation, fishing in restricted zones, systematic under declared catch, attempted bribery of a Liberian Coast Guard officer, and undocumented workers without passports living in unsanitary conditions. A shrimp trawler certified by the United States Department of State to export shrimp to the United States was caught without a valid fishing permit and without using the legally-required Turtle Excluder Devices (TEDs), and a refrigerated cargo reefer was arrested transmitting a false identity to the Liberian port authorities where it was planning to offload 460 tons of undocumented fish cargo. Thanks to these successes, *Operation Sola Stella* continues its mission and partnership with Liberian authorities in 2018. Fish stocks need preserving to prevent overfishing and ensure sustainability of fish protein in feeding Liberia (Sea Shepherd, 2018). NAFAA, in an interview for this study, state that this is not an issue anymore and that they have licenced four Chinese trawlers only to trawl beyond 6 nautical miles this year.

#### 5.3.11.6 Community Stability

Fishermen live close to their beaches and boats in overcrowded, poor environmental conditions, in areas lacking water and sanitation, electricity, buildings of permanent materials and access. The areas are subject to sea flooding as well as from poor land drainage. Thefts from houses and boats etc. are common and have serious impacts on the ability of households to survive. Men are the fishermen, women the food processors and sellers of the fish.

1976 The Banjor beach community reports an increase in the numbers of fishermen using the beach  
1977 of between 35-40%. They report accidents and drownings and gang attacks which they claim  
1978 are frequent. This is a newly expanding community experiencing rapid growth with lower  
1979 levels of managing community disputes.

1980 The Popo Beach / New Kru Town Community report an increase of 70% in the numbers of  
1981 fishermen in the last three years with a recent murder case currently in the courts. This  
1982 community does not report gang attacks – this is a more established community with  
1983 mechanisms for dealing with disputes. Similarly, the Kru Beach, West Point community  
1984 reports drownings but no violence over access to fishing.

1985 The Fanti Town, West Point community reports drownings and deaths as well as gang  
1986 problems owing in part to their more extensive and dangerous trips and conflicts with  
1987 Senegalese fishermen. This community has seen a 5-10% rise in the numbers of fishermen  
1988 here.

1989 The King Gray community reports a riot between Fanti net fishermen and the Kru fishermen  
1990 over damage to nets. They have a drowning approximately 1 every 3 years. The Bernard beach  
1991 Community lost two fishermen drowned in 2018. They also report gang attacks on the  
1992 equipment and communities allegedly by gangs wanting to extort funds from the community  
1993 as well as over damage to nets etc.

1994 Theft and losses of equipment and gang attacks are issues facing all fishing communities.

1995 Community fishing groups have twice monthly meetings attended by all fishermen and there  
1996 is an elected fishing chief. In emergencies, a special meeting may be called to help members  
1997 in difficulty. Other community management is primarily through elected leaders – the  
1998 Community Chairman and community elders - and compliance is based on trust.

#### 1999 **5.3.11.7 Fish Nurseries**

2000 All fishermen's groups assumed that spawning happened near rocks but did not know  
2001 nurseries for the fish they regularly take. They assume under rocks and in the river mouths.  
2002 For this reason, no trawling is allowed by fishing communities in the rivers.

2003 **5.3.11.8 Income from Fishing**

2004 The data presented in Table 5-30 are the result of deliberations by groups of fishermen and so  
2005 can only be considered indicative. Fishermen often resort to petty trading and general labour  
2006 contracts when fishing is low.

2007 **Table 5-30 Income from fishing based on deliberations by groups of fishermen**

<b>Banjor Beach</b> <ul style="list-style-type: none"> <li>• A motorised canoe can bring in a catch worth LRD 1,500 to 20,000 per day for 200-290 days per year divided up by crew numbers and without expenses, repairs etc.</li> <li>• A paddling Kru canoe can bring in LRD 150 to 1,000 per day, 200-290 days per year</li> <li>• The sale value of the catch has increased by 30% over the last three years</li> <li>• Canoe value USD 200 Kru canoe, USD 1,500 to 6,000 for a motorised canoe</li> <li>• Nets cost USD 250, thread nets USD 750-1,000</li> </ul>
<b>Popo/ Kru Beach</b> <ul style="list-style-type: none"> <li>• A motorised canoe can bring in LRD 0-6,000 per day around 190 days per year divided among the crew</li> <li>• No information on a Kru canoe</li> <li>• Sales have increased in value by 40% over the last three years</li> <li>• Motorised canoe costs USD 2,000 to 6,000 to buy and costs USD 1,000+ to run annually</li> <li>• A Kru paddle canoe costs USD 200 to USD 700 to buy</li> </ul>
<b>Kru Beach, West Point</b> <ul style="list-style-type: none"> <li>• Kru canoe can bring in LRD 500-1,000 per day per fisherman for 200 days per year</li> <li>• Sales have increased in value by 25% over the last three years</li> <li>• A motorised canoe 10-15 m long costs USD 1,500 to 2,000</li> <li>• A Kru paddle canoe costs USD 150-400</li> </ul>
<b>Fanti Town, West Point</b> <ul style="list-style-type: none"> <li>• A Kru canoe can bring in LRD 0-1,000 per day per fisherman, for around 200 days per year</li> <li>• The yield to a Fanti motorised canoe fisherman is highly variable and is spread over a number of days – around LRD 1,000-2,000 per man for 200-300 days a year</li> </ul>
<b>Bernard Beach</b> <ul style="list-style-type: none"> <li>• Fishermen make LRD 500-4,000 per day</li> <li>• Fishmongers make LRD 800 - 13,000 per day (highest sum is for selling Cassava fish and other large species to ready market; lowest sum is for selling Gbapele – small silver fish of mixed origins)</li> </ul>
<b>King Gray Town</b> <ul style="list-style-type: none"> <li>• Fishermen make LRD 1,000 - 5,000 per day fishing 160 days per year</li> <li>• Fishmongers make LRD 150 - 2,000 per day</li> </ul>

2008 **5.3.11.9 Project Impacts**

2009 All fishing communities had heard about and welcome the proposal to protect the coastline  
2010 and had strong opinions as to how the project should be designed and implemented.

2011 The biggest fear for all fishermen is drowning. Most fishermen cannot swim and Kru canoes  
2012 are particularly prone to capsizing when hauling nets in. Access to life jackets and a rope/  
2013 buoyancy ring on each beach would reduce the numbers of drownings each year.

2014 The concerns that were voiced are:

- 2015 • Flooding in communities threatens their health, their family welfare and income
- 2016 earning capabilities. In the rains some communities can be flooded daily. Homes have
- 2017 been washed away. Health and welfare are eroded in flooding
- 2018 • Lack of land for their community to grow in - their houses are small, often built of
- 2019 impermanent materials, lack water and sanitation and their communities have no
- 2020 vehicle access – no ambulances, no firefighting equipment.
- 2021 • Loss of income earning capability as land is reclaimed by the sea. They have few other
- 2022 skills or means of earning a living.
- 2023 • Fear of damage to their canoes as water levels rise and storms break on the coast.
- 2024 • Antagonism towards Senegalese fishermen as they have larger trawl nets that remove
- 2025 all fish.

2026 In general, they welcome the protection of the coast but fear:

- 2027 • Loss of access to the beaches – the community needs landing sites and lack of
- 2028 obstruction to get into shore and out to sea. The landing sites must be low enough for
- 2029 canoes to beach easily and be located near their housing.
- 2030 • Being compelled to stop fishing.
- 2031 • Being relocated for construction. They have to live near the sea as this is their
- 2032 livelihood. Being relocated during construction will disrupt their ability to fish.
- 2033 • Being relocated once the land is protected. Currently most communities have no land
- 2034 rights as they are on public land previously considered unusable for building.
- 2035 Increasingly people are building bigger buildings of permanent materials encroaching
- 2036 into slum communities. This process will escalate as land is protected and the value
- 2037 rises and the area offered for urban plot allocation by the administrative bodies.
- 2038 • Loss of the beach as an entertainment area – currently smoking weed on the beach is
- 2039 a major relaxation in the slums.

2040 Other welcomed opportunities are:

- 2041 • Employment of local youths in the construction.
- 2042 • Requests for landing piers and stages, processing sites and the opportunity to manage
- 2043 the fishing industry more effectively.
- 2044 • Security of tenure.

2045 **5.3.11.10 Capacity Building**

2046 The fishing communities need capacity building to enable development of the industry and  
2047 their capability to respond to variations in fishing as a means of income. Suggestions from the  
2048 fishermen's groups are:

- 2049 • Provision of life jackets and life guard;
- 2050 • Cold stores with power nearby to store catch, cool boxes to transport the catch;
- 2051 • Loans for nets and repairs/ maintenance;
- 2052 • Increased literacy and numeracy;
- 2053 • Safe and strong landing piers;
- 2054 • Public toilets, water and sanitation for the community; and
- 2055 • Supply of electricity from the Liberia Electricity Corporation (LEC).

2056 **5.3.11.11 Fish Mongering Activities**

2057 The data collected at seven focus group discussions with fishmongers in Monrovia are  
2058 presented in this section, and summarized in Table 5-31.



2059 Table 5-31 Fish mongering activities by community

Community and association name	Approximate no. of mongers	Type of fish bought (local names)	Processing	Sales per day per fishmonger	Number of days of sales per year
Banjor Beach (Banjor Beach Fish mongering Association)	630	<ul style="list-style-type: none"> <li>Bonny</li> <li>Cassava Fish</li> <li>Rarely a shark</li> <li>Gbapele</li> </ul>	<ul style="list-style-type: none"> <li>Fresh</li> <li>Dried</li> <li>Smoked</li> </ul>	LRD 200-500	Not available
Popo Beach, New Kru Town (Popo Beach and West Corner Women's Cooperative)	600+	<ul style="list-style-type: none"> <li>Bonny</li> <li>Cassava Fish</li> <li>Gbapele</li> <li>No endangered species</li> <li>Napleh</li> <li>Pipefish</li> </ul>	<ul style="list-style-type: none"> <li>Fresh</li> <li>Dried</li> <li>Smoked</li> </ul>	<ul style="list-style-type: none"> <li>Popo Beach: LRD 200-1,000</li> <li>New Kru Town: LRD 1,000-1,500 during the high season and LRD 100-500 during the low season</li> </ul>	290 days
Kru Beach, West Point	240	<ul style="list-style-type: none"> <li>Bonny</li> <li>Cassava Fish</li> <li>Catfish</li> <li>Gbapele</li> <li>Grouper</li> <li>Grunta</li> <li>Karngbay</li> <li>No endangered species</li> <li>Kruta</li> <li>Napleh</li> <li>Pipefish</li> <li>Rock fish</li> <li>Snappers</li> <li>Sole fish</li> </ul>	<ul style="list-style-type: none"> <li>Fresh</li> <li>Dried</li> <li>Smoked</li> <li>Fresh fish stored in private cold store when needed</li> </ul>	<ul style="list-style-type: none"> <li>LRD 1,000-5,000 during the high season</li> <li>LRD 500-2,000 during the low season</li> </ul>	200-290 days
Fanti Town, West Point (West Point Fishmongers Association)	1,000+	<ul style="list-style-type: none"> <li>Bonny</li> <li>Cassava Fish</li> <li>Catfish</li> <li>Gbapele</li> <li>Grouper</li> <li>No endangered species</li> <li>Grunta</li> <li>Karngbay</li> <li>Napleh</li> <li>Pipefish</li> <li>Pojoe</li> <li>Rarely a shark</li> </ul>	<ul style="list-style-type: none"> <li>Fresh</li> <li>Dried</li> <li>Smoked</li> </ul>	LRD 500-1,000	280 days
Bernard Beach	75+	<ul style="list-style-type: none"> <li>Bonny</li> <li>Karngbay</li> <li>Cassava Fish,</li> <li>Gbapele</li> </ul>	<ul style="list-style-type: none"> <li>Fresh</li> <li>Dried</li> <li>Smoked</li> <li>Muin-muin*</li> </ul>	Not available	160+ days
King Gray Town	30+	<ul style="list-style-type: none"> <li>Bonny</li> <li>Cassava Fish,</li> <li>Gbapele</li> <li>Grouper</li> <li>Karngbay</li> <li>Kuda</li> <li>Simon</li> </ul>	<ul style="list-style-type: none"> <li>Fresh</li> <li>Dried</li> <li>Smoked</li> <li>Muin-muin*</li> </ul>	Not available	160 days

\* Rotten fish that is salted and sun-dried

Fish mongering covers a complex interacting group of actions, as shown in Figure 5-58. After the fish is purchased from fishermen at the landing site, it is either directly sold or processed (drying or smoking) then sold. The fish is sold in a number of ways, including directly door to door in the community, door to door in non-fishing communities, selling fresh in Monrovia markets of the evening Benson Road fish market, to selling fresh or processed fish to outside sellers for sale in Monrovia or onward transport to sales in inland markets.

The shortest marketing trip for a fresh fish involves only one seller and one buyer – the longest sees the fish processed and transported through chains of marketers and transported over the country. The market range for Monrovia fish is extensive as traders take the smoked fish inland; the price increases with each trade.

- Fishmonger buys directly from the boat →
- Sells on own account in community or nearby
  - Sells to another seller who takes to a large market in Monrovia
  - Dries fish locally
  - Smokes fish locally
  - Sells to another seller who will
    - Sell on own account
    - Sells to another trader
    - Dries fish
      - Sells on own account
      - Sells to another trader
    - Smokes fish
      - Sells on own account
      - Sells to another trader

Figure 5-58 Diagram showing fish mongering activities

The actions of all fishmongers in a fishing community are governed by membership of the community to a Fish Mongering Association with an elected Chairwoman. These associations are based on trust and enable peaceful negotiated solutions for community issues in line with traditional Liberian customs. The Associations are primarily to manage the number of sellers in the community and secondly to resolve disputes. A small fee is paid monthly at the monthly meeting.

### Purchase of Fish

Fishmongers are aware of the likely landing time of the boats and assemble on the beach usually in the early afternoon onwards. For Kru canoes this can be anytime from 10 am to 5 pm. The fishing community uses mobile phones when in range to communicate landing times.

In a community, all fishmongers are free to buy from whichever crew they wish. However, many tend to buy from crews to which they are related by family, marriage or friendship but this tie is not essential. Would-be mongers are usually required to start selling Gbapele, a small, mixed-species silver fish, in local communities only graduating to being allowed to buy bigger fish once they have established a market of paying customers. Buyers of bigger fish usually have a marketing round of households that buy their fish from that seller.

Catches are purchased by the 10 litre bucket and can be a single type of fish or a mixture of fish. Discussions on price and type of fish to purchase are usual. A bucket/ bowl of Gbapele varies in price from LRD 1,200 to 1,800. Usually the fishmongers pay directly on receipt for the fish, a minority buy on credit to the crew, returning to the crew to pay after sale.

The groups state that they do not usually handle turtles, dolphins and rays as they have attended a workshop on endangered species although if they turn up in catches, they will be hidden from NAFAA inspection and sold.

### **Processing and Sale of Fish**

Fish can be sold and resold multiple times between landing and consumption and be processed at any point by any of a number of buyers/ sellers in the chain. The three methods of fish processing are described below.

Fresh fish: Fresh fish are usually washed after purchase and arranged either in bowls or wrapped in plastic and cardboard boxes (Figure 5-59). The fishmonger will either walk around her own community, a neighbouring community selling door to door on an identified round or take the fish to a bigger market – Banjor, Red Light, Duala, YOA, Greenville, etc. or sell on to another person who may do the same. Some sell fresh fish at the evening Benson Street Fish Market. Fresh fishes are usually sold whole without gutting or internal cleaning unless the fish is too large for one purchaser. Increasingly fishmongers are renting cold store space to keep fish fresher for longer thus increasing income. Generator driven freezers are found in all communities and non-fishing areas near the fishing communities.



Figure 5-59 Fresh fish at (a) New Kru Town and (b) West Point

**Dried Fish:** Fish of any species that are no longer completely fresh are often air-dried into muin-muin in salt outside houses on mats, nets, roofs, etc. (Figure 5-60). The salt can have spices added. The drying preserves the fish for longer and prevents spoiling. Dried fish is not as popular as smoked fish and hence has a smaller market, but often commands the same price as smoked fish. Not all fishmongers dry fish and it remains a niche activity ensuring some value for the catch.

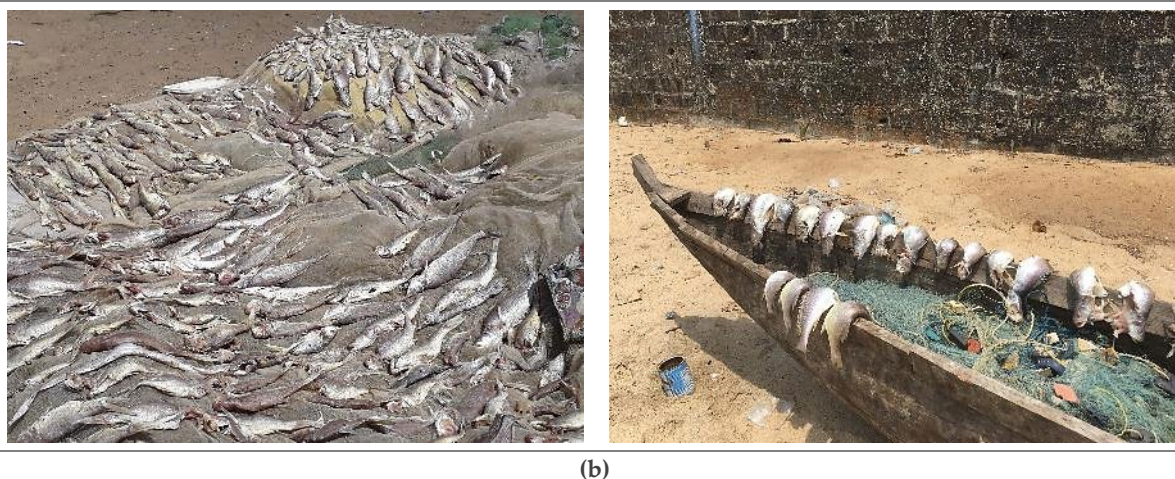
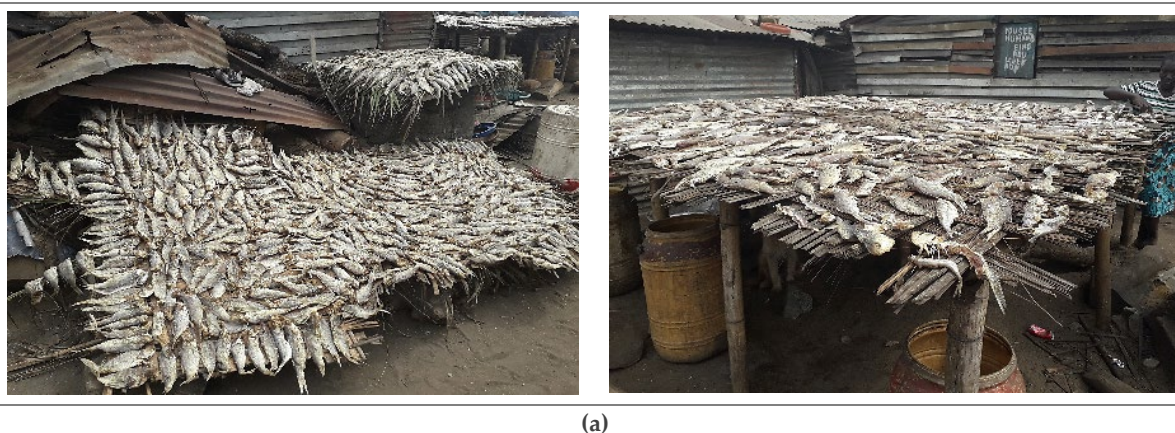


Figure 5-60 Fish drying at (a) Banjor Beach and (b) West Point



2116 Smoked Fish: Smoking fish is an intensive activity, usually undertaken by fishmongers who  
2117 buy fish particularly to do this. Smoking is carried out very close to the landing stages, near  
2118 to the sale site. Smoking fish is usually a female activity although some men are involved.

2119 Smoking is usually undertaken using an empty oil drum fired with mangrove wood with fish  
2120 laid out over wire grids and covered with makeshift lids (Figure 5-61). Some entrepreneurs  
2121 open up the oil drums to make larger drums out of combining three drums. Smoked fish is  
2122 sold on to traders going upcountry as well as to marketers from the larger markets coming in  
2123 to buy supplies. Smoked fish from Liberia constitute a major contribution to protein  
2124 consumed all over Liberia.



2125 Figure 5-61 Smoking fish at (a) Banjor Beach and (b) West Point

2126 Mangrove wood is traded into Monrovia from local sources or from further afield. The wood  
2127 is dried before transportation and sale / use in the fishing communities (Figure 5-62). Piles of  
2128 rubber wood were noted in West Point and may be used for smoking but is generally  
2129 considered to produce a less attractive taste.



Figure 5-62 Mangrove wood to be used for fish smoking

### Coastal Protection Issues

The fishmongers live in the same fishing communities alongside the fishermen and hence are affected in the same way by the rising sea levels and erosion by waves. All communities suffer flooding – often daily in the rainy season, have lost relatives, houses and property, and are hindered from processing and marketing fish when the community is flooded. Similarly, fish smoking is impossible with a flooded community.

The fish mongering focus groups put the problems of sea flooding and coastal erosion as their primary concern ahead of other issues such as clean water, sanitation and health services. A major concern is being forced to move if coastal erosion destroys their community or if the design of sea defence means loss of their homes. The fishmonger's future is inextricably entwined with that of the fishermen and the need to be near the sea shores. They welcome coastal protection but need to ensure that they can continue to access the beach, continue to use the beach for business and keep their houses where they are.

2145 Concerns associated with flooding are:

- 2146 • Loss of life;
- 2147 • Loss of houses, businesses, equipment, income;
- 2148 • Land take to build the protection;
- 2149 • Loss of beach landing sites;
- 2150 • Relocation away from the community;
- 2151 • Spoiling of beaches with construction materials; and
- 2152 • Loss of recreation space on beaches.

2153 The fishmonger and fishermen communities are located on public land that has had little  
2154 value as it is so vulnerable to flooding. The communities additionally fear that they will be  
2155 pushed out once the land is secure post protection to enable big business to build on dry land  
2156 and for the land to be sold off by MCC as an asset for development.

2157 These communities rely on the location for their survival. Relocation is not possible as there  
2158 are too many people in too many households needing land that is in very short supply in  
2159 Monrovia. Moving fishing communities out of town risks a drop in the supply of fish protein  
2160 to Monrovia and elsewhere. Increased travel costs for sellers into and out of town to other  
2161 locations reduces and negates profit margins already low.

2162 Profits from fish mongering vary from LRD 100 to 1,000 per day (< USD 1-7 USD per day) to  
2163 support 1-5 people for 7 days per week. It requires two incomes in the household to ensure  
2164 an income above the absolute poverty level of USD 1 per person per day. These very poor  
2165 communities are feeding much of Monrovia and the rest of the country. Profits and income  
2166 must rise to enable development in these communities – this can only happen if their  
2167 communities are safer from sea flooding and that fishing can happen more on more days.

2168 Relocating these communities will break survival strategies, demolish working and trading  
2169 relationships and result in lower incomes and increased poverty.

2170 Slum communities provide additional hazards for fishmongers and their families. There is  
2171 virtually no sanitation and clean water from hand pumps or communal does not generally  
2172 exist. The communities have no paved roads, no surface water drainage and no refuse



disposal systems. The health hazards are enormous and multiplied by the high density of buildings and high populations.

West Point was particularly badly hit in the 2014/2015 Ebola epidemic where poor living conditions combined with strong reliance on caring for sick relatives allowed the virus to spread out of control. Public Health controls had to be enforced at gunpoint, causing riots in very confined spaces. The area was quarantined off with a curfew and barricades, prices rocketed and thousands were infected. West Point only had 4 toilets for 20,000 people. There is considerable anti-establishment feeling in the area.

The communities hope for development – improvements to fish related incomes, provision of schools, clinics, roads, savings and credit schemes. Capacity building for fish mongers could be:

- Provision of cold rooms near to landing sites;
- Micro loans/ savings and credit etc. for fish selling;
- Provision/ promotion of cool boxes; and
- Workshops on fish handling hygiene and a quality recognition system.

### **5.3.12 Small Trading Businesses**

Very high proportions of working age low-income people engage in petty trading selling food, household items, clothes, etc. from small market stalls, from basins, wheelbarrows and hawkers on foot. The need is to reach as many potential customers as possible and make small profit margins on which to survive. Such petty trading is a universal factor of African urban life and is an extension of the daily/ weekly market system which takes goods to the buyers.

Formal markets are run by the Liberian Marketing Association who make a small charge to each seller for the right to sell in or near the market ground or hall. These markets take the place of small shops in the urban economy. In Monrovia there are a number of big markets in the city which draws huge numbers looking for bargains/ supplies.

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### 2198 5.3.13 Other Employment and Livelihoods

2199 Overall unemployment in Liberia is seemingly low at 2.8% nationally. However, a better  
2200 depiction of the fragility of the labour market is reflected in the vulnerable and informal  
2201 employment rates, which stand at 74.2% and 67.9% nationally. Both vulnerable and informal  
2202 employment rates are higher in rural areas than in urban. 54.1% of the working population is  
2203 employed in the private sector, which includes household entrepreneurial and farming  
2204 activities. The Government employs 20.9% of the labour force.

2205 The definition of an unemployed person, according to international standards, is one who  
2206 shows three characteristics. Firstly, the person should not be working. Secondly, the person  
2207 must be available to work, meaning would accept employment if they were offered any.  
2208 Thirdly, the person must be actively looking for work (by being registered at unemployment  
2209 office, for example) to be actually counted as unemployed. This last characteristic is sometimes  
2210 not included in environments where the labour market is strongly underdeveloped, which is  
2211 considered the case for Liberia. As such, the third condition of actively seeking work was not  
2212 considered in the methodology used here.

2213 The informal employment rate requires a more specific definition, based on certain profession  
2214 (using their ISCO code) and whether the employer is registered with the Ministry of  
2215 Commerce, among other characteristics. The exact definition used for this Statistical Abstract  
2216 can be found in the 2010 Liberia Labour Force Survey (LFS), since the LFS guidelines were  
2217 used to produce these estimates (LISGIS, 2011). In line with International Labour Organization  
2218 (ILO) standards, the base population for the calculation of the informal employment rate  
2219 excludes those employed in own account farming, but includes wage labourers working in  
2220 the agriculture sector. Thus a person working on his or her own farm is not included, while a  
2221 labourer on a rubber concession is.

2222 Finally, those in vulnerable employment are seen as those either employed on their own  
2223 account or working as a contributing family worker to either the family farm or the  
2224 household's non-agricultural business.

2225 Focusing first on unemployment, it is clear to see that the rate is low in Liberia. Nationally it  
2226 stands at 2.8%, reaching 4.5% in urban areas and 0.8% in rural areas. The highest regional rate

of unemployment is the 5.4% recorded for Montserrado, the lowest percentage is the 0.7% reported in the North Central region.

The disaggregation by consumption quintile reveals that unemployment is lowest among poorer Liberians. This is in line with the overall low unemployment rate in the country: unemployment is not an option. People need to find a means of income through some type of employment, however informal or vulnerable, in order to sustain themselves, even in rural areas.

Unemployment increases as people become less poor, only to fall again in the richest quintile. This probably is because, as poverty decreases, people have the chance to wait out for a better employment opportunity.

The informal employment rate in Montserrado (70.4%) is higher than the national average (67.9%). The proportion in vulnerable employment is lower – 55.7% against the national average of 74.1% but the Montserrado unemployment rate is nearly double the national average at 5.4% against 2.8%.

Reliance on informal employment disproportionately affects women more. Nationally 33.8% of men are in informal employment whilst, 86.4% of women are in informal employment showing that women are disproportionately at risk of informality and hence unreliable incomes. Informal employment is highest in urban areas – 69.4% while in rural areas it is at 63.2% but this figure excludes farming on own land. There is no breakdown of these figures to County level.

#### **5.3.13.1 Household Non-farm Business Characteristics**

Table 5-32 shows that most businesses can be classified as shopkeepers or traders (65.1%), followed by services (24.9%), and producers (10%). It should be noted that while a business can be classified in more than one way, for example, a producer and a shopkeeper, the questionnaire in the LFS only allowed for one main classification (LISGIS, 2011).

Services are a largely urban phenomenon (they represent 30.8% of businesses in urban areas, while only 8.9% in rural areas). Producers, on the other hand, are relatively more common in rural areas (21.4%) than urban areas (5.8%).

2255 Female managers are more prevalent in trading businesses, while male managers are more  
2256 evenly spread between the three different business types as defined in the 2011 LFS (LISGIS,  
2257 2011).

2258 Table 5-32 Distribution of the type of non-farm household enterprise (LISGIS, 2011)

Type of enterprise	Location			Gender of manager	
	Liberia	Urban	Rural	Male	Female
Shopkeeper / trader	65.1%	63.4%	69.7%	45.0%	77.8%
Producer	10.0%	5.8%	21.4%	16.0%	6.2%
Services	24.9%	30.8%	8.9%	39.0%	15.9%

### 2259 5.3.14 Labour and Working Conditions

2260 Many non-formal services are organised and regulated by the presence of “Unions” which  
2261 manage access to providing a service, moderate charges and dictate who can do what. Taxis,  
2262 motorcycle taxis and fishing/ fish mongering activities are all organised through a Union at  
2263 each location. Engaging the Unions or Associations are key to creating a development  
2264 initiative and way forward.

2265 There is a national employment minimum wage which varies between formal employment  
2266 sectors, but the concept of a minimum wage has not transferred to the informal sector.

### 2267 5.3.15 Infrastructure

2268 The data in this section is derived from the information gathered during the focus group  
2269 discussions for this study.

2270 The slum communities all lack services needed to start uplift and improvement.  
2271 Overcrowding is high, buildings are dense with only pathways between dwellings and no  
2272 access roads. All goods have to be carried in and out.

2273 Most communities lack schools and clinic facilities. Small school buildings were noted in  
2274 Bernard Beach on the periphery of the community and in West Point. No clinics were  
2275 identified – most community members have to leave the community to access health facilities.  
2276 A few pharmacy shops selling drugs were noted. Most residents access the main hospitals for  
2277 all their health care needs as and when they can afford to use the services.

2278 Three NGOs were identified working in these communities, the Young Men’s Christian  
2279 Association (YMCA), its partners and SLUMDAL are all aimed at poverty eradication in the

slums. The Disaster Victims Association operates in West Point. Under the Memorandum of Understanding between the YMCA of Liberia and SLUMDAL, the YMCA will serve as the technical support NGO for SLUMDAL for the purpose of enhancing its capacity to advocate on behalf of slum dwellers.

The YMCA will work with SLUMDAL to identify areas of need for leadership/capacity building support under the project in line with the budget allotted for support to local affiliation with Social Development Initiatives (SDI) (YMCA internal description of local partners) under the project, while YMCA in collaboration with SLUMDAL will work to support the establishment and growth of local association (federation) of slum dwellers for the proactive implementation of SDI rituals (YMCA terminology) such as the formation of saving groups in West Point and Slipway and profiling /enumeration exercises in target communities.

The YMCA of Liberia, with support from COMIC Relief and Y-CARE International, is implementing a slums development project titled: “Young People as Agents of Change Helping to Transform Slum Settlements”.

Additionally, YMCA in collaboration with SLUMDAL will provide support in the mobilization and strengthening of local associations of slum dwellers through exchange visits and targeted training on savings and credit and land rights and YMCA and SLUMDAL will collaborate to engage relevant government authorities, ministries, agencies and national and international NGOs to provide basic social services to improve the living conditions of people living in the informal settlement or slum communities in Monrovia.

### **5.3.16 Land Use**

The slum communities are not formally planned and activities are not regulated despite theoretically being subject to zoning laws, etc. The result is a chaotic mix of homes, businesses, schools and clinics built as possible without regulation. Most areas have no water supply even to a communal tap, no sanitation and very few public latrines. There is no system of waste disposal other than to throw into the rivers and sea. Disease vectors are very common.

2307 Pressures on land available for settlement has led to the invasion of mangrove areas north of  
2308 the Mesurado estuary. Areas have been cleared and informal housing built as the need for  
2309 housing increases (Figure 5-63).



2310  
2311 Figure 5-63 Informal housing built in the mangrove area

### 2312 5.3.17 Land Ownership and Customary Tenure

2313 Security of land tenure is a serious concern for many poor communities in Liberia. With the  
2314 project's protection of the coast, the values of land will be raised. Many members of the coastal  
2315 communities do not have formal title to the land they occupy, having settled there either with  
2316 customary rights allocated by a traditional Chief, or because of displacement during the civil  
2317 wars. A component of the adaptive interventions part of the project will address land  
2318 management issues and may need to focus on formalisation of registration in the low-lying  
2319 community lands.

2320 Residents of Monrovia's informal settlements are not protected by law or administrative  
2321 policies. There are no legal protections for residents of informal settlements, no process for  
2322 formalizing settlements, and no legal framework for government expropriations of land.  
2323 According to Bruce and Kanneh (2011), the lack of laws governing expropriation and  
2324 formalization is a major gap in the legal framework, particularly given the large number of  
2325 residents that would be negatively affected by forced evictions. As Liberian law does not

provide a framework for governing informal settlements, many administrative acts affecting their residents are based on established practice rather than formal law (Williams, 2011).

For example, in some larger, more established settlements like West Point, residents paid de facto taxes in the past (2008-09) to receive 'squatters' rights' certificates from the MCC. These certificates constituted a use and possession right on public land valid for one year. Despite their temporary nature and questionable legal basis, these certificates still conferred residents with a sense of security (Williams, 2011). Since 2010, however, the MCC has refused to issue or renew squatters' rights certificates. The Township Commissioner of West Point informally renews certificates for the settlement, and many residents continue to believe that these are validated by MCC. It is not known if the recently issued certificates could serve as a legal basis for challenging potential evictions by the MCC (Stevens, 2012).

One of the areas in which both the linkages and tensions between addressing the past and shaping a better future are most clearly evident is the issue of development-induced displacement in the capital city, Monrovia. The linkages lie in the fact that many, if not most of the slum-dwellers threatened with eviction as the city recovers from the war were originally displaced to Monrovia by conflict and are actively pursuing local integration as a durable solution. The tensions lie in the fact that informal settlements continue to be seen as an obstacle to development even as slum dwellers argue – with much justification – that they have contributed significantly to reconstruction through both their labour and the sweat equity represented by the neighbourhoods they have built.

The last several years have seen increasing numbers of evictions and demolitions in informal settlements in aid of both private investment and public infrastructure projects. Although the Land Commission charged with setting post-war policy has taken up urban land use as a priority issue in 2011, residents of informal settlements throughout Monrovia currently enjoy little security of tenure and remain vulnerable to development-induced displacement. The issue of development-induced displacement in Monrovia represents a concrete example of the manner in which development best practices may be pivotal to ending the humanitarian vulnerability caused by displacement.

In both human rights and development terms, the provision of tenure security, or legal guarantees that continued possession and use of property will not be arbitrarily interfered



with, is seen as an affirmative act that governments can and should undertake by adopting appropriate laws and policies and giving them effect. Crucially, tenure security should extend even to those who inhabit informal settlements without any form of legal title, protecting them from being evicted or resettled without the observance of minimum safeguards identified in both development and human rights standards. In this sense, outright ownership of property provides a very high degree of tenure security.

Multiple institutions at the township, municipal and national level share overlapping jurisdiction over the greater Monrovia area and have independent powers to demolish structures and evict their residents in accordance with their respective mandates. Levels of private investment and public infrastructure projects have increased, but investors, lenders and donors still act according to disparate and inconsistent resettlement guidelines – or no guidelines at all. Although slum dwellers have organized themselves quite effectively at the neighbourhood level, they have yet to coalesce into an effective interest group with the capability to formulate clear policy proposals and lobby for them (Bruce and Kanneh, 2011).

Public servants at the municipal and national level still tend to view slums primarily as an obstacle to development but are conscious of both the important role slum-dwellers play in the economic life of the city and the impracticability of plans based exclusively on demolition and resettlement. Meanwhile residents of informal settlements have in virtually all cases organized themselves and become accustomed to paying de facto taxes to local government in exchange for ‘squatters’ rights’ certificates. Most slum dwellers interviewed for this study through the focus groups on community impacts (chapter 1) understood and accepted that evictions and even large scale relocations might be inevitable in the future, and were primarily interested in ensuring that these were accompanied by social protection measures that would prevent the further impoverishment of those affected.

Current systems are antiquated, records are missing or destroyed, and current record systems and tools are inadequate. Maps, deeds, and other land documents are missing. The Liberian National Archives within the Ministry of Foreign Affairs has many boxes of crumbled record books and is working to recover other documents. Every Ministry will require technical training and up-to-date technological systems to initiate recovery.

Meanwhile, the relationship between the slums and the city and local authorities is another area of legal ambiguity. Although informal settlements have existed in Monrovia at least since the 1950s, they proliferated during and after the war and are now home to a majority of the capital's inhabitants. Early on during the conflict, the practice of charging an annual 'squatters' rights' fee to slum residents became widespread among the various local authorities in Monrovia. While ostensibly based on a provision of the 1957 Zoning Code on non-conforming structures, the issuance of squatters' rights is, in reality, simply an established de facto practice that is broadly accepted but not clearly legal. Regular payment of the fee entitles the holder "to occupy the area until such time as the government fines [sic] it necessary to use the land in which case, one month notice will be given to vacate the premises" (Bruce and Kanneh, 2011) . Whilst in some areas households still claim to be paying "fees" and some pay the house tax, the situation is highly variable and not uniform.

Squatters' right permits also prohibited the creation of permanent structures, a rule that is regularly flouted in practice. The fact that slum dwellers persist in building permanent structures indicates that community understanding of "squatters' rights", despite their own rules, have given rise to a perception of security of tenure on the part of their holders. However, critics have noted that such rights provide no objective tenure security and that slum dwellers that invest in permanent structures risk "becoming double losers having paid regular annual squatters' rights renewal fees to the Local Authorities with no guarantee for compensation or relocation assistance" (Bruce and Kanneh, 2011). Buildings of permanent materials are usual and noted as common in all slum communities visited for this study.

The precarious situation of slum dwellers in Monrovia is underscored by the lack of transparent and consistent policies or procedures related to their involuntary relocation. Evictions and demolitions fall within the remit of the MCC, comprising the Mayor and City Council, as well as a number of national level ministries and agencies, such as the Ministry for Public Works (MPW), which is responsible for applying the Zoning Law, the Ministry of Lands Mines and Energy (MLME), the EPA and others. The approach taken by the MCC has generally been benign, with demolitions to enforce safety codes balanced with some slum upgrading efforts.

The Mayor of Monrovia, in the past, initially sought to implement a more aggressive policy of slum clearance, but since adopted a more cautious approach. However, the MCC has forbidden the further sale of squatters' rights by the MCC, citing their unclear legal basis and past failures to transparently document how the proceeds were used (Bruce and Kanneh, 2011). Meanwhile, there is some anecdotal evidence that increasing numbers of refugees are now returning from abroad and actively seeking to reclaim or otherwise acquire urban land in Monrovia for investment purposes. As a result, property values are likely to rise and an increasing number of attempts to assert private property interests in occupied urban land are to be expected.

West Point is long-established, centrally-located, fully integrated into the urban economy and situated on public land. As a result, it is treated as a de facto administrative unit within the city and has received significant infrastructure improvements. West Point is Monrovia's best-known informal settlement and one of its oldest. It consists of a flat, sandy spit of land abutting the highly active Waterside market area. The area was built up in the 1940s through the deposit of sand dredged during the construction of the new port facilities on nearby Bushrod Island. As a result, West Point consists largely of recovered land, leaving it in relatively unambiguous public ownership relative to virtually all other areas of Monrovia, where historical claims cannot be ruled out. According to residents, West Point was officially made one of Monrovia's townships in 1960 and now houses as many as 70,000 people in six communities. As many as one-third of the area's residents arrived as displaced persons during the conflict in an influx that led to the physical expansion of the settlement.

Prior to the 1989-2003 wars in Liberia, several attempts were made to resettle the residents of West Point and other slums in new housing estates. However, the homes in new estates were allegedly allocated based on connections as well as need and had little impact on the informal settlements they were meant to replace. Indeed, although the pre-war Liberian National Housing Authority remains active, it is currently perceived as focused on market construction and in need of significant reorientation in order to be able to play a role in alleviating current slum conditions.

In the meantime, West Point has increasingly taken on the character of a de facto administrative unit with its own township administrative building, a court magistrate, a

police station, numerous schools, churches and mosques, and the completion of an asphalt access road. Many residents are allegedly above the poverty level based on income from jobs in the Waterside market along with a local fishing industry. The township also takes its local system of squatters' rights certificates quite seriously and considers itself more broadly to have achieved a social contract of sorts with the authorities. Although residents understand that the flat, exposed nature of the area may ultimately rule out continuation of its current dense residential use, they consider themselves entitled to resettlement that would allow the community to remain together and compensate for the loss of livelihoods connected with its current location.

The Peace Island settlement is a promontory surrounded by swamplands that lies within the Congo Town neighbourhood to the east of Monrovia's central districts (outside of the project area). The area was heavily forested and unsettled when unregistered Internally Displaced Persons (IDPs) initially began to clear it for residential plots in 2003. The population currently stands at nearly 30,000, with most families living on small plots laid out along access roads and fire lanes and demarcated with rocks and trees. The land occupied by the settlement is both valuable and contested, and tenure security has accordingly been tenuous. In 2007, faced with a demolition threat from the Ministry of Mines, Land and Energy, residents appealed to the President, who is said to have guaranteed that evictions would only go forward upon provision of alternative land and housing units. However, government officials have not extended services to Peace Island and are said to have prevented an NGO from providing wells. There are no schools and few jobs available on the island and residents were required to wade through a swamp to access the mainland until an aspiring politician bankrolled a causeway.

Pending completion of an urban land audit in Monrovia, the Land Commission may wish to consider measures that would afford slum residents a minimum degree of safety and tenure security without unnecessarily prejudicing the outcome of ownership disputes. These could include measures such as interim lease arrangements with residents of informal settlements, who would continue to occupy them with the possibility to access basic services subject to the requirement that they continue to take responsibility for local administration and report violations of zoning rules. A lease system could build on popular acceptance of squatters'

rights certificates but with a clearer legal basis and transparency regarding the collection and use of the revenues.

In approaching the development of an urban land policy, the Commission should consider carefully the balance between the equitable interests of the current slum-dwellers in the informal settlements they have built and administered and the legal interests of holders of valid title. While the destruction and loss of title records should not categorically disqualify the claims of alleged private owners of land in Monrovia, the policies underlying ordinary rules of escheat and adverse possession – e.g. that legal certainty must be balanced with policies to promote productive use and maintenance of landed property – should be borne in mind in assessing such claims. It is also important to note that urban land adjudication need not always be a zero-sum process. In cases in which both owners and current possessors of urban land can demonstrate strong interests, public authorities may be in a position to provide incentives to both parties to negotiate over the possibility of shared use of the land in question (Bruce and Kanneh, 2011).

### 5.3.18 Archaeological and Cultural Heritage

The study areas are located near to the Providence Island landing spot of freed American slaves who resettled to Liberia in the early 1820s (see Figure 5-64). The site is characterized by a cement pillar and concrete floor believed to be the 'first Concrete work in the history of the country, an ancient water well and an old landing docking platform for incoming canoes and ships. The rusted heavy steel bar of the dock is partly buried into the Mesurado River today. In addition to these elements, is the oldest cotton tree, 250 years according to history of the State. Providence Island was a major trade post for both Portuguese and ethnics of the land. Prior to being the site of returning descendants of former slaves, the Island had been one of the major slave embarkation sites. An application was made in 2017 to have the island declared a UNESCO World heritage site. The site is unaffected by the proposed project.

The only other site of potentially historical significance is Hotel Africa at the northern end of the study area. In 1979, the hotel, the largest in Liberia, hosted the Organisation of African Unity conference. The conference was led by President William Tolbert, Jr. who was the group's chair at the time, just months before he was overthrown by Samuel Doe. The hotel was badly looted during the civil war but remains of interest to some groups of Liberians.

2504 Coastal erosion has badly affected this site with a significant proportion of the buildings  
2505 having collapsed into the sea. The area has been taken over by a squatter community.  
2506 An extensive search has not revealed any other sites of historical, political or archaeological  
2507 importance in the project areas.



2508 **Figure 5-64 Providence Island**

## **6 STAKEHOLDER ENGAGEMENT AND PUBLIC PARTICIPATION**

### **6.1 PUBLIC CONSULTATION AND ENVIRONMENTAL AND SOCIAL DISCLOSURE**

The ESAR includes public consultation as part of the ongoing stakeholder engagement for the project. The project was discussed with a wide range of stakeholders including relevant government departments, industry groups, NGOs, and individual community members. Extensive on-ground consultation has been undertaken during the design of the project (as well as during the earlier projects that this project is aiming to upscale) and it is essential that consultation with any affected communities will continue.

Ongoing consultation will be guided by a Stakeholder Engagement Plan (SEP). The SEP will build on the public information and community engagement activities conducted for the ESAR. The SEP is discussed further in Section 8.9

It is anticipated that, based on the communities' expressed views to date, the project will be fully accepted, provided that communities can stay where they are and are protected from eviction.

### **6.2 COMMUNITY CONSULTATION UNDERTAKEN FOR ESAR**

An extensive community consultation exercise was undertaken for the ESAR over a three-week period in February 2019. In total, twenty communities were visited, all located in the frequently flooded zone along Monrovia's coasts. Seven of these communities are fishing communities, while 13 are not, but are all poor slums, regularly and frequently affected by sea flooding. In addition, the Disaster Victims Association in West Point, a Community Based Organisation (CBO), was consulted, thereby adding up to twenty-one meetings in total. Communities all report loss of lives, loss of structures (homes and workplaces), disruption to means of gaining a livelihood, increased uncertainty and a lack of anywhere else to go. Both fishing and non-fishing communities depend on their location for their livelihoods, and fears of loss of land, of inundation, forced relocation and lack of access to plots utilised for decades are deeply disturbing for all.



The Community Consultation Agenda is attached as Appendix C. The time available permitted only the conduct of one focus group discussion per non-fishing community. In fishing communities, the focus group discussion on community impacts was supplemented by two additional focus group discussions with both fishermen and fishmongers (usually women). Each consultation was arranged through the elected but unpaid Community Chairperson who called the community elders, women's and youth representatives as well as community members. Discussions with fishermen and fishmongers were arranged through the Fishing Chairman in the community and the Fishmonger Association local chairwomen. Attendance varied from 10 to 40 persons. A summary showing the communities consulted is presented in Table 6-1.

### 6.2.1 Impacts

All the communities visited have been in existence since before the civil war (1989-2003) and have seen rapid population growth since 2004 as people flocked to the capital to seek work and survival. Inhabitants of the affected communities are mostly squatters and tenants of squatter households. Approximately 50% own their building but not the land the building is on, the remainder rent rooms or buildings from others. Buildings are constructed from a variety of materials, many perishable, and are mostly in poor repair. Every community has experienced someone taking land and building a bigger permanent structure which indicates the transient nature of squatting and the likelihood of land pressures encouraging building on previously unsuitable land and relocation of residents.

Impacts by sea flooding are:

- Damage to beaches making canoe operations difficult;
- Damage to houses and homes;
- Displacement and family disintegration;
- Loss of business and livelihoods;
- Additional flooding caused by runoff from town side rain waters, mixing of waters;
- Washed away roads and paths and loss of land for housing;
- Increased poor health from inability to sleep in damp houses and waterborne disease vectors; and
- Deposition of garbage and sea flotsam and jetsam in households and pathways.



58 Table 6-1 List of communities where consultation meetings were held

Coastal section	Area name	Community name	No. of participants	Livelihood type
1	Hotel Africa	21. Hotel New Community	65	Petty trade/small business-used clothing and backyard gardening and sand mining/brick making
		22. Blessing Road Community	43	Petty trade/small business-used clothing and fishing mongering and brick making
		23. Fanti Town / Banjor Beach	45	Major livelihood type is fishing and fish mongering followed by small business/petty trade
2	New Kru Town (Borough)	24. New Kru Town / Popo Beach	45	Major livelihood type is fishing and fish mongering followed by small business/petty trade
		25. Coast Guard Base	32	Petty trade/small business-used clothing and fishing mongering
		26. Fundaye	29	Petty trade/small business-used clothing and fishing mongering
		27. Lagoon Community	7	Petty trade/small business-used clothing
3	West Point	28. Kru Beach	68	Major livelihood type is fishing and fish mongering followed by small business/petty trade
		29. Fanti Town	32	Major livelihood type is fishing and fish mongering followed by small business/petty trade
		30. White Flour	54	Major livelihood type is fishing and fish mongering followed by small business/petty trade
		31. New West Point	58	Major livelihood type is fishing and fish mongering followed by small business/petty trade
4	US Embassy to Barclay Training Center	32. Coconut Plantation	34	Petty trade/small business-used clothing and sand mining/bricks making
		33. Public Health Pond (PHP)	5	Petty trade/small business-used clothing and sand mining/bricks making
5	Barclay Training Center to Bernard Beach	34. People United Community (PUC)	24	Petty trade/small business-used clothing and sand mining/bricks making
		35. Old GSA	3	Petty trade/small business-used clothing and sand mining/bricks making
		36. Wisdom Town	27	Petty trade/small business-used clothing and sand mining/bricks making
		37. People Community School	22	Petty trade/small business-used clothing and sand mining/bricks making
		38. Kpelle Town and surrounding area	20	Major livelihood type is fishing and fish mongering followed by small business/petty trade and sand mining/bricks making
		39. Bernard Beach / Small Town	17	Major livelihood type is fishing and fish mongering followed by small business/petty trade and sand mining/bricks making
	ELWA	40. King Gray Town	11	Petty trade/small business-used clothing and sand mining/bricks making
3	West Point	41. Disaster Victims Association ( <i>Community Based Organisation</i> )	8	Petty trade/small business-used clothing and sand mining

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## 6.2.2 Concerns about the Project

Communities appeal to stay where they are – relocation would mean loss of livelihoods as traveling to and from a new home site would reduce income available for survival and mean losing such opportunities as they have now. Residents did not want to break up their communities and have to live near unknown people. Fears of increased theft and violence from not being known in the new place were frequently expressed.

Residents feel they have looked after the coastline to date and feel that they should be rewarded for their efforts – they regularly move washed in sand to drain their sea flooded communities, piling rocks etc. rather than be evicted as a nuisance.

Despite being squatters for the most part – a very few plots have a legal title deed – the communities feel they have a right to live in these areas and that being forced out would require full replacement for losses, livelihood and security of tenure. All house owners, squatters or legal, pay a real estate tax previously known as a Hut Tax at a rate of 0.25% construction materials cost per year to the Monrovia City Council or other administrative body. House owners feel this should entitle them to something. Squatting is not regarded as an illegal act – more a necessity given that there is nowhere else for people to live. Most squatters in the Sinkor belt said that they were allowed to squat in these areas as a result of a People's Redemption Council decree after the 1980 coup.

Communities had no clear idea about how to go about looking for a new place to live – most live with or near extended relatives and need the security of the home location from which to go out to find work and make money. The survival strategies of the very poor depend on a complex interaction of reciprocal family and neighbour support and future expectations of help based on past generosity. The breaking up of communities breaks support linkages, increase vulnerability and reduces resilience to difficulties.

Communities universally stated they would resist relocation as far as possible and that they would require good relocation compensation and assistance packages to enable them to move. They stressed this meant somewhere to go, security of tenure in the new location, sufficient money to rebuild a better house and support to living while they got back on their feet.

Concerns were expressed that if the land was protected they would be forced out by wealthier people. All communities are experiencing encroachment by outsiders building and concern is expressed about the legality of these structures and whether the community will be progressively pushed out. This is a very common concern for all communities who feel their legal status is very vulnerable.

Concerns were also raised about the amenity value of the beaches and that they feared they would be excluded from the beaches for recreational use – bars, entertainment cafes, sea views, palm groves, swimming and playing on the beach as well as working on the sand. The beaches are an important location for smoking weed as there is little to no police surveillance and people are free to do as they please.

### 6.2.3 Project Positives

Communities stated that they hoped that stopping the sea flooding would be at the start of an urban renewal programme that would add roads, mains power, water and sanitation, surface water sewers etc. for drainage and improved security for residents.

Improved security was wanted to both protect residents and their property but also to prevent illegal sand mining that affects communities and increases flooding when protective sand banks are removed.

All communities wanted local youth to be offered work on the construction and for the implementing agency to ensure smaller construction firms can tender for construction.

## 7 ENVIRONMENTAL AND SOCIAL RISK ASSESSMENT AND MITIGATION

### 7.1 SOCIAL AND ENVIRONMENTAL SCREENING POLICY REQUIREMENTS

As this project is supported by UNDP in its role as a GCF Accredited Entity, it has been screened against UNDP's Social and Environmental Screening Procedure (SESP) of 2016 under the Social and Environmental Standards (SES) of 2014. These comply with the requirements of the GCF's Environmental and Social Policy as adopted in March 2018. GCF's policy is over-arching and essentially provides guidance for strong environmental and social safeguards within which accredited agencies may implement projects using its funding.

Among these safeguards, the GCF puts the responsibility for screening environmental and social risks on to the accredited agencies that prepare and propose projects for funding. The GCF's Environmental and Social Policy however requires that the risks be determined by category. Paragraph 31 of the Policy reads as follows.

*GCF will require accredited entities to assign the appropriate environmental and social risk categories to activities in a manner consistent with the accreditation framework of GCF. The categories are as follows:*

*(a) Category A. Activities with potential significant adverse environmental and/or social risks and impacts that, individually or cumulatively, are diverse, irreversible, or unprecedented;*

*(b) Category B. Activities with potential limited adverse environmental and/or social risks and impacts that individually or cumulatively, are few, generally site-specific, largely reversible, and readily addressed through mitigation measures; and*

*(c) Category C. Activities with minimal or no adverse environmental and/or social risks and/or impacts.*

The Social and Environmental Screening presented for the project deemed it to be a moderate risk (Category B) project. This position is substantiated in this section of the ESAR. Discussions on the risk and impact assessment are also provided in the Social and Environmental Screening Template, which provided the underlying rationale for the project being classified

as a moderate risk. This ESAR provides further discussion below, using the SESP checklist as part of its basis (Section 7.2).

The following sections then describe the approach to the risk assessment (Section 0) and the detailed risk assessment itself (Section 7.4). The mitigation of environmental and social risks is outlined in the assessment matrix in Section 7.4, and described in more detail in the Environmental and Social Management Plan in chapter 8.

## **7.2 UNDP'S RISK SCREENING PROCESS**

This section provides an analysis of the ways in which the project fits with the UNDP's environmental and social safeguards system, as defined in the SESP and the SES.

### **7.2.1 Question 1: How Does the Project Integrate the SES Overarching Principles in Order to Strengthen Social and Environmental Sustainability?**

The UNDP's SES defines three overarching principles with which all interventions must conform.

#### **Principle 1: Human Rights**

The project is based on protection of the rights of a number of ethnic groups that underpin much of the sustainable economy of Monrovia. These communities are located for the most part on the coastal fringes that are most vulnerable to the key impacts of climate change – sea level rise and greater storm wave energy. This position cannot be altered because the communities' main livelihoods are artisanal fishing and the associated processing and marketing. This underpins the city's food security, and as the socio-economic baseline in this ESAR shows, the number of fishermen has increased significantly in the last few years. It also supports the livelihoods of the wider communities linked to the fishing people – service providers, petty traders and other small entrepreneurs – who live among and near these communities. They include a number of vulnerable groups, particularly single-parent households and elderly people. Hence, in terms of human rights, the project will ensure that the coastal communities are made resilient in practicing their ways of life in the face of the changing climatic conditions.



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## **Principle 2: Gender Equality and Women's Empowerment**

The Monrovia artisanal fisheries are traditionally segregated into gender-based tasks. All – as far as can be determined – of the actual fishers are male. However, the fish mongers are predominantly women, and there are about three times as many of them as there are fishermen. Since the women are at the heart of the trading process, it puts them into an economically powerful position. This relatively unusual empowerment of women is something that the project will seek to perpetuate. Further than this, the project will boost the capacity of the fish mongers through a number of issues, including encouragement and support in operating associations of fish processors and fish sellers; these complement the existing male-dominated Liberian Artisanal Fishermen's Association. Beyond the artisanal fishing industry, the wider society of traders and service providers appears to display the gender split of roles and income generation that is frequently found in Liberian low-income communities. While both men and women need to gain income to survive, women are still generally the carers and providers for their families, especially children, but usually need to have their own income generation activities as well. These may be co-dependent on the activity of their menfolk, or may be independent with their own businesses or at least their own income earning strategies. Women's businesses generally need to be located near to their homes so as to maximise sales and income as well as care for families. Resilience measures to be promoted by the project will consider ways of targeting women specifically.

The project must explore opportunities for this, such as gender-targeted vocational trainings and loan schemes for alternative livelihoods. Gender-specific impacts must also be addressed by holistic awareness-raising, so that both men and women are targeted by initiatives to increase understanding and promote amelioration of human rights in general and women's rights in particular. Issues such as awareness of disease avoidance and control will also help by reducing the broad societal impacts that are prevalent from a range of serious health problems. These would typically target a range of infectious and contagious diseases that include vector-borne diseases such as malaria, typhoid and lassa, and directly communicable diseases such as HIV / AIDS and Ebola (the latter as an awareness and preventative measure).

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### Principle 3: Environmental Sustainability

The project is one of environmental sustainability. It aims at improving the resilience of the coastal environment of Monrovia against the impacts of climate change affecting it (mainly the rising sea level and increased storm wave energy) while helping to develop the security of livelihoods and access to food in ways that minimize contributing to the drivers of climate change. The project provides measures to sustain this environment on all levels, with the two aims co-mingled within the approach.

- *The physical environment will be protected* by introducing institutional management interventions and soft engineering measures, where necessary, to protect the coastal beaches from erosion.
- *The biological environment*, by enhancing the protection and management of the wetlands and mangrove ecosystems in the Mesurado River and the Saint-Paul River estuaries, which are the most important carbon stores and fish breeding grounds in the area. This improvement will be achieved through the development of capacity to regulate and beneficate the quality and integrity of these ecosystems. Also, the project particularly emphasizes land use management that restricts or even withdraws existing urban encroachment from these areas, to ensure that space is made for mangroves to migrate inland as sea level rises. This is a key nature-based component of the project that will maintain the mangroves and improve their ecology.
- *The socio-economic environment will be protected* by ensuring the sustainability of the existing long-standing, low energy, biologically and economically sustainable fishery that helps to ensure the food security of the broader coastal communities of Monrovia, through eco-based solutions that include socio-economic and institutional reforms and strategic actions coupled with soft engineering measures. These interventions will include the physical protection of the landing beaches and the settlements behind them using green infrastructure and nature-based solutions wherever possible. In the same way, settlements of the broader coastal communities, businesses and important urban infrastructure will be protected.

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## 7.2.2 Question 2: What Are the Potential Social and Environmental Risks?

The project is associated with a certain number of potential social and environmental risks that may occur even when proper mitigation measures are established. Some of these risks could be project “killers” if the mitigation is not properly designed and applied in a timely way. If these risks were to be realised without adequate mitigation, they could damage or reverse the project’s intended outcomes of environmental sustainability, and the achievements of human rights and gender balance. The main potential social and environmental risks that are associated with the project are described below.

- Even though the project aims at protecting human rights, the risk will remain of the rights of some of the stakeholders being disregarded through unintentional oversight of a vulnerable group not previously identified in the complex urban communities. This may possibly lead to conflicts or violence among the communities affected.
- Gender equality is generally poor at present, largely owing to the competition for resources. The project is intended to enhance areas where there is a pro-female balance and to equalize the balance in other areas. However, there remains a minor risk of unintended consequences.
- While it is intended to be beneficial to the natural environment, the project might cause unexpected long-term adverse impacts to the estuarine or marine habitats. Detailed studies are proposed to try to avoid this consequence.
- The project involves construction works as well as quarrying activities, during which unexpected accidents might occur and adversely affect the physical, biological or socio-economic environment, or affect the health and safety of the workforce or the community. This can happen even when all works are conducted according to best practices and standards.
- Construction works for the project’s protective measures may require a considerable amount of water, raw materials and use of energy.
- A revetment in West Point will kill the relationship between the coastal communities and the beach, because there will be hardly any beach area after the revetment has been constructed. The beaches are important locations for the leisure, sports (football) and cultural events of the poor in Monrovia.

- 141 • Some project components require institutional commitment in government and civil  
142 society, and are therefore linked to the political will and capacity of these entities. This  
143 will always come with the risk that the current government might lack the  
144 determination or economic capacity for establishing and maintaining the proposed  
145 measures. Another risk in this category is that future governments may not allocate  
146 resources for the maintenance and enforcement of the measures, which are crucial for  
147 the sustainability of the project's positive intended effects.
- 148 • The project aims at raising awareness of the importance of protecting the mangroves  
149 as a key part of realizing its intended outcomes. However, this must be recognized as  
150 being part of a long process and may not be achieved in as timely a way as needed to  
151 counter the growing impacts of climate change. Moreover, the estuaries and  
152 mangroves in Monrovia are already heavily polluted and exploited, and the existing  
153 damage to these crucial environments may prove to be too extensive for control and  
154 protection.
- 155 • The project involves the cessation of the existing sand mining which is contributing to  
156 beach erosion in Monrovia, and the provision of replacement alternative inland  
157 resources for sand extraction. However, whether adequate sand sources exist within  
158 easy reach of Monrovia remains to be determined. In addition, resistance of the  
159 construction industry to the stopping of active beach sand extraction may arise, with  
160 the result that it may still take place in some areas.
- 161 • The project also involves reforming the utilization, allocation and management of  
162 coastal land to improve resilience against coastal erosion. However, the geography of  
163 Monrovia and the pressure for land may overcome the effective viable alternatives  
164 provided by the project and prevent the existing agencies from enforcing new  
165 allocation codes in coastal and estuarine areas. In addition, land tenure in Liberia is a  
166 very complicated matter and usually a cause of disputes and trials. Land tenure  
167 arrangements proposed by the project in the marginal coastal areas may prove to be  
168 too lengthy and complicated an undertaking to be resolved during the project  
169 implementation period. Its successful outcome may therefore depend on the  
170 government's commitment to continue this process in the long term.

### **7.2.3 Question 3: What is the Level of Significance of the Potential Social and Environmental Risks?**

The project aims at enhancing the environmental and socio-economic resilience of the coastal environment of Monrovia against the climate change impacts on its coast. The potential social and environmental risks associated with the project are mostly insignificant or of minor significance (reversible, manageable and short-term), except for few risks which are considered of higher significance described in Section 7.2.2. However, given the solid mitigation approach allocated for each of the project's higher risk elements (Section 7.4), and the project's Environmental and Social Management Plan proposed in Chapter 8, the potential risks associated with the project are reduced to "low" without exception (residual risk: "minor" in the risk assessment matrix in Section 7.4).

### **7.2.4 Question 4: What is the Overall Social and Environmental Risk Categorization of the Project?**

The project is one of social and environmental sustainability. However, associated with it are a certain number of risks and residual risks as discussed above. None of these should result in significant adverse social or environmental impacts or involve major displacement or resettlement. The project is not expected to affect any indigenous group or cultural heritage. It is not expected to affect critical habitats or produce considerable amounts of greenhouse gas emissions. The project is therefore considered to be of "Moderate Risk".

### **7.2.5 Question 5: Based on the Identified Risks and Project Risk Categorization, What Requirements of the SES are Relevant?**

The requirements of the SES that are most relevant to the project are as follows.

- The early inclusion and participation of affected stakeholders and the consideration of the human rights concerns of all affected communities, groups and individuals.
- The full participation of women in all decision making and the strengthening of women's position and influence in the affected communities.
- The enhancement of the project's environmental sustainability. This will be achieved through giving special consideration to:

- Biodiversity conservation and the sustainable management of natural resources (SES Standard 1);
- Community and occupational health and safety (SES Standard 3); and
- Pollution prevention and efficient use of resources (SES Standard 7).

#### **7.2.6 Question 6: What is the Level of Social and Environmental Assessment and Management Required to Address Potential Impacts and Risks (for Moderate and High Risk Projects)?**

According to national legislation, the project falls in the category of actions requiring the preparation of an ESIA (project listed in Annex 1 of the Environmental Protection and Management Law- see section 4.1.3 in Chapter 4). An ESIA will therefore be required.

For this reason, included in the ESMP are recommendations for undertaking a number of additional surveys and preparing additional detailed plans prior to the commencement of the project, which would typically be part of the ESIA. These surveys and plans are crucial to ensure that the project's potential impacts are reversible.

Detailed ESIA Surveys:

1. Marine and Estuarine Biological Survey;
2. Marine and Estuarine Sediment Survey;
3. Household Survey of Affected Communities; and
4. Fish Landing Survey (linked to 1 and 3 above).

Detailed ESMP Sub-plans:

1. Contractors' Oil Spill Response Plan (OSRP) for land and sea, including Marine Spill Contingency Plan;
2. Contractors' Emergency Response Plan;
3. Contractors' Rock Quarry Management Plan, including Blasting Plan;
4. Resettlement Action Plan for Affected Livelihoods (if the ESIA shows this to be required); and
5. Grievance Redress Mechanism.

Because of the need for these additional requirements, it is recommended that this ESAR be upgraded to a full ESIA that incorporates their findings and provides an updated ESMP; that

would include revised mitigation actions which are informed by the results of the surveys, as well as the additional sub-plans. This strategy will ensure compliance with national legislation.

## 7.2.7 Relevant Triggers from the UNDP Safeguards

The position of the project relative to the UNDP safeguards is explained in Table 7-1.

**Table 7-1 Analysis of the project's position relative to UNDP safeguards**

Standard	Triggered (Yes/No)	Reason
<b>Standard 1</b> Biodiversity Conservation and Sustainable Natural Resource Management	Yes	The project is working in a range of habitats, especially coastal, estuarine, mangrove and marine environments and involves excavation works resource extraction activities (namely terrestrial aggregate and rock quarrying).
<b>Standard 2</b> Climate Change Mitigation and Adaptation	Yes	During implementation, the project may result in a slight increase of GHG from increased traffic and construction machinery.
<b>Standard 3</b> Community Health, Safety and Working Conditions	Yes	The project includes construction works and quarrying which carry risks to the employees' health and safety. Construction activities will take place close to populated areas.
<b>Standard 4</b> Cultural Heritage	Yes	Standard 4 is triggered for precautionary reasons since the project includes construction and quarrying activities, and it is possible that these might give rise to unexpected impacts on cultural features.
<b>Standard 5</b> Displacement and Resettlement	No	The project does not involve significant physical or economic displacement. The revetment has been designed so that it is seaward of all existing houses, the existing road network and then the beach will be used for construction access, alternate boat storage and water access will be provided for fishers – the requirements for this have been discussed with local users..
<b>Standard 6</b> Indigenous Peoples	No	There are no groups qualifying as indigenous peoples in the project area under either national or international definitions.
<b>Standard 7</b> Pollution Prevention and Resource Efficiency	Yes	The project involves the use of water, energy, sand and rocks among other resources. Construction works and, quarrying could result in the release of contaminants to the environment. The project will also produce certain waste streams, which include small amounts of hazardous waste.



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### 7.3 RISK ASSESSMENT METHODOLOGY

The methodology adopted in this ESAR uses the UNDP's general, international risk assessment procedure, but enhanced by Earthtime's risk assessment system, which has been developed for use specifically in Liberia. This has the advantage of ensuring that the higher level and more general risks outlined in UNDP's framework are addressed, as well as the project-related, site-specific issues for which the Earthtime system was designed. It ensures that the needs of the Liberian Environmental Protection Agency (EPA) are fully addressed as well as the requirements of the UNDP and its donor partners.

Risks are assessed for significance of impact and likelihood of occurrence. This is a simple but effective way of assessing risk by answering the two key questions:

- What are the risks?
- How bad are the effects of the risks likely to be if they come about?
- How likely are they to happen?

These together give an indication of the importance of addressing the issue, and the prioritisation of resources. The fourth, related key question – What should be done about them? – is frequently addressed only in the risk control and management part of a report. In the Earthtime system, it is outlined as part of the risk assessment itself. This allows the likely residual risk to be assessed after mitigation measures have been applied. This means that the risk assessment matrix in section 7.4 contains two separate assessments of risk: the initial risk if an activity is allowed to happen with no safeguards; and the remaining risk if appropriate mitigation measures are implemented to agreed standards.

Significance is rated according to the severity of the risk. The various classes shown in Table 7-2 are determined by how serious an incident will be if the risk occurs. The UNDP's SESP gives guidance terms on the likely impact of the risk (critical, severe, moderate, minor, negligible), and Earthtime uses similar terms (severe, serious, limited, no risk). For example, with safety risks, a fatality would be critical or severe, a major injury severe or serious and a small injury minor or limited. At this stage the "no risk" class is not used in the assessment, because current non-risk issues are not listed; but this class would be used in a future update of the risk assessment, where effective control measures have been introduced that remove

263 the original risk. The Earthtime definitions and potential examples show real-life cases from  
264 Liberia, and are provided alongside the UNDP's definitions to help root the risk assessment  
265 in the Liberian context.

The likelihood of a risk occurring is based on the probability. This is grouped into simple chance percentages in the Earthtime risk assessment methodology with general terms (very likely, likely, quite likely, unlikely, very unlikely), and accompanied by definitions and examples of situations where there appears to be the given probability of the risk happening; again, these are specific to the Liberian operating context. The UNDP's SESP assesses the probability more qualitatively (expected, highly likely, moderately likely, not likely). These are shown comparatively in Table 7-3.

266 The UNDP system uses a simple matrix to determine a final category of combined risk, by  
267 plotting impact against probability into one of three categories: low, moderate or high. This is  
268 shown in Table 7-4, and is the system adopted in section 7.4 to ensure that the ESAR is fully  
269 compliant with UNDP's risk assessment process: this is what is shown in the  
270 "impact/probability" column of the risk assessment matrix in section 7.4.

271 Table 7-2 Combined UNDP and Earthtime risk significance definitions and typical examples

Significance or Impact	UNDP definition	Earthtime definition	Potential examples
<b>UNDP</b> <b>5. Critical</b>  <i>Earthtime</i> <b>A. Severe</b>	<p>Significant adverse impacts on human populations and/or environment. Adverse impacts high in magnitude and/or spatial extent (e.g. large geographic area, large number of people, transboundary impacts, cumulative impacts) and duration (e.g. long-term, permanent and/or irreversible); areas impacted include areas of high value and sensitivity (e.g. valuable ecosystems, critical habitats); adverse impacts to rights, lands, resources and territories of indigenous peoples; involve significant displacement or resettlement; generates significant quantities of greenhouse gas emissions; impacts may give rise to significant social conflict</p>	<p>Serious incident causing widespread pollution or other damage. One or more of:</p> <ul style="list-style-type: none"> <li>• Widespread damage to soil (more than 0.5 hectare).</li> <li>• Pollution of a river that renders it toxicologically unfit for drinking water or fishing until rectified.</li> <li>• Widespread smothering of land, swamps and water courses with sediment (more than 0.5 hectare).</li> <li>• Significant loss of plant or animal life (more than 100 trees or small animals killed; proportionate for grassland and insects).</li> <li>• Anything attributable to the death of a person through any form of workplace or project site injury, accident, smothering, drowning, poisoning, burning, asphyxiation or other cause.</li> </ul>	<p>Fuel tanker overturns or falls into a river. Major outflow of sediment due to failure of sediment controls at a quarry site. Major fire in a protected forest area. Death of a worker or member of the public run over by a project machine.</p>
<b>UNDP</b> <b>4. Severe</b>  <i>Earthtime</i> <b>B. Serious</b>	<p>Adverse impacts on people and/or environment of medium to large magnitude, spatial extent and duration more limited than critical (e.g. predictable, mostly temporary, reversible). The potential risk impacts of projects that may affect the human rights, lands, natural resources, territories, and traditional livelihoods of indigenous peoples are to be considered at a minimum potentially severe.</p>	<p>Significant incident causing localised pollution or other damage. One or more of:</p> <ul style="list-style-type: none"> <li>• Damage to soil (between 50 m<sup>2</sup> and 0.5 hectare).</li> <li>• Pollution of a river that renders it toxicologically unfit for drinking water for a period not exceeding 24 hours.</li> <li>• Pollution of a lake, swamp or the sea that renders it potentially toxicologically unfit for fishing so that fishing has to be suspended until tests prove otherwise.</li> <li>• Smothering of land, swamps and water courses with sediment (between 50 m<sup>2</sup> and 0.5 hectare).</li> <li>• Loss of plant or animal life (less than 100 trees or small animals killed, proportionate for grassland and insects).</li> <li>• Anything attributable to the injury or illness of a person through any form of workplace or project site injury, accident, smothering, drowning, poisoning, burning, asphyxiation or other cause.</li> </ul>	<p>Bad fuel spillage from machine. Diesel drums leak into a village water supply but no one consumes the water. Outflow of sediment from earthworks due to inadequate containment. Unnecessary clearance of land beyond agreed site boundaries. A worker breaks a leg by falling off a working site.</p>

Significance or Impact	UNDP definition	Earthtime definition	Potential examples
<b>UNDP</b> <b>3. Moderate and 2. Minor</b>  <i>Earthtime</i> <b>C. Limited</b>	<p>Moderate: Impacts of low magnitude, limited in scale (site-specific) and duration (temporary), can be avoided, managed and/or mitigated with relatively uncomplicated accepted measures.</p> <p>Minor: Very limited impacts in terms of magnitude (e.g. small affected area, very low number of people affected) and duration (short), may be easily avoided, managed, mitigated.</p>	<p>Lapses causing short term damage that can be easily rectified. One or more of:</p> <ul style="list-style-type: none"> <li>• Damage to soil (less than 50 m<sup>2</sup>).</li> <li>• No pollution of a river, lake, swamp or the sea other than fine suspended sediment (fine silt- or clay-sized).</li> <li>• Smothering of land, swamps and water courses with sediment (less than 50 m<sup>2</sup>).</li> <li>• No loss of plant or animal life (excluding minor damage to grass and insects).</li> <li>• Nothing attributable to the injury or illness of a person in relation to any aspect of project activities.</li> </ul>	<p>Small fuel spill or damaged sump leading to oil spill into soil.</p> <p>Limited sediment damage due to unmaintained sediment ponds.</p>
<b>UNDP</b> <b>1. Negligible</b>  <i>Earthtime</i> <b>D. No risk</b>	<p>Negligible or no adverse impacts on communities, individuals, and/or environment</p>	<p>Everything is as it should be. There is no risk; or lapses that were previously in one of categories 1 to 3 have now been completely resolved.</p>	<p>Any area of work where activities comply with the standards.</p>
<b>N.A.</b>		Not applicable: no risk is current in this area of work.	

272 Table 7-3 UNDP and Earthtime risk likelihoods, with probabilities, definitions and examples

Likelihood	Probability	Definition	Potential example
UNDP 5. Expected  <i>Earthtime Very likely</i>	81 to 100%	It is very likely – almost inevitable – that the problem will occur during the project period because there are no avoidance measures and the risk is present almost every day. In some cases, this category is also use for risks that have already occurred.	An accident at a construction or quarry site where it is found that local people walk through the middle of the working area with no controls.
UNDP 4. Highly likely  <i>Earthtime Likely</i>	61 to 80%	The problem is likely to occur during the project period because avoidance measures are weak, and the risk is constant or recurs frequently.	Sediment pollution in a river close to an earthwork site where there are no erosion control measures.
UNDP 3. Moderately likely  <i>Earthtime Quite likely</i>	41 to 60%	The scale of the problem is such that it may well occur even when avoidance measures are in place most of the time.	A worker inhales excessive amounts of dust during dry season earthworks.
UNDP 2. Not likely  <i>Earthtime Unlikely</i>	21 to 40%	The problem is unlikely to occur, or avoidance measures are in place but not always completely effective.	Diesel is spilt from a filling point despite the fact that procedures are normally followed by staff and workers.
UNDP 1. Slight  <i>Earthtime Very unlikely</i>	0 to 20%	It is very unlikely that the problem will occur because avoidance measures are excellent, or conditions are such that the risk occurs only very occasionally.	Noise pollution to communities from a quarry site that is at least 1 km from the nearest settlement.

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Table 7-4 UNDP risk matrix

Impact	5					
	4					
	3					
	2					
	1					
		1	2	3	4	5
Probability						
Green = Low, Yellow = Moderate, Red = High						

As stated above, the risk assessment process covers three main questions, but with a fourth question generated that is dealt with in the risk management and mitigation section of the ESAR:

1. What are the risks?
2. How bad are the effects of the risks likely to be if they come about?
3. How likely are they to happen?
4. What should be done about them?

By providing an initial assessment of the risk mitigation approach, it is possible to demonstrate in the risk assessment matrix whether the anticipated impacts of the risks can be mitigated or not. This in turn helps to determine the risk category of the project, since the reversibility of the impacts is a key determinant between Category A and Category B projects. In respect of this project, the UNDP is not mandated to implement Category A projects, and therefore if the risk is scored high in the impact/probability matrix and even after mitigation is still likely to be high, then it may affect the risk categorisation of the project and make it unsupportable. For transparency, therefore, the residual risk is recorded in the assessment matrix (Section 7.4) rather than being left as an assumption in the risk management and mitigation system (chapter 8).

The residual risk is given in terms of magnitude (large, medium, small, negligible) and sensitivity (low, moderate, high). Sensitivity is mostly hard to quantify, and so is mainly based on the professional judgement of the environmental and social specialists compiling this ESAR. It covers environmental receptors and resources, incorporating aspects such as their relative abundance, quality and regenerative capacity; and the apparent absorptive capacity of the environment to accommodate limited impacts without a significant loss of value or sustainability.

The resulting residual risk significance matrix is given in Table 7-5. It uses a simple assignation of the parameters listed above into four classes of significance (major, moderate, minor, insignificant).

Table 7-5 Earthtime residual risk significance matrix

	Significance of residual risk	Sensitivity		
		Low	Moderate	High
Magnitude of impact	Large	Moderate	Major	Major
	Medium	Minor	Moderate	Major
	Small	Insignificant	Minor	Moderate
	Negligible	Insignificant	Insignificant	Insignificant

It should be noted that because UNDP's risk matrix classifies impact level and probability into only three categories, it means that each of these groups is broad. Consequently, when compared with the residual risk, the colour coding does not always show a reduction as a result of mitigation. This is particularly true where the assessed risk is at a high point in the "Moderate" category (showing as yellow in Section 7.4) but with mitigation is expected still to have minor residual impacts (also showing as yellow in Section 7.4). This is a limitation in the use of a small number of colours to denote change for a rapid visual impression from the tables.

## 7.4 ENVIRONMENTAL AND SOCIAL RISK ASSESSMENT MATRIX

The environmental and social risk assessment matrix (Table 7-6) provides a combination of both the UNDP's high level view and Earthtime's country- and site-specific view, as described above. It also provides an outline of the mitigation approach that is taken forward either as part of project design or against a potential impact identified and listed in the Environmental and Social Management and Mitigation Plan (chapter 8 of this ESAR), allowing an assessment of the residual risk after mitigation to be shown: this demonstrates whether a risk can be controlled or not. The linkages between the risk assessment matrix and the impacts in the Environmental and Social Management and Monitoring Matrix (ESMMM) (Table 8-2) are shown in the "Corresponding Impact No." column on the right hand side of Table 7-6.



321 Table 7-6 Environmental and social risk assessment matrix

Ref.	Risk or Hazard	Assessment Summary	Impact / Probability	Outline Mitigation Approach	Residual Risk	Corresponding Impact No.
<b>1.</b>	<b>Human Rights (UNDP Principle 1)</b>					
1.1	Project leads to adverse impacts on enjoyment of the human rights (civil, political, economic, social or cultural) of the affected population and particularly of marginalized groups.	<ul style="list-style-type: none"> <li>The project is designed to promote the civil rights of the people affected, by ensuring that they can continue to pursue their livelihoods in areas threatened by the impacts of climate change.</li> </ul>	1/1	<ul style="list-style-type: none"> <li>The Environmental and Social Management and Monitoring Matrix (ESMMM) will include monitoring measures to ensure that benefits for its intended target groups are not diverted during implementation.</li> </ul>	Insignificant	ESMMM impacts 2.1-2.10, 5.2 and 5.8
1.2	Project has inequitable or discriminatory adverse impacts on affected populations, particularly people living in poverty or marginalized or excluded individuals or groups.	<ul style="list-style-type: none"> <li>The project specifically targets a number of poor and vulnerable communities and seeks to help safeguard their livelihoods.</li> </ul>	1/1	<ul style="list-style-type: none"> <li>The ESMMM will contain provisions to ensure the equitable sharing of project benefits, and monitoring measures to ensure that this is achieved.</li> </ul>	Insignificant	ESMMM impacts 2.1-2.5, -2.10, 5.2-5.3 and 5.8
1.3	Project could restrict availability, quality of and access to resources or basic services, in particular to marginalized individuals or groups.	<ul style="list-style-type: none"> <li>The project specifically intends to maintain access to resources and in this respect targets a number of poor and vulnerable communities, seeking to help safeguard their livelihoods.</li> <li>However, the availability, quality or access to the fisheries resources may be temporarily limited during the implementation of the project's protective measures if adequate mitigation measures are not established.</li> </ul>	2/1	<ul style="list-style-type: none"> <li>The ESMMM will contain provisions to ensure the equitable sharing of resources despite possible inadvertent project impacts, and monitoring measures to ensure that this is achieved.</li> </ul>	Insignificant	ESMMM impacts 1.1-1.2, , 2.9-2.10, 6.1-6.2, 7.1-7.7, 8.1-8.12, 10.1-10.5, 12.1 and 13.1-13.3
1.4	Project might exclude any potentially affected stakeholders, in particular marginalized groups, from fully participating in decisions that may affect them.	<ul style="list-style-type: none"> <li>Significant focussed stakeholder engagement has been undertaken, aiming to get a high level of representation from all parts of the local society.</li> </ul>	3/2	<ul style="list-style-type: none"> <li>The ESMMM will contain an integral stakeholder engagement plan to ensure that exclusion is minimised.</li> <li>The ESMMM will contain detailed provisions and monitoring systems to ensure full participation to the greatest extent possible.</li> </ul>	Insignificant	ESMMM impacts 2.1-2.5

Ref.	Risk or Hazard	Assessment Summary	Impact / Probability	Outline Mitigation Approach	Residual Risk	Corresponding Impact No.
1.5	Duty-bearers do not have the capacity to meet their obligations in the Project.	<ul style="list-style-type: none"> <li>Among the project's target governmental and non-governmental entities, capacity limitations have been identified.</li> </ul>	3/4	<ul style="list-style-type: none"> <li>The project's proposed adaptive measures include significant capacity development initiatives, aimed at a number of national and local institutions.</li> </ul>	Insignificant	Project design
1.6	Rights-holders do not have the capacity to claim their rights.	<ul style="list-style-type: none"> <li>Significant focussed stakeholder engagement has been undertaken, aiming to ensure that all parts of the local society are enabled to exercise their rights.</li> </ul>	3/2	<ul style="list-style-type: none"> <li>The ESMMM will contain an integral stakeholder engagement plan to ensure that all rights are addressed.</li> <li>The ESMMM will contain detailed provisions and monitoring systems to ensure the exercise of rights to the greatest extent possible.</li> </ul>	Insignificant	ESMMM impacts 2.1-2.5
1.7	Human rights concerns regarding the Project raised by local communities or individuals, given the opportunity, during the stakeholder engagement process.	<ul style="list-style-type: none"> <li>Human rights issues have been widely raised during stakeholder engagement and taken into account in project design.</li> <li>Most human rights issues relate to the expectation for people to continue living and deriving livelihoods in coastal areas threatened by the impacts of climate change.</li> </ul>	3/4	<ul style="list-style-type: none"> <li>Project design incorporates the demands of affected communities for their rights to remain in marginal areas as key elements.</li> <li>Project execution will endeavour to address all of these issues, but expectations are high and the impacts of climate change not yet fully understood.</li> </ul>	Minor	Project design
1.8	Project would exacerbate conflicts among and/or the risk of violence to project-affected communities and individuals.	<ul style="list-style-type: none"> <li>The project's target communities are poor and confined to marginal spatial areas. Hence there are already conflicts and occasional violence.</li> <li>The project is intended to alleviate the situation giving rise to localised conflict and violence.</li> </ul>	3/4	<ul style="list-style-type: none"> <li>Project design incorporates the main deprivation issues of affected communities in marginal areas.</li> <li>Project execution will endeavour to address all of these issues, but the constraints are serious and the impacts of climate change not yet fully understood.</li> </ul>	Minor	Project design

Ref.	Risk or Hazard	Assessment Summary	Impact / Probability	Outline Mitigation Approach	Residual Risk	Corresponding Impact No.
<b>2.</b>	<b>Gender Equality and Women's Empowerment (UNDP Principle 2):</b>					
2.1	Project has adverse impacts on gender equality and/or the situation of women and girls.	<ul style="list-style-type: none"> <li>At present, the significant pressure for limited resources means that gender equality is poor.</li> <li>The division of livelihoods in the main target communities means that the project is able to provide specific targeted interventions to alleviate the position of women and girls in society.</li> </ul>	3/3	<ul style="list-style-type: none"> <li>Project designs must require the full participation of women in all decision making.</li> <li>Specific initiatives must be included in the project that strengthen the position and influence of women.</li> </ul>	Minor	Project design
2.2	Project could reproduce discriminations against women based on gender, especially regarding participation in design and implementation or access to opportunities and benefits.	<ul style="list-style-type: none"> <li>Stakeholder discussions have ensured that women have been given strong voice in project design.</li> <li>Specific measures are included in the project to help strengthen the involvement of women in implementation.</li> <li>However, the significant pressure for limited resources means that intended benefits may be diverted.</li> </ul>	4/2	<ul style="list-style-type: none"> <li>Project designs must require the full participation of women in all decision making.</li> <li>Specific initiatives must be included in the project that strengthen the position and influence of women.</li> </ul>	Insignificant	Project design
2.3	Gender equality concerns regarding the Project raised by women's groups/leaders, given the opportunity, during the stakeholder engagement process.	<ul style="list-style-type: none"> <li>A wide range of women's rights issues have been raised during stakeholder engagement.</li> <li>Traditional segregation of tasks in the fisheries gives a strong entry point for project interventions.</li> <li>Nevertheless, it is clear that the project needs to move beyond traditional systems to help improve gender equality.</li> </ul>	3/4	<ul style="list-style-type: none"> <li>Capacity development of women, starting through their traditional roles and organisations as the intermediaries in the fishing industry, provides the entry point.</li> <li>Building on this, the project will embed gender equality in all of its activities.</li> </ul>	Insignificant	Project design

Ref.	Risk or Hazard	Assessment Summary	Impact / Probability	Outline Mitigation Approach	Residual Risk	Corresponding Impact No.
2.4	Project could limit women's ability to use, develop and protect natural resources, taking into account different roles and positions of women and men in accessing environmental goods and services.	<ul style="list-style-type: none"> <li>The project aims to ensure the sustainability of natural resource utilisation, with the role of women in this particularly highlighted and enhanced.</li> <li>However, implementation of project's protective measures may temporarily reduce fisheries productivity and limit the access of fish mongers (predominantly women) to fisheries products.</li> </ul>	3/3	<ul style="list-style-type: none"> <li>The strengthening of women's positions as the key intermediaries in fish handling, processing and marketing is intended to ensure that women have a stronger voice in natural resource management and sustainability.</li> </ul>	Insignificant	Project design
<b>3.</b>	<b>Environmental Sustainability (UNDP Principle 3)</b>					
<b>3.1</b>	<b>Standard 1: Biodiversity Conservation and Sustainable Natural Resource Management</b>					
3.1.1	Project might cause adverse impacts to habitats (e.g. modified, natural, and critical habitats) and/or ecosystems and ecosystem services (e.g. through habitat loss, conversion or degradation, fragmentation, hydrological changes).	<ul style="list-style-type: none"> <li>The project is working in a range of habitats, but especially estuarine mangrove and coastal environments.</li> <li>The project is intended to be beneficial to the natural and human environments, but unexpected consequences may occur.</li> </ul>	4/2	<ul style="list-style-type: none"> <li>The ESMMM must incorporate safeguards for all potentially affected habitats (terrestrial, estuarine and marine).</li> <li>Estuarine habitats require further research under the project as a basis for interventions.</li> <li>Biological surveys must be conducted in the potential disturbance areas prior to the commencement of any construction activities, and areas of high biological density or diversity must be avoided.</li> <li>Biological surveys must be conducted in the potential quarrying areas as to avoid, or minimize, impacts on fauna and flora.</li> </ul>	Minor	ESMMM impacts, -, 10.7, -10.1, 10.2 and 10.4

Ref.	Risk or Hazard	Assessment Summary	Impact / Probability	Outline Mitigation Approach	Residual Risk	Corresponding Impact No.
3.1.2	Project activities are proposed within or adjacent to critical habitats and/or environmentally sensitive areas, including legally protected areas (e.g. nature reserve, national park), areas proposed for protection, or recognized as such by authoritative sources and/or indigenous peoples or local communities.	<ul style="list-style-type: none"> <li>There are no known critical habitats within or in the direct vicinity of the project areas.</li> <li>No project activities are proposed in protected areas, but the Mesurado Wetland area which is a designated Ramsar site, lies approximately 2-3 km from coastal section 3 (West Point) and is connected to the project area through the Mesurado River.</li> <li>The project is intended to have a beneficial impact on environmentally sensitive mangroves, including the Mesurado Wetland mangroves.</li> </ul>	3/2	<ul style="list-style-type: none"> <li>The ESMMM must incorporate safeguards for all potentially affected habitats (terrestrial, estuarine and marine).</li> <li>Estuarine habitats require further research under the project as a basis for interventions.</li> <li>No quarrying will take place in or near critical habitats.</li> </ul>	Insignificant	ESMMM impacts -, , 10.1-10.2 and 10.4
3.1.3	Project involves changes to the use of lands and resources that may have adverse impacts on habitats, ecosystems, and/or livelihoods.	<ul style="list-style-type: none"> <li>The project is intended to have a beneficial impact on environmentally sensitive mangroves.</li> <li>The project will have limited physical impacts on the overall marine environment.</li> <li>However, impacts on specific areas of the coast, such as the inlet of the Mesurado estuary, could be locally significant if interventions are not specifically designed according to the prevailing dynamic processes.</li> <li>Some protective measures proposed, such as revetments, may limit the existing recreational use of beaches by the local communities.</li> </ul>	3/3	<ul style="list-style-type: none"> <li>The design of the project's interventions takes into account the likely coastal process reactions that will result from the construction of physical interventions.</li> <li>The ESMMM must incorporate safeguards for all potentially affected habitats (terrestrial, estuarine and marine).</li> <li>Estuarine habitats require further research under the project as a basis for interventions.</li> <li>The ESMMM must include measures to mitigate the impacts of proposed measures on the use of land and provide alternatives to maintain affected activities.</li> </ul>	Minor	ESMMM impacts 2.9-2.10, 10.1,- 10.1, 10.2 and 10.4

Ref.	Risk or Hazard	Assessment Summary	Impact / Probability	Outline Mitigation Approach	Residual Risk	Corresponding Impact No.
3.1.4	Project activities pose risks to endangered species.	<ul style="list-style-type: none"> <li>No endangered species have been detected in the project construction areas during the preparation of the ESAR.</li> <li>However, endangered species such as the African Sharp-Nosed Crocodile, the Red Colobus Monkey and the West African Manatee are expected to live in the Mesurado Wetland, 2-3 km inland from coastal section 3 (West Point).</li> <li>The project includes interventions to assess and regulate fisheries catches, which include some endangered species such as Cassava Croakers, some shark and ray species, as well as sea turtles and marine mammals such as the Sei Whale, the Blue Whale and the Atlantic Humpback Dolphin.</li> </ul>	2/3	<ul style="list-style-type: none"> <li>Project design must include the recording of all fish and other marine species encountered by Monrovia fishermen.</li> <li>Guidelines for the release of endangered bycatch species (e.g. marine turtles and hammerhead sharks) must be agreed with the fishermen.</li> <li>The ESMMM must include strict provisions on quarrying activities as to avoid any potential impact on endangered species.</li> </ul>	Insignificant	<p>Project design</p> <p>ESMMM impacts 10.1- and 10.5</p>
3.1.5	Project poses a risk of introducing invasive alien species.	<ul style="list-style-type: none"> <li>No route can be envisaged by which the project would introduce terrestrial invasive alien species.</li> </ul>	3/1	<ul style="list-style-type: none"> <li>No mitigation required.</li> </ul>	Insignificant	Not applicable
3.1.6	Project involves the transfer, handling or use of genetically modified organisms/living modified organisms that result from modern biotechnology and that may have an adverse effect on biodiversity?	<ul style="list-style-type: none"> <li>The project does not involve any of these activities.</li> </ul>	Not applicable	<ul style="list-style-type: none"> <li>No mitigation required.</li> </ul>	Not applicable	Not applicable
3.1.7	Project involves harvesting of natural forests, plantation development, or reforestation.	<ul style="list-style-type: none"> <li>The project does not involve any of these activities.</li> </ul>	Not applicable	<ul style="list-style-type: none"> <li>No mitigation required.</li> </ul>	Not applicable	Not applicable

Ref.	Risk or Hazard	Assessment Summary	Impact / Probability	Outline Mitigation Approach	Residual Risk	Corresponding Impact No.
3.1.8	Project involves the production and/or harvesting of livestock or aquatic species.	<ul style="list-style-type: none"> <li>The harvesting of fish from the inshore coastal area is one of the key focal areas of the project.</li> <li>The fishery is a low carbon industry and a key provider for the food security of Monrovia.</li> <li>The project's intention is to ensure that the fishery remains sustainable and based on low carbon technology.</li> </ul>	3/5	<ul style="list-style-type: none"> <li>Project design must address all aspects of research, capacity building and regulation in ensuring that the Monrovia fishery remains sustainable and continues to utilise low carbon output technologies.</li> </ul>	Insignificant	Project design
3.1.9	Project involves significant extraction, diversion or containment of surface or ground water.	<ul style="list-style-type: none"> <li>The project does not involve any of these activities.</li> </ul>	Not applicable	<ul style="list-style-type: none"> <li>No mitigation required.</li> </ul>	Not applicable	Not applicable
3.1.10	Project involves utilization of genetic resources? (e.g. collection and/or harvesting, commercial development)	<ul style="list-style-type: none"> <li>The project does not involve any of these activities.</li> </ul>	Not applicable	<ul style="list-style-type: none"> <li>No mitigation required.</li> </ul>	Not applicable	Not applicable
3.1.11	Project generates potential adverse transboundary or global environmental concerns.	<ul style="list-style-type: none"> <li>The project is not on a scale to risk this happening. Marine influences are all well within territorial waters.</li> </ul>	Not applicable	<ul style="list-style-type: none"> <li>No mitigation required.</li> </ul>	Not applicable	Not applicable
3.1.12	Project results in secondary or consequential development activities which could lead to adverse social and environmental effects, or would generate cumulative impacts with other known existing or planned activities in the area.	<ul style="list-style-type: none"> <li>The project aims to stop encroachment into the coastal mangroves, possibly displacing future development from these environmentally sensitive areas to less sensitive areas in the hinterland.</li> <li>A number of other consequential issues are possible.</li> </ul>	3/3	<ul style="list-style-type: none"> <li>Project design must ensure that the required knowledge acquisition, capacity building and enforcement are put in place to mitigate consequential impacts.</li> </ul>	Insignificant	Project design

Ref.	Risk or Hazard	Assessment Summary	Impact / Probability	Outline Mitigation Approach	Residual Risk	Corresponding Impact No.
<b>3.2</b>	<b>Standard 2: Climate Change Mitigation and Adaptation</b>					
3.21	Project results in significant greenhouse gas emissions or may exacerbate climate change.	<ul style="list-style-type: none"> <li>The project promotes low emissions options for sustainable livelihoods.</li> <li>The project is a response to the impacts of climate change and aims to mitigate these rather than to enhance them.</li> <li>During implementation, the project may result in a slight increase of greenhouse gases (GHG) in the area from increased traffic and construction machineries.</li> </ul>	1/3	<ul style="list-style-type: none"> <li>Project design must address all aspects of research, capacity building and regulation in ensuring that the Monrovia fishery remains sustainable and continues to utilise low carbon output technologies.</li> <li>ESMMM must include adequate measures on minimizing GHG emissions during implementation.</li> </ul>	Insignificant	Project design  ESMMM impacts 3.4-3.5 and 9.1-9.2,
3.22	Outcomes of the Project may be sensitive or vulnerable to potential impacts of climate change.	<ul style="list-style-type: none"> <li>The project is designed to alleviate the impacts of climate change. Hence it is resilient to climate change impacts by design.</li> </ul>	3/1	<ul style="list-style-type: none"> <li>Project design must encompass all possible impacts of climate change.</li> </ul>	Insignificant	Project design
3.23	Project may be likely to directly or indirectly increase social and environmental vulnerability to climate change now or in the future (also known as maladaptive practices).	<ul style="list-style-type: none"> <li>The project is designed to alleviate the impacts of climate change. It is being undertaken specifically to reduce vulnerability to climate change.</li> </ul>	3/1	<ul style="list-style-type: none"> <li>Project design must ensure that all aspects of vulnerability to climate change are addressed.</li> </ul>	Insignificant	Project design
<b>3.3</b>	<b>Standard 3: Community Health, Safety and Working Conditions</b>					
3.31	Elements of Project construction, operation, or decommissioning pose potential safety risks to local communities.	<ul style="list-style-type: none"> <li>Some project construction works will be undertaken close to communities and pose a potential risk to local people.</li> </ul>	2/4	<ul style="list-style-type: none"> <li>Strong adherence to standard construction site processes of work segregation from public access, traffic safety measures, and standard health and safety practices.</li> </ul>	Insignificant	ESMMM impacts 3.1-3.10
3.32	Project poses potential risks to community health and safety due to the transport, storage, and use and/or disposal of hazardous or dangerous materials (e.g. explosives, fuel and other chemicals during construction and operation).	<ul style="list-style-type: none"> <li>Construction works will utilise standard diesel fuel and hydrocarbon lubricants.</li> <li>Explosives may be used at quarry sites distant from the project area to obtain rock.</li> </ul>	3/4	<ul style="list-style-type: none"> <li>Specific provisions for hydrocarbon management will be included in the ESMMM.</li> <li>Specific provisions for quarry management will be included in the ESMMM.</li> </ul>	Insignificant	ESMMM impacts 3.2-3.3, 8.11, 12.2 and 13.1-13.3



Ref.	Risk or Hazard	Assessment Summary	Impact / Probability	Outline Mitigation Approach	Residual Risk	Corresponding Impact No.
3.33	Project involves large-scale infrastructure development (e.g. dams, roads, buildings).	<ul style="list-style-type: none"> <li>Project involves some coastal protection measures that include elements of physical construction.</li> </ul>	3/3	<ul style="list-style-type: none"> <li>Designs will ensure that environmental and social impacts are minimised to the greatest extents possible.</li> </ul>	Minor	Engineering specifications
3.34	Failure of structural elements of the Project poses risks to communities (e.g. collapse of buildings or infrastructure).	<ul style="list-style-type: none"> <li>Structural elements will all be related to coastal protection works. Hence any failures are not intrinsically dangerous, but might cause the situation to revert to the "without project" scenario.</li> </ul>	3/2	<ul style="list-style-type: none"> <li>Designs will ensure that structures are adequate for their purposes.</li> </ul>	Insignificant	Engineering specifications
3.35	Project is susceptible to or leads to increased vulnerability to earthquakes, subsidence, landslides, erosion, flooding or extreme climatic conditions.	<ul style="list-style-type: none"> <li>The project is one of adaptation and protection against the impacts of climate change, and hence is designed to be resilient to extreme climatic conditions.</li> <li>Other natural hazards are not applicable to this project.</li> </ul>	2/2	<ul style="list-style-type: none"> <li>Designs will ensure that structures are sufficiently resilient.</li> </ul>	Insignificant	Engineering specifications
3.36	Project results in potential increased health risks (e.g. from water-borne or other vector-borne diseases or communicable infections such as HIV/AIDS).	<ul style="list-style-type: none"> <li>These risks already exist in the project areas but will not be increased as a result of the project.</li> </ul>	1/1	<ul style="list-style-type: none"> <li>ESMMM will contain provision for awareness-raising measures on health risks as a matter of standard good practice.</li> </ul>	Insignificant	ESMMM impacts 2.6, 3.1-3.5 and 3.9-3.10
3.37	Project poses potential risks and vulnerabilities related to occupational health and safety due to physical, chemical, biological, and radiological hazards during Project construction, operation, or decommissioning.	<ul style="list-style-type: none"> <li>Some construction activities envisaged under the protective measures provisions of the project carry potential occupational health and safety risks.</li> </ul>	2/3	<ul style="list-style-type: none"> <li>ESMMM will include strict guidelines on the provisions of health and safety awareness, equipment and management for workers on construction sites.</li> </ul>	Minor	ESMMM impacts 4.1-4.8, -4.11 and 5.5-5.7
3.38	Project involves support for employment or livelihoods that may fail to comply with national and international labour standards (i.e. principles and standards of ILO fundamental conventions).	<ul style="list-style-type: none"> <li>Some construction activities envisaged under the protective measures provisions of the project will require contracted labour.</li> </ul>	2/2	<ul style="list-style-type: none"> <li>ESMMM will contain strict guidelines on the adherence to ILO and national labour standards.</li> </ul>	Insignificant	ESMMM impacts 5.1 and 5.2

Ref.	Risk or Hazard	Assessment Summary	Impact / Probability	Outline Mitigation Approach	Residual Risk	Corresponding Impact No.
3.39	Project engages security personnel that may pose a potential risk to health and safety of communities and/or individuals (e.g. due to a lack of adequate training or accountability).	<ul style="list-style-type: none"> <li>Security personnel are not envisaged as part of the project.</li> <li>However, security guards may be employed during construction to protect material and machinery at night.</li> </ul>	2/3	<ul style="list-style-type: none"> <li>Contract clause to require guards to be hired from accredited companies.</li> <li>Guards' capacities to be assessed and additional awareness training provided if required.</li> </ul>	Insignificant	Project design
3.4	<b>Standard 4: Cultural Heritage</b>					
3.41	Project may result in interventions that would potentially adversely impact sites, structures, or objects with historical, cultural, artistic, traditional or religious values or intangible forms of culture (e.g. knowledge, innovations, and practices).	<ul style="list-style-type: none"> <li>Few such sites exist in the project area, but those that do (mainly churches, in most coastal sections, and the abandoned Hotel Africa in coastal section 1) are identified and earmarked for inclusion in protection areas under project activities.</li> </ul>	2/1	<ul style="list-style-type: none"> <li>ESMMM to include provisions to ensure that all cultural heritage sites are given priority in protection.</li> </ul>	Insignificant	ESMMM impact 11.1
3.42	Project might utilise tangible and/or intangible forms of cultural heritage for commercial or other purposes.	<ul style="list-style-type: none"> <li>It is possible that church groups will participate in certain project activities in their roles as leading civil society organisations, but these would in no way be exploitative.</li> <li>No other areas where this might happen have been identified.</li> </ul>	2/1	<ul style="list-style-type: none"> <li>ESMMM to include specific mention of this to ensure that project monitoring maintains vigilance in this respect.</li> </ul>	Insignificant	ESMMM impact 1.2
3.5	<b>Standard 5: Displacement and Resettlement</b>					
3.51	Project might involve temporary or permanent and full or partial physical displacement.	<ul style="list-style-type: none"> <li>The project is designed to avoid physical displacement.</li> <li>Should this be proved necessary for a small number of people, then a full UNDP- (and IFC-) compliant resettlement approach will be used.</li> </ul>	3/2	<ul style="list-style-type: none"> <li>ESMMM to provide guidelines on the resettlement and compensation process that would need to be followed if any displacement proves necessary.</li> </ul>	Minor	ESMMM impact 2.10

Ref.	Risk or Hazard	Assessment Summary	Impact / Probability	Outline Mitigation Approach	Residual Risk	Corresponding Impact No.
3.52	Project could result in economic displacement (e.g. loss of assets or access to resources due to land acquisition or access restrictions – even in the absence of physical relocation).	<ul style="list-style-type: none"> <li>The project is designed to safeguard land resources and therefore to avoid any form of economic displacement.</li> <li>Should displacement prove necessary for a small number of businesses, then a full UNDP- (and IFC-) compliant resettlement approach will be used.</li> </ul>	2/2	<ul style="list-style-type: none"> <li>ESMMM to provide guidelines on the resettlement and compensation process that would need to be followed if any displacement proves necessary.</li> </ul>	Insignificant	ESMMM impacts 2.2-2.3, and 2.9-2.10
3.53	Project might lead to forced evictions.	<ul style="list-style-type: none"> <li>The project is designed to safeguard land resources and there will be no involuntary displacement.</li> </ul>	3/1	<ul style="list-style-type: none"> <li>ESMMM to provide guidelines on the resettlement and compensation processes to avoid the need for forced evictions in the event that any displacement becomes necessary.</li> </ul>	Insignificant	ESMMM impacts 2.2-2.3, and 2.9-2.10
3.54	Project might affect land tenure arrangements and/or community based property rights/customary rights to land, territories and/or resources.	<ul style="list-style-type: none"> <li>The project is designed to safeguard land resources and therefore to avoid major impacts on land rights.</li> <li>However, land rights in Liberia, particularly in marginal lands, are confused and require reform.</li> </ul>	3/3	<ul style="list-style-type: none"> <li>Project design to include a component to resolve and formalise land tenure in the project target areas as a parallel activity.</li> </ul>	Insignificant	Project design
<b>3.6</b>	<b>Standard 6: Indigenous Peoples</b>					
3.61	Indigenous peoples might be present in the Project area (including Project area of influence).	<ul style="list-style-type: none"> <li>Among the ethnic groups affected, the Kru are one of the biggest tribal groupings in Liberia.</li> <li>None of the ethnic groups affected have a sufficiently different culture to meet the definition of indigenous peoples.</li> </ul>	1/1	<ul style="list-style-type: none"> <li>The ESMMM will contain provisions for the equitable treatment of all project-affected people. Hence occasional indigenous individuals, if encountered, will be dealt with equitably.</li> </ul>	Insignificant	ESMMM impacts 2.1-2.5 and 2.7
3.62	Project or portions of it may be located on lands and territories claimed by indigenous peoples.	<ul style="list-style-type: none"> <li>There are no groups qualifying as indigenous peoples in the project area.</li> </ul>	Not applicable	<ul style="list-style-type: none"> <li>No mitigation required.</li> </ul>	Not applicable	Not applicable

Ref.	Risk or Hazard	Assessment Summary	Impact / Probability	Outline Mitigation Approach	Residual Risk	Corresponding Impact No.
3.63	Project might affect the human rights, lands, natural resources, territories, and traditional livelihoods of indigenous peoples (regardless of whether indigenous peoples possess the legal titles to such areas, whether the Project is located within or outside of the lands and territories inhabited by the affected peoples, or whether the indigenous peoples are recognized as indigenous peoples by the country in question.	<ul style="list-style-type: none"> <li>There are no groups qualifying as indigenous peoples in the project area under either national or international definitions.</li> </ul>	Not applicable	<ul style="list-style-type: none"> <li>No mitigation required.</li> </ul>	Not applicable	Not applicable
3.64	Inadequate culturally appropriate consultations carried out with the objective of achieving FPIC on matters that may affect the rights and interests, lands, resources, territories and traditional livelihoods of the indigenous peoples concerned.	<ul style="list-style-type: none"> <li>Comprehensive culturally appropriate consultations have been carried out, as shown in the ESAR.</li> <li>No factors triggering Free Prior Informed Consent (FPIC) procedures have been encountered.</li> </ul>	1/1	<ul style="list-style-type: none"> <li>The ESMMM will contain provisions to trigger FPIC procedures in the unlikely event of indigenous peoples being encountered in a pocket of the project-affected areas.</li> </ul>	Insignificant	ESMMM impact 2.1, 2.2, 2.4
3.65	Project might involve the utilization and/or commercial development of natural resources on lands and territories claimed by indigenous peoples.	<ul style="list-style-type: none"> <li>There are no groups qualifying as indigenous peoples in the project area.</li> </ul>	Not applicable	<ul style="list-style-type: none"> <li>No mitigation required.</li> </ul>	Not applicable	Not applicable
3.66	Possible forced eviction or the whole or partial physical or economic displacement of indigenous peoples, including through access restrictions to lands, territories, and resources.	<ul style="list-style-type: none"> <li>There are no groups qualifying as indigenous peoples in the project area.</li> </ul>	Not applicable	<ul style="list-style-type: none"> <li>No mitigation required.</li> </ul>	Not applicable	Not applicable

Ref.	Risk or Hazard	Assessment Summary	Impact / Probability	Outline Mitigation Approach	Residual Risk	Corresponding Impact No.
3.67	Project might adversely affect the development priorities of indigenous peoples as defined by them.	• There are no groups qualifying as indigenous peoples in the project area.	Not applicable	• No mitigation required.	Not applicable	Not applicable
3.68	Project might affect the physical and cultural survival of indigenous peoples.	• There are no groups qualifying as indigenous peoples in the project area.	Not applicable	• No mitigation required.	Not applicable	Not applicable
3.69	Project might affect the Cultural Heritage of indigenous peoples, including through the commercialization or use of their traditional knowledge and practices.	• There are no groups qualifying as indigenous peoples in the project area.	Not applicable	• No mitigation required.	Not applicable	Not applicable
<b>3.7</b>	<b>Standard 7: Pollution Prevention and Resource Efficiency</b>					
3.71	Project could result in the release of pollutants to the environment due to routine or non-routine circumstances with the potential for adverse local, regional, and/or transboundary impacts.	<ul style="list-style-type: none"> <li>• Construction works, and quarrying activities will utilise standard diesel fuel and hydrocarbon lubricants. These could have local impacts if spillages or leaks occur.</li> <li>• On-site cement mixing and concrete works may result in localized chemical spills.</li> </ul>	3/3	<ul style="list-style-type: none"> <li>• Specific provisions for hydrocarbon management will be included in the ESMMM.</li> <li>• Specific provisions for managing spills from cement and concrete works must be included in the ESMMM.</li> </ul>	Insignificant	ESMMM impacts 6.1-6.3, 8.6-8.7, 8.11, 12.2 and 13.1-13.3
3.72	Project could result in the generation of waste (both hazardous and non-hazardous).	• Small amounts of non-hazardous waste, and minor amounts of hazardous waste, may result from the construction activities in the proposed protective measures.	2/2	• The ESMMM will include a detailed waste management plan incorporated within it.	Insignificant	ESMMM impacts 12.1

Ref.	Risk or Hazard	Assessment Summary	Impact / Probability	Outline Mitigation Approach	Residual Risk	Corresponding Impact No.
3.73	Project could involve the manufacture, trade, release, and/or use of hazardous chemicals and/or materials (including chemicals or materials subject to international bans or phase-outs such as listed in the Stockholm Conventions on Persistent Organic Pollutants or the Montreal Protocol).	<ul style="list-style-type: none"> <li>No use of hazardous material in these categories is envisaged under any part of the project.</li> <li>Construction works will utilise standard diesel fuel and hydrocarbon lubricants.</li> </ul>	3/3	<ul style="list-style-type: none"> <li>ESMMM to contain provisions to avoid use of hazardous materials in line with national laws and regulations.</li> <li>Specific provisions for hydrocarbon management will be included in the ESMMM.</li> </ul>	Insignificant	ESMMM impact 13.1-13.3s
3.74	Project could involve the application of pesticides that may have a negative effect on the environment or human health.	<ul style="list-style-type: none"> <li>No use of pesticides is envisaged under any part of the project.</li> </ul>	Not applicable	<ul style="list-style-type: none"> <li>No mitigation required.</li> </ul>	Not applicable	Not applicable
3.75	Project could include activities that require significant consumption of raw materials, energy, and/or water.	<ul style="list-style-type: none"> <li>Construction works for the project's protective measures will require water use, certain raw materials and use of energy.</li> </ul>	2/3	<ul style="list-style-type: none"> <li>Designs will minimise the quantities of raw materials required and ensure the maximum level of local sourcing.</li> <li>The ESMMM will contain guidelines on the safe sourcing of the materials and the minimisation of energy.</li> </ul>	Minor	Project design ESMMM impacts 1.2 and 6.2
<b>4.</b>	<b>Risks Related to Proposed Project Interventions: Adaptive Interventions</b>					
4.01	Awareness raising of coastal issues among communities and agencies leads to pressure for inappropriate developments rather than project-related benefits. For example, if people understand that the coast is better protected, they may try to sell their land to outside developers, who then convert it to other uses.	<ul style="list-style-type: none"> <li>The project is working adjacent to a densely populated urban area with a history of poorly regulated development.</li> </ul>	3/2	<ul style="list-style-type: none"> <li>Awareness raising will be a core project activity undertaken by well-resourced teams and which builds on the strong stakeholder engagement and political support developed during project preparation.</li> <li>Capacity building of local and national administrative agencies is to be another core activity that is focussed on the enforcement of development controls.</li> </ul>	Insignificant	Project design

Ref.	Risk or Hazard	Assessment Summary	Impact / Probability	Outline Mitigation Approach	Residual Risk	Corresponding Impact No.
4.02	Protection of the artisanal fishing limit within 6 nautical miles of the coast is abandoned for political or economic reasons.	<ul style="list-style-type: none"> <li>Keeping exclusive access to the inshore fishery is a key aspect of ensuring that the fishery remains sustainable with a low carbon footprint.</li> <li>Pressure on Liberia to open its fisheries to commercial exploitation has economic and political support both at home and from abroad.</li> </ul>	3/3	<ul style="list-style-type: none"> <li>Project design must include a commitment by government to maintain reservation for artisanal fishing of the zone inshore of 6 nautical miles.</li> <li>Research on fish availability and sustainable quotas must be undertaken to support fishery management.</li> <li>Capacity building, institutional and within fishing groups, is required to help ensure this is upheld and enforced.</li> </ul>	Minor	Project design
4.03	Acceptance of artisanal drift net fishing by mainly Fanti motorised canoes beyond the 6 nautical mile limit is abandoned for political or economic reasons.	<ul style="list-style-type: none"> <li>Drift net fishing for small shoaling species frequently extends beyond the 6 nautical mile limit but is not restricted officially.</li> <li>This may be an important part of the fishery.</li> </ul>	3/2	<ul style="list-style-type: none"> <li>Project design must include a commitment by government to allow drift net fishing to continue beyond the 6 nautical miles zone.</li> <li>Research on fish availability and sustainable quotas must be undertaken to support fishery management.</li> <li>Capacity building, within both institutions and fishing groups, is required to help ensure this is upheld and enforced.</li> <li>Fish quotas should be considered for consolidation in regulations and laws.</li> </ul>	Insignificant	Project design
4.04	Stakeholders are not prepared to collaborate on research and the imposition of designated catch volumes.	<ul style="list-style-type: none"> <li>The artisanal fishing communities understand the need to ensure sustainability and are sometimes suspicious of other groups' motives and activities.</li> <li>Rivalries exist between fishing communities.</li> </ul>	2/3	<ul style="list-style-type: none"> <li>Project design must involve fishing communities fully in this process and ensure full, transparent engagement.</li> </ul>	Insignificant	Project design

Ref.	Risk or Hazard	Assessment Summary	Impact / Probability	Outline Mitigation Approach	Residual Risk	Corresponding Impact No.
4.05	Understanding of mangrove ecology and its role in supporting marine fisheries takes too long to contribute meaningfully to project interventions.	<ul style="list-style-type: none"> <li>There is little current knowledge of mangrove ecology in Liberia, although considerable international knowledge can be applied.</li> <li>Biological research can take time, and determining linkages to other ecosystems (e.g. between estuarine breeding grounds and open sea populations) can be complicated.</li> </ul>	3/4	<ul style="list-style-type: none"> <li>Project design must take account of the wide range of research required and ensure that timeframes are adequate to fill key knowledge gaps as effectively as possible.</li> </ul>	Minor	Project design
4.06	Fishermen's and fishmongers' associations are unwilling to encompass project-supported changes.	<ul style="list-style-type: none"> <li>The artisanal fishing communities understand the need to ensure sustainability and are sometimes suspicious of other groups' motives and activities.</li> <li>Rivalries exist between fishing communities.</li> </ul>	4/2	<ul style="list-style-type: none"> <li>Project design must involve community associations fully in this process and ensure full, transparent engagement.</li> </ul>	Insignificant	Project design
4.07	Fish consumers resist the introduction of improved smoking methods.	<ul style="list-style-type: none"> <li>Smoking is used as the main method of preserving fish for transport and distribution.</li> <li>No market information is currently available on consumers' preferences.</li> </ul>	3/2	<ul style="list-style-type: none"> <li>Project design must include market research on the flavours generated by alternative smoking technologies and the change in the product price that may result from introducing new techniques</li> </ul>	Insignificant	Project design
4.08	The scale of pollution in the creeks, estuaries and mangrove swamps around Monrovia proves too extensive for control by existing agencies.	<ul style="list-style-type: none"> <li>Much of the drainage of the greater Monrovia urban area appears to go into the Mesurado estuary. The nature and toxicity of this is largely unknown.</li> <li>Even with strong enforcement by strengthened agencies, it is possible that the physical reconstruction of drainage works required in the city negates this area of work.</li> </ul>	3/4	<ul style="list-style-type: none"> <li>Project design must include surveys of drainage and pollution sources, focussed on identifying curable problems to be addressed by the project, with others raised for longer term action by the authorities.</li> </ul>	Minor	Project design



Ref.	Risk or Hazard	Assessment Summary	Impact / Probability	Outline Mitigation Approach	Residual Risk	Corresponding Impact No.
4.09	Adequate inland resources for sand extraction cannot be found within easy reach of Monrovia.	<ul style="list-style-type: none"> <li>• Raised beach deposits exist not far from Monrovia, but whether adequate sand sources exist in them remains to be determined.</li> <li>• Pressure for building land on the coastal plain may make this economically non-viable</li> <li>• Other options for land-based sand sources may be viable (such as from crushed rock).</li> </ul>	3/4	<ul style="list-style-type: none"> <li>• Project design must provide adequate resources for widespread prospecting of potential options.</li> </ul>	Minor	Project design
4.10	The construction industry resists efforts for the cessation of sand extraction from active beaches.	<ul style="list-style-type: none"> <li>• Beach sand is readily available close to construction markets and is a resource often exploited by small entrepreneurs.</li> </ul>	3/4	<ul style="list-style-type: none"> <li>• The capacity of the relevant agencies must be strengthened to enforce the prohibition of sand extraction from beaches.</li> <li>• Project design must involve the groups affected by the cessation (sand miners, collectors, final sellers and buyers) in this project component and ensure full, transparent engagement.</li> </ul>	Minor	Project design
4.11	Pressure for land is too great for viable alternatives to utilisation allocation and management to be introduced effectively.	<ul style="list-style-type: none"> <li>• Monrovia is constrained by its geography but has grown significantly in recent decades, with considerable rural-urban migration and an increase in the birth rate after the civil war.</li> </ul>	3/4	<ul style="list-style-type: none"> <li>• Project design must include significant awareness raising of the increased risks posed by sea level rise and greater storm intensities.</li> </ul>	Minor	Project design
4.12	Pressure for land is too great for the existing agencies to enforce new allocation codes in mangrove and ocean shoreline areas.	<ul style="list-style-type: none"> <li>• Pressure for land is pushing people to live in areas that are already marginal but which will be uninhabitable following sea level rise.</li> </ul>		<ul style="list-style-type: none"> <li>• Project design must also include robust land allocation and management, which are supported by legal instruments and strengthened enforcement capacity.</li> <li>• This must be agreed as a key government commitment to the project.</li> </ul>		

Ref.	Risk or Hazard	Assessment Summary	Impact / Probability	Outline Mitigation Approach	Residual Risk	Corresponding Impact No.
4.13	Land tenure arrangements in marginal coastal areas proves too complicated to resolve during the project implementation period.	<ul style="list-style-type: none"> <li>Land tenure in Liberia is moving more towards a formal registration system, but traditional and customary rights are still exercised and recognised.</li> <li>De facto rights are claimed by many people displaced by the civil war or for other reasons.</li> <li>The situation is further complicated by disputes and by the volatility of land in marginal areas such as the eroding coastline and tidal estuarine areas.</li> </ul>	3/4	<ul style="list-style-type: none"> <li>Government commitment to address land tenure arrangements in coastal and tidal areas must be agreed as a condition of the project. This must include a commitment to new legal instruments and enforcement where necessary.</li> <li>Project design must support government actions by including messages on land tenure in its community awareness raising programmes.</li> <li>Project design must also include support to government agencies through its capacity strengthening programme.</li> </ul>	Minor	Project design
<b>5.</b>	<b>Risks Related to Proposed Project Interventions: Protective Interventions</b>					
5.01	Communities demand “hard” engineering solutions instead of the project’s “soft” solutions.	<ul style="list-style-type: none"> <li>There is a strong desire in Liberia to see tangible, physical results from all development projects and publicly funded schemes.</li> <li>Historical circumstances give rise to suspicions of corruption where physical actions are not to be clearly seen.</li> <li>Nevertheless, Liberian communities are increasingly well versed with the processes of consultation and softer forms of development.</li> </ul>	3/4	<ul style="list-style-type: none"> <li>Project design must include significant awareness raising of the land management and livelihoods adaptation issues that will give society increased resilience to the risks posed by sea level rise and greater storm intensities.</li> <li>Project design must also make good use of civil society organisation and ensure that as much of the decision making as possible is localised and fully transparent.</li> </ul>	Insignificant	Project design
5.02	Restricted beach landing areas at West Point make landing less safe for fishermen.	<ul style="list-style-type: none"> <li>Landing is not considered a time of danger for fishermen (hauling in nets at sea is most dangerous).</li> <li>People on the shore assist boats when landing.</li> </ul>	4/1	<ul style="list-style-type: none"> <li>The Feasibility Study outlines designs that will make landing sites more sheltered.</li> <li>Detailed design must ensure that safety in landing is fully checked.</li> </ul>	Insignificant	Project design

Ref.	Risk or Hazard	Assessment Summary	Impact / Probability	Outline Mitigation Approach	Residual Risk	Corresponding Impact No.
5.03	Small landing beaches do not allow sufficient space for boat storage and fish processing activities. The long beach at West Point will mostly erode away once the revetment is in place.	<ul style="list-style-type: none"> <li>Fishing activities use relatively small areas of the current beach.</li> <li>Communities are known to adapt to the space available, and so will be able to fit with most options that are technically feasible.</li> </ul>	3/2	<ul style="list-style-type: none"> <li>Community consultation must be continued during detailed design to ensure that the final layouts are compatible with community needs.</li> </ul>	Insignificant	ESMMM impacts 2.1 and 2.2
5.05	Building of the revetment at West Point disrupts access for fishing during the construction period.	<ul style="list-style-type: none"> <li>The current beach is long and there is scope for fishing activities to move temporarily without their activities being unduly disrupted.</li> </ul>	3/1	<ul style="list-style-type: none"> <li>Contractor must agree a schedule with the fishermen and fish mongers before mobilisation.</li> </ul>	Insignificant	ESMMM impacts 2.1 and 2.2
5.06	Construction of access roads in West Point requires the complete or partial removal of settlements and/or businesses	<ul style="list-style-type: none"> <li>Very few settlements or businesses may have to be removed to allow space for access roads to the beach in West Point.</li> </ul>	2/3	<ul style="list-style-type: none"> <li>Resettlement, if required, will be fully compliant with UNDP Standard 5 provisions.</li> <li>Procedures for temporary land access and grievance redress are provided and must be followed.</li> </ul>	Insignificant	ESMMM impacts 2.2-2.3, 2.9- 2.10
5.07	Revetment in West Point damage the relationship between the people (mostly the poor) and the beach.	<ul style="list-style-type: none"> <li>Recreational activities related to the beach in West Point include leisure activities (strolling and “chilling”), sports activities (mainly football) as well as religious and cultural events.</li> </ul>	3/4	<ul style="list-style-type: none"> <li>Project design includes the creation of a green promenade along the beach which can serve as an alternative space for strolling and leisure.</li> <li>Project design must incorporate the creation of spaces as football fields and areas for holding events, or one area for both purposes.</li> </ul>	Insignificant	Project design
5.08	Local communities do not respect the importance of the green promenade at West Point and vandalise the vegetation.	<ul style="list-style-type: none"> <li>Movable structures, equipment, material and anything of value are often vandalised in Liberia because of the lack of awareness coupled with the need and poverty of the people.</li> <li>West Point is the poorest slum in Monrovia and suffers a high rate of crime and vandalism.</li> </ul>	3/4	<ul style="list-style-type: none"> <li>Government commitment to address this issue by protecting the promenade possibly through employment of guards and enforcing strict consequences.</li> <li>Project must include awareness campaigns for the community on the importance of the promenade.</li> </ul>	Insignificant	Project design

Ref.	Risk or Hazard	Assessment Summary	Impact / Probability	Outline Mitigation Approach	Residual Risk	Corresponding Impact No.
5.09	The proposed small landing beaches outside the revetment at West Point are too small to accommodate all stakeholders' interests.	<ul style="list-style-type: none"> <li>Projections on the evolution of the number of Kru fishermen and fishing boats landing on West Point's beach are lacking. However, this community is expected to be more stable than the highly increasing New Kru Town community because of the lack of space for any further settlement in West Point.</li> </ul>	3/3	<ul style="list-style-type: none"> <li>Project design must include a thorough review of the actual and future need of the West Point Kru fishing communities in terms of landing space and space for activities carried out after landing.</li> <li>Project must include alternatives for landing sites if the revetment design does not allow enough space for the expanding number of boats. These may include the relatively sheltered area to the south of West Point Beach, which is protected from the waves by the Mamba Point rocky cliff, or the Fanti landing area inside the Mesurado Estuary.</li> </ul>	Insignificant	Project design
5.10	Adequate rock sources for revetment construction cannot be found within easy reach of Monrovia or utilised in environmentally acceptable ways.	<ul style="list-style-type: none"> <li>Outcrops of basalt and hard gneiss are generally available within a reasonable distance of Monrovia.</li> <li>Quarry management and haulage arrangements are not always undertaken to safe or environmentally acceptable standards.</li> </ul>	3/3	<ul style="list-style-type: none"> <li>The ESMMM must contain strict guidelines as to the measures to be taken and contract conditions imposed on any contractor engaged to quarry or transport rock.</li> <li>Quarry sources must be covered under the project's ESIA.</li> </ul>	Insignificant	ESMMM impacts 7.7, 8.10-8.11 and 10.3
5.11	Shore and nearshore sediment erosion and deposition change as a result of physical coastal interventions.	<ul style="list-style-type: none"> <li>Potential changes in the sediment erosion and deposition balance in or near the areas of physical interventions are possible.</li> <li>More investigation and research are needed to evaluate the real extant of the changes and how they might occur.</li> </ul>	3/2	<ul style="list-style-type: none"> <li>Establish a marine physical environmental monitoring programme as part of the ESIA and continue to operate it through project implementation.</li> </ul>	Minor	ESMMM impacts 7.1 and 7.2

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## 8 PLAN FOR ENVIRONMENTAL AND SOCIAL MANAGEMENT AND MITIGATION

This chapter identifies the key environmental and social indicators identified for the project and outlines respective management objectives, potential impacts, control activities and the environmental performance criteria against which these indicators will be judged (i.e. audited).

This section further addresses the need for monitoring and reporting of environmental and social performance with the aim of communicating the success and failures of control procedures, distinguishing issues that require rectification and identifying measures that will allow continuous improvement in the processes by which the project is managed.

### 8.1 OVERVIEW AND OBJECTIVES OF THE ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

The Environmental and Social Management Plan (ESMP) is a tool used to ensure that the impacts of project activities on the environment and society are minimized and that both will be safeguarded during the implementation of the proposed project, in compliance with all technical, regulatory, and institutional requirements.

This is the document that must be followed to ensure that identified and potential project impacts are kept within the allowable levels, unanticipated impacts are mitigated at an early stage, and the expected project benefits are realized. It has been prepared as a standalone, self-contained document so that it can be detached from the ESAR and used as a key management tool throughout the implementation of the project.

Therefore, the objectives of the ESMP are to:

- Draw together the measures required to mitigate environmental and social impacts, and group them logically into components with common themes;
- Define the specific actions to be taken, responsibilities for these actions, timetables for implementation and associated incremental costs; and
- Describe the arrangements for capacity building, monitoring and resourcing.

The ESMP is to be strictly implemented without ignoring any detail.

The ESMP has clearly defined actions, targets and timeframes, as well as precisely allocated responsibilities among the different organisations and personnel working on the project. The ESMP is to ensure the systematic and prompt recognition of problems and the effective actions to correct them.

Briefly, the execution of an ESMP is to facilitate the efficient implementation of mitigation measures to minimize impacts, prevent accidents and maximise the effectiveness of construction and subsequent operation of infrastructure, in a context of good management and information sharing among project personnel.

The ESMP will be updated from time to time by the implementing Project Management Unit (PMU) in consultation with the UNDP staff and the EPA to incorporate changes in the detailed design phase of the project.

## 8.2 PROJECT INTERVENTIONS

The following assumptions have been made in the preparation of this ESMP:

- Although the project focusses on interventions that will adapt to or protect against the effects of climate change in the immediate coastal zone, impacts from project activities might occur some way offshore or onshore, particularly with the sourcing of construction materials; and so the ESMP must cover all aspects of potential project impacts, wherever they might occur;
- All project activities will be undertaken to national and international standards of environmental and social compliance, and this requirement will be reflected in all service contracts;
- None of the interventions will require the permanent displacement of people;
- None of the interventions will be conducted in protected areas or sensitive locations;
- Appropriate erosion and sediment control will be required to be undertaken during all stages of the project's construction works; and
- There will be no tolerance of any release of pollution or chemicals as a result of the project's construction works.

This section summarizes project interventions. The first group of these are adaptive — mostly improvements in capacity and management to ensure the sustainability of livelihoods, and the security of food supply. The second group are protective interventions, which are typically hard engineering approaches in a strategy of direct defence against the impacts of climate change.

### 8.2.1 Adaptive Interventions

Adaptive interventions in the project are measures to help minimise the drivers of climate change. These exploit opportunities to safeguard currently sustainable livelihoods that are low consumers of carbon energy, and which consequently promise to give Liberia “green” living approaches for both the current and future generations. The project focuses largely on the inshore artisanal fishery of Monrovia, which contributes significantly to the city’s food security with very low carbon emissions; however, a number of interventions are required to ensure that the environment supporting this will continue to sustain it as climatic conditions change, and impacts increase as a result of higher sea levels and stronger storms.

A total of seven adaptive interventions are proposed in the project, under three groupings as follows.

- Strengthening governance:
  - Increase the capacity of the institutions responsible for integrated coastal zone management; and
  - Increase awareness of the importance of addressing climate change issues among the affected society.
- Adaptation of livelihoods and the environment:
  - Address the management of fishing, catches, and fish processing and storage;
  - Understand the biological resource and ensure its protection as necessary to sustain catch volumes; and
  - Understand and manage the pollution that threatens the biological resource in the urban proximity.
- Adaptation of infrastructure:
  - Alternative sources of construction sand; and
  - Options for climate-resilient infrastructure in coastal areas.

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## 8.2.2 Protective Interventions

The proposed protective interventions are:

- Coastal Section 3: West Point:
  - Revetment Wall;

A revetment wall is a protective structure constructed along the shore using quarry rocks (rip-rap) of different sizes and a geotextile layer to prevent sand transport through the structure. The rip rap will be supplied from a quarry.

## 8.3 INSTITUTIONAL ARRANGEMENTS FOR THE ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

### 8.3.1 Organisation

The organisation of the project is shown in Figure 8-1. The EPA will act as the national implementing partner under an agreement with the UNDP, from which it will also receive technical support. The EPA's implementation of the project will be directed by a Project Board of senior government and UNDP representatives. In turn, the EPA will appoint a National Project Director, a Project Manager and a Project Management Unit (PMU); the PMU will include specialists in environment, social development, and gender and social inclusion, as well as technical specialists. The PMU will contract service providers (responsible parties) to deliver the various project interventions. The PMU will be supported by a Project Implementation Support Team (PITST) composed of representatives of the numerous governmental and municipal agencies collaborating in the components of the project. Among the advisers in the PITST will be individuals designated to support the PMU on the topics of environment, social development, and gender and social inclusion, not just in the technical areas.



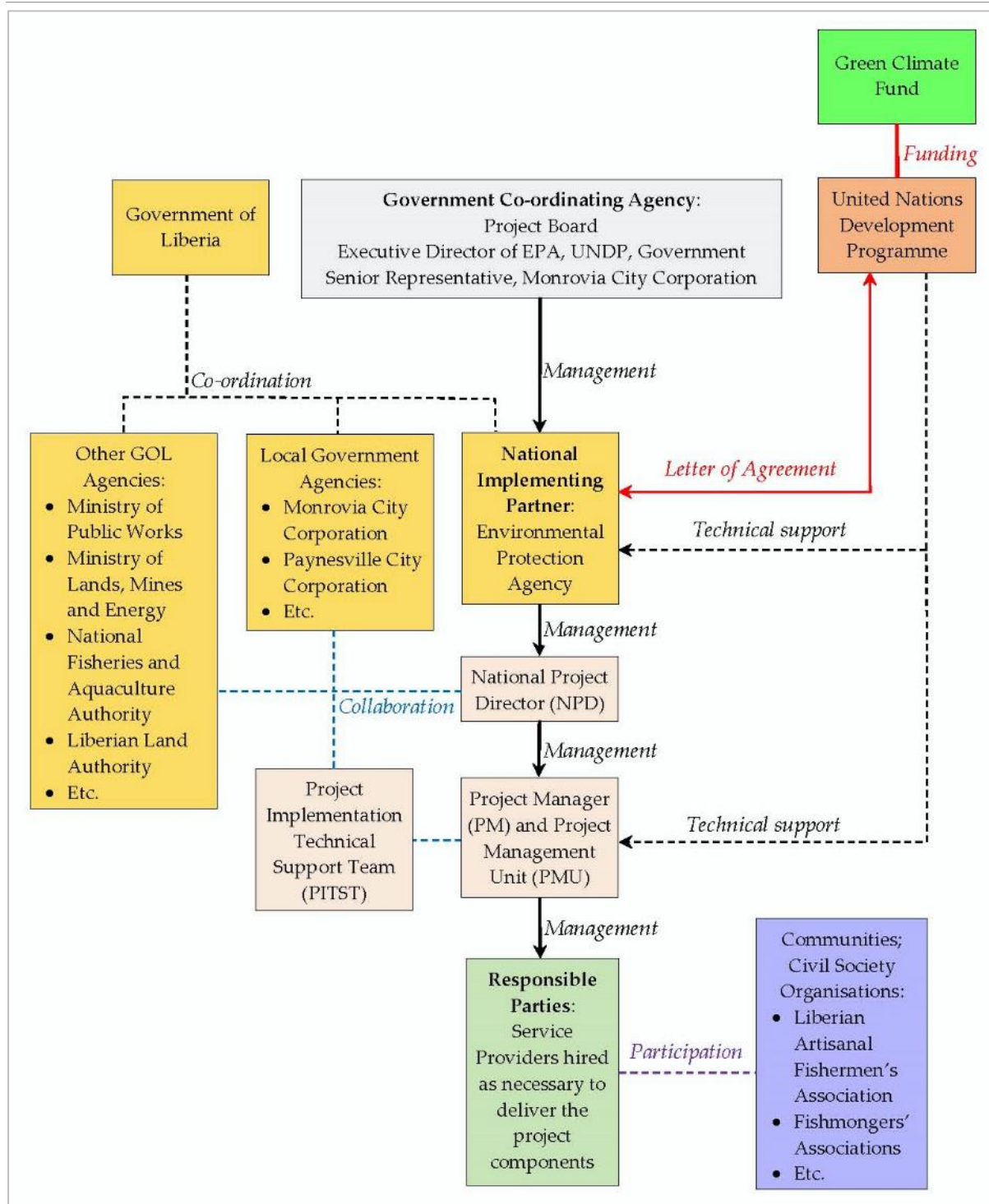


Figure 8-1 Project organisation chart

The ESMP will be assessed for each project intervention by the EPA and UNDP prior to any works being undertaken. The ESMP identifies potential risks to the environment and social matters from the various interventions and outlines strategies for managing those risks and minimising undesirable environmental and social impacts. Further, the ESMP provides a Grievance Redress Mechanism (GRM) for those that may be impacted by the projects that do not consider their views have been heard.

The PMU will be responsible for the supervision of the ESMP. It will have a small environmental team to take ownership of the ESMP and ensure that it is implemented throughout the project. This environmental team may be either directly appointed or contracted from an independent service provider. The UNDP will be required to endorse the PMU's arrangements and will ensure the ESMP is adequate and followed. The PMU will ensure timely remedial actions are taken by any deviating contractor where necessary.

### 8.3.2 Administration

The PMU's environmental team will be responsible for the revision or updates of this document during the course of work. It is the responsibility of the person to whom the document is issued as "owner" to ensure it is updated.

The site supervisor will be responsible for daily environmental inspections of the construction site. The PMU's environmental team will cross check these inspections by undertaking monthly audits.

All service providers and contractors will maintain and keep all administrative and environmental records which would include a log of complaints together with records of any measures taken to mitigate the cause of the complaints.

The service providers and contractors will be responsible for the day to day compliance of the ESMP. The ESMP must always be part of any tender documentation. The Project Manager will supervise the service providers and contractors.

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## **8.4 PROJECT DELIVERY AND ADMINISTRATION**

### **8.4.1 Project Delivery**

The project will be delivered on the ground via the EPA through its subsidiary departments and the National Project Director, Project Manager and PMU appointed for the project. In addition, collaboration with other agencies, existing NGOs and local communities is provided for through the PITST and the participation that will be required by the responsible parties (i.e. service providers) engaged to deliver the project interventions.

### **8.4.2 Administration of Environmental and Social Management Plan**

As the implementing agency, EPA will be responsible for responsible for the implementation with the ESMP via the delivery organisations.

The ESMP will be part of any tender documentation. The PMU will be responsible for the revision or updates of this document during the course of work. It is the responsibility of the person to whom the document is issued as owner (a member of the PMU environmental team) to ensure it is the most up to date version.

The UNDP and EPA are accountable for the provision of specialist advice on environmental and social issues to the delivery organisations (e.g. service providers, contractors and NGOs) and for environmental and social monitoring and reporting. The EPA or its delegate (i.e. the PMU) will assess the environmental and social performance of the service providers in charge of delivering each component throughout the project and ensure compliance with the ESMP. During operations the service providers will be accountable for implementation of the ESMP. Personnel working on all project interventions have accountability for preventing or minimising environmental and social impacts.

Each service provider's environmental officer will be responsible for daily environmental inspections of the project site. Through this arrangement, the service providers will be responsible for the day to day compliance of the ESMP. The PMU environmental team will cross check these inspections by undertaking monthly audits.

The service providers will maintain and keep all administrative and environmental records, which would include a log of complaints together with records of any measures taken to mitigate the cause of the complaints.

#### **8.4.3 Environmental Procedures, Site and Activity-specific Work Plans and Instructions**

Environmental procedures provide a written method describing how the management objectives for a particular environmental element are to be obtained. They contain the necessary detail to be site- or activity-specific and are required to be followed for all construction works. Site- and activity-specific work plans and instructions are to be issued and will follow the previously successful work undertaken on similar projects by the UNDP, EPA and the Ministry of Public Works (MPW).

#### **8.4.4 Environmental Incident Reporting**

Any incidents, including non-conformances to the procedures of the ESMP are to be recorded using an Incident Record and the details entered into a register. For any incident that causes or has the potential to cause material or serious environmental harm, the service provider's environmental officer shall notify the PMU environmental team as soon as possible. The service provider must cease work until remediation has been completed as per the approval of the PMU.

#### **8.4.5 Daily and Weekly Environmental Inspection Checklists**

A daily environmental checklist is to be completed at each work site by the relevant service provider's environmental officer and maintained within a register. A weekly environmental checklist is to be completed and will include reference to any issues identified in the daily checklists completed by the service provider's environmental officers. The completed checklist is to be forwarded to the PMU for review and follow-up if any issues are identified.

#### **8.4.6 Corrective Actions**

Any non-conformances to the ESMP are to be noted in weekly environmental inspections and logged into the register. Depending on the severity of the non-conformance, the service

provider's environmental officer may specify a corrective action on the weekly site inspection report. The progress of all corrective actions will be tracked using the register. Any non-conformances and the issue of corrective actions are to be advised to the PMU.

#### 8.4.7 Review and Auditing

The ESMP and its procedures are to be reviewed at least every two months by UNDP staff and the PMU environmental team. The objective of the review is to update the document to reflect knowledge gained during the course of project delivery and to reflect new knowledge and changed community values.

The ESMP will be reviewed and amendments made if:

- There are relevant changes to environmental conditions or generally accepted environmental practices; or
- New or previously unidentified environmental risks are identified; or
- Information from the project monitoring and surveillance systems indicate that current control measures require amendment to be effective; or
- There are changes to environmental legislation that are relevant to the project; or
- There is a request made by a relevant regulatory authority.

Any changes are to be developed and implemented in consultation between UNDP staff and the PMU, involving the EPA as necessary. When an update is made, all site personnel are to be made aware of the revision as soon as possible through a tool box meeting or written notification.

### 8.5 CAPACITY BUILDING AND TRAINING

The proper implementation of the ESMP is highly dependent on the available existing capacity and awareness of the EPA, the UNDP, the service providers' staff, the surrounding communities and the concerned stakeholders.

Training workshops are required to increase environmental and social awareness of all individuals concerned with the project and to train and follow-up with the workers who are specifically involved in site operations.

All project personnel will attend an induction that covers health, safety, environment and cultural awareness. All workers engaged in any activity with the potential to cause environmental harm (e.g. handling of hazardous materials) will receive task-specific environmental training.

#### 8.5.1 Induction Workshop – Adaptive and Protective Interventions

The PMU personnel, the UNDP personnel and the service providers' (especially construction contractors') professional staff involved in the site operations will be required to attend induction workshops prior to project initiation and throughout the project life. The objective of these workshops is to ensure appropriate health, safety, environmental and cultural awareness, while also providing knowledge and skills for the implementation of mitigation and monitoring measures.

In order to increase local awareness on these issues, the workshops can also be opened for individuals from the local community. They will be conducted twice a year during the implementation of adaptive interventions and the construction of protective interventions. The workshops will increase the environmental awareness of the participants by covering at least the following topics:

- Environmental laws, regulations, and standards;
- Project's potential impacts on the surrounding environment;
- Impact prevention and mitigation measures;
- Health and safety impacts and adequate mitigation measures;
- Community awareness, respect, gender equality, social inclusion and non-discrimination; and
- Sampling techniques and environmental monitoring guidelines.

#### 8.5.2 Construction Site Operation Training Workshop – Protective Interventions

On-site workers should receive appropriate training to undertake the duties of implementing the necessary mitigation measures. The training workshops should cover at least the following issues:

- Project's potential impacts on the surrounding environment;
- Project's potential impacts on occupational and public health and safety;
- Sources of impacts;
- Mitigation measures to be applied;
- Proper on-site behaviour expected on the environmental and social levels;
- Proper handling and storage of hazardous material and waste;
- Spill contingency plans; and
- Emergency response plan.

This could be achieved by small workshops conducted during the construction phase of the protective interventions for one or two days on a quarterly basis.

Additional workshops must be provided for specific jobs, including:

- Driving safely – for all drivers; and
- Safety and pollution prevention on ships – for all personnel working on ships.

These workshops can also be achieved by small workshops conducted during the construction phase of the protective interventions on a quarterly basis.

## 8.6 COMPLAINTS REGISTER AND GRIEVANCE REDRESS MECHANISM

The UNDP Social and Environmental Standards (SES) requires that stakeholders who may be adversely affected by a UNDP project can communicate their concerns about the social and environmental performance of the project through various entry points, scaled appropriately to the nature of the activity and its potential risks and impacts. Potentially affected stakeholders are required to be informed about available entry points for submitting their concerns as part of the stakeholder engagement process and when necessary, UNDP mandates an effective project-level grievance mechanism be available.

During the construction and implementation phases of the coastal protection project, a person or group of people can be adversely affected, directly or indirectly due to the project activities over the lifetime of the project design, implementation and restoration. The grievances that may arise can be related to social issues such as eligibility criteria and entitlements, disruption of services, temporary or permanent loss of livelihoods, and other social and cultural issues.

Grievances may also be related to environmental issues such as excessive dust generation, damages to infrastructure due to construction related vibrations or transportation of raw material, noise, traffic congestion, decrease in quality or quantity of private or public surface or ground water resources, damage to home gardens and agricultural lands etc.

Should such a situation arise, there must be a mechanism available through all implementing partners by which affected parties can resolve such issues in a cordial way with the project personnel in an efficient, unbiased, transparent, timely and cost-effective manner. To achieve this objective, a project level Grievance Redress Mechanism (GRM) has been developed.

The Complaints Register and GRM set out in this ESMP are to be used at all stages as part of the project and will provide an accessible, rapid, fair and effective response to concerned stakeholders, especially any vulnerable group who might lack access to formal legal regimes.

While recognising that many complaints may be resolved immediately, the Complaints Register and GRM set out in this ESMP encourages mutually acceptable resolution of issues as they arise.

#### 8.6.1 Complaints Register

A Complaints Register will be established as part of the project to record any concerns raised by the community during construction. All grievances must be recorded in the Complaints Register which logs all contacts and decisions, assessments, estimates, etc. required to deal with each complaint. Every time an activity related to each complaint is undertaken, this must be recorded in the register and the outcome reported in writing to the complainant, to the relevant Community Chairman and the EPA/ PMU. Action must be seen to have been taken, investigation must be proven to have been undertaken fairly, decisions proved to be fairly made and reported. A letter and verbal communication of the outcome must be made to the complainant in their preferred dialect.

Any grievance related to corruption or any unethical practice should be referred immediately to the Office of the Attorney General in Monrovia and the Office of Audit and Investigation (OAI) within the UNDP in New York.

It is the responsibility of the EPA/ PMU to monitor the nature of complaints, outcomes and resolutions on a monthly basis as part of the normal reporting process and then report to



UNDP Country Office. It is very common for local NGOs and CBOs to voluntarily monitor construction projects and to present themselves as intermediaries. If the management structure is aware of the complaints coming in, making measured responses that can be proven is vital. It is likely that the Township Commissioners and Borough Governor will come to discuss grievances and like to be aware of resolutions.

A summary list of complaints received and their disposition must be published in a report produced every six months by the EPA.

## 8.7 Grievance Redress Mechanism

A multi-tier GRM structure has been developed to address all complaints and grievances in the project. The GRM recommended is a system proven to work in poor communities in Liberia, is compliant with UNDP's Social Safeguards, follows customary norms and fits into the statutory administrative process of the Government of Liberia.

The GRM has been designed to be a problem-solving mechanism with voluntary good-faith efforts. The GRM is not a substitute for any legal process. The GRM will, as far as practicable, try to resolve complaints or grievances on terms that are mutually acceptable to all parties. When making a complaint or raising a grievance, all parties must act in good faith at all times, and should not attempt to delay or hinder any mutually acceptable resolution.

A grievance is any actual or perceived problem that might give grounds for a complaint. A GRM allows internal and external stakeholders to ask questions and raise issues, with the knowledge that they will be handled properly. As such it is clear proof of the commitment to deal quickly and carefully with all reasonable concerns and queries that people bring.

The recording, response to and reporting of grievances is a vital part of stakeholder engagement and constitutes a separate sub-activity. Grievances will be raised on a variety of issues, all must be recorded, effectively processed and reported. This section proposes a methodology for managing complaints systematically and effectively throughout the project.

Complaints vary widely and can include, for example, allegations of:

- Adverse environmental impact by contractors or sub-contractors – refusing access to the beach or dumping materials on canoe slipways;
- Damage to property by machinery accessing through very tight pathways;

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- Payments for employment access – charging youths for being given a job;
  - Disagreements over compensation assessment and payment;
  - Unfair allocation of contracts – not encouraging and enabling small contractors to tender for the works;
  - Poor quality of work in communities;
  - Culturally inappropriate behaviour; and
  - Others.

Eligibility criteria for the GRM include:

- a. Perceived negative economic, social or environmental impact on an individual or group, or concern about the potential to cause an impact;
- b. Clearly specified kind of impact that has occurred or has the potential to occur; and explanation of how the project caused or may cause such impact; and
- c. Individual or group filing of a complaint or grievance impacted, or at risk of being impacted; or the individual or group filing a complaint or grievance demonstrates that it has authority from an individual or group that have been or may potentially be impacted on to represent their interest.

Local communities and other interested stakeholders may raise a grievance or complaint at all times to the PMU and EPA. Affected local communities must be informed about the ESMP provisions, including its grievance mechanism and how to make a complaint.

The mechanism proposed here provides a system for recognizing and responding fairly, openly, coherently and efficiently to a complaint through identifying a person responsible for investigating the complaint and coordinating response.

The methodology covers:

- Receiving complaints through any of the EPA, PMU, Contractors, etc.;
- Assessing information needs;
- Allocating responsibility for investigation;
- Recording the process;

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- 356 • Contacting the complainant;
  - 357 • Determining the facts;
  - 358 • Agreeing responsibility and action where required;
  - 359 • Informing the complainant;
  - 360 • Dealing with disagreements over response and outcome ;
  - 361 • Implementing action;
  - 362 • Researching complainant satisfaction; AND
  - 363 • Monitoring and evaluating the outcome.
- 364 The grievance procedure must be:
- 365 • Legitimate in that it should be managed in a way that is credible to stakeholders, and
  - 366 immune from interference or undue influence.
  - 367 • Accessible: it must be well publicized, and open to all, regardless of language, literacy,
  - 368 financial means, or physical location.
  - 369 • Consistent: there must be absolute clarity about how the process works, how long it
  - 370 takes, and what it can (and cannot) achieve.
  - 371 • Equitable: everyone must be able to engage in the process on fair and equal terms.
  - 372 People must also be confident that there will be no adverse consequences or reprisals.
  - 373 • Sensitive to international standards: both the mechanism and the results should
  - 374 conform to internationally recognized standards for engaging with stakeholders.
  - 375 • Transparent: every aspect of the process should be as open and as candid as possible.
- 376 In general, the practical process for resolving a complaint has a number of tiers. At all levels,
- 377 the complainant can include witnesses, traditional authorities, an NGO or other civil society
- 378 representative to assist and support them.
- 379 • *Tier 1* Complainant discusses the issue with the designated officer of the Project
  - 380 Owner and sees if detailed explanation can resolve the complaint.

- *Tier 2* Complainant and Designated Safeguards Officer can discuss with the Town Chief, Fishing Chief or Fishmonger Chairwoman, depending on the nature of the complaint.
- *Tier 3* Community representative discusses the issue with the Contractor, PMU or EPA.
- *Tier 4* Complainant can escalate the issue to Township Commissioner or Borough Governor who will delegate an enquiry to the Administrative Officers to investigate and resolve if the issue is not related to construction.

If a complaint is of a sufficiently serious and extensive nature, the County Superintendent can convene a Grievance Committee consisting of Administrative Officers of the Township and includes a Civil Society representative. This is an established process in Liberia.

The Terms of Reference for the Grievance Redress Committee are:

- a. Provide support to the affected persons in solving their problems;
- b. Prioritize grievances and resolve them as quickly as possible;
- c. Provide information to the PMU on serious cases at the earliest opportunity;
- d. Co-ordinate with the aggrieved person or group and obtain proper and timely information on the solution worked out for their grievance; and
- e. Study the normally occurring grievances and advise the PMU, and Project Board on remedial actions to avoid further occurrences.

The Grievance Redress Committee will hold the necessary meetings with the aggrieved party and the concerned officer, and attempt to find a solution acceptable at all levels. The committee would record the minutes of the meeting. A civil society representative may be invited as an observer or as support to the complainant.

The Grievance Redress Committee will communicate proposed responses to the complainant formally. If the proposed response satisfies the complainant, the response will be implemented and the complaint or grievance closed. In cases where a proposed response is unsatisfactory to the complainant, the Grievance Redress Committee may choose to revise the proposed response to meet the complainant's remaining concerns, or to indicate to the

complainant that no other response appears feasible to the committee. A complainant may decide to take a legal or any other recourse if they are not satisfied with the resolutions due to the deliberations of the various tiers of the GRM.

The GRM has been designed to ensure that an individual or group are not financially impacted by the process of making a complaint or grievance. The GRM will cover any reasonable costs in engaging a suitably qualified person to assist in the preparation of a legitimate complaint or grievance. Where a complaint or grievance is seen to be ineligible, the GRM will not cover these costs.

Information about the GRM and how to make a complaint or grievance must be placed at prominent places for the information of the key stakeholders and freely advised to all through the media and at all meetings.

The PMU social safeguards officer will be designated as the key officer in charge of the GRM. The Terms of Reference for this position (as amended from time to time) will have the following key responsibilities:

- a. Co-ordinate formation of Grievance Redress Committees before the commencement of site activities and construction works to resolve issues;
- b. Act as the focal point at the PMU on Grievance Redress issues and facilitate the resolution of issues within the PMU;
- c. Create awareness of the GRM amongst all the stakeholders through public awareness campaigns;
- d. Assist in the redress of all grievances by co-ordinating with the parties concerned;
- e. Maintain information on grievances and their redress;
- f. Monitor the activities of the PMU and service providers on grievances issues;
- g. Prepare the appropriate section of monthly and quarterly progress reports; and
- h. Ensure the UNDP Country Office is advised on complaints.

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### 8.7.1 External Resolution Mechanism

In addition to the project-level and national GRMs, complainants have the option to access UNDP's Accountability Mechanism, with both compliance and grievance functions. The Social and Environmental Compliance Unit investigates allegations that UNDP's standards, screening procedure or other UNDP social and environmental commitments are not being implemented adequately, and that harm may result to people or the environment. The Social and Environmental Compliance Unit is housed in the Office of Audit and Investigations, and managed by a Lead Compliance Officer. A compliance review is available to any community or individual with concerns about the impacts of a UNDP project. The Social and Environmental Compliance Unit is mandated to investigate valid requests from locally impacted people independently and impartially, and to report its findings and recommendations publicly.

The Stakeholder Response Mechanism offers locally affected people an opportunity to work with other stakeholders to resolve concerns, complaints and grievances about the social and environmental impacts of a UNDP project. The Stakeholder Response Mechanism is intended to supplement the proactive stakeholder engagement that is required of UNDP and its implementing partners throughout the project cycle. Communities and individuals may request a Stakeholder Response Mechanism process when they have used standard channels for project management and quality assurance, and are not satisfied with the response (in this case the project level GRM). When a valid Stakeholder Response Mechanism request is submitted, UNDP focal points at country, regional and headquarters levels will work with concerned stakeholders and implementing partners to address and resolve the concerns. Full details are posted by UNDP at the website [www.undp.org/secu-srm](http://www.undp.org/secu-srm).

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## 8.8 GOVERNING LEGISLATION

The two main pieces of Liberian legislation relevant to the project are the Environmental Protection Agency Act, based on which the EPA was created, and the Environment Protection

and Management Law (EPML). The EPML provides the legal framework for the sustainable development, management and protection of the environment by the EPA in partnership with relevant parties. It also defines the specific requirements for performing an Environmental and Social Impact Assessment (ESIA) and other measures required to protect the environment in Liberia.

The project considered in this report includes building structures for erosion control, which falls under the “Land Reclamation and Land Development” category in Annex I of the EPML, and therefore is required to get a permit from the EPA before commencement of activities. This permit can be obtained by following the ESIA process defined in section 0 of this ESAR. Several environmental quality standards are partly prepared by the EPA. Some of these standards likely to be relevant for aspects of this project are: (1) Air Quality Standards; (2) Water Quality Standards; (3) Noise Level Standards; and (4) Waste Management Standards. These are presented in detail in section 4.4 of this report.

Liberia is a signatory of a number of international treaties, conventions and protocols relevant to the project (see section 0 of this report). These cover aspects related to biodiversity conservation, wetlands, air quality, climate change, waste transport, socio-culture, maritime activities, gender-based violence and discrimination, and other issues. In addition, the project must comply with international standards for shipping activities as defined by the International Maritime Organisation.

Apart from national and international provisions, the project must meet the requirements of the GCF’s Environmental and Social Policy and the UNDP’s Social and Environmental Standards, described in sections 4.8.1 and 4.8.2 of this report.

## 8.9 STAKEHOLDER ENGAGEMENT AND PUBLIC PARTICIPATION

### 8.9.1 Requirements

In June 2014, UNDP adopted mandatory Social and Environmental Standards (SES) for all of UNDP’s projects and programmes effective 1 January 2015, as part of the UNDP’s quality assurance process outlined in UNDP Strategic Plan Integrated Results and Resources Framework (IRRF). The objectives of the Standards are to:

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- (i) strengthen the social and environmental outcomes of UNDP projects;
  - (ii) avoid adverse impacts to people and the environment affected by projects;
  - (iii) minimize, mitigate, and manage adverse impacts where avoidance is not possible;
  - (iv) strengthen UNDP and partner capacities for managing social and environmental risks; and
  - (v) ensure full and effective stakeholder engagement, including through a mechanism to respond to complaints from project-affected people.

The process to meet the objectives of the SES are required as part of the Stakeholder Response Mechanism. To fulfil these criteria the ESMP requires a UNDP-SES compliant Stakeholder Engagement and Public Participation Plan (SEP), together with process and structure, to guide information, consultation and participation of all stakeholders to the project.

The PMU must design and implement the SEP to build on the public information and community engagement activities conducted for the ESAR and any other initial contacts developed during the project's initial stages by UNDP, consultants, researchers etc. As the project development continues into implementation and construction, there is a need to continue to conduct public consultation both with affected communities and interested parties during the entire project cycle.

The SEP will build on the public information and community engagement activities conducted for the ESAR.

The SEP will involve the following:

- Conducting stakeholder engagement before the letting of the service and construction contracts, which will require the following elements:
  - Stakeholder identification and analysis with a particular emphasis to organizing dialogue with affected groups; giving special attention to vulnerable groups whose vital interests, particularly employment, can potentially be affected by the project;
  - Stakeholder engagement planning; engagement activities and consultations where appropriate, diverse consultation methods (meetings, roundtable discussions, public hearings, focus groups, radio, newspapers etc.);
  - Information disclosure;



- Consultation and engagement;
- GRM; and
- Recording all activities and regular reporting to interested stakeholders, EPA and UNDP.
- Adopting and implementing the SEP prior to the letting of service and construction contracts, proportionate to the nature and scale of the project and its potential adverse impacts on the affected communities. It must relate to the sensitivity of the environment and social concerns, and the level of public interest.
- Identifying and documenting the various individuals or groups who (i) are affected or likely to be affected (directly or indirectly) by the project (affected parties), or (ii) may have an interest in the project (other interested parties).
- Establishing an effective grievance mechanism to facilitate prevention and timely resolution of disputes or conflicts that may arise during the project life cycle. This last is very important and must have staffing in place before works start, see section 8.5.

## 8.9.2 Contents of Stakeholder Engagement Plan

The SEP must be written, maintained and managed by the PMU Safeguards Officer. This individual is responsible for the SEP and must regularly report through the Project Manager to the Project Director and the EPA.

The plan requires:

1. Identification of interested parties and stakeholders;
2. Interaction with each party to define interests, roles and responsibilities;
3. Records of the details of all contacts with all parties in the stakeholder engagement matrix;
4. Reporting arrangements on stakeholder engagements to PMU, EPA and UNDP;
5. Planning for future engagement with each party over the lifetime of the project in a SEP;
6. Creation of a Public Information Dissemination Plan;
7. Creation of a Community Consultation Plan;
8. Implementation plan for ongoing stakeholder engagement; and
9. A system for monitoring the SEP and for third party evaluation of its efficiency.

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### 8.9.3 Identifying Stakeholders, Communication Needs and Recording

The PMU Safeguards Officer must gather information on all groups and individuals previously contacted by the project to date from all project-related organisations, including the service providers, and record this information in a stakeholder engagement matrix. This database must be added to and updated to reflect changes in stakeholder information, interests and priorities, contact information and designated responsible contact personnel. The aim is to be able to identify all interest groups of whatever size, be able to make contact easily and to know what sort of information, consultation and participation can be expected.

The PMU Safeguards Officer must collect information on contacts made by other PMU staff in the course of their work. This information should consist of the circulation of meeting minutes recorded on a proforma.

The matrix is divided into groups of stakeholders according to their interests, roles and responsibilities, means of communication, information needs and the need for consultation.

### 8.9.4 Reporting

The PMU Safeguards Officer must report to the Project Manager weekly on all contacts generated or recorded, highlight issues arising and advise on resolutions required. There must also be a specific section on grievances received and the outcomes of the GRM.

The PMU shall incorporate the stakeholder engagement report in weekly and monthly reports to the EPA and UNDP.

### 8.9.5 The Stakeholder Engagement Plan

The analysis of the data on interested groups, individuals and organisations enables a plan to be developed to guide the future information requirements both by the project and by stakeholders. The plan describes the following main topics.

1. What stakeholder interactions are needed at each stage of the project to enable people to be consulted and allowed to participate according to interests at critical project points.

2. The messages that the project needs to communicate to which audience at which stage of the project, ensuring that official government and legal requirements for public notices are scheduled appropriately.
3. The activities required to undertake consultation, communication and participation.
4. A process for monitoring stakeholder activities – internal and external third party where appropriate.
5. A basis for estimating the staff required and a budget to cover stakeholder activities.

The SEP contains a sub-plan for Public Information Dissemination. This takes forward the analysis of which groups need to know what at each stage of the project and categorises each information need into a time-based programme. The programme sets out a hierarchy of messages required for delivery to each interest group or stakeholder to maximise information dissemination, efficiency of delivery and comprehension by the stakeholders targeted for each message.

For each message the choice of media and delivery process is extremely important – public announcement, newspaper advertisement, radio announcements or discussion programmes, leaflets, brochures etc. Added to this is the choice of language acceptable to the target audience. The plan lists all potential messages, design, choice of language and media, timing, repetitions required, cost of development and delivery. The budget must include a 20 percent contingency for dealing with unexpected information requirements. The plan shall include a recording and reporting mechanism that is easily shareable with project partners. The PMU social safeguards officer will include public information activities as part of the stakeholder engagement reporting process.

Similarly, the SEP needs a Community Consultation Plan as a further sub-plan, to ensure that communities most directly affected are properly and effectively informed and consulted about aspects of the project which will impact their homes, families and livelihoods. The PMU social safeguards officer needs to determine the format of the consultation and calculate how many meetings, surveys, focus groups etc. are required by each community group affected by the project over each project stage, and assess the format of each consultation exercise.

The plan must calculate the time and cost of each consultation phase and estimate the PMU staff time required to achieve each consultation, surveys, or focus group including the analysis of the information exchanged and reporting to the PMU, EPA and UNDP.

The SEP requires an implementation section which sets out roles and responsibilities of each actor and action required under the plan, the logistics required and the budget needed over the life of the project. This also includes the staff required to deliver an effective stakeholder engagement programme, such as the skill levels required and assessment of the work experience and cultural backgrounds needed. The plan shall define the process for agreement for and procurement of the items and staff required for implementation.

The SEP must include a monitoring process for its activities, and set targets and indicators for activities against which progress can be assessed, performance evaluated, lessons learned and the programme redirected if needed.

## 8.10 BUDGET

A budget has been prepared for the implementation of the ESMP as follows.

Table 8-1 Budget for implementation of ESMP, assuming that all interventions are implemented

Item	Cost
ESMP Updating and Auditing	\$10,000
General ESMP Expenses	\$20,000
Ecological Monitoring (40 sites - two assessments/year over seven years)	\$170,000
Water Quality Monitoring (monitoring to be undertaken over seven years)	\$310,000
Water Quality Sample Laboratory Analysis (monitoring to be undertaken over seven years)	\$85,000
Sediment Sample Field Testing (monitoring to be undertaken over seven years)	\$125,000
Sediment Sample Laboratory Analysis (monitoring to be undertaken over seven years)	\$125,000
Erosion, Drainage and Sediment Control (includes silt curtains etc)	\$75,000
Archaeological Management	\$25,000
Stakeholder Engagement Workshops	\$140,000
Grievance Redress Mechanism expenses	\$50,000
<b>Total</b>	<b>\$1,135,000</b>

## 8.11 ENVIRONMENTAL AND SOCIAL MANAGEMENT AND MONITORING MATRIX

The Environmental and Social Management and Monitoring Matrix (ESMMM) is designed as a cover-all, one-stop mitigation and monitoring plan for all social and environmental impacts. As such, it incorporates elements of a range of possible sub-plans which, in some ESMPs, are listed separately. In this ESMMM, the sub-plans are combined into a single entity. This makes

both management and monitoring simpler, and ensures that there are no gaps between the different safeguard elements.

This ESMMM therefore works through a series of key environmental and social indicators, listed below. The potential impacts identified in the ESAR are listed under these indicators, so that each aspect of environmental and social protection can be easily found among the mitigation and monitoring tables. The mitigation and monitoring measures are to ensure compliance with local and international legislation, standards and guidelines (see sections 1, 8.7 and Appendix D). The “Standard to be met” column of Table 8-2 shows the linkages between the ESMMM and the standards and guidelines listed in Appendix D.

1. General Environmental Protection
2. Community Protection Measures, including Gender and Social Inclusion
3. Environmental Health and Safety
4. Occupational Health and Safety
5. Labour and Working Conditions
6. Water Resources Management
7. Coastal Sediment Resources Management
8. Soil and Land Resources Management
9. Dust and Air Quality Management
10. Flora and Fauna Protection
11. Archaeology and Cultural Sites Management
12. Waste Management
13. Hazardous Materials Management

Table 8-2 – the ESMMM – lays out the arrangements for safeguarding the environment and society through the practical mitigation of identified impacts according to identified responsibilities, the monitoring of this and the identification of the measures to be taken, again with the defined responsibilities for action. This matrix forms the core of the ESMP, since it shows exactly what must be done, by whom, when and to what standard; and also it shows who will monitor its implementation and when, and what actions are found to be necessary.

It should be noted that the majority of environmental and social mitigation is required in relation to the physical construction of the project’s proposed protective interventions. Most

of these are in the project implementation period, during the actual construction works. Depending on the nature of the works, they might affect the marine environment, the coastal tidal environment, or the terrestrial edaphic and aquatic (land and water) environment. Because of the broad range of different environments in which the project will work there are many safeguards required, although many will only be relevant for certain activities. For example, actions such as the quarrying and transporting of rock for revetments from inland quarries are included, as they will be impacts caused by the project even though they will not affect the actual coastal fringe.

The ESMMM has identified additional surveys and management plans that must be conducted before any activities take place, in addition to the ESIA. These are mentioned within the ESMMM and summarized below.

1. Detailed ESIA Surveys

1.1. Marine and Estuarine Biological Survey

1.2. Marine and Estuarine Sediment Survey

1.3. Household Survey of Affected Communities

1.4. Fish Landing Survey (linked to 1.1 and 1.3 above)

2. Detailed Sub-plans

2.1. Contractors' Oil Spill Response Plan (OSRP) for land

2.2. Contractors' Oil Spill Response Plan (OSRP) for sea, including a Marine Spill Contingency Plan

2.3. Contractors' Emergency Response Plan

2.4. Contractors' Rock Quarry Management Plan, including Blasting Plan

2.5. Resettlement Action Plan for Affected Livelihoods

2.6. Grievance Redress Mechanism (GRM)

680 Table 8-2 Environmental and Social Management and Monitoring Matrix (ESMMM), with responsibilities

Environmental and Social Management and Monitoring Matrix (ESMMM)							
Potential impacts	Mitigation measures	Responsibility for implementation	Standard to be met (refer Appendix D)	Monitoring			
				Check timing	Responsibility for checking	Assessment of condition	Action required
1. General environmental protection							
1.1 General environmental damage in the form of degraded water resources, degraded land, lowered quality of living, reduced quality of resources, etc. in the areas where interventions are taking place.	<ul style="list-style-type: none"><li>• Avoid damage to any part of the environment (water, soil, plants, animals, human resources and settlements) as far as possible.</li><li>• If damage cannot be avoided, then mitigate or compensate for the damage.</li><li>• Avoid any work beyond the agreed boundaries of the work sites.</li><li>• Agree on mitigation or compensation arrangements before starting any work.</li><li>• Do not hide any damage or pollution. In the event of an accident, it is better to consult the EPA and agree on a mitigation plan than to risk prosecution under the law.</li></ul>	Service provider	All standards and guidelines	<ul style="list-style-type: none"><li>• Before starting work</li><li>• Monthly during site operations</li><li>• After completion of site operations</li></ul>	<ul style="list-style-type: none"><li>• PMU Environmental Officer, for bio-physical matters</li><li>• PMU Social Safeguards Officer, for socio-economic matters</li></ul>	<ul style="list-style-type: none"><li>• Visual inspection</li><li>• Documentation</li><li>• To be completed at each check</li></ul>	To be completed at check if compliance is not satisfactory. State who is responsible for action.

Environmental and Social Management and Monitoring Matrix (ESMMM)							
Potential impacts	Mitigation measures	Responsibility for implementation	Standard to be met (refer Appendix D)	Monitoring			
				Check timing	Responsibility for checking	Assessment of condition	Action required
1.2 Limited awareness or respect about the importance and value of the environment among labour force leads to an excessive amount of damage to resources or disruption of people's livelihoods in the areas where interventions are taking place.	<ul style="list-style-type: none"> <li>• Develop and implement an induction program for all site personnel, which includes as a minimum an outline of the minimum requirements for environmental management relating to the site.</li> <li>• Ensure that the site supervisors brief all workers at the start of every job, and at the beginning of each week, on the main environmental messages.</li> <li>• Ensure that all professional and technical staff respect the environment and understand why they must.</li> <li>• Do not allow staff and workers to neglect environmental issues. This may lead to offences under the Environment Protection and Management Law.</li> <li>• Do not ignore blatant disregard for environmental and social issues by professional and technical staff.</li> </ul>	Service provider	All standards and guidelines	Monthly during site operations	PMU Environmental Officer	<ul style="list-style-type: none"> <li>• Interviews with the site-workers</li> <li>• To be completed at each check</li> </ul>	To be completed at check if compliance is not satisfactory. State who is responsible for action.



Environmental and Social Management and Monitoring Matrix (ESMMM)							
Potential impacts	Mitigation measures	Responsibility for implementation	Standard to be met (refer Appendix D)	Monitoring			
				Check timing	Responsibility for checking	Assessment of condition	Action required
2. Community protection measures, including gender and social inclusion							
2.1 Consultation with local communities is inadequate to ensure support for the project and avoid disputes.	<ul style="list-style-type: none"><li>• Refer Appendix D2.20</li><li>• Undertake regular meetings with community leaders and community interest groups.</li><li>• Carry out community consultation on the purpose and benefits of making changes to land use.</li><li>• Get community buy-in on any change of land use.</li><li>• Community consultation during detailed design must ensure that the final layouts are compatible with community needs.</li><li>• Ensure awareness of the Grievance Redress Mechanism process.</li><li>• Implement all provisions agreed in the Stakeholder Engagement Plan.</li><li>• Support communities in times of crisis to the greatest extent possible.</li></ul>	Service provider	Guideline D.2.20	<ul style="list-style-type: none"><li>• Before starting work</li><li>• Monthly during site operations</li></ul>	PMU Social Safeguards Officer	<ul style="list-style-type: none"><li>• Interviews with communities</li><li>• To be completed at each check</li></ul>	To be completed at check if compliance is not satisfactory. State who is responsible for action.

Environmental and Social Management and Monitoring Matrix (ESMMM)							
Potential impacts	Mitigation measures	Responsibility for implementation	Standard to be met (refer Appendix D)	Monitoring			
				Check timing	Responsibility for checking	Assessment of condition	Action required
2.2 Displacement of dwellings, structures, business, crops and economic trees along the revetment wall and access road alignment and proposed quarry site; Local people's livelihoods are adversely affected by project activities.	<ul style="list-style-type: none"> <li>• Refer Appendix D2.21, D.2.22, D2.24</li> <li>• Conduct a Household Survey of Affected Communities</li> <li>• Undertake Fish Landing Survey</li> <li>• Develop a Resettlement Action Plan (RAP) for Affected Livelihoods.</li> <li>• Establish an equitable and fair employment strategy. Liaise with the CLO to ensure that it is understood in the local communities (i.e. that it is transparent).</li> <li>• Give priority to local men and women in labour crews, and those whose livelihoods are affected by project activities.</li> <li>• Pay the usual accepted County wage rates.</li> <li>• Do not demand unpaid work by locals.</li> <li>• Contractor must agree a construction schedule with the fishermen and fish mongers before mobilisation, to ensure that fishing is not disrupted.</li> </ul>	Service provider	Guidelines D.2.21 and D.2.22	<ul style="list-style-type: none"> <li>• Resettlement Action Plan: part of the ESIA.</li> <li>• Monthly during site operations</li> </ul>	PMU Social Safeguards Officer	<ul style="list-style-type: none"> <li>• Documentation</li> <li>• Interviews with communities</li> <li>• To be completed at each check</li> </ul>	To be completed at check if compliance is not satisfactory. State who is responsible for action.

Environmental and Social Management and Monitoring Matrix (ESMMM)							
Potential impacts	Mitigation measures	Responsibility for implementation	Standard to be met (refer Appendix D)	Monitoring			
				Check timing	Responsibility for checking	Assessment of condition	Action required
2.3 Damage to agricultural crops and trees detracts from people's livelihoods.	<ul style="list-style-type: none"> <li>• Avoid the use of cultivated land wherever possible. This includes fallow agricultural land, rubber and other tree plantations.</li> <li>• Where use of such land is required, check with the community liaison staff at last four weeks prior to commencement of activities (ideally earlier) that mitigation measures have been agreed and implemented.</li> <li>• Do not start using cultivated land before the occupier has fully agreed the compensation strategy, all amounts have been paid and this is confirmed by the community liaison staff.</li> <li>• Avoid damage to crops or land beyond agreed boundaries.</li> </ul>	Service provider	Guidelines D.2.21 and D.2.22	<ul style="list-style-type: none"> <li>• Before starting work</li> <li>• Monthly during site operations</li> </ul>	PMU Social Safeguards Officer	<ul style="list-style-type: none"> <li>• Documentation</li> <li>• Interviews with communities</li> <li>• To be completed at each check</li> </ul>	To be completed at check if compliance is not satisfactory. State who is responsible for action.
2.4 Cumulative losses are incurred by social groups unable to respond to change.	<ul style="list-style-type: none"> <li>• Give priority to local men and women in labour crews, and those whose livelihoods are affected by project activities.</li> <li>• Maintain an active policy to ensure gender equality and opportunities for vulnerable groups.</li> <li>• Pay the usual accepted County wage rates.</li> <li>• Do not demand unpaid work by locals.</li> </ul>	Service provider	Guidelines D.2.21 and D.2.22	Monthly during site operations	PMU Social Safeguards Officer	<ul style="list-style-type: none"> <li>• Interviews with communities</li> <li>• To be completed at each check</li> </ul>	To be completed at check if compliance is not satisfactory. State who is responsible for action.

Environmental and Social Management and Monitoring Matrix (ESMMM)							
Potential impacts	Mitigation measures	Responsibility for implementation	Standard to be met (refer Appendix D)	Monitoring			
				Check timing	Responsibility for checking	Assessment of condition	Action required
2.5 Project-affected persons are unable to seek the redress of their grievances.	<ul style="list-style-type: none"> <li>• Implement Grievance Redress Mechanism (described in ESAR).</li> <li>• Ensure that the Grievance Redress Mechanism is widely publicised and that it is understood and accessible in all project-affected communities. Refer Appendix D2.20</li> <li>• Treat all complaints and disputes with respect and fairness. Explain decisions to community leaders and get their support.</li> </ul>	Service provider	Guideline D.2.20	<ul style="list-style-type: none"> <li>• Before starting work</li> <li>• Monthly during site operations</li> </ul>	PMU Social Safeguards Officer	<ul style="list-style-type: none"> <li>• Documentation</li> <li>• Interviews with communities</li> <li>• To be completed at each check</li> </ul>	To be completed at check if compliance is not satisfactory. State who is responsible for action.

Environmental and Social Management and Monitoring Matrix (ESMMM)							
Potential impacts	Mitigation measures	Responsibility for implementation	Standard to be met (refer Appendix D)	Monitoring			
				Check timing	Responsibility for checking	Assessment of condition	Action required
2.6 Infectious and contagious diseases are spread amongst the communities near the areas where interventions are taking place.	<ul style="list-style-type: none"> <li>• Medical screening of staff and workers</li> <li>• Ensure that non-local workers are accommodated in sound, dry buildings, with good ventilation and clean water supplies, and with good cleanliness and sanitation arrangements.</li> <li>• Provide bed nets to all non-local workers.</li> <li>• Monitor and control the habitats of malaria vectors.</li> <li>• Provide awareness trainings to workers and nearby communities, on the prevention of contagion and infection from diseases such as influenza, Ebola, sexually transmitted diseases and HIV.</li> <li>• Encourage workers to abstain from sex with local people, or to use suitable protection such as condoms.</li> </ul>	Service provider	Not applicable	<ul style="list-style-type: none"> <li>• Before starting work</li> <li>• Weekly during site operations</li> </ul>	PMU Health and Safety Officer	<ul style="list-style-type: none"> <li>• Visual inspection</li> <li>• Documentation</li> <li>• Interviews with workers</li> <li>• To be completed at each check</li> </ul>	To be completed at check if compliance is not satisfactory. State who is responsible for action.

Environmental and Social Management and Monitoring Matrix (ESMMM)							
Potential impacts	Mitigation measures	Responsibility for implementation	Standard to be met (refer Appendix D)	Monitoring			
				Check timing	Responsibility for checking	Assessment of condition	Action required
2.7 Sexual exploitation and gender-based violence increase in local communities, particularly in the five coastal sections due to the influx of temporary labourers.	<ul style="list-style-type: none"> <li>• Maximise the use of local labour, to reduce influxes.</li> <li>• Contractors to adopt a code of conduct for their workers regarding their interaction with the local communities</li> <li>• Issue policy statements on the project's adherence to Liberian law regarding sexual exploitation (including minors and prostitution) and gender-based violence.</li> <li>• Maintain a zero tolerance punitive regime among all project and all service providers' staff and workers.</li> <li>• Include awareness raising on these issues in trainings and site briefings.</li> </ul>	Service provider	Guideline D.2.4	<ul style="list-style-type: none"> <li>• Before starting work</li> <li>• Monthly during site operations</li> </ul>	PMU Health and Safety Officer, supported by PMU Social Safeguards Officer	<ul style="list-style-type: none"> <li>• Interviews with workers</li> <li>• To be completed at each check</li> </ul>	To be completed at check if compliance is not satisfactory. State who is responsible for action.
2.8 Fish consumers resist the introduction of improved smoking methods because they change the flavor and cost of fish, which affects the livelihood of fish mongers.	<ul style="list-style-type: none"> <li>• Project design must include market research on the flavours generated by alternative smoking methods and the change in the product price that may result from introducing new techniques.</li> </ul>	ESIA Consultant	Not applicable	<ul style="list-style-type: none"> <li>• Part of the ESIA</li> </ul>	PMU Social Safeguards Officer	<ul style="list-style-type: none"> <li>• Documentation</li> <li>• Interviews with consumers and fisher mongers</li> <li>• To be checked as part of ESIA</li> </ul>	To be completed at check if compliance is not satisfactory. State who is responsible for action.

Environmental and Social Management and Monitoring Matrix (ESMMM)							
Potential impacts	Mitigation measures	Responsibility for implementation	Standard to be met (refer Appendix D)	Monitoring			
				Check timing	Responsibility for checking	Assessment of condition	Action required
2.9 Service providers' materials stores, workshops, machinery parking areas, laydown yards, etc. are located on the landing and recreational beaches, disrupting fishing and leisure activities.	<ul style="list-style-type: none"> <li>The location for the Service providers' materials stores, workshops, machinery parking areas, laydown yards, etc. must be agreed upon with community leaders and agreed by the project in advance.</li> <li>Refer Appendix D2.20, D2.21, D2.16</li> </ul>	Service provider	Guidelines D.2.21	<ul style="list-style-type: none"> <li>Monthly during the running of construction contracts.</li> </ul>	PMU Environmental Officer	<ul style="list-style-type: none"> <li>Site inspection</li> </ul>	To be completed at check if compliance is not satisfactory. State who is responsible for action.
2.10 Construction of access roads to the construction sites requires temporary resettlement of settlements and/or businesses.	<ul style="list-style-type: none"> <li>Conduct a Household Survey of Affected Communities</li> <li>Develop a Resettlement and Compensation Action Plan (RCAP) if required</li> <li>Implementation of Grievance Redress Mechanism (GRM)</li> <li>Implement Livelihood Restoration Plan.</li> </ul>	Service provider	Guidelines D.2.23	<ul style="list-style-type: none"> <li>Before starting work</li> </ul>	PMU Social Safeguards Officer	<ul style="list-style-type: none"> <li>Documentation</li> <li>Interviews with affected people.</li> </ul>	To be completed at check if compliance is not satisfactory. State who is responsible for action.

Environmental and Social Management and Monitoring Matrix (ESMMM)							
Potential impacts	Mitigation measures	Responsibility for implementation	Standard to be met (refer Appendix D)	Monitoring			
				Check timing	Responsibility for checking	Assessment of condition	Action required
3. Environmental health and safety							
3.1 Injuries occur to the public, especially children, during works in the areas where interventions are taking place.	<ul style="list-style-type: none"><li>• Ensure full separation of the public from working sites.</li><li>• Fence off working areas so that people cannot be injured by things dropped on them or falling into excavations.</li><li>• Hazardous areas to be appropriately signed and lit</li><li>• Implement traffic management for construction vehicles, including audible/visual warnings, driver training, speed restrictions in sensitive areas, and traffic controllers.</li><li>• Maintain a clean site so that dangerous articles are not left lying around near the work site, especially at night.</li></ul>	Service provider	Not applicable	<ul style="list-style-type: none"><li>• Before starting work</li><li>• Monthly during site operations</li><li>• After completion of site operations</li></ul>	PMU Health and Safety Officer	<ul style="list-style-type: none"><li>• Visual inspection</li><li>• Documentation</li><li>• To be completed at each check</li></ul>	To be completed at check if compliance is not satisfactory. State who is responsible for action.
3.2 Injuries occur to the public from exposure to hazardous substances (e.g. cement, diesel) in the areas where interventions are taking place.	<ul style="list-style-type: none"><li>• Ensure full separation of the public from storage facilities.</li><li>• Enforce the exclusion of non-project personnel from all sites with hazardous substances.</li><li>• Refer Appendix D2.12, D2.13, D2.14, D2.15, D2.18</li></ul>	Service provider	Guideline D.2.13	<ul style="list-style-type: none"><li>• Before starting work</li><li>• Monthly during site operations</li><li>• After completion of site operations</li></ul>	PMU Health and Safety Officer	<ul style="list-style-type: none"><li>• Visual inspection</li><li>• Documentation</li><li>• To be completed at each check</li></ul>	To be completed at check if compliance is not satisfactory. State who is responsible for action.



Environmental and Social Management and Monitoring Matrix (ESMMM)							
Potential impacts	Mitigation measures	Responsibility for implementation	Standard to be met (refer Appendix D)	Monitoring			
				Check timing	Responsibility for checking	Assessment of condition	Action required
3.3 Injuries occur to the public near quarry sites	<ul style="list-style-type: none"> <li>• Maintain the quarry area in a clean, safe and efficient condition.</li> <li>• Ensure that quarry blasting does not create excessive noise and vibration disturbance to communities.</li> <li>• Enforce a 500 metre safety zone cleared around the blasting site.</li> <li>• Inform the communities of a blast at least 48 hours in advance.</li> <li>• Sound a loud double siren before blasting shots are fired.</li> <li>• Follow the Obligatory Procedure for Blasting at Quarries. Refer Appendix D2.18 and D2.19</li> </ul>	Service provider	Guidelines D.2. 18 and D.2. 19	<ul style="list-style-type: none"> <li>• Monthly during site operations</li> </ul>	PMU Health and Safety Officer	<ul style="list-style-type: none"> <li>• Visual inspection</li> <li>• Documentation</li> <li>• To be completed at each check</li> </ul>	To be completed at check if compliance is not satisfactory. State who is responsible for action.
3.4 Airborne and deposited dust provide a health risk in the vicinity of habitation, traffic and crops.	<ul style="list-style-type: none"> <li>• Refer Appendix D1.1</li> <li>• Enforce dust control measures during the dry season.</li> <li>• Do not allow dust generation to affect the ambient air quality outside the site.</li> <li>• Enforce strict speed limits on earth tracks by placing speed bumps.</li> <li>• Spray dust suppression water as required on to dry earth surfaces, but ensure it is not applied at such rates that it causes erosion and washing out of the roads.</li> <li>• Stop work in very windy, dry weather.</li> <li>• Fit crushers with water sprays.</li> </ul>	Service provider	Standard D.1.1	<ul style="list-style-type: none"> <li>• Before start of work</li> <li>• Monthly during site operations</li> </ul>	PMU Health and Safety Officer	<ul style="list-style-type: none"> <li>• Visual inspection</li> <li>• Documentation</li> <li>• To be completed at each check</li> </ul>	To be completed at check if compliance is not satisfactory. State who is responsible for action.

Environmental and Social Management and Monitoring Matrix (ESMMM)							
Potential impacts	Mitigation measures	Responsibility for implementation	Standard to be met (refer Appendix D)	Monitoring			
				Check timing	Responsibility for checking	Assessment of condition	Action required
3.5 Use of public roads by project vehicles increases the accident rate and generates nuisance levels of dust, especially in built-up areas.	<ul style="list-style-type: none"> <li>• Minimise vehicle movements.</li> <li>• Enforce transport rules and regulations rigorously.</li> <li>• Conduct driving safety awareness campaigns.</li> <li>• Do not tolerate any poor behaviour, dangerous driving or even minor traffic infringements by any staff or sub-Service providers.</li> <li>• Do not allow dust generation to affect the ambient air quality outside the site.</li> <li>• Spray dust suppression water as required, but ensure it is not applied at such rates that it causes erosion and washing out of the roads. Refer Appendix D2.7</li> </ul>	Service provider's Site Manager	Standard D.1.1	<ul style="list-style-type: none"> <li>• Before start of work</li> <li>• Monthly during site operations</li> </ul>	<ul style="list-style-type: none"> <li>• PMU Health and Safety Officer</li> <li>• PMU Environmental Officer</li> </ul>	<ul style="list-style-type: none"> <li>• Visual inspection</li> <li>• Documentation</li> <li>• Interviews with workers</li> <li>• To be completed at each check</li> </ul>	To be completed at check if compliance is not satisfactory. State who is responsible for action.

3.6 Noise from construction activities causes disturbance.	<ul style="list-style-type: none"> <li>• Refer Appendix D1.3</li> <li>• Minimise site-generated noise to the greatest possible extent.</li> <li>• Do not allow works to occur during the hours of darkness (6 pm to 6 am), on Sundays and religious holidays, other than in exceptional circumstances. If it is necessary to work at other times (e.g. to avoid high tides), work schedules must be discussed and agreed upon in consultation with the EPA and the local communities.</li> <li>• Provide temporary construction noise barriers in the form of solid hoardings where there may be an impact on specific residents.</li> <li>• Provide warnings of blasting, starting at least 24 hours ahead, and ensure no one is within the 500 m clearance zone.</li> <li>• Provide communities, through the CLO, with details of the works programme.</li> <li>• Do not deviate from the agreed timing of works.</li> <li>• Consult nearby residents in advance of construction activities particularly if noise generating construction activities are to be carried out outside of 'daytime' hours: 6 am-6 pm in order to accommodate tidal conditions.</li> </ul>	Service provider	Standard D.1.3	<ul style="list-style-type: none"> <li>• Before starting work</li> <li>• Monthly during site operations</li> </ul>	<ul style="list-style-type: none"> <li>• PMU Social Safeguards Officer</li> <li>• PMU Health and Safety Officer</li> </ul>	<ul style="list-style-type: none"> <li>• Visual inspection</li> <li>• Documentation</li> <li>• Interviews with workers</li> <li>• Interviews with communities</li> <li>• Noise measurements</li> <li>• To be completed at each check</li> </ul>	To be completed at check if compliance is not satisfactory. State who is responsible for action.
3.7 Noise from construction machinery (plant,	<ul style="list-style-type: none"> <li>• Refer Appendix D1.3 and D1.4</li> <li>• Select plant and equipment and specific design work practices to</li> </ul>	Service provider	Standard D.1.3	<ul style="list-style-type: none"> <li>• Before starting work</li> </ul>	<ul style="list-style-type: none"> <li>• PMU Social Safeguards Officer</li> </ul>	<ul style="list-style-type: none"> <li>• Visual inspection</li> <li>• Documentation</li> </ul>	To be completed at check if

Environmental and Social Management and Monitoring Matrix (ESMMM)							
Potential impacts	Mitigation measures	Responsibility for implementation	Standard to be met (refer Appendix D)	Monitoring			
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transportation activities, etc.) causes disturbance.	<p>ensure that noise emissions are minimised during construction, including all pumping equipment.</p> <ul style="list-style-type: none"> <li>• Specific noise reduction devices such as silencers and mufflers shall be installed as appropriate to site plant and equipment.</li> <li>• The use of substitution control strategies shall be implemented, whereby excessive noise generating equipment are replaced with other alternatives.</li> </ul>			<ul style="list-style-type: none"> <li>• Monthly during site operations</li> </ul>	<ul style="list-style-type: none"> <li>• PMU Health and Safety Officer</li> </ul>	<ul style="list-style-type: none"> <li>• Interviews with workers</li> <li>• Interviews with communities</li> <li>• Noise measurements</li> <li>• To be completed at each check</li> </ul>	compliance is not satisfactory. State who is responsible for action.

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Potential impacts	Mitigation measures	Responsibility for implementation	Standard to be met (refer Appendix D)	Monitoring			
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3.8 Ground or air vibration cause damage to structures in neighbouring areas.	<ul style="list-style-type: none"> <li>• Refer Appendix D1.4</li> <li>• Identify properties, structures and habitat locations that will be sensitive to vibration impacts resulting from construction activities.</li> <li>• Design to give due regard to temporary and permanent mitigation measures for noise and vibration from construction and operational vibration impacts.</li> <li>• All incidents, complaints and non-compliances related to vibration shall be reported in accordance with the site incident reporting procedures and summarised in the register.</li> <li>• Minimise heavy truck and machine operations within 200 metres of buildings.</li> <li>• During blasting operations, ensure staggered charge sequences to minimise ground vibrations and air overpressure.</li> <li>• Provide warnings of blasting, starting at least 24 hours ahead, and ensure no one is within the 500-m clearance zone.</li> </ul>	Service provider	Standard D.1.4	<ul style="list-style-type: none"> <li>• Before starting work</li> <li>• Monthly during site operations</li> </ul>	PMU Social Safeguards Officer	<ul style="list-style-type: none"> <li>• Visual inspection</li> <li>• Documentation</li> <li>• Interviews with communities</li> <li>• To be completed at each check</li> </ul>	To be completed at check if compliance is not satisfactory. State who is responsible for action.

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Potential impacts	Mitigation measures	Responsibility for implementation	Standard to be met (refer Appendix D)	Monitoring			
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3.9 Construction sites are left in such a condition that injuries occur to the public, especially children, after works are completed.	<ul style="list-style-type: none"> <li>• Maintain high standards in the finishing of site works.</li> <li>• Review completed works and undertake a safety audit.</li> <li>• Design and implement any corrections that are required to ensure that the construction works done by the project are fully safe for use.</li> </ul>	Service provider and Site Engineer	Not applicable	<ul style="list-style-type: none"> <li>• Before starting work</li> <li>• Monthly during site operations</li> <li>• After completion of site operations</li> </ul>	PMU Health and Safety Officer	<ul style="list-style-type: none"> <li>• Visual inspection</li> <li>• Documentation</li> <li>• To be completed at each check</li> </ul>	To be completed at check if compliance is not satisfactory. State who is responsible for action.
3.10 Community ill-health from waste generation and management at work sites and interventions areas.	<ul style="list-style-type: none"> <li>• As for potential impacts 12.1 and 12.2 – see below.</li> </ul>	Service provider	Guideline D.2.12	<ul style="list-style-type: none"> <li>• Before start of work</li> <li>• Monthly during site operations</li> </ul>	<ul style="list-style-type: none"> <li>• PMU Health and Safety Officer</li> <li>• PMU Social Safeguards Officer</li> </ul>	<ul style="list-style-type: none"> <li>• Visual inspection</li> <li>• Documentation</li> <li>• Interviews with the workers</li> <li>• Interviews with the neighbouring communities</li> <li>• To be completed at each check</li> </ul>	To be completed at check if compliance is not satisfactory. State who is responsible for action.

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Potential impacts	Mitigation measures	Responsibility for implementation	Standard to be met (refer Appendix D)	Monitoring			
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4. Occupational health and safety							
4.1 Workers are unaware of the dangers from the sites they are working in, leading to high rates of injury.	<ul style="list-style-type: none"><li>• Ensure that workers are given safety inductions, toolbox talks and full daily and weekly briefings.</li><li>• Develop a culture of admonishment for unsafe acts.</li><li>• Obligate managers to set good examples for respecting safety on site.</li><li>• Only allow workers to use machine tools if they have been trained to do so.</li><li>• Ensure that all working sites are kept tidy, and that potential obstructions are removed.</li></ul>	Service provider	Not applicable	Weekly during site operations	PMU Health and Safety Officer	<ul style="list-style-type: none"><li>• Interviews with workers</li><li>• To be completed at each check</li></ul>	To be completed at check if compliance is not satisfactory. State who is responsible for action.
4.2 Injuries due to inadequate provision of safety equipment.	<ul style="list-style-type: none"><li>• Provide all workers with safety equipment appropriate to the work that they are doing.</li><li>• Do not allow workers on to a site unless they are wearing the appropriate safety gear.</li><li>• Keep first aid kits on all work sites and ensure they remain stocked and all items are in-date.</li><li>• Ensure that there are two people on each work site who know what to do if there is an accident and how to use the first aid kit.</li></ul>	Service provider	Guideline D.2.1	Weekly during site operations	PMU Health and Safety Officer	<ul style="list-style-type: none"><li>• Visual inspection</li><li>• Documentation</li><li>• Interviews with workers</li><li>• To be completed at each check</li></ul>	To be completed at check if compliance is not satisfactory. State who is responsible for action.

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Potential impacts	Mitigation measures	Responsibility for implementation	Standard to be met (refer Appendix D)	Monitoring			
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4.3 Injuries occur from moving plant (i.e. vehicles, trucks, dozers, excavators, graders, rollers, etc.).	<ul style="list-style-type: none"> <li>• Instruct foremen and supervisors to ensure a safe distance between workers and machines.</li> <li>• Be particularly strict about the use of PPE.</li> <li>• Where workers have to be close to machines, place a spotter with a whistle to alert the operator if someone is at risk.</li> <li>• If an unsafe act is witnessed, stop the work and admonish the culprit fully, in front of all the other workers.</li> </ul>	Service provider	Guideline D.2.1	Weekly during site operations	PMU Health and Safety Officer	<ul style="list-style-type: none"> <li>• Visual inspection</li> <li>• Documentation</li> <li>• Interviews with workers</li> <li>• To be completed at each check</li> </ul>	To be completed at check if compliance is not satisfactory. State who is responsible for action.
4.4 Injuries occur from static plant (i.e. crushers, generators, etc.).	<ul style="list-style-type: none"> <li>• Ensure that barriers and guards are kept in place so that people cannot come into contact with moving parts accidentally.</li> <li>• Issue strict procedures for stopping plant to carry out servicing actions.</li> <li>• Ensure that there is always a chief operator in place with an emergency stop button, watching over the plant.</li> <li>• If an unsafe act is witnessed, stop the work and admonish the culprit fully, in front of all the other workers.</li> </ul>	Service provider	Not applicable	Weekly during site operations	PMU Health and Safety Officer	<ul style="list-style-type: none"> <li>• Visual inspection</li> <li>• Documentation</li> <li>• Interviews with workers</li> <li>• To be completed at each check</li> </ul>	To be completed at check if compliance is not satisfactory. State who is responsible for action.



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Potential impacts	Mitigation measures	Responsibility for implementation	Standard to be met (refer Appendix D)	Monitoring			
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4.5 Injuries occur from exposure to hazardous substances (e.g. cement, diesel).	<ul style="list-style-type: none"> <li>• Only use the designated areas for storage of hazardous materials.</li> <li>• Provide training for all personnel handling fuel and oil.</li> <li>• Have controls in place to minimise opportunities for fuel pilferage.</li> <li>• Check facilities, safeguards and procedures for any potential for explosions to occur.</li> <li>• Issue strict protocols for the use of cement, ready-mix concrete, etc. at the appropriate plants.</li> <li>• Enforce the reporting system for spillage incidents.</li> </ul>	Service provider	Guideline D.2.13	Weekly during site operations	PMU Health and Safety Officer	<ul style="list-style-type: none"> <li>• Visual inspection</li> <li>• Documentation</li> <li>• Interviews with workers</li> <li>• To be completed at each check</li> </ul>	To be completed at check if compliance is not satisfactory. State who is responsible for action.

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4.6 Injuries occur as a result of vehicle accidents.	<ul style="list-style-type: none"> <li>• Check the serviceability and running condition of all light vehicles, trucks and mobile plant, and maintain it as appropriate.</li> <li>• Test all project and Service providers' drivers and either pass them to drive, send them for more training or ban them from driving.</li> <li>• Ensure the obligatory speed limits are followed.</li> <li>• Maintain a distance of 200 metres between loaded trucks.</li> <li>• Make reverse parking compulsory at all locations.</li> <li>• Ban all driving between 7 pm and 6 am.</li> <li>• Introduce random breath testing of drivers for alcohol.</li> </ul>	Service provider	Not applicable	Weekly during site operations	PMU Health and Safety Officer	<ul style="list-style-type: none"> <li>• Visual inspection</li> <li>• Documentation</li> <li>• Interviews with workers</li> <li>• To be completed at each check</li> </ul>	To be completed at check if compliance is not satisfactory. State who is responsible for action.

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Potential impacts	Mitigation measures	Responsibility for implementation	Standard to be met (refer Appendix D)	Monitoring			
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4.7 Injuries occur from passengers being carried in the wrong places on pickups, trailers and trucks.	<ul style="list-style-type: none"> <li>• Never allow anyone to travel in the bucket of a pick-up or truck.</li> <li>• Never allow anyone to travel in a trailer.</li> <li>• Never allow anyone to travel on a tractor, excavator, dozer, grader, roller or other single-seat machine as passenger (only the operator).</li> <li>• Insist that every passenger must be in a proper seat, with no sharing of seats.</li> <li>• Ensure that seat belts are available for all seats and train drivers not to start the engine until they are all in place.</li> <li>• Maintain a zero tolerance policy for the above rules.</li> <li>• If workers need to be transported, provide jeeps or buses.</li> </ul>	Service provider	Not applicable	Weekly during site operations	PMU Health and Safety Officer	<ul style="list-style-type: none"> <li>• Visual inspection</li> <li>• Documentation</li> <li>• Interviews with workers</li> <li>• To be completed at each check</li> </ul>	To be completed at check if compliance is not satisfactory. State who is responsible for action.
4.8 Injuries occur from poor management of quarrying and blasting activities	<ul style="list-style-type: none"> <li>• Enforce a 500 metre safety zone cleared around the blasting site.</li> <li>• Post warning notices around the site, giving at least 24 hours warning of a blast.</li> <li>• Sound a loud double siren before blasting shots are fired.</li> <li>• Follow the Obligatory Procedure for Blasting at Quarries.</li> <li>• Store explosives and detonators in separate, secure and locked containers.</li> </ul>	Service provider	Guidelines D.2. 18 and D.2. 19	Monthly during site operations	PMU Health and Safety Officer	<ul style="list-style-type: none"> <li>• Visual inspection</li> <li>• Documentation</li> <li>• Interviews with workers</li> <li>• To be completed at each check</li> </ul>	To be completed at check if compliance is not satisfactory. State who is responsible for action.

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Potential impacts	Mitigation measures	Responsibility for implementation	Standard to be met (refer Appendix D)	Monitoring			
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4.9 Excessive noise levels occur from construction activities (plant, transportation activities, etc.) cause hearing damage.	<ul style="list-style-type: none"> <li>• Refer Appendix D1.3</li> <li>• Minimise site-generated noise to the greatest possible extent.</li> <li>• Provide all site workers exposed to noise over 70 dB(A) with ear protection.</li> <li>• Do not allow any person to come close to a machine without having ear protection in place.</li> <li>• Conduct employee and operator training to improve awareness of the need to minimise excessive noise in work practices through implementation of measures.</li> </ul>	Service provider	Standard D.1.3	<ul style="list-style-type: none"> <li>• Before starting work</li> <li>• Monthly during site operations</li> </ul>	<ul style="list-style-type: none"> <li>• PMU Social Safeguards Officer.</li> <li>• PMU Health and Safety Officer</li> </ul>	<ul style="list-style-type: none"> <li>• Visual inspection</li> <li>• Documentation</li> <li>• Interviews with workers</li> <li>• Interviews with communities</li> <li>• Noise measurements</li> <li>• To be completed at each check</li> </ul>	To be completed at check if compliance is not satisfactory. State who is responsible for action.

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Potential impacts	Mitigation measures	Responsibility for implementation	Standard to be met (refer Appendix D)	Monitoring			
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4.10 Fire and emergency management and prevention strategies are put in place construction sites.	<ul style="list-style-type: none"> <li>• Develop an Emergency Response Plan.</li> <li>• Flammable and combustible liquids bunding/storage areas must be designed and built in accordance with appropriate international standards.</li> <li>• Fire extinguishers are to be available at every work site.</li> <li>• No open fires are permitted within the project area.</li> <li>• Communication equipment and emergency protocols must be established prior to commencement of construction activities.</li> <li>• All staff must be trained in emergency preparedness and response.</li> </ul>	Service provider	Not applicable	<ul style="list-style-type: none"> <li>• Before starting work</li> <li>• Monthly during site operations</li> </ul>	PMU Health and Safety Officer	<ul style="list-style-type: none"> <li>• Visual inspection</li> <li>• Documentation</li> <li>• To be completed at each check</li> </ul>	To be completed at check if compliance is not satisfactory. State who is responsible for action.
4.11 Ill-health of workers from waste generation and management at work sites and interventions areas.	<ul style="list-style-type: none"> <li>• As for potential impacts 12.1 and 12.2 – see below.</li> </ul>	Service provider	Guideline D.2.12	<ul style="list-style-type: none"> <li>• Before start of work</li> <li>• Monthly during site operations</li> </ul>	PMU Environmental Officer	<ul style="list-style-type: none"> <li>• Visual inspection</li> <li>• Documentation</li> <li>• Interviews with the workers</li> <li>• To be completed at each check</li> </ul>	To be completed at check if compliance is not satisfactory. State who is responsible for action.

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Potential impacts	Mitigation measures	Responsibility for implementation	Standard to be met (refer Appendix D)	Monitoring			
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5. Labour and working conditions							
5.1 Children are employed on site.	<ul style="list-style-type: none"><li>Contractor contracts to include clauses relating to labour laws (national and International)</li><li>Develop, adopt and implement labor management guidelines to safeguard against prevalent poor labour practices</li><li>Instruct all foremen and supervisors to check the identity cards of all new workers, to ascertain that they are over 16 years old.</li><li>If you see someone on site who appears to be younger than 18 years old, check their identity directly.</li></ul>	Service provider	Guideline D.2.24	<ul style="list-style-type: none"><li>Before starting work</li><li>Weekly during site operations</li></ul>	PMU Social Safeguards Officer	<ul style="list-style-type: none"><li>Visual inspection</li><li>Documentation</li><li>To be completed at each check</li></ul>	To be completed at check if compliance is not satisfactory. State who is responsible for action.
5.2 Women are discriminated against in employment or on site.	<ul style="list-style-type: none"><li>Develop, adopt and implement labor management guidelines to safeguard against prevalent poor labour practices</li><li>Issue a simple but strong policy statement to all managers, stating that men and women are to be treated equally in all respects.</li><li>Instruct managers to ensure that there are no signs of discrimination in their work divisions.</li><li>If you come across evidence of sexual discrimination, deal with it in a no tolerance fashion.</li></ul>	Service provider	Guideline D.2.4	<ul style="list-style-type: none"><li>Before starting work</li><li>Weekly during site operations</li></ul>	PMU Social Safeguards Officer	<ul style="list-style-type: none"><li>Visual inspection</li><li>Documentation</li><li>Interviews with workers</li><li>To be completed at each check</li></ul>	To be completed at check if compliance is not satisfactory. State who is responsible for action.

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5.3 Local people are not given adequate opportunities for employment, and outsiders are brought in instead.	<ul style="list-style-type: none"> <li>• Establish an equitable and fair employment strategy. Liaise with the community liaison staff to ensure that it is understood in the local communities (i.e. that it is transparent).</li> <li>• Give priority to local men and women in labour crews, whose livelihoods are affected by project activities.</li> <li>• Pay the usual accepted County wage rates.</li> <li>• Do not demand unpaid work by locals.</li> <li>• Refer Appendix D2.24</li> </ul>	Service provider	Not applicable	<ul style="list-style-type: none"> <li>• Before starting work</li> <li>• Monthly during site operations</li> </ul>	PMU Social Safeguards Officer	<ul style="list-style-type: none"> <li>• Visual inspection</li> <li>• Documentation</li> <li>• To be completed at each check</li> </ul>	To be completed at check if compliance is not satisfactory. State who is responsible for action.
5.4 Water and food are not provided to workers.	<ul style="list-style-type: none"> <li>• Organize a barrel of drinking water with a tap to be made available to each labour gang.</li> <li>• Instruct foremen and supervisors to check that their workers are able to obtain adequate food and water.</li> <li>• If there is a problem on a particular part of the site, take action to ensure it is resolved.</li> <li>• Never expect workers to operate on site unless they have a plentiful supply of clean drinking water.</li> <li>• Avoid using bottled water if at all possible. If this does have to be done, ensure that the used bottles are collected for recycling.</li> </ul>	Service provider	Not applicable	<ul style="list-style-type: none"> <li>• Before starting work</li> <li>• Weekly during site operations</li> </ul>	Health and Safety Officer	<ul style="list-style-type: none"> <li>• Visual inspection</li> <li>• Documentation</li> <li>• To be completed at each check</li> </ul>	To be completed at check if compliance is not satisfactory. State who is responsible for action.

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5.5 Accommodation for non-local workers is inadequate or unhealthy.	<ul style="list-style-type: none"> <li>• Ensure that non-local workers are accommodated in sound, dry buildings, with good ventilation and clean water supplies, and with good cleanliness and sanitation arrangements (refer Appendix D2.17).</li> <li>• Provide bed nets to all non-local workers.</li> <li>• Monitor and control the habitats of malaria vectors.</li> <li>• Instruct foremen and supervisors to check that their local workers are able to find suitable accommodation.</li> <li>• If accommodation has to be provided in some part of the site, it must be large enough, clean, dry, screened from mosquitoes and with good running water and sanitation.</li> <li>• Never expect workers to share crowded or unsanitary accommodation.</li> </ul>	Service provider	Not applicable	<ul style="list-style-type: none"> <li>• Before starting work</li> <li>• Monthly during site operations</li> </ul>	Health and Safety Officer	<ul style="list-style-type: none"> <li>• Visual inspection</li> <li>• Documentation</li> <li>• To be completed at each check</li> </ul>	To be completed at check if compliance is not satisfactory. State who is responsible for action.



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Potential impacts	Mitigation measures	Responsibility for implementation	Standard to be met (refer Appendix D)	Monitoring			
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5.6 Poor sanitation at long term work sites, including ships, leads to illnesses in workers and pollution of the environment.	<ul style="list-style-type: none"> <li>• Provide proper water closet toilet facilities at all long term (&gt; 1 month) work sites.</li> <li>• Do not allow water to run out at toilets.</li> <li>• Maintain all toilets in a clean and sanitary condition.</li> <li>• Ensure that toilets on ships are maintained and operated in accordance with international maritime standards.</li> </ul>	Service provider	Guideline D.2.17	<ul style="list-style-type: none"> <li>• Before starting work</li> <li>• Monthly during site operations</li> </ul>	Health and Safety Officer	<ul style="list-style-type: none"> <li>• Visual inspection</li> <li>• Documentation</li> <li>• To be completed at each check</li> </ul>	To be completed at check if compliance is not satisfactory. State who is responsible for action.
5.7 Lack of sanitation at temporary work sites leads to illnesses in workers and pollution of the environment.	<ul style="list-style-type: none"> <li>• Provide proper earth pit latrines at all work sites where work will be undertaken for periods of up to one month.</li> <li>• Fill the latrines in once they become full and when site work is complete.</li> <li>• Do not allow site workers to defecate in the open anywhere on the site or in its vicinity.</li> <li>• Add the use of sanitation arrangements in tool box talks.</li> </ul>	Service provider	Guideline D.2.17	<ul style="list-style-type: none"> <li>• Before starting work</li> <li>• Monthly during site operations</li> </ul>	Health and Safety Officer	<ul style="list-style-type: none"> <li>• Visual inspection</li> <li>• Documentation</li> <li>• To be completed at each check</li> </ul>	To be completed at check if compliance is not satisfactory. State who is responsible for action.

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Potential impacts	Mitigation measures	Responsibility for implementation	Standard to be met (refer Appendix D)	Monitoring			
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5.8 Influx of a large number of workers into the project area for a short time has a negative impact on communities.	<ul style="list-style-type: none"> <li>• Ensure that all professional and technical staff respect the local communities and behave well.</li> <li>• Do not ignore blatant disrespect for communities by professional and technical staff.</li> <li>• Ensure that the site supervisors brief all workers at the start of every job, and at the beginning of each week, on the main messages regarding respect for the local communities.</li> <li>• Provide awareness trainings to workers and nearby communities, on the prevention of contagion and infection from diseases such as influenza, Ebola, sexually transmitted diseases and HIV.</li> <li>• Encourage workers to abstain from sex with local people, or to use suitable protection such as condoms.</li> <li>• Issue policy statements on the project's adherence to Liberian law regarding sexual exploitation (including minors and prostitution) and gender-based violence.</li> <li>• Maintain a zero tolerance punitive regime among all staff and workers on all behavioural issues.</li> </ul>	Service provider	Guideline D.2.4	<ul style="list-style-type: none"> <li>• Before starting work</li> <li>• Monthly during site operations</li> </ul>	PMU Social Safeguards Officer assisted by the Health and Safety Officer	<ul style="list-style-type: none"> <li>• Visual inspection</li> <li>• Documentation</li> <li>• To be completed at each check</li> </ul>	To be completed at check if compliance is not satisfactory. State who is responsible for action.

Environmental and Social Management and Monitoring Matrix (ESMMM)							
Potential impacts	Mitigation measures	Responsibility for implementation	Standard to be met (refer Appendix D)	Monitoring			
				Check timing	Responsibility for checking	Assessment of condition	Action required
5.9 Labour disputes occur.	<ul style="list-style-type: none"> <li>• Ensure that the foremen and supervisors always act in a professional and fair manner to all staff.</li> <li>• Show respect to anyone raising a complaint, and deal with it promptly and fairly.</li> <li>• Instruct the community liaison staff to maintain close contact with the local communities and groups of local workers, and to raise any emerging concerns before they become serious.</li> </ul>	Service provider	Not applicable	<ul style="list-style-type: none"> <li>• Before starting work</li> <li>• Monthly during site operations</li> </ul>	PMU Social Safeguards Officer	<ul style="list-style-type: none"> <li>• Interviews with workers</li> <li>• Documentation</li> <li>• To be completed at each check</li> </ul>	To be completed at check if compliance is not satisfactory. State who is responsible for action.

Environmental and Social Management and Monitoring Matrix (ESMMM)							
Potential impacts	Mitigation measures	Responsibility for implementation	Standard to be met (refer Appendix D)	Monitoring			
				Check timing	Responsibility for checking	Assessment of condition	Action required
6. Water resources management							
6.1a Damage to water resources by pollution with waste, sewage, sediment, oil or chemicals in runoff in coastal and estuarine water systems, in rivers and in water supply boreholes.	<ul style="list-style-type: none"><li>• Do not dispose of anything into any kind of water body.</li><li>• Keep earthworks, work sites, tracks and other cleared areas as far as possible from the sea, watercourses or other water bodies.</li><li>• Where earthworks, tracks, roads and other cleared areas are within 50 m of the sea, watercourses or other water bodies, take special care to ensure that fuel, oil and other hazardous substances, and any earthworks, are properly contained.</li><li>• Designated areas for storage of fuels, oils, chemicals or other hazardous liquids must have compacted impermeable bases and be surrounded by a bund to contain any spillage. Refuelling must be undertaken in areas away from water systems.</li><li>• Construction materials must not be stockpiled in proximity to any part of the aquatic environment where there is any possibility of release into the environment.</li></ul>	Service provider	Standard D.1.2, Guidelines D.2.5, D.2.6.3, D.2.12.1, D.2.13, D.2.16, D.2.17 D.2.18.9	<ul style="list-style-type: none"><li>• Before starting work</li><li>• Monthly during site operations</li></ul>	PMU Environmental Officer	<ul style="list-style-type: none"><li>• Visual inspection</li><li>• Documentation</li><li>• Water sampling</li><li>• To be completed at each check</li></ul>	To be completed at check if compliance is not satisfactory. State who is responsible for action.

Environmental and Social Management and Monitoring Matrix (ESMMM)							
Potential impacts	Mitigation measures	Responsibility for implementation	Standard to be met (refer Appendix D)	Monitoring			
				Check timing	Responsibility for checking	Assessment of condition	Action required
6.1b Damage to water resources by pollution with waste, sewage, sediment, oil or chemicals in runoff in coastal and estuarine water systems, in rivers and in water supply boreholes.	<ul style="list-style-type: none"> <li>Construction equipment will be removed from proximity to the aquatic environment at the end of each working day or if heavy rainfall is predicted.</li> <li>Check all vehicles, equipment and material storage areas daily for possible fuel, oil and chemical leaks.</li> <li>Monitor coastal, estuarine and freshwater surface and groundwater quality routinely.</li> <li>Schedule major earthworks only in the dry season.</li> <li>Schedule works in stages to ensure that disturbed areas are revegetated and stabilised progressively and as soon as practicable after completion of works.</li> <li>Use surface protection measures to control soil erosion and protect watercourses.</li> <li>Regulate construction site water discharge and runoff using sediment ponds.</li> <li>Develop and implement site specific measures to address drainage control, sediment and erosion controls and stockpiling of materials including soil during construction of all components of the project.</li> </ul>	Service provider	Standard D.1.2, Guidelines D.2.5, D.2.6.3, D.2.12.1, D.2.13, D.2.16, D.2.17 and D.2.18.9	<ul style="list-style-type: none"> <li>Before starting work</li> <li>Monthly during site operations</li> </ul>	PMU Environmental Officer	<ul style="list-style-type: none"> <li>Visual inspection</li> <li>Documentation</li> <li>Water sampling</li> <li>To be completed at each check</li> </ul>	To be completed at check if compliance is not satisfactory. State who is responsible for action.

Environmental and Social Management and Monitoring Matrix (ESMMM)							
Potential impacts	Mitigation measures	Responsibility for implementation	Standard to be met (refer Appendix D)	Monitoring			
				Check timing	Responsibility for checking	Assessment of condition	Action required
6.1c Damage to water resources by pollution with waste, sewage, sediment, oil or chemicals in runoff in coastal and estuarine water systems, in rivers and in water supply boreholes.	<ul style="list-style-type: none"> <li>Ensure that the machines that will be shipped into Liberia for the construction of the protective interventions are certified for use in coastal environment and are inspected by the consultant prior to shipping.</li> </ul>	Service provider	Standard D.1.2, Guidelines D.2.5, D.2.6.3, D.2.12.1, D.2.13, D.2.16, D.2.17 and D.2.18.9	<ul style="list-style-type: none"> <li>Before starting work</li> <li>Monthly during site operations</li> </ul>	PMU Environmental Officer	<ul style="list-style-type: none"> <li>Visual inspection</li> <li>Documentation</li> <li>Water sampling</li> <li>To be completed at each check</li> </ul>	To be completed at check if compliance is not satisfactory. State who is responsible for action.
6.2 Extraction of freshwater resources affects water supply for the communities in the project area.	<ul style="list-style-type: none"> <li>Ensure that all community water supplies are safeguarded. Confirm the location of local water supplies before extracting. Be prepared to bring in clean water for communities where the works have polluted their water sources</li> <li>Do not extract so much water from a supply that the normal users are short.</li> </ul>	Service provider	Not applicable	<ul style="list-style-type: none"> <li>Before starting work</li> <li>Monthly during site operations</li> </ul>	PMU Social Safeguards Officer assisted by the PMU Environmental Officer	<ul style="list-style-type: none"> <li>Visual inspection</li> <li>Documentation</li> <li>To be completed at each check</li> </ul>	To be completed at check if compliance is not satisfactory. State who is responsible for action.

Environmental and Social Management and Monitoring Matrix (ESMMM)							
Potential impacts	Mitigation measures	Responsibility for implementation	Standard to be met (refer Appendix D)	Monitoring			
				Check timing	Responsibility for checking	Assessment of condition	Action required
7. Coastal sediment resources management							
7.1 Shore and nearshore sediment erosion and deposition change as a result of physical coastal interventions.	<ul style="list-style-type: none"><li>• Undertake a marine and estuarine sediment survey.</li><li>• Establish a marine physical environmental monitoring programme as part of the ESIA.</li><li>• Continue to operate the monitoring programme throughout project implementation.</li></ul>	ESIA Consultant / EPA	Not applicable	<ul style="list-style-type: none"><li>• Part of the ESIA</li><li>• Regularly throughout the project</li><li>• After project completion</li></ul>	PMU Environmental Officer	<ul style="list-style-type: none"><li>• Visual inspection</li><li>• Sampling</li><li>• Documentation</li><li>• To be completed at each check</li></ul>	To be completed at check if compliance is not satisfactory. State who is responsible for action.
7.2 Changed sediment fluxes in the Mesurado Estuary. This may act as a sediment sink as a result of climate change leading to sea level rise, potentially affected by geomorphological changes to the West Point beach following construction of the revetment.	<ul style="list-style-type: none"><li>• Conduct a sediment survey in the Mesurado Estuary as part of the ESIA and establish a sediment monitoring programme.</li><li>• Continue to operate the sediment monitoring programme through project implementation.</li></ul>	ESIA Consultant / EPA	Not applicable	<ul style="list-style-type: none"><li>• Part of the ESIA</li><li>• Regularly throughout the project</li><li>• After project completion</li></ul>	PMU Environmental Officer	<ul style="list-style-type: none"><li>• Visual inspection</li><li>• Sediment sampling</li><li>• To be completed at each check</li></ul>	To be completed at check if compliance is not satisfactory. State who is responsible for action.

Environmental and Social Management and Monitoring Matrix (ESMMM)							
Potential impacts	Mitigation measures	Responsibility for implementation	Standard to be met (refer Appendix D)	Monitoring			
				Check timing	Responsibility for checking	Assessment of condition	Action required
7.3 Presence of UXO in the construction or quarrying sites.	<ul style="list-style-type: none"> <li>• If anything that looks like a bomb is seen during project activities, stop work immediately. Clear the area and notify the supervisor.</li> <li>• The incident should be reported to the Armed Forces of Liberia (AFL).</li> <li>• Activities may be resumed once clearance is received from AFL.</li> </ul>	Service provider	No UXO	Throughout the project	PMU Health and Safety Officer	<ul style="list-style-type: none"> <li>• Walkover visual inspections</li> <li>• Interviews with workers</li> </ul>	To be completed at check if compliance is not satisfactory. State who is responsible for action.
<b>8. Soil and land resources management</b>							
8.1 Loss of surface soil and sedimentation to the surface and/or groundwater systems in quarry sites due to excessive disturbance.	<u>Minimize disturbance</u> <ul style="list-style-type: none"> <li>• Only disturb the soil where it is necessary to do so for the agreed works. Schedule works to minimise cleared areas and exposed soils at all times.</li> <li>• Use existing tracks and previously disturbed areas as far as possible.</li> <li>• Keep earthworks, tracks and other cleared areas as far as possible from watercourses or water bodies</li> <li>• Do not make access tracks wider or other cleared areas larger than is absolutely necessary.</li> </ul>	Service provider	Guidelines D.2.6 and D.2.7	<ul style="list-style-type: none"> <li>• Before start of work</li> <li>• Monthly during site operations</li> </ul>	PMU Environmental Officer	<ul style="list-style-type: none"> <li>• Visual inspection</li> <li>• Documentation</li> <li>• To be completed at each check</li> </ul>	To be completed at check if compliance is not satisfactory. State who is responsible for action.



Environmental and Social Management and Monitoring Matrix (ESMMM)							
Potential impacts	Mitigation measures	Responsibility for implementation	Standard to be met (refer Appendix D)	Monitoring			
				Check timing	Responsibility for checking	Assessment of condition	Action required
8.2 Loss of surface soil and sedimentation to the surface and/or groundwater systems in quarry sites due to erosion.	<p><u>Prevent erosion</u></p> <ul style="list-style-type: none"> <li>Do not allow erosion to happen without taking rapid control measures: install erosion and sediment controls as the very first physical site activity. Ensure regular inspection and maintenance of these control measures.</li> <li>Incorporate the design and location of temporary and permanent soil protection measures for all exposed areas and drainage lines. These shall be implemented prior to pre-construction activities and shall remain onsite during work.</li> <li>Schedule major earthworks and vegetation disturbance only in the dry season.</li> <li>Mulching shall be used as a form of erosion and sediment control and where used on any slopes (dependent on site selection), include extra sediment fencing during high rainfall.</li> <li>Undertake soil erosion and sediment controls as necessary, to protect areas from slips and erosion. All soil slopes steeper than 10° must be revegetated.</li> </ul>	Service provider	Guidelines D.2.8, D.2.9, D.2.10 and D.2.11	<ul style="list-style-type: none"> <li>Before start of work</li> <li>Monthly during site operations</li> </ul>	PMU Environmental Officer	<ul style="list-style-type: none"> <li>Visual inspection</li> <li>Documentation</li> <li>To be completed at each check</li> </ul>	To be completed at check if compliance is not satisfactory. State who is responsible for action.

Environmental and Social Management and Monitoring Matrix (ESMMM)							
Potential impacts	Mitigation measures	Responsibility for implementation	Standard to be met (refer Appendix D)	Monitoring			
				Check timing	Responsibility for checking	Assessment of condition	Action required
8.3 Loss of surface soil and sedimentation to the surface and/or groundwater systems in quarry sites due to unprotected slope surfaces.	<u>Protect slope surfaces</u> <ul style="list-style-type: none"> <li>• Grade any newly formed slopes to the minimum angle possible.</li> <li>• Cut slopes to grades appropriate to the material found.</li> <li>• Level surfaces to prevent erosion as soon as works have been completed.</li> <li>• Keep earth piles away from the edges of steep slopes and watercourses.</li> <li>• Allow small plants to grow back on the edges of tracks.</li> </ul>	Service provider	Guidelines D.2.8, D.2.9, D.2.10 and D.2.11	<ul style="list-style-type: none"> <li>• Before start of work</li> <li>• Monthly during site operations</li> </ul>	PMU Environmental Officer	<ul style="list-style-type: none"> <li>• Visual inspection</li> <li>• Documentation</li> <li>• To be completed at each check</li> </ul>	To be completed at check if compliance is not satisfactory. State who is responsible for action.
8.4 Loss of surface soil and sedimentation to the surface and/or groundwater systems in quarry sites due to improper management of topsoil.	<u>Save and reuse topsoil</u> <ul style="list-style-type: none"> <li>• Where it is present, top soil to a depth of 200 mm should be removed and stockpiled for later site restoration. Use stockpiled topsoil during revegetation and/or place removed soils back onto agricultural lands</li> <li>• Schedule works to minimise the duration of stockpiling topsoil material. Vegetate stockpiles if storage is required for long periods.</li> <li>• Locate stockpile areas away from drainage pathways, waterways and sensitive locations.</li> <li>• Avoid compaction of the soil in temporary use areas by limiting machine and vehicle access.</li> <li>• Deep-rip compacted soil using the tines on a bulldozer at the start of site rehabilitation.</li> </ul>	Service provider	Guideline D.2.6	<ul style="list-style-type: none"> <li>• Before start of work</li> <li>• Monthly during site operations</li> </ul>	PMU Environmental Officer	<ul style="list-style-type: none"> <li>• Visual inspection</li> <li>• Documentation</li> <li>• To be completed at each check</li> </ul>	To be completed at check if compliance is not satisfactory. State who is responsible for action.

Environmental and Social Management and Monitoring Matrix (ESMMM)							
Potential impacts	Mitigation measures	Responsibility for implementation	Standard to be met (refer Appendix D)	Monitoring			
				Check timing	Responsibility for checking	Assessment of condition	Action required
8.5 Loss of surface soil and sedimentation to the surface and/or groundwater systems in quarry sites due to improper drainage management.	<u>Provide drainage management</u> <ul style="list-style-type: none"> <li>Design storm water management measures to reduce flow velocities and avoid concentrating runoff.</li> <li>Grassed buffer strips shall be incorporated where necessary to reduce water velocity during earthworks.</li> <li>Include check dams in drainage lines where necessary to reduce flow velocities and provide some filtration of sediment. Regularly inspect and maintain check dams.</li> <li>Excess sediment in all erosion and sediment control structures (e.g. sediment basins, check dams) shall be removed when necessary to allow for adequate holding capacity.</li> <li>Where earthworks, tracks and other cleared areas are within 50 m of watercourses or bodies, take special care to ensure that fuel, oil and other hazardous substances, and any earthworks, are properly contained. Ensure proper bunding of containment area.</li> </ul>	Service provider	Guidelines D.2.6, D.2.7 and D.2.16	<ul style="list-style-type: none"> <li>Before start of work</li> <li>Monthly during site operations</li> </ul>	PMU Environmental Officer	<ul style="list-style-type: none"> <li>Visual inspection</li> <li>Documentation</li> <li>To be completed at each check</li> </ul>	To be completed at check if compliance is not satisfactory. State who is responsible for action.

Environmental and Social Management and Monitoring Matrix (ESMMM)							
Potential impacts	Mitigation measures	Responsibility for implementation	Standard to be met (refer Appendix D)	Monitoring			
				Check timing	Responsibility for checking	Assessment of condition	Action required
8.6 Soil contamination occurs as a result of project activities.	<ul style="list-style-type: none"> <li>• If contamination is suspected (outside of the project footprints), undertake a site contamination investigation, activate management procedures and obtain advice, permits and approval (as required).</li> <li>• Adhere to best practice for the removal and disposal of contaminated soil/ material from site (if required), including contaminated soil within the project footprints.</li> <li>• Ensure that drainage control measures for runoff do not come in contact with contaminated areas (including contaminated material within the project footprints) but are instead directed/diverted to stable areas for release.</li> <li>• Avoid importing fill that may result in site contamination and lacks accompanying certification or documentation.</li> </ul>	Service provider	Guidelines D.2.7, D.2.14 and D.2.17	<ul style="list-style-type: none"> <li>• Before start of work</li> <li>• Monthly during site operations</li> </ul>	PMU Environmental Officer	<ul style="list-style-type: none"> <li>• Visual inspection</li> <li>• Documentation</li> <li>• To be completed at each check</li> <li>• Sampling of soil when accidents occur</li> </ul>	To be completed at check if compliance is not satisfactory. State who is responsible for action.

Environmental and Social Management and Monitoring Matrix (ESMMM)							
Potential impacts	Mitigation measures	Responsibility for implementation	Standard to be met (refer Appendix D)	Monitoring			
				Check timing	Responsibility for checking	Assessment of condition	Action required
8.7 Soil contamination occurs as a result of incorrect waste management.	<ul style="list-style-type: none"> <li>All mitigation measures as for impact 12.2</li> </ul>	Service provider	Guideline D.2.12	<ul style="list-style-type: none"> <li>Before start of work</li> <li>Monthly during site operations</li> </ul>	PMU Environmental Officer	<ul style="list-style-type: none"> <li>Visual inspection</li> <li>Documentation</li> <li>Interviews with the workers</li> <li>Interviews with the neighbouring communities</li> <li>To be completed at each check</li> </ul>	To be completed at check if compliance is not satisfactory. State who is responsible for action.
8.8 Disposal of excess soil or silt leads to damage to land at the disposal site.	<ul style="list-style-type: none"> <li>Soil removed from excavations is to be beneficially reused e.g. returned to farm land, etc.</li> <li>Soil should be tested to confirm suitability for proposed use.</li> </ul>	Service provider	Guideline D.2.6	<ul style="list-style-type: none"> <li>Before start of work</li> <li>Monthly during site operations</li> </ul>	PMU Environmental Officer	<ul style="list-style-type: none"> <li>Visual inspection</li> <li>Documentation</li> <li>To be completed at each check</li> </ul>	To be completed at check if compliance is not satisfactory. State who is responsible for action.
8.9 Biodiversity (i.e. natural plants or animals) is destroyed unnecessarily.	<ul style="list-style-type: none"> <li>Instruct workforce not to hunt, deal in or transport bushmeat on site. Bushmeat includes proscribed marine species, such as turtles and turtle eggs.</li> <li>Provide meat from domestic animals if there is no alternative.</li> <li>Avoid all use of fire.</li> </ul>	Service provider	Standard D.1.5 and Guidelines D.2.2 and D.2.4	<ul style="list-style-type: none"> <li>Before start of work</li> <li>Monthly during site operations</li> </ul>	PMU Environmental Officer	<ul style="list-style-type: none"> <li>Visual inspection</li> <li>Documentation</li> <li>To be completed at each check</li> </ul>	To be completed at check if compliance is not satisfactory. State who is responsible for action.

Environmental and Social Management and Monitoring Matrix (ESMMM)							
Potential impacts	Mitigation measures	Responsibility for implementation	Standard to be met (refer Appendix D)	Monitoring			
				Check timing	Responsibility for checking	Assessment of condition	Action required
8.10 Construction materials are quarried and borrowed indiscriminately, leading to loss of forest and bush, and increased pollution.	<ul style="list-style-type: none"> <li>Identify borrow pits and quarry areas as early as possible, and conduct specific impact assessment and mitigation on these areas.</li> <li>Allow adequate time for the consultation, resettlement and compensation of people whose land is affected.</li> <li>Ensure that only the approved borrow pits and quarries are used.</li> <li>Install sediment control measures to prevent runoff from borrow pits and quarries causing contamination and siltation of water bodies.</li> <li>Take appropriate measures to prevent emissions and dust from affecting the ambient air quality outside the immediate site boundaries.</li> <li>Ensure proper geotechnical management so that excavations and tips do not trigger slope instability.</li> <li>Maintain borrow pits and quarries in a clean, safe and efficient condition.</li> <li>Take appropriate measures to prevent excessive noise and emissions from crushers.</li> <li>Rehabilitate borrow pits and quarries to a fully stable and vegetated condition after work has ceased.</li> </ul>	Service provider	Standards D.1.1, D.1.2, D.1.3, Guidelines D.2.2 and D.2.5	<ul style="list-style-type: none"> <li>Before start of work</li> <li>Monthly during site operations</li> </ul>	PMU Environmental Officer	<ul style="list-style-type: none"> <li>Visual inspection</li> <li>Documentation</li> <li>To be completed at each check</li> </ul>	To be completed at check if compliance is not satisfactory. State who is responsible for action.

Environmental and Social Management and Monitoring Matrix (ESMMM)							
Potential impacts	Mitigation measures	Responsibility for implementation	Standard to be met (refer Appendix D)	Monitoring			
				Check timing	Responsibility for checking	Assessment of condition	Action required
8.11 At quarries, the storage and use of explosives leads to fires or uncontrolled explosions.	<ul style="list-style-type: none"> <li>• Develop a Rock Quarry Management Plan, including a Blasting Plan</li> <li>• Obtain formal licensing from the government.</li> <li>• Abide by Liberian laws and regulations, and UNMIL guidelines, regarding the handling, storage and use of explosives.</li> <li>• Be particularly strict in enforcing safety regulations when using explosives.</li> <li>• Ensure that quarry blasting does not create excessive noise and vibration disturbance to wildlife and communities.</li> <li>• Do not allow any unauthorised person to have access to explosives.</li> <li>• Do not allow anyone to use welding equipment, use a mobile phone, smoke, cook food or light any fire within 50 m of an explosives store.</li> <li>• Ensure a security guard is assigned to be present in front of the explosives fence at all times.</li> </ul>	Service provider	Guideline D.2.2018	<ul style="list-style-type: none"> <li>• Before start of work</li> <li>• Monthly during site operations</li> </ul>	PMU Environmental Officer	<ul style="list-style-type: none"> <li>• Visual inspection</li> <li>• Documentation</li> <li>• To be completed at each check</li> </ul>	To be completed at check if compliance is not satisfactory. State who is responsible for action.

Environmental and Social Management and Monitoring Matrix (ESMMM)							
Potential impacts	Mitigation measures	Responsibility for implementation	Standard to be met (refer Appendix D)	Monitoring			
				Check timing	Responsibility for checking	Assessment of condition	Action required
8.12 Workers start bush fires.	<ul style="list-style-type: none"> <li>Do not cut any more vegetation than is necessary for site access and working.</li> <li>Prohibit the use of fire to remove vegetation.</li> <li>Forbid the burning of cut vegetation.</li> <li>In the dry season, ensure that site cooking fires are carefully located and are fully extinguished once their use has been finished.</li> </ul>	Service provider	Guideline D.2.2	<ul style="list-style-type: none"> <li>Before start of work</li> <li>Monthly during site operations</li> </ul>	PMU Environmental Officer	<ul style="list-style-type: none"> <li>Visual inspection</li> <li>Documentation</li> <li>To be completed at each check</li> </ul>	To be completed at check if compliance is not satisfactory. State who is responsible for action.



Environmental and Social Management and Monitoring Matrix (ESMMM)							
Potential impacts	Mitigation measures	Responsibility for implementation	Standard to be met (refer Appendix D)	Monitoring			
				Check timing	Responsibility for checking	Assessment of condition	Action required
9. Dust and air quality management							
9.1 Dust and other emission levels at sensitive receptors increase due to construction and transportation activities.	<ul style="list-style-type: none"><li>• Implement effective dust management measures in all areas during construction and operation.</li><li>• Do not allow dust generation to affect the ambient air quality outside the site.</li><li>• Restrict speeds on roads and access tracks. Enforce strict speed limits on earth tracks by placing speed bumps.</li><li>• Enforce dust control measures during the dry season.</li><li>• Stop work in very windy, dry weather.</li><li>• Schedule proposed works to ensure major vegetation disturbance and earthworks are minimised.</li><li>• Locate material stockpile areas as far as practicable from sensitive receptors. Cover if appropriate.</li><li>• Spray water onto dry earth surfaces.</li><li>• Rubbish receptacles should be covered and located as far as practicable from sensitive locations.</li><li>•</li></ul>	Service provider	Standard D.1.1	Monthly during site operations	PMU Environmental Officer	<ul style="list-style-type: none"><li>• Visual inspection</li><li>• Documentation</li><li>• Air quality monitoring using dust meters</li><li>• To be completed at each check</li></ul>	To be completed at check if compliance is not satisfactory. State who is responsible for action.

Environmental and Social Management and Monitoring Matrix (ESMMM)							
Potential impacts	Mitigation measures	Responsibility for implementation	Standard to be met (refer Appendix D)	Monitoring			
				Check timing	Responsibility for checking	Assessment of condition	Action required
9.2 Increase in local air pollution from vehicle and machinery emissions.	<ul style="list-style-type: none"> <li>• Use only vehicles, equipment and ships with engines that comply with national emissions standards.</li> <li>• Ensure vehicles and machines are switched off when not in use.</li> <li>• Ensure only vehicles required to undertake works are operated on site.</li> <li>• Ensure all construction vehicles, ships, plant and machinery are maintained and operated in accordance with design standards and specifications.</li> <li>• Locate storage areas for vehicles, ships, plant and equipment as far as practicable from sensitive locations.</li> <li>• Direct exhaust emissions of mobile plant away from the ground.</li> </ul>	Service provider	Standard D.1.1	Monthly during site operations	PMU Environmental Officer	<ul style="list-style-type: none"> <li>• Visual inspection</li> <li>• Documentation</li> <li>• Air quality monitoring using gas analysers</li> <li>• To be completed at each check</li> </ul>	To be completed at check if compliance is not satisfactory. State who is responsible for action.
<b>10. Flora and fauna protection</b>							
10.1 Changes to the marine, coastal and estuarine biological environments result from sediment alterations and changes in water quality, including salinity.	<ul style="list-style-type: none"> <li>• Marine and Estuarine Biological Survey</li> <li>• Establish a marine biological environmental monitoring programme as part of the ESIA and continue to operate it through project implementation. Establish a water and monitoring programme as part of the ESIA and continue to operate it through project implementation.</li> </ul>	ESIA Consultant / EPA	Not applicable	<ul style="list-style-type: none"> <li>• Before the ESIA</li> <li>• Continuously throughout the project</li> <li>• After project completion</li> </ul>	PMU Environmental Officer	<ul style="list-style-type: none"> <li>• Documentation</li> <li>• To be completed at each check</li> </ul>	To be completed at check if compliance is not satisfactory. State who is responsible for action.

Environmental and Social Management and Monitoring Matrix (ESMMM)							
Potential impacts	Mitigation measures	Responsibility for implementation	Standard to be met (refer Appendix D)	Monitoring			
				Check timing	Responsibility for checking	Assessment of condition	Action required
10.2 Habitat loss and disturbance of terrestrial fauna	<ul style="list-style-type: none"> <li>• Limit vegetation clearing and minimise habitat disturbance through adequate protection and management of retained vegetation.</li> <li>• Minimise noise levels and lighting intrusion throughout construction and operation in the vicinity of any sensitive locations.</li> <li>• Ensure that all site personnel are made aware of sensitive fauna/habitat areas and the requirements for the protection of these areas.</li> </ul>	Service provider	Standard D.1.3, Guidelines D.2.2 and D.2.7	<ul style="list-style-type: none"> <li>• Before start of work</li> <li>• Monthly during site operations</li> </ul>	PMU Environmental Officer	<ul style="list-style-type: none"> <li>• Visual inspection</li> <li>• Documentation</li> <li>• To be completed at each check</li> </ul>	To be completed at check if compliance is not satisfactory. State who is responsible for action.

Environmental and Social Management and Monitoring Matrix (ESMMM)							
Potential impacts	Mitigation measures	Responsibility for implementation	Standard to be met (refer Appendix D)	Monitoring			
				Check timing	Responsibility for checking	Assessment of condition	Action required
10.310 Construction materials are quarried and borrowed indiscriminately, leading to loss of forest and bush, and increased pollution.	<ul style="list-style-type: none"> <li>Identify quarry areas as early as possible, and conduct specific impact assessment and mitigation on these areas.</li> <li>Allow adequate time for the consultation, resettlement and compensation of people whose land is affected.</li> <li>Develop a Rock Quarry Management Plan.</li> <li>Ensure that only the approved quarries are used.</li> <li>Install sediment control measures to prevent runoff from quarries causing contamination and siltation of water bodies.</li> <li>Maintain quarries in a clean, safe and efficient condition.</li> <li>Take appropriate measures to prevent excessive noise and emissions from crushers.</li> <li>Rehabilitate quarries to a fully stable and vegetated condition after work has ceased.</li> </ul>	Service provider	Standards D.1.1, D.1.2, D.1.3, Guidelines D.2.2 and D.2.5	<ul style="list-style-type: none"> <li>Before start of work</li> <li>Monthly during site operations</li> </ul>	PMU Environmental Officer	<ul style="list-style-type: none"> <li>Visual inspection</li> <li>Documentation</li> <li>To be completed at each check</li> </ul>	To be completed at check if compliance is not satisfactory. State who is responsible for action.

Environmental and Social Management and Monitoring Matrix (ESMMM)							
Potential impacts	Mitigation measures	Responsibility for implementation	Standard to be met (refer Appendix D)	Monitoring			
				Check timing	Responsibility for checking	Assessment of condition	Action required
10.4 Forest and bush are destroyed unnecessarily.	<ul style="list-style-type: none"> <li>Only cut vegetation that is in the way. This means plants that are in the direct area required for the agreed works.</li> <li>Do not cut any more vegetation than is necessary for site access and working.</li> <li>Do not use fire to remove vegetation.</li> <li>Do not burn cut vegetation.</li> <li>Instruct workforce not to collect or purchase non-timber forest products (NTFPs) on site or in markets.</li> <li>Provide workers with food from domesticated plants when they are living in places where there is no market source of it.</li> <li>Erect highly visible perimeter markings representing the boundary of the area which has been handed over.</li> </ul>	Service provider	Guidelines D.2.2 and D.2.4	<ul style="list-style-type: none"> <li>Before start of work</li> <li>Monthly during site operations</li> </ul>	PMU Environmental Officer	<ul style="list-style-type: none"> <li>Visual inspection</li> <li>Documentation</li> <li>To be completed at each check</li> </ul>	To be completed at check if compliance is not satisfactory. State who is responsible for action.
10.5 Biodiversity is destroyed unnecessarily.	<ul style="list-style-type: none"> <li>Instruct workforce not to hunt, deal in or transport bushmeat on site. This includes protected marine species, such as turtles and turtle eggs.</li> <li>Provide meat from domestic animals if there is no alternative.</li> <li>Avoid all use of fire.</li> <li>Provide workers with meat from domesticated animals when they are living in places where there is no market source of it.</li> </ul>	Service provider	Standard D.1.5 and Guideline D.2.4	<ul style="list-style-type: none"> <li>Before start of work</li> <li>Monthly during site operations</li> </ul>	PMU Environmental Officer	<ul style="list-style-type: none"> <li>Visual inspection</li> <li>Documentation</li> <li>To be completed at each check</li> </ul>	To be completed at check if compliance is not satisfactory. State who is responsible for action.

Environmental and Social Management and Monitoring Matrix (ESMMM)							
Potential impacts	Mitigation measures	Responsibility for implementation	Standard to be met (refer Appendix D)	Monitoring			
				Check timing	Responsibility for checking	Assessment of condition	Action required
11. Archaeology and cultural sites management							
11.1 Damage or disturbance to significant important archaeological, indigenous and/or cultural heritage sites during land clearing and earth works activities.	<ul style="list-style-type: none"><li>• Check with local people as to whether any activities will affect sites of cultural or religious importance.</li><li>• Avoid any works where cultural sites might be affected, as far as possible.</li><li>• If an unexpected archaeological, indigenous, and/or cultural heritage site is discovered, immediately cease work within the area that the site has been observed and consult with the relevant authority or traditional owner groups, UNDP, EPA or archaeologist. This is reflected in the Chance Find Procedure, found in Guideline D.2.3.</li><li>• If damage to cultural sites cannot be avoided, agree compensation measures with the local community.</li></ul>	Service provider	Guideline D.2.3	<ul style="list-style-type: none"><li>• Before starting work</li><li>• As required thereafter</li></ul>	Service provider’s PMU Social Safeguards Officer	<ul style="list-style-type: none"><li>• Visual inspection</li><li>• Documentation</li><li>• Interviews with communities</li><li>• To be completed at each check</li></ul>	To be completed at check if compliance is not satisfactory. State who is responsible for action.

Environmental and Social Management and Monitoring Matrix (ESMMM)							
Potential impacts	Mitigation measures	Responsibility for implementation	Standard to be met (refer Appendix D)	Monitoring			
				Check timing	Responsibility for checking	Assessment of condition	Action required
12. Waste management							
12.1 Production of waste and excessive use of resources.	<ul style="list-style-type: none"><li>• Preference shall be given to materials that can be used to construct the project that would reduce the direct and indirect waste generated.</li><li>• The use of construction materials shall be optimised and where possible a recycling policy adopted.</li><li>• Any contaminated waste shall be disposed of at an approved facility.</li><li>• Recyclable waste (including oil and some construction waste) shall be collected separately and disposed of at certified specialist facilities.</li><li>• Waste sites shall be sufficiently covered to ensure that wildlife does not have access.</li></ul>	Service provider	Guideline D.2.12	<ul style="list-style-type: none"><li>• Before start of work</li><li>• Monthly during site operations</li></ul>	PMU Environmental Officer	<ul style="list-style-type: none"><li>• Visual inspection</li><li>• Documentation</li><li>• To be completed at each check</li></ul>	To be completed at check if compliance is not satisfactory. State who is responsible for action.

Environmental and Social Management and Monitoring Matrix (ESMMM)							
Potential impacts	Mitigation measures	Responsibility for implementation	Standard to be met (refer Appendix D)	Monitoring			
				Check timing	Responsibility for checking	Assessment of condition	Action required
12.2 Waste is incorrectly managed, leading to pollution.	<ul style="list-style-type: none"> <li>• Operate a waste management strategy based on principles of reduction, recovery, recycle and reuse. Conduct recycling and waste reduction campaigns among the project staff, service providers and workforce.</li> <li>• Separate waste streams shall be maintained at all times i.e. general domestic waste, construction and contaminated waste. Specific areas on site shall be designated for the temporary management of the various waste streams.</li> <li>• Ensure use of PPE by staff when handling all forms of waste.</li> <li>• Ensure that waste collection, segregation, storage and disposal systems avoid spills, contamination, and hazards to human and animal health.</li> <li>• Dispose of wastes in the most environmentally sound manner possible, using EPA-authorized facilities.</li> <li>• Never burn waste, creating air pollution.</li> </ul>	Service provider	Guideline D.2.12	<ul style="list-style-type: none"> <li>• Before start of work</li> <li>• Monthly during site operations</li> </ul>	PMU Environmental Officer	<ul style="list-style-type: none"> <li>• Visual inspection</li> <li>• Documentation</li> <li>• Interviews with the workers</li> <li>• Interviews with the neighbouring communities</li> <li>• To be completed at each check</li> <li>• Sampling of soil, groundwater, coastal, estuarine and/or surface water when accidents occur</li> </ul>	To be completed at check if compliance is not satisfactory. State who is responsible for action.



Environmental and Social Management and Monitoring Matrix (ESMMM)							
Potential impacts	Mitigation measures	Responsibility for implementation	Standard to be met (refer Appendix D)	Monitoring			
				Check timing	Responsibility for checking	Assessment of condition	Action required
13. Hazardous materials management							
13.1 Pollution to air, soil or water and danger (illness or injury) from the delivery and handling of hazardous materials (including fuels, lubricants and cement) at project workshops, plants and construction sites.	<ul style="list-style-type: none"><li>• Develop an Oil Spill Response Plan (OSRP) for land and sea, including a Marine Spill Contingency Plan.</li><li>• Follow the hazardous materials management guidelines fully.</li><li>• Use the safest available transportation option. On roads, use convoys with accompanying support.</li><li>• Deliver only to prepared locations.</li><li>• Maintain supplies of spill kits and granules in all vehicles and at all offloading locations.</li><li>• Ensure competent drivers and close supervision.</li><li>• Provide spill contingency and emergency training to all personnel involved in the movement and handling of hazardous materials.</li><li>• Use international labelling for identifying hazardous substances.</li><li>• Maintain emergency response plans for a spillage event and appropriate equipment at each facility.</li></ul>	Service provider's Site Manager	Guidelines D.2.13 and D.2.14	<ul style="list-style-type: none"><li>• Before start of work</li><li>• Monthly during site operations</li></ul>	PMU Environmental Officer	<ul style="list-style-type: none"><li>• Visual inspection</li><li>• Documentation</li><li>• To be completed at each check</li></ul>	To be completed at check if compliance is not satisfactory. State who is responsible for action.

Environmental and Social Management and Monitoring Matrix (ESMMM)							
Potential impacts	Mitigation measures	Responsibility for implementation	Standard to be met (refer Appendix D)	Monitoring			
				Check timing	Responsibility for checking	Assessment of condition	Action required
13.2a Pollution to air, soil or water and danger (illness or injury) from fuel and oil storage at project stores and workshops.	<ul style="list-style-type: none"> <li>• Develop a spill contingency plan.</li> <li>• Follow the hazardous materials management guidelines fully.</li> <li>• Only use designated storage areas, with bunding of 150% volume of total capacity.</li> <li>• Only use facilities located down gradient of public water supply boreholes and distant from watercourses.</li> <li>• Ensure that there are retention systems, including walls, bunds and lined drains to contain any spillages.</li> <li>• Ensure that there is hard standing, with a drainage system that includes oil/water separators.</li> <li>• Ensure spill kits and granules are available, and if used, dispose of waste appropriately.</li> <li>• Check facilities, safeguards and procedures for any potential for explosions to occur.</li> <li>• Provide training for all personnel handling fuel and oil, including spill contingency training.</li> <li>• Take rapid action if uncontained spills and leakages occur, to prevent soil, and ground and surface water contamination.</li> </ul>	Service provider's Site Manager	Guidelines D.2.13, D.2.14 and D.2.15	<ul style="list-style-type: none"> <li>• Before start of work</li> <li>• Monthly during site operations</li> </ul>	PMU Environmental Officer	<ul style="list-style-type: none"> <li>• Visual inspection</li> <li>• Documentation</li> <li>• Interviews with workers</li> <li>• To be completed at each check</li> <li>• Sampling of surface water, groundwater and/or soil when accidents occur</li> </ul>	To be completed at check if compliance is not satisfactory. State who is responsible for action.

Environmental and Social Management and Monitoring Matrix (ESMMM)							
Potential impacts	Mitigation measures	Responsibility for implementation	Standard to be met (refer Appendix D)	Monitoring			
				Check timing	Responsibility for checking	Assessment of condition	Action required
13.2b Pollution to air, soil or water and danger (illness or injury) from fuel and oil storage at project stores and workshops.	<ul style="list-style-type: none"> <li>Do not allow soils to become contaminated and effectively sterilised, or for water courses to be affected by runoff carrying toxic substances, affecting community water supplies, aquatic biodiversity and wildlife.</li> <li>Have controls in place to minimise opportunities for fuel pilferage.</li> </ul>	Service provider's Site Manager	Guidelines D.2.13, D.2.14 and D.2.15	<ul style="list-style-type: none"> <li>Before start of work</li> <li>Monthly during site operations</li> </ul>	PMU Environmental Officer	<ul style="list-style-type: none"> <li>Visual inspection</li> <li>Documentation</li> <li>Interviews with workers</li> <li>To be completed at each check</li> <li>Sampling of surface water, groundwater and/or soil when accidents occur</li> </ul>	To be completed at check if compliance is not satisfactory. State who is responsible for action.
13.3 Pollution to air, soil or water and danger (illness or injury) from refuelling operations at project camps, workshops, plants and construction sites.	<ul style="list-style-type: none"> <li>Develop a spill contingency plan.</li> <li>Prepare strict procedures for refuelling vehicles and site plant.</li> <li>Spill kits are to be carried by all refuelling vehicles.</li> <li>Refuel vehicles only on impermeable hard standings with controlled drainage (traps and interceptors).</li> <li>Plant refuelling on site is to be carried out according to strict protocols for refuelling in unprotected areas.</li> <li>Provide spill contingency training to all personnel involved in refuelling operations.</li> <li>Enforce the reporting system for spillage incidents.</li> </ul>	Service provider's Site Manager	Guidelines D.2.14 and D.2.15	<ul style="list-style-type: none"> <li>Before start of work</li> <li>Monthly during site operations</li> </ul>	PMU Environmental Officer	<ul style="list-style-type: none"> <li>Visual inspection</li> <li>Documentation</li> <li>To be completed at each check</li> <li>Sampling of surface water, groundwater and/or soil when accidents occur</li> </ul>	To be completed at check if compliance is not satisfactory. State who is responsible for action.

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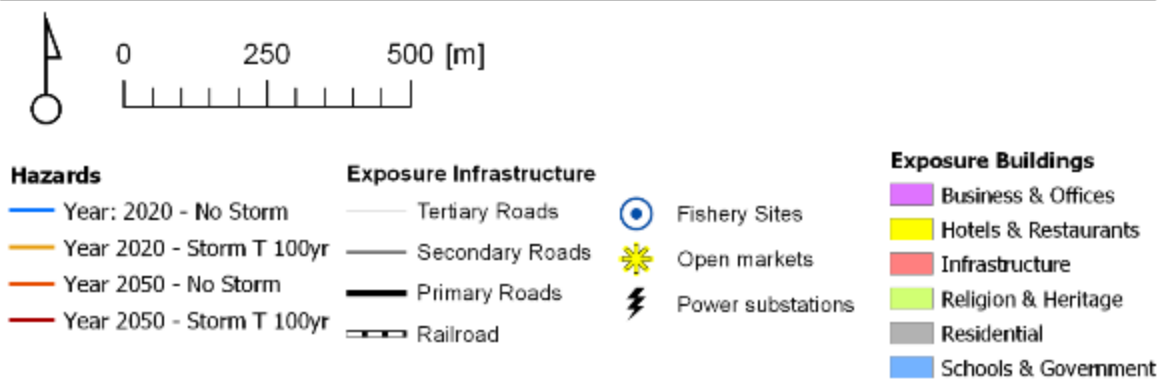
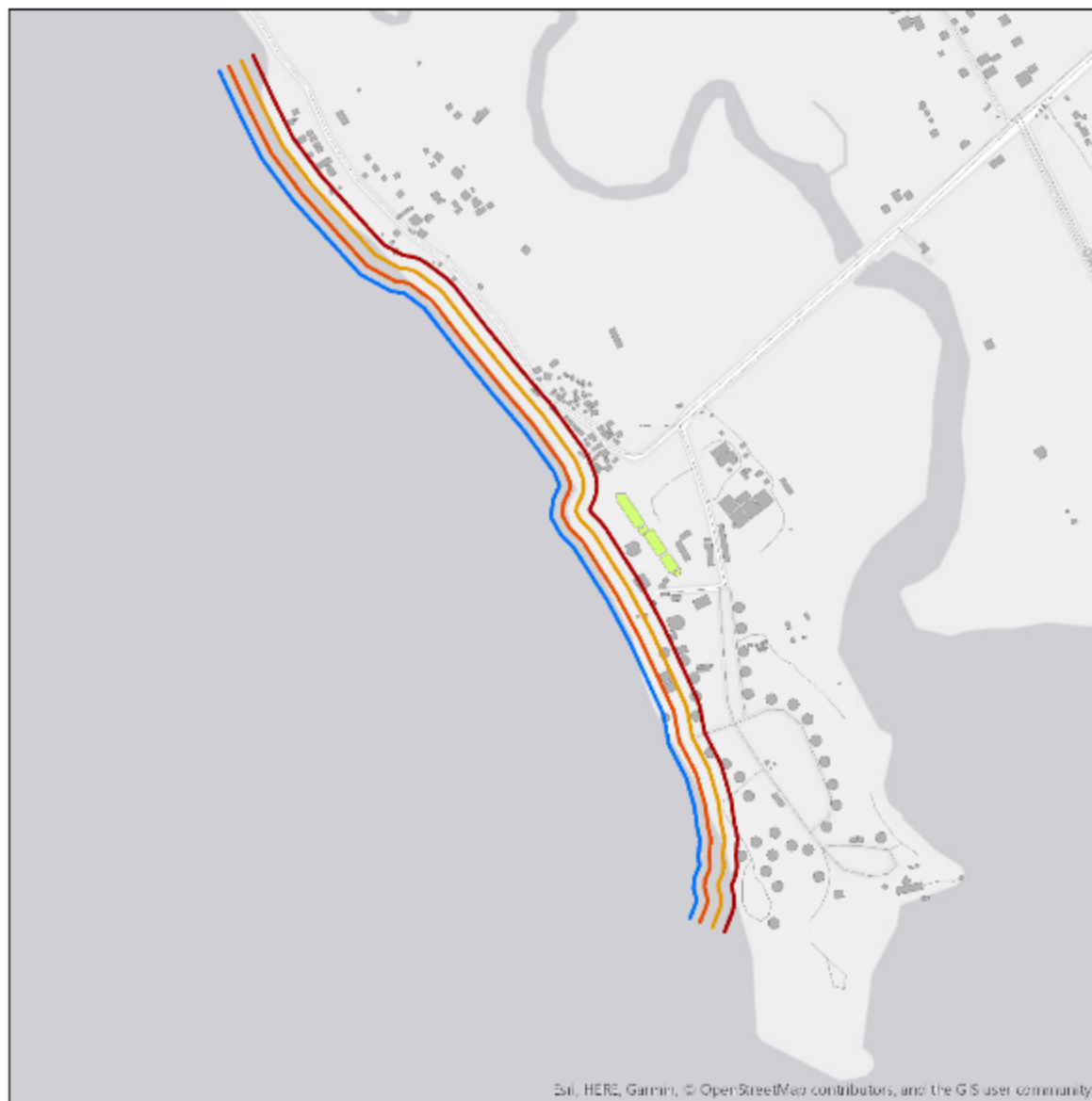
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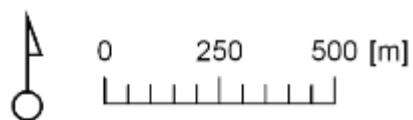
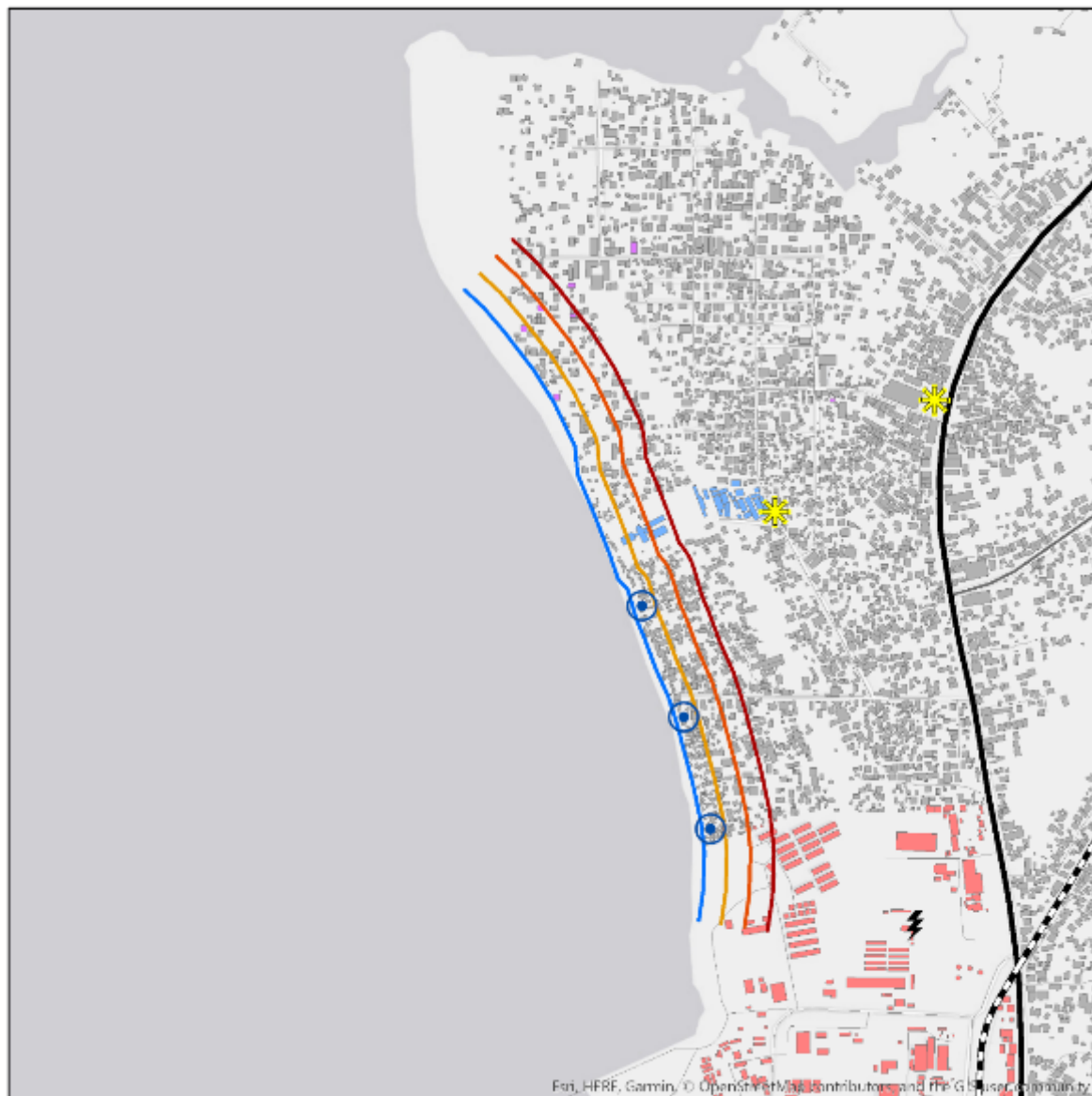
## 1 APPENDIX A VULNERABILITY MAPS

- 2 The following maps are taken from the Revised Interim Report (CDR International, 2019a).

## Coastal Section 1



## Coastal Section 2



### Hazards

- Year: 2020 - No Storm
- Year 2020 - Storm T 100yr
- Year 2050 - No Storm
- Year 2050 - Storm T 100yr

### Exposure Infrastructure

- Tertiary Roads
- Secondary Roads
- Primary Roads
- Railroad

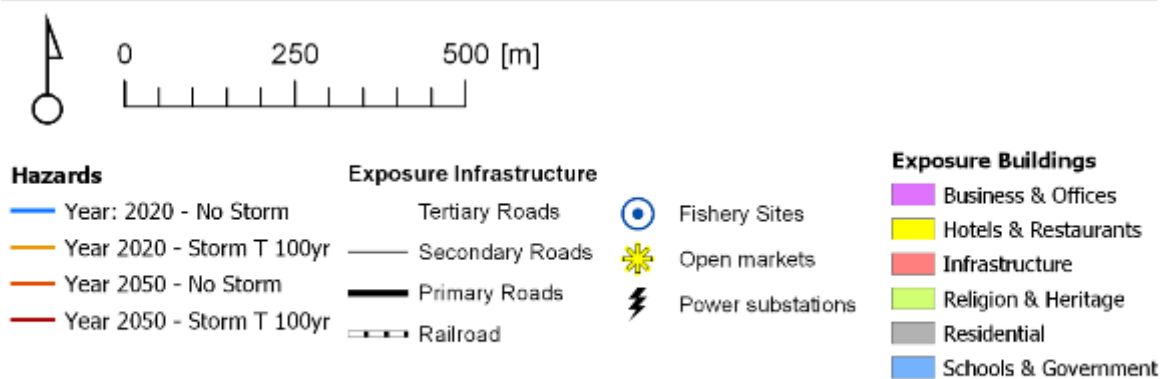
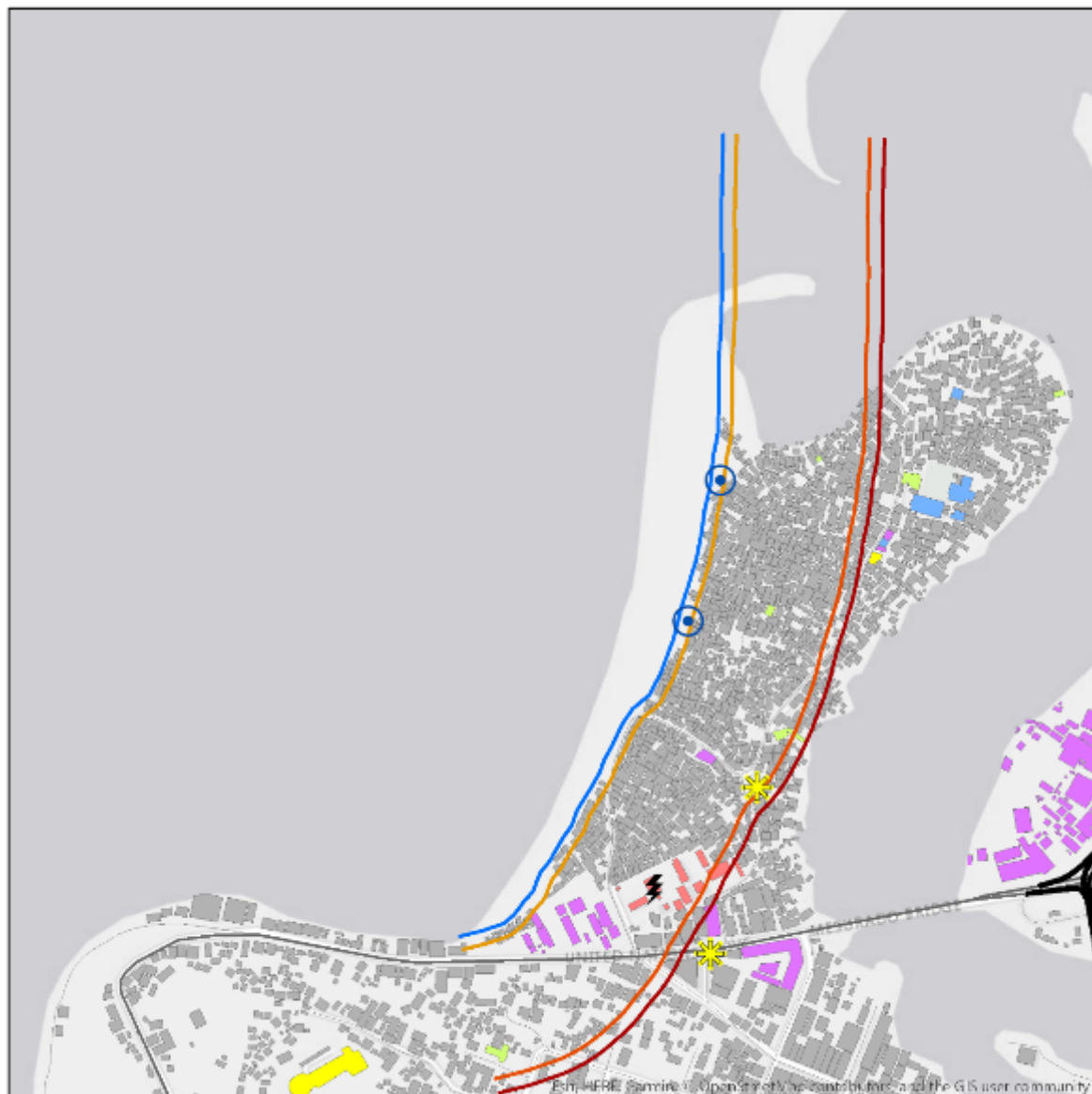
- Fishery Sites
- ✱ Open markets
- ⚡ Power substations

### Exposure Buildings

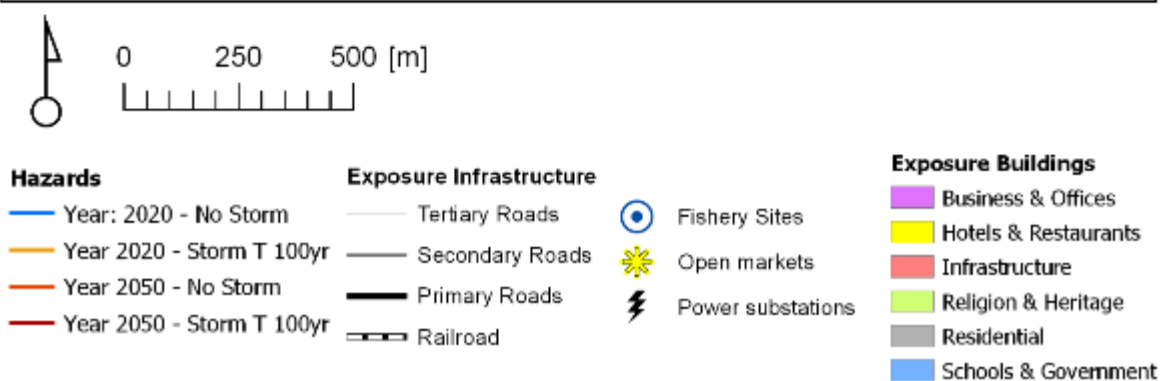
- Business & Offices
- Hotels & Restaurants
- Infrastructure
- Religion & Heritage
- Residential
- Schools & Government



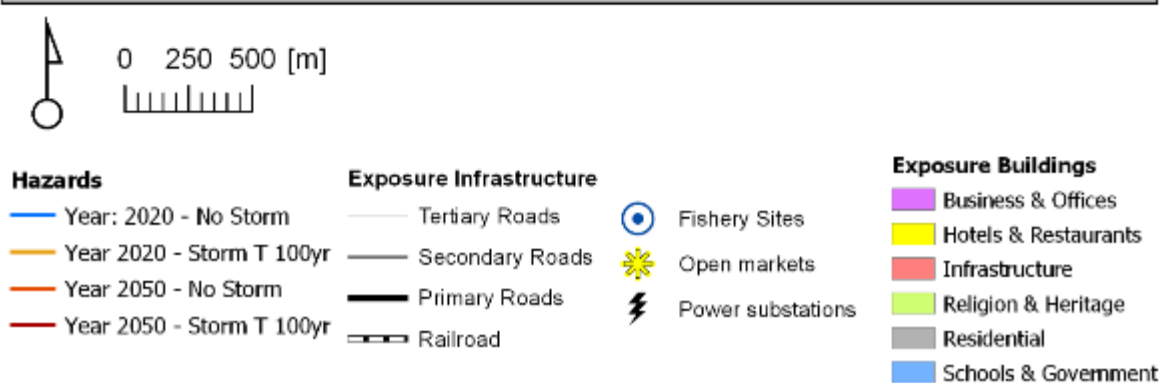
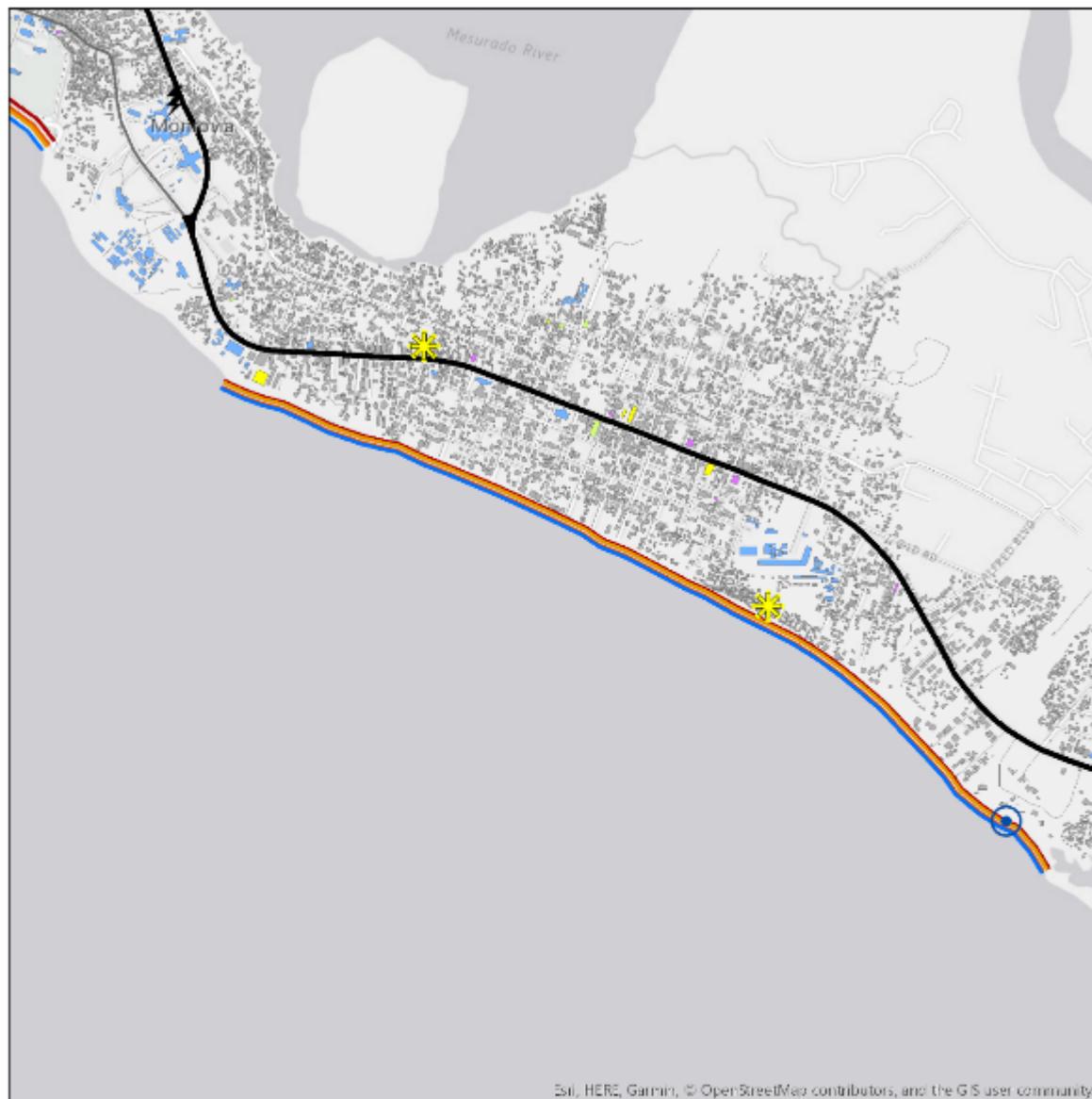
### Coastal Section 3



## Coastal Section 4



## Coastal Section 5



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## 1 APPENDIX B LABORATORY RESULTS



Earthtime Inc.  
Earthtime Building  
U.N. Drive  
Clara Town  
Monrovia  
Liberia  
**Attention:** Chiniwa El Tayar

Unit 7-8 Hawarden Business Park  
Manor Road (off Manor Lane)  
Hawarden  
Deeside  
CH5 3US  
Tel: (01244) 528700  
Fax: (01244) 528701  
email: hawardencustomerservices@alsglobal.com  
Website: www.alsenvironmental.co.uk

## CERTIFICATE OF ANALYSIS

**Date of report Generation:** 19 March 2019  
**Customer:** H\_EARTH\_LIB  
**Sample Delivery Group (SDG):** 190216-11  
**Your Reference:** B1804-07  
**Location:** Atlantic Ocean  
**Report No:** 497498

This report has been revised and directly supersedes 496476 in its entirety.

We received 17 samples on Friday February 15, 2019 and 17 of these samples were scheduled for analysis which was completed on Tuesday March 12, 2019. Accredited laboratory tests are defined within the report, but opinions, interpretations and on-site data expressed herein are outside the scope of ISO 17025 accreditation.

Should this report require incorporation into client reports, it must be used in its entirety and not simply with the data sections alone.

Chemical testing (unless subcontracted) performed at ALS Life Sciences Ltd Hawarden (Method codes TM) or ALS Life Sciences Ltd Aberdeen (Method codes S).

All sample data is provided by the customer. The reported results relate to the sample supplied, and on the basis that this data is correct.

Incorrect sampling dates and/or sample information will affect the validity of results.

The customer is not permitted to reproduce this report except in full without the approval of the laboratory.

Approved By:

**Sonia McWhan**  
Operations Manager



ALS Life Sciences Limited, Registered Office: Units 7 & 8 Hawarden Business Park, Manor Road, Hawarden, Deeside, CH5 3US. Registered in England and Wales No. 4057291.

Version: 2.2 Version Issued: 19/03/2019



# CERTIFICATE OF ANALYSIS

Validated

SDG: 160216-11 Client Reference: B1804-07 Report Number: 497498  
Location: Atlantic Ocean Order Number: Superseded Report: 496476

## Received Sample Overview

Lab Sample No(s)	Customer Sample Ref.	AGS Ref.	Depth (m)	Sampled Date
18365324	5		1.00	09/02/2019
18365055	2a		1.00	09/02/2019
18365058	3a		1.00	09/02/2019
18365320	4a		1.00	09/02/2019
18365327	7a		1.00	09/02/2019
18365690	8a		1.00	09/02/2019
18365693	9a		1.00	09/02/2019
18365054	1b		1.00	09/02/2019
18365056	2b		1.00	09/02/2019
18365059	3b		1.00	09/02/2019
18365322	4b		1.00	09/02/2019
18365326	6b		1.00	09/02/2019
18365328	7b		1.00	09/02/2019
18365601	8b		1.00	09/02/2019
18365695	9b		1.00	09/02/2019
18365061	3c		1.00	09/02/2019
18365696	SP		1.00	09/02/2019

### Maximum Sample/Coolbox Temperature (°C) :

14.2

ISO5657-3 Water quality - Sampling - Part3 -




During Transportation samples shall be stored in a cooling device capable of maintaining a temperature of (5±3) °C.

ALS have data which show that a cool box with 4 frozen icepacks is capable of maintaining pre-chilled samples at a temperature of (5±3)°C for a period of up to 24hrs.

Only received samples which have had analysis scheduled will be shown on the following pages.






 <b>Results Legend</b>  Test  No Determination Possible  <b>Sample Types -</b> S - Soil/Solid UNS - Unspecified Solid GW - Ground Water SW - Surface Water LC - Land Leachate PL - Prepared Leachate PR - Process Water SA - Saline Water TE - Trade Effluent TS - Treated Sewage US - Untreated Sewage RE - Recreational Water DW - Drinking Water Non-regulatory UNL - Unspecified Liquid SL - Sludge G - Gas OTH - Other			<b>Lab Sample No(s)</b>		19365320		19365327		19365690		19365693
<b>Customer Sample Reference</b>					4A		7A		8A		9A
<b>ACS Reference</b>											
<b>Depth (m)</b>					1.00		1.00		1.00		1.00
<b>Container</b>					HN03 Filtered (ALE204)	HN03 Filtered (ALE204)	HN03 Filtered (ALE204)	HN03 Filtered (ALE204)	HN03 Filtered (ALE204)	HN03 Filtered (ALE204)	HN03 Filtered (ALE204)
<b>Sample Type</b>					Tipilastic (ALE221)	Tipilastic (ALE221)	Tipilastic (ALE221)	Tipilastic (ALE221)	Tipilastic (ALE221)	Tipilastic (ALE221)	Tipilastic (ALE221)
<b>Sample Type</b>					UNL	UNL	UNL	UNL	UNL	UNL	UNL
Aerobic N Nitrogen	All	NDPs: 0 Tests: 17			X		X		X		X
COD Unfiltered	All	NDPs: 0 Tests: 17	X				X				X
Conductivity (at 20 deg C)	All	NDPs: 0 Tests: 17	X				X				X
EPH (DRO) (C10 C40) Aqueous (W)	All	NDPs: 0 Tests: 17	X				X				X
GRO by GC FID (W)	All	NDPs: 0 Tests: 17				X		X		X	
Nitro by Kono (w)	All	NDPs: 0 Tests: 17	X				X				X
pH Value	All	NDPs: 0 Tests: 17	X				X				X
Saline Cyanides (W)	All	NDPs: 0 Tests: 17				X			X		
Saline Metals (Dissolved)	All	NDPs: 0 Tests: 17			X			X			
Saline TON	All	NDPs: 0 Tests: 17			X			X			X
Suspended Solids	All	NDPs: 0 Tests: 17	X				X				X
TOC (Saline)(W-TOC-R)	All	NDPs: 0 Tests: 17	X				X				X
Total Dissolved Solids (Grav)	All	NDPs: 0 Tests: 17	X				X				X
Total EPH (W)	All	NDPs: 0 Tests: 17	X				X				X
Turbidity in meters	All	NDPs: 0 Tests: 17				X		X		X	

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		<b>CERTIFICATE OF ANALYSIS</b>										<div>Validated</div>			
<b>SDG:</b> 140216-11		<b>Location:</b> Atlantic Ocean		<b>Client Reference:</b> B1804-07				<b>Order Number:</b>				<b>Report Number:</b> 497498		<b>Superseded Report:</b> 496476	
<b>Results Legend</b> <div><div>X</div> Test</div> <div><div>N</div> No Determination Possible</div> <b>Sample Types -</b> S - Soil/Solid UNS - Unspecified Solid GW - Ground Water SW - Surface Water LE - Land Leachate PL - Prepared Leachate PR - Process Water SA - Saline Water TE - Trade Effluent TS - Treated Sewage US - Untreated Sewage RE - Recreational Water DW - Drinking Water Non-regulatory UNL - Unspecified Liquid SL - Sludge G - Gas OTH - Other	<b>Lab Sample No(s)</b>		19365039		19365034		19365035		19365039						
	<b>Customer Sample Reference</b>		9a		1b		2b		3b						
	<b>ACS Reference</b>														
	<b>Depth (m)</b>		1.00		1.00		1.00		1.00						
	<b>Container</b>		NIOH (AL2451)		HNO3 Filtered (AL2204) H2SO4 (AL2449)		HNO3 Filtered (AL2204) H2SO4 (AL2449)		HNO3 Filtered (AL2204) H2SO4 (AL2449)						
	<b>Sample Type</b>		UNL		UNL		UNL		UNL						
Ammoniacal Nitrogen	All	NDFP: 0 Task: 17				X			X				X		
CO2 Influent	All	NDFP: 0 Task: 17				X						X			
Conductivity (at 20 deg C)	All	NDFP: 0 Task: 17				X						X			
EPH (DRO) (C10-C40) Aqueous (M)	All	NDFP: 0 Task: 17				X						X			
GRD by GC-FID (M)	All	NDFP: 0 Task: 17			X			X				X			
Mn by Rhm (M)	All	NDFP: 0 Task: 17			X			X				X			
pH Value	All	NDFP: 0 Task: 17				X			X				X		
Saline Dynamics (M)	All	NDFP: 0 Task: 17				X						X			
Saline Matrix Detected*	All	NDFP: 0 Task: 17		X			X			X			X		
Saline TON	All	NDFP: 0 Task: 17				X				X			X		
Suspended Solids	All	NDFP: 0 Task: 17				X			X			X			
TOD (Saline) (W TOC) (R)	All	NDFP: 0 Task: 17				X			X			X			
Total Dissolved Solids (Grey)	All	NDFP: 0 Task: 17				X			X			X			
Total SPH (eq)	All	NDFP: 0 Task: 17			X			X				X			
Turbidity in water	All	NDFP: 0 Task: 17			X			X				X			

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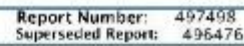
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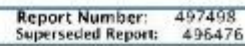
16:37:29 19/03/2019

 <b>Results Legend</b>  Test  No Determination Possible  <b>Sample Types -</b> S - Soil/Solid LNS - Unspecified Solid GW - Ground Water SW - Surface Water LE - Land Leachate PL - Prepared Leachate PR - Process Water SA - Saline Water TE - Trade Effluent TS - Treated Sewage US - Untreated Sewage RE - Recreational Water DW - Drinking Water Non-regulatory UNL - Unspecified Liquid SL - Sludge G - Gas OIH - Other		Lab Sample No(s)	19365696
		Customer Sample Reference	SP
		AGS Reference	
		Depth (m)	1.00
		Container	HNO3 Filtered (ALE204) NAOH (ALE245) Vial (ALE297)
		Sample Type	UNL
Ammoniacal Nitrogen	All	NDPs: 0 Tests: 17	
COD Unfiltered	All	NDPs: 0 Tests: 17	
Conductivity (at 20 deg C)	All	NDPs: 0 Tests: 17	
EPH (DRO) (C10-C40) Aqueous (W)	All	NDPs: 0 Tests: 17	
GRD by GC FID (W)	All	NDPs: 0 Tests: 17	X
Nitrite by Kato (w)	All	NDPs: 0 Tests: 17	
pH Value	All	NDPs: 0 Tests: 17	
Saline Cyanides (W)*	All	NDPs: 0 Tests: 17	X
Saline Metals Dissolved*	All	NDPs: 0 Tests: 17	X
Saline TON	All	NDPs: 0 Tests: 17	
Suspended Solids	All	NDPs: 0 Tests: 17	
TOC (Saline)(W TOC IR)*	All	NDPs: 0 Tests: 17	
Total Dissolved Solids (Grav)	All	NDPs: 0 Tests: 17	
Total EPH (aq)	All	NDPs: 0 Tests: 17	
Turbidity in water	All	NDPs: 0 Tests: 17	

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Report Number:	497498
Superseded Report:	496476

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## Validated

Report Number: 497498  
Superseded Report: 496476

Results Legend		Customer Sample Ref	35	36	37	38	39	40
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37	38	39	40	41	42	43	44	45
46	47	48	49	50	51	52	53	54
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748	749	750	751	752	753	754	755	756
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892	893	894	895	896	897	898	899	900
901	902	903	904	905	906	907	908	909
910	911	912	913	914	915	916	917	918
919	920	921	922	923	924	925	926	927
928	929	930	931	932	933	934	935	936
937	938	939	940	941	942	943	944	945
946	947	948	949	950	951	952	953	954
955	956	957	958	959	960	961	962	963
964	965	966	967	968	969	970	971	972
973	974	975	976	977	978	979	980	981
982	983	984	985	986	987	988	989	990
991	992	993	994	995	996	997	998	999
1000	1001	1002	1003	1004	1005	1006	1007	1008
1009	1010	1011	1012	1013	1014	1015	1016	1017
1018	1019	1020	1021	1022	1023	1024	1025	1026
1027	1028	1029	1030	1031	1032	1033	1034	1035
1036	1037	1038	1039	1040	1041	1042	1043	1044
1045	1046	1047	1048	1049	1050	1051	1052	1053
1054	1055	1056	1057	1058	1059	1060	1061	1062
1063	1064	1065	1066	1067	1068	1069	1070	1071
1072	1073	1074	1075	1076	1077	1078	1079	1080
1081	1082	1083	1084	1085	1086	1087	1088	1089
1090	1091	1092	1093	1094	1095	1096	1097	1098
1099	1100	1101	1102	1103	1104	1105	1106	1107
1108	1109	1110	1111	1112	1113	1114	1115	1116
1117	1118	1119	1120	1121	1122	1123	1124	1125
1126	1127	1128	1129	1130	1131	1132	1133	1134
1135	1136	1137	1138	1139	1140	1141	1142	1143
1144	1145	1146	1147	1148	1149	1150	1151	1152
1153	1154	1155	1156	1157	1158	1159	1160	1161
1162	1163	1164	1165	1166	1167	1168	1169	1170
1171	1172	1173	1174	1175	1176	1177	1178	1179
1180	1181	1182	1183	1184	1185	1186	1187	1188
1189	1190	1191	1192	1193	1194	1195	1196	1197
1198	1199	1200	1201	1202	1203	1204	1205	1206
1207	1208	1209	1210	1211	1212	1213	1214	1215
1216	1217	1218	1219	1220	1221	1222	1223	1224
1225	1226	1227	1228	1229	1230	1231	1232	1233
1234	1235	1236	1237	1238	1239	1240	1241	1242
1243	1244	1245	1246	1247	1248	1249	1250	1251
1252	1253	1254	1255	1256	1257	1258	1259	1260
1261	1262	1263	1264	1265	1266	1267	1268	1269
1270	1271	1272	1273	1274	1275	1276	1277	1278
1279	1280	1281	1282	1283	1284	1285	1286	1287
1288	1289	1290	1291	1292	1293	1294	1295	1296
1297	1298	1299	1300	1301	1302	1303	1304	1305
1306	1307	1308	1309	1310	1311	1312	1313	1314
1315	1316	1317	1318	1319	1320	1321	1322	1323
1324	1325	1326	1327	1328	1329	1330	1331	1332
1333	1334	1335	1336	1337	1338	1339	1340	1341
1342	1343	1344	1345	1346	1347	1348	1349	1350
1351	1352	1353	1354	1355	1356	1357	1358	1359
1360	1361	1362	1363	1364	1365	1366	1367	1368
1369	1370	1371	1372	1373	1374	1375	1376	1377
1378	1379	1380	1381	1382	1383	1384	1385	1386
1387	1388	1389	1390	1391	1392	1393	1394	1395
1396	1397	1398	1399	1400	1401	1402	1403	1404
1405	1406	1407	1408	1409	1410	1411	1412	1413
1414	1415	1416	1417	1418	1419	1420	1421	1422

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CERTIFICATE OF ANALYSIS

Validated

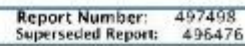
SDG: 190216-11  
Location: Atlantic Ocean

Client Reference: B1804-07  
Order Number:

Report Number: 497498  
Superseded Report: 496476

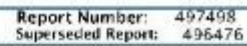
Results Legend		Customer Sample Ref	7a	8a	9a	3a	8P
J	100% Pass	Depth (m)	1.01	1.01	1.01	1.01	1.01
M	100% Pass	Sample Type	Water	Water	Water	Water	Water
S	100% Pass	Date Sampled	15/02/2019	15/02/2019	15/02/2019	15/02/2019	15/02/2019
U	100% Pass	Sample 1 mm	15/02/2019	15/02/2019	15/02/2019	15/02/2019	15/02/2019
F	100% Pass	Date Received	15/02/2019	15/02/2019	15/02/2019	15/02/2019	15/02/2019
R	100% Pass	Lab Sample Ref	150216-11	150216-11	150216-11	150216-11	150216-11
N	100% Pass	Lab Sample Ref (2)	150216-11	150216-11	150216-11	150216-11	150216-11
D	100% Pass	Lab Sample Ref (3)	150216-11	150216-11	150216-11	150216-11	150216-11
A	100% Pass	Component	LOD/Units	Method			
P	100% Pass	Cyanide Complex as CN*	mg/l	SUB	<0.5	<0.5	<0.5
Q	100% Pass	TOC (Saline)*	<2.5 mg/l	SUB	<2.5	<2.5	<2.5
T	100% Pass	Cyanide Free as CN*	<0.005 mg/l	SUB	<0.5	<0.5	<0.5
V	100% Pass	Arsenic, Dissolved*	µg/l	SUB	1.83	1.85	1.82
W	100% Pass	Cyanide as CN*	<0.5 mg/l	SUB	<0.5	<0.5	<0.5
X	100% Pass	Cadmium, Dissolved*	<0.05 µg/l	SUB	<0.02	<0.02	0.00408
Y	100% Pass	Iron, Dissolved*	<4 µg/l	SUB	<0.004	<0.004	0.00758
Z	100% Pass	Lead, Dissolved*	µg/l	SUB	<0.1	<0.1	0.0158
AA	100% Pass	Mercury, Dissolved*	<0.002 µg/l	SUB	<0.002	<0.002	<0.002
AB	100% Pass	Dissolved solids, Total (gravimetric)	<10 mg/l	TM021	36200	38100	38600
AC	100% Pass	Suspended solids, Total	<2 mg/l	TM022	48	20	63.5
AD	100% Pass	Ammoniacal Nitrogen as N	<0.2 mg/l	TM056	<0.2	<0.2	<0.2
AE	100% Pass	COD, unfiltered	<7 mg/l	TM107	444	480	628
AF	100% Pass	Conductivity @ 20 deg.C	<0.095 mS/cm	TM120	46.8	47.4	46.2
AG	100% Pass	Salinity	<2	TM126	33.4	34.7	33.8
AH	100% Pass	EPH Range >C10 - C40 (aq)	<100 µg/l	TM172	<100	<100	<100
AI	100% Pass	Total EPH (C5-C40) (aq)	<100 µg/l	TM172	<100	<100	<100
AJ	100% Pass	Nitrite as NO2	<0.05 mg/l	TM184	<0.05	<0.05	<0.05
AK	100% Pass	Turbidity	<0.1 ntu	TM106	0.641	0.581	0.576
AL	100% Pass	pH	<1 pH Units	TM256	7.67	5.03	8.23
AM	100% Pass	Saline TON as NO3	<0.3 mg/l	TM281	<0.3	<0.3	<0.3
AN	100% Pass	Saline Nitrate as NO3	<0.3 mg/l	TM281	<0.3	<0.3	<0.3
AO	100% Pass	Cyanide Complex as CN*	mg/l	SUB			<0.5
AP	100% Pass	TOC (Saline)*	<2.5 mg/l	SUB			<2.5
AQ	100% Pass	Cyanide Free as CN*	<0.005 mg/l	SUB			<0.5
AR	100% Pass	Arsenic, Dissolved*	µg/l	SUB			1.62
AS	100% Pass	Cyanide as CN*	<0.5 mg/l	SUB			<0.5
AT	100% Pass	Cadmium, Dissolved*	<0.05 µg/l	SUB			<0.05
AV	100% Pass	Iron, Dissolved*	<4 µg/l	SUB			<0.004
AW	100% Pass	Lead, Dissolved*	µg/l	SUB			<0.3
AX	100% Pass	Mercury, Dissolved*	<0.002 µg/l	SUB			<0.002
AY	100% Pass	Dissolved solids, Total (gravimetric)	<10 mg/l	TM021			27400
AZ	100% Pass	Suspended solids, Total	<2 mg/l	TM022			48

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# CERTIFICATE OF ANALYSIS

Validated

SDG: 130216-11 Client Reference: B1804-07 Report Number: 497498  
Location: Atlantic Ocean Order Number: Superseded Report: 496476

## Table of Results - Appendix

Method No	Reference	Description
SUB		Subcontracted Test
TM021	Method 2540C, AWWA/APHA, 20th Ed., 1999	Determination of total dissolved solids in waters by gravimetry
TM022	Method 2540D, AWWA/APHA, 20th Ed., 1999 / BS 2690: Part120 1981 BS EN 672	Determination of total suspended solids in waters
TM061	Method for the Determination of EPH, Massachusetts Dept. of EP, 1986	Determination of Extractable Petroleum Hydrocarbons by GC-FID (C10-C40)
TM098	BS 2690: Part 7:1958 / BS 6058: Part2:11:1984	Determination of Ammonium in Water Samples using the Kone Analyser
TM107	ISO 8060-1989	Determination of Chemical Oxygen Demand using COD On Lange Kit
TM120	Method 2610B, AWWA/APHA, 20th Ed., 1999 / BS 2680: Part 9:1970	Determination of Electrical Conductivity using a Conductivity Meter
TM172	Analysis of Petroleum Hydrocarbons in Environmental Media - Total Petroleum Hydrocarbon Criteria	EPH in Waters
TM184	EPA Methods 325.1 & 325.2	The Determination of Anions in Aqueous Matrices using the Kone Spectrophotometric Analyser
TM195	Colour and Turbidity of water. Methods for the Examination of Waters and Associated Materials. HMSO, 1981, ISBN 0 11 751855 3.	Determination of Turbidity in Waters & Associated Matrices
TM245	By GC-FID	Determination of GRO by Headspace in waters
TM256	The measurement of Electrical Conductivity and the Laboratory determination of pH Value of Natural, Treated and Wastewaters. HMSO, 1978, ISBN 011 751428 4.	Determination of pH in Water and Leachate using the GLPH pH Meter
TM281		The Determination of Total Oxidized Nitrogen in Saline Matrices using the Kone Spectrophotometric Analyser

NA = not applicable.

Chemical testing (unless subcontracted) performed at ALS Life Sciences Ltd Hawarden (Method codes TM) or ALS Life Sciences Ltd Aberdeen (Method codes S).





# CERTIFICATE OF ANALYSIS

Validated

SDG: 150216-11  
Location: Atlantic Ocean

Client Reference: B1804-07  
Order Number:

Report Number: 497498  
Superseded Report: 496476

## Test Completion Dates

Lab Sample No(s)	19065324	19065355	19065358	19065320	19065327	19065890	19065893	19065054	19065058	19065059
Customer Sample Ref.	1	2a	3a	4a	5a	6a	7a	8a	9a	10a
AGS Ref.										
Depth	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Type	Saline D (SA)	Saline D (SA)	Saline C (SA)	Water	Water	Water	Water	Saline D (SA)	Saline D (SA)	Saline C (SA)
Ammoniacal Nitrogen	22-Feb-2019	22-Feb-2019	22-Feb-2019	22-Feb-2019	22-Feb-2019	22-Feb-2019	22-Feb-2019	22-Feb-2019	22-Feb-2019	22-Feb-2019
ODD Unfiltered	21-Feb-2019	21-Feb-2019	21-Feb-2019	21-Feb-2019	21-Feb-2019	21-Feb-2019	21-Feb-2019	21-Feb-2019	21-Feb-2019	21-Feb-2019
Conductivity (at 20 deg C)	21-Feb-2019	21-Feb-2019	21-Feb-2019	21-Feb-2019	21-Feb-2019	21-Feb-2019	21-Feb-2019	21-Feb-2019	21-Feb-2019	21-Feb-2019
EPH (DRD) (C10-C40) Aqueous (K)	20-Feb-2019	20-Feb-2019	19-Feb-2019	20-Feb-2019	20-Feb-2019	20-Feb-2019	20-Feb-2019	20-Feb-2019	20-Feb-2019	20-Feb-2019
ORP by GC-PI (K)	22-Feb-2019	22-Feb-2019	22-Feb-2019	22-Feb-2019	22-Feb-2019	22-Feb-2019	22-Feb-2019	22-Feb-2019	22-Feb-2019	22-Feb-2019
Nitrite by Kone (a)	18-Feb-2019	18-Feb-2019	18-Feb-2019	18-Feb-2019	18-Feb-2019	18-Feb-2019	18-Feb-2019	18-Feb-2019	18-Feb-2019	18-Feb-2019
pH Value	21-Feb-2019	21-Feb-2019	22-Feb-2019	22-Feb-2019	21-Feb-2019	22-Feb-2019	22-Feb-2019	21-Feb-2019	22-Feb-2019	22-Feb-2019
Saline Cyanides (K)	12-Mar-2019	12-Mar-2019	12-Mar-2019	12-Mar-2019	12-Mar-2019	12-Mar-2019	12-Mar-2019	12-Mar-2019	12-Mar-2019	12-Mar-2019
Saline Metals Dissolved	22-Feb-2019	22-Feb-2019	22-Feb-2019	22-Feb-2019	22-Feb-2019	22-Feb-2019	22-Feb-2019	22-Feb-2019	22-Feb-2019	22-Feb-2019
Saline TON	22-Feb-2019	22-Feb-2019	22-Feb-2019	22-Feb-2019	22-Feb-2019	22-Feb-2019	22-Feb-2019	22-Feb-2019	22-Feb-2019	22-Feb-2019
Suspended Solids	19-Feb-2019	19-Feb-2019	19-Feb-2019	19-Feb-2019	19-Feb-2019	19-Feb-2019	19-Feb-2019	19-Feb-2019	19-Feb-2019	19-Feb-2019
TDC (Saline) (W-TDC-R)	22-Feb-2019	22-Feb-2019	22-Feb-2019	22-Feb-2019	22-Feb-2019	22-Feb-2019	22-Feb-2019	22-Feb-2019	22-Feb-2019	22-Feb-2019
Total Dissolved Solids (Dry)	20-Feb-2019	20-Feb-2019	20-Feb-2019	20-Feb-2019	20-Feb-2019	20-Feb-2019	20-Feb-2019	20-Feb-2019	20-Feb-2019	20-Feb-2019
Total BPH (eq)	22-Feb-2019	22-Feb-2019	22-Feb-2019	22-Feb-2019	22-Feb-2019	22-Feb-2019	22-Feb-2019	22-Feb-2019	22-Feb-2019	22-Feb-2019
Turbidity in water	18-Feb-2019	18-Feb-2019	18-Feb-2019	18-Feb-2019	18-Feb-2019	18-Feb-2019	18-Feb-2019	18-Feb-2019	18-Feb-2019	18-Feb-2019

Lab Sample No(s)	19065322	19065328	19065328	19065891	19065895	19065051	19065856
Customer Sample Ref.	1a	2a	3a	4a	5a	6a	7a
AGS Ref.							
Depth	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Type	Water	Water	Water	Water	Water	Saline D (SA)	Water
Ammoniacal Nitrogen	22-Feb-2019	22-Feb-2019	22-Feb-2019	22-Feb-2019	22-Feb-2019	22-Feb-2019	22-Feb-2019
ODD Unfiltered	20-Feb-2019	21-Feb-2019	21-Feb-2019	20-Feb-2019	21-Feb-2019	20-Feb-2019	20-Feb-2019
Conductivity (at 20 deg C)	21-Feb-2019	21-Feb-2019	21-Feb-2019	21-Feb-2019	21-Feb-2019	21-Feb-2019	21-Feb-2019
EPH (DRD) (C10-C40) Aqueous (K)	20-Feb-2019	19-Feb-2019	20-Feb-2019	20-Feb-2019	20-Feb-2019	19-Feb-2019	19-Feb-2019
ORP by GC-PI (K)	22-Feb-2019	22-Feb-2019	22-Feb-2019	22-Feb-2019	22-Feb-2019	22-Feb-2019	22-Feb-2019
Nitrite by Kone (a)	18-Feb-2019	18-Feb-2019	18-Feb-2019	18-Feb-2019	18-Feb-2019	18-Feb-2019	18-Feb-2019
pH Value	22-Feb-2019	21-Feb-2019	21-Feb-2019	22-Feb-2019	22-Feb-2019	22-Feb-2019	21-Feb-2019
Saline Cyanides (K)	12-Mar-2019	12-Mar-2019	12-Mar-2019	12-Mar-2019	12-Mar-2019	12-Mar-2019	12-Mar-2019
Saline Metals Dissolved	22-Feb-2019	22-Feb-2019	22-Feb-2019	22-Feb-2019	22-Feb-2019	22-Feb-2019	22-Feb-2019
Saline TON	22-Feb-2019	22-Feb-2019	22-Feb-2019	22-Feb-2019	22-Feb-2019	22-Feb-2019	22-Feb-2019
Suspended Solids	19-Feb-2019	19-Feb-2019	19-Feb-2019	19-Feb-2019	19-Feb-2019	19-Feb-2019	19-Feb-2019
TDC (Saline) (W-TDC-R)	22-Feb-2019	22-Feb-2019	22-Feb-2019	22-Feb-2019	22-Feb-2019	22-Feb-2019	22-Feb-2019
Total Dissolved Solids (Dry)	20-Feb-2019	20-Feb-2019	20-Feb-2019	20-Feb-2019	20-Feb-2019	20-Feb-2019	20-Feb-2019
Total BPH (eq)	22-Feb-2019	22-Feb-2019	22-Feb-2019	22-Feb-2019	22-Feb-2019	22-Feb-2019	22-Feb-2019
Turbidity in water	18-Feb-2019	18-Feb-2019	18-Feb-2019	18-Feb-2019	18-Feb-2019	18-Feb-2019	18-Feb-2019

16.37.29 19/03/2019



## CERTIFICATE OF ANALYSIS

Work Order	PR1915169	Issue Date	22-Feb-2019
Customer	ALS Life Sciences Ltd	Laboratory	ALS Czech Republic, s.r.o.
Contact	Reporting	Contact	Client Service
Address	Unit 7-8 Hawarden Business Park Manor Road, Hawarden CH5 3US Deeside United Kingdom	Address	Na Harfe 336/9 Prague 9 - Vysocany 190 00 Czech Republic
E-mail	euhdinsubconresults@ALSGlobal.com	E-mail	customer.support@alsglobal.com
Telephone	---	Telephone	+420 226 226 228
Project	190216-11	Page	1 of 3
Order number	190216-11	Date Samples Received	19-Feb-2019
		Quote number	PR2018ALSAL-GB0004 (CZ-256-18-0022)
Site	---	Date of test	20-Feb-2019 - 22-Feb-2019
Sampled by	Client	QC Level	ALS CR Standard Quality Control Schedule

### General Comments

This report shall not be reproduced except in full, without prior written approval from the laboratory.

The laboratory declares that the test results relate only to the listed samples.

Sample(s) PR1915169/001-017, method W-TOC-IR - required dilution due to high salt content. LOR has been adjusted accordingly.

### Responsible for accuracy

Signatories  
Zdeněk Jiráček

Position  
Environmental Business Unit  
Manager

Testing Laboratory No. 1163  
Accredited by CAI according to  
CSN EN ISO/IEC 17025:2005





Issue Date : 22-Feb-2019  
Page : 2 of 3  
Work Order : PR1915169  
Customer : ALS Life Sciences Ltd



## Analytical Results

Sub-Matrix: SEAWATER				Client sample ID	19374895	19374953	19370238
				Laboratory sample ID	PR1915169-001	PR1915169-002	PR1915169-003
				Client sampling date / time	20-Feb-2019 00:00	20-Feb-2019 00:00	20-Feb-2019 00:00
Parameter	Method	LOR	Unit	Result	MU	Result	MU
<b>Aggregate Parameters</b>							
Total Organic Carbon	W-TOC-IR	0.50	mg/L	3.13	± 20.0%	3.38	± 20.0%

Sub-Matrix: SEAWATER				Client sample ID	19370282	19370089	19370314
				Laboratory sample ID	PR1915169-004	PR1915169-005	PR1915169-006
				Client sampling date / time	20-Feb-2019 00:00	20-Feb-2019 00:00	20-Feb-2019 00:00
Parameter	Method	LOR	Unit	Result	MU	Result	MU
<b>Aggregate Parameters</b>							
Total Organic Carbon	W-TOC-IR	0.50	mg/L	2.61	± 20.0%	<2.50	---

Sub-Matrix: SEAWATER				Client sample ID	19373480	---	---
				Laboratory sample ID	PR1915169-009	---	---
				Client sampling date / time	20-Feb-2019 00:00	---	---
Parameter	Method	LOR	Unit	Result	MU	Result	MU
<b>Aggregate Parameters</b>							
Total Organic Carbon	W-TOC-IR	0.50	mg/L	<2.50	---	---	---

Sub-Matrix: WATER				Client sample ID	19375006	19375053	19373442
				Laboratory sample ID	PR1915169-007	PR1915169-008	PR1915169-010
				Client sampling date / time	20-Feb-2019 00:00	20-Feb-2019 00:00	20-Feb-2019 00:00
Parameter	Method	LOR	Unit	Result	MU	Result	MU
<b>Aggregate Parameters</b>							
Total Organic Carbon	W-TOC-IR	0.50	mg/L	<2.50	---	<2.50	---

Sub-Matrix: WATER				Client sample ID	19373415	19373394	19370296
				Laboratory sample ID	PR1915169-011	PR1915169-012	PR1915169-013
				Client sampling date / time	20-Feb-2019 00:00	20-Feb-2019 00:00	20-Feb-2019 00:00
Parameter	Method	LOR	Unit	Result	MU	Result	MU
<b>Aggregate Parameters</b>							
Total Organic Carbon	W-TOC-IR	0.50	mg/L	<2.50	---	<2.50	---

Sub-Matrix: WATER				Client sample ID	19370364	19371123	19371124
				Laboratory sample ID	PR1915169-014	PR1915169-015	PR1915169-016
				Client sampling date / time	20-Feb-2019 00:00	20-Feb-2019 00:00	20-Feb-2019 00:00
Parameter	Method	LOR	Unit	Result	MU	Result	MU
<b>Aggregate Parameters</b>							
Total Organic Carbon	W-TOC-IR	0.50	mg/L	<2.50	---	2.76	± 20.0%

Sub-Matrix: WATER				Client sample ID	19371118	---	---
				Laboratory sample ID	PR1915169-017	---	---
				Client sampling date / time	20-Feb-2019 00:00	---	---
Parameter	Method	LOR	Unit	Result	MU	Result	MU
<b>Aggregate Parameters</b>							
Total Organic Carbon	W-TOC-IR	0.50	mg/L	<2.50	---	---	---

If no sampling time is provided, the sampling time will default 00:00 on the date of sampling. If no sampling date is provided, delivery date in brackets without a time component will be displayed instead. Measurement uncertainty is expressed as expanded measurement uncertainty with coverage factor k = 2, representing 95% confidence level.

Key: LOR = Limit of reporting; MU = Measurement Uncertainty

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Issue Date : 22-Feb-2019  
Page : 3 of 3  
Work Order : PR1915169  
Customer : ALS Life Sciences Ltd



**The end of result part of the certificate of analysis**

**Brief Method Summaries**

Analytical Methods	Method Descriptions
Location of test performance: Na Hradě 336/9 Prague 9 - Vysocany Czech Republic 190 00	
W-TOC-IR	CZ_SOP_D08_02_059 (CSN EN 1484, CSN EN 16192, SM 5310) Determination of total organic carbon (TOC), dissolved organic carbon (DOC), total inorganic carbon (TIC) and total carbon (TC) by IR detection.

A "\*" symbol preceding any method indicates laboratory or subcontractor non-accredited test. In the case when a procedure belonging to an accredited method was used for non-accredited matrix, would apply that the reported results are non-accredited. Please refer to General Comment section on front page for information. If the report contains subcontracted analysis, those are made in a subcontracted laboratory outside the laboratories ALS Czech Republic, s.r.o.  
The calculation methods of summation parameters are available on request in the client service.

## Report

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L1904721

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Date received 2019-02-20  
Issued 2019-02-21

ALS Life Sciences

Hawarden Bus.Park, Manor Lane  
CH5 3US Hawarden, Deeside  
United Kingdom

Project 190216-11

### Analysis: V5BAS

Your ID	19375250					
Sampled	2019-02-09					
LabID	U11568713					
Analysis	Results	Uncertainty (±)	Unit	Method	Issuer	Sign
Filtrated with 0,45µm before the analysis	Nej			1	I	HUCH
Fe	0.00851	0.00215	mg/l	1	H	NIPA
As	2.61	1.14	µg/l	1	H	NIPA
Ba	6.43	1.42	µg/l	1	H	NIPA
Cd	<0.05		µg/l	1	H	NIPA
Cr	0.349	0.131	µg/l	1	H	NIPA
Cu	0.568	0.376	µg/l	1	H	NIPA
Hg	<0.002		µg/l	1	F	EVRI
Ni	<0.5		µg/l	1	H	NIPA
Pb	<0.3		µg/l	1	H	NIPA
V	1.32	0.28	µg/l	1	H	NIPA
Zn	<2		µg/l	1	H	NIPA

Your ID	19375257					
Sampled	2019-02-09					
LabID	U11568714					
Analysis	Results	Uncertainty (±)	Unit	Method	Issuer	Sign
Filtrated with 0,45µm before the analysis	Nej			1	I	HUCH
Fe	<0.004		mg/l	1	H	NIPA
As	1.38	0.46	µg/l	1	H	NIPA
Ba	6.61	1.45	µg/l	1	H	NIPA
Cd	<0.05		µg/l	1	H	NIPA
Cr	0.353	0.129	µg/l	1	H	NIPA
Cu	0.512	0.164	µg/l	1	H	NIPA
Hg	<0.002		µg/l	1	F	EVRI
Ni	0.578	0.168	µg/l	1	H	NIPA
Pb	<0.3		µg/l	1	H	NIPA
V	1.43	0.30	µg/l	1	H	NIPA
Zn	<2		µg/l	1	H	NIPA

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**L1904721**

1DZ9S7FYTZB



Your ID	<b>19370410</b>					
Sampled	<b>2019-02-09</b>					
LabID	U11568715					
Analysis	Results	Uncertainty (±)	Unit	Method	Issuer	Sign
Filtrated with 0,45µm before the analysis	Nej			1	I	HUCH
Fe	<0.004		mg/l	1	H	NIPA
As	1.80	0.57	µg/l	1	H	NIPA
Ba	16.0	3.5	µg/l	1	H	NIPA
Cd	<0.05		µg/l	1	H	NIPA
Cr	0.334	0.121	µg/l	1	H	NIPA
Cu	0.651	0.227	µg/l	1	H	NIPA
Hg	<0.002		µg/l	1	F	EVRI
Ni	<0.5		µg/l	1	H	NIPA
Pb	<0.3		µg/l	1	H	NIPA
V	1.20	0.27	µg/l	1	H	NIPA
Zn	2.29	0.92	µg/l	1	H	NIPA

Your ID	<b>19370433</b>					
Sampled	<b>2019-02-09</b>					
LabID	U11568716					
Analysis	Results	Uncertainty (±)	Unit	Method	Issuer	Sign
Filtrated with 0,45µm before the analysis	Nej			1	I	HUCH
Fe	<0.004		mg/l	1	H	NIPA
As	<0.5		µg/l	1	H	NIPA
Ba	38.9	8.5	µg/l	1	H	NIPA
Cd	<0.05		µg/l	1	H	NIPA
Cr	0.366	0.101	µg/l	1	H	NIPA
Cu	<0.5		µg/l	1	H	NIPA
Hg	<0.002		µg/l	1	F	EVRI
Ni	0.669	0.293	µg/l	1	H	NIPA
Pb	<0.3		µg/l	1	H	NIPA
V	0.424	0.108	µg/l	1	H	NIPA
Zn	<2		µg/l	1	H	NIPA

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Your ID	19370452					
Sampled	2019-02-09					
LabID	U11568717					
Analysis	Results	Uncertainty (±)	Unit	Method	Issuer	Sign
Filtrated with 0.45µm before the analysis	Nej			1	I	HUCH
Fe	<0.004		mg/l	1	H	NIPA
As	1.21	0.35	µg/l	1	H	NIPA
Ba	26.2	5.7	µg/l	1	H	NIPA
Cd	<0.05		µg/l	1	H	NIPA
Cr	0.732	0.179	µg/l	1	H	NIPA
Cu	1.46	0.66	µg/l	1	H	NIPA
Hg	<0.002		µg/l	1	F	EVRI
Ni	<0.5		µg/l	1	H	NIPA
Pb	<0.3		µg/l	1	H	NIPA
V	0.814	0.214	µg/l	1	H	NIPA
Zn	<2		µg/l	1	H	NIPA

Your ID	19370457					
Sampled	2019-02-09					
LabID	U11568718					
Analysis	Results	Uncertainty (±)	Unit	Method	Issuer	Sign
Filtrated with 0,45µm before the analysis	Nej			1	I	HUCH
Fe	<0.004		mg/l	1	H	NIPA
As	1.62	0.31	µg/l	1	H	NIPA
Ba	21.4	4.7	µg/l	1	H	NIPA
Cd	<0.05		µg/l	1	H	NIPA
Cr	0.249	0.095	µg/l	1	H	NIPA
Cu	<0.5		µg/l	1	H	NIPA
Hg	<0.002		µg/l	1	F	EVRI
Ni	<0.5		µg/l	1	H	NIPA
Pb	<0.3		µg/l	1	H	NIPA
V	1.02	0.23	µg/l	1	H	NIPA
Zn	<2		µg/l	1	H	NIPA

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**L1904721**

1DZ9S7FYTZB



Your ID	<b>19373541</b>					
Sampled	<b>2019-02-09</b>					
LabID	U11568719					
Analysis	Results	Uncertainty (±)	Unit	Method	Issuer	Sign
Filtrated with 0,45µm before the analysis *	Nej			1	I	HUCH
Fe	<0.004		mg/l	1	H	NIPA
As	1.75	0.35	µg/l	1	H	NIPA
Ba	11.4	2.5	µg/l	1	H	NIPA
Cd	<0.05		µg/l	1	H	NIPA
Cr	0.230	0.094	µg/l	1	H	NIPA
Cu	<0.5		µg/l	1	H	NIPA
Hg	<0.002		µg/l	1	F	EVRI
Ni	<0.5		µg/l	1	H	NIPA
Pb	<0.3		µg/l	1	H	NIPA
V	1.34	0.29	µg/l	1	H	NIPA
Zn	<2		µg/l	1	H	NIPA

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L1904721

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Method specification	
1	<p>Analysis according to package V-5, V-6:</p> <p>Analysis of water samples without dissolution. When filtration has been performed, a filter of 0,45µm was used.</p> <p>For W an unacidified sample portion was analyzed. For other elements the samples were acidified with 1 ml ultra-high purity nitric acid per 100 ml. This does not apply to samples that were already acidic upon receipt by the laboratory.</p> <p>The ICP-SFMS analyses were carried out according to SS EN ISO 17294-1, 2 (modified) and US EPA Method 200.8 (modified). The ICP-AES analyses were carried out according to SS EN ISO 11885 (modified) and US EPA Method 200.7 (modified). The AFS analyses for Hg were carried out according to SS EN ISO 17852.</p> <p>Note that limits of reporting may be affected if, e.g. additional dilution was required because of matrix effects, or the sample quantity was limited.</p>

Approver	
EVRI	Evy Rickfors
HUCH	Huimin Chen
NIPA	Nicola Pallavicini

Issuer <sup>1</sup>	
F	AFS
H	ICP-SFMS
I	Man.Inm.

\* indicates unaccredited analysis.

The uncertainty is given as extended uncertainty (according to the definition in "Guide to the Expression of Uncertainty in Measurement", JCGM 100:2008 Corrected version 2010) calculated with a coverage factor of 2, which gives a confidence level of approximately 95%.

Measurement of uncertainty is reported only for detected substances with levels above the reporting limits.

The uncertainty from subcontractors is often given as extended uncertainty calculated with a coverage factor of 2. Contact the laboratory for further information.

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The results apply only to the material that has been identified, received, and tested.

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<sup>1</sup> The technical unit within ALS Scandinavia where the analysis was carried out, alternatively the subcontractor for the analysis.

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**L1904722**

10Z9TMPMLA9



Date received **2019-02-20**  
Issued **2019-02-21**

**ALS Life Sciences**

**Hawarden Bus.Park, Manor Lane  
CH5 3US Hawarden, Deeside  
United Kingdom**

Project **190216-11**

### Analysis: V2BAS

Your ID	<b>19375262</b>						
Sampled	<b>2019-02-09</b>						
LabID	<b>U11568720</b>						
Analysis	Results	Uncertainty (±)	Unit	Method	Issuer	Sign	
Filtrated with 0,45µm before the analysis	Nej			1	I	HUCH	
Fe	<0.004		mg/l	1	H	NIPA	
As	1.61	0.48	µg/l	1	H	NIPA	
Ba	12.4	2.3	µg/l	1	H	NIPA	
Cd	<0.02		µg/l	1	H	NIPA	
Cr	0.188	0.069	µg/l	1	H	NIPA	
Cu	<1		µg/l	1	H	NIPA	
Hg	<0.002		µg/l	1	F	EVRI	
Ni	<0.5		µg/l	1	H	NIPA	
Pb	<0.1		µg/l	1	H	NIPA	
V	1.45	0.30	µg/l	1	H	NIPA	
Zn	<2		µg/l	1	H	NIPA	

Your ID	<b>19375243</b>						
Sampled	<b>2019-02-09</b>						
LabID	<b>U11568721</b>						
Analysis	Results	Uncertainty (±)	Unit	Method	Issuer	Sign	
Filtrated with 0,45µm before the analysis	Nej			1	I	HUCH	
Fe	<0.002		mg/l	1	H	NIPA	
As	2.53	0.44	µg/l	1	H	NIPA	
Ba	9.38	1.72	µg/l	1	H	NIPA	
Cd	0.0176	0.0057	µg/l	1	H	NIPA	
Cr	0.282	0.067	µg/l	1	H	NIPA	
Cu	0.810	0.345	µg/l	1	H	NIPA	
Hg	<0.002		µg/l	1	F	EVRI	
Ni	<0.3		µg/l	1	H	NIPA	
Pb	0.0918	0.0404	µg/l	1	H	NIPA	
V	1.51	0.28	µg/l	1	H	NIPA	
Zn	<1		µg/l	1	H	NIPA	

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10Z9TMPMLA9



Your ID	19373545					
Sampled	2019-02-09					
LabID	U11568722					
Analysis	Results	Uncertainty (±)	Unit	Method	Issuer	Sign
Filtrated with 0,45µm before the analysis	Nej			1	I	HUCH
Fe	<0.002		mg/l	1	H	NIPA
As	2.82	0.49	µg/l	1	H	NIPA
Ba	7.32	1.44	µg/l	1	H	NIPA
Cd	0.0109	0.0054	µg/l	1	H	NIPA
Cr	0.575	0.125	µg/l	1	H	NIPA
Cu	<0.5		µg/l	1	H	NIPA
Hg	<0.002		µg/l	1	F	EVRI
Ni	<0.3		µg/l	1	H	NIPA
Pb	<0.05		µg/l	1	H	NIPA
V	1.54	0.29	µg/l	1	H	NIPA
Zn	<1		µg/l	1	H	NIPA

Your ID	19373550					
Sampled	2019-02-09					
LabID	U11568723					
Analysis	Results	Uncertainty (±)	Unit	Method	Issuer	Sign
Filtrated with 0,45µm before the analysis <sup>2</sup>	Nej			1	I	HUCH
Fe	<0.002		mg/l	1	H	NIPA
As	2.89	0.61	µg/l	1	H	NIPA
Ba	9.12	1.76	µg/l	1	H	NIPA
Cd	0.0127	0.0060	µg/l	1	H	NIPA
Cr	0.300	0.130	µg/l	1	H	NIPA
Cu	<0.5		µg/l	1	H	NIPA
Hg	<0.002		µg/l	1	F	EVRI
Ni	0.428	0.208	µg/l	1	H	NIPA
Pb	<0.05		µg/l	1	H	NIPA
V	1.30	0.32	µg/l	1	H	NIPA
Zn	<1		µg/l	1	H	NIPA

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Your ID	19373559					
Sampled	2019-02-09					
LabID	U11568724					
Analysis	Results	Uncertainty (±)	Unit	Method	Issuer	Sign
Filtrated with 0,45µm before the analysis	Nej			1	I	HUCH
Fe	<0.004		mg/l	1	H	NIPA
As	1.83	0.78	µg/l	1	H	NIPA
Ba	7.72	2.13	µg/l	1	H	NIPA
Cd	<0.02		µg/l	1	H	NIPA
Cr	0.436	0.106	µg/l	1	H	NIPA
Cu	<1		µg/l	1	H	NIPA
Hg	<0.002		µg/l	1	F	EVRI
Ni	<0.5		µg/l	1	H	NIPA
Pb	<0.1		µg/l	1	H	NIPA
V	1.47	0.29	µg/l	1	H	NIPA
Zn	<2		µg/l	1	H	NIPA

Your ID	19370503					
Sampled	2019-02-09					
LabID	U11568725					
Analysis	Results	Uncertainty (±)	Unit	Method	Issuer	Sign
Filtrated with 0,45µm before the analysis	Nej			1	I	HUCH
Fe	<0.002		mg/l	1	H	NIPA
As	2.03	0.38	µg/l	1	H	NIPA
Ba	5.49	1.06	µg/l	1	H	NIPA
Cd	0.0105	0.0048	µg/l	1	H	NIPA
Cr	0.506	0.112	µg/l	1	H	NIPA
Cu	<0.5		µg/l	1	H	NIPA
Hg	<0.002		µg/l	1	F	EVRI
Ni	0.262	0.167	µg/l	1	H	NIPA
Pb	<0.05		µg/l	1	H	NIPA
V	1.53	0.57	µg/l	1	H	NIPA
Zn	<1		µg/l	1	H	NIPA

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Your ID	19370482					
Sampled	2019-02-09					
LabID	U11568726					
Analysis	Results	Uncertainty (±)	Unit	Method	Issuer	Sign
Filtrated with 0,45µm before the analysis	Nej			1	I	HUCH
Fe	<0.004		mg/l	1	H	NIPA
As	1.95	0.38	µg/l	1	H	NIPA
Ba	5.59	1.04	µg/l	1	H	NIPA
Cd	<0.02		µg/l	1	H	NIPA
Cr	0.359	0.084	µg/l	1	H	NIPA
Cu	<1		µg/l	1	H	NIPA
Hg	<0.002		µg/l	1	F	EVRI
Ni	<0.5		µg/l	1	H	NIPA
Pb	<0.1		µg/l	1	H	NIPA
V	1.72	0.32	µg/l	1	H	NIPA
Zn	<2		µg/l	1	H	NIPA

Your ID	19371097					
Sampled	2019-02-09					
LabID	U11568727					
Analysis	Results	Uncertainty (±)	Unit	Method	Issuer	Sign
Filtrated with 0,45µm before the analysis	Nej			1	I	HUCH
Fe	<0.002		mg/l	1	H	NIPA
As	2.43	0.53	µg/l	1	H	NIPA
Ba	5.46	1.01	µg/l	1	H	NIPA
Cd	0.0115	0.0053	µg/l	1	H	NIPA
Cr	0.491	0.094	µg/l	1	H	NIPA
Cu	<0.5		µg/l	1	H	NIPA
Hg	<0.002		µg/l	1	F	EVRI
Ni	<0.3		µg/l	1	H	NIPA
Pb	<0.05		µg/l	1	H	NIPA
V	1.85	0.35	µg/l	1	H	NIPA
Zn	<1		µg/l	1	H	NIPA

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Your ID	19371093					
Sampled	2019-02-09					
LabID	U11568728					
Analysis	Results	Uncertainty (±)	Unit	Method	Issuer	Sign
Filtrated with 0.45µm before the analysis	Nej			1	I	HUCH
Fe	<0.004		mg/l	1	H	NIPA
As	1.82	0.83	µg/l	1	H	NIPA
Ba	5.73	1.06	µg/l	1	H	NIPA
Cd	<0.02		µg/l	1	H	NIPA
Cr	0.218	0.126	µg/l	1	H	NIPA
Cu	<1		µg/l	1	H	NIPA
Hg	<0.002		µg/l	1	F	EVRI
Ni	<0.5		µg/l	1	H	NIPA
Pb	<0.1		µg/l	1	H	NIPA
V	1.81	0.33	µg/l	1	H	NIPA
Zn	<2		µg/l	1	H	NIPA

Your ID	19371111					
Sampled	2019-02-09					
LabID	U11568729					
Analysis	Results	Uncertainty (±)	Unit	Method	Issuer	Sign
Filtrated with 0,45µm before the analysis	Nej			1	I	HUCH
Fe	0.00758	0.00166	mg/l	1	H	NIPA
As	0.343	0.062	µg/l	1	H	NIPA
Ba	43.2	7.9	µg/l	1	H	NIPA
Cd	0.00408	0.00127	µg/l	1	H	NIPA
Cr	0.591	0.112	µg/l	1	H	NIPA
Cu	0.477	0.097	µg/l	1	H	NIPA
Hg	<0.002		µg/l	1	F	EVRI
Ni	0.504	0.095	µg/l	1	H	NIPA
Pb	0.0169	0.0054	µg/l	1	H	NIPA
V	0.392	0.078	µg/l	1	H	NIPA
Zn	0.920	0.239	µg/l	1	H	NIPA

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L1904722

10Z9TMPMLA9



Method specification	
1	<p>Analysis according to package V-2:</p> <p>Analysis of water samples without dissolution. When filtration has been performed, a filter of 0,45µm was used.</p> <p>For W an unacidified sample portion was analyzed. For other elements the samples were acidified with 1 ml ultra-high purity nitric acid per 100 ml. This does not apply to samples that were already acidic upon receipt by the laboratory.</p> <p>The ICP-SFMS analyses were carried out according to SS EN ISO 17294- 2: 2016 and US EPA Method 200.8: 1994. The ICP-AES analyses were carried out according to SS EN ISO 11885: 2009 and US EPA Method 200.7: 1994. The AFS analyses for Hg were carried out according to SS EN ISO 17852: 2008.</p> <p>Note that limits of reporting may be affected if, e.g. additional dilution was required because of matrix effects, or the sample quantity was limited.</p>

Approver	
EVRI	Evy Rickefors
HUCH	Huimin Chen
NIPA	Nicola Pallavicini

Issuer <sup>1</sup>	
F	AFS
H	ICP-SFMS
I	Man.Inm.

\* indicates unaccredited analysis.

The uncertainty is given as extended uncertainty (according to the definition in "Guide to the Expression of Uncertainty in Measurement", JCGM 100:2008 Corrected version 2010) calculated with a coverage factor of 2, which gives a confidence level of approximately 95%.

Measurement of uncertainty is reported only for detected substances with levels above the reporting limits.

The uncertainty from subcontractors is often given as extended uncertainty calculated with a coverage factor of 2. Contact the laboratory for further information.

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<sup>1</sup> The technical unit within ALS Scandinavia where the analysis was carried out, alternatively the subcontractor for the analysis.

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## Analytical Report

Final Report

Report ID - 20129483 - 1

Batch description: Job ID 190216-11 Cyanide analysis

Reported on:  
12-Mar-2019

Hawarden Subcontractors  
ALS Life Sciences Ltd  
Units 7 & 8 Hawarden Business Park  
Off Manor Lane  
Hawarden  
Deeside  
CH5 3US

Dear Hawarden

Please find attached the results for the batch of 17 samples described below.

Samples Registered on:	22-Feb-2019
Analysis Started on:	23-Feb-2019
Analysis Completed on:	12-Mar-2019
Results for Batch Number	20129483
Your Purchase Order Number:	None Supplied
You will be invoiced shortly by our accounts department.	

If we can be of further assistance then please do not hesitate to contact us.

Yours sincerely



**Lawrence Green**  
Customer Services Team Manager  
Tel: 0800 092 0786  
[nls@environment-agency.gov.uk](mailto:nls@environment-agency.gov.uk)

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# National Laboratory Service

## Analytical Report

Final Report

Report ID - 20129483 - 1

Batch description: Job ID 190216-11 Cyanide analysis

Reported on:  
12-Mar-2019

Client: ALS Life Sciences Ltd Project: 15266 Master Quote  
Quote Description: Saline Water  
Folder No: 004314018 Sampled on: 9-Feb-19 @ (Time not supplied)  
Comments: 19375241 1b  
Quote No: 15266 Matrix: Saline Water

Analyte	Result	Units	Flag	MRV	Accord	Lab ID	Testcode
Cyanide : Complex as CN	<0.500	mg/l			None	NLS	864
Cyanide : Free as CN	<0.500	mg/l	OR DC	0.005	None	SX	183
Cyanide as CN	<0.500	mg/l		0.5	None	SX	182

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# National Laboratory Service

## Analytical Report

Final Report

Report ID - 20129483 - 1

Batch description: Job ID 190216-11 Cyanide analysis

Reported on:  
12-Mar-2019

Client: ALS Life Sciences Ltd Project: 15266 Master Quote  
Quote Description: Saline Water  
Folder No: 004314019 Sampled on: 9-Feb-19 @ (Time not supplied)  
Comments: 19375087 2a  
Quote No: 15266 Matrix: Saline Water

Analyte	Result	Units	Flag	MRV	Accord	Lab ID	Testcode
Cyanide : Complex as CN	<0.500	mg/l			None	NLS	864
Cyanide : Free as CN	<0.500	mg/l	OR DC	0.005	None	SX	183
Cyanide as CN	<0.500	mg/l		0.5	None	SX	182

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# National Laboratory Service

## Analytical Report

Final Report

Report ID - 20129483 - 1

Batch description: Job ID 190216-11 Cyanide analysis

Reported on:  
12-Mar-2019

Client: ALS Life Sciences Ltd Project: 15266 Master Quote  
Quote Description: Saline Water  
Folder No: 004314020 Sampled on: 9-Feb-19 @ (Time not supplied)  
Comments: 19370371 2b  
Quote No: 15266 Matrix: Saline Water

Analyte	Result	Units	Flag	MRV	Accord	Lab ID	Testcode
Cyanide : Complex as CN	<0.500	mg/l			None	NLS	864
Cyanide : Free as CN	<0.500	mg/l	OR DC	0.005	None	SX	183
Cyanide as CN	<0.500	mg/l		0.5	None	SX	182

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# National Laboratory Service

## Analytical Report

Final Report

Report ID - 20129483 - 1

Batch description: Job ID 190216-11 Cyanide analysis

Reported on:  
12-Mar-2019

Client: ALS Life Sciences Ltd Project: 15266 Master Quote  
Quote Description: Saline Water  
Folder No: 004314021 Sampled on: 9-Feb-19 @ (Time not supplied)  
Comments: 19370466 3a  
Quote No: 15266 Matrix: Saline Water

Analyte	Result	Units	Flag	MRV	Accord	Lab ID	Testcode
Cyanide : Complex as CN	<0.500	mg/l			None	NLS	864
Cyanide : Free as CN	<0.500	mg/l	OR DC	0.005	None	SX	183
Cyanide as CN	<0.500	mg/l		0.5	None	SX	182

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# National Laboratory Service

## Analytical Report

Final Report

Report ID - 20129483 - 1

Batch description: Job ID 190216-11 Cyanide analysis

Reported on:  
12-Mar-2019

Client: ALS Life Sciences Ltd Project: 15266 Master Quote  
Quote Description: Saline Water  
Folder No: 004314022 Sampled on: 9-Feb-19 @ (Time not supplied)  
Comments: 19370438 3b  
Quote No: 15266 Matrix: Saline Water

Analyte	Result	Units	Flag	MRV	Accord	Lab ID	Testcode
Cyanide : Complex as CN	<0.500	mg/l			None	NLS	864
Cyanide : Free as CN	<0.500	mg/l	OR DC	0.005	None	SX	183
Cyanide as CN	<0.500	mg/l		0.5	None	SX	182

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## Analytical Report

Final Report

Report ID - 20129483 - 1

Batch description: Job ID 190216-11 Cyanide analysis

Reported on:  
12-Mar-2019

Client: ALS Life Sciences Ltd Project: 15266 Master Quote  
Folder No: 004314023 Quote Description: Saline Water  
Comments: 19370419 3c Sampled on: 9-Feb-19 @ (Time not supplied)  
Quote No: 15266 Matrix: Saline Water

Analyte	Result	Units	Flag	MRV	Accepted	Lab ID	Testcode
Cyanide : Complex as CN	<0.500	mg/l			None	NLS	864
Cyanide : Free as CN	<0.500	mg/l	OR DC	0.005	None	SX	183
Cyanide as CN	<0.500	mg/l		0.5	None	SX	182

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## Analytical Report

Final Report

Report ID - 20129483 - 1

Batch description: Job ID 190216-11 Cyanide analysis

Reported on:  
12-Mar-2019

Client: ALS Life Sciences Ltd Project: 15266 Master Quote  
Quote Description: Saline Water  
Folder No: 004314024 Sampled on: 9-Feb-19 @ (Time not supplied)  
Comments: 19375253 4a  
Quote No: 15266 Matrix: Saline Water

Analyte	Result	Units	Flag	MRV	Accord	Lab ID	Testcode
Cyanide : Complex as CN	<0.500	mg/l			None	NLS	864
Cyanide : Free as CN	<0.500	mg/l	OR DC	0.005	None	SX	183
ELEVATED_MRV_100 : Dilution required (result accuracy may be reduced)							
Cyanide as CN	<0.500	mg/l		0.5	None	SX	182

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# National Laboratory Service

## Analytical Report

Final Report

Report ID - 20129483 - 1

Batch description: Job ID 190216-11 Cyanide analysis

Reported on:  
12-Mar-2019

Client: ALS Life Sciences Ltd Project: 15266 Master Quote  
Quote Description: Saline Water  
Folder No: 004314025 Sampled on: 9-Feb-19 @ (Time not supplied)  
Comments: 19375237 4b  
Quote No: 15266 Matrix: Saline Water

Analyte	Result	Units	Flag	MRV	Accord	Lab ID	Testcode
Cyanide : Complex as CN	<0.500	mg/l			None	NLS	864
Cyanide : Free as CN	<0.500	mg/l	OR DC	0.005	None	SX	183
Cyanide as CN	<0.500	mg/l		0.5	None	SX	182

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# National Laboratory Service

## Analytical Report

Final Report

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Batch description: Job ID 190216-11 Cyanide analysis

Reported on:  
12-Mar-2019

Client:	ALS Life Sciences Ltd	Project:	15266 Master Quote				
Quote Description:		Saline Water					
Folder No:	004314026	Sampled on:	9-Feb-19 @ (Time not supplied)				
Comments:	19373519 5						
Quote No:	15266	Matrix:	Saline Water				
Analyte	Result	Units	Flag	MRV	Accord	Lab ID	Testcode
Cyanide : Complex as CN	<0.500	mg/l			None	NLS	864
Cyanide : Free as CN	<0.500	mg/l	OR DC	0.005	None	SX	183
ELEVATED_MRV_100 : Dilution required (result accuracy may be reduced)							
Cyanide as CN	<0.500	mg/l		0.5	None	SX	182

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# National Laboratory Service

## Analytical Report

Final Report

Report ID - 20129483 - 1

Batch description: Job ID 190216-11 Cyanide analysis

Reported on:  
12-Mar-2019

Client:	ALS Life Sciences Ltd	Project:	15266 Master Quote				
Quote Description:		Saline Water					
Folder No:	004314027	Sampled on:	9-Feb-19 @ (Time not supplied)				
Comments:	19373553 5b						
Quote No:	15266	Matrix:	Saline Water				
Analyte	Result	Units	Flag	MRV	Accord	Lab ID	Testcode
Cyanide : Complex as CN	<0.500	mg/l			None	NLS	864
Cyanide : Free as CN	<0.500	mg/l	OR DC	0.005	None	SX	183
ELEVATED_MRV_100 : Dilution required (result accuracy may be reduced)							
Cyanide as CN	<0.500	mg/l		0.5	None	SX	182

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# National Laboratory Service

## Analytical Report

Final Report

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Batch description: Job ID 190216-11 Cyanide analysis

Reported on:  
12-Mar-2019

Client: ALS Life Sciences Ltd Project: 15266 Master Quote  
Quote Description: Saline Water  
Folder No: 004314028 Sampled on: 9-Feb-19 @ (Time not supplied)  
Comments: 19373546 7a  
Quote No: 15266 Matrix: Saline Water

Analyte	Result	Units	Flag	MRV	Accord	Lab ID	Testcode
Cyanide : Complex as CN	<0.500	mg/l			None	NLS	864
Cyanide : Free as CN	<0.500	mg/l	OR DC	0.005	None	SX	183
			ELEVATED_MRV_100 : Dilution required (result accuracy may be reduced)				
Cyanide as CN	<0.500	mg/l		0.5	None	SX	182

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# National Laboratory Service

## Analytical Report

Final Report

Report ID - 20129483 - 1

Batch description: Job ID 190216-11 Cyanide analysis

Reported on:  
12-Mar-2019

Client: ALS Life Sciences Ltd Project: 15266 Master Quote  
Quote Description: Saline Water  
Folder No: 004314029 Sampled on: 9-Feb-19 @ (Time not supplied)  
Comments: 19373542 7b  
Quote No: 15266 Matrix: Saline Water

Analyte	Result	Units	Flag	MRV	Accord	Lab ID	Testcode
Cyanide : Complex as CN	<0.500	mg/l			None	NLS	864
Cyanide : Free as CN	<0.500	mg/l	OR DC	0.005	None	SX	183
Cyanide as CN	<0.500	mg/l		0.5	None	SX	182

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# National Laboratory Service

## Analytical Report

Final Report

Report ID - 20129483 - 1

Batch description: Job ID 190216-11 Cyanide analysis

Reported on:  
12-Mar-2019

Client: ALS Life Sciences Ltd Project: 15266 Master Quote  
Quote Description: Saline Water  
Folder No: 004314030  
Comments: 19370498 8a  
Quote No: 15266  
Sampled on: 9-Feb-19 @ (Time not supplied)  
Matrix: Saline Water

Analyte	Result	Units	Flag	MRV	Accord	Lab ID	Testcode
Cyanide : Complex as CN	<0.500	mg/l			None	NLS	864
Cyanide : Free as CN	<0.500	mg/l	OR DC	0.005	None	SX	183
Cyanide as CN	<0.500	mg/l		0.5	None	SX	182

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# National Laboratory Service

## Analytical Report

Final Report

Report ID - 20129483 - 1

Batch description: Job ID 190216-11 Cyanide analysis

Reported on:  
12-Mar-2019

Client: ALS Life Sciences Ltd Project: 15266 Master Quote  
Quote Description: Saline Water  
Folder No: 004314031  
Comments: 19370502 8b  
Quote No: 15266  
Sampled on: 9-Feb-19 @ (Time not supplied)  
Matrix: Saline Water

Analyte	Result	Units	Flag	MRV	Accord	Lab ID	Testcode
Cyanide : Complex as CN	<0.500	mg/l			None	NLS	864
Cyanide : Free as CN	<0.500	mg/l	OR DC	0.005	None	SX	183
Cyanide as CN	<0.500	mg/l		0.5	None	SX	182

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# National Laboratory Service

## Analytical Report

Final Report

Report ID - 20129483 - 1

Batch description: Job ID 190216-11 Cyanide analysis

Reported on:  
12-Mar-2019

Client: ALS Life Sciences Ltd Project: 15266 Master Quote  
Quote Description: Saline Water  
Folder No: 004314032  
Comments: 19371102 9a  
Quote No: 15266  
Sampled on: 9-Feb-19 @ (Time not supplied)  
Matrix: Saline Water

Analyte	Result	Units	Flag	MRV	Accord	Lab ID	Testcode
Cyanide : Complex as CN	<0.500	mg/l			None	NLS	864
Cyanide : Free as CN	<0.500	mg/l	OR DC	0.005	None	SX	183
Cyanide as CN	<0.500	mg/l		0.5	None	SX	182

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# National Laboratory Service

## Analytical Report

Final Report

Report ID - 20129483 - 1

Batch description: Job ID 190216-11 Cyanide analysis

Reported on:  
12-Mar-2019

Client: ALS Life Sciences Ltd Project: 15266 Master Quote  
Quote Description: Saline Water  
Folder No: 004314033  
Comments: 19371087 9b  
Quote No: 15266  
Sampled on: 9-Feb-19 @ (Time not supplied)  
Matrix: Saline Water

Analyte	Result	Units	Flag	MRV	Accord	Lab ID	Testcode
Cyanide : Complex as CN	<0.500	mg/l			None	NLS	864
Cyanide : Free as CN	<0.500	mg/l	OR DC	0.005	None	SX	183
			ELEVATED_MR_V_100 : Dilution required (result accuracy may be reduced)				
Cyanide as CN	<0.500	mg/l		0.5	None	SX	182

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# National Laboratory Service

## Analytical Report

Final Report

Report ID - 20129483 - 1

Batch description: Job ID 190216-11 Cyanide analysis

Reported on:  
12-Mar-2019

Client: ALS Life Sciences Ltd Project: 15266 Master Quote  
Quote Description: Saline Water  
Folder No: 004314034  
Comments: 19371101 SP  
Quote No: 15266  
Matrix: Saline Water  
Sampled on: 9-Feb-19 @ (Time not supplied)

Analyte	Result	Units	Flag	MRV	Accepted	Lab ID	Testcode
Cyanide : Complex as CN	<0.500	mg/l			None	NLS	864
Cyanide : Free as CN	<0.500	mg/l	OR DC	0.005	None	SX	183
Cyanide as CN	<0.500	mg/l		0.5	None	SX	182

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Method Description Summary for all samples in batch Number 20129483

- 182 SX I Cyanide - (total) - UV digested, determined colorimetrically by CF analyser  
183 SX I Cyanide - (free) - determined colorimetrically by CF analyser  
854 Parameter by calculation



James Trout  
Laboratory Site Manager

The results in this Certificate of Analysis are the definitive test results. Any accompanying results are provided for ease of use by the customer and should be used with caution.

All reporting limits quoted are those achievable for clean samples of the relevant matrix. No allowance is made for instances when dilutions are necessary owing to the nature of the sample or insufficient volume of the sample being available. In these cases higher reporting limits may be quoted and will be above the MRV.

Minimum Reporting Value (MRV). A minimum concentration selected for reporting purposes (i.e. the less than value), which is higher than the statistically derived method limit of detection.

Solid sample results are determined on a "dried" sample fraction except for parameters where the method description identifies that "as received" sample was used.

Uncertainty of Measurement information relating to sample results is supplied upon request. Uncertainty is estimated from the performance of routine quality control standards, using the calculation  $2 \times \text{Relative Standard Deviation} + \text{Bias}$ . This is based on the guidance issued by the UKTAG Chemistry task team - Guidance on the implementation of the Quality Assurance/Quality Control requirements associated with Commission Directive 2009/90/EC, Article 4 (UoM =  $2 \times \% \text{RSD}$ ), with a contribution added for the bias.

Key to Results Flags:

DB - Samples received outside specified stability times. It is possible that the results may be compromised.

DC - Analysis started outside of specified stability time. It is possible that the results may be compromised.

The analysis start date specified is the date of the first test, dates for other analysis are available on request.

Please note all samples will be retained for 10 working days for aqueous samples and 30 working days for solid samples after reporting unless otherwise agreed with Customer Services.

Key to Accreditation: UKAS = Methodology accredited to ISO/IEC 17025:2005, MCertS = Methodology accredited to MCertS Performance Standard for testing of soils, none = Methodology not accredited.

Key to Lab ID: LE = Leeds, NM = Nottingham, SX = Starcross, SC = Sub-Contracted outside NLS, FI = Field Data - outside NLS, NLS = Calculated.

Any subsequent version of this report denoted with a higher version number will supersede this and any previous versions.

END OF TEST REPORT

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## CERTIFICATE OF ANALYSIS

SDG: 190216-11 Client Reference: B1804-07 Report Number: 497499  
Location: Atlantic Ocean Order Number: Superseded Report:

### Appendix

### General

1. Results are expressed on a dry weight basis (dried at 35°C) for all soil analyses except for the following: NRA and CEN Leach tests, flash point LOI, pH, ammonium as NH<sub>4</sub> by the BRE method, VOC TICs and SVOC TICs.

2. Samples will be run in duplicate upon request, but an additional charge may be incurred.

3. If sufficient sample is received a sub sample will be retained free of charge for 30 days after analysis is completed (e-mailed) for all sample types unless the sample is destroyed on testing. The prepared soil sub sample that is analysed for asbestos will be retained for a period of 6 months after the analysis date. All bulk samples will be retained for a period of 6 months after the analysis date. All samples received and not scheduled will be disposed of one month after the date of receipt unless we are instructed to the contrary. Once the initial period has expired a storage charge will be applied for each month or part thereof until the client cancels the request for sample storage. ALS reserve the right to charge for samples received and stored but not analysed.

4. With respect to turnaround, we will always endeavour to meet client requirements wherever possible, but turnaround times cannot be absolutely guaranteed due to so many variables beyond our control.

5. We take responsibility for any test performed by sub-contractors (marked with an asterisk). We endeavour to use UKAS/MCERTS Accredited Laboratories, who either complete a quality questionnaire or are audited by ourselves. For some determinands there are no UKAS/MCERTS Accredited Laboratories, in this instance a laboratory with a known track record will be utilised.

6. When requested, the individual sub sample scheduled will be analysed in-house for the presence of asbestos fibres and asbestos containing material by our documented in-house method TM068 based on HSG 248 (2005), which is accredited to ISO 17025. If a specific asbestos fibre type is not found this will be reported as 'Not detected'. If no asbestos fibre types are found all will be reported as 'Not detected' and the sub sample analysed deemed to be clear of asbestos. If an asbestos fibre type is found it will be reported as detected (for each fibre type found). Testing can be carried out on asbestos positive samples, but, due to Health and Safety considerations, may be replaced by alternative tests or reported as No Determination Possible (NDP). The quantity of asbestos present is not determined unless specifically requested.

7. If no separate volatile sample is supplied by the client, or if a headspace or sediment is present in the volatile sample, the integrity of the data may be compromised. This will be flagged up as an invalid VOC on the test schedule and the result marked as deviating on the test certificate.

8. If appropriate preserved bottles are not received preservation will take place on receipt. However, the integrity of the data may be compromised.

9. NDP - No determination possible due to insufficient/unusable sample.

10. Metals in water are performed on a filtered sample, and therefore represent dissolved metals - total metals must be requested separately.

11. Results relate only to the items tested.

12. LoDs (Limit of Detection) for wet tests reported on a dry weight basis are not corrected for moisture content.

13. **Surrogate recoveries** - Surrogates are added to your sample to monitor recovery of the test required. A % recovery is reported, results are not corrected for the recovery measured. Typical recoveries for organics tests are 70-130%. Recoveries in soils are affected by organic rich or clay rich matrices. Waters can be affected by remediation fluids or high amounts of sediment. Test results are only ever reported if all of the associated quality checks pass; it is assumed that all recoveries outside of the values above are due to matrix effect.

14. **Product analyses** - Organic analyses on products can only be semi-quantitative due to the matrix effects and high dilution factors employed.

15. Phenols/machydric by HPLC include phenol, cresols (2-Methylphenol, 3-Methylphenol and 4-Methylphenol) and Xylenols (2,3 Dimethylphenol, 2,4 Dimethylphenol, 2,5 Dimethylphenol, 2,6 Dimethylphenol, 3,4 Dimethylphenol, 3,5 Dimethylphenol).

16. Total of 6 specified phenols by HPLC includes Phenol, 2,3,5-Trimethyl Phenol, 2-Isopropylphenol, Cresols and Xylenols (as detailed in 15).

17. Stones/debris are not routinely removed. We always endeavour to take a representative sub sample from the received sample.

18. In certain circumstances the method detection limit may be elevated due to the sample being outside the calibration range. Other factors that may contribute to this include possible interferences. In both cases the sample would be diluted which would cause the method detection limit to be raised.

19. Mercury results quoted on soils will not include volatile mercury as the analysis is performed on a dried and crushed sample.

20. For leachate preparations other than Zero Headspace Extraction (ZHE) volatile loss may occur.

21. For the BSEN 12467-3 two batch process to allow the cumulative release to be calculated, the volume of the leachate produced is measured and filtered for all tests. We therefore cannot carry out any unfiltered analysis. The tests affected include volatiles GC/FID/GCMS and all sub-contracted analysis.

22. We are accredited to MCERTS for sand, clay and loam/speck, or any of these materials - whether these are derived from naturally occurring soil profiles, or from fill/made ground, as long as these materials constitute the major part of the sample. Other coarse granular material such as concrete, gravel and brick are not accredited if they comprise the major part of the sample.

23. Analysis and identification of specific compounds using GC/FID is by retention time only, and we routinely calibrate and quantify for benzene, toluene, ethylbenzenes and xylenes (BTEX). For total volatiles in the C5-C12 range, the total area of the chromatogram is integrated and expressed as ug/l or ug/g. Although this analysis is commonly used for the quantification of gasoline range organics (GRO), the system will also detect other compounds such as chlorinated solvents, and this may lead to a falsely high result with respect to hydrocarbons only. It is not possible to specifically identify these non-hydrocarbons, as standards are not routinely run for any other compounds, and for more definitive identification, volatiles by GC/MS should be utilised.

24. **Tentatively Identified Compounds (TICs)** are non-target peaks in VOC and SVOC analysis. All non-target peaks detected with a concentration above the LoD are subjected to a mass spectral library search. Non-target peaks with a library search confidence of >75% are reported based on the best mass spectral library match. When a non-target peak with a library search confidence of <75% is detected it is reported as 'mixed hydrocarbons'. Non-target compounds identified from the scan data are semi-quantified relative to one of the deuterated internal standards, under the same chromatographic conditions as the target compounds. This result is reported as a semi-quantitative value and reported as Tentatively Identified Compounds (TICs). TICs are outside the scope of UKAS accreditation and are not moisture corrected.

### Sample Deviations

If a sample is classed as deviated then the associated results may be compromised.

1	Container with Headspace provided for volatiles analysis
2	Incorrect container received
3	Deviation from method
5	Sampled on date not provided
6	Sample holding time exceeded in laboratory
7	Sample holding time exceeded due to late arrival of instructions or samples

### Asbestos

#### Identification of Asbestos in Bulk Materials & Soils

The results for identification of asbestos in bulk materials are obtained from supplied bulk materials which have been examined to determine the presence of asbestos fibres using ALS (Hawarden) in-house method of transmitted/polarised light microscopy and central stop dispersion staining, based on HSG 248 (2005).

The results for identification of asbestos in soils are obtained from a homogenised sub sample which has been examined to determine the presence of asbestos fibres using ALS (Hawarden) in-house method of transmitted/polarised light microscopy and central stop dispersion staining, based on HSG 248 (2005).

Asbestos Type	Concentration
Chrysotile	White Asbestos
Amosite	Brown Asbestos
Crocidolite	Blue Asbestos
Talcus Actinolite	-
Phenyl Anthracite	-
Fibrous Talc	-

#### Visual Estimation Of Fibre Content

Estimation of fibre content is not permitted as part of our UKAS accredited test other than: - Trace - Where only one or two asbestos fibres were identified.

Further guidance on typical asbestos fibre content of manufactured products can be found in HSG 264.

The identification of asbestos containing materials and soils falls within our schedule of tests for which we hold UKAS accreditation, however opinions, interpretations and all other information contained in the report are outside the scope of UKAS accreditation.

18:38:37 19/03/2019

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Modification Date:

19/03/2019



Earthtime Inc.  
Earthtime Building  
U.N. Drive  
Clara Town  
Monrovia  
Liberia  
  
Attention: Ghinwa El Tayar

Unit 7-8 Hawarden Business Park  
Manor Road (off Manor Lane)  
Hawarden  
Deeside  
CH5 3US  
Tel: (01244) 528700  
Fax: (01244) 528701  
email: hawardencustomerservices@alsglobal.com  
Website: www.alsenvironmental.co.uk

## CERTIFICATE OF ANALYSIS

Date of report Generation:	13 March 2019
Customer:	H_EARTH_LIB
Sample Delivery Group (SDG):	190222-130
Your Reference:	B1804-07
Location:	Mesurado Estuary
Report No:	496657

This report has been revised and directly supersedes 495745 in its entirety.

We received 4 samples on Friday February 22, 2019 and 4 of these samples were scheduled for analysis which was completed on Wednesday March 13, 2019. Accredited laboratory tests are defined within the report, but opinions, interpretations and on-site data expressed herein are outside the scope of ISO 17025 accreditation.

Should this report require incorporation into client reports, it must be used in its entirety and not simply with the data sections alone.

Chemical testing (unless subcontracted) performed at ALS Life Sciences Ltd Hawarden (Method codes TM) or ALS Life Sciences Ltd Aberdeen (Method codes S).

All sample data is provided by the customer. The reported results relate to the sample supplied, and on the basis that this data is correct.

Incorrect sampling dates and/or sample information will affect the validity of results.

The customer is not permitted to reproduce this report except in full without the approval of the laboratory.

Approved By:

**Sonia McWhan**  
Operations Manager



ALS Life Sciences Limited. Registered Office: Units 7 & 8 Hawarden Business Park, Manor Road, Hawarden, Deeside, CH5 3US. Registered in England and Wales No. 4057291.

Version: 2.2      Version Issued: 13/03/2019



# CERTIFICATE OF ANALYSIS

Validated

SDG: 150222-130 Client Reference: B1804-07 Report Number: 495657  
Location: Mesurado Estuary Order Number: Superseded Report: 495745

## Received Sample Overview

Lab Sample No(s)	Customer Sample Ref.	AGS Ref.	Depth (m)	Sampled Date
19419478	8A			19/02/2019
19419476	MR1			19/02/2019
19419476	MR2			19/02/2019
19419477	MR3			19/02/2019

Maximum Sample/Coolbox Temperature (°C) :

6.2

ISO5657-3 Water quality - Sampling - Part3 -

During Transportation samples shall be stored in a cooling device capable of maintaining a temperature of (5±3)°C.

ALS have data which show that a cool box with 4 frozen ice packs is capable of maintaining pre-chilled samples at a temperature of (5±3)°C for a period of up to 24hrs.


Only received samples which have had analysis scheduled will be shown on the following pages.



ALS		CERTIFICATE OF ANALYSIS				Validated		
SDG: 150222-130		Client Reference: B1804-07		Report Number: 495657				
Location: Mesurado Estuary		Order Number:		Superseded Report: 495745				
<b>Results Legend</b> Test No Determination Possible  <b>Sample Types -</b> S - Solid Solid UNS - Unspecified Solid GW - Ground Water SW - Surface Water LE - Land Leachate PI - Prepared Leachate PW - Process Water SA - Saline Water TE - Trade Effluent TS - Treated Sewage US - Untreated Sewage RE - Recirculation Water DW - Drinking Water Non-regulatory UNL - Unspecified Liquid SL - Sludge G - Gas OTH - Other	<b>Lab Sample No(s)</b>		10418478		10418479		10418477	
	<b>Customer Sample Reference</b>		GR		MRT		MRS	
	<b>AGS Reference</b>							
	<b>Depth (m)</b>							
	<b>Container</b>		0.5 glass bottle (V/L227)		0.5 glass bottle (V/L227)		0.5 glass bottle (V/L227)	
	<b>Sample Type</b>		SA		SA		SA	
<b>Parameter/Analysis</b>		ND Pa: 0 Test: 4		ND Pa: 0 Test: 4		ND Pa: 0 Test: 4		
COB Unfiltered		ND Pa: 0 Test: 4		ND Pa: 0 Test: 4		ND Pa: 0 Test: 4		
Conductivity (uS/cm @ 25°C)		ND Pa: 0 Test: 4		ND Pa: 0 Test: 4		ND Pa: 0 Test: 4		
EPH (DRO) (DRO) (DRO) (DRO)		ND Pa: 0 Test: 4		ND Pa: 0 Test: 4		ND Pa: 0 Test: 4		
GRD by GRD (G)		ND Pa: 0 Test: 4		ND Pa: 0 Test: 4		ND Pa: 0 Test: 4		
Nitrate by Nitrate		ND Pa: 0 Test: 4		ND Pa: 0 Test: 4		ND Pa: 0 Test: 4		
pH Value		ND Pa: 0 Test: 4		ND Pa: 0 Test: 4		ND Pa: 0 Test: 4		
Saline Oxides (NO <sub>3</sub> )		ND Pa: 0 Test: 4		ND Pa: 0 Test: 4		ND Pa: 0 Test: 4		
Saline Nitrate Disposal		ND Pa: 0 Test: 4		ND Pa: 0 Test: 4		ND Pa: 0 Test: 4		
Saline TON		ND Pa: 0 Test: 4		ND Pa: 0 Test: 4		ND Pa: 0 Test: 4		
Suspended Solids		ND Pa: 0 Test: 4		ND Pa: 0 Test: 4		ND Pa: 0 Test: 4		
TCC (Saline) (WTOC-RT)		ND Pa: 0 Test: 4		ND Pa: 0 Test: 4		ND Pa: 0 Test: 4		
Total Dissolved Solids (Diss)		ND Pa: 0 Test: 4		ND Pa: 0 Test: 4		ND Pa: 0 Test: 4		
Total EPH (mg)		ND Pa: 0 Test: 4		ND Pa: 0 Test: 4		ND Pa: 0 Test: 4		
Turbidity in water		ND Pa: 0 Test: 4		ND Pa: 0 Test: 4		ND Pa: 0 Test: 4		

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<div></div>			
<div><div><div>X</div>Test</div><div><div>N</div>No Determination Possible</div></div> <div>Sample Types - S - Solid/Solid UNS - Unspecified Solid GW - Ground Water SW - Surface Water LE - Land Leachate PI - Prepared Leachate PR - Process Water SA - Saline Water TE - Trade Effluent TS - Treated Sewage US - Untreated Sewage RE - Recreational Water DW - Drinking Water Non-regulatory UNL - Unspecified Liquid SL - Sludge G - Gas OTH - Other</div>		Lab Sample No(s)	15415417
		Customer Sample Reference	N/A
		AGS Reference	
		Depth (m)	
		Container	<div>Standard (ALE221)</div> <div>ISO 304 (ALE244)</div> <div>F-N-3 Filtered (ALE250)</div> <div>NaOH (ALE245)</div> <div>VIA (ALE297)</div>
		Sample Type	<div>SA</div> <div>SA</div> <div>SA</div> <div>SA</div> <div>SA</div>
Ammoniacal Nitrogen	AI	NDPx: 0 Tests: 4	<div><div>X</div></div>
COD Unfiltered	AI	NDPx: 0 Tests: 4	<div><div>X</div></div>
Conductivity (at 25 deg. C)	AI	NDPx: 0 Tests: 4	<div><div>X</div></div>
EPH (DRO, C/D/CAN) Agarous (%)	AI	NDPx: 0 Tests: 4	
ORC by GC-FID (A)	AI	NDPx: 0 Tests: 4	<div><div>X</div></div>
Nitrate by Cone (a)	AI	NDPx: 0 Tests: 4	<div><div>X</div></div>
pH Value	AI	NDPx: 0 Tests: 4	<div><div>X</div></div>
Saline Oxidant (H <sup>+</sup> )	AI	NDPx: 0 Tests: 4	<div><div>X</div></div>
Saline Metals Dissolved*	AI	NDPx: 0 Tests: 4	<div><div>X</div></div>
Saline TON	AI	NDPx: 0 Tests: 4	<div><div>X</div></div>
Suspended Solids	AI	NDPx: 0 Tests: 4	<div><div>X</div></div>
TOC (Saline)(W-TOC-IR)*	AI	NDPx: 0 Tests: 4	<div><div>X</div></div>
Total Dissolved Solids (Cm)	AI	NDPx: 0 Tests: 4	<div><div>X</div></div>
Total EP+4 (ug)	AI	NDPx: 0 Tests: 4	
Turbidity in water	AI	NDPx: 0 Tests: 4	<div><div>X</div></div>

15:55:39 13/03/2019



## Validated

Report Number:	496657
Superseded Report:	496746

[illegible]

15:55:39 13/03/2019





# CERTIFICATE OF ANALYSIS

Validated

SDG: 150222-130 Client Reference: B1804-07 Report Number: 495657  
Location: Mesurado Estuary Order Number: Superseded Report: 495745

## Table of Results - Appendix

Method No	Reference	Description
SUB		Subcontracted Test
TM021	Method 2540C, APHA/AAPHA, 20th Ed., 1998	Determination of total dissolved solids in waters by gravimetry
TM022	Method 2540C, APHA/AAPHA, 20th Ed., 1998 / BS 2690 Part 20 1981 BS EN 572	Determination of total suspended solids in waters
TM061	Method for the Determination of EPH, Massachusetts Dept of EP, 1998	Determination of Extractable Petroleum Hydrocarbons by GC-FO (C10-C40)
TM089	US 2592 Part 1 1968 / BS 6100 Part 2 11 1994	Determination of Ammonium in Water Samples using the Koro Analyser
TM107	ISO 6010-1989	Determination of Chemical Oxygen Demand using COD for Large Kit
TM120	Method 2510B, APHA/AAPHA, 20th Ed., 1998 / BS 2880 Part 5 1973	Determination of Electrical Conductivity using a Conductivity Meter
TM172	Analysis of Petroleum Hydrocarbons in Environmental Media - Total Petroleum Hydrocarbon Criteria	EPH in Waters
TM184	EPA Methods 376.1 & 375.2	The Determination of Aromatics in Aqueous Matrices using the Koro Spectrophotometric Analysers
TM185	Colour and Turbidity of water: Methods for the Examination of Waters and Associated Materials. HMSO, 1961, ISBN 0 11 751955 3	Determination of Turbidity in Waters & Associated Matrices
TM245	By GC-FID	Determination of GRC by Headspace in waters
TM258	The measurement of Electrical Conductivity and the Laboratory determination of pH Value of Natural, Treated and Wastewaters. HMSO, 1978, ISBN 0 11 751428 4	Determination of pH in Water and Leachate using the GLP-H2-Meter
TM281		The Determination of Total Dissolved Nitrogen in Saline Matrices using the Koro Spectrophotometric Analysers

NA = not applicable

Chemical testing (unless subcontracted) performed at ALS Life Sciences Ltd Haverdorn (Method codes TM) or ALS Life Sciences Ltd Aberdeen (Method codes S).





# CERTIFICATE OF ANALYSIS

Validated

SDG: 150222-130  
Location: Mesurado Estuary

Client Reference: B1804-07  
Order Number:

Report Number: 495657  
Superseded Report: 495745

## Test Completion Dates

Lab Sample No(s)	15419478	15419479	15419475	15419477
Customer Sample Ref.	NA	NA1	NA2	NA3
AGS Ref.				
Depth				
Type	Saline D (SA)	Saline D (SA)	Saline D (SA)	Saline D (SA)
Ammonia/Nitrogen	01-Mar-2019	01-Mar-2019	01-Mar-2019	01-Mar-2019
CDD Unfiltered	26-Feb-2019	26-Feb-2019	26-Feb-2019	27-Feb-2019
Conductivity (at 25 deg C)	27-Feb-2019	27-Feb-2019	27-Feb-2019	27-Feb-2019
CPI (PMD) (CPI (AQUA) Aquasol (M)	27-Feb-2019	27-Feb-2019	27-Feb-2019	27-Feb-2019
G-10 by (G-10) (G)	01-Mar-2019	01-Mar-2019	01-Mar-2019	01-Mar-2019
Nitrate by (Nitrate) (N)	26-Feb-2019	26-Feb-2019	26-Feb-2019	26-Feb-2019
pH Value	26-Feb-2019	26-Feb-2019	26-Feb-2019	26-Feb-2019
Saline Oxidant (AO)	05-Mar-2019	05-Mar-2019	05-Mar-2019	05-Mar-2019
Saline Nitrate (Discrete)	07-Mar-2019	07-Mar-2019	07-Mar-2019	07-Mar-2019
Saline TDS	12-Mar-2019	12-Mar-2019	12-Mar-2019	12-Mar-2019
Suspended Solids	26-Feb-2019	26-Feb-2019	26-Feb-2019	26-Feb-2019
TCC (Saline) (WTOC IF)	04-Mar-2019	04-Mar-2019	04-Mar-2019	04-Mar-2019
Total Dissolved Solids (DMA)	26-Feb-2019	26-Feb-2019	26-Feb-2019	26-Feb-2019
Total CP (G/g)	01-Mar-2019	01-Mar-2019	01-Mar-2019	01-Mar-2019
Turbidity (Nephel)	26-Feb-2019	26-Feb-2019	26-Feb-2019	26-Feb-2019



## CERTIFICATE OF ANALYSIS

Work Order	PR1918386	Issue Date	04-Mar-2019
Customer	ALS Life Sciences Ltd	Laboratory	ALS Czech Republic, s.r.o.
Contact	Reporting	Contact	Client Service
Address	Unit 7-8 Hawarden Business Park Manor Road, Hawarden CH5 3US Deeside United Kingdom	Address	Na Harfe 336/9 Prague 9 - Vysocany 190 00 Czech Republic
E-mail	euhdinsubconresults@ALSGlobal.com	E-mail	customer.support@alsglobal.com
Telephone	---	Telephone	+420 226 226 228
Project	190222-130	Page	1 of 2
Order number	---	Date Samples Received	27-Feb-2019
Site	---	Quote number	PR2018ALSAL-GB0004 (CZ-256-18-0022)
Sampled by	---	Date of test	28-Feb-2019 - 04-Mar-2019
		QC Level	ALS CR Standard Quality Control Schedule

### General Comments

This report shall not be reproduced except in full, without prior written approval from the laboratory.

The laboratory declares that the test results relate only to the listed samples.

Sample(s) PR1918386/001-004, method W-TOC-IR - required dilution due to high salt content. LOR has been adjusted accordingly.

### Responsible for accuracy

Signatories  
Zdeněk Jiráček

Position  
Environmental Business Unit  
Manager

Testing Laboratory No. 1163  
Accredited by CAI according to  
CSN EN ISO/IEC 17025:2005



Issue Date : 04-Mar-2019  
Page : 2 of 2  
Work Order : PR1918386  
Customer : ALS Life Sciences Ltd



## Analytical Results

Sub-Matrix: SALINE WATER				Client sample ID	19433083 6A	19433087 MR1	19433086 MR2
				Laboratory sample ID	PR1918386-001	PR1918386-002	PR1918386-003
				Client sampling date / time	19-Feb-2019 00:00	19-Feb-2019 00:00	19-Feb-2019 00:00
Parameter	Method	LOR	Unit	Result	MU	Result	MU
<b>Aggregate Parameters</b>							
Total Organic Carbon	W-TOC-IR	0.50	mg/L	4.74	± 20.0%	3.21	± 20.0%

Sub-Matrix: SALINE WATER				Client sample ID	19433074 MR3	---	---
				Laboratory sample ID	PR1918386-004	---	---
				Client sampling date / time	19-Feb-2019 00:00	---	---
Parameter	Method	LOR	Unit	Result	MU	Result	MU
<b>Aggregate Parameters</b>							
Total Organic Carbon	W-TOC-IR	0.50	mg/L	<2.50	---	---	---

If no sampling time is provided, the sampling time will default 00:00 on the date of sampling. If no sampling date is provided, delivery date in brackets without a time component will be displayed instead. Measurement uncertainty is expressed as expanded measurement uncertainty with coverage factor  $k = 2$ , representing 95% confidence level.

Key: LOR = Limit of reporting; MU = Measurement Uncertainty

## The end of result part of the certificate of analysis

### Brief Method Summaries

Analytical Methods	Method Descriptions
Location of test performance: Na Harte 336/9 Prague 9 - Vysocany, Czech Republic 190 00	
W-TOC-IR	CZ_SOP_D06_02_058 (CSN EN 1484, CSN EN 16192, SM 5310) Determination of total organic carbon (TOC), dissolved organic carbon (DOC), total inorganic carbon (TIC) and total carbon (TC) by IR detection.

A "\*" symbol preceding any method indicates laboratory or subcontractor non-accredited test. In the case when a procedure belonging to an accredited method was used for non-accredited matrix, would apply that the reported results are non-accredited. Please refer to General Comment section on front page for information. If the report contains subcontracted analysis, those are made in a subcontracted laboratory outside the laboratories ALS Czech Republic, s.r.o.

The calculation methods of summation parameters are available on request in the client service.

## National Laboratory Service

### Analytical Report

Final Report - Amended - Issue 2

Report ID - 20129539 - 2

Batch description: 190222-130

Reported on:  
04-Mar-2019

Hawarden Subcontractors  
ALS Life Sciences Ltd  
Units 7 & 8 Hawarden Business Park  
Off Manor Lane  
Hawarden  
Deeside  
CH5 3US

Dear Hawarden

Please find attached the results for the batch of 4 samples described below.

Samples Registered on:	27-Feb-2019
Analysis Started on:	28-Feb-2019
Analysis Completed on:	04-Mar-2019
Results for Batch Number	20129539
Your Purchase Order Number:	None Supplied
You will be invoiced shortly by our accounts department.	

If we can be of further assistance then please do not hesitate to contact us.

Yours sincerely



**Lawrence Green**  
Customer Services Team Manager  
Tel: 0800 092 0786  
[nls@environment-agency.gov.uk](mailto:nls@environment-agency.gov.uk)

Opinions and interpretations expressed herein are outside the scope of UKAS Accreditation. Details of analytical procedures and performance data are available on request. The date of sample analysis is available on request.

The Environment Agency carries out analytical work to high standards and within the scope of its UKAS accreditation, but has no knowledge of whether the circumstances or the validity of the procedures used to obtain the samples provided to the laboratory were representative of the need for which the information was required.

The Environment Agency and/or its staff does not therefore accept any liability for the consequences of any acts or omissions made on the basis of the analysis or advice or interpretation provided.

NLS Leeds  
Olympia House  
Gelderd Lane  
Gelderd Road  
Leeds LS12 6DD

NLS Nottingham  
Meadow Lane  
Nottingham  
NG2 3HN

NLS Starcross  
Staplake Mount  
Starcross  
Exeter  
EX6 8FD



Page 1 of 6

**Analytical Report**

Final Report - Amended - Issue 2

Report ID - 20129539 - 2

Batch description: 190222-130

Reported on:  
04-Mar-2019

Client: ALS Life Sciences Ltd Project: 15266 Master Quote  
Folder No: 004321892 Quote Description: Saline Water  
Comments: 6A Sampled on: 19-Feb-19 @ (Time not supplied)  
Quote No: 15266 Matrix: Saline Water

<u>Analyte</u>	<u>Result</u>	<u>Units</u>	<u>Flag</u>	<u>MRV</u>	<u>Accord</u>	<u>Lab ID</u>	<u>Testcode</u>
Cyanide : Complex as CN	<0.500	mg/l			None	NLS	864
Cyanide : Free as CN	<0.005	mg/l	DR DC DO	0.005	None	SX	183
Cyanide as CN	<0.5	mg/l	DO	0.5	None	SX	182

NLS Leeds  
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NLS Nottingham  
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Nottingham  
NG2 3HN

NLS Starcross  
Staplake Mount  
Starcross  
Exeter  
EX6 8FD



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## Analytical Report

Final Report - Amended - Issue 2

Report ID - 20129539 - 2

Batch description: 190222-130

Reported on:  
04-Mar-2019

Client: ALS Life Sciences Ltd Project: 15266 Master Quote  
Folder No: 004321903 Quote Description: Saline Water  
Comments: MR1 Sampled on: 19-Feb-19 @ (Time not supplied)  
Quote No: 15266 Matrix: Saline Water

Analyte	Result	Units	Flag	MRV	Accord	Lab ID	Testcode
Cyanide : Complex as CN	<0.500	mg/l			None	NLS	864
Cyanide : Free as CN	<0.005	mg/l	DE DC DO	0.005	None	SX	183
Cyanide as CN	<0.5	mg/l	DO	0.5	None	SX	182

NLS Leeds  
Olympia House  
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NLS Nottingham  
Meadow Lane  
Nottingham  
NG2 3HN

NLS Sturcross  
Staplake Mount  
Sturcross  
Exeter  
EX6 8FD



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## Analytical Report

Final Report - Amended - Issue 2

Report ID - 20129539 - 2

Batch description: 190222-130

Reported on:  
04-Mar-2019

Client: ALS Life Sciences Ltd Project: 15266 Master Quote  
Quote Description: Saline Water  
Folder No: 004321904 Sampled on: 19-Feb-19 @ (Time not supplied)  
Comments: MR2  
Quote No: 15266 Matrix: Saline Water

Analyte	Result	Units	Flag	MRV	Accord	Lab ID	Testcode
Cyanide : Complex as CN	<0.500	mg/l			None	NLS	864
Cyanide : Free as CN	<0.005	mg/l	DR DC DO	0.005	None	SX	183
Cyanide as CN	<0.5	mg/l	DO	0.5	None	SX	182

NLS Leeds  
Olympia House  
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Gelderd Road  
Leeds LS12 6DD

NLS Nottingham  
Meadow Lane  
Nottingham  
NG2 3HN

NLS Starcross  
Staplake Mount  
Starcross  
Exeter  
EX6 8FD



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## Analytical Report

Final Report - Amended - Issue 2

Report ID - 20129539 - 2

Batch description: 190222-130

Reported on:  
04-Mar-2019

Client: ALS Life Sciences Ltd Project: 15266 Master Quote  
Quote Description: Saline Water  
Folder No: 004321905 Sampled on: 19-Feb-19 @ (Time not supplied)  
Comments: MR3  
Quote No: 15266 Matrix: Saline Water

Analyte	Result	Units	Flag	MRV	Accord	Lab ID	Testcode
Cyanide : Complex as CN	<0.500	mg/l			None	NLS	864
Cyanide : Free as CN	<0.005	mg/l	DE DC DO	0.005	None	SX	183
Cyanide as CN	<0.5	mg/l	DO	0.5	None	SX	182

NLS Leeds  
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Gelderd Road  
Leeds LS12 6DD

NLS Nottingham  
Meadow Lane  
Nottingham  
NG2 3HN

NLS Starcross  
Staplake Mount  
Starcross  
Exeter  
EX6 8FD



Page 5 of 6





## Analytical Report

Final Report - Amended - Issue 2

Report ID - 20129539 - 2

Batch description: 190222-130

Reported on:  
04-Mar-2019

### Method Description Summary for all samples in batch Number 20129539

- 182 SX I Cyanide - (total) - UV digested, determined colorimetrically by CF analyser
- 183 SX I Cyanide - (free) - determined colorimetrically by CF analyser
- 854 Parameter by calculation

James Trout  
Laboratory Site Manager

The results in this Certificate of Analysis are the definitive test results. Any accompanying results are provided for ease of use by the customer and should be used with caution.

All reporting limits quoted are those achievable for clean samples of the relevant matrix. No allowance is made for instances when dilutions are necessary owing to the nature of the sample or insufficient volume of the sample being available. In these cases higher reporting limits may be quoted and will be above the MRV.

Minimum Reporting Value (MRV). A minimum concentration selected for reporting purposes (i.e. the less than value), which is higher than the statistically derived method limit of detection.

Solid sample results are determined on a "dried" sample fraction except for parameters where the method description identifies that "as received" sample was used.

Uncertainty of Measurement information relating to sample results is supplied upon request. Uncertainty is estimated from the performance of routine quality control standards, using the calculation  $2 \times \text{Relative Standard Deviation} + \text{Bias}$ . This is based on the guidance issued by the UKTAG Chemistry task team - Guidance on the implementation of the Quality Assurance/Quality Control requirements associated with Commission Directive 2009/90/EC, Article 4 (UoM =  $2 \times \%RSD$ ), with a contribution added for the bias.

#### Key to Results Flags:

DB Samples received outside specified stability times. It is possible that the results may be compromised.

DC Analysis started outside of specified stability time. It is possible that the results may be compromised.

DD Laboratory unable to verify storage conditions prior to receipt it is possible that results may be compromised.

The analysis start date specified is the date of the first test, dates for other analysis are available on request.

Please note all samples will be retained for 10 working days for aqueous samples and 30 working days for solid samples after reporting unless otherwise agreed with Customer Services.

Key to Accreditation: UKAS = Methodology accredited to ISO/IEC 17025:2005, MCertS = Methodology accredited to MCertS Performance Standard for testing of soils, none = Methodology not accredited.

Key to Lab ID: LE = Leeds, NM = Nottingham, SX = Starcross, SC = Sub-Contracted outside NLS, FI = Field Data - outside NLS, NLS = Calculated.

Any subsequent version of this report denoted with a higher version number will supersede this and any previous versions.

NLS Leeds  
Olympia House  
Gelderd Lane  
Gelderd Road  
Leeds LS12 6DD

NLS Nottingham  
Meadow Lane  
Nottingham  
NG2 3HN

NLS Starcross  
Staplake Mount  
Starcross  
Exeter  
EX6 8FD



Page 6 of 6

National  
Laboratory  
Service

Analytical Report

Final Report - Amended - Issue 2

Report ID - 20129539 - 2

Batch description: 190222-130

Reported on:  
04-Mar-2019

END OF TEST REPORT

NLS Leeds  
Olympia House  
Gelderd Lane  
Gelderd Road  
Leeds LS12 8DD

NLS Nottingham  
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 Environment  
Agency  
Page 7 of 6

## Report

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L1906115

1F5T003WPU0



Date received 2019-03-04  
Issued 2019-03-07

ALS Life Sciences

Hawarden Bus.Park, Manor Lane  
CH5 3US Hawarden, Deeside  
United Kingdom

Project 190222-130

### Analysis: V5BAS

Your ID	19433060					
Sampled	2019-02-19					
LabID	U11573507					
Analysis	Results	Uncertainty (±)	Unit	Method	Issuer	Sign
Filtrated with 0,45µm before the analysis	No			1	I	ASAP
Fe	0.0101	0.0025	mg/l	1	H	FIWU
As	0.624	0.208	µg/l	1	H	FIWU
Cd	<0.05		µg/l	1	H	FIWU
Hg	<0.002		µg/l	1	F	EVRI
Pb	<0.3		µg/l	1	H	FIWU

Your ID	19433059					
Sampled	2019-02-19					
LabID	U11573508					
Analysis	Results	Uncertainty (±)	Unit	Method	Issuer	Sign
Filtrated with 0,45µm before the analysis	No			1	I	ASAP
Fe	0.00564	0.00213	mg/l	1	H	FIWU
As	1.58	0.62	µg/l	1	H	FIWU
Cd	<0.05		µg/l	1	H	FIWU
Hg	<0.002		µg/l	1	F	EVRI
Pb	<0.3		µg/l	1	H	FIWU

Your ID	19433056					
Sampled	2019-02-19					
LabID	U11573509					
Analysis	Results	Uncertainty (±)	Unit	Method	Issuer	Sign
Filtrated with 0,45µm before the analysis	No			1	I	ASAP
Fe	0.00806	0.00311	mg/l	1	H	FIWU
As	1.07	0.71	µg/l	1	H	FIWU
Cd	0.0583	0.0239	µg/l	1	H	FIWU
Hg	<0.002		µg/l	1	F	EVRI
Pb	<0.3		µg/l	1	H	FIWU

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## Report

Page 2 (3)



**L1906115**

1F5T003WPU0



Your ID	19433064						
Sampled	2019-02-19						
LabID	U11573510						
Analysis	Results	Uncertainty (±)	Unit	Method	Issuer	Sign	
Filtrated with 0,45µm before the analysis	No			1	I	ASAP	
Fe	0.00524	0.00118	mg/l	1	H	FIWU	
As	1.43	0.39	µg/l	1	H	FIWU	
Cd	<0.05		µg/l	1	H	FIWU	
Hg	<0.002		µg/l	1	F	EVRI	
Pb	<0.3		µg/l	1	H	FIWU	

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## Report

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L1906115

1F5T003WPU0



Method specification	
1	<p>Analysis according to package V-5, V-6:</p> <p>Analysis of water samples without dissolution. When filtration has been performed, a filter of 0,45µm was used.</p> <p>For W an unacidified sample portion was analyzed. For other elements the samples were acidified with 1 ml ultra-high purity nitric acid per 100 ml. This does not apply to samples that were already acidic upon receipt by the laboratory.</p> <p>The ICP-SFMS analyses were carried out according to SS EN ISO 17294-1, 2 (modified) and US EPA Method 200.8 (modified). The ICP-AES analyses were carried out according to SS EN ISO 11885 (modified) and US EPA Method 200.7 (modified). The AFS analyses for Hg were carried out according to SS EN ISO 17852.</p> <p>Note that limits of reporting may be affected if, e.g. additional dilution was required because of matrix effects, or the sample quantity was limited.</p>

Approver	
ASAP	Åsa Apelqvist
EVRI	Evy Rickefors
FIWU	Filip Wuotila

Issuer <sup>1</sup>	
F	AFS
H	ICP-SFMS
I	Man, Inm.

\* indicates unaccredited analysis.

The uncertainty is given as extended uncertainty (according to the definition in "Guide to the Expression of Uncertainty in Measurement", JCGM 100:2008 Corrected version 2010) calculated with a coverage factor of 2, which gives a confidence level of approximately 95%.

Measurement of uncertainty is reported only for detected substances with levels above the reporting limits.

The uncertainty from subcontractors is often given as extended uncertainty calculated with a coverage factor of 2. Contact the laboratory for further information.

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The results apply only to the material that has been identified, received, and tested.

Regarding the laboratory's liability in relation to assignment, please refer to our latest product catalogue or website <http://www.alsglobal.se>

The digitally signed PDF file represents the original report. Any printouts are to be considered as copies.

<sup>1</sup> The technical unit within ALS Scandinavia where the analysis was carried out, alternatively the subcontractor for the analysis.

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## CERTIFICATE OF ANALYSIS

SDG:	190222-130	Client Reference:	B1804-07	Report Number:	490667
Location:	Mesurado Estuary	Order Number:		Superseded Report:	495745

## Appendix

## General

1. Results are expressed on a dry weight basis (dried at 80°C) for all soil analyses except for the following: NRA and CEN Leach tests, flash point LCI, pH, ammonium as NH4 by the BRE method, VOC TICs and SVOC TICs.

2. Samples will be run in duplicate upon request, but an additional charge may be incurred.

3. If sufficient sample is received a sub sample will be retained free of charge for 30 days after analysis is completed (e-mailed) for all sample types unless the sample is destroyed on testing. The prepared soil sub sample that is analysed for asbestos will be retained for a period of 6 months after the analysis date. All bulk samples will be retained for a period of 6 months after the analysis date. All samples received and not scheduled will be disposed of one month after the date of receipt unless we are instructed to the contrary. Once the initial period has expired, a storage charge will be applied for each month or part thereof until the client cancels the request for sample storage. ALS reserve the right to charge for samples received and stored but not analysed.

4. With respect to turnaround, we will always endeavour to meet client requirements wherever possible, but turnaround times cannot be absolutely guaranteed due to so many variables beyond our control.

5. We take responsibility for any test performed by sub-contractors (marked with an asterisk). We endeavour to use UKASIMCERTS Accredited Laboratories, who either complete a quality questionnaire or are audited by ourselves. For some determinands there are no UKASIMCERTS Accredited Laboratories. In this instance a laboratory with a known track record will be utilised.

6. When requested, the individual sub sample scheduled will be analysed in house for the presence of asbestos fibres and asbestos containing materials by our documented in house method TM048 based on HSG 248 (2005), which is accredited to ISO17025. If a specific asbestos fibre type is not found this will be reported as 'not detected'. If no asbestos fibre types are found all will be reported as 'Not detected' and the sub sample analysed deemed to be clear of asbestos. If an asbestos fibre type is found it will be reported as detected (for each fibre type found). Testing can be carried out on asbestos positive samples, but, due to health and safety considerations, may be replaced by alternative tests or reported as No Determination Possible (NDP). The quantity of asbestos present is not determined unless specifically requested.

7. If no separate volatile sample is supplied by the client, or if a headspace or sediment is present in the volatile sample, the integrity of the data may be compromised. This will be flagged up as an invalid VOC on the test schedule and the result marked as deviating on the test certificate.

8. If appropriate preserved bottles are not received preservation will take place on receipt. However, the integrity of the data may be compromised.

9. NDP - No determination possible due to insufficient/unusable sample.

10. Metals in water are performed on a filtered sample, and therefore represent dissolved metals - total metals must be requested separately.

11. Results relate only to the items tested.

12. LoDs (Limit of Detection) for wet tests reported on a dry weight basis are not corrected for moisture content.

13. Surrogate recoveries - Surrogates are added to your sample to monitor recovery of the test requested. A % recovery is reported, results are not corrected for the recovery measured. Typical recoveries for organics tests are 70-100%. Recoveries in soils are affected by organic rich or clay rich matrices. Values can be affected by remediation fluids or high amounts of sediment. Test results are only ever reported if all of the associated quality checks pass; it is assumed that all recoveries outside of the values above are due to matrix effect.

14. Product analyses - Organic analyses on products can only be semi-quantitative due to the matrix effects and high dilution factors employed.

15. Phenols monohydric by HPLC include: phenol, cresols (2-Methylphenol, 3-Methylphenol and 4-Methylphenol) and Xylenols (2,3 Dimethylphenol, 2,4 Dimethylphenol, 2,5 Dimethylphenol, 2,6 Dimethylphenol, 3,6 Dimethylphenol, 3,5 Dimethylphenol).

16. Total of 5 specified phenols by HPLC includes: Phenol, 2,3,5-Trimethyl Phenol, 2,4-bisopropylphenol, Cresols and Xylenols (as detailed in 15).

17. Stones/debris are not routinely removed. We always endeavour to take a representative sub sample from the received sample.

18. In certain circumstances the method detection limit may be elevated due to the sample being outside the calibration range. Other factors that may contribute to this include possible interferences. In both cases the sample would be diluted which would cause the method detection limit to be raised.

19. Mercury results quoted on soils will not include volatile mercury as the analysis is performed on a dried and crushed sample.

20. For leachate preparations other than Zero Headspace Extraction (ZHE) volatile loss may occur.

21. For the BSEN 12457-3 two batch process to allow the cumulative release to be calculated, the volume of the leachate produced is measured and filtered for all tests. We therefore cannot carry out any unfiltered analysis. The tests affected include volatiles GCR/GCMS and all sub-contracted analysis.

22. We are accredited to MCDR18 for sand, clay and loam/topsoil, or any of these materials - whether these are derived from naturally occurring soil profiles or from fill/made ground, as long as these materials constitute the major part of the sample. Other coarse granular material such as concrete, gravel and brick are not accredited if they comprise the major part of the sample.

23. Analysis and identification of specific compounds using GC/MS is by retention time only, and we routinely calibrate and quantify for benzene, toluene, ethylbenzene and xylene (BTEX). For total volatiles in the C5-C12 range, the total area of the chromatogram is integrated and expressed as ug/g or ug/l. Although this analysis is commonly used for the quantification of gasoline range organics (GRO), the system will also detect other compounds such as chlorinated solvents, and this may lead to a falsely high result with respect to hydrocarbons only. It is not possible to specifically identify these non-hydrocarbons, as standards are not routinely run for any other compounds, and for more definitive identification, volatiles by GC/MS should be utilised.

24. Tentatively Identified Compounds (TICs) are non-target peaks in VOC and SVOC analysis. All non-target peaks detected with a concentration above the LoD are subjected to a mass spectral library search. Non-target peaks with a library search confidence of >75% are reported based on the best mass spectral library match. When a non-target peak with a library search confidence of <75% is detected it is reported as 'mixed hydrocarbons'. Non-target compounds identified from the scan data are semi-quantified relative to one of the deuterated internal standards, under the same chromatographic conditions as the target compounds. This result is reported as a semi quantitative value and reported as Tentatively Identified Compounds (TICs). TICs are outside the scope of UKAS accreditation and are not moisture corrected.

## Sample Deviations

If a sample is classed as deviated then the associated results may be compromised.

1	Container with Headspace provided for volatiles analysis
2	Incorrect container received
3	Deviation from method
5	Sampled on date not provided
+	Sample holding time exceeded in laboratory
@	Sample holding time exceeded due to late arrival of instructions or samples

## Asbestos

### Identification of Asbestos in Bulk Materials & Soils

The results for identification of asbestos in bulk materials are obtained from supplied bulk materials which have been examined to determine the presence of asbestos fibres using ALS (In-house) in-house method of transmitted/polarised light microscopy and central stop dispersion staining, based on HSG 248 (2005).

The results for identification of asbestos in soils are obtained from a homogenised sub sample which has been examined to determine the presence of asbestos fibres using ALS (In-house) in-house method of transmitted/polarised light microscopy and central stop dispersion staining, based on HSG 248 (2005).

Asbestos Type	Concentration
Chrysotile	Not detected
Amosite	Detected
Crocidolite	Not detected
Total Asbestos	-
Phenol Soluble Phase	-
Fibre Counts	-

### Visual Estimation Of Fibre Content

Estimation of fibre content is not permitted as part of our UKAS accredited test other than: - Trace - Where only one or two asbestos fibres were identified.

Further guidance on typical asbestos fibre content of manufactured products can be found in HSG 264.

The identification of asbestos containing materials and soils falls within our schedule of tests for which we hold UKAS accreditation, however opinions, interpretations and all other information contained in the report are outside the scope of UKAS accreditation.

15:56:07 13/03/2019

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Modification Date

13/03/2019

77

78

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## 1 APPENDIX C SOCIAL INVESTIGATION FORMS

## 2 Appendix C.1 Focus Group Questionnaire for Fishermen

3 Name of Community: \_\_\_\_\_

4 Location: Study Area \_\_\_\_\_ Ward \_\_\_\_\_

5 Attendance Disaggregated

6 Elders \_\_\_\_\_ Women \_\_\_\_\_ Youth \_\_\_\_\_ Disabled \_\_\_\_\_ Total \_\_\_\_\_

7 Interview conducted by: \_\_\_\_\_ and \_\_\_\_\_

8 Date of Interview: \_\_\_\_\_

### 9 Introduction

10 I am Vaanii Kiazolu and my colleague is Judy Fallah. We are conducting a study to get  
11 feedback from people in fishing communities in coastal communities Montserrado County on  
12 how you undertake fishing, where and how and how that gives you a livelihood. We will also  
13 talk to the fishsellers/ mongers to learn more about how they make a livelihood. We would  
14 also like to know what would be your reaction to a proposed coastal protection project in this  
15 community.

### 16 Fishing Activities

17 1. Name of fishing community – are there a number of names?  
18

19 2. Name of landing site GPS location – where do fishermen and crews live? How close  
20 is it needed to be to where you live  
21

22 3. Boat specs: Numbers/ type; length; material; where constructed; propulsion type:  
23 motorized, sail, oars  
24

25 4. Fishing gear used (we need to know the local names of gear) Use photos  
26

27 5. Number of fishermen on boat at sea/ boat



- 
- 28 6. Number of days spent at sea on each trip  
29 a. If answer to (6) is one day, number of hours/day  
30 b. If answer to (6) is one day, time of the day (AM, PM, in between)
- 31 7. High season months; Low season months; No fishing months – how do they manage  
32 variation in availability
- 33 8. Usual fishing locations map, names or areas, community mapping exercise If  
34 possible
- 35 9. Does anyone fish and catch fish in the Mesurado estuary?
- 36 10. Fished species (we need to know the local names of fish) use pictures, get all names  
37 and preferred sizes
- 38 11. The 3 most fished species per fishing gear used
- 39 12. Average number of monthly by-catches of each of the following animals: Use  
40 pictures – are these sold? Put back? Any endangered? What do they know about  
41 endangered species?  
42 ➤ sea turtles  
43 ➤ dolphins  
44 ➤ sharks  
45 ➤ rays
- 46 13. Locations of fish spawning grounds if known – may have to do mapping exercise by  
47 GPS on boat
- 48 14. Locations of fish nurseries if known ditto
- 49 15. Arrangements for processing and marketing the catch beaches/ other
- 50 16. Number of people involved in processing and marketing the catch
- 51 17. How often there are accidents or fatalities drownings/ deaths/ knife injuries/ tackle  
52 injuries/ chronic problems caused by the work/ gang problems
- 53

---

54 18. What are the major needs of this community and why?

55 a. Which of these needs you would say is first, second, third .....?

56 **Economic data**

57 19. Growth in number of fishermen in last 3 years Discuss with fishing chairmen  
58 changes in numbers

59 20. Sales of fish per day (in dollars)/ average earnings of fisherman per day this will be  
60 seasonal – ask for a diary?

61 21. Number of days per year fishing variation in season?

62 22. Change in sales in last 3 years (% growth or decline)

63 23. Values (dollars) of boats and any other fisheries production materials (nets, fish  
64 storage assets) changes over time, survey of maintenance expenditure/ owner

65 **Political Economy**

66 Who makes decision for the community?

67 Why?

68 How many times do you meet to discuss town matters?

69 Who are those invited to the discussion?

70 Who decides on land issues?

71 Is there anyone who owns private/deeded land in this community?

- 
- 72 How would you react if you were told to leave this community/relocated?
- 73 What would be good about this project?
- 74 What would you fear or see happening as a result of this project?
- 75 What would you expect?

---

## 76    **Appendix C.2      Focus Group Questionnaire for Fishmongers**

77    Name of Community: \_\_\_\_\_

78    Location: Study Area \_\_\_\_\_ Ward \_\_\_\_\_

79    Attendance Disaggregated

80    Elders \_\_\_\_\_ Women \_\_\_\_\_ Youth \_\_\_\_\_ Disabled \_\_\_\_\_ Total \_\_\_\_\_

81    Interview conducted by: \_\_\_\_\_ and \_\_\_\_\_

82    Date of Interview: \_\_\_\_\_

### 83    **Introduction:**

84    I am Vaanii Kiazolu and my colleague is Judy Fallah. We are conducting a study to get  
85    feedback from people in fishing communities in coastal communities Montserrado County on  
86    how you undertake fishing, where and how and how that gives you a livelihood. We will also  
87    talk to the fishsellers/ mongers to learn more about how they make a livelihood. We would  
88    also like to know what would be your reaction to a proposed coastal protection project in this  
89    community.

### 90    **Fishing Activities**

- 91        1.    Name of fishing community – are there a number of names?
- 92        2.    Name of landing site GPS location – where do fishmongers live? How close is it  
93                needed to be to where you live
- 94        3.    How many crews do you buy from?
- 95        4.    Are you family of or otherwise related to the crew(s) you buy from?
- 96        5.    Which fish do you buy? Can you choose? Photos/ price discussion

- 
- 97        6. How many people in your team? How do you process the fish
- 98        7. Do you smoke fish yourselves – if not who do you sell to do this?
- 99        8. How do you know when to come to the beach to buy fish
- 100       9. High season months; Low season months; No fishing months – how do they manage  
101       variation in availability
- 102       10. How do you sell – carry fish to other places??
- 103       11. Average number of monthly sales of each of the following fish:
- 104       Use pictures – are these sold? Put back? Any endangered? What do they know about  
105       endangered species?
- 106       ➤ sea turtles
- 107       ➤ dolphins
- 108       ➤ sharks
- 109       ➤ rays
- 110       12. Arrangements for processing and marketing the catch beaches/ other – is there a  
111       cooperative or fish selling union?
- 112       13. Number of people involved in processing and marketing the catch
- 113       14. How often there are accidents or fatalities drownings/ deaths/ knife injuries/ tackle  
114       injuries/ chronic problems caused by the work/ gang problems
- 115       15. What are the major needs of this community and why?
- 116       a. Which of these needs you would say is first, second, third .....?
- 117       **Economic data**
- 118       16. Growth in number of fishermen crews in last 3 years
- 119       17. Sales of fish per day (in dollars)/ average earnings of fishmonger per day this will be  
120       seasonal

- 
- 121 18. Number of days per year fish selling - variation in season?
- 122 19. Change in sales in last 3 years (% growth or decline)
- 123 20. Values (dollars) of fish sales and any other fisheries processing materials - changes
- 124 over time.

125 **Political Economy**

- 126 Who makes decision for the community?
- 127 Why?
- 128 How many times do you meet to discuss town matters?
- 129 Who are those invited to the discussion?
- 130 Who decides on land issues?
- 131 Is there anyone who owns private/deeded land in this community?
- 132 How would you react if you were told to leave this community/relocated?
- 133 What would be good about this project?
- 134 What would you fear or see happening as a result of this project?
- 135 What would you expect?

---

### 136    **Appendix C.3      Focus Group Questionnaire for Communities**

137    Name of Community: \_\_\_\_\_

138    Location: Study Area \_\_\_\_\_ Ward \_\_\_\_\_

139    Attendance Disaggregated

140    Elders \_\_\_\_\_ Women \_\_\_\_\_ Youth \_\_\_\_\_ Disabled \_\_\_\_\_ Total \_\_\_\_\_

141    Interview conducted by: \_\_\_\_\_ and \_\_\_\_\_

142    Date of Interview: \_\_\_\_\_

#### 143    **Introduction:**

144    I am Vaanii Kiazolu and my colleague is Judy Fallah. We are conducting a study to get  
145    feedback from people in coastal communities Montserrado County on what would be your  
146    reaction to a proposed coastal protection project in this community.

#### 147    **Socio-economic Activities**

- 148    1. How has coastal erosion affected your community?
- 149    2. What are the activities that people use to gain a living?
- 150    3. Which of these activities do you use to earn cash income?
- 151    4. What do you spend your money on mainly?
- 152    5. Where do you sell these products/ fish and how far is it from here?
- 153    6. Do you do any other business in this community?
- 154    7. What are the major needs of this community and why?

---

155 8. Which of these needs are first, second, third?

156 **Political Economy**

157 9. Who makes decisions in this community

158 a. Why?

159 10. How often do you meet to discuss Town matters?

160 11. Who are invited to the discussion?

161 12. Who decides on land issues?

162 13. Is there anyone who owns private/ deeded land in this community?

163 14. How would you react if you were told to leave this community/relocated?

164 15. What would be good about this project?

165 16. What would you fear or see happening as a result of this project?

166 17. What would you expect from this project?



---

1 **APPENDIX D ENVIRONMENTAL AND SOCIAL**  
2 **STANDARDS AND GUIDELINES**

## 3 **Appendix D.1 Formally Issued Environmental Standards**

### 4 **D.1.1 Air Pollution Prevention and Control**

#### 5 **D.1.1.1 Control Measures**

6 The following prevention and control measures shall be adopted in order to reduce fugitive  
7 dust emissions.

8 To control fugitive dust emission from drilling, wet drilling shall be used. Where there is a  
9 scarcity of water, a suitably designed dust extractor may instead be provided for dry drilling  
10 along with a dust collection hood at the mouth of the drill hole collar.

11 Where possible, blasting sites shall be pre-wetted before blasting during the dry season.

12 The time of blasting shall be planned to suit local conditions, avoiding blasting during  
13 temperature inversions and strong winds blowing towards residential areas.

14 Dust suppression and dust extraction systems shall be provided at crusher hoppers, crushing,  
15 screening, ore bunkers, transfer points, loading points and other handling areas where dust  
16 may be generated. Appropriate transfer chutes shall be provided at discharge and loading  
17 points to minimise the drop height and spread of air borne dust.

18 Where appropriate, enclosures shall be provided to crushing and screening plants, conveyors,  
19 transfer points in order to reduce the fugitive dust emissions. At stockpile areas, water sprays  
20 shall be used wherever possible to prevent dust from getting air borne at times of dry weather  
21 and strong winds.

22 All haul roads and other heavily used roads shall be sprayed with water as necessary to  
23 suppress dust.

24 During dry weather and strong winds, when dust generated from operations may spread  
25 beyond the site, quarry benches and other working areas shall be sprayed with water from  
26 mobile water tankers as necessary according to conditions.

27 Appropriate vegetation shall be maintained alongside roads to help trap fugitive dust caused  
28 by the movement of vehicles and plant.

An appropriate vegetation green belt of a minimum width of two hundred metres shall be maintained around the perimeter of crushing and screening plants, batching plants, stockpile and loading areas, quarry working areas and so on. Green belts should be maintained particularly if these sites are located in close proximity to villages and residential areas.

Operators' cabins in all mobile and fixed plant shall be provided with dust proof enclosures. Persons working in dust prone areas shall be provided with suitable dust masks.

#### **D.1.1.2 Ambient Air Quality Tolerance Limits**

Operations involving any dust- or gaseous-generating activity must not exceed the standards given in the tables below. These limits apply to all machinery, vehicle and power generation emissions, as well as to the generation of dust from earthworks, ore and rock crushing, and vehicle movements.

The tables below present both international and national standards. The most stringent of the two should be achieved. Both are given in this standard because measurement techniques vary and the differences of averaging periods may mean that one table can be used for interpretation rather than the other.

In practice, emission fluctuations, meteorological conditions and baseline concentrations mean that in many cases compliance with the standard for 90 percent of the time can be accepted except where sensitive receptors are within the influence zone.

47 Ambient air quality tolerance limits (adapted from EPML- Air Quality and Standards Regulations, 2009)

Pollutant	Time weighted average	Industrial area	Residential, rural and other area	Controlled areas***
Sulphur oxides (SO <sub>x</sub> )	Annual average*	80 µg/m <sup>3</sup>	60 µg/m <sup>3</sup>	15 µg/m <sup>3</sup>
	24 hours**	120 µg/m <sup>3</sup>	80 µg/m <sup>3</sup>	30 µg/m <sup>3</sup>
	Annual average		0.019 ppm/50 µg/m <sup>3</sup>	
	Monthly average			
	24 hours		0.048 ppm /125 µg/m <sup>3</sup>	
	One hour			
	Instant peak		500 µg/m <sup>3</sup>	
	Instant peak (10 min)		0.191 ppm	
Nitrogen oxides (NO <sub>x</sub> )	Annual average*	80 µg/m <sup>3</sup>	60 µg/m <sup>3</sup>	15 µg/m <sup>3</sup>
	24 hours**	120 µg/m <sup>3</sup>	80 µg/m <sup>3</sup>	30 µg/m <sup>3</sup>
	8 hours			
	Annual average		0.2 ppm	
	Monthly average		0.3 ppm	
	24 hours		0.4 ppm	
	One hour		0.8 ppm	
	Instant peak		1.4 ppm	
Nitrogen dioxide	Annual average		0.05 ppm	
	Monthly average		0.08 ppm	
	24 hours		0.1 ppm	
	One hour		0.2 ppm	
	Instant peak		0.5 ppm	
Suspended particulate matter (SPM)	Annual average*	360 µg/m <sup>3</sup>	140 µg/m <sup>3</sup>	70 µg/m <sup>3</sup>
	24 hours**	500 µg/m <sup>3</sup>	200 µg/m <sup>3</sup>	100 µg/m <sup>3</sup>
	Annual Average****		100 µg/m <sup>3</sup>	
	24 hours***		180 µg/m <sup>3</sup>	
Respirable particulate matter (<10 µm) (RPM)	Annual average*	120 µg/m <sup>3</sup>	60 µg/m <sup>3</sup>	50 µg/m <sup>3</sup>
	24 hours**	150 µg/m <sup>3</sup>	100 µg/m <sup>3</sup>	75 µg/m <sup>3</sup>
Lead (Pb)	Annual average*	1.0 µg/m <sup>3</sup>	0.75 µg/m <sup>3</sup>	0.50 µg/m <sup>3</sup>
	24 hours**	1.5 µg/m <sup>3</sup>	1.00 µg/m <sup>3</sup>	0.75 µg/m <sup>3</sup>
	Monthly average		2.5	
Carbon monoxide (CO)/ carbon dioxide (CO <sub>2</sub> )	8 hours**	5.0 mg/m <sup>3</sup>	2.0 mg/m <sup>3</sup>	1.0 mg/m <sup>3</sup>
	1 hour	10.0 mg/m <sup>3</sup>	4.0 mg/m <sup>3</sup>	2.0 mg/m <sup>3</sup>
Hydrocarbons (HC)	24 hours**			
Volatile organic compounds (VOC)	24 hours**			
Ozone	One hour		0.12 ppm	
	Instant peak		1.25 ppm	
<p>* Annual arithmetic mean of minimum 104 measurements in a year taken twice a week 24 hourly at uniform interval.</p> <p>** 24 hourly/8 hourly values should be met 98% of the time in a year. However, 2% of the time, it may exceed but not on two consecutive days. The 24-hour limit may not be exceeded more than three times in one year.</p> <p>*** Not to be exceeded more than once per year average concentration</p> <p>Whenever and wherever two consecutive values exceed the limit specified above for the respective category, it would be considered adequate reason to institute regular/continuous monitoring and further investigations.</p>				

## D.1.2 Water Quality

The supervising consultant and contractor are to ensure that the standards in the table below are maintained as far as is possible in any water flows affected by its operations. Where the ambient water quality is lower than the standard, then the water shall be restored to the ambient quality.

Liberian primary water quality standards for coastal water marine outfalls, class SW-II (EPML – Water Quality Control and Standards Regulations, 2009)

Parameter	Range
pH	6.5 – 8.5
Dissolved oxygen (DO)	4.0 mg/L or 50% saturation value, whichever is higher
Colour and odour	No noticeable colour or offensive odour
Floating matters	Nothing obnoxious or detrimental for purpose of use
Turbidity	30 NTU (Nephelometric Turbidity Unit)
Faecal coliform	100/100 mL (MPN)
Biochemical oxygen demand (BOD) (3 days at 27°C)	3 mg/L
Class SW-II: water used for bathing, contact water sports and commercial fishing	

### Categories of water use

- Class I: Drinking water; water supply for industry requiring drinking water.
- Class II: Natural and cultivated fisheries, public bathing places, recreational water sports.
- Class III: Industrial supplies (other than for drinking); irrigation of agricultural land.

The Liberian water quality standard table also gives the World Health Organisation (WHO) guideline standard where it is available. The absence of a WHO guideline value usually suggests that there is not considered to be a health risk.

63 **Liberian water quality standards for Class II waters (Ministry of Health and Social Welfare, 1987)**

Parameter	Unit	WHO	Class I	Class II	Class III
pH	-logH	-	6.5-8.0	6.0-9.0	5.5-9.0
Chloride	Cl mg/l	350	≤ 250.0	≤ 350.0	≤ 450.0
Sulphate	SO <sub>4</sub> mg/l		≤ 150.0	≤ 200.0	≤ 250.0
Hardness	CaCO <sub>3</sub> mg/l	100-500	≤ 190.0	≤ 300.0	≤ 600.0
Total iron	Fe mg/l	0.1	≤ 0.1	≤ 1.5	≤ 2.0
Manganese	Mn mg/l	0.1	≤ 0.1	≤ 0.3	≤ 0.8
Total zinc	Zn mg/l	5	≤ 1.0	≤ 2.0	≤ 5.0
Coliform bacteria	n/ml	0	0	0	≤ 5
Total bacteria	n/ml	0	0	≤ 10	≤ 50
Dissolved substances	mg/l	500	≤ 500.0	≤ 1000.0	≤ 1200.0
Suspended solids	mg/l	-	≤ 10.0	≤ 30.0	≤ 50.0
Ammonia	NH <sub>4</sub> mg/l	0.5	≤ 1.0	≤ 3.0	≤ 6.0
Nitrate	NO <sub>3</sub> mg/l	50	≤ 40.0	≤ 60.0	≤ 80.0
Nitrite	NO <sub>2</sub> mg/l	-	≤ 0.1	≤ 0.5	≤ 1.0
Phosphate	PO <sub>4</sub> mg/l	-	≤ 0.01	≤ 0.02	≤ 0.05
Phenols	mg/l	0.001	≤ 0.001	≤ 0.02	≤ 0.05
Detergents	mg/l	-	≤ 1.0	≤ 2.0	≤ 3.0
Fluoride	F mg/l	1.5	≤ 1.5	≤ 1.5	≤ 2.0
Cyanide	Cn mg/l	0.05	n.d.	≤ 0.02	≤ 0.05
Lead	Pb mg/l	0.1	≤ 0.1	≤ 0.1	≤ 0.1
Mercury	Hg mg/l	0.01	n.d.	≤ 0.005	≤ 0.01
Copper	Cu mg/l	0.05	≤ 0.01	≤ 0.01	≤ 0.2
Cadmium	Cd mg/l	0.01	n.d.	≤ 0.001	≤ 0.01
Chromium trivalent	Cr mg/l	-	≤ 0.5	≤ 0.5	≤ 0.8
Chromium hexavalent	Cr mg/l	0.05	≤ 0.05	≤ 0.1	≤ 0.1
Nickel	Ni mg/l	-	≤ 1.0	≤ 1.0	≤ 1.0
Silver	Ag mg/l	0.05	≤ 0.01	≤ 0.01	≤ 0.01
Vanadium	V mg/l	-	≤ 1.0	≤ 1.0	≤ 1.0
Boron	B mg/l	-	≤ 1.0	≤ 1.0	≤ 1.0
Arsenic	As mg/l	0.05	≤ 0.05	≤ 0.05	≤ 0.2

64 **D.1.3 Limitation of Noise Emissions**

65 **D.1.3.1 Introduction and Measurement**

66 Between the quietest audible sound and the loudest tolerable sound there is a million-to-one  
67 ratio in sound pressure (measured in Pascals or Pa). Because of this wide range, a noise level  
68 scale based on logarithms is used in noise measurement, called the decibel (dB) scale.  
69 Audibility of sound covers a range of approximately 0 to 140 dB.

70 The human ear system does not respond uniformly to sound across the detectable frequency  
71 range and consequently instrumentation used to measure noise is weighted to represent the  
72 performance of the ear. This is known as the 'A weighting' and annotated as dB (A). The table  
73 below lists the sound pressure level in dB (A) for common situations.

74 Sound pressure levels for a range of situations

Typical noise levels dB(A)	Example
0	Threshold of hearing
30	Rural area at night, still air
40	Public library; refrigerator humming at 2 metres
50	Quiet office, no machinery; boiling kettle at 0.5 metre
60	Normal conversation
70	Telephone ringing at 2 metres; vacuum cleaner at 3 metres
80	General factory noise level
100	Pneumatic drill at 5 metres
120	Discotheque – 1 metre in front of loudspeaker
140	Threshold of pain

75 The noise level at a measurement point is rarely steady, even in rural areas, and varies over a  
76 range dependent upon the effects of local noise sources. Close to a busy road, the noise level  
77 may vary over a range of 5 dB(A), whereas in a suburban area this may increase up to 40  
78 dB(A) and more due to the multitude of noise sources in such areas (cars, dogs, aircraft etc.)  
79 and their variable operation. Furthermore, the range of night time noise levels will often be  
80 smaller and the levels significantly reduced compared to daytime levels.

81 The equivalent continuous A-weighted sound pressure level, LAeq, is the single number that  
82 represents the average sound energy measured over that period. The LAeq is the sound level  
83 of a notionally steady sound having the same energy as a fluctuating sound over a specified  
84 measurement period.

85 Human subjects are generally only capable of noticing changes in noise levels of no less than  
86 3 dB(A). It is generally accepted that a change of 10 dB(A) in an overall, steady noise level is  
87 perceived to the human ear as a doubling (or halving) of the noise level.

88 A parameter that is widely accepted as reflecting human perception of the ambient noise is  
89 the background noise level, LA90. This is the noise level exceeded for 90% of the measurement  
90 period and generally reflects the noise level in the lulls between individual noise events. Over  
91 a one hour period the LA90 will be the noise level exceeded for 54 minutes.

92 The parameter LA10 is used to describe road traffic noise. This is the noise level exceeded for  
93 10% of the measurement period. Over a one hour period, the LA10 will be the noise level  
94 exceeded for 6 minutes.

### D.1.3.2 Acceptable Noise Levels

No operations of the project or its contractors should exceed the levels of, or exposures to, noise as given in the tables below.

Where it is not feasible to reduce noise levels to those given below, suitable earth bunds or other barriers to the lateral spreading of noise shall be designed and installed to ensure compliance.

Noise impacts should not exceed the levels given in the tables below. These are given as façade levels at the wall of a property (e.g. just outside a window). Façade level is 3 dB(A) higher than the free-field level due to reflection from the façade.

Maximum permissible noise levels for general environment (EPML - Noise Pollution Control and Standards Regulations, 2017)

Facility	Noise Limits dB (A) (Leq)	
	Day	Night
Any building used as hospital, convalescence home, home for the aged, sanatorium and institutes of higher learning, conference rooms, public library, environmental or recreational sites	45	35
Residential buildings	50	35
Mixed residential (with some commercial and entertainment)	55	45
Residential + industry or small-scale production + commerce	60	50
Industrial	70	60
<i>Time Frame:</i> <i>Day: 6.00 a.m. to 10.00 p.m.</i> <i>Night: 10.00 p.m. to 6.00 a.m.</i> <i>The time frame takes into consideration human activity</i>		

Maximum permissible noise levels (continuous or intermittent noise) from a factory or workshop (EPML - Noise Pollution Control and Standards Regulations, 2017)

Leq dB (A)	Duration (daily)	Duration (weekly)
85	8 hours	40 hours
88	4 hours	20 hours
91	2 hours	10 hours
94	1 hour	5 hours
97	30 minutes	2.5 hours
100	15 minutes	1.25 hours
103	7.5 minutes	37.5 minutes
106	3.75 minutes	18.75 minutes
109	1.875 minutes	9.375 minutes
<i>Noise Levels shall not exceed a Leq of -</i> <i>(i) Factory/Workshops 85 dB (A)</i> <i>(ii) Offices 50 dB (A)</i> <i>(iii) Factory/Workshop Compound 75 dB (A)</i>		



108 Maximum permissible noise levels for impact or impulsive noise (EPML - Noise Pollution Control and  
109 Standards Regulations, 2017)

Sound Level dB (A) (Lmax)	Permitted number of Impulses or Impacts per Day
140	100
130	1,000
120	10,000

110 Maximum permissible noise levels for construction sites (EPML - Noise Pollution Control and Standards  
111 Regulations, 2017)

Noise Control Zone	Sound Level dB (A) (Leq)	
	Day	Night
Residential Area	60	40
Commercial Area	75	50
Industrial Area	85	65
<i>Time Frame:</i> <i>Day: 6.00 a.m. to 10.00 p.m.</i> <i>Night: 10.00 p.m. to 6.00 a.m.</i> <i>The time frame takes into consideration human activity</i>		

112 Maximum permissible noise levels for accelerating vehicles (adapted from EPML - Noise Pollution Control and  
113 Standards Regulations, 2017)

Vehicle type		Sound Level dB(A) (Leq)
Vehicles intended for carriage of passengers and equipped with not more than nine seats, including the driver's seat		78
Vehicles intended for carriage of passengers, and equipped with not more than nine seats, including the driver's seat and having maximum permissible mass of more than 3.5 tonnes	a) - with an engine power of more than 150 KW	80
	b) - with an engine power of less than 150 KW	83
Vehicles intended for carriage of passengers and equipped with more than nine seats including the driver's seat: vehicles intended for carriage of goods	a) - with a maximum permissible mass not exceeding 2 tonnes	79
	b) - with a maximum permissible mass exceeding 2 tonnes but not exceeding 3.5 tonnes	80
Vehicles intended for the carriage of goods and having a maximum permissible mass exceeding 3.5 tonnes	a) -with an engine power of less than 75 KW	81
	b) -with an engine power of not less than 75 KW but less than 150KW	83
	c) -with an engine power of not less than 150 KW	84

114 Maximum permissible noise levels for residential and commercial areas (EPML - Noise Pollution Control and  
115 Standards Regulations, 2017)

Facility	Limit Value in dB(C)
For any building used as a hospital, school, convalescent home, old age home or residential building.	109 dB (C)
For any building in an area used for residential and one or more of the following purposes: Commerce, small-scale production, entertainment, or any residential apartment in an area that is used for purposes of industry, commerce or small-scale production, or any building used for the purpose of industry, commerce or small-scale production.	114 dB (C)

## **D.1.4 Limitation of Vibrations and Air Overpressure**

### **D.1.4.1 Ground Vibrations: Introduction and Measurement**

When an object is in contact with a vibrating surface it is displaced about its reference (stationary) position. Displacement (in mm) is therefore one parameter that can be used to describe the magnitude of a vibration. For sinusoidal signals, displacement, velocity (mms-1) and acceleration (mms-2) amplitudes are related mathematically by a function of frequency and time. If phase is neglected (as is always the case when making time-average measurements), then the velocity can be obtained by dividing the acceleration signal by a factor proportional to frequency (measured in Hertz, Hz) and the displacement can be obtained by dividing the acceleration signal by a factor proportional to the square of frequency. Modern electronic integrating meters are capable of providing a wide range of measurement parameters during any single vibration measurement.

For a complex acceleration signal giving rise to a complicated time history, there are several additional quantities which can be used to describe the vibration:

- The root mean square value (rms) is obtained by taking the square root of the means of the sum of the squares of the instantaneous acceleration measured during the total measurement time (T);
- The peak value is the maximum instantaneous acceleration measured during the measurement time, T. It is a useful indicator of the magnitude of short duration shocks; and
- The peak particle velocity (ppv) is the maximum instantaneous velocity of a particle at a point during a given time interval.

### **D.1.4.2 Context**

In general, buildings are reasonably resilient to ground-borne vibration and vibration-induced damage is rare. Vibration-induced damage can arise in different ways, making it difficult to arrive at universal criteria that will adequately and simply indicate damage risk. Damage can occur directly due to high dynamic stresses, due to accelerated ageing or indirectly, when high quasi-static stresses are induced by, for example, soil compaction.

Given the construction of many of the residential properties in rural Liberia (sun-dried clay blocks, with a very thin concrete skim direct on to the clay) and the likely levels of ground borne vibration, it is considered that these types of properties will not suffer from cosmetic damage due to vibration. Measurements are therefore recommended only for short duration vibrations (such as from blasting) or for particular, very sensitive receptors.

The British Standard BS 7385-2:1993 (Evaluation and measurement for vibration in buildings – Part 2: Guide to damage levels from ground borne vibration) provides guidance on vibration levels likely to result in cosmetic damage (e.g. plaster cracks). Limits for transient vibration, above which cosmetic damage could occur, are given in the table below, taken directly from that standard.

#### **D.1.4.3 Transient Vibration Levels for Cosmetic Damage**

The vibration velocities given in the table below must be adhered to in relation to project activities.

Type of Building	Peak component particle velocity in frequency range of predominant pulse	
	4 Hz to 15 Hz	15 Hz and above
Reinforced or framed structures Industrial and heavy commercial buildings	50 mms <sup>-1</sup> at 4 Hz and above	
Un-reinforced or light framed structure Residential or light commercial buildings	15 mms <sup>-1</sup> at 4 Hz increasing to 20 mms <sup>-1</sup> at 15 Hz	20 mms <sup>-1</sup> at 15 Hz increasing to 50 mms <sup>-1</sup> at 40 Hz and above

Notes. 1. Values referred to are at the base of the building.  
2. For un-reinforced or light framed structures and residential or light commercial buildings, a maximum displacement of 0.6 mm (zero to peak) is not to be exceeded.

The guide values relate predominantly to transient vibration which does not give rise to resonant responses in structures. Where the dynamic loading caused by continuous vibration is such as to give rise to dynamic magnification due to resonance, especially at the lower frequencies where lower guide values apply, then the guide values in the table may need to be reduced by up to 50%.

#### **D.1.4.4 Air Overpressure Limits**

Air overpressure (or blast overpressure) is the pressure or high energy impulse noise caused by a shock wave over and above normal atmospheric pressure.

Based on a review of international standards, the figure of 133 dB (L) is adopted at 500 metres from the blast site (the standard evacuation zone) or at the nearest non-quarry-related structure if closer.

#### **D.1.4.5 Standard Measures to Reduce Ground Vibrations and Air Overpressure in Blasting**

The following standard measures shall be used in all blasting operations by or on behalf of the project, to reduce ground vibrations and air overpressure. It is recognised that these are difficult to predict owing to the many factors involved in ground conditions, distance to receptor, atmospheric conditions and the intention of individual blasting operations.

- Explosive quantities shall be minimised to the least amount required to accomplish the required task.
- The spacing of blast holes shall be optimised so as to accomplish the required task with the least amount of explosive possible.
- Detonator timings shall be optimised to minimise ground vibrations. Normally the standard 8 millisecond rule between blast holes shall apply, unless the use of electronic timers allows for better patterns.
- Burden depth and blast hole diameter shall be optimised to obtain the best balance between reduced ground vibrations and reduced air overpressure.

It is expected that the quarry operator will undertake a series of trials to reach the optimal reduced ground vibration and air overpressure impacts over the first five blasts at a particular site.

### **D.1.5 Bushmeat Hunting, Dealing, Transporting and Use**

#### **D.1.5.1 Statutory Regulations**

The Draft Hunting Regulations of Liberia, drawn up under the National Forestry Law (2006) proposed the following provisions.

1. A person with a valid hunting licence issued by the Forestry Development Authority may hunt during the Open Hunting Season, from 1 October to 31 March.
2. No hunter may take more than 3 wild animals per week.

3. No bush meat trader may carry more than 20 pieces (quarters) of meat at a time.

#### **D.1.5.2 Permitted Bushmeat**

No person is permitted to hunt for bushmeat on project land, including the road right-of-way.

The legally permitted take per licensed hunter on non-project land of common non-protected species is as follows.

Animal	Number per week
Black deer (black duiker)	2
Blue tongue (Maxwell's duiker)	2
Red deer (bush buck)	1
Black backed (bay duiker)	2
Porcupine (crested porcupine)	3
Hedge hog (brush-tailed porcupine)	3
Ground hog (cane rat)	3
Opassum (giant rat)	3
Ground squirrel	3

#### **D.1.5.3 Prohibited Bushmeat**

The following animals are fully protected and may not be hunted at all. All project staff and contractors' employees are absolutely forbidden from hunting, dealing in, transporting and using these animals or any products associated with them (including eggs).

1. Baboon (West African chimpanzee)	2. Ant bear (tree pangolin)
3. King monkey (black and white colobus)	4. Sea cow (West African manatee)
5. Red monkey (red colobus)	6. Alligator (Nile crocodile)
7. Olive colobus	8. Alligator (African slender-snouted crocodile)
9. Diana monkey	10. Crocodile (African dwarf crocodile)
11. Jackal (sooty mangabey)	12. Boa constrictor (rock python)
13. Lesser galago	14. Boa constrictor (ball python)
15. Clawless otter	16. All sea turtles
17. Bosman's potto	18. All birds of prey (ospreys, falcons, buzzards, kestrels)
19. Forest elephant	20. All hornbills
21. Elk deer (bongo)	22. Bare-headed rockfowl
23. Bush galago (demidoff's dwarf galago)	24. Grey-necked rockfowl
25. Black back (Ogilby's duiker)	26. White-necked rockfowl
27. White antelope (Jentink's duiker)	28. Guinea fowl (white-breasted guinea fowl)
29. Marking deer (zebra duiker)	30. Little egret
31. Water deer (water chevrotain)	32. Cattle egret
33. Water cow (pygmy hippopotamus)	34. Secretary bird
35. Leopard	36. Jabiru or saddle bill
37. Liberian mongoose	38. Sacred ibis
39. Bush cat (golden cat)	40. Hadada
41. Big ant bear (giant pangolin)	42. Goliath heron
43. Ant bear (long-tailed pangolin)	

206 **D.1.5.4 Partially Protected Animals**

207 The following animals are fully protected between 1st August and 1st December in any year  
208 and may not be hunted during this period. The young and adults with young of these species  
209 are fully protected at all times. All project staff and contractors' employees are absolutely  
210 forbidden from hunting, dealing in, transporting and using these animals or any products  
211 associated with them (including eggs) except in accordance with these rules.

- |                                       |                           |
|---------------------------------------|---------------------------|
| 1. Mona monkey                        | 2. Serval                 |
| 3. Lesser spot-nosed monkey           | 4. African civet          |
| 5. White coloured mangabey            | 6. Two spotted palm civet |
| 7. Bush cow (forest buffalo)          | 8. African python         |
| 9. Yellow back (yellow-backed duiker) | 10. All turacos           |
| 11. Tricky jack (royal antelope)      | 12. All bushfowl          |
| 13. Bay duiker                        | 14. Stone partridge       |
| 15. Red hog (red river hog)           | 16. All parrots           |
| 17. Black hog (giant forest hog)      | 18. All doves and pigeons |
| 19. Forest genet                      | 20. Hartlaub's duck       |
| 21. Bush genet                        | 22. White faced duck      |
| 23. Wild cat                          | 24. Fulvous duck          |
| 25. Gambian mongoose                  | 26. Pygmy goose           |
| 27. Side striped jackal               | 28. Knob billed goose     |
| 29. Lynx                              |                           |

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## 212 **Appendix D.2 Environmental and Social Guidelines**

### 213 **D.2.1 Personal Protective Equipment Provision to Site Staff and Workers**

214 The site in-charge or contractor shall supply high quality personal protective equipment (PPE)  
215 meeting international standards, as appropriate to the needs for each work site and worker's  
216 task. The necessary equipment is to be provided to all staff and workers entering the site,  
217 irrespective of rank and level of seniority. The equipment is to be comfortable for prolonged  
218 use, and is to be replaced as soon as it loses its effectiveness.

219 The site in-charge or contractor is responsible for ensuring that all staff and workers use  
220 appropriate safety gear during all hours of work on each site.

221 Fluorescent jackets shall be worn when on any construction or operational site, or in the  
222 proximity of other workers operating machines or tools, or engaged in potentially dangerous  
223 activities such as erecting structures.

224 Helmets shall be worn when on any construction or operational site, or whenever there is a  
225 danger of head injury from falling or moving items, such as loose formwork, unsecured  
226 overhead structures and the tools of other workers.

227 Goggles shall be worn whenever there is a risk of flying debris, from the use of hammers,  
228 drills or other fast-moving or impact-creating tools and machines.

229 Gloves shall be worn whenever there is a risk of hand injury from hard or sharp materials  
230 such as wood or metal, or sparks; they shall also be worn when handling caustic materials  
231 such as cement.

232 Boots with steel toe and side protection shall be worn when on any construction or operational  
233 site, or whenever there is a risk of foot injury from fast-moving or impact-creating tools and  
234 machines, such as drills, sledge hammers and pick axes.

235 Ear protection shall be worn whenever a person is within 20 metres of any machine making a  
236 loud noise, including generators, drills, compressors, power saws, grinders, or earth-moving  
237 and compacting machines. No individual shall be exposed to noise levels in excess of 85 dB  
238 without wearing ear protection. Environmental Department staff can measure site noise on  
239 request.

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## **D.2.2 Bush Clearance**

The clearance of vegetation is permitted in certain areas in preparation of earthworks or for access to facilities. The swathe that may be cut is limited to the minimum required for the purpose in hand. In the case of roads, the swathe is to cover only the width of the road and its immediate drainage works.

No vegetation may be cleared unless it is explicitly covered in the conditions of the relevant Environmental Permit. This may be allowed for in the ESIA Report or the Environmental and Social Management Plan.

Vegetation shall normally be cleared only by cutting. The use of fire, herbicides or other poisons is not permitted. The use of earth-moving equipment is permitted only if the works require the grubbing out of plant roots. Otherwise all roots and stumps shall be left in the ground.

Vegetation may be cut using either hand or machine tools. In all cases, appropriate personal protective equipment shall be used by the workers involved.

The vegetative debris shall be laid down to rot, thereby acting as mulch and helping to mitigate damage to the soil. Where clearance is for construction, then the debris may be removed to a suitable approved dump site.

If a bare sloping area is created by vegetation clearance, then appropriate erosion control measures shall be implemented. Separate guidelines are provided to cover this.

No tree of more than five metres in height should be felled using a standard bulldozer or excavator. An axe or saw should be used. Chainsaws should only be used by trained operators (see guidance below). Even with manual saws, trees taller than 8 metres in height should be felled only by experienced workers. Where specialist large machines (see below) are available and slopes are less than 20 degrees and tree roots are to be grubbed out, then trees more than five metres in height may be felled by machine. However, no tree greater than 25 metres in height may be felled except by use of a chainsaw.



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## **D.2.3 Procedure for Unexpected Cultural Sites and Archaeological Finds**

### **D.2.3.1 Introduction**

This guideline describes the actions required when project work for or by the project encounters sites of cultural heritage value, archaeological remains, graves and human remains. The purpose of this chance finds procedure is to ensure that a protocol is in place for identification, data collection, reporting; and, if necessary, salvage of significant chance finds. The National Museum of Liberia, in consultation with the EPA will determination the level of significance for purposes of salvage.

In its ESIA studies, the EPA's consultants have encouraged communities to identify and map sacred sites – forests, groves, bushes, stones and rocks, caves, sites of archaeological or ancestral history and graves, and areas for African Traditional Religions. It is possible that some sites have been forgotten, missed or are important to people still displaced. It is also possible that there may be the discovery of human remains left from the civil war or more recent incidents.

### **D.2.3.2 Possible Sites**

A site of importance is defined as any of the following.

- Any physical place or geographical feature identified by local people as culturally important – usually these will be identified by local people working on the site as they are found.
- Any archaeologically significant structure or artefact. These may be difficult to identify but may be, for example, stone circles or unusual mounds that only appear as brush is cut back.
- Graves – these may be stone markers only revealed on cutting back brush.
- Exposed human remains – these may be recent, related to civil war incidents or much older.

Cultural sites may be difficult to identify without explanation by local people. Features to look out for include signs of human activity or artefacts around large or unusual trees, bushes and rocks, particularly in remote locations. Contractors must be sensitive to comments by Liberian

staff regarding cultural sites. Sometimes these may sound derogatory because of differences between Liberia's ethnic cultures; but all cultural sites are valuable to someone.

An archaeological site is a place in which evidence of past human activities is preserved. Sites that are buried or not identified by prior surveys may be discovered during project land clearing and in the first few metres of excavation. They may exhibit features such as scatters of broken pottery, flakes of worked stone, bones, discarded shellfish, walls of former buildings, or iron smelting works. These artefacts usually have no commercial value but are of value in defining a history of human occupation.

#### **D.2.3.3 Action Required**

The Community Liaison Unit will include physical cultural resource awareness training for all staff and contractors during site induction and follow-up with reminder information on responsibility and respect for such resources in the event of a chance find, and the appropriate procedure to follow. In order to prevent vandalism, the Contractor, the Contractor's staff and the Project staff must keep confidential the location of the suspected find

The procedure below states the steps that must be undertaken to report, investigate and deal with chance finds in the concession area and associated works.

#### **D.2.3.4 Procedure**

Step	Responsibility	Action
1. Realisation	Worker	Report find to supervisor.
2. Halt action	Supervisor/ Engineer	1. Assess find.
		2. Report to supervising consultant's representative.
		3. Stop any action by workers or machinery that may affect the integrity of the find within at least 10 metres of the find.
		4. Post a guard.
		5. Record his inspection in the responsible contractor's daybook.
3 Investigate nature of find	Supervising consultant's representative	Require the designated Community Liaison Officer to visit the find, check and report back on the type of find.
4 Site Visit	Community Liaison Officer	Visit, inspect, and locate the site by GPS, and report to the supervising consultant representative.
		Report the find in the cultural heritage database and Community Engagement Matrix.
5. <b>Action</b>	Supervising consultant's representative	Call in the Liberian National Police to investigate the cause of death and determine whether this is a crime scene. The LNP will then take charge and manage removal of the remains.
a) In the case of human remains		

Step	Responsibility	Action
b) In the case of a clearly identifiable grave	Community Liaison Officer	The CLO must try to identify relatives through community leaders or the Community Liaison Officer and arrange for relocation of the body by the nearest relatives. Removal costs and rituals associated with grave relocation will be paid from the project's resettlement compensation budget.
c) In the case of a feature that may be archaeologically significant	Supervising consultant's representative	<ol style="list-style-type: none"> <li>1. Contact the University of Liberia, Liberia College of Social Science and Humanities, Anthropology Department</li> <li>2. Request rapid appraisal visit to site by a competent specialist.</li> <li>3. Commission specialist investigation with a view to researching, preserving or relocating the find if it is of archaeological significance.</li> <li>4. Liaise with the project design team to avoid the site either temporarily or permanently.</li> <li>5. Costs of the specialist visit, appraisal and any conservation or relocation activities will be met from the project's resettlement compensation budget.</li> </ol>
d) In the case of a site of cultural value	Community Liaison Officer	<ol style="list-style-type: none"> <li>1. Contact the local community, elders, Poro and Sande leaders, and the Leader of the Animals to investigate claims to cultural significance.</li> <li>2. Liaise with the project design team to avoid the site either temporarily or permanently.</li> <li>3. If not possible to avoid, agree a relocation package and timetable with costs met from the project's resettlement compensation budget.</li> <li>4. Oversee and monitor the relocation to the agreed timetable and cost.</li> </ol>
6 <b>Reporting</b> At each level of report, the responsible officers will report appropriate information on the site	Cultural Heritage Resource Assistant with all involved officers	Enter appropriate information into the cultural heritage database and Community Engagement Matrix: <ol style="list-style-type: none"> <li>a) Location – GPS co-ordinates.</li> <li>b) Conditions in which the discovery occurred.</li> <li>c) Type – principle evidence for suspected archaeological sites, or informant declaration in the case of cultural sites.</li> <li>d) Area – horizontal and vertical.</li> <li>e) Work stopped – task and schedule.</li> </ol>

## D.2.4 Code of Practice for Staff, Worker and Visitor Behaviour

All contractors' managers must ensure that their staff uphold this Code of Practice at all times.

Project contractors are guests of the communities in which they are living and working. They must fit with local customs and laws. Many staff are from other parts of Liberia and from other countries, and some will be in the project area for only short periods. Cultural differences and poor behaviour of workers can lead to tension between local communities and workers housed in camps. This Code of Practice demands moderate and tolerant behaviour of all people associated with the project.

319 All project staff, the employees of contractors and visitors to camps and work sites, must abide  
320 by the following rules to ensure harmonious co-existence.

- 321 • Adhere to Liberian laws and regulations.
- 322 • Respect local communities, religions and customs.
- 323 • Respect all groups within the towns and camps.
- 324 • Behave in a moderate, modest and tolerant manner.
- 325 • Avoid causing disturbance or undertaking any unruly or anti-social behaviour at any  
326 time.
- 327 • Do not hunt, fish, keep animals or gather forest products, except in line with the law  
328 and the rules of local communities.
- 329 • Bring no firearms, ammunition, dangerous weapons or fireworks in the towns, camps  
330 or work sites.
- 331 • Use vehicles safely at all times.
- 332 • Use security passes as required for different areas.

333 All employers shall maintain a zero tolerance policy towards the following.

- 334 • Infringement of any Liberian law.
- 335 • Bribery, fraud or attempts at these.
- 336 • Racist, discriminatory or anti-religious behaviour.
- 337 • Involvement in prostitution on project property or in project vehicles.
- 338 • Any form of sexual exploitation or abuse.
- 339 • Involvement in violence of any sort.
- 340 • Repeated excessive consumption of alcohol.
- 341 • Intoxication on any work site.
- 342 • Dealing with proscribed bush meat.
- 343 • The use of any non-prescribed or illegal narcotic substance.

344 The EPA and the supervising consultant have the right to require intoxication or controlled  
345 substance testing at any time.

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## **D.2.5 Control of Water Pollution**

### **D.2.5.1 General**

No person shall discharge or apply any poisonous, toxic, noxious or obstructing matter, radioactive waste or other pollutants unless the discharge of such material is treated to permissible standards as defined in the project's environmental permit.

No person shall:

- Generate and discharge any form of effluent on to land or into any water resource without compliance with an approved Environmental Management Plan and a valid Environmental Certificate;
- Discharge wastewater or effluent off an operational site, which does not meet the water quality requirements stipulated in the appropriate licence for effluent discharge; or
- Discharge into any water resource effluent from a sewage treatment plant, trade or industrial facility without both treatment and a valid effluent discharge license.

In rural Liberia, all surface water courses are used for drinking water supplies at some point during the agricultural year.

### **D.2.5.2 Prevention of Water Pollution**

Surface run-off from earthworks, waste dumps and other areas shall be properly controlled, collected and treated before discharging into natural water courses. Silt traps and check dams of appropriate sizes shall be constructed at all strategic points to control surface run-off. All run-off water shall be diverted through a series of sedimentation basins to remove suspended particles and chemicals as necessary.

Entrained sediment shall be collected as close to the source as possible. In particular, coarse sediment (sand- and coarse silt-sized particles) should be removed from water courses at the point where they leave the source of supply. Coarse sediment can destroy riverine biotic systems that can otherwise thrive close to earthworks sites.

Sedimentation ponds and check dams shall be de-silted at regular intervals, as required to maintain effectiveness.

Re-vegetation of exposed surfaces shall be done as far as possible in the earthworks and other operational sites, and around all ancillary infrastructure and access tracks. A separate series of guidelines covers these works.

All efforts shall be made to re-use and re-cycle treated effluents to the maximum possible extent in order to achieve zero effluent discharge.

Domestic effluents shall be treated in properly designed oxidation ponds or by any other suitable sewage treatment method. Outfalls should be allowed to discharge into the environment only where the quality standards are met. The supervising consultant shall be responsible for monitoring this, but may require a contractor to undertake monitoring on its behalf. Where camps are operated by contractors, then the operator is responsible for monitoring outfalls.

Workshops, fuelling stations and other areas handling fuels, lubricants and other hazardous substances shall be subject to special provisions. These are covered in detail by separate guidelines.

#### **D.2.5.3    Protection and Conservation of Riparian and Estuarine Peripheral Areas**

Riparian land is the area along the banks of rivers and creeks, and edges of swamps, where there is a dynamic complex of plant, animal and micro-organism communities and their non-living environment adjacent to and associated with a watercourse. Estuarine peripheral areas are around the edges of tidal inlets, immediately outside the zone of saline water intrusion, and where there are also particular ecosystems. Although both of these bands of land vary, a practical guideline is to take them as occupying 50 metres on each side of a watercourse for riparian zones, and 50 metres from the highest point of tidal water ingress in the case of estuarine areas. In specific conditions, where there is a strong case for a narrower width, this may be reduced to a minimum of 15 metres.

The following activities shall not be permitted on riparian or estuarine peripheral land except as provided in the following two paragraphs:

- Tillage or cultivation;
- Clearing of trees or other vegetation;
- Building of permanent or temporary structures;

- Disposal of any form of waste;
- Excavation of soil or development of borrow pits or quarries; or
- Any other activity that may degrade the water resource.

If any of the above activities must take place within a 50-metre riparian or estuarine peripheral zone, a full environmental management plan must be prepared that demonstrates how any impacts will be mitigated, with control measures put in place before any other site works start.

Where it is essential that tracks or roads must cross a riparian zone, they shall be aligned to cross at right angles, thereby minimising disruption to this valuable habitat. The area cleared for them shall be kept as narrow as possible and special provision shall be made for soil erosion control measures. Culverts shall be installed so that vehicles do not drive through the water.

Riparian and estuarine peripheral zones should be considered as key areas in all work site environmental monitoring. Water quality assessment or the health and diversity of indicator insect species such as dragonflies shall be used to judge the effectiveness of mitigation measures.

#### **D.2.5.4 Spillage**

No person shall wilfully and deliberately allow any substance to spill out into any water resource (fresh or saline) or on to land where such spillage may contaminate either soil or a body of surface or groundwater, or the sea.

In the event of accidental spillage where such spillage may contaminate either soil or a body of surface or groundwater, the following actions shall be taken.

- The person responsible for or causing or finding the spilt substance shall immediately inform the supervising consultant of the accident.
- The supervising consultant shall take immediate and adequate measures to prevent spread of the spillage and its likely adverse effects to soil and water resources.
- The supervising consultant shall take measures to notify the public of the spillage and also to cause action to be taken to deal with the spillage.

In this context the supervising consultant is represented by the Manager responsible for that overall site.

## **D.2.6 Topsoil Stripping, Stockpiling and Restoration**

### **D.2.6.1 Overview**

This guideline provides guidance on the management of topsoil and subsoil in engineering operations. Topsoil is an important resource, both ecologically and economically, since it is the source of all terrestrial life. Topsoil is therefore classed as an asset and must be treated as a living entity. Under no circumstances is topsoil a waste material. Subsoil is an essential foundation to topsoil and where possible should also be saved to aid later rehabilitation.

The recommended sequence for stripping, stockpiling and restoring of topsoil from a borrow area or other site, is as follows. The paragraphs below give details on how each step should be undertaken.

1. Delineate borrow (or other) area.
2. Delineate topsoil storage area.
3. Complete land access procedure.
4. Construct access tracks.
5. Clear vegetation and dispose.
6. Install drainage and silt traps.
7. Grub roots and stumps.
8. Strip topsoil from borrow area.
9. Place topsoil on designated storage.
10. Stockpile unusable subsoil if present.
11. Remove approved earthfill to construction site.
12. Replace subsoil if available.
13. Replace topsoil and rehabilitate.
14. Undertake revegetation works to restore habitat.

### **D.2.6.2 Field Identification of Topsoil**

Topsoil is the darker coloured surface layer that varies in depth depending on location, but in general is 100 to 150 mm in depth. It is the soil layer with the greatest proportion of organic



matter (in the form of fine roots, decomposing plant material and microbial animals). Where there is any leaf litter on the soil surface, this should be considered part of the topsoil. Topsoil depth and quality generally increases from a hilltop to the toe of a slope. Swamps may contain considerable thicknesses of topsoil that are highly fertile if managed correctly.

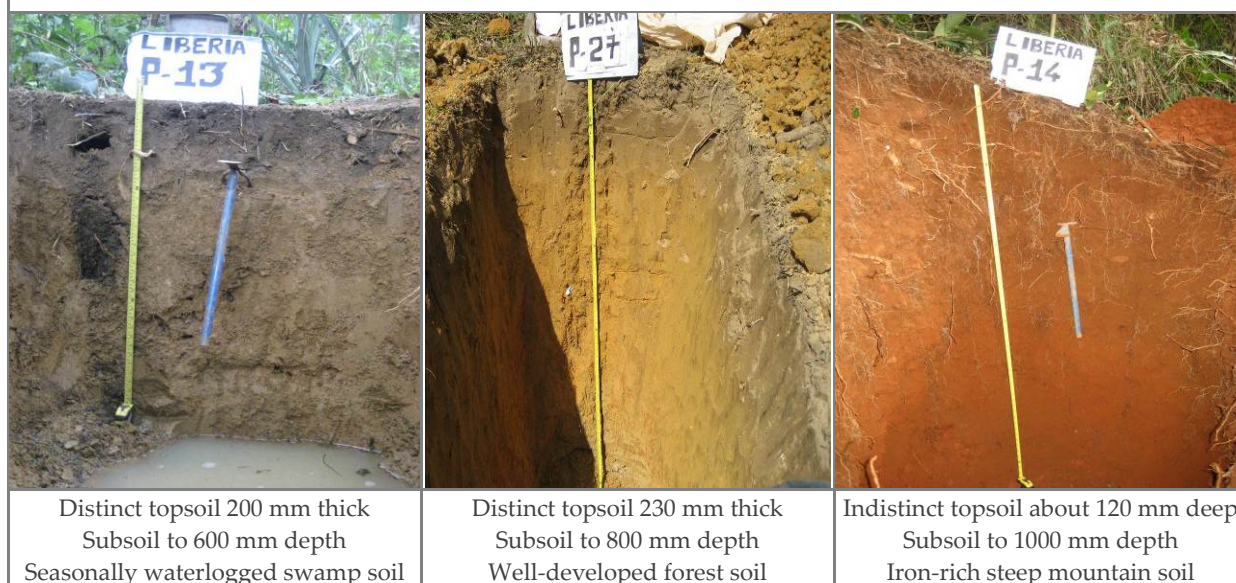
With depth in the soil profile, the material becomes increasingly less weathered and thus of decreasing value as plant-growing material. This is the subsoil. The downward change is often gradual and thus it is a matter of judgement as to where to make the cut-off. However, the subsoil horizon from 150 to 500 or 600 mm contains soil that is of value in restoration, as it contains some organic material and raised nutrient levels, and is weathered to a consistency that will help facilitate later regrowth when it is re-laid as a foundation below the topsoil. Note, however, that lack of cleared land for storage space means that the contractor will not normally need to take subsoil for storage unless it is found between the topsoil and the approved borrow material.

#### Identification of topsoil and subsoil

Topsoil is the darker surface layer of soil. It is usually from the surface to a depth of 150 mm (6 in) or slightly more. It may include decaying plant material on the surface (dead leaves and sticks).

Subsoil is the weathered layer below the topsoil. This almost always extends to 500 mm (20 in) below the surface and sometimes much more. In most of the borrow areas, subsoil will be classed as approved engineering earthfill material and removed to the construction sites.

The illustrations below show typical soil profiles. In all of them, the topsoil layer is visible.



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#### **D.2.6.3    Storage of Topsoil**

The location for a soil stockpile shall be in a place where it will not erode, block drainage, or interfere with work on the site. The stockpile location must be selected to avoid steep slopes (gentler than 1:4 to avoid slippage), flood plains and natural channels. It shall be at least 30 metres from a water course, pond or swamp to prevent sedimentation and damage to riparian habitat.

Topsoil should not be stored on another topsoil or subsoil of highly contrasting texture. Sandy topsoil over clay subsoil is a particularly poor combination, especially on slopes: water may creep along the junction between the soil layers and cause the topsoil layer to slip or slough.

Subsoil should not be stored on top of topsoil. If necessary, the topsoil at a stockpile location must be stripped off and the subsoil laid down, before the topsoil is replaced on top of it.

On large sites, re-spreading may be easier and more economical when soil is stockpiled in small piles located near the areas where it will be re-used. One approach appropriate for some borrow areas, is for removal and replacement of topsoil in successive strips as the borrowing moves across the area.

Before any topsoil is stored in a designated area, vegetation must be cut and a full drainage and sediment control system installed. The grubbing of stumps and roots may also be necessary to aid the processes of topsoil placement, management and later recovery for use in rehabilitation works.

As far as the terrain allows, storage areas should be gently convex in design so that run-off is managed and does not lead to erosion and instability. The slopes used should be at a maximum angle of 18 to 20° to enable working, and subject to final assessment and sign-off by the authorised engineer to ensure that the slopes are stable in the short and long term.

Where stockpiles are on slopes, the downward slope shall be adapted to retard run-off water and prevent erosion. Erosion control berms and appropriate drainage channels may be used to achieve this. An alternative is to create “moonscape” indentations to retard run-off, placed in a staggered manner to ensure they do not form continuous lines

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#### **D.2.6.4    Management of Topsoil (and Subsoil) Stores**

The management of topsoil storage areas shall be determined on an area-by-area basis and an appropriate plan agreed. All storage areas will be in approved locations, with sites prepared as described above. The main management options are as follows.

- Temporary storage of topsoil, with it replaced to site within the same dry season.
- Longer term storage requiring management interventions, including revegetation, periodic aeration, erosion controls and other work.
- Initial stabilisation followed by handover for approved use by the landowner under an agreement in line with the Resettlement Action Plan.

Topsoil stockpile height shall not exceed 1 metre. If space permits, where topsoil is being stockpiled on areas where agriculture will remain active as part of the management plan, then it should be limited in height to 0.5 m to retain topsoil characteristics (significant biological activity really continues only to a depth of 300 mm). Gentle compaction is necessary, but should be as light as possible, such as one pass by a tracked excavator or small bulldozer; but never by a roller or vibrating compactor.

Soil stockpiles shall be protected against erosion and soil loss by temporarily planting or seeding with a locally collected species of grass. This must be done as soon as possible, but only when there is enough moisture in the soil for germination and growth. In the wet season, no stockpile shall be unprotected for more than 30 days after its formation. While vegetation is becoming established, the stockpile may need additional protection by a silt fence or other sediment barrier on the down-gradient sides.

If stockpiles will not be removed within the same dry season as they were created, they should be stabilised with permanent vegetation to control erosion and weed growth. This will involve the planting of fast-growing pioneer shrubs or trees.

No seeds or plants from sources outside of the County where activities are taking place may be used on any revegetation sites. Invasive plants also must not be used. This is on account of the need to protect the local biodiversity to the greatest extent possible.

Fine-textured topsoil may need aeration periodically if there is a risk of waterlogging and the generation of anaerobic conditions. This can be achieved by turning down the stockpiles once

a year, or using a chisel plough or tines on a small bulldozer, but the most suitable method will be dependent on the height of the stockpile. Revegetation may be required after the aeration operations.

The depth of a subsoil stockpile is limited by stability concerns. As it is laid, the soil should be compacted in layers of 1 metre thickness. Usually a height of 3 metres is the maximum that should be permitted without stabilisation measures being required. Compaction is to ensure integrity, not to create a full engineering fill specification, and should be achieved using a few passes by a tracked machine.

#### **D.2.6.5 Replacement of Topsoil (and Subsoil) in Land Rehabilitation**

Before spreading soil back on to a site, erosion and sedimentation control practices such as run-off water diversions, berms, and sediment basins shall be put in place. The slopes and elevations should be graded smooth for the receipt of soil. Slopes steeper than 1v:3h should not normally be considered for re-soiling, but instead should be protected by direct planting with suitable pioneer species.

Topsoil shall be spread evenly over freshly laid subsoil in a layer of 150 to 200 mm depth (or as otherwise approved by the appropriate supervising consultant representative). When the soil is dry, light compaction shall be provided, such as by one pass by a tracked excavator or small bulldozer. When the soil is moist or wet, then it should be harrowed using standard agricultural implements, or raked by hand, to form a fine tilth. No topsoil operations shall be undertaken while it is muddy or when the subgrade is saturated. The running of vehicles over newly spread topsoil shall be minimised to avoid excessive compaction.

Where embankments are being constructed (such as part of a permanent drainage system), the slope, ground and climatic conditions may reduce the ability of the topsoil layer to bind well with the subsoil layer. In these situations, offsetting lifts of material to create an uneven surface prior to topsoil placement should be considered.

Where subsoil is available, its use should be considered as part of the rehabilitation process. Where the substrate has the characteristics of subsoil, particularly in terms of allowing root penetration and plant growth (i.e. similar physical and chemical properties to natural subsoil in a similar site), then it may be appropriate only to add topsoil and not to expend energy and

resources in re-laying subsoil unnecessarily. Available subsoil may be better retained for the rehabilitation of sites with very poor substrate.

Immediately prior to spreading any available subsoil, the subgrade should be loosened by disking or scarifying to a depth of at least 150 mm to ensure bonding between the layers.

Subsoil shall be distributed uniformly to a minimum compact depth of 500 mm and compaction achieved using a few passes by a tracked machine. No soil shall be spread while it is muddy or when the subgrade is saturated. Any irregularities in the surface shall be corrected that result from stockpiling or other operations, to prevent the formation of depressions or water pockets.

#### **D.2.6.6 Placement of Topsoil on Engineered Structures**

The placement of topsoil on engineered structures shall be at the discretion of the appropriate supervising consultant representative. In some cases, especially on embankment slopes, it is better to plant vegetation straight on to the earthfill structure rather than to attempt to stabilise a veneer of topsoil. This is because unconsolidated topsoil can become saturated in heavy rain due to the discontinuity below it to a compacted and impermeable substrate; in extreme conditions this can lead to a small mud flow of the topsoil. In some cases topsoil may be specified in porous bags, especially at the toe of a slope, to allow vegetation to grow, while the bags provide temporary stability and protection from scour erosion.

#### **D.2.6.7 Rehabilitation of Topsoil**

Simply replacing topsoil back on top of an altered surface does not constitute rehabilitation. In the best cases, following topsoil placement, the only rehabilitation required is revegetation using planted grasses, as described in the next sub-section, and tending for a period of a few years to allow the processes of nature to aid the rehabilitation process. But in certain cases other work may be needed to ensure that the topsoil returns to a good condition. After stockpiling for periods of more than about six months, the topsoil characteristics will have altered so that only the surface 300 mm or so retains real topsoil characteristics, and the lower 700 mm or so starts to have characteristics more like subsoil.

In many site rehabilitation cases it is difficult to establish the right drainage regime for the soil. Sometimes it may be necessary to alter the compaction or the drainage system to achieve

this. Compaction can be reduced by ripping or ploughing the soil, or increased by running machines over it. Frequently the problem lies in the discontinuity between a relatively loose replaced topsoil and the hard substrate below, which does not have the same physical characteristics of naturally occurring subsoil, or the same physical continuity with the topsoil. Therefore the surface conditions and drainage network in a re-engineered site may need to be quite different from what was there before disturbance.

Compost or manufactured organic soil amendments can be added to topsoil to increase its organic content and assist in rebuilding soil micro-organism populations. Undecomposed organic materials such as wood bark or fibre, grass hay or grain straw should not be mixed into topsoil unless nitrogen fertiliser is included (organic material uses nitrogen to break down and decompose the fibres). Compost derived from livestock or green urban waste (cut brush) is far superior to non-composted manure or wood fibre.

Some borrow areas may be utilised to introduce improved agricultural methods with members of the local communities. If this is done, an agreement may be made to take the area under the control of the livelihoods restoration component of the Resettlement Action Plan before rehabilitation is complete.

#### **D.2.6.8 Revegetation of Topsoil**

All topsoil surfaces must be revegetated as soon as there is enough moisture at the start of the rainy season to allow plant growth. In many cases, the seeds and residual plant parts in the topsoil will grow, giving the initiation of natural revegetation. However, some areas of topsoil require special treatment. These include, but may not be limited to, the following.

- Alongside drains.
- Alongside roads.
- On slopes above water courses.
- On steep slopes.
- Around the crest of cut slopes.

In these locations, intensive revegetation measures are essential. The appropriate supervising consultant representative will make a specific instruction as to the extent of revegetation on

site, but as a general rule, at least four lines of planted grasses are required on all peripheries of topsoil stockpiles and rehabilitated borrow areas.

The use of hydro-seeding or other mechanical applications of seeds or plants is not permitted. This is because abundant native species of grass are available locally, and their planting by hand is an excellent way to increase local employment opportunities. The main revegetation technique is therefore the use of planted grass slips (see appropriate guideline). Other revegetation techniques that may be required are as follows.

- Brush layers, made of hardwood cuttings of certain shrubs or small trees. These can be used to create stronger, more substantial barriers to erosion where run-off tends to be concentrated. This technique is described in a separate guideline below.
- Tree or shrub seedling planting. Plants raised from seed in a nursery are planted on to a site to start the process of restoration of the forest vegetation community. This technique is described in a separate guideline below.

#### **D.2.7 Constructing and Maintaining Earth Access Tracks**

Earth tracks shall be aligned to follow the best possible route. Wherever feasible, they shall avoid steep slopes and swamps. The amount of cut and fill shall be minimised.

The adequate provision of culverts shall be ensured, both for capacity and frequency, and scour protection shall be provided as necessary. Catch pits shall be used to capture sediment at pipe culvert inlets and turnouts. The routine emptying of the catch pit sumps shall be included in the maintenance schedule.

Soil conservation measures shall be provided as appropriate, including grassed and vegetated cut and fill slopes, grassed longitudinal road drains, check dams in drains for shallow gradients, and concrete or masonry lined drains for steep gradients.

The creation of flattening gradients along roadside drains shall be avoided. A reduction in gradient causes sediment to settle and block the drain: this particularly applies in dips approaching an outfall to a watercourse because the gradient of the vertical alignment of the road flattens here. As far as it is possible ditches shall be formed with a constant or increasing gradient moving downstream.

Silt traps shall be used where required on drainage outfalls.

When carrying out machine maintenance, particularly when a grader is used, it must be ensured that vegetated drains are left intact, and silt is removed from the drains using an appropriate ditching machine or by hand.

Graders and dozers must not be used to push waste material on to surrounding land (windrow). This material shall be recycled on to the track or disposed of at a suitable waste dump.

Routine environmental monitoring shall be undertaken of the water quality downstream of all earth tracks.

## **D.2.8 Selection of Revegetation Techniques for Erosion Prevention**

### **D.2.8.1 Selection of Technique**

Revegetation techniques should normally be used to cover bare soil slopes, to begin the process of restoring the natural habitat, to control soil erosion or to stabilise or prevent shallow landslips (i.e. where the depth to the sliding surface is shallow, up to 0.5 m).

The table below summarises the best available techniques for different situations.

Location	Technique	Advantages	Disadvantages
Cut slope in soil	Grass planting in lines, using rooted slips.	Rapid and complete surface cover.	Requires a soil slope without too many stones. Slow to establish on hard cut slopes.
Road edge or shoulder in soil			
Fill slopes and backfill above walls	Brush layers using hardwood cuttings from trees or shrubs.	Instant physical barrier that interrupts runoff. Stronger than grass. Often successful on stony debris.	Can only be installed on slopes of 1V:1.25H or less, on unconsolidated materials.
Small erosion gullies or small seasonal stream channels			
Other bare areas	Tree planting using potted seedlings from a nursery.	Allows a long term forest mix of trees to be restored.	Takes a long time to establish a complete cover. Seedlings are vulnerable to grazing for a few years.



## 657 D.2.8.2 Materials for Revegetation

Grass slips are small sections of a grass plant, made by splitting up a large clump. The stems are cut down to a height of 100 to 200 mm and the roots cut back to 40 to 80 mm. There should be 2 or 3 stems per slip



Hardwood cuttings are taken from the branches of certain types of small trees. They are cut to be between 450 and 600 mm long, and the diameter should be between 20 and 40 mm in diameter. Shoots and leaves are trimmed off.

It is very important that plant materials for revegetation works are kept cool and damp when they are being moved and prepared.



## 658 D.2.9 Revegetation Using Planted Grasses

659 **Function.** Grass slips (rooted cuttings), rooted stem cuttings or clumps grown from seed are  
660 planted in lines on the slope. This form of revegetation uses large clump grasses.

661 Grasses planted in contour or horizontal lines protect the slope with their roots and, by  
662 providing a surface cover, reduce the speed of runoff and catch debris, thereby armouring it.

663 Grasses planted in diagonal lines protect the slope with their roots and by providing a surface  
664 cover, while at the same time helping to drain surface water. They have limited functions of  
665 catching debris and draining surface water. The main engineering functions are to armour  
666 and reinforce the soil surface, with secondary functions to catch debris and drain moisture.  
667 This technique offers the best compromise of the grass line planting systems in many  
668 situations.

669 **Sites.** Almost any slope less than 50°.

670 Contour or horizontal lines are used on all slopes less than 35°. Also on steep (35° to 50°) dry  
671 sites, where moisture needs to be conserved. They are most widely used on well-drained  
672 materials where increased infiltration is unlikely to cause problems. On cultivated slopes,

horizontal lines of grass planted at intervals across a field can be used to avoid loss of soil and to help conserve moisture, as a standard soil conservation measure.

Diagonal lines are used on poorly drained materials on steep slopes (35° to 50°) where an increase in infiltration can lead to liquefaction of the soil. It is also useful on damp sites, where moisture needs to be shed.

**Timing.** Planting work should only be done in the wet season. The slope should be moist when the planting is done. If it does not rain within 24 hours of the work being done, water the plants every day until it does rain. On small sites this may be done by hand but on large sites it will require a water truck and spray cannon.

**Spacing of plants.** Line spacing depends largely on the steepness of the slope.

- Within rows: plants at 100-mm centres.
- Row spacings: rows at 500-mm centres for diagonal lines;
- For contour lines:
  - slope < 30°: 1,000 mm;
  - slope 30-45°: 500 mm;
  - slope > 45°: 300 mm.

**Materials.** Grass slips are small sections of a grass plant, made by splitting up a large clump. The stems are cut down to a height of 100 to 200 mm and the roots cut back to 40 to 80 mm. There should be 2 or 3 stems per slip. The clumps must be obtained locally (i.e. from similar terrain within 15 km of the planting site) where their loss will not cause soil erosion to start. The source location should have similar environmental characteristics (altitude and soil particularly) to the destination site. The material must be between 6 and 18 months old. Grass clumps must be dug up and brought to site on the same day that the slips are made and planted, and kept cool and moist.

**Construction.** Prepare the site well in advance of planting. Slopes should be trimmed to an even grade. Trimming should achieve a slope that meets the appropriate design for the material. If there is no design, it should be cut or finished with a straight profile, without undulations that give over-steep portions that are steeper than the grade appropriate for the material.

After slope trimming, remove all debris and either remove or fill in surface irregularities so that there is nowhere for erosion to start. If the site is on backfill material, it should be thoroughly compacted, preferably when moist.

Always start grass planting at the top of the slope and work downwards.

Mark out the lines with string, using a tape measure and spirit level. Make sure the lines run exactly as required by the specification.

Split the grass plants out to give the maximum planting material. Trim off long roots and cut the shoots off at about 100-mm above ground level. Wrap the plants in damp hessian to keep them moist until they are planted.

With a planting bar (typically a 500-mm section of re-bar with a flattened end), make a hole just big enough for the roots. Place the grass into the hole, taking care not to tangle the roots or have them curved back to the surface. Fill the soil in around them, firming it gently with your fingers. Take care to avoid leaving an air pocket by the roots.

If it looks dry and there is no prospect of rain for a day or two, consider watering the plants by hand.

**Example illustration.** Grass slips are planted in lines across the slope. The best results usually come from lines that are at 45° to the maximum slope. Start from the top and work downwards.

Mark out the lines on the slope and then plant the grass slips to the original depth and gently firm the soil back around them.



## D.2.10 Revegetation Using Hardwood Cuttings (Brush Layers)

**Function.** Woody (or hardwood) cuttings are laid in lines across the slope, usually following the contour. Brush layers protect and reinforce a slope in weak soil. They catch debris and provide a strong and low-cost barrier to erosion, especially on debris slopes, however loose.

**Sites.** This technique can be used on a wide range of sites up to about 45°. It is particularly effective on debris sites, fill slopes and high embankments.

**Timing.** Planting work should only be done in the wet season. The slope should be moist when the planting is done. If it does not rain within 24 hours of the work being done, water the plants by hand every day until it does rain.

**Spacing.** Spacing between brush layers depends on the steepness of the slope. The following spaces should be used.

- Slope less than 30° 2-m interval;
- Slope 30 to 45° 1-m interval.

Within the brush layers, cuttings should be at 50 mm centres, in the double layer described below.

**Materials.** Cuttings made from woody material of shrubs or trees that coppice well. They must be obtained locally (i.e. within 3 km of the planting site). The material must be between 6 and 18 months old. Cuttings shall be 20 to 40 mm in diameter and 450 to 600 mm long. When taking the cuttings, cut the top at right angles to the stem and the bottom at 45° to make it clear as to which way they should be inserted. Cuttings must be taken the same day that they are to be planted, and kept cool and moist.

**Construction.** Prepare the site well in advance of planting. Slopes should be trimmed to an even grade. Trimming should achieve a slope that meets the appropriate design for the material. If there is no design, it should be cut or finished with a straight profile, without undulations that give over-steep portions that are steeper than the grade appropriate for the material.

After slope trimming, remove all debris and either remove or fill in surface irregularities so that there is nowhere for erosion to start. If the site is on backfill material, it should be thoroughly compacted, preferably when moist.

Using string, mark the lines to be planted, starting 500 mm from the base of the slope.

Always install brush layers from the bottom of the slope, and work upwards. Form a small terrace, with a 20% fall back into the slope. The terrace should be 400 mm wide. If you are brush layering a gravel-filled road embankment you should lay a 50-mm thick layer of soil along this terrace to improve rooting conditions.

- 751 Lay the first layer of cuttings along the terrace, with a 50-mm interval between the cuttings.  
752 Leave at least one bud and up to 1/3 of the cuttings sticking beyond the terrace edge and the  
753 rest inside. The branch growing tips should point towards the outside of the terrace.  
754 Lay a 20 mm-thick layer of soil in between the cuttings to provide a loose cushion.  
755 Lay a second layer of cuttings on top of this, staggered with the first layer. On a gravel-filled  
756 embankment slope lay an 80-mm layer of soil over the cuttings before you do any backfilling.  
757 Partly backfill the terrace with the excavated materials. This should not be more than 50 mm  
758 thick.  
759 Mark a line 1 metre above the first brush layer and set the string for the next layer.  
760 Repeat the process. As the next terrace is cut, always fill the lower bench with the material  
761 excavated from above and compact it reasonably well by gentle foot pressure.  
762 Good site supervision is essential to ensure that lines run along the contours and do not  
763 concentrate runoff; also to make sure that cuttings are not allowed to dry in the sun. Well-  
764 buried cuttings have a higher survival rate.

Example illustration. Mark out horizontal lines every 2 metres down the slope. Start from the bottom and work upwards. Dig shallow trenches along the lines, 350 to 450 mm wide.

Lay the cuttings across the trenches with the bottom inwards and 80 to 100 mm of the top protruding from the slope. The cuttings should be 50 mm apart. Place a small amount of soil over the cuttings and then lay another line of cuttings. Replace all the soil and firm it down gently.



## 765 D.2.11 Revegetation Using Shrub and Tree Seedlings

766 **Function.** Shrubs or trees are planted at regular intervals on a bare area of soil. As they grow,  
767 they create a dense network of roots in the soil, helping to reinforce it against erosion or mass  
768 failure. It helps to re-establish a vegetation cover on disturbed areas.

769 **Sites.** This method can be used without adverse effects on almost any slope up to 30°. With  
770 care, it can be used on slopes between 30° and 45°. It can be used on any material and site other  
771 than bare rock.

**Timing.** Planting work should only be done in the wet season. The slope should be moist when the planting is done. If it does not rain within 24 hours of the work being done, water the plants by hand every day until it does rain.

**Spacing.** The spacing of plants is important. The main considerations are cost and the speed with which a full cover is required. In typical forestry sites, a spacing of 2 × 1 metres is normal, requiring 2,500 plants per hectare. However, in revegetation sites a spacing of 1 × 1 metre is usually necessary, requiring 10,000 plants per hectare. Plants should be planted in off-set rows unless a different pattern is needed for specific erosion control or landscaping effects.

**Construction.** Prepare the site well in advance of planting. Remove all debris and remove or fill surface irregularities. If the site is on backfill material, thoroughly compact it, preferably when it is moist. Cut all weeds.

If possible, dig pits for the shrubs or trees in advance of the planting programme, but refill them the same day. Pits should be 300-mm deep and 300-mm in diameter if this is possible without causing excessive damage to the slope.

When the ground is wet enough to support reasonable growth, plant out good quality seedlings from a nursery. The bigger the hole made, the better it is for the plant; but there must be a compromise between helping the plant and avoiding excessive disturbance to the slope.

Carefully remove the pot. If it is a polythene bag, do this by slicing it down the side with a razor blade. Take care not to cut the roots.

Plant the seedling in the pit, filling the soil carefully around the cylinder of roots and soil from the pot. Ensure there are no cavities. Firm the soil all around the seedling with gentle foot pressure.

If available, mix a few handfuls of well-rotted compost with the soil around the roots when you are backfilling the hole. Remove any weeds around the plant. Add mulch around the seedling, but with a slight gap so that it does not touch the stem.

Main advantages. Planting shrubs and trees reinforces and restores a slope by establishing a community of larger plants.

Main limitations. Seedlings take about 5 years (or more) to provide a canopy, produce useful materials or contribute significantly to slope strengthening. Care and protection are required in the first three years.

## **D.2.12 Management of Waste**

### **D.2.12.1 Waste Management in General**

The principles of pollution prevention includes the following key messages.

- Everyone should minimise waste production to save money and resources.
- A review of the options for minimising waste will usually help to find ways to save money on raw materials and waste disposal costs.
- Reuse your waste or buy in products that can be reused many times – it will save money in the long term.
- Recycle as much waste as possible.

A waste management strategy is to be managed on the principles of reduction, recovery, recycle and reuse. Recycling and waste reduction campaigns shall be conducted whenever there is evidence of unnecessary waste generation.

A distinction will be made between waste materials that have a potential commercial value – which shall be classed as assets – and those with no value – which shall be considered non-assets.

Waste materials shall be collected and segregated at the source. Care shall be taken to avoid spills during storage and handling. Workers must use appropriate personal protective equipment when handling all forms of waste.

Full records shall be maintained of the types and quantities of waste generation, storage, transfers and disposals.

Landfill sites should be selected with care and the location and details approved by the Environmental Protection Agency. They should be in areas that are not prone to slippage, cannot leach to surface water and groundwater, and are a suitable distance (at least 400 metres) from settlement. They should be located down gradient of any water supply boreholes. The base of a landfill site should be lined with an impermeable membrane and

seepage water piped to a sewage treatment plant. As it is filled, the site should be progressively compacted and buried with soil. Always ensure that landfill sites are in secure compounds.

#### **D.2.12.2 Waste Materials that are Assets**

**Topsoil.** Waste topsoil generation should be minimised by disturbing the soil only where it is necessary to do so. Topsoil is to be removed carefully, by scraping it off in thin layers. It will be stored in shallow stockpiles, which must not be compacted. Stockpiles shall be planted with grass to prevent erosion and maintain soil quality. Once the work has been completed, the topsoil must be returned to rehabilitated areas.

Under no circumstances shall topsoil be sent to spoil tips, allowed to erode or be contaminated with other substances. Traffic must not be allowed to run on topsoil, causing it to become compacted, either in its natural state or in stockpiles. Topsoil is the source of almost all food, and its protection means the protection of life itself.

**Scrap metals.** Metallic objects and components should be re-used as far as it is practicable and safe to do so. Scrap items shall be segregated and kept in safe, dry locations, such as shipping containers. Aluminum items, especially used drink cans, shall be crushed to reduce storage volume. Once accumulated, batches of scrap metals shall be sold to an authorised dealer.

**Used commercial and industrial machines (vehicles, trucks, generators etc.).** Wastage should be reduced by using machines for their full design life, and repairing rather than replacing them. Once defunct, they should be stripped of re-usable parts and stored securely, in a bunded and covered area. Machines shall be decommissioned thoroughly, all fuel and lubricants removed, moving parts degreased and components with valuable materials such as copper and lead removed for separate disposal as described above. Remaining usable scrap shall then be sold as an asset, as described above.

Under no circumstances shall machines be placed into landfill sites, allowed to be stolen by informal scrappers or sold to unauthorised companies, uncertified small enterprises or individuals who might re-use their components without proper disposal of unwanted parts.

**Used oil drums.** Used oil drums shall be stored securely, in a bunded and covered storage area. They shall be recycled for waste oil or other appropriate uses. They are not to be sold to



unauthorised companies or uncertified small enterprises. If they need to be cleaned, they shall be washed in an area with a full oil separator drainage system.

#### **D.2.12.3 Non-asset Waste**

**Vegetation.** The cutting of vegetation shall be minimised by only cutting plants or plant parts that are in the way of approved activities. This means plants that are in the direct area required for access tracks, quarry areas or other purposes. Vegetation shall be cut into small pieces and stacked beside the working area to decompose slowly. It shall not be burnt, either standing or cut.

Plantation trees and agricultural plants shall not be cut without following the procedures given in the Resettlement Action Plan.

**Spoil (overburden).** Damage to land and wasted energy shall be minimised by removing spoil only where it is essential to do so. Spoil shall be placed only in designated and approved spoil tip sites, which must be prepared in advance. Preparation shall include the installation of drainage blankets and slope toe retaining walls as necessary to ensure permanent stability. Spoil shall be placed in shallow layers, not more than 2 metres in thickness, compacted and shaped as they are developed. Erosion protection shall be provided as necessary to ensure that there is no sediment washed into water courses; this will usually be done using planted grasses. The water regime and stability of spoil tips shall be monitored and action taken as required to resolving any problems that are identified. Spoil tips will be kept away from watercourses and seasonal drainage channels unless adequate through-flow has been provided. The use of any spoil tip will be discontinued when the designated area has been used up.

**Contaminated soils.** The contamination of soil will be avoided by adhering to the hazardous materials storage and handling guidelines. Any soil that has become contaminated will be excavated and removed to a level and secure area, surrounded by an earth bund. The contaminated soil shall be treated fully using an approved bioremediation agent. The area affected will be fully rehabilitated, either using appropriate topsoil from a stockpile, or by replacing the remediated soil as soon as it has been decontaminated. This process will be used in every case where there has been any spill of hydrocarbons or other chemicals. Under no circumstances will contaminated soils be dumped untreated.

**Used lubricants.** Waste from excessive used oils shall be reduced by using lubricants for their full design life. Used lubricants shall be stored securely, in strong, leak-proof drums in either a double-walled container or in a bunded and covered storage area. Spill kits will be maintained ready and serviceable in all storage and handling areas, and carried in transporting vehicles. Used oil may be sold to large rubber factories for use in the boilers, or to disposal companies with valid certification from the Environmental Protection Agency. Under no circumstances may any form of used lubricant be poured away, either into the soil or into water, or sold to chain saw operators.

**Oily water from workshops and fueling stations.** Industrial oil-water separators shall be installed as part of the drainage system at every mechanical workshop and every fueling station. Drainage shall be arranged such that all spillages and rainwater drain through the separator. All separators shall be maintained according to the manufacturer's instructions.

**Used grease.** Waste from excessive used grease shall be reduced by using it for its full design life. Used grease shall be stored securely, in strong, leak-proof drums in a bunded and covered storage area. Grease shall be incinerated at a high temperature in a proper industrial incinerator.

**Used engine filters (fuel and oil filters).** Waste from excessive used filters shall be reduced by using them for their full design life, and if possible ensuring this is reached by appropriate cleaning. Used filters shall be stored securely, in strong, leak-proof drums in a bunded and covered storage area. Used filters may be sold to disposal companies with valid certification from the Environmental Protection Agency. Alternatively, filters may be crushed to remove residual fuel or oil, and incinerated at a high temperature in a proper industrial incinerator.

**Used hazardous containers (paint tins, pesticide containers, etc).** Used containers shall be stored securely, in strong, leak-proof drums in a bunded and covered storage area. Used paint tins and pesticide containers shall be crushed as far as possible and sent to an approved landfill site. Under no circumstances shall containers or any parts of them be sold to unauthorised companies or uncertified small enterprises. Containers must not be washed in open water courses or areas that do not drain to a proper sewage treatment plant.

**Used tyres.** Wastage shall be reduced by using tyres for their full design life (usually until the tread is less than 1.2 mm for road vehicles). Used tyres shall be stored securely, in a recognised

storage area. They may be sold to companies that will recycle them for non-road uses. Where there is doubt about the future use of tyres, they should be slashed before sale to make them useless for road vehicles. Tyres should also not be sold to people who will use them for quarrying, since this involves air pollution from low temperature burning. Tyres may also be chipped and sent to approved companies that can burn them in furnaces at high temperatures or sent to an approved landfill site.

**Used batteries (12-volt lead-acid and gel-filled batteries).** Where possible, batteries should be purchased under a buy-back policy from the suppliers to avoid the storage and handling of waste batteries. Wastage should be minimised by using batteries for their full design life, servicing and recharging them where feasible. Used batteries shall be stored securely, in strong, leak-proof containers in a bunded and covered storage area. Batteries containing lead shall be sold for recycling by companies with valid certification from the Environmental Protection Agency. Under no circumstances shall batteries be sold to unauthorised companies, uncertified small enterprises or individuals who might re-use their components without proper disposal of acid or other unwanted parts.

**Used personal protective equipment (PPE).** Wastage should be reduced by using PPE for its full design life. Used PPE should be stored securely, in strong, leak-proof containers in a bunded and covered storage area. PPE shall be sorted into chemically contaminated (e.g. overalls and gloves stained with creosote from handling rail ties) and non-contaminated items. Chemically contaminated PPE shall be incinerated at high temperature in an industrial incinerator or, if this is not possible, in a purpose-dug pit. Residues shall be placed into an approved landfill site. Non-contaminated PPE shall be placed into an approved landfill site.

**Used workshop clothing and rags (i.e. oily waste).** Wastage should be reduced by using clothing and rags for as long as it is safe to do so. Oily waste should be stored securely, in strong, leak-proof containers in a bunded and covered storage area. It shall be incinerated at high temperature in an industrial incinerator or, if this is not possible, in a purpose-dug pit. Residues shall be placed into an approved landfill site.

**Household waste.** Awareness programmes shall be undertaken to encourage waste minimisation. The use of throw-away plastic bags shall be discouraged inside the concession. Households shall be given the necessary waste bins to segregate their waste into aluminium

(e.g. foil and drink cans), steel (e.g. food tins), glass, plastics, cardboard, compostable and other waste. The segregated waste shall be collected for disposal as follows.

- Aluminium, steel, glass, plastics and cardboard shall be sold for recycling by companies with valid certification from the Environmental Protection Agency.
- Compostable waste shall be composted and, once fully decomposed and sterile, spread to land as fertiliser or mulch.
- The remaining waste shall be sent to an approved landfill.

**Food waste.** Wastage shall be minimised by ensuring that canteens do not over-cook. Canteen staff shall be encouraged to use uneaten food for themselves and their families if it is still safe. Arrangements shall be made for farmers of domesticated animals to collect food waste for feeding to their stock. Any unused vegetable material shall be composted and unused animal products sent to an approved landfill site. All food waste shall be stored and transported in containers that are proof against dogs, crows and rodents.

**Clinic waste.** All biomedical waste shall be stored in appropriate sealed containers. Wastes shall be segregated in the hospital or clinic into different categories, in the appropriate colour bins; it is important to ensure staff involved in the handling of waste are equipped with appropriate PPE. Biomedical waste shall be incinerated at a temperature of 800 to 1600°C in an approved specialist incinerator. Incinerator ash and residues shall be placed into an approved landfill site. Only appropriately trained staff shall handle hospital wastes and operate incinerators.

**Used Domestic Machines (refrigerators, air conditioners, washing machines etc.) and IT Equipment (computers, printers, UPS etc.).** Wastage shall be reduced by using machines for their full design life, and repairing rather than replacing them. Used machines shall be stored securely, in a bunded and covered storage area. Re-usable parts should be stripped out for repairing other equipment. Machines shall be sold for recycling by companies with valid certification from the Environmental Protection Agency. Under no circumstances shall machines be sold to unauthorised companies, uncertified small enterprises or individuals who might re-use their components without proper disposal of unwanted parts.

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#### **D.2.12.4 Recording Hazardous Waste Management and Disposal**

Workshops, operational departments and contractors are required to record the accumulation, storage and transfer of potentially hazardous waste (including materials that may be used for environmentally unsound purposes after transfer). This shall include, but not necessarily be limited to, the following:

- Used commercial and industrial machines (vehicles, trucks, generators, etc.);
- Used lubricants;
- Oily water of any kind;
- Used engine filters (fuel and oil filters);
- Used hazardous containers (paint tins, pesticide containers, etc.);
- Used tyres;
- Used batteries (12-volt lead-acid and gel-filled batteries); and
- Hospital waste (biomedical and clinical).

The unit generating the waste must keep a Waste Materials Record Book. This must contain as a minimum, full records of the following:

- Weekly or monthly estimate of the quantities of each type of hazardous waste;
- The location of storage and any special storage measures employed;
- Each disposal of waste, including the type, quantity, date and location of each transfer;
- The destination of all disposed waste, including the details of any waste management contractor, the method of transport and the point of transfer of responsibility;
- Where a waste contractor is involved, a copy or details of the contractor's Environmental Permit for waste handling and disposal; and
- Any accident or loss involving hazardous or potentially hazardous waste materials.

Waste Materials Record Books may be inspected at any time as part of environmental audits.

#### **D.2.13 Storage, Dispensing and Disposal of Hazardous Materials**

The contractor shall take full responsibility for the use and effects of any hazardous materials that are required for operations that are part of the project. The contractor is further responsible for complying with the supervising consultant's policies and procedures as may

from time to time be communicated, and will ensure that all aspects of the spill clean-up plan are followed in the event of a spill (see appropriate guideline).

All materials that are potentially hazardous to the environment must be stored or disposed of in accordance with this guideline. Hazardous materials include, but are not limited to, substances such as fuels, lubricants, preservatives, herbicides, pesticides, explosives, cement, lime, slurry clays, bentonite, catalysts or other chemicals, in solid or liquid form, or sewage and foul waste water.

Approval by the supervising consultant for the use, storage and disposal of hazardous materials shall not reduce the contractor's responsibility to prevent all leaks and spillages, nor his liability to remedy the damages which may be caused should such incidents occur.

**Prevention:** Every effort will be made to prevent spills and leaks of any kind. All hazardous materials will be stored in appropriate ways, in line with international safety practices. All operators and supervisors will be trained in appropriate inspection procedures and checks. All problems detected during inspection must be passed on to the relevant superior officer. Appropriate repairs will be made immediately.

**Storage:** Hazardous materials shall be stored at least 400 metres from the sea, a water course, spring, swamp, drain or well, and at least 400 metres from a dwelling. Storage areas shall have barriers and impervious surfaces preventing leakages of spilt material outside the storage area or into the underlying soils. They shall be protected from rainfall and secure against intrusion by people other than the contractor's personnel.

**Fuelling operations:** Fuel tanks will be bunded: i.e. there must be secondary containment for the full capacity of the tank in the event of a leak from the tank. A trained attendant will always be in control of fuelling nozzles during refuelling operations. Designated fuelling areas will be bunded (diked) and lined to capture any unexpected releases of fuel. Oil and lubricant dispensing drums will have spill containment trays and liners, or both, to catch and contain material.

**Disposal:** All used oils, lubricants, solvents, and filters will be recycled whenever possible. Where excess quantities of a hazardous material need to be disposed of, then the contractor shall prepare a disposal plan and seek the approval of the supervising consultant before

implementing it. In general, hazardous solids that need to be disposed shall be buried in a location proposed by the contractor and approved by the supervising consultant. Disposal sites must be situated at least 400 metres from any dwelling and at least 400 metres from a water body or water course. They should not be on cultivated land. Wherever possible, they should be on a permeable but not sandy soil. Holes shall be a minimum of 2 metres deep when first excavated and all materials must be buried under at least 1 metre of soil.

**Sewage disposal:** Sewage and foul waste water shall be disposed into a covered underground septic tank. If this is a permanent feature, then it shall have an underground soakaway so that water does not seep on to the surface. All parts of the system shall be at least 100 metres from a water body or water course. The contractor shall present his plans for such facilities to the supervising consultant for approval prior to their implementation.

**Fuel contamination of water:** Where there is a significant risk of water becoming contaminated with any form of fuel, such as in port areas, then appropriate containment equipment (e.g. floating bunds or barriers, absorbent pads etc.) will be kept in readiness at fuel dispensing areas to assist in cleaning up any spills that may occur.

**Cleaning up spills:** In the event of a spill or release of any material, the spill will be stopped and the incident reported to the nearest representative of the supervising consultant. The substance will then be cleaned up immediately, disposed of in an approved manner and the contaminated environment cleaned to the satisfaction of the supervising consultant. A separate guideline covers this in detail.

#### **D.2.14 Cleaning-up of Pollution by Hazardous Materials**

This guideline covers the action to be taken in the event of the leakage or spillage of any environmentally hazardous material, such as fuel, oil, chemicals of any kind, or drilling slurry, into either a water course or standing water body, or into soil. It contains the minimum details that must be included in spill clean-up plans of all contractors to the supervising consultant, and any Sub-contractors that may be engaged by the contractors. Before bringing any hazardous materials to the site, the contractor must prepare a spill clean-up plan in accordance with this guideline and gain the approval of the supervising consultant.

The purpose of a spill clean-up plan is to provide guidelines to prevent environmental contamination, and the procedures to be followed should hazardous materials enter the environment. It applies to all working areas of the project.

The contractor must prepare on-site spill clean-up plans for all hazardous materials to be used on the site. This is a regulatory requirement of the Government of Liberia, and the minimum details that must be in the plan are as follows: (a) how incidents will be contained and controlled so as to minimise the effects and to limit danger to persons, the environment and property; (b) how the necessary measures will be implemented to protect people and the environment; (c) a description of the actions that will be taken to control the conditions and to limit their consequences, including a description of the safety equipment and resources available; and (d) arrangements for training staff in the duties they will be expected to perform. The emergency plan shall be simple and straightforward.

The following principles must apply in the plan: (a) the source of the leak or spill must be stopped immediately it is discovered; (b) the alarm must be raised throughout the site; (c) work on the site must be stopped and all available resources directed into resolving the problem; (d) emergency measures must be taken to contain all remaining material; (e) where appropriate, measures must be taken to neutralise hazardous substances; (e) the supervising consultant representative shall be informed immediately; and (f) site-specific and material-specific details will be given for the disposal of contaminated soil and water, and mitigation of the damage caused.

The contractor shall ensure that all site supervision staff are aware of the plan and capable of implementing it. In the event of a leak or spillage, the contractor shall bear all liability whether the plan is implemented or not.

Spill response procedure: Every spill clean-up plan must contain, as a minimum, details of the following emergency procedures:

The person who discovers any spill must notify fellow workers and inform the supervisor that a spill has occurred. If anyone is injured or in danger, they must be rescued if it is safe to do so, and appropriate rescue and medical assistance called if required. All site staff must be informed if there is a risk of fire or explosion, or of a collapse of infrastructure, and in these cases all unnecessary personnel must be evacuated to a safe location.



All staff will react promptly to all spills, no matter how insignificant they may appear. Whatever resources are available will be diverted immediately to assist in resolving the spill. The supervising consultant's representative will both be notified immediately if any spill or release occurs, however small. As much information as possible should be provided about the spill location, type of material, approximate quantity, and extent of damage. The area surrounding the spill will be secured and contained to minimise additional contamination, for example by building an earth bund or the deployment of floating bunds. Emergency containment should be started as soon as possible. This will give time for a full pollution-control strategy to be designed, agreed and implemented.

## **D.2.15 Prevention of Pollution from Refuelling Facilities**

### **D.2.15.1 General**

Oil is the most common water pollutant, with the potential to harm watercourses and groundwater. In addition, certain fuels, such as petrol, are highly flammable and are tightly regulated for safety reasons. This guidance is applicable to all refueling facilities and should be consulted regardless of the type of facility.

### **D.2.15.2 Types of Drainage System**

Clean water. All clean, uncontaminated rainwater should be channeled to:

- a surface water drainage system;
- a combined drainage system downstream of the oil separator;
- directly to a local watercourse or soak-away.

This includes roof water and uncontaminated drainage from those areas of the site where vehicles are not stored, repaired, refueled or washed. Such discharges may require prior permission from the EPA or the local sewer provider.

Contaminated water. The entire area where fuel is delivered, stored and dispensed should be isolated from the surface water drainage system, open ground or other porous surfaces. This can be achieved using drainage grids, gullies or kerbs in conjunction with surfaces impermeable to the products used. Potentially contaminated water and spills should be directed through an oil separator and prevented from seeping into the soil and groundwater

below the site. The separator should be of an adequate size to serve the surface area catchment of the site.

Sustainable drainage systems. The use of sustainable drainage systems (SUDS) should be considered. SUDS such as constructed wetlands or reed beds may offer an environmentally sound alternative to traditional methods of treating drainage effluent. Wetland or equivalent technology can be used for a variety of wastewater treatment purposes at refueling facilities. It may also be suitable as a replacement for on-site separators for oily water run-off, provided the system is compatible with local groundwater conditions. Wetlands systems can offer an acceptable level of environmental protection provided they are properly designed, installed and maintained. In some situations, they may provide better environmental protection than conventional drainage systems.

Washing activities. All washing and cleaning operations, including the washing of all vehicles or plant, should be carried out in a designated area clearly marked on the ground and in any plans. The cleaning area should be isolated from both the surface water drainage system and unmade ground or porous surfaces (e.g. using drainage grids, gullies or kerbs). Wash water should be re-circulated whenever possible. Otherwise it should drain to, or be disposed of, via the foul sewer (where available).

Cleaning agents such as detergents (including biodegradable ones) should never be allowed to enter the surface water system or to soak into groundwater unless specifically permitted after appropriate treatment. They should not enter oil separators because they reduce their effectiveness (the oil will be dispersed and washed through).

Training in dealing with emergencies. Staff should be trained to deal with an environmental incident. Set up a system of written training records and make these available for inspection. Training should include a background to environmental sensitivities around the site and a formal emergency procedure that details actions to be taken in the event of:

- a spillage;
- a fire;
- a collision with equipment;
- odours being detected off-site;
- a suspected leak being identified.

Make this procedure available on-site in case an emergency arises.

Waste management. To avoid pollution, all waste (including separator waste and oil spill adsorbent materials) must be handled, stored and disposed of correctly. Waste producers and holders must ensure that waste:

- does not escape from their control;
- is passed only to a registered waste carrier for recycling or disposal at a suitably licensed facility;
- is accompanied by a transfer note with a full written description of the waste.

#### **D.2.15.3 Fuel Tank Bund Rain Water Discharge Procedure**

Diesel fuel is a hazardous substance which can cause extensive pollution to soil and water. Fuel tanks must be bunded to ensure that if a tank leaks, the fuel does not escape into the environment. However, if the bunded area is not roofed, rain water will accumulate in the bund. This needs to be drained out under controlled conditions.

The supervisor is responsible for ensuring that no leaked fuel within the bund is allowed to get out of the bund. Should there be an accidental spill or leakage, then the supervisor is responsible for ensuring that it is cleaned up immediately and the matter reported to his manager. In any event, the fuel must be cleaned before any water is drained from the bund.

The following procedure shall be followed.

1. The supervisor shall be present throughout the process of draining the bund.
2. The valve on the bund outlet must be kept closed at all times except when it is being drained.
3. At a designated time on each working day, the supervisor must inspect the bund and assess: (a) whether there has been any spillage or leakage of water from any tank; and (b) whether any rain water has accumulated and needs to be drained off.
4. If any fuel has leaked, then the cause of the leak must be investigated immediately and the leak stopped if possible. This might be done using a tank repair compound such as "Plug Pattie", which is contained in the re-fueling station's fuel and oil spill kit. After this it must be reported to the manager. The leaked fuel must then be mopped up using appropriate pads from the spill kit. Once used, these must be placed in the

polythene bags provided in the spill kit and disposed of correctly.

5. If there is water in the bund that appears uncontaminated with fuel, it may be drained off. This is done by opening the valve at the outlet, and allowing the water to flow out through the filter or water-oil separator. The supervisor must watch this process carefully, and must ensure that the flow from the valve is adjusted so that it does not flood the filter. Normally the filter will not cope with the full flow from a valve opened completely.

6. Once the bund has been drained, the valve must be screwed shut again.

7. All other staff, including security guards, are to be instructed that it is forbidden for them to drain water from the bund except when the supervisor is present.

#### **D.2.15.4 Re-fuelling Spill Prevention Procedure**

Diesel fuel is a hazardous substance which can cause extensive pollution to soil and water. It is also a valuable asset.

The supervisor is responsible for ensuring that no fuel is spilt. Should there be an accidental spill, then the supervisor is responsible for ensuring that it is cleaned up immediately and the matter reported to his manager.

Only a trained pump operator may use a fuel pump. Drivers are not permitted to do this.

The following procedure shall be followed.

1. The hard standing in front of the fuel pump must be kept clean at all times. It must be swept at least once per working day.
2. Vehicles must be positioned on the hard standing, with the fuel filling location between 1 and 2 metres from the pump.
3. The fuel filler cap must be removed from the vehicle before the hose is taken from the pump.
4. When moving the hose from the pump, the nozzle must be kept upright at all times.
5. The nozzle is to be inserted carefully into the vehicle filler pipe, and pushed in as far as it will go.
6. Only when the nozzle is fully inserted may the pump be started.
7. While filling the vehicle, the pump operator must watch the nozzle and reduce the pump speed if there is any splashing from the filler pipe.

8. If the nozzle does not have an automatic shut-off valve, the filling must be done slowly and the filler pipe watched carefully to ensure that the pump is stopped well before the tank overflows.
9. Once filling is complete, the pump must be switched off before the nozzle is moved.
10. The nozzle must be removed slowly and carefully, and held in an upright position as it is moved back to its cradle on the pump. The hose must then be stowed neatly beside the pump.
11. The filler cap is then to be replaced on the vehicle, and screwed down firmly.
12. If any fuel has been spilt, it must be mopped up immediately using appropriate pads from the re-fueling station's fuel and oil spill kit. Once used, these must be placed in the polythene bags provided in the spill kit and disposed of correctly.

## **D.2.16 Pollution Prevention in Vehicle and Plant Workshops**

### **D.2.16.1 Introduction**

Workshops and service centres carry out a number of operations and processes that have the potential to damage the environment. These include the cleaning of vehicles, the storage, use and disposal of polluting liquids such as oils, paints, solvents, coolant additives, brake fluids and solid waste such as oil filters, exhaust systems, batteries and tyres. Unless the site drainage is correct, waste is properly managed and spillage control procedures are in place, environmental harm could occur.

### **D.2.16.2 Vehicle and Plant Maintenance Areas**

Internal gullies or grids must not drain to the surface water system. If the workshop pit is subject to water infiltration, and is served by a gully and pump, then this should be directed to the foul sewer. Areas where maintenance or dismantling activities are carried out must have an impermeable surface and a raised edge with drainage to a sealed sump or via an oil separator to the foul sewer.

Disposal of waste liquids. Used liquids, such as lubricating oil, hydraulic fluid, coolant and solvents from degreasing activities, must not be disposed of into surface water systems. They should be collected in a suitably bunded tank. This oil can be taken for use in the furnaces of rubber factories until such time as Liberia has recycling facilities.

Batteries. Batteries containing acid should be stored intact and upright in an acid resistant bunded compound or purpose built bin. Both the lead and the plastic cases can be recycled, so they should be collected for sale to an authorised contractor. Storage can be minimised by the use of one-for-one exchange schemes, whereby old batteries are collected when new ones are delivered.

Tyres and other discarded dry parts. Tyres must never be burnt on site. They can be treated as a dry material for storage, but if burnt, release compounds that are extremely polluting. Tyres should be disposed of by a suitably licensed tyre incinerating or recycling company.

Oil filters and other oil contaminated components. There are certified contractors for used oil filters, and so these should be stored. Alternatively, discarded oil filters can be crushed on site and the oil and metal recovered. Intact or crushed filters and other oil contaminated parts such as engines, gearboxes and axles should be stored either in a sealed container or within an impermeable bunded area, preferably roofed to prevent the entry of rain.

Other wastes. Skips should have a designated use and be clearly marked to indicate what materials they may be used for. Material stored in skips should be drained or dry and the skips covered to prevent the entry of rainwater and kept watertight to prevent leakage. If any contaminated liquid does accumulate, it should be removed and suitably disposed of. Note that scrap metal is a potential asset.

#### **D.2.16.3 Oil, Fuel and Chemical Storage**

Above ground storage tanks. All oil storage tanks and drums, including waste oil, must be sited on an impermeable base within an oil-tight bund wall. Any fill and draw pipes, valves and sight gauges should be enclosed within its curtilage and tank vent pipes should be directed downwards into the bund, so that in the event of overfilling the discharge is contained. Bunds should be examined on a regular basis and any rainfall that accumulates removed by bailing or by pumping under a manually controlled system. This water may be contaminated and should be disposed of with care.

Internal storage tanks should also be bunded as above and, if served by a remote fill point, the drainage from the area should pass through a suitably sized oil separator. A high level alarm, which provides an additional safeguard against overfilling, is recommended for all storage tanks.

Underground storage tanks. Underground tanks and pipelines are susceptible to damage and corrosion, and above ground facilities are preferred. In areas of high groundwater vulnerability, the EPA may object to the installation of underground storage tanks. Where underground storage is necessary, a number of protective measures, such as double skinned tanks and piping, and leak detection, may be required. Regular inspection, stock reconciliation and pressure testing are essential, especially where groundwater pollution could occur. The location of underground piping should be identified and clearly marked in order to avoid damage through excessive surface loading.

Chemical storage. Chemicals such as detergents, degreasers, solvents and hydraulic fluids should be securely stored with storage vessels labelled to show their contents and should be kept as close to the point of use and as far from surface water drains as possible.

Refueling facilities. These are covered by a separate guideline. The risk of pollution from refueling areas is especially high. Such areas should be isolated from general yard drainage, (for example by using a raised kerb or roll-over bund). Particular care should be taken in the cleaning of such areas.

#### **D.2.16.4 Degreasing and Cleaning**

The cleaning and degreasing of vehicles and components must be carried out in a designated wash-bay and not on unmade ground or in areas which discharge to surface water drains, watercourses or soak-away. A wash water recycling system will reduce water use and associated costs. The wash-bay should be impermeable and isolated from the surrounding area by a raised kerb or roll-over bund, with the effluent directed to foul sewer. Particular care should be taken when using hydrocarbons such as paraffin and white spirit as degreasers, as these substances are toxic to river life. In no circumstances should these substances be discharged to surface water drains.

### **D.2.17 Sanitation and Sewage Disposal**

#### **D.2.17.1 Pit Latrines**

Where temporary toilets are required on site, earth pit latrines are the preferred option. These shall consist of a simple pit with a well-ventilated shelter over the top.

Pit latrines shall be sited in locations that meet the following criteria:

- 
- 1295       • Within the right of way of the road.
- 1296       • At least 50 metres from a water course or water body of any description.
- 1297       • At least 100 metres from a drinking water source. This shall be determined by asking
- 1298       members of local communities to show their sources of drinking water before siting a
- 1299       latrine.
- 1300       • At least 50 metres from a house.
- 1301       • Where neither surface nor ground water is likely to collect in the pit.
- 1302   Holes should be around 1.5 metres deep, and certainly not less than 1 metre, and
- 1303   approximately 1 metre in diameter. They shall be completely enclosed by a sound wooden
- 1304   platform over the top, apart from:
- 1305       • A small hinged cover that allows use of the latrine but can be closed when not in use;
- 1306       and
- 1307       • A vertical vent pipe at least 2 metres long, with mosquito mesh over the top, made of
- 1308       bamboo or plastic.
- 1309   A short burst (10 seconds) of disinfectant or insecticide should be sprayed, or a small amount
- 1310   of lime thrown into the latrine every 2 to 3 days, to stop mosquitoes from breeding in water
- 1311   collected in the pit.
- 1312   The latrine shall be moved to a new location if it becomes unpleasant to use due to excessive
- 1313   smell, becomes full, or a month of use time elapses. When this is done, the pit must be carefully
- 1314   backfilled and the soil compacted. The ground surface over and around the pit shall be
- 1315   regraded and made good, and if necessary revegetated.
- 1316   **D.2.17.2   Septic Tanks**
- 1317   Outlying housing areas and camps should use appropriately-sized septic tank systems, with
- 1318   the liquids drawn off into an underground soakaway (see below). For temporary purposes,
- 1319   liquids from septic tanks may be drawn off by tanker and discharged into a sewage treatment
- 1320   plant.
- 1321   The following guidelines are to be followed to provide for the underground soaking away of
- 1322   liquids emanating from septic tanks.



- Select an area for the soakaway that is at least 50 metres down gradient, at least 250 metres laterally and at least 500 metres up gradient of any boreholes or water supplies.
- Excavate a trench for the underground soakaway (2 metres deep by 1.5 metres wide by 50 metres long).
- Line the large trench for the soakaway with permeable geotextile.
- Place a layer of clean stone of 50 to 100 mm size to 100 mm that is 600 mm thick throughout the trench.
- Lay a UPVC pipe of 150 mm diameter perforated with at least 100 holes of 8 mm diameter per metre of pipe. The upper end shall be connected to the outlet from the septic tank and the lower end shall be covered over with permeable geotextile.
- Fill the trench with clean stone of 50 to 100 mm size to 1 metre below ground level.
- Place a sheet of permeable geotextile over the stone and then backfill the trench to ground level with 1 metre thickness of soil. This shall be lightly compacted by running an excavator track over the backfilled trench.

Other designs and sizes are permitted if supported by appropriate civil engineering calculations and design.

#### **D.2.17.3 Soakaway for “Grey” Water Only**

“Grey” water is used water derived from kitchens, showers, laundries and other washing areas, but not from toilets. It should normally be sent to a sewage treatment plant or septic tank. If no sewerage system is available or the soil has low permeability (making it difficult to dispose of large volumes of water in a soakaway), then a reed bed system may be used.

A reed bed system uses a minimum of three and preferably five separate ponds in series, for the biological treatment of water. Water should be resident in the system for at least 7 days. This usually requires 3 m<sup>2</sup> of reed bed surface area per person using the system, with an outlet pipe height of 0.5 metre.

When the pond series is constructed, local swamp reeds should be transplanted into the ponds. During use, it must be ensured that the reeds are healthy and growing vigorously. If the reeds are dead, the system must be stopped until new reeds have been established.

Discharge from the final pond may go into an open water course. Samples should be tested regularly for bacterial quality if there is a water supply known to exist downstream.

#### **D.2.17.4 Chemical Toilets**

The use of chemical toilets is strongly discouraged. They may only be used at project sites where it is proven that neither a standard water closet and septic tank system, nor a pit latrine, are practical. There are two main risks involved in chemical toilets: (a) damage to soils, plants, animals and water from the chemicals used in the toilets; and (b) health dangers to people in the vicinity from the sewage being disposed.

Waste from chemical toilets shall not be poured into a foul drain leading into a sewage treatment plant that relies on biological aerobic digestion, since the bacteria would be killed by the discharge from chemical toilets; and this would ruin the treatment process. Chemical toilets should also not be discharged into septic tanks, since the chemical used in toilets can have an adverse effect on the sewage digestion process in this situation as well.

A disposal hole must be excavated to receive waste from chemical toilets. A suitable hole must be situated at least 100 metres from any dwelling and at least 100 metres from a water course, spring or well. Wherever possible, it should be on a permeable but not sandy soil. Holes shall be two metres deep when first excavated.

When full or nearly full, chemical toilets shall be transported to the approved emptying point for careful disposal under proper supervision. Once emptied, the toilet shall be sluiced down with plenty of water. The toilet receptacle shall also be well washed out with water and disinfectant, all of which shall also be discharged into the disposal hole.

Each time a toilet is emptied into the hole, the waste shall be covered with 100 mm of soil. When the hole has only 0.5 metre of depth remaining, it shall be completely filled and a new hole started.

#### **D.2.18 Use of Explosives in Quarries**

##### **D.2.18.1 Legislative Background**

The Minerals and Mining Act (2000) makes the following provisions, which must be complied with under all circumstances.

“The conditions for the import, export, manufacture, storage, handling, purchase, sale and use of explosives shall be as strictly prescribed by the laws of Liberia.” [Section 16.11]

“All Quarry operators shall apply to the Ministry of State for Presidential Affairs, or to such other agency of Government as required by the laws of Liberia, for permission to import, export, buy, sell, manufacture, store handle, purchase, use, dispose of or otherwise deal in or with explosives.” [Section 16.12]

#### **D.2.18.2 Meanings of Terms**

In this guideline, the following meanings shall apply.

(a) “Operator” in relation to a site where blasting is taking place means the person in overall control of the working of the quarry.

(b) “Shot” means a single shot or a series of shots fired as part of one blast.

(c) “Shotfirer” means a person appointed to be responsible for shotfiring operations.

(d) “Shotfiring operations” include:

(i) checking to ensure that the blasting specification is still appropriate for the site conditions at the time the blasting is to take place;

(ii) mixing explosives;

(iii) priming a cartridge;

(iv) charging and stemming a shothole;

(v) linking or connecting a round of shots;

(vi) withdrawal and sheltering of persons;

(vii) inspecting and testing a shotfiring circuit;

(viii) firing a shot; and

(ix) checking for misfires.

#### **D.2.18.3 Transport and Storage of Explosives**

Explosives shall be transported in escorted convoys, in accordance with all prevailing transport and safety rules.

Explosives shall be stored in locked shipping containers in a secure compound sealed from the rest of the quarry site, and with permanent guards to ensure no unauthorised access.

Separate containers shall be used for different components (detonators, fuses, charges etc.) and shall be placed at least 10 metres apart with earthen bunds in between.

#### **D.2.18.4 Clearance of the Site and Safety Zone**

- a. The contractor shall not permit any blasting to take place without a 500-metre safety zone cleared around the site. This zone shall be cleared of people, structures and all other infrastructure.
- b. Warning notices shall be posted around the site, giving at least 24 hours warning of a blast.
- c. The Operator shall notify the CLO in good time to allow deployment of its staff at least one week before a blast or series of blasts, to prepare communities for the blasting and to notify them of the times of blast(s). The signalling system shall also be explained.
- d. A siren shall be sounded 30 minutes, 10 minutes, 5 minutes and 1 minute before a blast takes place. The siren shall be loud enough to be heard clearly throughout the site and safety zone. This shall include persons operating machines or required to use ear protection.
- e. Where farms occur within the 500-metre safety zone, patrols shall be sent out to ensure they are cleared of people in good time. The warning signal sequence for the blast shall not be started until the patrols have reported that the farms are clear to the best of their knowledge and that they themselves are in places of safety.
- f. Where a footpath runs into the safety zone, guards shall be posted at least one hour before the blast to prevent people from entering the safety zone.
- g. The site is to be cleared of personnel as soon as the first warning siren is sounded.

#### **D.2.18.5 Operator's Duties**

- (a) The operator shall:
- (i) ensure, so far as is reasonably practicable, that all explosives are stored, transported and used safely and securely;
  - (ii) appoint one or more competent individuals to organise and supervise all work involving the use of explosives ("the Explosives Supervisor");
  - (iii) ensure that at no time is there more than one person acting as the Explosives Supervisor at the site; and

(iv) keep a copy of the written statement of duties of the person or persons appointed under paragraph (a)(ii) for at least twelve months after the date on which the appointment ceased to have effect.

(b) It shall be the duty of the operator to ensure that:

(i) there are suitable and sufficient written rules and procedures for:

- shotfiring operations;
- appointing shotfirers and storekeepers;
- authorising other persons who will be involved with the storage, transport or use of explosives;
- dealing with misfires; and
- ensuring, so far as is reasonably practicable, that such rules and procedures are complied with;

(ii) an adequate written specification (whether produced by or for the operator) is prepared for each shotfiring operation to ensure, so far as is reasonably practicable, that when such firing occurs it will not give rise to danger; and

(iii) a copy of the specification referred to in sub-paragraph (b) is given to any person upon whom it imposes duties.

(c) The operator shall ensure that operations involving the storage, transport or use of explosives are carried out by

- (i) a duly authorised and competent person; or
- (ii) a trainee under the close supervision of a duly authorised and competent person.

(d) The operator shall ensure that:

- (i) such facilities and equipment as are necessary to enable shotfiring operations to be carried out safely are provided;
- (ii) any vehicle which is provided for use in relation to shotfiring operations is so marked as to be readily identifiable from a distance;
- (iii) detonators are stored in separate containers from other explosives; and
- (iv) explosives are kept at all times either in a locked explosives store or under the constant supervision of a suitable person.

(e) The operator shall ensure, so far as is reasonably practicable, that each shotfiring operation is carried out safely and in accordance with the rules required to be made in pursuance of

paragraph (b)(i) and any specification required to be prepared in pursuance of paragraph (b)(ii).

#### **D.2.18.6 Supervision of Shotfiring and Records of Appointment**

(a) The operator shall take all reasonable steps to ensure that:

- (i) a trainee shotfirer does not fire shots and is not required to fire shots, except when he is under the close personal supervision of a shotfirer, until the operator is satisfied that he has completed a suitable period of training and has appropriate practical experience; and
- (ii) all shotfiring operations are carried out under the close personal supervision of the shotfirer.

(b) The operator shall ensure that a record of the appointment of any shotfirer or trainee shotfirer is kept at a suitable place until three years after that shotfirer's employment or trainee shotfirer's employment ends.

#### **D.2.18.7 Shotfirer's Duties**

Before a shot is fired, a shotfirer shall:

- (i) check that the procedure has been followed for clearing the site and the 500-metre safety zone;
- (ii) check the shotfiring system or circuit to ensure that it has been connected correctly;
- (iii) where electrical detonators are used, ensure that they have been correctly connected to the shotfiring system or circuit and that the shotfiring system or circuit is tested with an instrument suitable for the purpose from a position of safety;
- (iv) where appropriate, ensure that the electrical integrity of the shotfiring system or circuit is such as to make a misfire unlikely; and
- (v) ensure that the shot is fired from a safe place.

#### **D.2.18.8 Misfires**

In the event of a misfire the operator shall ensure, so far as is reasonably practicable, that:

- (i) apart from himself, no person other than the Explosives Supervisor, shotfirer, trainee shotfirer or any other person authorised by him enters the danger area until a period of five minutes has elapsed since the misfire and any shotfiring apparatus has been disconnected from the shot;

- (ii) appropriate steps are taken to determine the cause of and to deal with the misfire;
- (iii) a suitable record is kept of the misfire for at least three years; and
- (iv) appropriate steps are taken to prevent theft of the explosives and detonators or their initiation by an unauthorised person.

#### **D.2.18.9 Use of ANFO**

Where an ANFO (ammonium nitrate / fuel oil) mixture is used, special precautions shall be taken to ensure that there is no pollution. Both of the ingredients can be extremely damaging if they are leached into water courses. For this reason, the following precautions shall be taken when ANFO is used as an explosive.

- (a) Ammonium nitrate shall be stored in sealed bags in a dry location.
- (b) Fuel oil shall be stored and transported as per the fuel guidelines.
- (c) Mixing of ANFO shall be done in such a way that there is no spillage or contamination of the ground. Should any spillage occur, then the spilt material shall be cleaned immediately and all contaminated soil shall be removed for remediation.
- (d) The filling and blasting of holes shall be done in the same day to avoid the leaching of ANFO into the water table and polluting of groundwater.

#### **D.2.18.10 Prohibited Activities**

- (a) A person other than a person appointed by the Ministry of Lands, Mines and Energy as an Explosives Inspector, a person engaged in the transport of explosives to or from the work site, a shotfirer, a trainee shotfirer, a person authorised to handle explosives at a work site or a person appointed to be in charge of the explosives store shall not handle explosives.
- (b) A person shall not bring any substance or article (other than explosives) likely to cause an unintended explosion or fire within ten metres of any explosives or take any naked flame within ten metres of any explosives.
- (c) A person shall not forcibly remove any detonator lead or other system for initiating shots from a shothole after the shothole has been charged and primed.
- (d) A person shall not charge or fire a shot:

- 
- 1523 (i) unless there is sufficient visibility to ensure that work preparatory to shotfiring, the  
1524 shotfiring operation and any site inspection after the shot is fired can be carried out safely;  
1525 (ii) in a shothole which has previously been fired, unless he is dealing with a misfire; or  
1526 (iii) in any tunnel or other excavation (not being merely a shothole) in the face or side of  
1527 the quarry wall for the purpose of extracting rock.
- 1528 (e) A person shall not fire a shot:
- 1529 (i) unless he is a shotfirer or trainee shotfirer; and  
1530 (ii) other than by means of a suitable exploder, and the purpose of these guidelines, a  
1531 safety fuse shall not be deemed to be a suitable exploder.
- 1532 (f) No person shall be in possession of a mobile telephone when:
- 1533 (i) within 50 metres of a charged blast hole;  
1534 (ii) inside an explosive storage compound; or  
1535 (iii) on a vehicle transporting detonators.



1536 **D.2.19 Warning of Blasting at Quarries**

1537 Blasting causes considerable concerns locally and can damage the structures of poorly-built  
1538 houses nearby. The obligatory procedure given below is to be followed for this activity.

**Obligatory Procedure for Blasting at Quarries**

1. Never blast on Sundays, national public holidays, nor at night (6 pm to 7 am).
2. Blasting shall be announced at least 60 hours in advance and the timing agreed with the Community Liaison Officer.
3. The blasting warning news shall be broadcast on local radio for a minimum of two days in advance: this shall be done in all local languages as well as English and on at least two radio stations.
4. Communities shall be fully informed of the blast at least 48 hours in advance. To achieve this, workers shall be sent out to carry the blasting notices to all the villages and farms within 2 km from the quarry, to inform the precise time of the blasting operation. The workers shall post the notices on specially appointed notice boards at prominent locations at the nearby villages, the quarry access road and other approaches to the area. The notices shall explain the siren signals (1 hour, 15 minutes and 5 minutes before, and all-clear afterwards) and the grievance redress mechanism.
5. The workers shall also discuss the significance of the blast with the Village Chief or other community representative.
6. The day before any blasting, the Quarry Manager and the Community Liaison Officer shall visit all households judged to be close enough to the 500-metre fly rock exclusion zone as to require warning of evacuation.
7. On the day of any blasting, additional security shall be deployed around the quarry, and patrols made to enforce the exclusion of people from the 500-metre safety zone.
8. The Blast Operator will sound a loud double siren (15 seconds each with a 15-second gap) 1 hour, 15 minutes and 5 minutes before the blasting shots are fired.
9. Workers equipped with radios for communication shall be sent in all directions from the blasting area to enforce the clearance within the 500-metre fly rock danger zone 1 hour in advance, and keep watching every path leading to the blasting area until the blasting has finished.
10. The Blast Operator shall separately ensure that all workers and security guards are removed to an approved safe location before the blast.
11. At the last minute, the Blast Operator shall confirm the safety one more time through the radios, and then does the blasting.
12. After the blast, the Blast Operator shall check that all shots have fired and that the site is now safe. The all-clear shall then be sounded (a single siren of 30 seconds).
13. After the all-clear has sounded, the Community Liaison Team is sent to the villages to do the investigation for any possible damage.
14. A grievance process including a guidance form for all complaints shall be established, and a reporting mechanism to reach resolution.
15. In the event of a postponement for any reason, the all-clear shall be sounded. The Quarry Manager shall arrange a new time of blasting, which shall be not less than 48 hours ahead. The affected communities shall be informed of the reasons for postponement and updates provided every 24 hours until the blast takes place.

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## **D.2.20 Community Consultation**

This guideline provides the procedure for the ways in which communities of affected persons including project near neighbours, that must be followed to ensure compliance with UNDP policy, Liberian law, current socially acceptable practice in Liberia as well as international best-practice. It provides a brief overview of the project's approach to all forms of community Consultation by the Project Management Unit, its officers, contractors and Sub-Contractors.

UNDP Social safeguards require adequate, effective and recorded consultation and information exchanges with community stakeholders interested in the project. The PMU is required to have a Stakeholder Engagement Plan which contains plans for managing and recording contacts with communities, grievances and a plan for regular community consultation and information over the project life.

Each organisation must have a Safeguards Officer to manage the community and stakeholder engagement process. Each organisation may employ a Community Liaison Officer to undertake this activity, in smaller organisations the CLO may also have the safeguarding responsibilities. The Safeguard Officer / Community Liaison Officer must have experience in community consultation in slum communities in Liberia. Safeguard Officers and CLOs of Contracting bodies must be aware of and use the same processes to organise and record/report community interactions as set out in the PMU Stakeholder Engagement Plan.

### **D.2.20.1 Principles**

Communities have the right to clear, timely information about project activities which will affect their community in some way. Relations between project components and communities are most positive when there is a Stakeholder Engagement Plan defining actions and process.

### **D.2.20.2 Scope**

This guideline is to assist all project actors to undertake community consultation. It applies to all aspects of work by Contractors and Sub-Contractors in relation to the project.

### **D.2.20.3 Background**

If communities are informed about project activities in advance and are offered the opportunity to raise issues and offer suggestions to mitigate negative impacts, relationships are less tense, accommodations negotiated more easily, international and national NGO

scrutiny is easier to manage and the recording requirement allows for proof of consultation and participation.

- Communities have the right to be informed and consulted about asset acquisition and to be treated fairly and considerately.
- Information must be made available at the right times, in the right languages and media to be effective.
- All organisations must have a delegated safeguards Officer and/or Community Liaison Officer (CLO) responsible for Community interaction and a budget for community meetings, information materials, radio announcements etc.
- There must be an effective Grievance Redress Mechanism in place.
- Each organisation must take on board the need for a Safeguards Officer or CLO to front community contact whilst training all staff on community awareness and the protocols mandated for community contact.
- All community interactions must be recorded and reported weekly to the PMU and UNDP.
- The PMU will make the Stakeholder Engagement Plan available to all contractors etc. and monitor compliance on a weekly basis.

#### D.2.20.4 Procedure

Step	Action	Notes
1	Develop and share a Stakeholder Engagement Plan, grievance redress mechanism and protocols for recording community interaction.	PMU to produce copies of the plan, meeting and other forms of contact recording and reporting procedures and train other bodies to use the system.
2	Each Safeguard Officer shall inform the local authority of the start of community consultation, identify the voluntary Community Chairmen – equivalent of urban Town Chiefs- and meet the Chairmen, their Elders and local key individuals.	Personal contacts and the use of cell phones is the best way of making contact.
3	Plan how issues will be discussed over time and whether meetings with Community representatives is needed or whether an open community meeting is required at each point.	It is important to include local administration and to maintain inclusion and consultation. Contractor to provide information for and participate in all media information programmes and LCFs, as required.
4	Set up Local Consultative Fora as set out in the SEP to advise on project issues where required, e.g., for resettlement or other key issues.	The project's Community Liaison officer (CLO) to initiate and to use the standardised processes.
5	Conduct meetings and contacts using the protocols established in the SEP.	PMU to set out recording formats.
6	Report community attitudes, needs and priorities, suggestions and difficulties weekly.	Management to review weekly, maintain awareness of community issues and participate in the project management of stakeholder interests.

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## **D.2.21 Safeguarding of Local People's Livelihoods**

This guideline provides the procedure for ensuring that the mostly negative project impacts on local people's livelihoods during construction are recognised, are mitigated as soon as possible and appropriately. This guideline does not cover restoration of livelihoods caused by formal resettlement and displacement of economic activities as this is covered in the Resettlement guideline. This guideline provides a brief overview of the project's approach to all forms of impact on livelihoods by the Project, its officers, contractors and Sub-Contractors.

The affected slum communities are densely populated, physically overcrowded and are a complex interaction of people's economic activities associated with their home locations. The communities are dominated by the fishing industry – launching canoes, catching fish, repairing equipment, processing fish, marketing fish and fish products interweaved with the provision of support services, tailors, food stores, market stalls selling everything, street hawking of goods, sellers of street food in a myriad of small scale interactions dependent on proximity of manufacture or processing with the sales market. Any action by the PMU or the Contractor that competes for space in these communities or which affects employment opportunities risks increased impoverishment of the affected person, risks project reputation and increases the likelihood of negative attention by the media and politicians.

Each organisation must have a Safeguards Officer to manage community and stakeholder impacts. Each organisation may employ a Community Liaison Officer (CLO) to undertake this activity, in smaller organisations the CLO may also have the safeguarding responsibilities. The Safeguard Officer / Community Liaison Officer must have experience in community consultation in slum communities in Liberia. Safeguard Officers and CLOs of Contracting bodies must be aware of and use the same processes to organise and record/ report community impacts to the PMU Stakeholder Engagement Plan.

### **D.2.21.1 Principles**

People have the right to have the potential impact of project activities on their livelihoods considered at all stages of the project planning and design process, to have negative impacts mitigated effectively and for potential positive impacts to be promoted through project implementation.

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#### **D.2.21.2 Scope**

This guideline is to assist all project actors to undertake impact assessment and mitigation outside of the formal Resettlement Action Plan process which is the correct protocol for dealing with identifiable in advance, major, temporary or permanent economic displacement issues. This guideline applies to all aspects of daily work by Contractors and Sub-Contractors in relation to the project.

The sorts of impacts on livelihoods considered to be regulated by this guideline are:

- Loss of market stall site caused by the need to run trucks through areas used by marketers.
- Loss of canoe landing sites through ill-considered materials storage sites that force fishermen out of their beaches.
- Construction organisation which prevents access to workplaces, storage sites or processing facilities.
- Unintentional damage to income generation activities through dumping materials in certain places, spillages.
- Blocking access to shop fronts/ warehouses or go-down yards.
- Forcing changes in economic activities leading to lack of daylight to undertake income earning tasks at times available to the worker, e.g., construction schedules restricting access to areas until after dark when women have to be caring for their families and have no time to make/ process/ sell goods to gain an income.

#### **D.2.21.3 Background**

Economic survival in slum communities is always a desperate juggling of activities with low profit margins, poor understanding or analysis of opportunities for change in an insecure and potentially dangerous environment. Levels of violence are higher than in wealthier communities, attitudes to the safety of others are poor, basic survival and family care dominate daily life. Survival in these communities is heavily dependent on reciprocal assistance and support offered between households. Damaging these dependencies and interactions has a high potential for increased poverty and decreased survival. The project must therefore work hard to prevent negative impacts by clear planning, effective

communication with communities and placing real emphasis on understanding how daily activities impinge on local people.

- All organisations must have a delegated safeguards Officer and/or Community Liaison Officer (CLO) responsible for Community interaction a remit to understand the complexities of economic life around the project site.
- There must be an effective Grievance Redress Mechanism in place.
- Each organisation must review the job card protocol for each activity and conduct an appraisal of how the activity may affect local people and implement procedures to mitigate negative impacts –
  - By rescheduling deliveries to non-peak times;
  - Discussing with marketers how best not to disrupt their activities;
  - Considering the livelihood activities around each site or activity, revisit this analysis over time;
  - Discuss with communities;
  - Regularly review the work plan and discuss ways of reducing impacts; and
  - Look for positive ways of assisting local livelihoods
    - Employ youth especially as unskilled labour;
    - Purchase supplies locally from local sellers; and
    - Contribute to community initiatives.
- All actions responding to mitigating negative and enhancing positive impacts must be recorded and reported weekly to the PMU and UNDP.

#### D.2.21.4 Procedure

Step	Action	Notes
1	Develop a livelihoods impact review protocol and review weekly.	PMU to require such feedback from contractors and relate against complaints in the Grievance Redress Mechanism.
2	Each Safeguard Officer shall review the job cards and work plans weekly to identify potential negative impacts and propose alternative less damaging methods/ locations.	Review all job cards weekly, relate to Grievances received.
3	Safeguards Officer to have regular contact and feedback from communities about impacts and efforts to mitigate.	All feedback to be recorded and reported.
4	Use the Local Consultative Fora as to discuss and advise on project issues where required.	The project's Community Liaison officer (CLO) to initiate and to use the standardised processes.
5	Document positive impacts intended and delivered.	PMU to set out recording formats.

Step	Action	Notes
6	Report community attitudes and suggestions and difficulties weekly to PMU and UNDP.	Management to review weekly, maintain awareness of impacts issues.

## D.2.22 Resettlement and Relocation Guidelines

This guideline provides the procedure for the displacement of any person, property or livelihood that must be followed to ensure compliance with UNDP policy and Liberian laws, current socially acceptable practice as well as international best-practice. It provides a brief overview of the project's approach to all forms of resettlement. UNDP Policy on Involuntary Resettlement and Displacement requires a Resettlement Action Plan to ensure adequate consultation, information exchanges and adherence to due process through the planning and implementation of any resettlement to ensure that the affected persons are not disadvantaged by the relocation of their houses and displacement of their livelihoods.

The communities and households living in the project affected slums are some of the most vulnerable Monrovia residents and whose livelihood depends on living and working close to their work areas i.e. fishing beaches. Given the very low-incomes, poor access to resources to relocate and the difficulty of finding another house plot in which to live in these communities, it is imperative that the full Resettlement Action Plan process is undertaken when any relocation is required. Abiding by the RAP process protects the Contractor, the Project Implementation Consultant, the Liberia UNDP County Office from criticism and objections and complaints arising from the need to relocate very vulnerable people away from their livelihoods and communities. A formal RAP ensures that the Affected Persons are properly treated and recompensed to the point of being able to rebuild their lives to a better standard. This requirement is non-negotiable.

### D.2.22.1 Principles

Land potentially used or owned by communities cannot be accessed until ownership and use has been researched and clarified, a Resettlement Action Plan produced and full and fair compensation has been made for losses and livelihood restoration commenced. The payment and livelihood restoration must be verified by a third party organisation with resettlement verification experience.

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#### **D.2.22.2 Scope**

This guideline is to assist the Project Management Unit to hire a competent resettlement consultancy or similar body with Liberian resettlement experience to research and write a Resettlement Action Plan (RAP). The Project Management Unit can then use the RAP to negotiate for and make payment or other forms of compensation to communities and individuals for loss of land, assets, usage rights or access routes, and to design and implement mitigation measures for loss of livelihoods. It applies to all work in relation to the project.

#### **D.2.22.3 Background**

Whilst the project as a government entity has the right to use public land in its designated areas, that land is densely populated. People have legal title to parts of the area and very many communities have “squatter” customary rights to use of the land and resources in the area. Under all international agency policies on resettlement and in Liberian law:

- Squatters and displaced persons have equal right to compensation for losses at full market value to be able to rebuild to at least the same if not better standards than before and restoration of incomes.
- Communities have the right to be informed and consulted about asset acquisition and to be treated fairly and considerately.
- There must be an effective Grievance Redress Mechanism in place
- Community and household interviews are required to assess losses and impacts on livelihoods, and these take some time to undertake. The internationally recognised process for researching impacts and losses must be adhered to.

Under Liberian law, acquisition and payment of compensation can be made by the project or can be delegated to an agent, but land ownership is devolved back to the government. The procedures below are required to be followed.

A single project resettlement and compensation policy applies throughout its areas of activity, which must be defined in a Resettlement Action Plan (RAP) prepared alongside the Environmental and Social Impact Assessment.



1719 Appropriate mitigation measures i.e. house construction, livelihood programmes etc., with  
1720 income support during the changeover, need to be in place, agreed and funded by the project  
1721 before contracts can be agreed for work in areas where people are adversely affected.

1722 **D.2.22.4 Procedure for Acquisition and Occupation**

Step	Action	Notes
1	Contractor asset requirements are identified.	Produce precise map data for all activities and locations.
2	Contractor identifies the resettlement needed and writes Terms of Reference for an experienced local organisation to a research and write a Resettlement Action Plan to UNDP social safeguard standards.	An experienced local organisation is needed as they can mobilise quickly, are familiar with the Monrovia slum locations and can communicate easily with affected persons.
3	The RAP process is discussed with all relevant urban local Authorities Compensation, Government stakeholders are engaged and the compensation process discussed and agreed with County / City / Borough and Township Land Commissioner and delegates.	It is important to include local administration and to maintain inclusion and consultation.
4	The RAP consultants draw up a community consultation and information plan. Community sensitisation is undertaken to make communities aware of potential land and asset needs. A public information campaign is activated in relevant areas. Local Consultative Forums are set up.	The project's Community Liaison officer (CLO) to initiate and to use the standardised processes. Contractor to provide information for and participate in all media information programmes and LCFs, as required.
5	Community and household surveys of asset loss and livelihood sources are undertaken – the needs and rights of men and women are assessed individually within households; the needs of the elderly and disabled are also to be addressed individually.	Household interviews and community surveys to be undertaken as defined by the project's RAP. This activity must be sub-contracted to the contracted RAP consultants/NGO. Loss of assets affect men and women separately, therefore interviews at household level require multiple approaches.
6	Compensation values are negotiated through community meetings with local Community Chairmen and Elders and Affected Persons, and appropriate mitigation programmes are agreed.	Entitlement matrix is provided. Any individual negotiations outside of this which change the provisions in the matrix must be agreed with the CLO and the affected person.
7	A RAP report is drawn up and must be agreed by both the Project Management Unit, UNDP and concerned local Authorities and EPA.	The RAP report lists the procedures to be followed, the list of Aps and their losses, the entitlement to compensation or other programmes, costs and implementation methodology and partners, and monitoring and evaluation procedures.
8	Agreement through the environmental permitting process to continue with land, asset and resource acquisition.	Project to apply and inform contractor and CLO.
9	Payment of cash compensation or implementation of replacement land for land taken etc.	Payments to be made in public at open meetings and recorded in writing with signatures, and the recipient photographed with the compensation or meeting record confirming alternative compensation. Sufficient time has to be allowed for rebuilding houses, finding land etc. – the time to do this must be recompensed to the AP as undertaking this activity deprives the person of income earning opportunities.

Step	Action	Notes
10	Livelihood restoration activities are implemented.	Ongoing programmes of income and livelihood restoration are required to be in place. An NGO can be hired to undertake any such work.
11	Access to land and resources is permitted <u>only after</u> payment has been made and relocation achieved and verified by a third party.	Contracts can be let for work after all compensation is verified as paid and alternatives are in place and that new livelihoods are effective. The Project Manager must sign to certify that this has been done.
12	Monitoring of contractor activity and of compensation management etc. by local people.	At its discretion, the project may hire and deploy monitors to oversee impact mitigation and to assist CLO.

## D.2.23 Temporary Land Access Procedure

### D.2.23.1 Overview

The Project will occupy and use land for storage, labour camps, laydown areas and as work areas. Some areas will be needed for less than 6 months – others such as laydown, helipads and storage, may be taken on a voluntarily agreed long lease/rental and arranged between the Contractors and the Owners for periods longer than 6 months. If left unmitigated, such temporary access could potentially have a major adverse impact on local communities and the environment. To ensure adequate mitigation is applied, the following measures are proposed, that adhere to national regulations, UNDP's guidelines and the IFC Performance Standards.

### D.2.23.2 Minimum Requirements

The following general principles will apply to all temporary access sites throughout all project activities:

- The procedure covers all land use for less than one year;
- Homestead areas and cultural sites will be avoided to the extent feasible;
- Temporary land access will minimize the extent and duration of land requirement wherever feasible;
- Where there is more than one option, the preference will be first for barren government land, followed by fallow land. Cultivated land will be selected only as a last resort;
- If the land is cultivated, then avoid such lands where there is standing crop;
- The land footprint will include area required for access/entry; laydown areas for equipment; temporary storage needs; and the core work area. This footprint will be physically demarcated and fenced;

- Compensation for the demarcated land area will include a component of rental and replacement cost for crops or assets on the land cleared and/or damaged as agreed with the land owner. The negotiation will use the county rates for valuation of losses as agreed by the Superintendent as a minimum;
- The grievance mechanism put in place by the project will be explained to the landowner prior to any access. Any inadvertent destruction of property or impacts from site activities will be handled under this grievance mechanism;
- The Contractor will ensure that local authorities and land owners are consulted and their agreement to access the land area has been documented and the rental payment made and receipted prior to the commencement of activities; and
- The Contractor is obligated to restore the land to its pre-activity status using properly agreed rehabilitation works and standards after the completion of construction phase works whilst within the rental period.

Assets under the scope of the temporary land access process include the following:

- All assets (crops, structures and trees), which are located within the demarcated area for temporary access;
- Fences and other structures demarcating areas belonging to the plotholder will be avoided wherever possible, or otherwise will be replaced on completion of the works. Fences shall be built to demarcate the loaned area;
- Other assets (unproductive) such as boreholes, graves, sacred sites, structures etc. will be avoided and fenced off during the temporary land access delineation; and
- Other potential social impacts not resulting in actual physical damage may be managed via the Grievance Redress Mechanism. Examples include noise disturbance, traffic, labour influx, workforce behaviour, etc.

#### **D.2.23.3 Site Demarcation**

Temporary land access must meet the following siting criteria:

- No clearing of forest or residences;
- No impact to cultural sites;
- No physical displacement;
- No significant grading;

- 1776 • At least 200 m from the nearest residence (except in West Point);
- 1777 • Outside any protected area; and
- 1778 • Must have a voluntary agreement in place with property owner.

1779 The agreed/planned temporary access areas will be demarcated on site in the presence of the  
1780 land owners and/tenants, as applicable.

### 1781 **Compensation Assessment**

1782 The Contractor will:

- 1783 • Identify the specific individual and/or community groups that have rights on the  
1784 identified land parcels;
- 1785 • Determine the type of rights on the affected land parcel (e.g. ownership being different  
1786 from the actual use);
- 1787 • Identify the stakeholder group who will be eligible for receiving compensation;
- 1788 • Explain to the owners/other stakeholders the principles of temporary or long term  
1789 lease land access and the project's Grievance Redress Mechanism;
- 1790 • Identify the nature of use of the land and the specific assets to be affected due to the  
1791 construction/access activities;
- 1792 • Use rates for crops, trees and any other structures (potentially damaged) as set by the  
1793 County Superintendent, to assess compensation at replacement cost;
- 1794 • Agree on this compensation rate with the land owner/entity – this will be documented  
1795 in a separate/formal agreement and paid prior to entry to the land, and the receipt  
1796 shall be copied to the Engineer / EPA; and
- 1797 • For construction access, if the use or access of the land by the Contractor exceeds 6  
1798 months of continuous occupation, a transition allowance of 1 year will be provided  
1799 (extendable every 6 months thereafter) along with renewal of the rental agreements.

### 1800 **Access to Land**

1801 Once the temporary land access compensation evaluation has been performed, and the  
1802 agreement has been signed on the compensation amount, the Contractor will provide a clear  
1803 understanding of the timeline, start date and details of any rental agreement to be signed etc.  
1804 Prior to initiating any work, the Contractor will demarcate the area required, so as to restrict

the access to the land parcel and avoid any safety concerns for the local community. Where appropriate, signage shall be put up to inform the local community of the activities being undertaken and to restrict access to the area.

#### **Restoration**

Once the construction phase activities are complete, the Contractor will undertake the following:

- Restore the affected land parcel to its pre-activity status (i.e. refilling of top soil; and to any other state as agreed with the land owner);
- Ensure that all personnel and equipment that were in use are moved out;
- Ensure that any temporary structures have been dismantled;
- Ensure that the affected individual/community group has validated closure of the activity on the land parcel; and
- Get a written sign-off from the owner/owners.

The final compensation amount for any due rental/access amount and for any unintended damage shall then be paid and the final receipt of acknowledgement shall be taken from the landowner.

#### **D.2.23.4 Documentation and Record Keeping**

All communication and interaction with external stakeholders regarding temporary land access activities, before, during and after handover, will be clearly documented. Records will include the location, people consulted, summary of key points discussed, concerns, action items etc. Consensus and agreements reached will be documented and signed by the relevant stakeholders.

Key documents to be maintained by a Contractor seeking land access will include:

- Records of key meetings;
- Demarcated Land Compensation Form for temporary land access compensation;
- Permission for land access;
- Payment Receipt;
- Any rental agreement or contract with the land owner (if applicable); and

- 1833 • Summary notes with photographs of the site before and after access along with any  
1834 remarks.

1835 **D.2.23.5 Record Form for Key Meetings**

Date	Location	Name of Representative	Key Discussion Points	Reference to Previous Actions or Commitments	Actions for the Current Meeting	Signature

1836 **D.2.23.6 Demarcated Land Compensation Form**

Reference number of the form							
Location/Settlement/Municipality/County							
Date							
Asset owner's name/Land registration number/Identification number							
CROP			TREES			STRUCTURE	
Crop type	Area	Amount (LD)	Type of Trees	Number	Amount (LD)	Type of Structure	Amount (LD)
Actual damage (only to be completed if there has been accidental damage)							
CROP			TREES			STRUCTURE	
Crop type	Area	Amount (LD)	Type of Trees	Number	Amount (LD)	Type of Structure	Amount (LD)
Any other unintended damage:							
Total Compensation:							
Comments (if other type assets are found and photographic reference)							
<ul style="list-style-type: none"> <li>I _____ (Land user and/or asset owner), confirm that: <ul style="list-style-type: none"> <li>I own the above-detailed crops/ trees to be impacted by the _____ Project work;</li> <li>The asset inventory table completed above is accurate;</li> <li>I permit damages to the crops or trees for the duration of the required access in agreement that I will be compensated for any losses as stated; and</li> </ul> </li> </ul>							

<ul style="list-style-type: none"> <li>○ I understood and agree with the compensation and grievance processes as explained by the Contractor, in the presence of witnesses.</li> </ul>			
<ul style="list-style-type: none"> <li>• I _____ (Contractor's Land Officer) , confirm that I have explained the compensation and grievance process to the Asset Owner and have left a copy of this form with them.</li> </ul>			
<ul style="list-style-type: none"> <li>• _____ (The Contractor) confirms that: <ul style="list-style-type: none"> <li>○ Compensation will be paid for losses to assets as a result of the _____ Project work using agreed rates (reference rates applied, to match replacement cost _____)</li> <li>○ In case of a formal rental payment, a separate rental agreement will be signed;</li> <li>○ Compensation will be paid before initiation of work and will be reassessed based on unintended damage at the time of completion of activities; and</li> <li>○ The Contractor will restore the land.</li> </ul> </li> </ul>			
Signature of Contractor's Representative	Signature of Land Owner	Signature of County Superintendent's Representative	Signature of local Chief

1837 **D.2.23.7 Payment Receipt Form**

Date			
Rental Agreement Reference Number			
Total Payment before access			
Payment due			
Total Payment received			
Signature of Contractor's Representative	Signature of Land Owner	Signature of County Superintendent's Representative	Signature of local Chief

1838 **D.2.24 Employment of Young People on Site**

1839 This guideline provides the procedure for ensuring that all workers on site employed by the  
1840 Project Implementation Consultant, the Contractor or Sub-Contractor are aged 16 or over  
1841 years. The employment of Liberians is subject to a series of labour laws enacted from 1956 to  
1842 the latest in 2015, the Decent Work Act. This act specifically states that no one under the age  
1843 of 16 years may be employed; the preference is for young people to stay in school and reach  
1844 the School Leaving Certificate standard.

1845 International Agencies prohibit the employment of young people under the age of 18 on  
1846 projects. UNDP balances the need for youth employment with the preference for continuing  
1847 education and supports many youth employment initiatives. In the Monrovia Coastal  
1848 Protection Project, no young person under the age of 16 may be employed. Recruiting and

employing local youth to work on the project is an important benefit that will create community participation and so should be encouraged.

This guideline provides suggestions on the project's approach to ensuring employment of those 16 or older by the Project, its officers, contractors and Sub-Contractors.

### **Principles of Liberian Labour Law**

1. There cannot be discrimination for employment based on age, race, sex, tribal origins
2. Working hours, conditions, pay and benefits are regulated by law
3. Labour Offices are available to assist in the recruitment of workers should this be needed and can help with vetting for age and names.

The employing Contractor must:

1. Verify the name and age of the employee using the national identity card, social security and welfare registration card, voter's registration card etc. with a photograph incorporated.
2. In the absence of such a card – which can be an indicator of being under 16, the employee can be asked to produce a birth certificate and school reports from which age can be estimated.
3. Photographic identity cards are most useful as the photograph can possibly verify the identity of the applicant.
4. Employees whose ages or identity are in doubt can be referred to the Labour Office for verification

Children are not allowed on site for any reason – bringing food, selling food and drinks, playing, passing through, carrying messages. The prevention of such activity is rightly the concern of the Health and Safety requirements for working.