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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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| <b>Prepared by</b>   | Earthtime  |                            |  |
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| <b>Approved by</b>   | Wassim Hamdan  | Project Manager            | Earthtime  |
| <b>Prepared by</b>   | John Howell  | Environmental Expert       | Earthtime  |
|  | Yasmin El Helwe                                      | Environmental Consultant   | Earthtime  |
|  | Ghinwa El Tayar                                      | Environmental Consultant   | Earthtime  |
|  | Nabil El Masri                                       | Geographer and GIS Analyst | Earthtime  |
|  | Hilary Byrne   | Social Expert              | Earthtime  |
|  | Vaanii Kiazolu                                       | Social Consultant          | Earthtime  |
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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  |

---

|                 |  |
|-----------------|--|
| 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  |

---

|                |   |
|----------------|---|
| 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                                   |
| NOx            | 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)  |

---

|                 |  |
|-----------------|--|
| 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                                |

---

## 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 style="text-align: center;"><b>Exchange Rate</b></p> |
|---|

|  |
|--|
| <p style="text-align: center;">USD 1 = Liberian Dollar (LRD) 162 (March 2, 2019)</p> |
|--|

|   |
|---|
| <p style="text-align: center;">Source: <a href="http://www.oanda.com">www.oanda.com</a></p> |
|---|

---

# 1 EXECUTIVE SUMMARY

## 2 A. INTRODUCTION

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

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

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

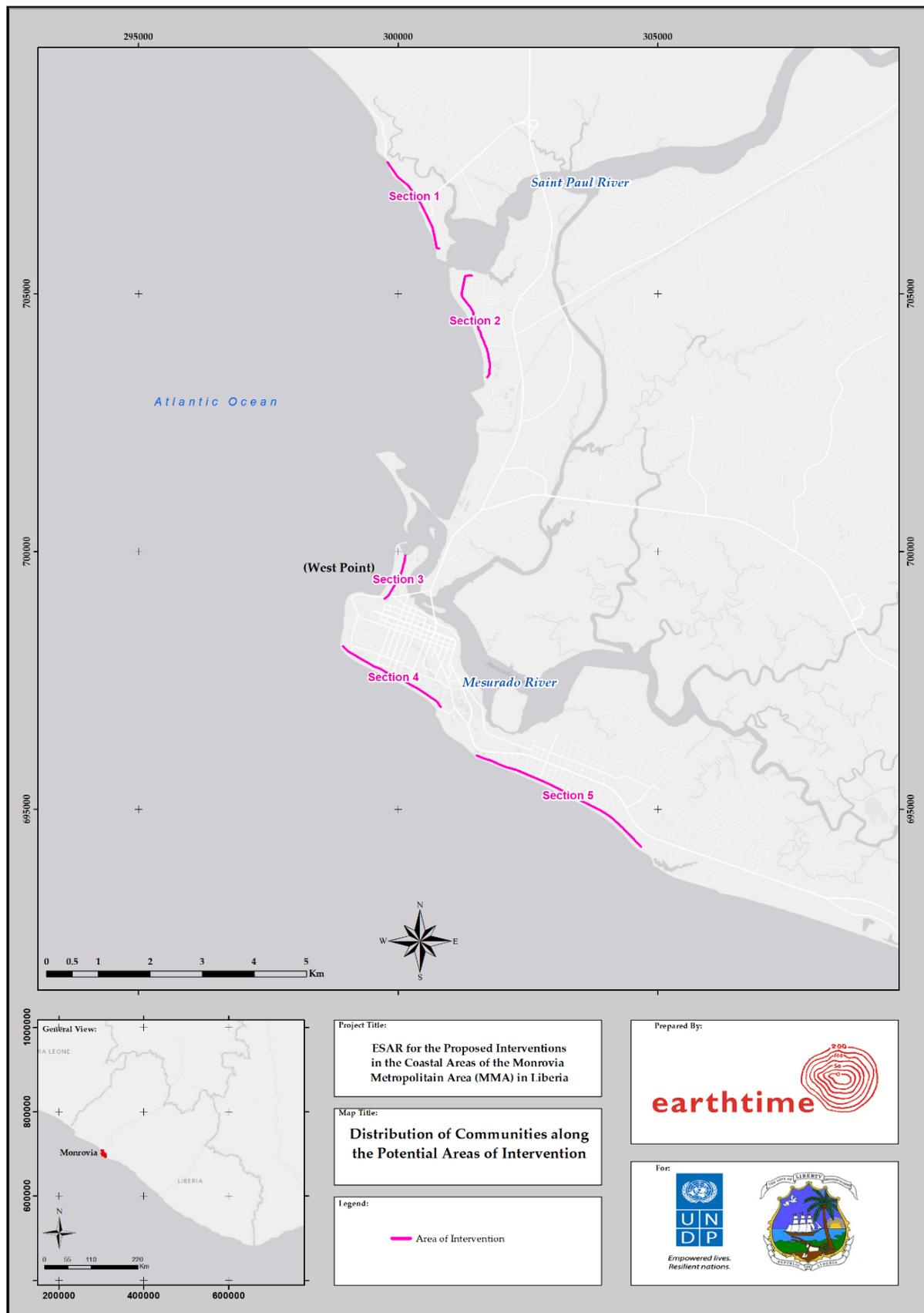
30 inshore fish and crustaceans that keep the artisanal fishery both highly productive and  
31 sustainable. Hence this strategy is central to sustaining the fishery and keeping Monrovia food  
32 secure while minimising carbon emissions – and thereby its contribution to the drivers of  
33 climate change.

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

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

## 50 **B. PROJECT DESCRIPTION**

51 The project reviewed five coastal sections in Monrovia, as shown in the figure and table below.  
52 These coastal sections represent areas that are all experiencing coastal retreat and where  
53 fishing activities are prominent, since some of their sandy beaches offer suitable locations for  
54 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

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

## 95   **C. PROJECT ALTERNATIVES**

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

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

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

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

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

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

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

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

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

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

128 The ESAR is developed and presented in a manner that meets the SESP and Stakeholder  
129 Response Mechanism (SRM) requirements and objectives. Standard 5 (Displacement and  
130 Resettlement) and Standard 6 (Indigenous Peoples) of the Social and Environmental  
131 Standards (SES) were not considered to be relevant in this context, as the resettlement of  
132 people and impacts on indigenous groups are not anticipated (although these matters need to  
133 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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## 134 E. DESCRIPTION OF THE OVERALL ENVIRONMENT

### 135 Physical Environment

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

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

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

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

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

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

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

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

## 179 **Biological Environment**

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

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

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

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

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

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

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

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

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

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

## 219 **Socio-economic Environment**

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

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

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

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

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

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

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

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

## 254 **Community Consultation**

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

263 The majority of the inhabitants of the coastal communities are squatters and tenants of  
264 squatter households. The communities have all experienced the impacts of sea flooding,  
265 which has led to damage of their canoes and homes, displacement, and loss of livelihoods.  
266 Consequently they welcome the idea of coastal protection, while having some concerns. A  
267 major concern raised regarding the project was an appeal for residents to stay where they are  
268 as relocation means loss of livelihoods, loss of beach space for recreational use, and the  
269 breaking up of communities. The communities feel that they have a right to live in these areas  
270 especially as they feel they have looked after the coastline. Another concern was fear of being  
271 forced out by wealthier people if the land was protected. On the other hand, communities  
272 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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## 300 H. PLAN FOR ENVIRONMENTAL AND SOCIAL MANAGEMENT AND MITIGATION

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

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

- 315 1. General Environmental Protection
- 316 2. Community Protection Measures, including Gender and Social Inclusion
- 317 3. Environmental Health and Safety
- 318 4. Occupational Health and Safety
- 319 5. Labour and Working Conditions
- 320 6. Water Resources Management
- 321 7. Coastal Sediment Resources Management
- 322 8. Soil and Land Resources Management
- 323 9. Dust and Air Quality Management
- 324 10. Flora and Fauna Protection
- 325 11. Archaeology and Cultural Sites Management
- 326 12. Waste Management
- 327 13. Hazardous Materials Management

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

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

335 1. Detailed ESIA Surveys

336 1.1. Marine and Estuarine Biological Survey

337 1.2. Marine and Estuarine Sediment Survey

338 1.3. Household Survey of Affected Communities

339 1.4. Fish Landing Survey (linked to 1.1 and 1.3 above)

340 2. Detailed Sub-plans

341 2.1. Contractors' Oil Spill Response Plan for land

342 2.2. Contractors' Oil Spill Response Plan for sea, including a Marine Spill Contingency  
343 Plan

344 2.3. Contractors' Emergency Response Plan

345 2.4. Contractors' Rock Quarry Management Plan, including Blasting Plan

346 2.5. Resettlement Action Plan for Affected Livelihoods

347 2.6. Grievance Redress Mechanism

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# 1 INTRODUCTION

## 2 1.1 PROJECT BASIS

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

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

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

## 42 **1.2 ENVIRONMENTAL AND SOCIAL ASSESSMENT REPORT**

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

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

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

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

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

66 a) To provide a description and review (from the environmental and social perspectives) of  
67 the proposed project interventions.

68 b) To provide an initial overview of the environment as it currently exists and will be  
69 affected by the project. We have covered all aspects of the physical, biological and socio-  
70 economic environments.

71 c) To engage with stakeholders and incorporate their views in the process.

72 d) To assess the environmental and social risks associated with the project, and ways in  
73 which they must be mitigated.

74 e) To define the screening process for individual project treatments to ensure that they  
75 comply with the requirements of the UNDP, the Green Climate Fund (GCF) and the  
76 Environmental Protection Agency (EPA) as the regulatory entity for the Government of  
77 Liberia (GoL), for which it is defined by the Environment Protection and Management  
78 Law 2003 (EPML).

79 f) To describe the process to be followed in complying with the EPML 2003 during project  
80 implementation.

81 g) To provide an overall ESMP, which includes the mitigation measures.

82 h) To set the scene for a full Environmental and Social Impact Assessment (ESIA) of project  
83 components, since it has been determined that this level of investigation is required under  
84 the EPML 2003.

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

### 97 1.3 STRUCTURE OF THE ESAR

98 The ESAR has been organized in eight chapters covering all the items required by the UNDP's  
 99 2014 Environmental Screening Procedure (SESP) and Social and Environmental Standards  
 100 (SES). The ESAR structure is summarized in Table 1-1.

101 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

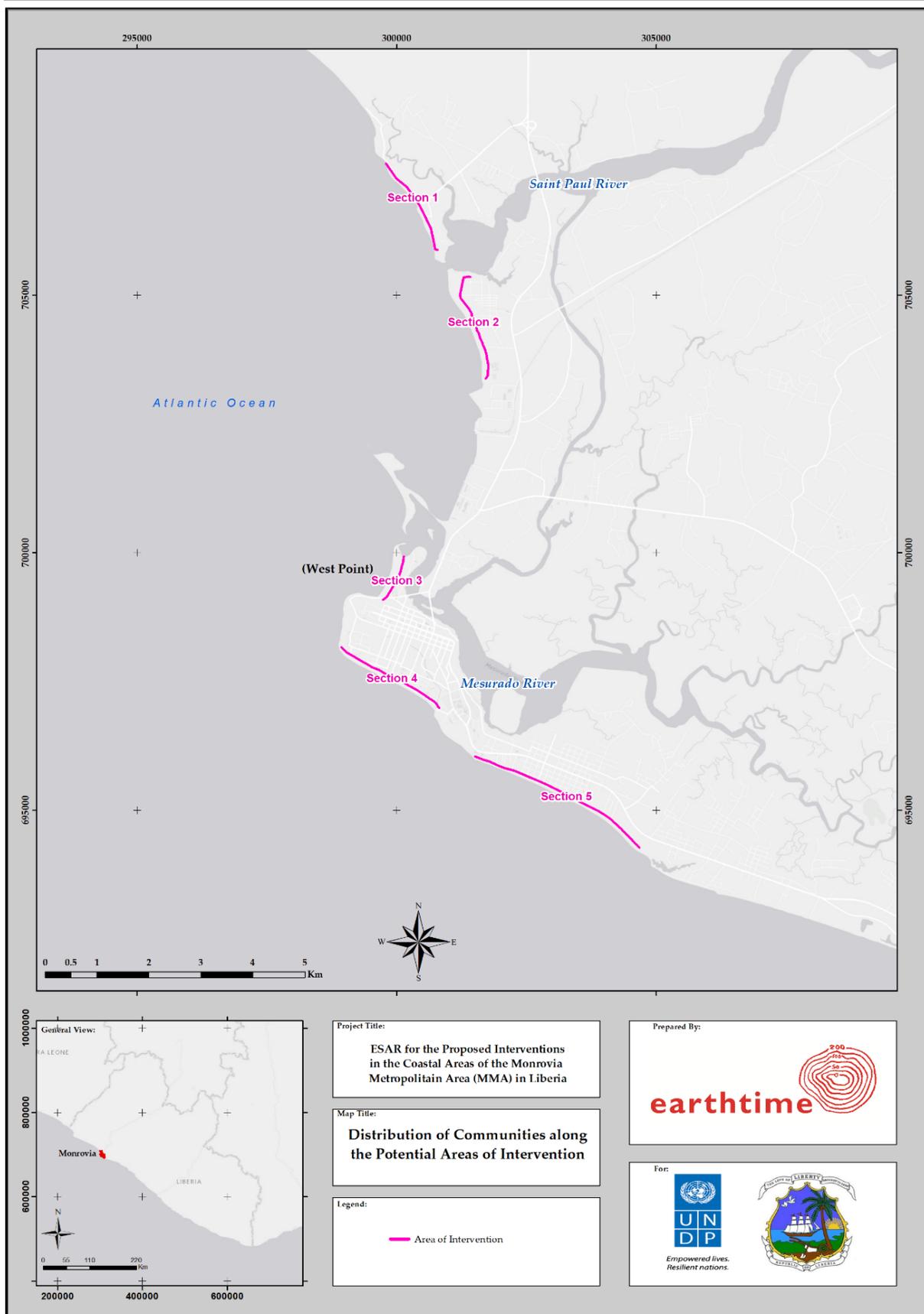
Liberia is located on the southwest corner of West Africa. Positioned on the Atlantic coastline, it lies between longitudes 7°30' and 11°30' west and latitudes 4°18' and 8°30' north and has a total surface area of 111,370 km<sup>2</sup>. Liberia is bordered by Guinea on the north, Sierra Leone on the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



25  
26 Figure 2-1 Project location map



(a)



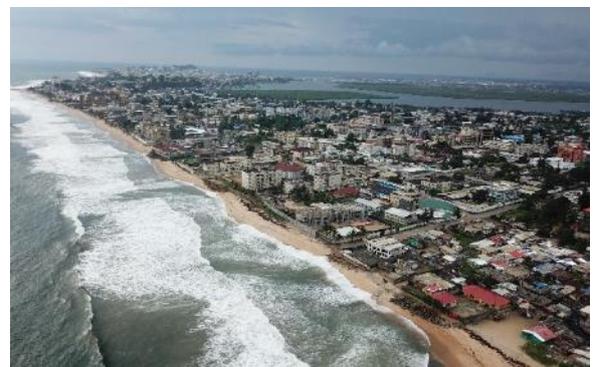
(b)



(c)



(d)



(e)

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

---

## 30 2.2 PROPOSED INTERVENTIONS

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

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

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

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

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

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

---

## 58 2.2.1 Adaptive Interventions

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

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

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

- 
- 88       • Adaptation of infrastructure:
- 89             ○ Alternative sources of construction sand; and
- 90             ○ Options for climate-resilient infrastructure in coastal areas.

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

### 95 **2.2.2 Protective Interventions**

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

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

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

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

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

- 110       • *The Rock Manual: The use of rock in hydraulic engineering (Vol. 683)* (Construction  
111       Industry Research, Information Association, Civieltechnisch Centrum Uitvoering  
112       Research en Regelgeving (Netherlands) and Centre d'études maritimes et fluviales  
113       (France), 2007);
- 114       • *The Coastal Engineering Manual* (Washington, D.C.: U.S. Army Corps of Engineers,  
115       2006); and

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

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



122 Figure 2-3 Examples of rip-rap revetment walls

## 123 2.3 PROJECT ACTIVITIES

### 124 2.3.1 Adaptive Interventions

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

138 Table 2-2 Activities planned for each adaptive intervention

| Adaptive intervention   | Aims  | Activities   |
|---|---|--|
| <b>Strengthening governance</b>   |   |  |
| 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> | <p><b>Component 1.1: Capacity building ICZM</b></p> <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> <p><b>Component 1.2: Strengthening coordination between institutions</b></p> <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> <p><b>Component 1.3: Improvement of land use planning and enforcement</b></p> <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>                             | <p><b>Component 2.1: Investigations</b></p> <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> <p><b>Component 2.2: Implementation</b></p> <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>  |
| <b>Adaptation of livelihoods and the environment</b>  |   |  |
| 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>   | <p><b>Component 3.1: Investigations</b></p> <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> <p><b>Component 3.2: Implementation</b></p> <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>  | <p><b>Component 4.1: Investigations</b></p> <ul style="list-style-type: none"> <li>Study of the marine and estuarine biological environment</li> </ul> <p><b>Component 4.2: Implementation</b></p> <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>                     | <p><b>Component 5.1: Investigations</b></p> <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> <p><b>Component 5.2: Implementation</b></p> <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> |
| <b>Adaptation of infrastructure</b>                |   |   |
| 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> | <p><b>Component 6.1: Investigations</b></p> <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> <p><b>Component 6.2: Implementation</b></p> <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> | <p><b>Component 1: Developing knowledge on the vulnerability and potential resiliency options for infrastructure</b></p> <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> <hr/> <p><b>Component 2: Capacity building in resilient road infrastructure for relevant authorities</b></p> <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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### 139 2.3.2 Protective Interventions

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

#### 143 Preparation Phase

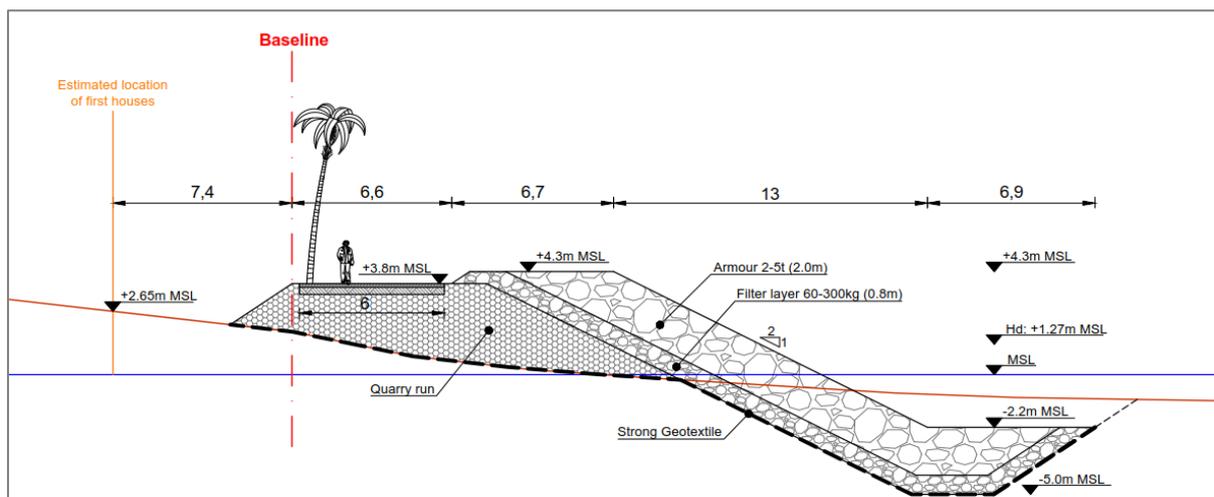
- 144 • Mobilization;
- 145 • Setting up of the construction yard
  - 146 ○ Maintenance equipment;
  - 147 ○ Water use (sanitation and concrete mixing);
  - 148 ○ Waste treatment (chemicals, solid waste, etc.);
  - 149 ○ Fuel storage and fuelling facilities;
  - 150 ○ Offices;
  - 151 ○ Concrete mixing;
  - 152 ○ Casting and construction of concrete elements; and
- 153 • Stockpiling of rocks and other materials for construction.

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

- 155 • Stockpiling of armour rock;
- 156 • Construction of bund;
- 157 • Excavation;
- 158 • Disposal / stockpiling of excavated material;
- 159 • Placement of geotextile;
- 160 • Placement of underlayer;
- 161 • Placement of armour;
- 162 • Backfilling;
- 163 • Reshaping the base layer / bund of the promenade;
- 164 • Possible installation of drainage;
- 165 • Addition of the top layer of the promenade; and
- 166 • Planting of trees and other vegetation on the promenade.

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

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



180  
 181 Figure 2-4 Typical cross-section of the proposed revetment at West Point.

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

---

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.



- Groyne
- Beach fishery site
- Baseline
- Beach nourishment
- Revetment
- Revetment Light
- End of project chainage
- Settlement boundary

192  
193  
194

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

## 195 2.4 EQUIPMENT

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

199 Table 2-3 Construction equipment

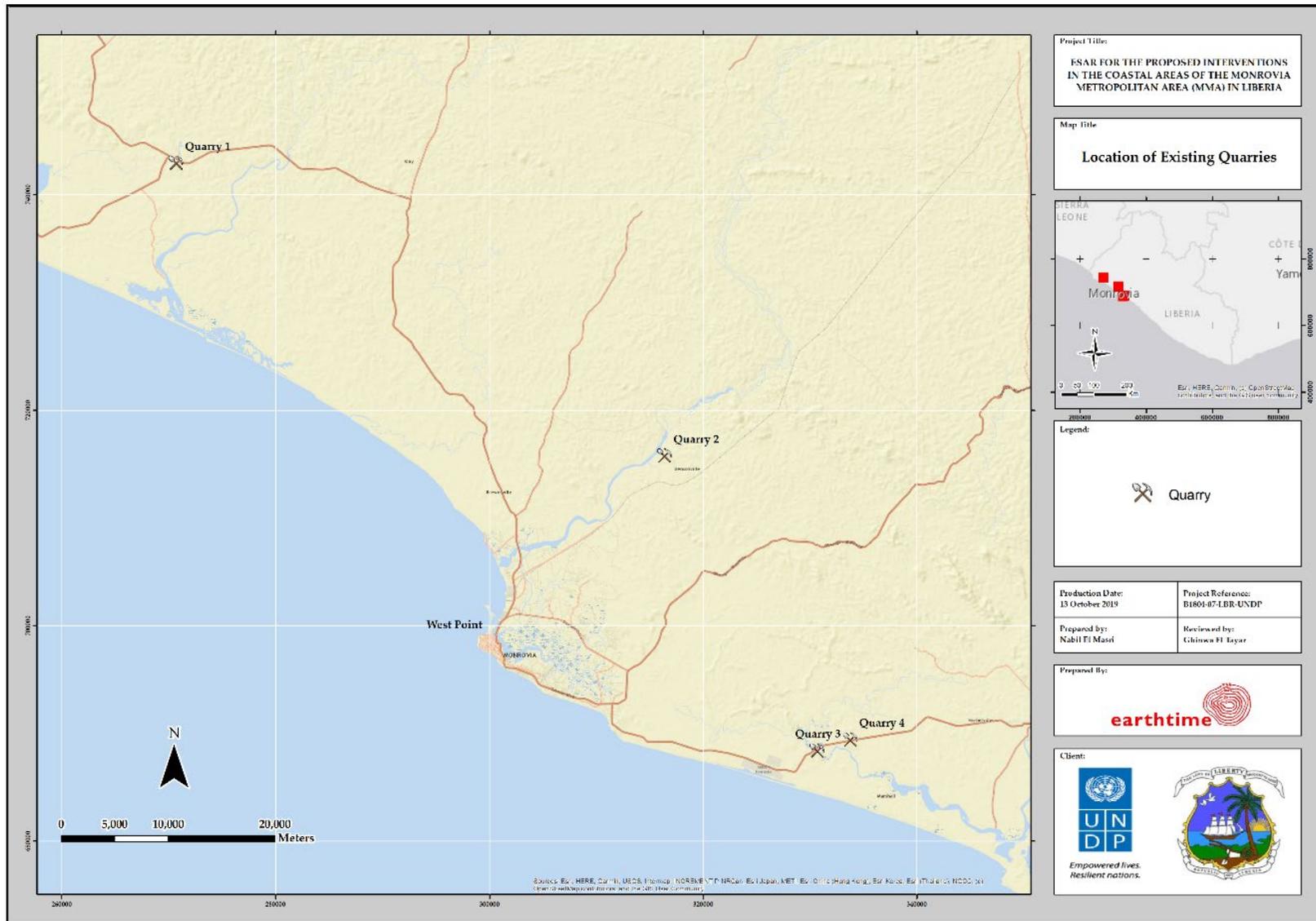
| Equipment type and characteristics   | Minimum no. required |
|--|----------------------|
| Caterpillar (CAT) 390 long-reach excavator with GPS, rock buckets, skeleton buckets and grapples | 2                    |
| Caterpillar (CAT) 330 excavator with bucket and excavation bucket                                | 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  | -                    |

## 200 2.5 MATERIALS

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

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

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



213

214

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

## 215 2.6 WASTE

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

218 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.   |

## 219 2.7 EMPLOYMENT

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

223 Employment will include equal opportunities for both men and women. A written statement  
224 in all service providers' contracts will include commitment to equality, social inclusion and  
225 adherence to the prohibition of child labour according to the ILO Minimum Age Convention,  
226 1973 (no 138), which sets the general minimum age for admission to employment or work at  
227 15 years (13 years for light work) and minimum age for hazardous work at 18 years (16 years  
228 under certain strict conditions).

229 It is expected that the construction of the protective interventions will employ around 7  
230 expatriates and 20 to 25 skilled local staff, plus a larger number of unskilled local workers.  
231 The minimum key staff will include managers, supervisors, surveyors, mechanics, machine  
232 operators, drivers, safety officers and security officers. Expatriate workers will be housed in  
233 one or two rented apartments, while local workers will find their own accommodation space  
234 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

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

32 The Do Nothing alternative is therefore not a supportable proposition.

### 33 3.2 ALTERNATIVE LOCATIONS

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

38 Alternative locations within the Monrovia Metropolitan area are:

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

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

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

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

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

### 65 **3.3 ALTERNATIVE INTERVENTIONS**

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

#### 72 **3.3.1 Adaptive Interventions**

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

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

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

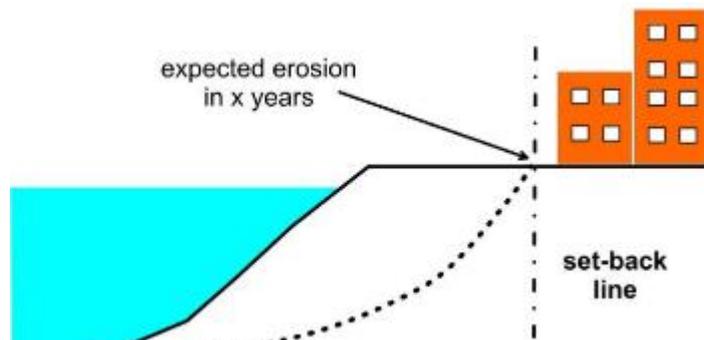
88 An alternative adaptation strategy might be to support an increasing industrialisation of the  
89 fishery as a way to increase resilience against the impacts of climate change. Kru, Fanti and  
90 Popoh wooden canoes could be replaced by small trawlers built of steel and powered by diesel  
91 engines,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

### 100 **3.3.2 Protective Interventions**

#### 101 **3.3.2.1 Retreat Strategy**

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

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



110  
111 Figure 3-1 Example showing a setback line

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

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

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

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

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### 130 3.3.2.2 Physical Adapt Strategy

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

### 137 3.3.2.3 Defend Strategy

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

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

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

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

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

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

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

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

### 181 3.4 DESIGN ALTERNATIVES

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

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

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

- 201 1. The high cost of the dredging and nourishments on both the environmental level and  
202 the economic level.
- 203 2. The coastal retreat in this section could not be strongly attributed to climate change  
204 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   |
|--------------------------------|--|------|---|
| Mining and quarrying           | 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   |
| Occupational health and safety | 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.   |
| Public health and safety       | 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.   |
| Land rights                    | 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 adjudatory 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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#### 11 **4.1.1 Constitution of the Republic of Liberia**

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

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

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

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

#### 27 **4.1.2 The Environmental Protection Agency Act**

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

33 Thus, the Environmental Protection Agency of Liberia (EPA) was created by the Act creating  
34 the Environment Protection Agency of the Republic of Liberia, known as the Environment  
35 Protection Agency Act. The Act was approved on November 26, 2002 and published on April  
36 30, 2003. The establishment of the EPA marked a significant step forward in the protection  
37 and management of the environment of Liberia.

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

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

### 67 4.1.3 Act Adopting the Environment Protection and Management Law of the 68 Republic of Liberia

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

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

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

79 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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## 85 4.2 NATIONAL ENVIRONMENTAL ADMINISTRATIVE FRAMEWORK

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

### 89 4.2.1 The Administrative Sub-Divisions of Liberia

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

- 92 • national level;
- 93 • county level;
- 94 • district level; and
- 95 • clan level.

#### 96 4.2.1.1 Role of National Level Authorities

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

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

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109 **4.2.1.2 Role of County Level Authorities**

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

118 **4.2.1.3 Role of District Level Authorities**

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

128 **4.2.1.4 Role of Clan Level Authorities**

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

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## 136 4.2.2 Environmental and Social Institutional Framework

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

### 140 4.2.2.1 National Level

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

151 Table 4-5 summarizes the key functions of the EPA and other institutions relevant to  
152 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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#### 154 4.2.2.2 Local Level

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

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

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

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

#### 176 4.2.3 **Environmental Inspectors and Courts**

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

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180 **4.2.3.1 Environmental Inspectors**

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

193 **4.2.3.2 Environmental Courts**

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

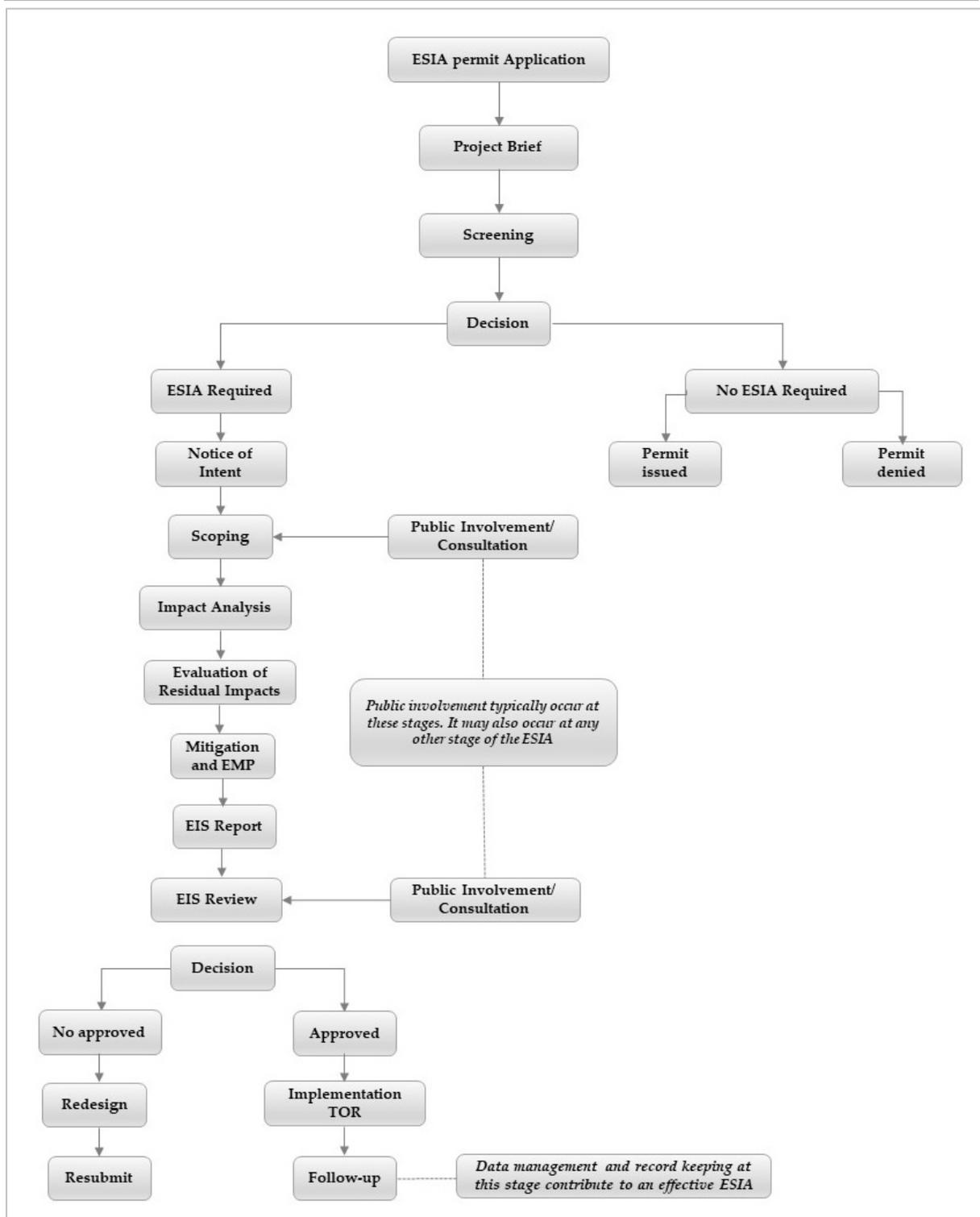
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### 201 4.3 ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT PROCESS IN LIBERIA

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

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

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



249

250

Figure 4-1 ESIA process in Liberia

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### 251 4.3.1 Public Consultation Requirements of the ESIA Process

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

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

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## 281 4.4 TERMS OF REFERENCE FOR ENVIRONMENTAL AND SOCIAL IMPACT 282 ASSESSMENT REPORTS IN LIBERIA

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

- 285 • Executive summary
- 286 • Introduction or overview of the project
- 287 • Policy, legal and administrative framework
- 288 • Detailed project description
- 289 • Description of the potentially affected environment including specific information  
290 necessary for identifying and assessing the environmental effect of the proposed  
291 project of activities
- 292 • Impact prediction and evaluation
- 293 • Socio-economic analysis of project impacts
- 294 • Economic information regarding the project
- 295 • Environmental management plan and mitigation measures
- 296 • Identification of alternatives
- 297 • Environmental management and training
- 298 • Monitoring program
- 299 • Public participation
- 300 • A statement of the degree of irreversible damage and an explanation
- 301 • A description of the best available technology
- 302 • An emergency response plan
- 303 • An indication of any difficulty encountered in the EIA
- 304 • Conclusion and recommendations
- 305 • List of references
- 306 • Annexes

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## 307 4.5 NATIONAL ENVIRONMENTAL QUALITY STANDARDS

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

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

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

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

331 Table 4-6 Ambient air quality tolerance limits (adapted from EPML- Air Quality and Standards Regulations,  
332 2009)

| Pollutant   | Time weighted average | Industrial area        | Residential, rural and other area | Controlled areas***    |
|---|-----------------------|------------------------|-----------------------------------|------------------------|
| Sulphur oxides (SOx)                                    | 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 (NOx)                                   | 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                          |                        |

\* Annual arithmetic mean of minimum 104 measurements in a year taken twice a week 24 hourly at uniform interval.  
\*\* 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.  
\*\*\* Not to be exceeded more than once per year average concentration.  
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.

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>  | Class II: water used for fisheries, cultivated fisheries, organized public bath, recreational water sports |           |            |
| mg  |  |           | Milligram  |
| L   |  |           | Litre      |
| mL  |  |           | Millilitre |
| n   |  |           | Count      |
| n.d.  | Non detectable   |           |            |
| Prepared for the Government of Liberia by UN Department of Technical Cooperation for UNDP New York 1987 |  |           |            |

336 Table 4-9 Maximum permissible noise levels for general environment (EPML - Noise Pollution Control and  
337 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><br>Day: 6.00 a.m. to 10.00 p.m.<br>Night: 10.00 p.m. to 6.00 a.m.<br>The time frame takes into consideration human activity  |                           |       |

338 Table 4-10 Maximum permissible noise levels (continuous or intermittent noise) from a factory or workshop  
339 (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     |
| Noise Levels shall not exceed a Leq of -<br>(i) Factory/Workshops 85 dB (A)<br>(ii) Offices 50 dB (A)<br>(iii) Factory/Workshop Compound 75 dB (A) |                  |                   |

340 Table 4-11 Maximum permissible noise levels for impact or impulsive noise (EPML - Noise Pollution Control  
341 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  |

342 Table 4-12 Maximum permissible noise levels for construction sites (EPML - Noise Pollution Control and  
343 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><br>Day: 6.00 a.m. to 10.00 p.m.<br>Night: 10.00 p.m. to 6.00 a.m.<br>The time frame takes into consideration human activity |                          |       |

344 Table 4-13 Maximum permissible noise levels for accelerating vehicles (adapted from EPML - Noise Pollution  
345 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                      |

346 Table 4-14 Maximum permissible noise levels for residential and commercial areas (EPML - Noise Pollution  
347 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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## 348 4.6 MULTILATERAL AGREEMENTS AND BIODIVERSITY PROTOCOLS

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

- 355 • International Maritime Organization's Manual on Oil Pollution (2011 Edition).
- 356 • International Maritime Organization's Field Guide for Oil Spill Response in Tropical  
357 Waters, 1997.
- 358 • International Chamber of Shipping (Oil Companies International Marine Forum) Ship  
359 to Ship Transfer Guide for Petroleum (4th Edition), 2005.
- 360 • 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  |
|-----------------|--|------------------------------|---|
| Air quality     | 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             |   |
| Climate change  | 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               |   |
| Waste transport | 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            |   |
| Socio-cultural  | 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   |
|-----------------|---|------------------------------------|--|
| <b>Maritime</b> | 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                    |  |
| <b>Other</b>    | 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.  |

## 363 4.7 GENDER EQUALITY FRAMEWORK IN LIBERIA

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

373 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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## 374 4.8 GCF AND UNDP ENVIRONMENTAL AND SOCIAL REQUIREMENTS

### 375 4.8.1 GCF Environmental and Social Policy

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

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

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

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

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

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

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

#### 408   **4.8.2 UNDP Social and Environmental Standards**

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

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

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

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

- 422       • human rights-based approach to development programming;  
423       • gender equality; and  
424       • environmental sustainability.

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

428 The SES are comprised of 7 standards:

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

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

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

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

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

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

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## 1 5 DESCRIPTION OF THE OVERALL ENVIRONMENT

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

### 8 5.1 PHYSICAL ENVIRONMENT

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

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

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

#### 21 5.1.1 Existing Climate

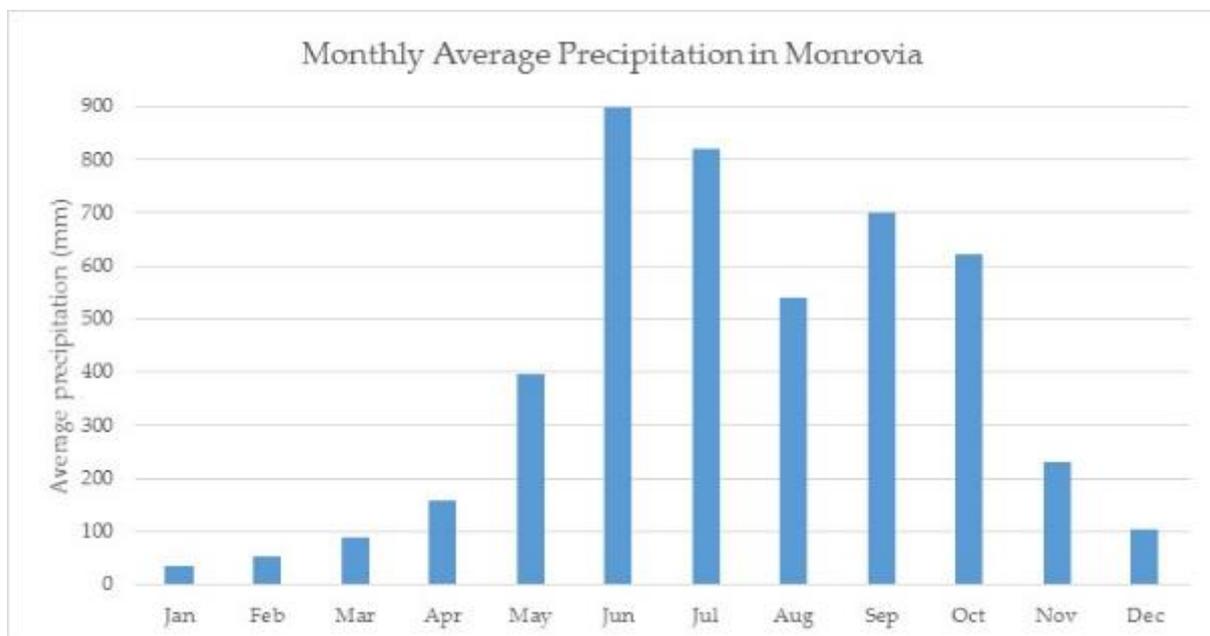
22 The climate of Liberia is highly influenced by its equatorial position in the Inter-Tropical  
23 Convergence Zone, an area encircling the equator where winds originating in the northern  
24 and southern hemispheres come together. In Liberia, the Inter-Tropical Convergence Zone is  
25 primarily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

28 **5.1.1.1 Temperature**

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

35 **5.1.1.2 Precipitation**

36 Liberia has two seasons – a dry season, which usually runs from November to April, and a  
37 rainy season, which generally runs from May to October. The annual precipitation in  
38 Monrovia is around 4,600 mm. The heaviest rainfall generally falls in June, July and  
39 September. The average rainfall per month recorded between 1944 and 1973 in Monrovia are  
40 presented in Figure 5-1. Precipitation in Monrovia is typically intense and of short duration,  
41 called convective rainfall. Its diurnal distribution generally shows that two-thirds of the rain  
42 falls during the night between 6:00 pm and 7:00 am (UNDP, 2006; Brandolini and Tigani,  
43 2006).

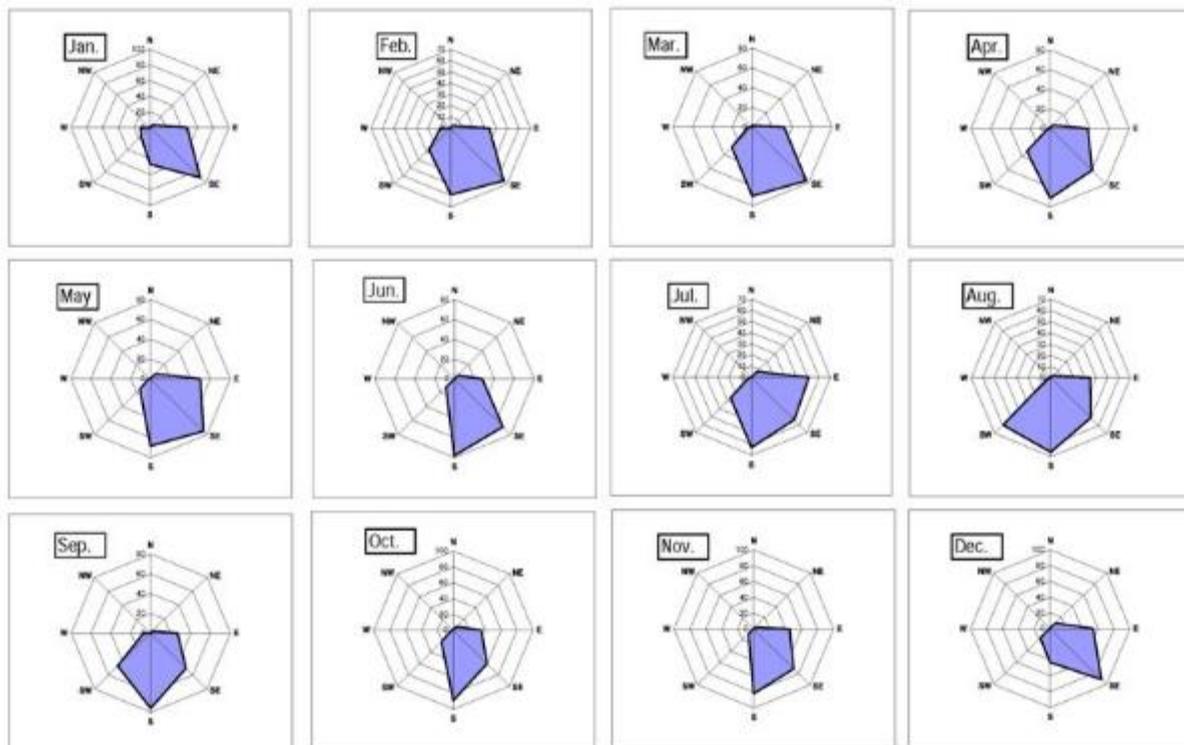


44  
45 Figure 5-1 Monthly average precipitation in Monrovia between 1944 and 1973 (mm) (adapted from LHS, 1980)

46 **5.1.1.3 Wind**

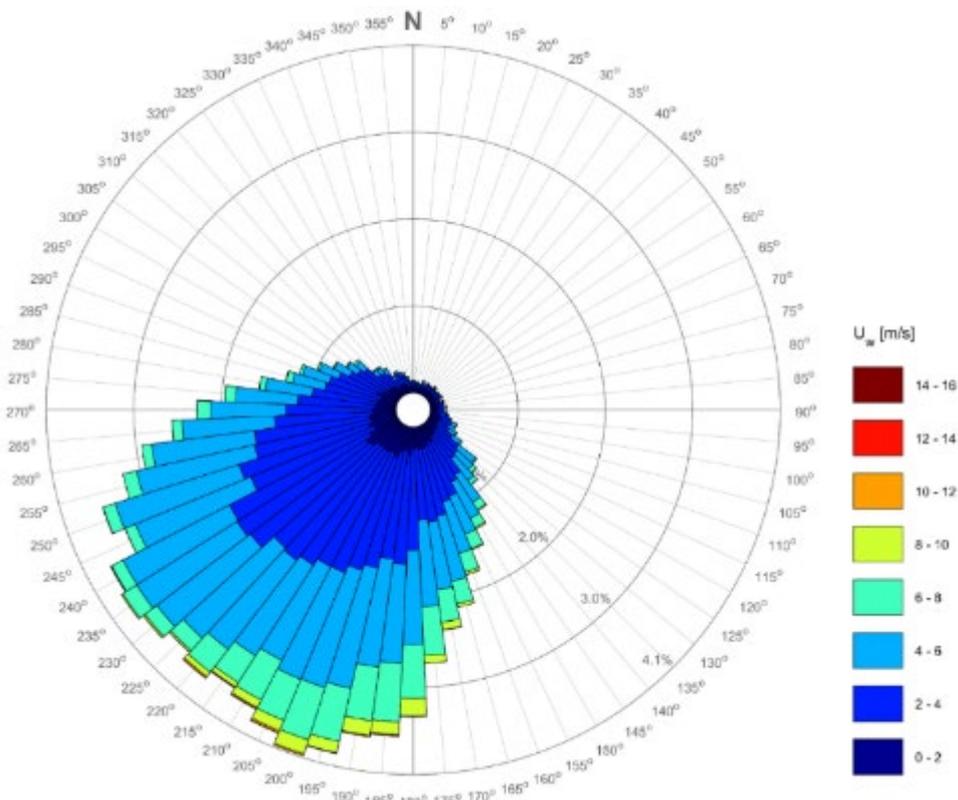
47 The seasons in Liberia mainly result from the movement of air masses. The Inter-tropical  
48 Convergence Zone (ITCZ) follows the sun to move north of the Equator and the coast in the  
49 northern hemisphere summer, drawing relatively cool but moist air from the South Atlantic  
50 Ocean on to the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

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



61  
62 Figure 5-2 Monthly frequency of onshore wind direction at Robertsfield between 2000 and 2006 (JICA, 2009).  
63 Note that these diagrams show the direction of source of wind.

64 Offshore winds originate from the north and northeast. Wind speed varies between 0 to  
65 10 m/s, creating a calm to moderate wind climate in Monrovia (Figure 5-3). While these are  
66 gentler than the onshore winds, they can include the very dry and dust-laden Harmattan.



67  
68 Figure 5-3 Rose diagram of offshore winds (CDR International, 2019a). Note that this diagram shows the  
69 direction of flow of the wind, the opposite to Figure 5-2.

#### 70 5.1.1.4 Relative Humidity

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

76 Daily variation observed in Monrovia during the dry season show that relative humidity  
77 decreases to 80-85% during the day, and can even reach 65% during January and February,  
78 the driest months of the year. At night and in the early mornings, relative humidity reaches  
79 90-100%, regardless of the season (Schulze, 1973).

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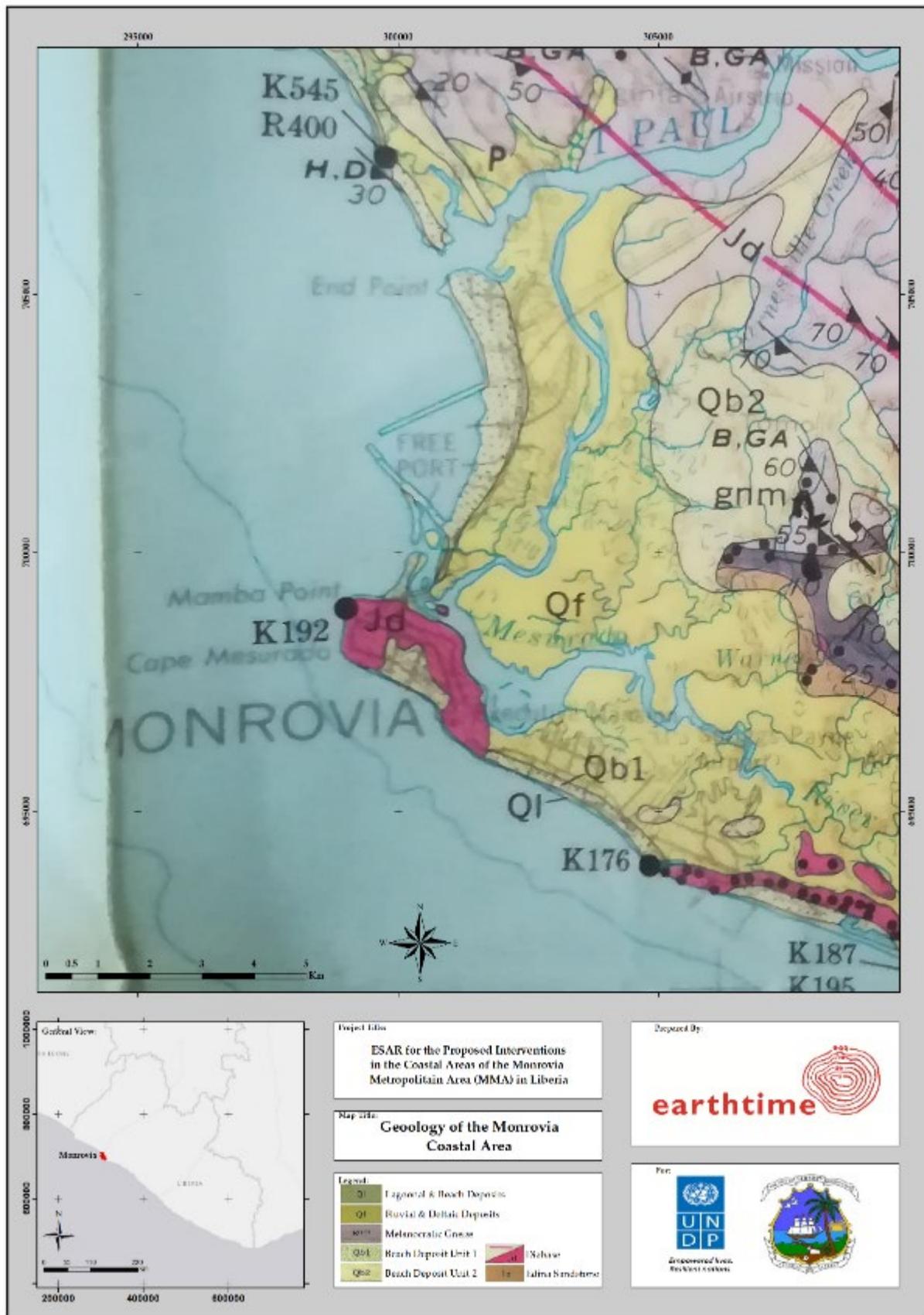
## 80 5.1.2 Geology, Coastal Topography and Bathymetry

### 81 5.1.2.1 Geology

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

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

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



96

97 Figure 5-4 Geological map of the project area

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### 98 5.1.2.2 Coastal Topography and Bathymetry - General

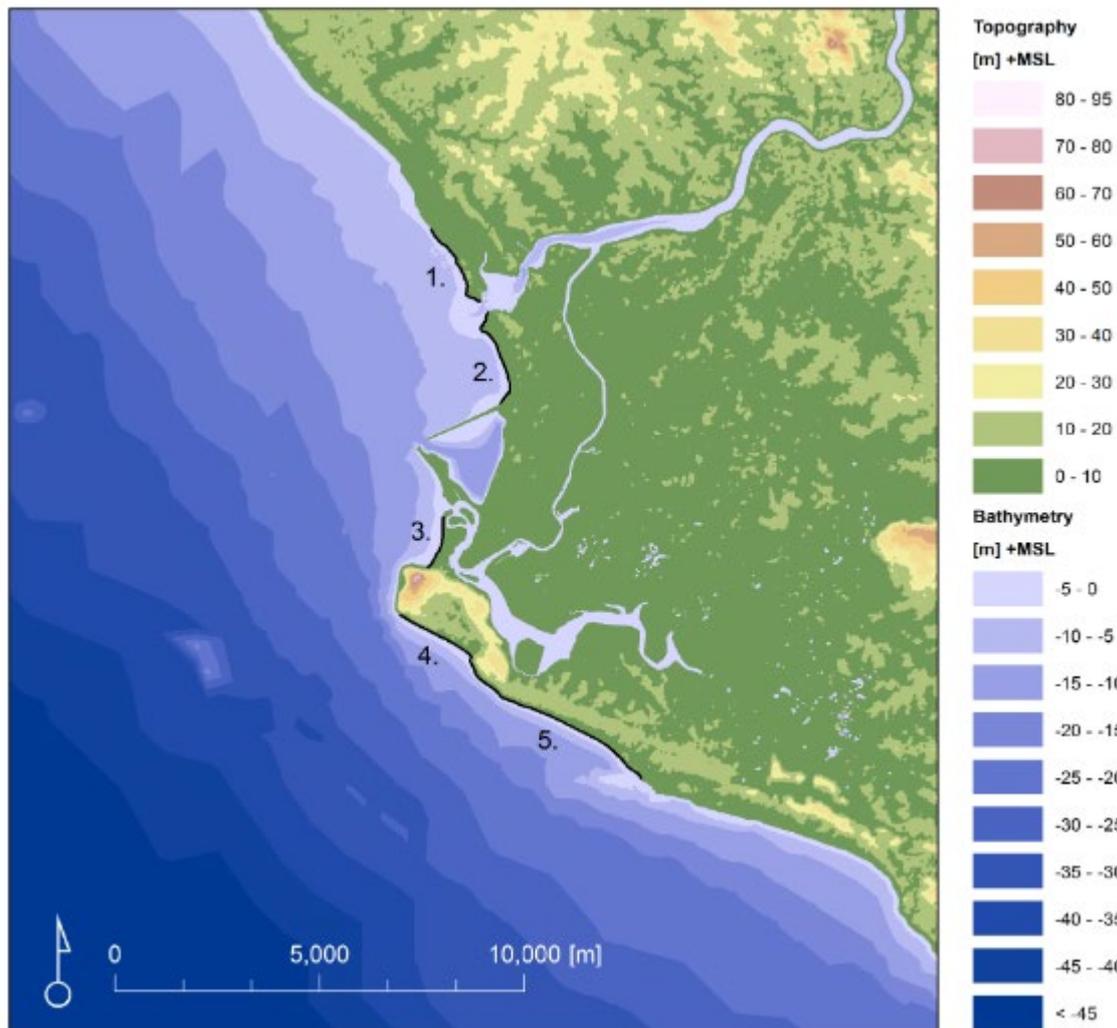
99 Liberia can be divided into three distinct topographical areas:

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

105 The project area falls within the flat coastal plain area in Monrovia. Coastal sections 1, 2 and  
106 3 are relatively flat, low-lying lands that have an average terrain elevation of 0 to 10 m +MSL.  
107 The Cape of Monrovia, southwest of Coastal section 3, is a hill that reaches up to 80 m +MSL  
108 in elevation, making it the highest point in Monrovia. Coastal sections 4 and 5 have an average  
109 terrain elevation that ranges between 0 and 20 m +MSL, with occasional points that can reach  
110 up to 30 m +MSL (Figure 5-5).

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

120 In the project area, the bathymetric topography of coastal sections 1 and 2 is characterized by  
121 gentle slopes, while coastal sections 3, 4 and 5 have steeper slopes, as can be seen in Figure  
122 5-5. For example, at a distance of 5,000 m from the shore, the depth ranges between 15 and  
123 20 m below MSL for coastal sections 1 and 2, while it ranges between 20 and 25 m below MSL  
124 for coastal section 3, and between 30 and 35 m below MSL for coastal sections 4 and 5.



125  
126 Figure 5-5 Bathymetric and topographic map of the project area (CDR International, 2018)

127 **5.1.2.3 Coastal Topography and Bathymetry - West Point**

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



135

136

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

137

### 5.1.3 Seismicity

138

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.

139

140

141

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.

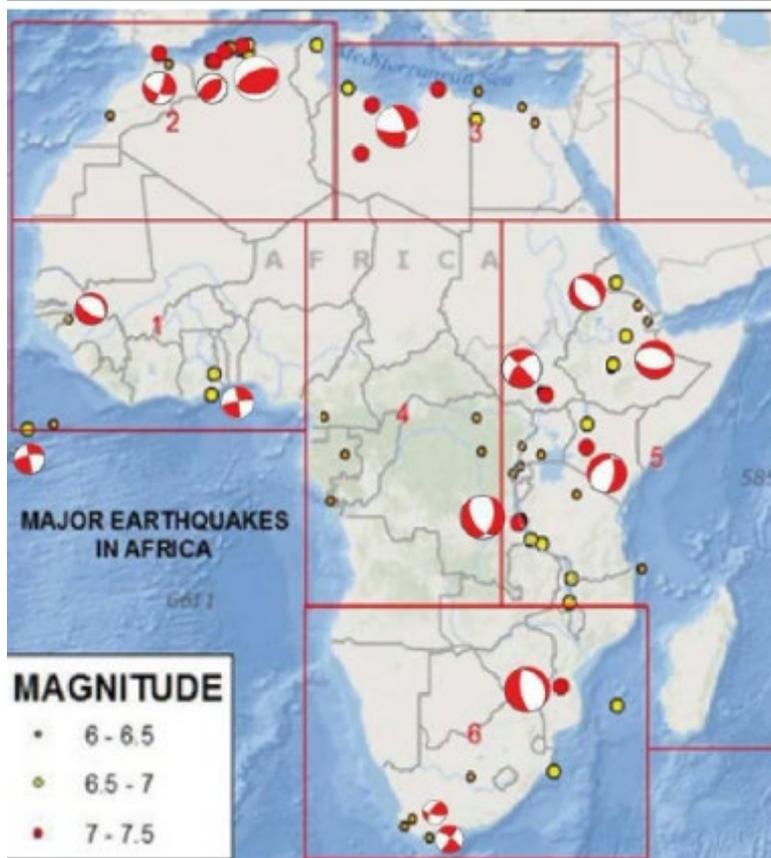
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144

145

146



147

148

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

149

#### 5.1.4 Currents, Tides and Wave Regimes

150

##### 5.1.4.1 Currents

151

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.

158

159

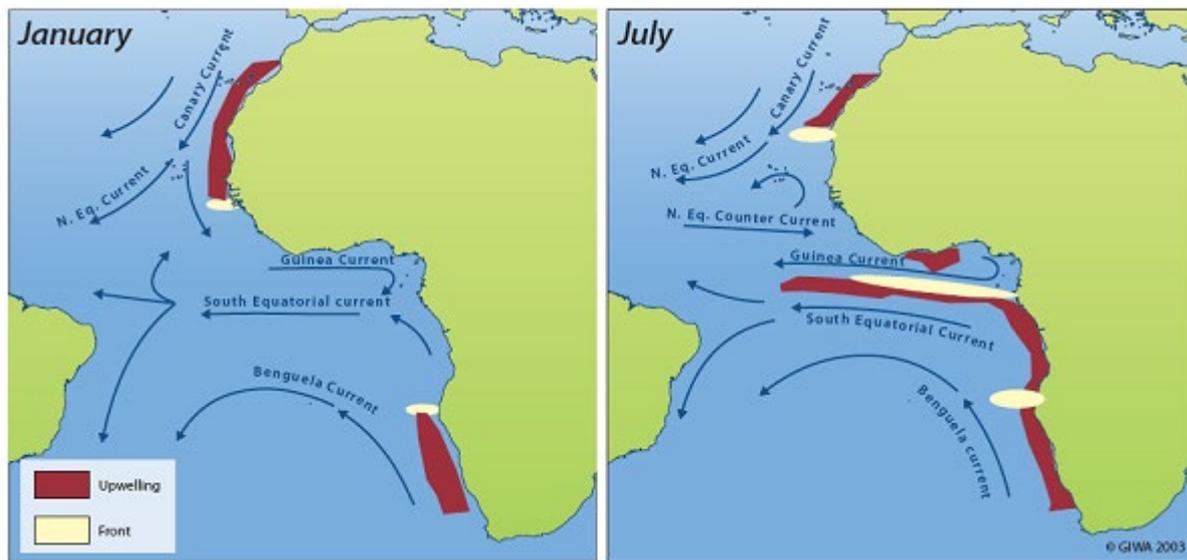
160

161

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

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

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



168  
169 Figure 5-8 Current system of the central Atlantic Ocean (Abe et al., 2003)

#### 170 5.1.4.2 Tides

171 Monrovia's shoreline experiences a semi-diurnal tide (two high tides and two low tides daily).  
172 The first tide usually occurs between 12:00 AM and 6:00 AM, the second between 6:00 AM  
173 and 12:00 PM, the third between 12:00 PM and 6:00 PM, and the fourth between 6:00 PM and  
174 12:00 AM. An example of the daily tidal variation for March 4, 2019 is provided in Figure 5-9.

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

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



180

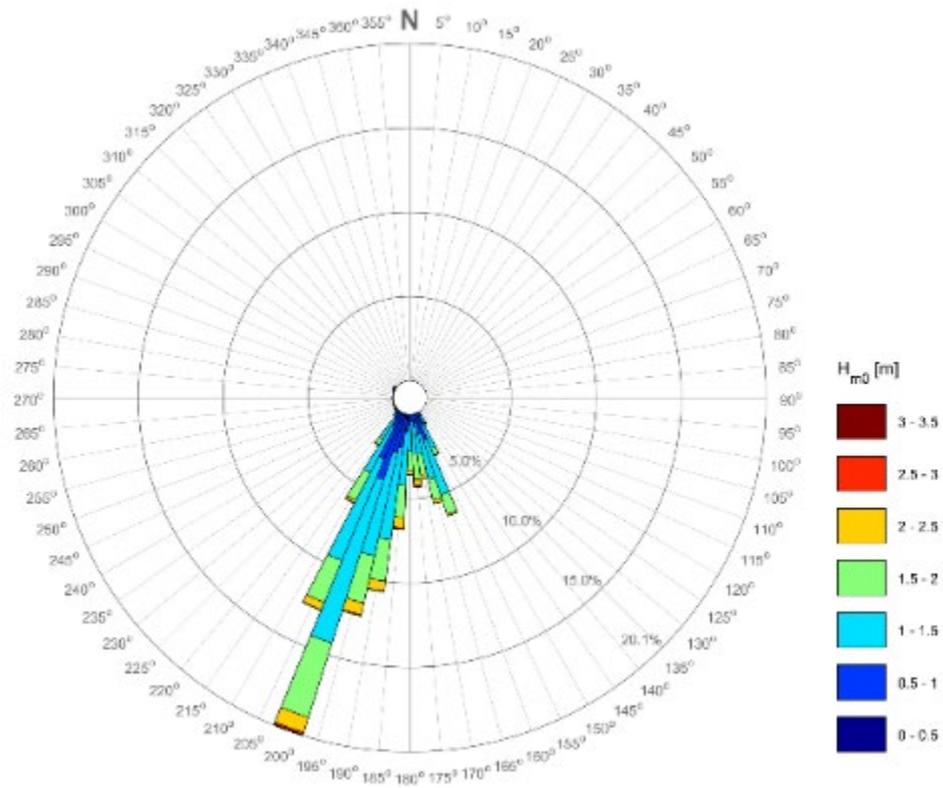
181 Figure 5-9 High tides and low tides in Monrovia on March 4, 2019 (Tides4Fishing, 2019)

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

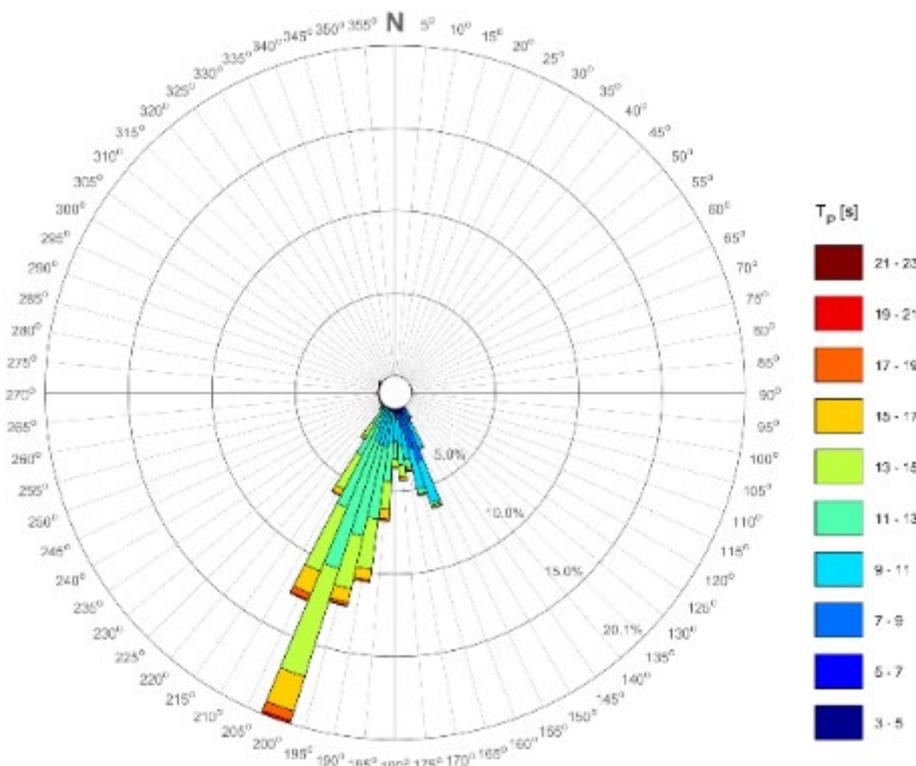
| Datum                           | Tidal level with respect to mean sea level (m +MSL) | Tidal level with respect to lowest astronomical tide (m +LAT) |
|---------------------------------|---|---|
| Highest astronomical tide (HAT) | 0.78  | 1.54  |
| Mean high water springs (MHWS)  | 0.62  | 1.38  |
| 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  |

183 **5.1.4.3 Waves**

184 The wave regime of Liberia’s coastline is largely dominated by long period swell waves  
 185 (average: 12 s, but can go up to 23 s) generated by distant storms in the South Atlantic Ocean.  
 186 These swell waves are highly energetic, leading to strong wave breaking onto the shoreline,  
 187 and are relatively uniform in direction and in height, as can be seen in Figure 5-10. Two main  
 188 distinct systems can be observed: the dominant swell system originating from the SSW  
 189 (~200°N), and another system originating from the SSE (~160°N). It is possible for both systems  
 190 to occur simultaneously. A third system can be distinguished which originates from the WNW  
 191 (~300°N), but is considered very weak (CDR International, 2019a).



(a)

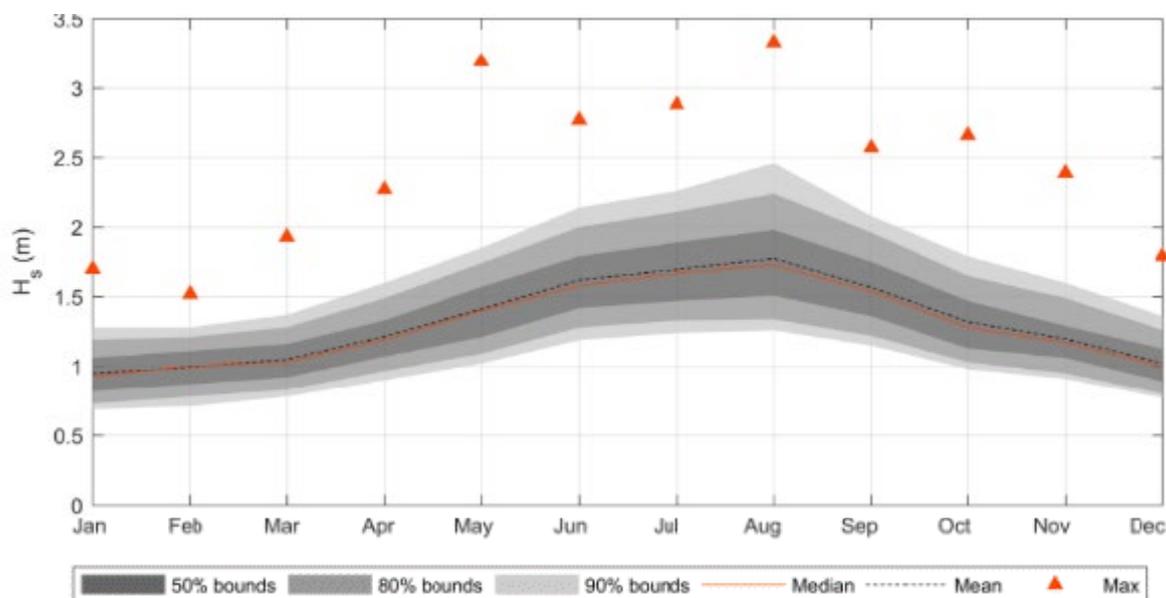


(b)

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

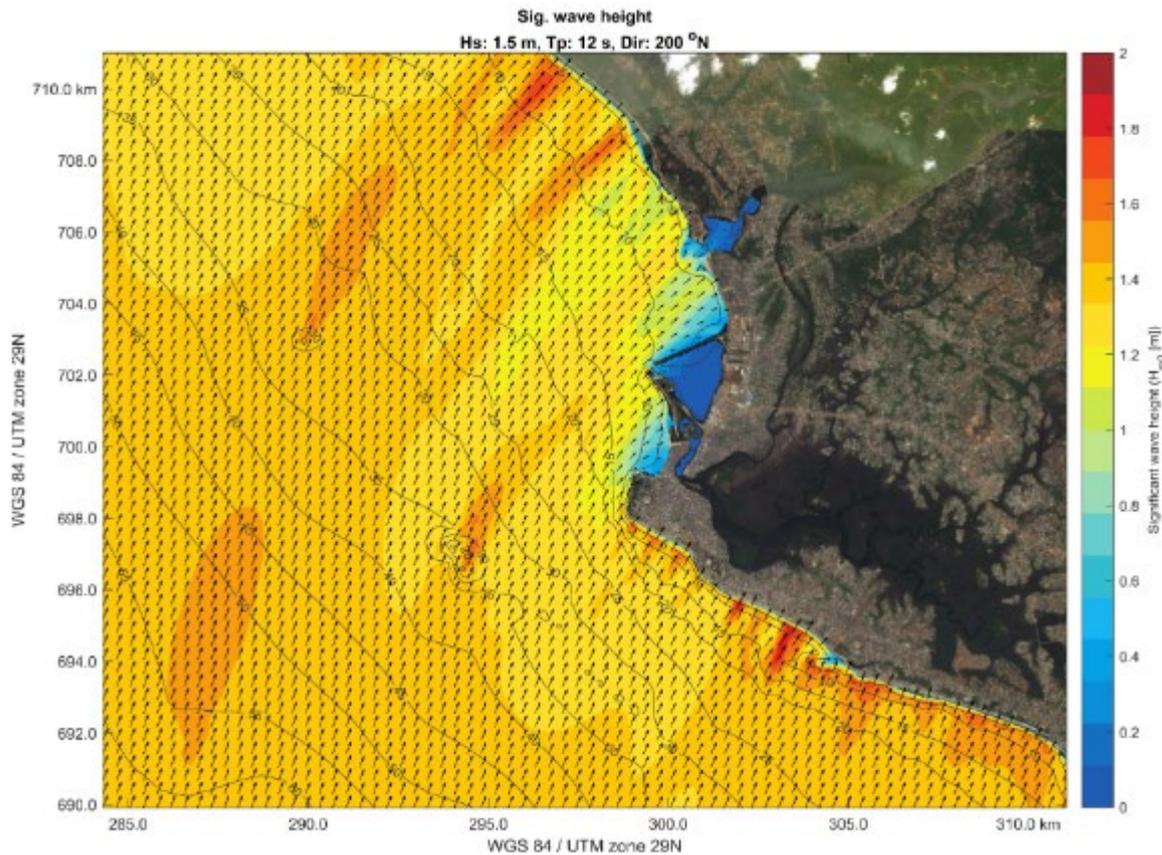
194 Wave heights have a seasonal variation and generally range between 0.5 and 2 m (PhysE,  
195 2010). Offshore waves are higher between June and September (rainy season), compared to  
196 other months, as can be seen in Figure 5-11. The average offshore wave height is 1.75 m during  
197 the rainy season and 1 m during the dry season. In addition, the wave height distribution is  
198 wide in the rainy season, compared to a more uniform one in the dry season. The most extreme  
199 waves occur during the rainy season.

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



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

204 The simulated nearshore wave field for average offshore wave conditions is shown in Figure  
205 5-12. The colours indicate the significant wave height, the arrows show the mean wave  
206 direction and the contour lines show the imposed bathymetry. As can be seen, the significant  
207 wave height generally ranges between 1.1 and 1.3 m, with occasional locations where wave  
208 height is as high as 1.8 m. The predominant wave direction is SSW.



209

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

### 211 5.1.5 Ocean Water

#### 212 5.1.5.1 Ocean Water in Liberia

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

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

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

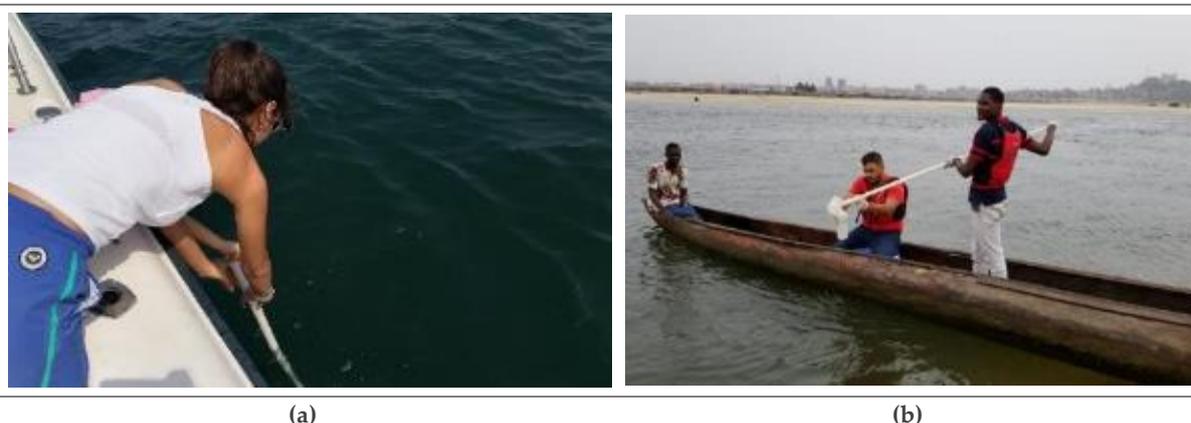
235 In the project area, the coastal waters are mainly influenced by inputs from the Mesurado  
236 River (north of coastal section 3) and the St. Paul River (between coastal sections 1 and 2) (see  
237 section 5.1.6.1), and to a lesser extent by inputs from the Farmington River (southeast of  
238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



240  
241 **Figure 5-13 Sewer outlet in coastal section 5 discharging raw wastewater in the Atlantic Ocean**

242 **5.1.5.2 Baseline Water Quality Collection in the Project Area**

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

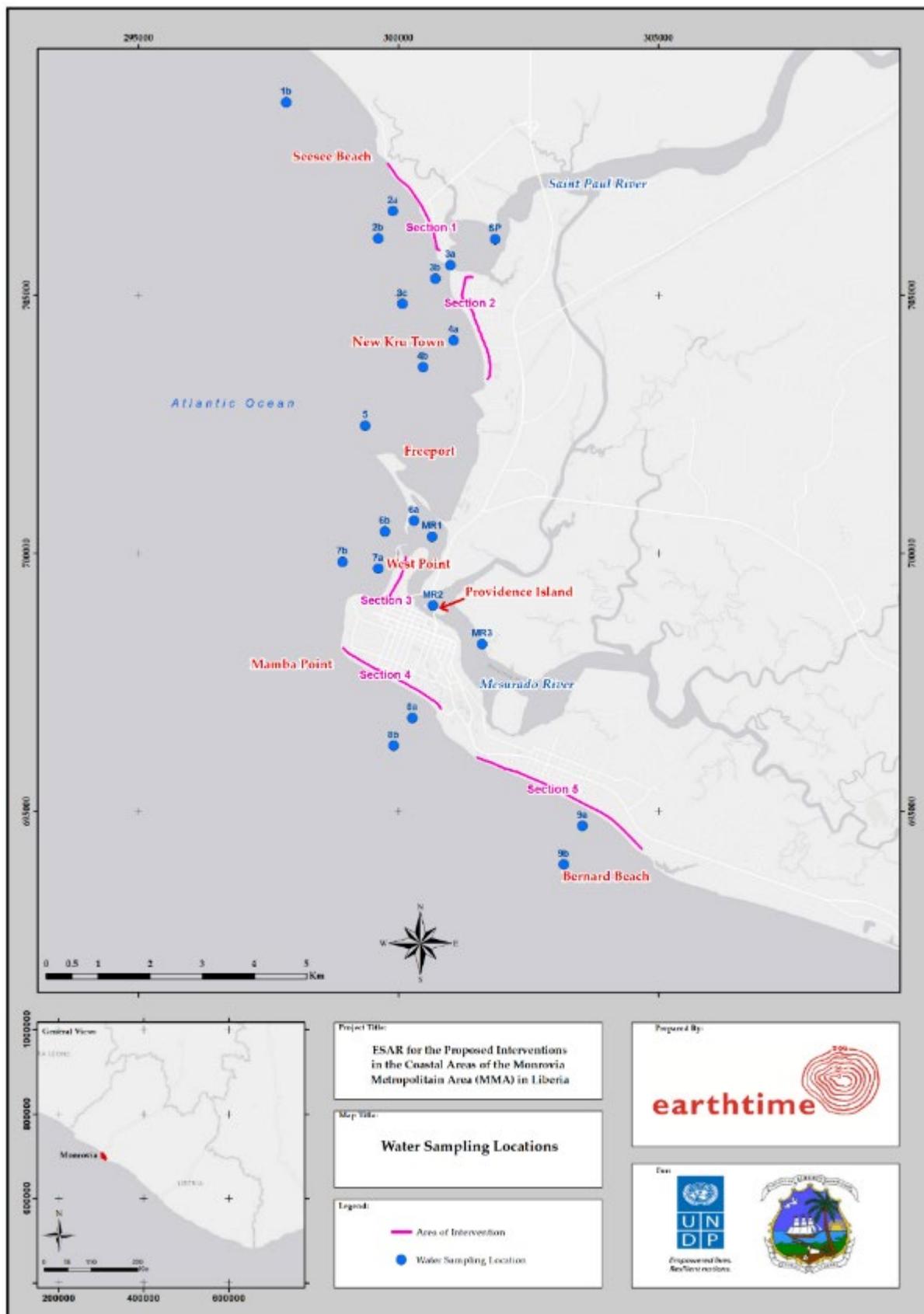


247 Figure 5-14 (a) Atlantic Ocean water sampling; (b) Mesurado estuary water sampling

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

249 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              |



250  
251 Figure 5-15 Water sampling locations

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

- 254 • During high tide, two samples were collected facing each coastal stretch: one at  
255 approximately 300-400 m from the coast (samples 2a, 4a, 7a, 8a, 9a) and one at  
256 approximately 1 km from the coast (samples 2b, 4b, 7b, 8b, 9b). Nearshore sampling  
257 locations were adjusted on-site to avoid possible damage to the boat by occasional  
258 nearshore rocks. The distances of 500 m and 1 km are still within the coastal  
259 environment (not offshore). They were chosen because project activities will take place  
260 at or near the coast, and impacts resulting from these activities are expected to be  
261 confined to a maximum of 1 km distance from the shore.
- 262 • During low tide, two samples were collected from the St. Paul River mouth (samples  
263 SP and 3a) and two samples at distances of 200 m (sample 3b) and 1 km (sample 3c)  
264 from the coastal waters facing the St. Paul River mouth.
- 265 • During low tide, one sample was collected from the Mesurado River mouth (sample  
266 6a), three samples from the Mesurado River estuarine area (samples MR1, MR2 and  
267 MR3), and one at 300 m from the coast facing the Mesurado River mouth (sample 6b).
- 268 • Samples were also collected from points of interest such as the outlet of Monrovia's  
269 Freeport (sample 5), and downdrift of coastal section 1 (sample 1b).

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

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

280 Water samples were collected as per the following procedure.

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

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

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

### 298 **5.1.5.3 Laboratory Results and Analysis**

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

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

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

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

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

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

328 COD values detected in samples collected from the Atlantic Ocean were in the order of 450 to  
329 650 mg/L. In the St. Paul estuarine area, COD values increased as the fresh water mixed with  
330 ocean water, with COD values ranging between 86 in sample SP and 330 mg/L in sample 3c.  
331 On the other hand, COD ranged between 27 and 1,030 mg/L in the Mesurado estuarine area.  
332 COD values increased from 433 to 608 and 1,030 mg/L at MR3, MR2 and MR1, respectively.  
333 As the Mesurado River water flows down from the wetlands towards the ocean, it carries with  
334 it oxidisable pollutants, namely faecal matter. The water downstream therefore has a higher  
335 COD content than the water upstream. As the Mesurado River water mixes with ocean water,  
336 pollutants become diluted, resulting in lower COD content in samples 6a and 6b of 512 and  
337 27 mg/L, respectively. Nitrites and Nitrates were mostly below detectable limits. Total organic  
338 carbon (TOC) was detected in 8 samples out of 21.

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

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

- 352 • Arsenic was detected in 20 out of 21 sampling locations (only sample 3a had an arsenic  
353 concentration below detection limit). Arsenic could result from gold mining, which is  
354 a prevalent industry in Liberia.
- 355 • Cadmium was detected in samples SP, 4b, 6b, MR2, 7a, 8a and 9a, and ranged between  
356 0.00408 and 0.0583 µg/L. These concentrations are considered minimal. Sources of  
357 cadmium could be the use of fertilizers, sewage water, and wastewater or runoff from  
358 batteries and paint industries.
- 359 • Iron was detected in samples 1b, SP, 6a, MR1, MR2 and MR3, and ranged between  
360 0.00524 and 0.0101 µg/L. Iron occurrence in surface water in Liberia is usually linked  
361 to the high level of irons naturally occurring in the Liberian soils.
- 362 • Lead was detected in samples SP and 4b, and ranged between 0.0169 and 0.0918 µg/L.  
363 Lead could result from a variety of sources, such as deposits of lead-containing dust  
364 from the atmosphere, industrial wastewater and urban runoff, but none can be  
365 identified.
- 366 • Mercury was not detected in any of the samples.

367 Cyanide, nitrite, petroleum hydrocarbons (GRO, EPH and TPH CWG) and phenols were not  
368 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<br>(SW-II Waters) | MoH<br>(Class II) | 1b          | 2a     | 2b     | SP    | 3a     | 3b     | 3c     |
| <b>Inorganics</b>                               |       |                             |                   |             |        |        |       |        |        |        |
| 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 NO <sub>2</sub>                      | 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 NO <sub>3</sub>               | mg/L  | N/A                         | 60                | <0.3        | 0.367  | <0.3   | <0.3  | <0.3   | 0.549  | <0.3   |
| Saline TON as NO <sub>3</sub>                   | 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  |
| <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                | 2.61        | 1.38   | 1.8    | 0.343 | <0.5   | 1.21   | 1.62   |

| Parameter  | Unit | Standard                    |                   | Sample Code |        |        |         |        |        |                        |
|--|------|-----------------------------|-------------------|-------------|--------|--------|---------|--------|--------|------------------------|
|  |      | EPML 2009<br>(SW-II Waters) | MoH<br>(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<br>(SW-II Waters) | MoH<br>(Class II) | 4a          | 4b     | 5      | 6a     | 6b     | MR1    | MR2    |
| <b>Inorganics</b>                               |       |                             |                   |             |        |        |        |        |        |        |
| 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 NO <sub>2</sub>                      | 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 NO <sub>3</sub>               | mg/L  | N/A                         | 60                | <0.3        | <0.3   | <0.3   | <0.3   | 0.694  | 0.669  | <0.3   |
| Saline TON as NO <sub>3</sub>                   | 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   |
| <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   |

| Parameter  | Unit | Standard                    |                   | Sample Code |        |        |        |        |   |         |
|--|------|-----------------------------|-------------------|-------------|--------|--------|--------|--------|---|---------|
|  |      | EPML 2009<br>(SW-II Waters) | MoH<br>(Class II) | 4a          | 4b     | 5      | 6a     | 6b     | MR1   | MR2     |
| <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                | 1.61        | 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  |
| <b>Color Code</b>  |      |                             |                   |             |        |        |        |        |   |         |
| Exceeds or outside of range of MoH standard for Class II |      |                             |                   |             |        |        |        |        | - = Test not performed<br>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<br>(SW-II Waters) | MoH<br>(Class II) | MR3         | 7a     | 7b     | 8a     | 8b     | 9a     | 9b     |
| <b>Inorganics</b>                     |       |                             |                   |             |        |        |        |        |        |        |
| 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<br>(SW-II Waters) | MoH<br>(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>  |      |                             |                   |             |        |        |        |        |        |   |
| Exceeds or outside of range of MoH standard for Class II |      |                             |                   |             |        |        |        |        |        | - = Test not performed<br>N/A = Not Available |

## 372 5.1.6 Terrestrial Surface and Ground Water

### 373 5.1.6.1 Surface Water

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



383 Figure 5-16 Mouth of the St. Paul River

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



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

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



404  
405 Figure 5-18 Stockton Creek linking the St. Paul River to the Mesurado River

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

408 River waters are often contaminated due to:

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

#### 417 5.1.6.2 Groundwater

418 The Quaternary deposits (beach, lagoonal, fluvial and deltaic deposits) in the area are known  
419 to possibly be good aquifers for shallow wells. Groundwater depth in Monrovia varies from  
420 1.5 m to 2.5 m between the rainy and dry seasons, respectively: this is a general figure and not  
421 specific to the immediate coastal areas. The unconsolidated sediments in the study area are  
422 mainly recharged by heavy rainfall. During the peak of the wet season, when water levels are  
423 at their highest, discharge from the aquifer can reach up to 30-40 mm per day. Most people  
424 tap this source by using shallow wells (Earthtime Inc., 2015).

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

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

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## 431 5.1.7 Coastal and Benthic Sediments

### 432 5.1.7.1 Coastal and Benthic Sediments in Liberia

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

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

### 452 5.1.7.2 Baseline Coastal and Benthic Sediments in the Project Area

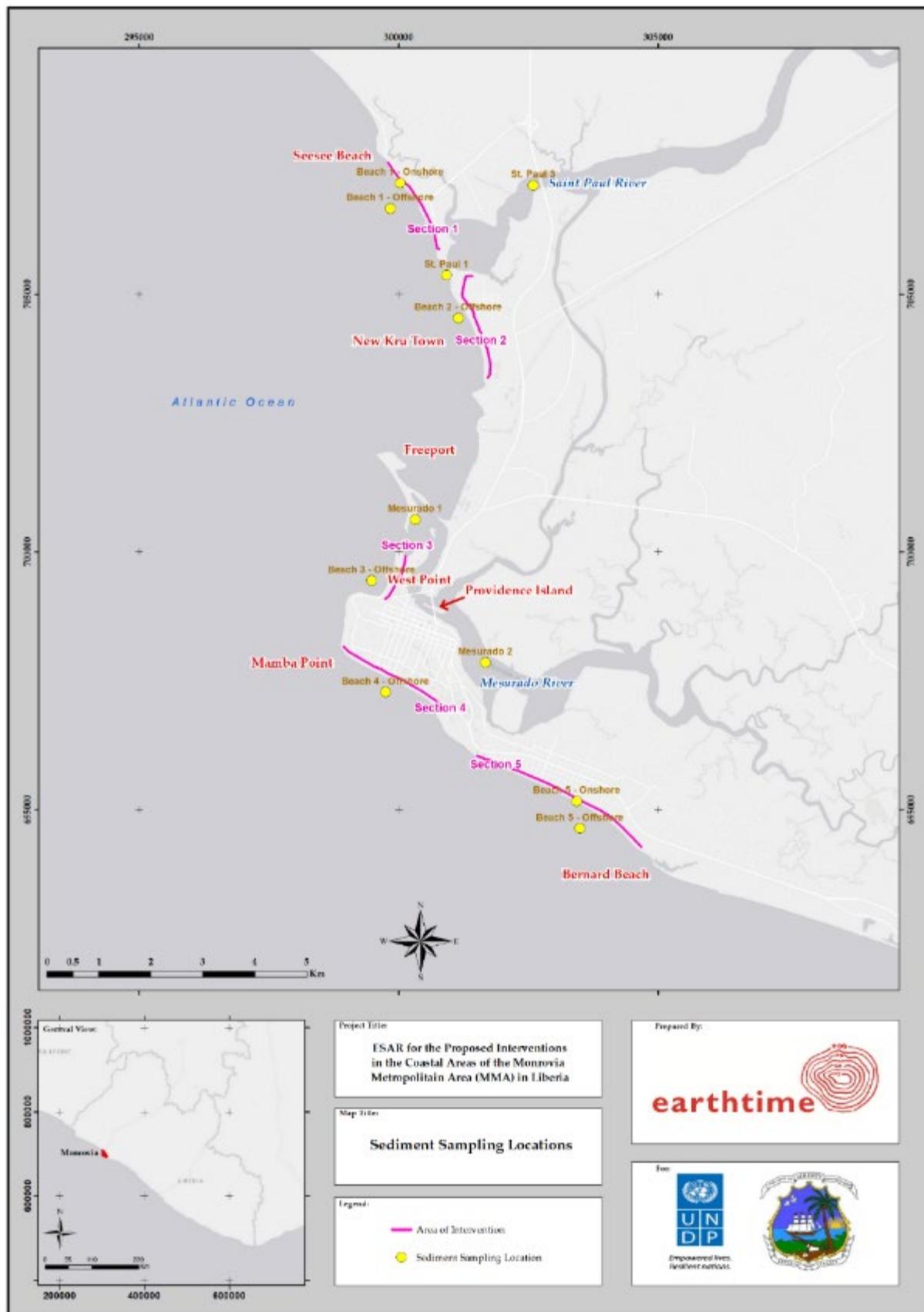
453 CDR International conducted a spot sediment sampling between October 12 and 27, 2018.  
454 Sediment samples were collected from the beach and the seabed using a Van Veen Grab  
455 Sampler (Figure 5-19). Sampling was conducted onshore and offshore of the five coastal  
456 sections, and in the estuarine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



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

461 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  |



462  
463 Figure 5-20 Sediment sampling locations

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

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

|                                 | Gravel<br>(> 2 mm) | Sand<br>(0.063 - 2 mm) | Silt<br>(0.002 - 0.063 mm) | Clay<br>(< 0.002 mm) |
|---------------------------------|--------------------|------------------------|----------------------------|----------------------|
| <b>Onshore samples</b>          |                    |                        |                            |                      |
| 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%                  | -                          | -                    |
| <b>Offshore samples</b>         |                    |                        |                            |                      |
| 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%                 |
| <b>Mesurado estuary samples</b> |                    |                        |                            |                      |
| Mesurado 1                      | -                  | 93.5%                  | 1.5%                       | 5.0%                 |
| Mesurado 2                      | -                  | 100.0%                 | -                          | -                    |
| <b>St. Paul River samples</b>   |                    |                        |                            |                      |
| St. Paul 1                      | 14.5%              | 85.5%                  | -                          | -                    |
| St. Paul 3                      | 4.7%               | 95.3%                  | -                          | -                    |

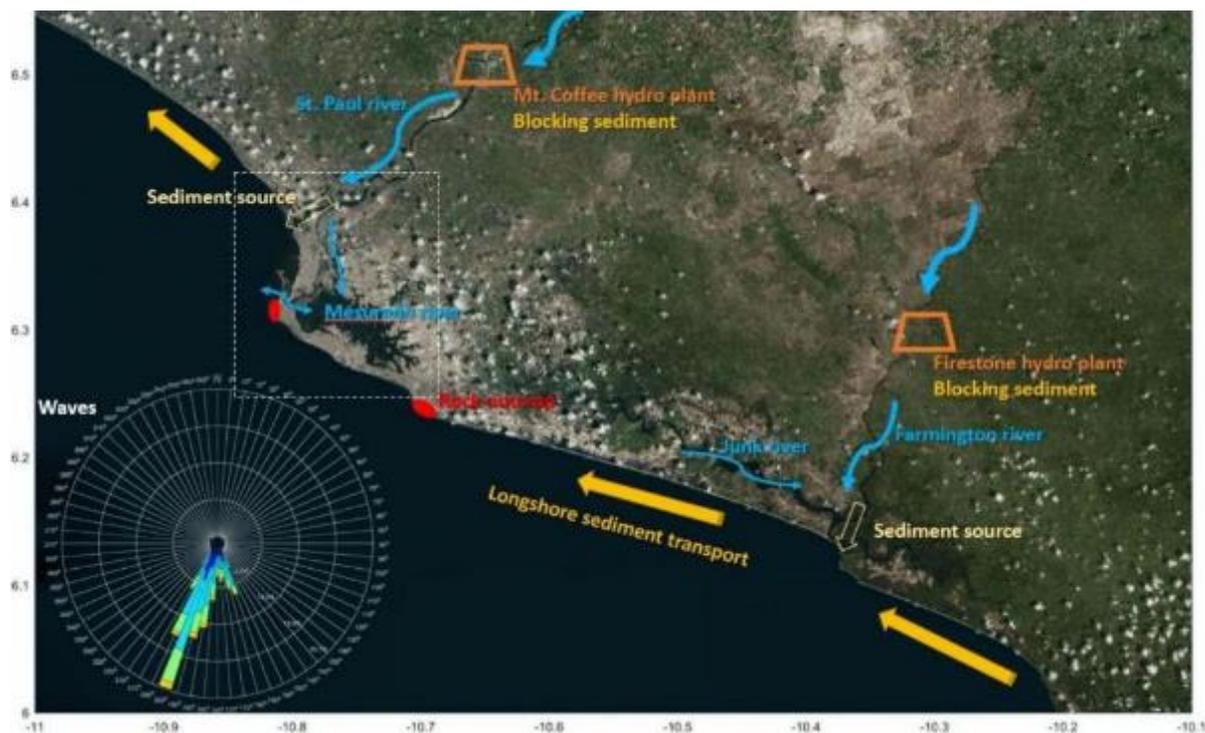
470 All sediment samples collected contained more than 85% of sand. The following observations  
471 can be made.

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

481 **5.1.7.3 Sediment Budget in the Project Area**

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

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



493  
494 Figure 5-21 Coastal processes in Greater Monrovia (adapted from CDR International, 2018)

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

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



502  
503 **Figure 5-22 Sand miners transporting sand in their canoes in the Mesurado River**

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

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

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

514 **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                                       |

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

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

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

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

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

### 538 **5.1.8 Air Quality**

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

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

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

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

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

### 565 5.1.9 Ambient Light

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

571 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         |

### 572 5.1.10 Ambient Noise

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

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

585 Baseline noise measurements conducted by Environmental Resource Management (ERM) at  
586 the Free Port of Monrovia in October 2012 showed that day and night-time noise levels are  
587 comparable inside the port (WCL Port Facilities Area) in an area where human activity is  
588 limited, and are mostly affected by noise from the sea (Table 5-10). The results were well below  
589 the Liberian standards for industrial areas. On the other hand, noise levels recorded at Gate  
590 3, a community area near the U.N. Drive highway, were typical for urban areas with busy  
591 roads, as day and night-time noise levels differing by  $\pm 10$  dBA (Western Cluster Limited,  
592 2013). Results at Gate 3 were higher than the Liberian standards for industrial areas, and for  
593 areas with a mix of residential, industrial, small scale production and commerce activities.

594 Table 5-10 Baseline noise measurement conducted by ERM in October 2012 (adapted from Western Cluster  
595 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       |

596 **5.1.11 Visual Amenity**

597 Coastal section 1 (Figure 5-23a) mainly consists of long stretches of steep, sandy beaches and  
598 a gently-sloping shoreface with several rock outcrops located nearshore and along the  
599 coastline. The main landmark in Coastal section 1 is Hotel Africa, an abandoned hotel that has  
600 historical value for the Monrovia society (Figure 5-23b). Within the premises of Hotel Africa  
601 are a number of abandoned huts which previously housed the United Nations Mission in  
602 Liberia (UNMIL) (Figure 5-23c). Remnants of an old revetment wall and collapsed buildings  
603 are present along the coast (Figure 5-23d). North of Hotel Africa are a few entertainment  
604 beaches that are mostly visited by beach-goers during the weekends and holidays. These  
605 entertainment beaches are bordered by bamboo fences and have parasols mostly made of  
606 coconut or palm tree branches (Figure 5-23e). Further north of the entertainment beaches is  
607 Banjor Beach Community, whose residents solely rely on fishing for their livelihoods (Figure  
608 5-23f). Some communities reside around Hotel Africa, but the region is not densely populated.



(a)



(b)



(c)



(d)



(e)



(f)

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

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



(a)



(b)



(c)



(d)



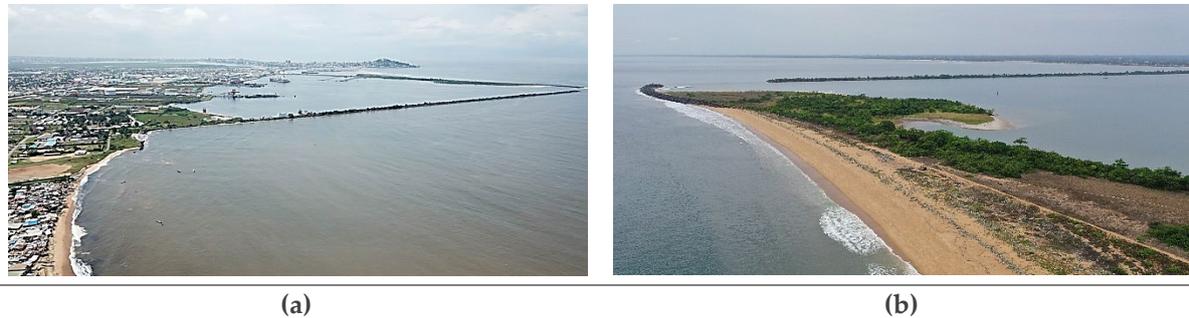
(e)



(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

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



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

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





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

634 Coastal section 4 (Figure 5-27a) is located at the south of an important economic district of  
635 Monrovia. It has a steep beach and shoreface. The western part of this coastal stretch (Figure  
636 5-27b) mostly consists of shanties, permanent housing buildings, hotels and shops. Some  
637 residents have installed make shift, low cost wave protection in front of their dwellings to  
638 protect them from the waves (Figure 5-27c). The beach on the eastern part is bordered by a  
639 road that runs parallel to the coast, next to which is the Barclay Training Center, a military  
640 base known as BTC (Figure 5-27d). The beach in coastal section 4 is often used by locals for  
641 sports activities (mainly football) and recreation. A sewer discharges raw wastewater onto the  
642 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)

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

### 650 5.1.12 Unexploded Ordnance

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

660 2003) (Landmine and Cluster Munition Monitor, 2014). Cluster bombs appear not to have been  
661 used in Liberia.

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

### 670 **5.1.13 Climate Change and Projected Effects**

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

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

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

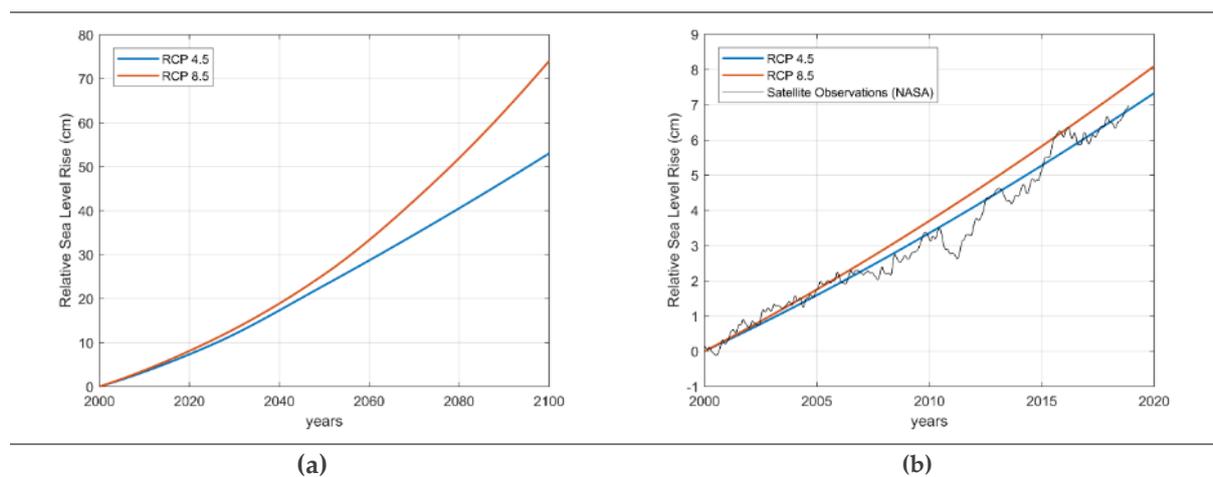
683 Coastal retreat occurs as a consequence of these processes.

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

687 **5.1.13.1 Sea Level Rise**

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

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

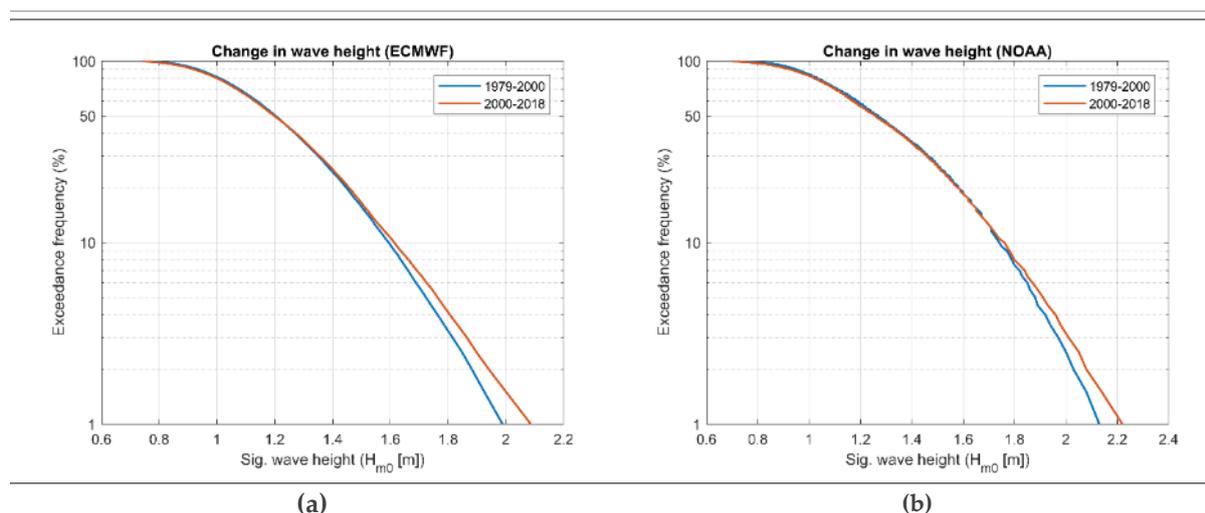


700 Figure 5-29 Projected relative sea level rise for RCP 4.5 and RCP 8.5 for the years 2000 to 2100; (b) Comparison  
701 between projected sea level rise and observed sea level rise for the years 2000 to 2020 (CDR International, 2019a)

702 **5.1.13.2 Change in Wave Climate**

703 Over the last decade, the wave climate in Liberia has changed, as can be seen in Figure 5-30.  
704 Due to climate change, the wave height distribution has changed between the periods of 1979-  
705 2000 and 2000-2018, with the higher waves (especially the 10% highest waves) becoming  
706 higher and increasing up to 3 to 5%.

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



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

### 712 5.1.13.3 Change in Storms and Storm Erosion

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

717 Due to climate change, the 100 year wave height will have a return period of approximately  
718 40 years with RCP 4.5 and 25 years with RCP 8.5 in 2100. In other words, storms will occur  
719 twice more often with RCP 4.5, and four times more often with RCP 8.5.

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

724 Table 5-11: Additional coastal retreat (storm erosion) due to storms with a return period of 100 years for the  
725 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   |

726 **5.1.13.4 Change in Sediment Exchange with Rivers and Estuaries**

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

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

- 733 • The sediment import of the St. Paul River will increase by 12% and 18% in the year  
734 2100 for RCP 4.5 and RCP 8.5, respectively. This will primarily be caused by the high  
735 contribution of anthropogenic effects, such as expected deforestation and change in  
736 land-use.
- 737 • Similarly, the sediment import of the Farmington River will increase by 10% and 12%  
738 in the year 2100 for RCP 4.5 and RCP 8.5, respectively. This will also mainly be caused  
739 by the high contribution of anthropogenic effects, such as expected deforestation and  
740 change in land-use.
- 741 • The sediment demand of the Mesurado River will significantly increase due to climate  
742 change.

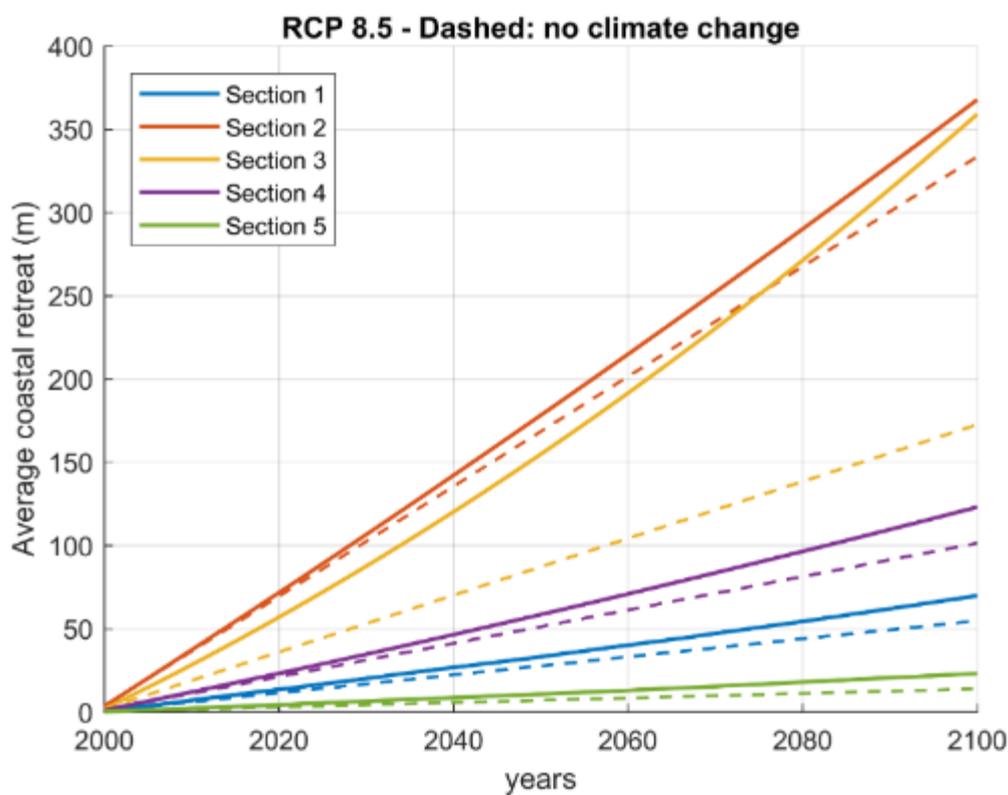
743 **5.1.13.5 Coastal Retreat**

744 For the last decade, coastal retreat has posed the most pronounced environmental threat on  
745 the coast of Monrovia, leading to loss of land, valuable assets and recreational beaches. The  
746 average coastal retreat along the coastal sections between 2008 and 2018 is shown in Table  
747 5-12. Coastal sections 2 and 3 have been the most impacted, while coastal section 5 has been  
748 the least impacted.

749 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   |

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



759  
760 Figure 5-31 Average coastal retreat with (continuous line) and without (dashed line) climate change (CDR  
761 International, 2019a)

---

## 762 5.2 BIOLOGICAL ENVIRONMENT

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

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

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

### 777 5.2.1 Coastal and Marine Ecosystems

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

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

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

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

#### 801 5.2.1.1 Beaches

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

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



818

819

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



820

821

822

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)

823 **5.2.1.2 Coastal Savannah**

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

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



832  
833 **Figure 5-34 A stretch of coastal savannah fringing the beach at the northern coast of Monrovia (coastal section 1)**

834 **5.2.1.3 Coastal Wetlands**

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

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

---

## 845 **The Mangrove Ecosystem**

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

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

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

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



881  
882 Figure 5-35 Mangrove trees at the St. Paul River Estuary

### 883 **Mesurado Wetland**

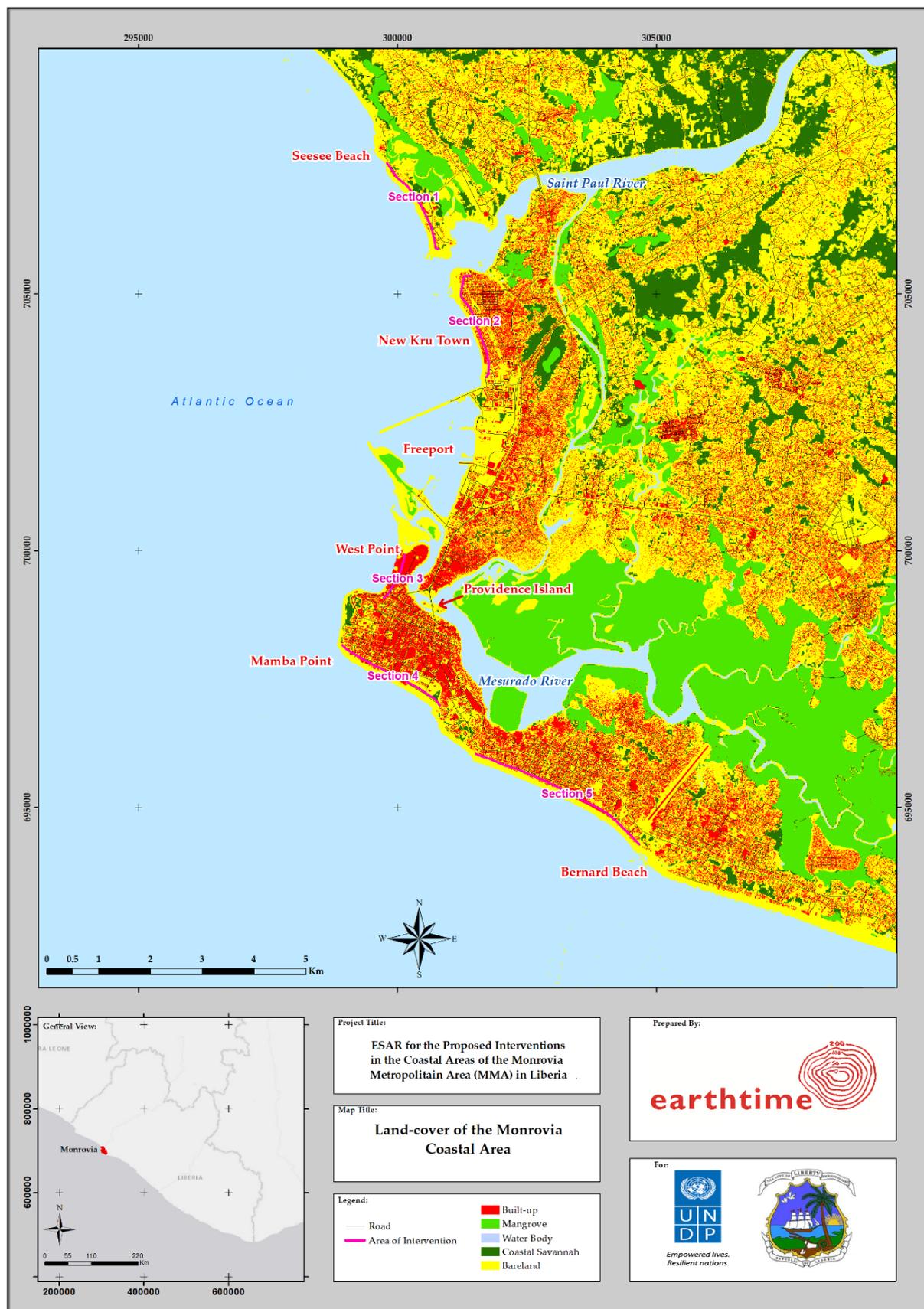
884 The Mesurado Wetland is situated in the heart of the city of Monrovia (Figure 5-36). This  
885 estuarine wetland of 6,670 hectares is one of the five designated Wetlands of International  
886 Importance in Liberia. This site has a high ecological value, mainly due to three mangrove  
887 species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

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

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

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



904  
905

Figure 5-36 Land cover map of the project area



906  
907

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



908  
909

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

### 910 **Other Coastal Wetland Areas in Monrovia**

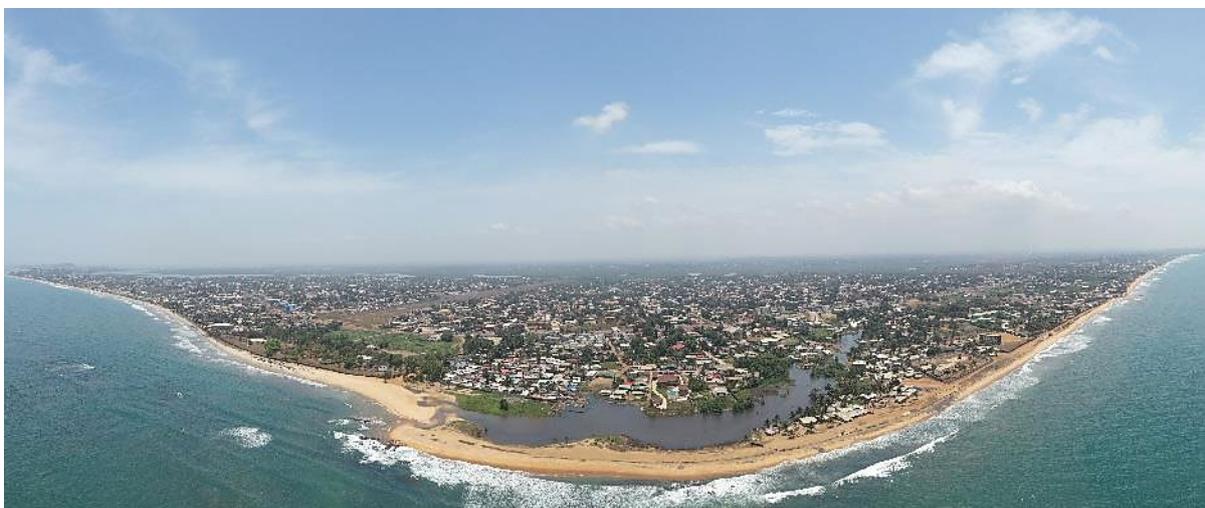
911 Apart from the Mesurado Wetland which covers a big part of the city, the coast of Monrovia  
912 harbours smaller wetland areas which provide ecological benefits to the coast. An estuarine  
913 mangrove area is found in the St. Paul River Estuary at the northern bank of the St. Paul River  
914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

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

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



923  
924 **Figure 5-39 Mangrove area lying parallel to the beach at the northern bank of the St. Paul River Mouth (coastal**  
925 **section 1)**



926  
927 **Figure 5-40 Bernard Beach lagoon lying parallel to the coast to the east of coastal section 5**

---

928 **5.2.1.4 Seagrass Beds**

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

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

938 **5.2.1.5 Shelf Habitats**

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

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

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

#### 966 5.2.1.6 Coral Reefs

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

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

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

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

## 991 5.2.2 Coastal Biodiversity

### 992 5.2.2.1 Coastal Flora

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

997 According to the most recent National Biodiversity Strategy and Action Plan submitted by the  
998 Government of Liberia to the Convention on Biological Diversity, a fifth species (*Conocarpus*  
999 *erectus*) may also occur in the country; its presence is yet to be confirmed (Republic of Liberia,  
1000 2017). Although the occurrence of *Conocarpus erectus* was stated in many references, Adam  
1001 (1970), Spalding et al. (1997) and Corcoran et al. (2007) describe *C. erectus* to be the dominant  
1002 mangrove species around Cape Palmas in southeastern Liberia and to occur in the central  
1003 coast of Liberia. They also refer to the presence of *Acrostichum aureum* in the Cape Palmas area.

1004 Also common in the coastal zones are palm trees such as the coconut tree (*Cocos nucifera*), the  
1005 African oil palm (*Elaeis guineensis*) and the raphia palms (*Raphia palma-pinus*, *Raphia vinifera*  
1006 and *Raphia hookeri*). Mango trees (*Magnifera indica*), papaya trees (*Carica papaya*) and other fruit  
1007 trees as well as some ornamental plants are also common in the coastal area.

1008 Minor seagrass growth may occur in the coastal areas of Monrovia, especially in lagoons and  
1009 wetland areas such as the Mesurado Wetland. Published data verifying their existence and  
1010 taxonomy is not available. Liberia has only three recorded species of seagrass (*Cymodocea*  
1011 *nodosa*, *Ruppia maritima* and *Halodule wrightii*), the most common being *Halodule wrightii* (Dr.  
1012 Aaron Lobo, Personal Communication, February 12, 2019).

---

1013 **5.2.2.2 Coastal Fauna**

1014 The wetland ecosystems of Monrovia support a very diverse assemblage of faunal species,  
1015 some of which have high biological, conservational or economical values. Important faunal  
1016 species of the Mesurado Wetland are listed in Table 5-13. The listing is extracted from the  
1017 Ramsar site designation documents (2006). Detailed information on the diversity, structure  
1018 and species abundance of these assemblages is not available.

1019 Although not mentioned in the Ramsar documents, the West African Manatee *Trichechus*  
1020 *senegalensis* (IUCN status: Vulnerable) was recorded in the Mesurado Wetland as well as in  
1021 the St. Paul River Estuary (Dr. Aaron Lobo, Personal Communication, February, 12, 2019).  
1022 Other mammals that are expected to occur in the coastal wetland areas of Monrovia are rats,  
1023 mice, bats, duikers and antelopes species.

1024 Apart from the crocodile species listed in Table 5-13, reptiles expected to exist in these  
1025 wetlands are water snakes, lizards, skinks as well as turtles. In addition, a multitude of birds,  
1026 molluscs, fish, crabs and shrimps are found in the wetlands. Nonetheless no published data  
1027 about the exact taxonomy of these faunal species is available. Adult marine turtles may also  
1028 be encountered nesting in sheltered wetland areas. Their juveniles may be found traversing  
1029 the coastal estuaries while reaching to the ocean.

1030 In contrast, the faunal diversity of sandy beaches along the coast is relatively very low. It is  
1031 limited to some crab (Figure 5-41a), lizard, mollusc and insect species as well as birds. Birds  
1032 commonly found resting or feeding on sandy beaches in Liberia are terns, herons (Figure  
1033 5-41b) and waders (Gatter, 1997). It is not likely that sea turtles nest on beaches of Monrovia  
1034 because of the relatively high human traffic on these beaches. Surveys carried out by  
1035 Earthtime's social team among the different fishermen communities of Monrovia did confirm  
1036 that turtles do not nest on the city's beaches. However, numerous records of turtle nesting  
1037 activities are reported for the southeast beaches of Liberia up to Grand Bassa County (see  
1038 section 5.2.3.2 - Marine Reptiles).

1039

1040 Table 5-13 Important mammal, reptile and bird species of the Mesurado Wetland (adapted from The Ramsar  
1041 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 sandwicensis</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)

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(a)



(b)

1043 Figure 5-41 Ghost Crab foraging on a beach in the southeast of Monrovia in March 2019; (b) Herons near the  
1044 beach in Monrovia

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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)



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

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### 5.2.3 Marine Biodiversity

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#### 5.2.3.1 Marine Flora

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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).

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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.

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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.

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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 breviararticulatus</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>           |                                   |

1072 5.2.3.2 **Marine Fauna**

1073 **Marine Invertebrates**

1074 Detailed surveys of marine invertebrates in Liberia are lacking. However, the nearshore zone  
1075 has well developed crustacean and mollusc populations, including commercially valued  
1076 species. Crustaceans include penaeid shrimps and crabs; molluscs include oysters, cones,  
1077 conches, arcs, and volutes.

1078 A list presented in Liberia's first National Biodiversity Strategy and Action Plan (NBSAP) in  
1079 2003 defined marine invertebrates for the locations of ELWA, Banjor and West Point (in  
1080 Montserrado County) and Marshall (in Margibi County) (Table 5-15). It included species of  
1081 different habitats, ranging from pelagic to benthic. No information on the exact methods of  
1082 data collection was provided (GoL, 2003b). However, the listed species can be considered to  
1083 be commonly found in the project area. One of these species, the Portuguese Man of War, is  
1084 shown in Figure 5-44.

1085 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>Haliotis 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 winkle | Intertidal            |
|               | <i>Ventricolaria</i>             | Venus clam              | Shallow water         |
|               | <i>Crassostreaa 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               |



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

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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>.

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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%),

1107 and then molluscs (23%), collectively comprising 88% of the macrofauna. Other higher order  
1108 taxa collectively making up 12% of the total abundance included echinoderms, sipunculans  
1109 (peanut worms), nematodes (round worms), nemertean (ribbon worms), enteropneusts  
1110 (acorn worms), platyhelminths (flatworms), hydroids, sea anemones, and bryozoans. Table  
1111 5-16 presents the abundance and types of macrofauna recorded in the study area. Of the 99  
1112 families identified, nine were most common and these made up more than 50% of the total  
1113 abundance (Table 5-17). Dominant families were typical cosmopolitan inhabitants of shelf and  
1114 slope sediments worldwide (TDI Brooks Intl. and Interact PMTI, 2013). These included  
1115 spionid, cirratulid, paraonid polychaetes, phoxocephalid amphipods and thyasirid and  
1116 nuculanid (bivalve) molluscs.

1117 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. |

1118 Table 5-17 Dominant families of macrofauna in Exxon Mobil's Block 13 (TDI Brooks Intl. and Interact PMTI,  
1119 2013)

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

1120 **Marine Birds**

1121 In general, terns and most importantly black terns (*Chlidonias niger*) pass through the offshore  
1122 waters of Liberia, mainly in the spring when food stocks are high (Gatter, 1997). A survey of  
1123 the pelagic resources and marine ecosystems off West Africa undertaken by R/V Dr. Dridjtof  
1124 Nansen in 2017 revealed an abundance of Arctic and comic terns offshore Liberia. The survey  
1125 also identified a juvenile gannet, a skua and a white-fronted petrel (Boyer et al., 2017). Birdlife  
1126 International's database lists 19 species of seabirds for Liberia (Table 5-18).

1127 **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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1128 **Marine Mammals**

1129 Specific records of marine mammal occurrences in Liberian waters are scarce. The most  
1130 comprehensive data source on marine mammals in Liberia is the result of a focused literature  
1131 review on the occurrence of both marine mammals and sea turtles, which was undertaken by  
1132 Dr. Caroline R. Weir in 2013 as part of the ESIA for Exxon Mobil's Block LB-13 Exploratory  
1133 Drilling Program. The literature review was able to locate reliable records for the confirmed  
1134 occurrence of nine marine mammal species within the Liberian EEZ. These are:

- 1135 • the Bryde's Whale;
- 1136 • the Humpback Whale;
- 1137 • the Sperm Whale;
- 1138 • the Killer Whale;
- 1139 • the Short-Finned Pilot Whale;
- 1140 • the Pantropical Spotted Dolphin;
- 1141 • the Spinner Dolphin, the Clymene Dolphin; and
- 1142 • the West African Manatee (Weir, 2013).

1143 A further 19 marine mammal species were confirmed to occur within the wider study area  
1144 examined in the literature review and are considered very likely to occur in Liberian waters  
1145 on an occasional or regular basis. These are: the Blue Whale, the Fin Whale, the Sei Whale, the  
1146 Common Minke Whale, the Dwarf Sperm Whale, the Pygmy Sperm Whale, Cuvier's Beaked  
1147 Whale, Gervais' Beaked Whale, the False Killer Whale, the Melon-Headed Whale, the Pygmy  
1148 Killer Whale, the Atlantic Humpback Dolphin, the Rough-Toothed Dolphin, Risso's Dolphin,  
1149 the Bottlenose Dolphin, the Atlantic Spotted Dolphin, the Striped Dolphin, the Common  
1150 Dolphin and Fraser's Dolphin. One further species, the Blainville's Beaked Whale, has not  
1151 been documented within the study area but is expected to occur in the region based on its  
1152 worldwide distribution (Weir, 2013).

1153 Consequently, a marine mammal fauna list consisting of 29 confirmed and potential species  
1154 was identified for Liberia, comprising six baleen whale species, three sperm whale species,  
1155 three beaked whale species, 16 delphinid species (Figure 5-45) and a single species of Sirenia  
1156 (sea cows and manatees). Of these, two species are of particular conservation importance in  
1157 the region, the Atlantic Humpback Dolphin and the West African Manatee, as both are

1158 endemic to the tropical Atlantic coast of Africa and both are on the IUCN Red List of  
1159 threatened species (Table 5-19). Both species inhabit nearshore coastal waters and estuaries  
1160 (and freshwater rivers and lakes in the case of the manatee) and are therefore very vulnerable  
1161 to human impacts such as by-catch, hunting, and habitat loss (Acorn Intl. and Earthtime Inc.,  
1162 2014).



1163  
1164 Figure 5-45 Dolphins 15 km off Monrovia (Extreme Fishing Charters, undated)

1165 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)

1166 Interviews with local fishermen in Monrovia revealed a good level of awareness regarding  
1167 endangered marine mammal species. All interviewed fishermen groups stated that they do  
1168 not catch marine mammals. The meeting with NAFAA also confirmed that catching marine  
1169 mammals is prohibited and that the enforcement is strong regarding this matter. However, it  
1170 is very likely that marine mammals are still being caught, sold and/or consumed by the local  
1171 fishing communities, given the fact that they are poor and in need of any money they can  
1172 acquire (see section 5.3.11.11).

1173 **Marine Reptiles**

1174 Accessible material in terms of specific records of sea turtle occurrence in Liberian waters and  
1175 coastal areas is very limited. The focused literature review on the occurrence of both marine  
1176 mammals and sea turtles in the area, which was undertaken by Dr. Caroline R. Weir in 2013  
1177 as part of the ESIA for Exxon Mobil’s Block LB-13 Exploratory Drilling Program, concluded  
1178 that information available on sea turtles in Liberian waters is largely generic and anecdotal,  
1179 and refers predominantly to -mostly dead- sea turtles encountered during opportunistic  
1180 surveys and unverified reports from fishermen (Acorn Intl. and Earthtime Inc., 2014).

1181 However, the review did confirm that four species of sea turtles are present in Liberian waters  
1182 and nest in Liberia: the Olive Ridley, Leatherback, Green and Hawksbill turtles (Table 5-20).  
1183 Anecdotal references to the occurrence of nesting Loggerhead turtles did not seem to be  
1184 supported by verified records, although it should be expected that foraging loggerhead turtles  
1185 do occur at sea within the Liberian EEZ (Weir, 2013). Satellite-tracked Loggerhead turtles from  
1186 the Cape Verde population travelled at least as far south as Sierra Leone on foraging  
1187 excursions (Hawkes et al., 2006) and may be expected to also venture into Liberian waters.

1188 **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>Erethmocheys imbricata</i> | Hawksbill Turtle   | CR                      |

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

1189 Basic information on sea turtles nesting in Liberia cover only the southeastern part of Liberia.  
1190 Information relating to the northern part of Liberia could not be located. In 2003, the Save My  
1191 Future Foundation (SAMFU) published data on turtle nesting on beaches of Sinoe, Grand-Kru  
1192 and Maryland County. More recently (since 2013), the Sea Turtle Watch (STW), another local  
1193 non-governmental organisation (NGO), has been doing some work on sea turtle conservation  
1194 in the Grand Bassa and Rivercess counties. Findings of both the SAMFU and the STW show  
1195 that the Olive Ridley and Leatherback turtles (Figure 5-46) are the most abundant species in  
1196 Liberia, followed by the Hawksbill and Green turtles.

1197 On the other hand, no information could be located regarding the distribution of these animals  
1198 at sea, although it can be expected that most - if not all - of the sea turtle species recorded use

1199 both coastal and pelagic waters in Liberia's EEZ for foraging and migrating, and are present  
1200 in these habitats throughout the year (Weir, 2013). Furthermore, anecdotal information  
1201 suggests a nesting period from September to March, which corresponds with the documented  
1202 nesting seasonality of Green, Leatherback and Olive Ridley turtles in nearby countries. It  
1203 should also be considered that males, non-breeding females and immature turtles may occupy  
1204 foraging habitat year-round, and that seasonality of nesting behaviour is only a small -  
1205 although crucial with regards to population longevity - part of the overall picture (Weir, 2013).



1206  
1207 Figure 5-46 A Leatherback sea turtle (*Dermochelys coriacea*) being released at the Samuel Brown Town beach -  
1208 District #1, Grand Bassa. (Reuben Chinney, February 2016)

1209 Despite national and international initiatives to protect these endangered species, sea turtles  
1210 are still hunted for food throughout Liberia. Their eggs are also collected by humans,  
1211 destroyed by dogs and pigs on the beaches, and occasionally caught by artisanal fishermen in  
1212 nets. However, lately, a better level of awareness with regards to sea turtle conservation is  
1213 observed among coastal communities. This was noticed during Earthtime's recent interviews  
1214 with the local fishermen communities. All interviewed fishermen reported that they do not  
1215 catch or kill sea turtles. However, as it is the case for marine mammals, it is very unlikely that  
1216 the by-caught sea turtles are returned to sea, given the high poverty level of the fishermen  
1217 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 Dolphinfish                   | Forbor                              | LC                      |
| Coryphaenidae   | <i>Coryphaena hippurus</i>        | Mahi Mahi, Dorado, Common Dolphinfish | 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 Sicklefish                    | 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 Sengalensis</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                      |
| Xiphidae       | <i>Xiphias gladius</i>           | Swordfish                       | Unknown                    | LC                      |

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

1234 For the aim of this project, an effort to gather information on the common fish species and  
1235 fishing grounds in the Monrovia area was made one of the emphases of the interviews held  
1236 by Earthtime's social team with the local fishermen communities of Monrovia. This part of the  
1237 interviews aimed at identifying:

- 1238 • the most common fish in the area;
- 1239 • the seasonal variations in fishing, which gives an idea on the seasonal patterns of fish  
1240 occurrence in the area;
- 1241 • the common fishing grounds; and
- 1242 • the catches of sharks and rays.

1243 The results of these interviews, described in detail in section 5.3.11.5 (Table 5-31), showed that  
1244 Cassava Croakers (Cassava Fish), West African Ilisha (Gbapele), Sardine (Bonny) and  
1245 Barracuda (Pipe fish) are the most abundant in the coastal waters of Monrovia, up to 6  
1246 Nautical Miles (NM). Cassava Croakers seem to be mostly abundant at 2-3 NM offshore. Other  
1247 fish commonly present are Groupers, Snappers and the Lesser African Threadfin (Butternose).  
1248 Tuna species (Figure 5-47), Wahoos, Marlins and Sailfish (all three are locally called Napleh),  
1249 Sharks and Rays are more common in the offshore waters beyond 6 NM. The fishing season  
1250 extends usually from October to May. June to September is considered to be a low season for  
1251 net fishing (Cassava, Sardine, Barracuda, Ilisha, etc.) but the high season for hook and line  
1252 fishing, which targets mostly Snappers on rocky bottoms. This means that the fish is mostly  
1253 abundant from October to May (examples shown in Figure 5-48), except for fish foraging on  
1254 rocky bottoms, such as Snappers, which are frequent between June and September.

1255



1256 Figure 5-47 Yellowfin Tuna at sea off Monrovia (Extreme Fishing Charters, 2018)

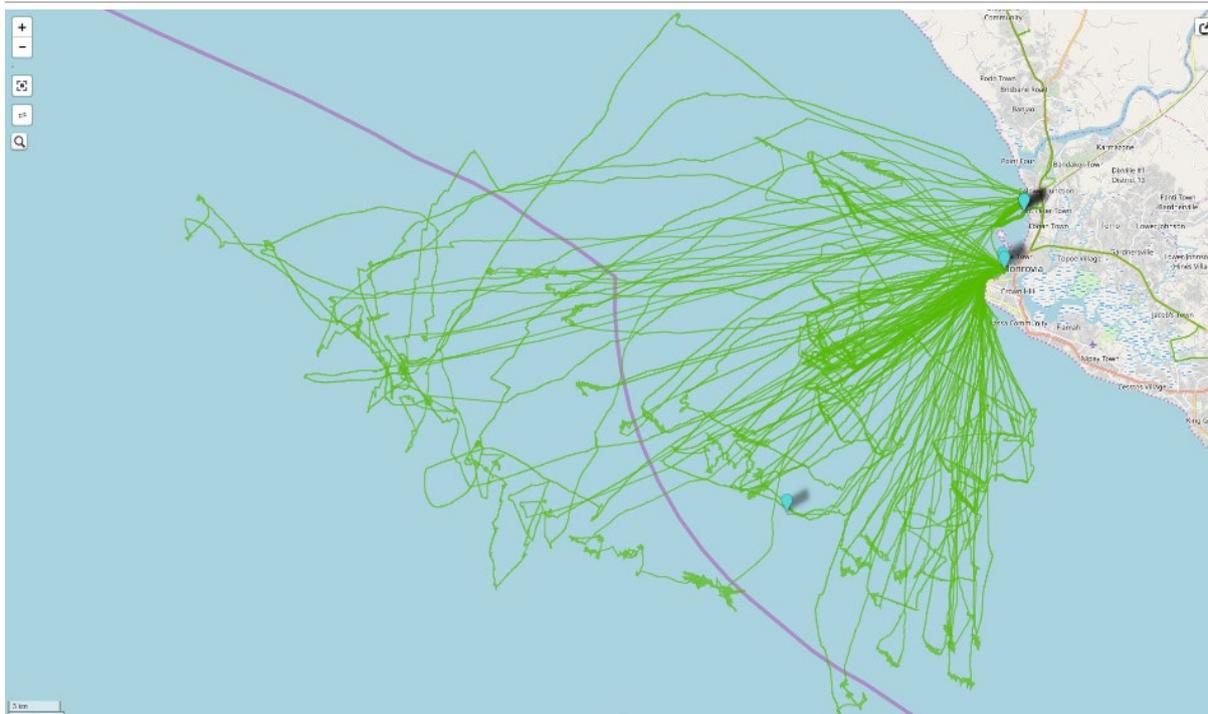


1257 Figure 5-48 Fish caught at West Point in February 2019 (a) Cassava Fish (*Pseudolithus* sp), Pipefish (*Sphyrna* sp) and Snakefish (*Muraenidae* family); (b) Cassava Fish (*Pseudolithus* sp), Pipefish (*Sphyrna* sp) and Pojoe  
1258 (Carangidae family); (c) Forbor (*Corypheana* sp); (d) Red snapper (*Lutjanus* sp)  
1259

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1260 Recently, some effort, albeit still primitive, has been carried out by the NAFAA and the World  
1261 Bank for the mapping of artisanal fishing grounds as well as the coupling of fishing tracks  
1262 with landings data. A data collection system was setup in 2018 in few selected fishing  
1263 communities of Monrovia and Robertsport in Grand Cape Mount County. This pilot project  
1264 aimed at linking vessel tracking system technology with mobile phone technology which  
1265 combines information on fishing effort with information on the fish landed from tracked  
1266 fishing trips. Some fishing tracks recorded by Fanti and Kru canoes from West Point and the  
1267 Mesurado Pier Communities in Monrovia are presented in Figure 5-49. The figure provides  
1268 an example of the usual fishing grounds locations of these communities. The furthest reaching  
1269 canoes are Fanti canoes, since they are typically much longer and broader than those of the  
1270 Kru and powered by outboard motors.

1271 To identify the linkages between landings data and the trip where fish were caught, landings  
1272 were recorded from canoes fitted with trackers. An example of this is shown in Figure 5-50.  
1273 This kind of data has the potential to provide improved information on the fishing locations  
1274 and seasonal variations of the fishing effort of the coastal fishing communities of Monrovia.  
1275 As a result, it will be possible to better quantify the project impacts pertaining to fish  
1276 distribution, abundance and diversity, as well as the underlying impacts on local coastal  
1277 fisheries.

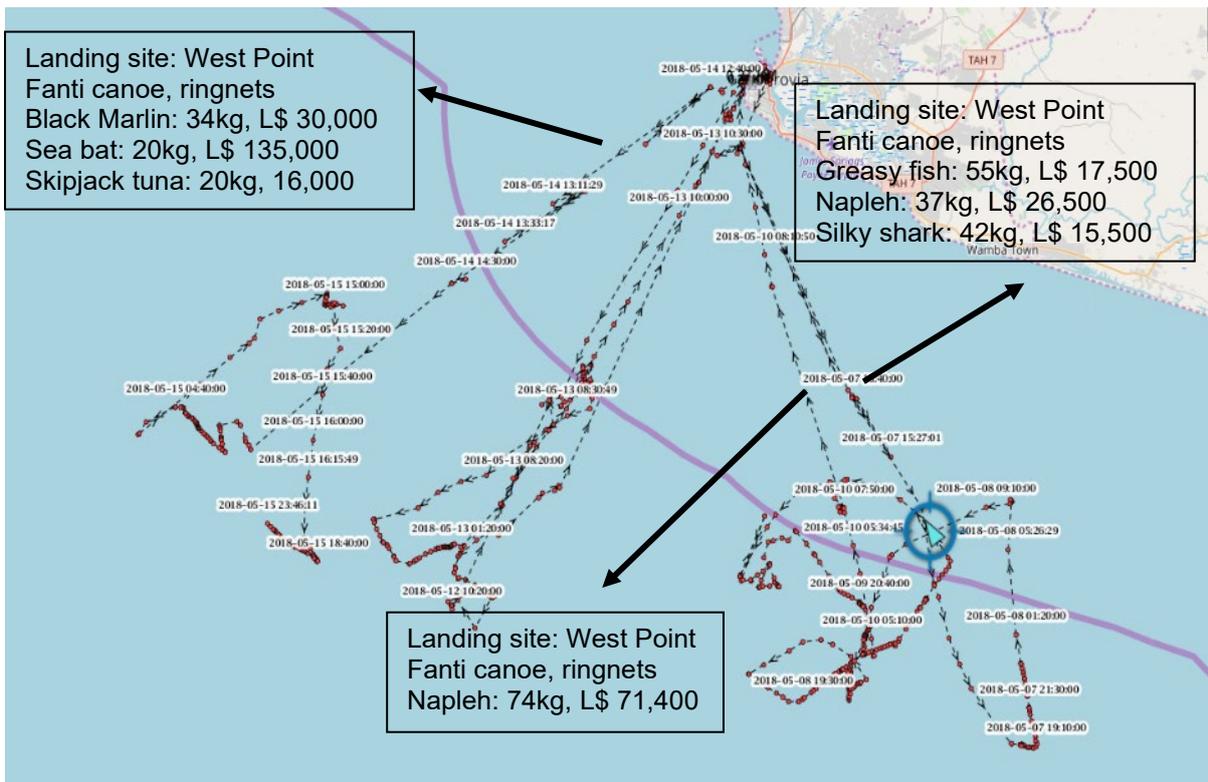


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Figure 5-49 Recorded vessel tracks (green lines) in Monrovia in relation to the 12 nautical mile limit (purple line) (NAFAA, World Bank and MacAllister Elliott & Partners, 2018)



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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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#### 1285 5.2.4 The Biological Environment in West Point

1286 In coastal section 3 (West Point), where the construction of a revetment wall is planned, the  
1287 beach is narrow and sandy and is home to a few species of crabs, molluscs, lizards and birds  
1288 as elsewhere in the altered littoral fringe habitats close to Monrovia. Data on the biological  
1289 diversity found on this beach are not available. The biological value is expected to be low as  
1290 this is a beach which is constantly frequented by the fishermen and local community of West  
1291 Point. It is polluted by solid waste and is widely used by the West Point community for  
1292 defecation, due to the lack of toilets available in the township. The coastal savannah that  
1293 usually fringes beaches in Liberia is not present on the geomorphological formation  
1294 underlying West Point, which is an unconsolidated sand spit: built structures start  
1295 immediately above the active inter-tidal beach (Figure 5-51). Also, there is no mangrove  
1296 development along the beach, because of the exposure to strong waves. However, a small  
1297 patch of mangroves is found on the little island located behind the northern end of the beach  
1298 at the outlet of the Mesurado River. Some mangrove trees, as well as some coastal savannah  
1299 species, are also observed on the small beach created by the sand deposits south of the  
1300 northern breakwater of the Monrovia port (Figure 5-52). On the northern end of West Point  
1301 also, nested behind the beach, is a small lagoon that is surrounded by built structures and is  
1302 being filled with solid waste and old tires to make space for new structures. It is heavily  
1303 polluted by this waste and does not appear to harbour any important biological life (Figure  
1304 5-53).

1305 Data on the continental shelf biodiversity in front of the West Point beach are also not  
1306 available. However, it is expected that the usual soft bottom-dwelling (infauna and epifauna)  
1307 species described earlier are found. Interviews with the West Point Kru fishermen, who fish  
1308 in the nearshore waters of West Point, revealed that the most commonly fished species are  
1309 Barracuda (Pipe Fish), Cassava Croakers (Cassava Fish) and Snappers. The high proportion  
1310 of Snappers in the landings suggests that there are patches of rocky sea bed offshore from  
1311 West Point because these species are usually caught over rocky bottoms.

1312 The biological data on the ecology and biodiversity of the West Point beach and continental  
1313 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**



1321

1322

1323

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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### 1324 5.3 SOCIO-ECONOMIC ENVIRONMENT

1325 Monrovia is situated in the District of Greater Monrovia in Montserrado County, central  
1326 coastal Liberia. Municipally, Greater Monrovia District is subdivided into two city  
1327 corporations and ten other local authorities (nine townships and one borough). Established  
1328 by law in 1973 and operational since 1976, the Monrovia City Corporation (MCC) is  
1329 responsible for the city's administration. The Paynesville City Corporation (PCC) is  
1330 responsible for services in their area to the east of central Monrovia. The MCC also provides  
1331 urban services to the townships and borough through a revenue-sharing arrangement, but  
1332 has no zoning or enforcement jurisdiction in them. Administratively, instead of being divided  
1333 into clans like other districts of Liberia, Greater Monrovia is divided into 16 "zones". Like clans  
1334 in rural areas, these zones are subdivided into 161 "communities".

1335 Monrovia lies along the Cape Mesurado peninsula, between the Atlantic Ocean and the  
1336 Mesurado River, whose mouth forms a large natural harbour and was the historical reason  
1337 for the location of the town at this point. The city of Monrovia is spread across the Mesurado  
1338 peninsula, with the greater Metropolitan area encircling the marshy Mesurado River's mouth.  
1339 The historic downtown, centred on Broad Street, is at the very end of the peninsula, with the  
1340 major market district, Waterside, immediately to the north, facing the city's large natural  
1341 harbour. Around the centre are a number of low-income informal communities built on low-  
1342 lying, frequently flooded land that was less attractive for development because of the  
1343 flooding. These communities are vital for the continued success of Monrovia.

1344 Northwest of Waterside is the large, low-income West Point community which is both a zone  
1345 and a township. Further east down the peninsula is the Sinkor section of Monrovia which has  
1346 several informal communities along the beach front.

1347 The St. Paul River lies directly north of the city and forms the northern boundary of Bushrod  
1348 Island, which is reached by crossing the "New Bridge" from downtown Monrovia.

1349 On Bushrod Island, north of central Monrovia is the New Kru Town zone and Borough.  
1350 Further north of Bushrod Island are newer communities growing around the site of the former  
1351 Hotel Africa.

1352 The Multi-stakeholder Analysis Report (Mayson, 2018) identified 15 low income communities  
1353 living and working on the coastline in Monrovia exposed to flooding. This number was  
1354 increased to 20 during the community consultation period for this study as communities  
1355 defined their own boundaries (Table 5-22). All these communities lie in the sea flooding areas;  
1356 their geographical distribution is shown in Figure 5-54.

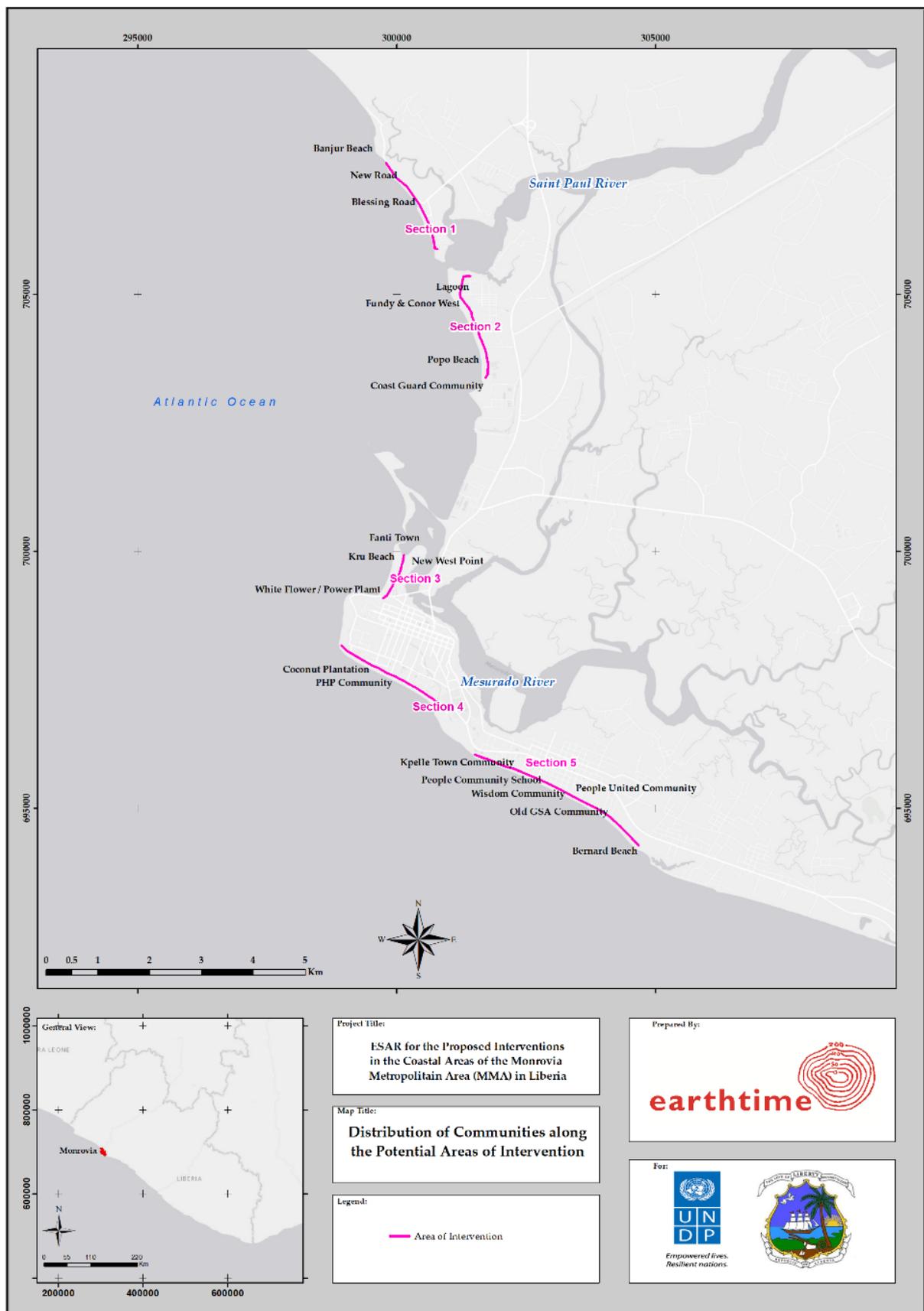
1357 Table 5-22 List of low-income communities affected by sea flooding and climate change; fishing communities  
1358 are shaded

| 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.

1359 Official statistical population data for the low-income communities affected by sea flooding  
1360 and climate change is not available at the individual community level or even at zone / town /  
1361 ward level inside each of the administrative areas. Data offered in this socio-economic section  
1362 has been drawn from the most recent, available data but often refers to the whole of Monrovia  
1363 or the Montserrado County in which Monrovia is located. The data presented are fully  
1364 referenced and the applicability of each datum to the study area noted.

1365 A Community Consultation exercise for this ESAR collected information from within the  
1366 communities on activities and facilities which is presented in this section.



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1368

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

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### 1369 5.3.1 Methodology for Social Investigations

1370 The requirements of the UNDP ESAR are:

- 1371 1. The collection of secondary data to outline the communities affected by the proposed  
1372 project,
- 1373 2. Rapid appraisal of social fishing livelihoods issues upon which little or no available  
1374 data is available and which it is vital that the project must be informed about during  
1375 the design process.
- 1376 3. A community consultation to ensure all affected communities are aware of and kept  
1377 informed about the project and that their views are incorporated in project design.

1378 Secondary data from census and other official statistical material published by the Liberia  
1379 Institute of Statistics and Geo-Information Services (LISGIS) were gathered from online  
1380 sources and followed up where possible in Monrovia. However, the last census was  
1381 conducted in 2008 (LISGIS, 2009) and the extraction of data to enumeration areas covering the  
1382 affected communities was not possible. Secondary data presented here has been extracted to  
1383 the smallest effective and appropriate level consistent with confidence in the material.

1384 The second area for data collection was for a rapid appraisal of the fishing-based communities  
1385 along the beaches potentially affected by sea level changes and the possible locations of coastal  
1386 interventions. The aim of the appraisal was to collect background information about fishing  
1387 and fish processing / selling (mongering) activities to inform the environmental investigations  
1388 as well as help define the scope and nature of social impacts of the project. This data was  
1389 collected through a series of focus group discussions with fishermen and fishmongers.

1390 The key assumption for rapid appraisal data collection is that the answers are deemed to be  
1391 true as there is no opportunity to triangulate the data collected through rapid survey  
1392 techniques. The aim of the investigation is to gather background information into how  
1393 fishermen communities operate, how and where they fish, the equipment used, frequency of  
1394 fishing, type of catch and an outline of the economy of fishing and its role in Monrovia's life  
1395 and that of Liberia as a whole. Similarly, the background information into fish mongering  
1396 activities covered buying, processing and selling the different types of fish and the variety of  
1397 marketing opportunities available to fishing communities.

1398 Focus group discussions (FGDs) were chosen as the data collection process for this topic. For  
1399 the small length of time available for the ESAR, focus groups maximise the collection of data  
1400 from a wider spectrum of affected people in a short amount of time. Collective information  
1401 gathered in such groups tends towards greater accuracy and more balanced replies as the  
1402 answers recorded are a collective agreement. The focus group discussion topics for both  
1403 fishermen and fishmongers were developed out of discussions with the environmentalists  
1404 and economists on the team, as well as our knowledge and experience of how low income  
1405 communities in Monrovia operate and a need to collect community impact material as rapidly  
1406 as possible.

1407 A list of topics was drawn up and discussed before piloting the FGD formats in the field. The  
1408 topics were reviewed and revised after two FGDs to each target group to include more in-  
1409 depth investigation into community management and interactions with the MCC, PCC and  
1410 Borough / Township Authorities. The FGD proformas for both fishermen and fish mongering  
1411 groups are included in Appendix C.1 and Appendix C.2.

1412 The FGDs were conducted by a senior Liberian Social Consultant and a female Liberian  
1413 Interviewer assisted by an environmental trainee who surveyed the GPS coordinates for each  
1414 community to enable accurate plotting on a map (Figure 5-55). The discussions were  
1415 organized in advance through contact by the team with the voluntary Community Chairmen  
1416 for the community and the Fishing Chairmen and Fish mongering Chairs – usually female.  
1417 The team requested a time to meet the community to come and discuss the fishing livelihoods  
1418 in the community and to explore community views on impacts. The communities have to have  
1419 some time to organize such meetings so that sufficient and representative community  
1420 members are available to participate. Discussion notes and attendance records were kept of  
1421 all meetings.

1422 The fishing livelihoods FGDs were only administered to fishing communities. However there  
1423 are a number of non-fishing communities also affected by flooding from the sea, potential sea  
1424 level changes and loss of homes and livelihoods through flooding. All affected communities  
1425 have to be consulted throughout the planning and implementation phases to ensure all  
1426 impacts are identified and that concerns are addressed and unfortunate, unforeseen impacts  
1427 are not created by the project. To this end all communities were invited to meet the team to

1428 discuss possible impacts and the nature of the impact these may have on the project. A focus  
1429 group proforma was drawn up to discuss these issues with both fishing and non-fishing  
1430 communities (Appendix C.3).



1431 Figure 5-55 Focus group discussions at West Point

1432 The communities were listed on the basis of a Multi-stakeholder Analysis Report (Mayson,  
1433 2018) which had identified 15 low income communities living and working on the coastline  
1434 in Monrovia exposed to flooding. This number was increased to 20 during the community  
1435 consultation period for this study as communities defined their own boundaries. All these  
1436 communities lie in the sea flooding areas and include fishing and non-fishing communities.  
1437 A further meeting (making 21 in total) was held with the Disaster Victims Association, a  
1438 Monrovia NGO based in West Point with the aim of supporting communities in need. The  
1439 NGO was set up in 2015 after the major West African Ebola epidemic and has helped flooded  
1440 community members gain some help. A list of the locations where stakeholder meetings were  
1441 held is presented in Table 5-23.

1442 The Community Consultation exercise for this ESAR also collected information from within  
1443 the communities on activities and facilities which is presented in this section. This information  
1444 adds to the understanding of how communities are affected by flooding and how mitigation  
1445 measures, particularly this which would involve resettlement, would affect these  
1446 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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### 1448 5.3.2 Population

1449 The 2008 census (LISGIS, 2009) recorded the population of Monrovia as 1.01 million people  
1450 with the wards in the slum community areas recording a population of 127,243 people –  
1451 approximately a quarter of Monrovia’s population. By 2015, Monrovia’s population had risen  
1452 to 1.28 million (LISGIS, 2016) but there are no further up to date estimates for population levels  
1453 in the slum communities from LISGIS. Cities Alliance, a global partner of UN-Habitat  
1454 estimates that by 2016, almost a quarter of Liberians – approximately 1 million - live in the  
1455 slums of greater Monrovia and face the challenge of living in poor housing with inadequate  
1456 water supply and very little sanitation, including poorly constructed housing, lack of basic  
1457 social services, infrastructure, lack of finance and severe overcrowding (Front Page Africa,  
1458 2017).

1459 These communities contribute to the economy of Monrovia by providing goods and services  
1460 needed by the population. The coastal communities provide sustainable fish supplies to feed  
1461 the city and a myriad set of services catering for both fishing and non-fishing communities -  
1462 canoe/ boat and net repairs, small scale metal work, other food supplies, building supplies,  
1463 transport, health and education services – that feed into and support the lives of Monrovia  
1464 residents.

1465 These communities need to live and work in the areas to ensure survival. Relocation disrupts  
1466 livelihood strategies and systems, and these are difficult to replace as the nature of the  
1467 interdependence of home and work is so complex and access to the sea so vital. This social  
1468 assessment concentrates on the 20 low-income communities in the areas potentially affected  
1469 – positively and negatively – by the proposed interventions. Table 5-24 indicates the income  
1470 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<br>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

1502 the main languages spoken. The Kru are one of the three main indigenous group players in  
1503 Liberia's socio-political activities along with the Krahn and Mano people.

1504 It should be emphasized that all ethnic groups are found in most communities and whilst  
1505 fishing is mainly the preserve of the Fanti, Kru and former Popo, that other tribes, particularly  
1506 the Bassa are involved in fishing in Liberia and are often found in Monrovia as crew or  
1507 mongers.

#### 1508 5.3.4 Poverty

1509 The Liberia 2014/2015 Household Income and Expenditure Survey (HIES) gives the most  
1510 recent demographic statistics for Liberia (LISGIS, 2016). This data is aggregated to County  
1511 level and therefore is difficult to use to describe only the low-income communities in  
1512 Monrovia but it is all there is. Montserrado County which contains the District of Monrovia is  
1513 reported as a unit. This survey found that approximately a third of all Liberians live in  
1514 Montserrado County (32%). Unless stated otherwise, the data presented in this section is  
1515 drawn from the HIES study.

1516 In 2014/15, there were an estimated 938,383 households in Liberia, with an average household  
1517 size of 4.26 persons per household; households were larger in urban areas (4.37) than rural  
1518 areas (4.16). Out of a population of approximately 4 million persons, 48.5% are male and 51.5%  
1519 female. Liberia has a young population with almost one in three Liberians being less than ten  
1520 years of age. 52.7% of the population are of working age (between 15 and 65), and only 2.6%  
1521 are 65 years old or older. The HIES survey reported an average household size of 4.0 persons  
1522 in Montserrado County, lower than the national average. Montserrado had a lower than the  
1523 national average proportion of 0-14 years and higher than national average of those aged 15-  
1524 64. This reflects the pattern of families sending members to Monrovia to generate a home base,  
1525 gain employment and support other members.

1526 The HIES survey calculated three poverty lines: the food poverty line, defined as the line  
1527 below which individuals cannot meet their basic food needs; the absolute poverty line,  
1528 defined as the line below which individuals cannot meet their food and non-food minimum  
1529 needs, and the extreme poverty line, defined as the line below which individuals' total food  
1530 and non-food consumption falls below the minimum food requirements.

1531 The headcount absolute poverty figure for the country is 54.1%. Rural poverty affects 70.0%  
1532 of the population and urban absolute poverty is 43.3%. Regional absolute poverty was lowest  
1533 in Montserrado County at 31.6% households reflecting greater employment and income  
1534 generation potential. In Montserrado, the food poverty level was marginally higher than the  
1535 absolute poverty level, 32.5% compared to 31.6%. This indicates that even though some  
1536 households have sufficient expenditures that they are above the absolute poverty line, non-  
1537 food spending consumes a greater share of total resources, crowding out food spending.  
1538 Extreme poverty in Liberia affects 12.2% households, the level by county was the lowest for  
1539 Montserrado at 6.6%. These figures show that poverty is lowest in the capital area but this  
1540 generalisation hides the great variation in household incomes and access to basic life support.  
1541 The low-income communities tend to have the highest poverty indicators in the County – high  
1542 levels of unemployment, underemployment, greater reliance on the informal sector work,  
1543 alongside higher income communities where formal sector employment is more common and  
1544 where wages can buy essentials.

1545 Nationally 65.5% of total spending is on food, including the equivalent market value of home  
1546 production, and 34.5% on non-food, including estimated rent for those that own their homes  
1547 and the estimated use value of household assets. The share of food is higher in rural areas,  
1548 73.2%, compared to urban areas, 60.2%. This is consistent with rural areas being generally  
1549 poorer than urban areas, therefore devoting a larger share of the budget to food spending,  
1550 and to the larger number of necessary non-food expenditure in urban areas, including rent,  
1551 and transportation. Montserrado has the lowest share of food spending to total spending,  
1552 55.4%. In Montserrado, less than 2% of total food spending comes from home production  
1553 compared to 20% nationally. Spending on education was highest in Montserrado at 16.3% of  
1554 non-food spending compared with 12% nationally but health spending was close to the  
1555 national average at 2.2%.

1556 The highest levels of poverty are found among household heads under age 20, 71.0%, but  
1557 these represent less than 0.5% of total household heads. The lowest poverty rate, 45.8%, is  
1558 found for household heads between age 20 and 29. The poverty rate for households' head  
1559 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  
1560 household heads above age 60.

1561 The highest levels of poverty are found in households in which the head has no formal  
1562 education, 69.3%, compared to 59.6% for heads with at least some primary education, 47.0%  
1563 for heads with at least some secondary education, and 23.6% for heads with post-secondary  
1564 education. In terms of food poverty, a larger percentage of those with secondary education  
1565 are in food poverty than in poverty overall, which is consistent with most individuals with  
1566 post-secondary education residing in Montserrado. The difference, however, is more extreme  
1567 than was found between Montserrado and other areas, indicating that in particularly those  
1568 with higher education are more likely to forego food consumption in favour of non-food  
1569 spending as the costs of living other than on food expenditure is so high. Finally, there is  
1570 almost no difference in extreme poverty between those with no education and primary  
1571 education.

1572 Investigations into incomes from the project affected areas by this survey indicate that  
1573 incomes from fishing is around USD 3-7 per person per day and that incomes from non-  
1574 fishing can be a little higher. This data is anecdotal and is only indicative. What should be  
1575 emphasized is the variation in income earning potential from all low income activities. Income  
1576 earning can be zero one day and USD 10 the next dependent on the availability of work, the  
1577 weather, fish stocks and general unpredictability of life. Low income communities surveyed  
1578 prioritise spending on food and water, followed by school fees, rental payments and health  
1579 expenditure, reflecting the realities of life.

### 1580 5.3.5 Language and Religion

1581 The native languages can be grouped in four language families: Mande, Kru, Mel, and the  
1582 divergent language Gola and about 30 dialects. Most tribal/ ethnic groups in Liberia have a  
1583 language specific to their group although the official language is English.

1584 According to the 2008 National Census, 85.5% of Liberia's population practices Christianity.  
1585 Muslims comprise 12.2% of the population, largely coming from the Mandingo and Vai ethnic  
1586 groups. The vast majority of Muslims are Malikite Sunni, with sizeable Shia and Ahmadiyya  
1587 minorities. Traditional indigenous religions are practiced by 0.5% of the population, while  
1588 0.4% subscribe to no religion (LISGIS, 2009).

1589 Christian denominations include the Lutheran, Baptist, Episcopal, Presbyterian, Roman  
1590 Catholic, United Methodist, African Methodist Episcopal (AME) and AME Zion  
1591 denominations, and a variety of Pentecostal churches. Some of the Pentecostal movements are  
1592 affiliated with churches outside the country, while others are independent. There are also  
1593 members of the Church of Jesus Christ of Latter Day Saints (Mormons) and Seventh-day  
1594 Adventists. Christians live throughout the country.

1595 In a religious context, the term *kwi* connotes a style of worship of a particular Christian church  
1596 which is marked by formality and decorum. *Kwi* is a Liberian term used to connote  
1597 Westernization. Services in churches considered to be non-*kwi* have more outward spiritualist  
1598 expression, with dancing and even street processions in colourful costumes as key elements.  
1599 Non-*kwi* churches also have self-proclaimed prophets who interpret dreams and visions, and  
1600 prioritize a direct experience with the Holy Spirit. Liberia's educated elite have historically  
1601 regarded the apostolic churches as churches of the uneducated and thus non-*kwi*.

1602 Vai Muslims live predominantly in the west of Liberia while Mandingo Muslims, originally  
1603 from the Sahel, reside throughout the country.

1604 Regardless of public statements of identification with Christianity, a "vast majority" of  
1605 Liberians believe a supernatural world of ancestral and bush spirits that impact daily life.  
1606 Ethnic groups in some regions of Liberia participate in the traditional religious practices of  
1607 the Poro and Sande secret societies, with the exception of the Krahn ethnic group, who have  
1608 their own secret society (Olukoji, 2006).

1609 "Liberian religious culture is characterised by a predisposition towards secrecy (encapsulated  
1610 in the concept of *ifa mo* - "do not speak it") and an ingrained belief in the intervention of  
1611 mysterious forces in human affairs". "Both elite and non-elite Liberians usually attribute  
1612 events to the activities of secret powers and forces". "Beliefs include the conviction that there  
1613 are deep and hidden things about an individual that only diviners, priests, and other qualified  
1614 persons can unravel. This presupposes that whatever exists or happens in the physical realm  
1615 has foundations in the spirit world" (Olukoji, 2006).

1616 All religions are found in the low income communities – the 2008 census estimates 85% of  
1617 Montserrado County citizens are from a wide variety of Christian religions with  
1618 approximately 12.5% Muslim. Less than 1% claimed other religious beliefs. Traditional Poro /

1619 Sande systems are not present in the slums. Christian churches were found in all communities  
1620 whilst Muslims tend to attend mosques located outside the low income communities (LISGIS,  
1621 2009).

### 1622 **5.3.6 Indigenous Peoples, Minorities and Social Inclusion**

1623 None of the ethnic, tribal or language groups forms a distinctive majority, see Table 5-25. The  
1624 ethnic mix of Liberian societies does not have groups that could be more identifiable than  
1625 others as “indigenous” using the international definition of the term by the UNDP (UNDG,  
1626 2009) and other agencies (IFC, 2012a; IFC, 2012b). International usage refers to communities  
1627 with separate languages, culture, livelihoods very distinct from the main stream groups in a  
1628 country such that they incur additional disadvantage or require different approaches for  
1629 engagement.

1630 While each ethnic group / tribe in Liberia has its own language and customs, these are not  
1631 sufficiently distinct to entitle any group to special status. Historically the greatest division was  
1632 between the descendants of returned former slaves – the Americo-Liberian / Congo people –  
1633 and those tribes originally resident. The laws enshrining separate rights have been dismantled  
1634 and no group is additionally disadvantaged by law or practice to warrant separate  
1635 consideration. In mixed communities, most people are similarly poor and lack access to  
1636 services and ways of improving livelihood. No communities in the study area are differently  
1637 disadvantaged and all are equally vulnerable.

1638 No Liberian group is sufficiently small to be termed a minority, the previously Togolese Popo  
1639 fishing group could have been regarded as a minority as could the small groups of Cote  
1640 Ivorian and Senegalese fishermen occasionally found in Liberia, not necessarily in Monrovia.  
1641 However, these groups are integrating rapidly through proximity and intermarriage such that  
1642 designation as a minority is not useful.

1643 The main causes of social exclusion in these low income communities are the twin problems  
1644 of poverty and lack of opportunities. The legacy of the 20 years’ civil war is of the failure of  
1645 educational opportunities, limited learning and lack of study skills and knowledge is such  
1646 that job opportunities for the illiterate or low levels of literacy and low skilled are limited,  
1647 further skills cannot be easily acquired without education and advancement is restricted.

1648 People are immensely resourceful in finding ways to generate income and work hard to make  
1649 a living. Goods are sold from wheelbarrows, from pitches along the roads or door to door.  
1650 Households often have a micro workshop making small quantities of industrial products or a  
1651 food processing capability or a repair shop as part of their house structure. Transportation of  
1652 goods and people in low-income communities is provided by vehicle taxis, tuk-tuks / kekeh,  
1653 motorcycle and bicycle taxis, handcarts, human portorage as well as busses and trucks. Such  
1654 activities require large inputs of time and deflect energies from advancement.

1655 Exclusion arises through:

- 1656 • Lack of understanding, not comprehending or analysing information;
- 1657 • Lack of the School Leaving Certificate needed to access further training;
- 1658 • Lack of a sufficient English vocabulary, of reading and writing skills;
- 1659 • Not owning a radio;
- 1660 • Not joining unions of workers or traders;
- 1661 • Lack of time to attend meetings because of work in the home or to gain income; and
- 1662 • In some areas, prejudice against women's participation or involvement.

1663 Inclusion requires:

- 1664 • Ensuring that all elements of the community have access to meetings and information  
1665 by using radio and local languages;
- 1666 • Investigating community membership and seeking out and removing barriers to  
1667 participation;
- 1668 • Ensuring that questions are fully answered and comprehended as often as required;
- 1669 • Transmitting information using a variety of media;
- 1670 • Repeating consultation exercises in sufficient numbers to ensure maximum coverage;
- 1671 • Ensuring that the Administrative system and the Chiefdom systems are informed and  
1672 that information is passed down through the community; and
- 1673 • Enabling all voices to be heard at decision making times.

1674 No group living in the affected communities is socially excluded by factors such as tribal  
1675 origin, language spoken, historical or cultural influences.

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### 1676 5.3.7 Gender Dynamics

1677 Using the HIES survey to compare poverty levels by the gender of the household head, there  
1678 is no difference in poverty between male and female-headed households nationally (LISGIS,  
1679 2016).

1680 There appears to be a gender split of roles and income generation within Liberian low-income  
1681 communities with both men and women needing to gain income to survive. Fewer women-  
1682 headed households are found, indicating a generally lower status, less influence in decision-  
1683 making and less access to property and resources. Most of the women who head households  
1684 are divorced or widowed, with the result that they have reduced livelihoods options.

1685 In most parts of Liberia, including the proposed project target areas, women are still generally  
1686 the carers and providers for their families especially children but usually need to have their  
1687 own income generation activities. These may be co-dependent on the activity of their men or  
1688 be independent and own their own businesses or at least have their own income earning  
1689 strategies. Women's businesses generally need to be located near to their homes so as to  
1690 maximise sales and income as well as care for families, whereas men tend to undertake  
1691 hawking or work further afield. A survey undertaken by ArcelorMittal in 2013 as part of its  
1692 ESIA showed that, when holding other variables constant, being female had led to a  
1693 significant decrease in individual income by on average US\$266 over the year prior to the  
1694 survey, with an effect of between US\$498 and US\$34 in individual income for females. This  
1695 was in a sample of 1019 individuals, where the average annual income per capita (total income  
1696 recorded divided by number of individuals in the sample) was US\$498. However, high  
1697 variation was found in incomes with the highest annual income recorded at US\$24,792 and  
1698 the lowest at US \$8 (URS, 2013).

1699 In artisanal fishing communities, the actual fishing is primarily undertaken by men and the  
1700 processing and sale of the fish (fish mongering) are undertaken by their wives and female  
1701 relatives. It is generally thought that up to three women will process and sell the catch of each  
1702 man from each canoe or boat. The women buy the catch from the boat owner on the beach  
1703 and clean the fish nearby. Some fish is then sold on to hawkers or suppliers further in town  
1704 whilst other fish is taken to smoke. Fish smoking is undertaken by both men and women and  
1705 both sell the produce. These are often a separate group from the fishermen and the

1706 fishmongers. Catching, processing and selling the fish is therefore an extended family activity  
1707 and supports entire households. One fisherman's catch may support 5-12 persons. Fish  
1708 mongering offers women independent income generation, a direct means of support for the  
1709 children close to the home and to the means of sales (EJF, 2012). The section on fisheries  
1710 describes these activities in greater detail (Section 5.3.10).

1711 As these communities are largely based on an essentially informal economy, they are also  
1712 somewhat affected by social difficulties resulting from an underlying insecurity. While  
1713 unemployment and drug abuse affect both sexes, women can be particularly vulnerable to  
1714 exploitation by disadvantaged men frustrated by their inability to make significant headway  
1715 in society. This tends to lead to high rates of teenage pregnancies and the driving of women  
1716 into prostitution. Hence it is clear that poverty in the coastal urban communities affects  
1717 everyone, but its implications are experienced disproportionately more by women.

#### 1718 **5.3.8 Health**

1719 Liberia is one of the poorest countries in the world. Civil wars 1980-2003 killed around 250,000  
1720 people and displaced many more and destroyed most of the country's healthcare facilities.  
1721 World Health Organisation (WHO) statistics (WHO, 2019) show that life expectancy in Liberia  
1722 has risen from 47 post war to 63 years but is still much lower than the world average and other  
1723 West African countries. Communicable diseases such as malaria, HIV/AIDS, tuberculosis, and  
1724 meningitis are widespread (IHME, 2017). In 2008, Liberia had only one doctor and 27 nurses  
1725 per 100,000 people (UNFPA, 2012).

1726 Liberia was ill-equipped to handle the outbreak of Ebola in 2014 -2015. The Ebola epidemic  
1727 hit the Monrovia slum communities very hard. Ebola was first reported in Liberia in Lofa and  
1728 Nimba Counties in late March 2014 but spread rapidly and was carried quickly to Monrovia  
1729 communities. The cramped and overcrowded living conditions in the slums and traditional  
1730 methods of caring for the sick and dead created a situation whereby Ebola rapidly spread and  
1731 was a major problem in areas like West Point where overcrowding and care traditions for the  
1732 sick and dead caused an Ebola epidemic that was devastating to the community as widely  
1733 reported in Frontline Africa, 2014-2015 and other Liberian newspapers and media.

1734 A considerable amount of the population still suffers from mental illnesses or were mentally  
1735 or physically traumatized, due to 14 years of intense civil conflict. A study by the American  
1736 Medical Association (AMA) in 2008 had showed that a staggering 40% of adults had shown  
1737 symptoms of major depressive disorders. 44% of adults also had symptoms of post-traumatic  
1738 stress disorder (PTSD) (Johnson et al., 2008).

1739 HIV/AIDS is one of the biggest diseases that has affected and is affecting Liberia to date. At  
1740 any given time, 33,000 people are living with HIV in Liberia of whom nearly 60% are female.  
1741 Due to Liberia's incapability to treat this disease, only about 1.2% of those affected survive the  
1742 disease. The youth in Liberia is one of the biggest contributors to the extensive post-conflict  
1743 HIV/AIDS problem. This is due to the risky high rate of unprotected sex among adolescents.  
1744 Malnutrition is widespread in Liberia, particularly in low-income communities: Nationally,  
1745 40% of children have unnatural stunted growth and 7% of Liberia's population have highly  
1746 acute malnutrition (LISGIS, 2013).

1747 It is estimated that around half of all girls in Liberia have been subject to female genital  
1748 mutilation (FGM), which is culturally ingrained in society. It is seen as an important precursor  
1749 to marriage, to ensure a girl's purity. It causes numerous health problems and can sometimes  
1750 be fatal. Reuters reported in 2016 that Liberia's parliament removed a ban on female genital  
1751 mutilation from a new domestic violence law. The law listed it as a criminal offense, when it  
1752 was first submitted to lawmakers in September 2015. Opposition from several politicians in  
1753 April led to the FGM provision being removed from the bill (Reuters press release, 2016).

1754 It is estimated that the water production rate in Monrovia post war is only 10 percent of the  
1755 production rate of 1990 and that many communities cannot access clean drinking water.  
1756 Additionally, the Liberia Water and Sewer Corporation (LWSC) and private pumpers have  
1757 become more dependent on groundwater wells, however very few of the wells are believed  
1758 to be free of contamination. The LWSC still requires significant subsidies from outside donors  
1759 even though service is reduced to only a small part of Monrovia. The populations outside the  
1760 supplied areas have to rely on purchasing water from vendors, spring water, untreated  
1761 surface water and community operated wells in poor states of maintenance (USAID, 2010).

1762 Finally, all sewerage systems have broken down. In Monrovia, the government and donors  
1763 have relied on pumper trucks and septic tanks to remove wastewater and sewerage that has

1764 collected in low spots in the old system pipes since lift station pumps and the wastewater  
1765 treatment plant have been inoperable for the duration of the civil war and since. As a result,  
1766 most Liberians have come to rely on pit latrines or onsite septic tanks. In those areas where  
1767 sewerage or sanitation facilities are not available or completely inoperable, residents have  
1768 resorted to open defecation (USAID, 2010). The situation has not improved to date for the  
1769 communities interviewed for this study – the communities report that the beaches are  
1770 commonly used as open defecation sites for low-income communities.

### 1771 **5.3.9 Education**

1772 Education service delivery in Liberia was severely affected by the First Liberian Civil War and  
1773 Second Liberian Civil War; between 1989 and 2003 and literacy levels plummeted. Education  
1774 in Liberia is allegedly free for primary students attending a government school, but most of  
1775 these schools lack adequate learning facilities and extra funds are requested from parents.

1776 Liberia's education sector is hampered by inadequate schools and supplies, as well as a lack  
1777 of qualified teachers and corruption. A Primary School Certificate is achieved at the end of six  
1778 years primary education and a Liberia Junior High School Certificate Examination (after three  
1779 years) and a Liberia Senior High School Certificate (a further three years) can be achieved.

1780 Higher education is provided by a number of public and private universities. The University  
1781 of Liberia is the country's largest and oldest university. Located in Monrovia, the university  
1782 opened in 1862 and today has six colleges. Other universities and colleges, most faith-based,  
1783 have opened in the country since the end of the civil war.

1784 Education: An estimated 66.7% of Liberians are able to read and write. Urban residents are  
1785 more likely to be literate (76.0%) than rural residents (50.1%). A larger gap exists between  
1786 gender literacy rates, with 80.6% of males reported as literate and just 54.8% of females.  
1787 Majority of students are enrolled in government institutions (47.7%), private non-religious  
1788 schools are the second most common provider (29.3%), followed by religious entities. (LISGIS,  
1789 2017).

1790 The 2016 HIES survey reported regional differences in literacy, with a lower literacy rate of  
1791 41.9% in Grand Cape Mount County and a relatively high rate of 82.1% in Montserrado  
1792 County. From the data based on consumption quintiles, it can be seen that literacy is highly

1793 correlated with poverty. Poorer residents are less likely to be literate (42.9%). Most students  
1794 (49.2%) take between 10 and 30 minutes to reach school on foot. Nearly all students reach  
1795 school within 60 minutes, however 6.6% take longer. Textbooks used by students are  
1796 predominantly borrowed from school or owned by the household (47.4% and 33.4%  
1797 respectively). However, in urban areas, the proportion that owns a textbook is higher (42%),  
1798 while in rural areas, those who borrow from schools is much higher (74.3%) (LISGIS, 2017).

### 1799 5.3.10 Fisheries

1800 The marine fishery resources of Liberia are exploited by two types of fisheries:

- 1801 • The artisanal canoe fishery operating in estuaries and shallow inshore waters and  
1802 extending from the shoreline to a depth of 20-40 m;
- 1803 • The industrial trawl fishery supposedly operating in open deeper waters, and  
1804 targeting finfish or shrimp. It is illegal to trawl inside 6 nautical miles from the coast.

1805 There are three types of artisanal fishing units: small Kru canoes, medium Kru canoes and  
1806 large Fanti canoes. These are shown in Figure 5-56 and described in Table 5-26.



1807 Figure 5-56 (a) Typical Kru canoes; (b) Typical Fanti canoes

1808 The Environmental Justice Foundation (EJF) is a NGO working with fishing communities in  
1809 Liberia and Sierra Leone in partnership with the Society of Conservation of Nature in Liberia  
1810 (SCNL). The aim is to engage with fishing communities, build capacity with local partners,  
1811 develop Collaborative Management Associations to safeguard sustainable fishing and protect  
1812 marine diversity. The EJF report on Liberian Fishing Communities looked at the challenges  
1813 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)<br>Some Togolese (Popo) | 1-3 men   | Small<br>(< 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.<br>A minority stays out overnight and returns the next morning. | Hook and line; occasionally gillnets   | Mostly demersal      |
|            | Liberians (Kru)                                | 3-5 men   | Medium<br>(> 6 m)  | Propelled by sails or paddles, some powered by 7 horse power outboard engines.   |  |  |                      |
| Fanti      | Ghanaians (Fanti)                              | 12-20 men | Large<br>(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 |

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### 1831 5.3.11 Survey of Fishing Communities in Monrovia

1832 A survey of the low-income fishing communities in Monrovia was commissioned as part of  
1833 this ESAR. The survey was undertaken in February 2019 with the aim of discussing how  
1834 fishing communities operate. The data on fishing techniques is needed for the environmental  
1835 inputs to the ESAR whilst information on how these communities survive is needed for the  
1836 social assessment part of the ESAR. The methodology for these surveys is presented in section  
1837 5.3.1. The consultations with fishermen and fishmongers included the affected community  
1838 impact agenda.

#### 1839 5.3.11.1 Location

1840 The fishing communities are located on the Atlantic Coast of Monrovia at a number of  
1841 locations where they have access to beaches sufficiently smooth enough to beach load canoes.  
1842 As Monrovia has expanded these communities have become more crowded, pressures on  
1843 housing become more intense and these areas have become slums. By this term we mean,  
1844 informal, high population density, low income communities, lacking in planning, usually as  
1845 squatters on public land and not owned privately. Building materials vary from mats and  
1846 straw through corrugated iron sheets in various states of disintegration to buildings of  
1847 permanent materials. These communities usually lack road access and basic services. Many  
1848 communities have been in place for at least 40 years and believe they have “squatters’ rights”  
1849 via “adverse possession”.

1850 Six fishing communities are identified along the Monrovia Coastline:

- 1851 • Banjor Beach near Hotel Africa
- 1852 • Popo beach – New Kru Town
- 1853 • Kru Beach – West Point
- 1854 • Fanti Town – West Point
- 1855 • King Gray Town - ELWA
- 1856 • Bernard Beach – Paynesville.

1857 Each community has an unpaid, elected Community Chairman who reports to and is in  
1858 contact with the City administration. Each fishing community has a Fishing Association with  
1859 a Fishing Chairman to manage fishing interests and disputes in the community. Each  
1860 community has a community Fish Mongering Association to assist the selling of catches with  
1861 a Chairwoman to manage any disputes. “Associations” to manage groups of people in an  
1862 industry or local sector are a very common feature of Liberian community organisation. The  
1863 Association manages entry to the activity, draws a small monthly contribution from members,  
1864 regulates activities and manages disputes.

1865 Fishing communities require immediate access to gently sloping beaches which can allow the  
1866 beaching of the loaded canoes for selling the fish, repairing nets and other equipment and  
1867 canoe and net storage when the sea is too rough to go out, as shown in Figure 5-57. Access to  
1868 beaches is vital for storage and associated processing works as without such spaces fishing  
1869 cannot be undertaken. Coastal space is very limited and needs to be protected for fishermen  
1870 to continue their vital role in feeding Monrovia and the rest of Liberia. Reducing beach access  
1871 and utilising beaches for rock / building material storage etc. will negatively impact fishing  
1872 communities. Depending on the size of the fishing community, each community will have one  
1873 to three 3 beaches / landing stages that they use, as shown in Table 5-28. More than one  
1874 community can use a beach and there are places where Fanti and Kru crewed canoes beach  
1875 alongside.



(a)



(b)



(c)

(d)

1876 Figure 5-57 (a) Fishermen landing their canoes at King Gray; (b) Fishermen taking the fish out of their nets in  
 1877 order to sell them at West Point; (c) Fishermen repairing their nets at West Point Fanti Town; (d) Storage of nets  
 1878 on the beach in West Point Fanti Town

1879 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,<br>New Kru Town in Borough<br>of New Kru Town | Popo Beach   | Popo Beach            |
|  | New Kru Town West<br>(also known as members of the Cape Mount /<br>Bomi Collective Management Association (CMA)) | New Kru Town West     |
| West Point – Township<br>within the Monrovia City<br>Council             | Kru Beach  | Power Plant           |
|  |  | Du Side               |
|  |  | Kru Beach             |
|  | Fanti Town,<br>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             |

1880 **5.3.11.2 Ethnicity**

1881 In general, the fishing communities are either Kru, Fanti or Popo and identify as such. Kru  
 1882 people are ethnic Liberians originally from Maryland in south east Liberia. They have a  
 1883 traditional fishing style and customs but post-civil war have intermarried with other ethnic  
 1884 Liberian groups. They are renowned for their maritime skills and work as crews  
 1885 internationally.

1886 Fanti fishermen were originally from Ghana but have lived and fished in Liberia since the  
 1887 1920’s. In the 1984 population census the Fanti were included as a population group despite  
 1888 not being citizens. Some Fanti have intermarried and have Liberian citizenship papers. This  
 1889 group are the most populous fishing group in Monrovia, have bigger boats and fish in

1890 different areas to the Kru. The Fanti fishermen are settled at various fishing locations along  
1891 the Liberian coast, e.g., Bassa, Cape Palmas, Cape Mount and Sinoe (Ssentongo, 1987).

1892 Popo fishermen were originally Togolese and migrated west in the twentieth century and  
1893 settled in small communities in Monrovia and elsewhere in Liberia. They are gradually  
1894 integrating and intermarrying with other Liberians. Some have Liberian citizenship.

1895 Bassa fishermen are found on the south Monrovia beaches.

1896 Communities are not solely one ethnic group. The Fanti and Popo often live and fish alongside  
1897 each other and both Popo and Kru live in West Point. Community disputes are usually  
1898 handled by the Fishing Chairman, Fish mongering Chairlady or the Community Chairman/  
1899 woman. Only if such mediation is unsuccessful is the dispute escalated to the Borough  
1900 Governor/ Township Commissioner's Office.

### 1901 **5.3.11.3 Fishing Equipment**

1902 The fishing equipment used by fishermen's groups at the different fishing communities is  
1903 presented in Table 5-28.

### 1904 **5.3.11.4 Costs**

1905 • A fishing licence is required per boat and is issued by the National Fisheries and  
1906 Aquaculture Authority (NAFAA) at LRD 10,000 = approximately USD 62 for a Kru  
1907 canoe owned by a Liberian. Licences for larger boats vary and permits for non-  
1908 Liberians are much higher. The NAFAA has recently started collecting the licence  
1909 using mobile money collection through the phone networks.

1910 • The Kru canoes are all built in Liberia, while some of the bigger Fanti canoes are built  
1911 in Ghana. One respondent said that the hollowed tree hulls of the Fanti canoe were  
1912 often brought up from Ghana and the planked superstructure built in Liberia.

1913 ○ A motorised canoe 10-15 m long costs USD 1,500 to 2,000, some report  
1914 USD 5,000; whereas

1915 ○ A Kru paddle canoe costs USD 150-400.

1916 • Hooks – LRD 200 - 1,000 per packet.

1917 • 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<br>Women 1,965<br>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<br>Women 4,018<br>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<br>Draw-way (seine nets)   | 1-2 persons  |
| Kru Beach, West Point*   | 236-387                 | Men 7,130<br>Women 4,966<br>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<br>Women 2,721<br>Total 5,429                           | Motorised canoes 40 HP (some made in Ghana)  | Bonny net – Gbapele nets (gillnets)<br>Use GPS and compass<br>Life jackets   | 4-15 persons |
|  |                         |   | Paddling canoes 6-15 m in length   |  | 1-3 persons  |
| Bernard Beach  | 46                      | No census data available.<br>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.<br>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)<br>Hook and line  | 2-4 persons  |
| <sup>◇</sup> English name in parentheses<br>* Called Lagoon East and West in census<br>** Called Fish Town in census |                         |   |  |  |              |

1919

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1920 **5.3.11.5 Fishing Activity**

1921 Fishing activities are dominated by men. However, a very few women own canoes, employ a  
1922 crew and market their own fish catch.

1923 From the survey, it is clear that motorised canoes are generally bigger, have bigger crews,  
1924 undertake longer voyages and catch a greater variety of fish. The Fanti Town, West Point  
1925 community travel the furthest, going all the way north up the coast on trips of up to 4 days.  
1926 Some crews will sell fish to other communities north of Monrovia to fund their return journey  
1927 and if the catch may go off owing to bad weather. This group are more likely to be in dispute  
1928 with Senegalese fisher crews over access to northern Liberian fishing zones.

1929 Paddled canoes are mostly operated by the Kru and Popo communities. These are smaller  
1930 than the usual motorised canoe, travel less far and are less used in the rainy season when seas  
1931 are rougher. The Kru fishing communities in Monrovia tend to have a daily schedule  
1932 returning the same day to sell their catch. Those that stay out overnight return the next  
1933 morning. Sharks and occasional rays are caught only by the bigger canoes travelling furthest.

1934 Details on the fishing activities of communities in the project area are shown in Table 5-29.

1935 One major issue arises of the impact that illegal fishing is having on the supply of fish in  
1936 Liberian coastal waters and in disputes with other nationals' boats. Currently individual Fanti  
1937 boats from Senegal travel down to Northern Liberian coastal waters to fish and land the fish  
1938 to sell in Liberia. Recently permission was granted for up to 300 boats to enter Liberian waters  
1939 which would have a serious impact on fish stocks that Liberians depend on. This may be  
1940 revoked soon.

1941 The NAFAA report that they have observed larger, cold storage boats coming down from  
1942 Senegal carrying a number of Fanti type motorised canoes and crews on board. The canoes  
1943 are deployed to fish from the boat which collects and stores the catch before returning to  
1944 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<br>(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                             |

1946 Further illegal fishing has been documented by the Sea Shepherd Global INGO of European  
1947 and Chinese trawlers fishing in Liberian waters. In February 2017, Sea Shepherd Global  
1948 launched a campaign in partnership with the Liberian Ministry of National Defence to fight  
1949 illegal, unreported and unregulated (IUU) fishing in the West African coastal waters of  
1950 Liberia. Developing countries are particularly vulnerable to IUU fishing, which accounts for  
1951 up to 40% of the fish caught in West African waters. The resources of the Liberian Coast Guard  
1952 to monitor, control and survey all of Liberia's sovereign waters are stretched. Sea Shepherd's  
1953 mission is to assist them in identifying and arresting the unlicensed foreign industrial vessels  
1954 operating in its waters, and to protect the six nautical miles closest to shore reserved for  
1955 subsistence, artisanal and semi-artisanal fishing, an industry which employs 33,000 Liberians.  
1956 In its first three months, *Operation Sola Stella* resulted in the arrest of five illegal fishing vessels  
1957 committing over 50 violations of Liberian laws and maritime regulations, including fishing  
1958 without permits, operating without vessel documentation, fishing in restricted zones,  
1959 systematic under declared catch, attempted bribery of a Liberian Coast Guard officer, and  
1960 undocumented workers without passports living in unsanitary conditions. A shrimp trawler  
1961 certified by the United States Department of State to export shrimp to the United States was  
1962 caught without a valid fishing permit and without using the legally-required Turtle Excluder  
1963 Devices (TEDs), and a refrigerated cargo reefer was arrested transmitting a false identity to  
1964 the Liberian port authorities where it was planning to offload 460 tons of undocumented fish  
1965 cargo. Thanks to these successes, *Operation Sola Stella* continues its mission and partnership  
1966 with Liberian authorities in 2018. Fish stocks need preserving to prevent overfishing and  
1967 ensure sustainability of fish protein in feeding Liberia (Sea Shepherd, 2018). NAFAA, in an  
1968 interview for this study, state that this is not an issue anymore and that they have licenced  
1969 four Chinese trawlers only to trawl beyond 6 nautical miles this year.

#### 1970 5.3.11.6 Community Stability

1971 Fishermen live close to their beaches and boats in overcrowded, poor environmental  
1972 conditions, in areas lacking water and sanitation, electricity, buildings of permanent materials  
1973 and access. The areas are subject to sea flooding as well as from poor land drainage. Thefts  
1974 from houses and boats etc. are common and have serious impacts on the ability of households  
1975 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**

|   |
|---|
| <p><b>Banjor Beach</b></p> <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> |
| <p><b>Popo/ Kru Beach</b></p> <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>   |
| <p><b>Kru Beach, West Point</b></p> <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>   |
| <p><b>Fanti Town, West Point</b></p> <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>   |
| <p><b>Bernard Beach</b></p> <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>   |
| <p><b>King Gray Town</b></p> <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<br>(Banjor Beach Fish mongering Association)                    | 630                        | <ul style="list-style-type: none"> <li>• Bonny</li> <li>• Cassava Fish</li> <li>• Rarely a shark</li> </ul>   | <ul style="list-style-type: none"> <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<br>(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> </ul>   | <ul style="list-style-type: none"> <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> </ul> | <ul style="list-style-type: none"> <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> </ul> <p>• Fresh fish stored in private cold store when needed</p> | <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<br>(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> </ul>                                       | <ul style="list-style-type: none"> <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> </ul>  | <ul style="list-style-type: none"> <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

2060 Fish mongering covers a complex interacting group of actions, as shown in Figure 5-58. After  
2061 the fish is purchased from fishermen at the landing site, it is either directly sold or processed  
2062 (drying or smoking) then sold. The fish is sold in a number of ways, including directly door  
2063 to door in the community, door to door in non-fishing communities, selling fresh in Monrovia  
2064 markets of the evening Benson Road fish market, to selling fresh or processed fish to outside  
2065 sellers for sale in Monrovia or onward transport to sales in inland markets.

2066 The shortest marketing trip for a fresh fish involves only one seller and one buyer – the longest  
2067 sees the fish processed and transported through chains of marketers and transported over the  
2068 country. The market range for Monrovia fish is extensive as traders take the smoked fish  
2069 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

2070 **Figure 5-58 Diagram showing fish mongering activities**

2071 The actions of all fishmongers in a fishing community are governed by membership of the  
2072 community to a Fish Mongering Association with an elected Chairwoman. These associations  
2073 are based on trust and enable peaceful negotiated solutions for community issues in line with  
2074 traditional Liberian customs. The Associations are primarily to manage the number of sellers  
2075 in the community and secondly to resolve disputes. A small fee is paid monthly at the monthly  
2076 meeting.

### 2077 **Purchase of Fish**

2078 Fishmongers are aware of the likely landing time of the boats and assemble on the beach  
2079 usually in the early afternoon onwards. For Kru canoes this can be anytime from 10 am to  
2080 5 pm. The fishing community uses mobile phones when in range to communicate landing  
2081 times.

2082 In a community, all fishmongers are free to buy from whichever crew they wish. However,  
2083 many tend to buy from crews to which they are related by family, marriage or friendship but  
2084 this tie is not essential. Would-be mongers are usually required to start selling Gbapele, a  
2085 small, mixed-species silver fish, in local communities only graduating to being allowed to buy  
2086 bigger fish once they have established a market of paying customers. Buyers of bigger fish  
2087 usually have a marketing round of households that buy their fish from that seller.

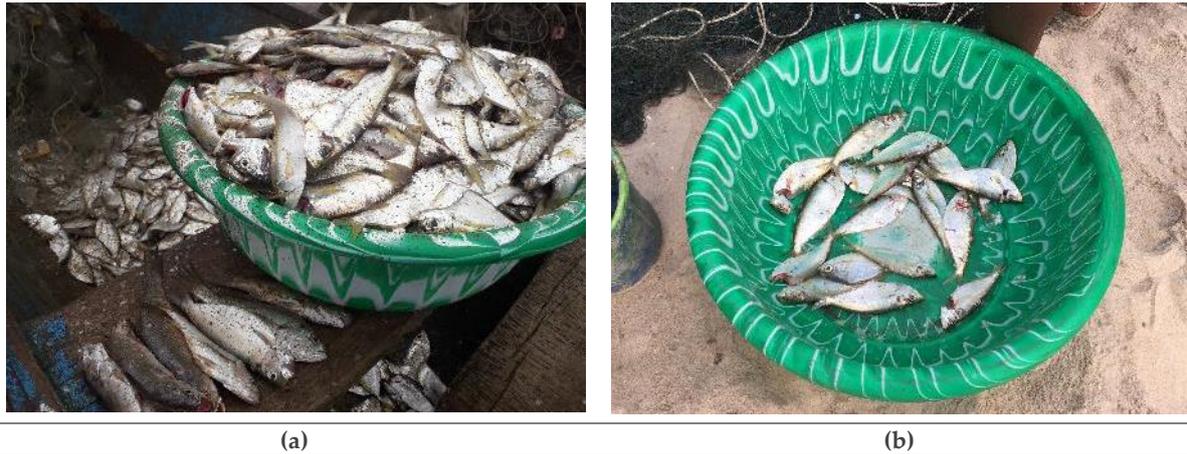
2088 Catches are purchased by the 10 litre bucket and can be a single type of fish or a mixture of  
2089 fish. Discussions on price and type of fish to purchase are usual. A bucket/ bowl of Gbapele  
2090 varies in price from LRD 1,200 to 1,800. Usually the fishmongers pay directly on receipt for  
2091 the fish, a minority buy on credit to the crew, returning to the crew to pay after sale.

2092 The groups state that they do not usually handle turtles, dolphins and rays as they have  
2093 attended a workshop on endangered species although if they turn up in catches, they will be  
2094 hidden from NAFAA inspection and sold.

#### 2095 **Processing and Sale of Fish**

2096 Fish can be sold and resold multiple times between landing and consumption and be  
2097 processed at any point by any of a number of buyers/ sellers in the chain. The three methods  
2098 of fish processing are described below.

2099 Fresh fish: Fresh fish are usually washed after purchase and arranged either in bowls or  
2100 wrapped in plastic and cardboard boxes (Figure 5-59). The fishmonger will either walk around  
2101 her own community, a neighbouring community selling door to door on an identified round  
2102 or take the fish to a bigger market – Banjor, Red Light, Duala, YOA, Greenville, etc. or sell on  
2103 to another person who may do the same. Some sell fresh fish at the evening Benson Street Fish  
2104 Market. Fresh fishes are usually sold whole without gutting or internal cleaning unless the  
2105 fish is too large for one purchaser. Increasingly fishmongers are renting cold store space to  
2106 keep fish fresher for longer thus increasing income. Generator driven freezers are found in all  
2107 communities and non-fishing areas near the fishing communities.



2108 Figure 5-59 Fresh fish at (a) New Kru Town and (b) West Point

2109 Dried Fish: Fish of any species that are no longer completely fresh are often air-dried into  
2110 muiin-muiin in salt outside houses on mats, nets, roofs, etc. (Figure 5-60). The salt can have  
2111 spices added. The drying preserves the fish for longer and prevents spoiling. Dried fish is not  
2112 as popular as smoked fish and hence has a smaller market, but often commands the same  
2113 price as smoked fish. Not all fishmongers dry fish and it remains a niche activity ensuring  
2114 some value for the catch.



2115 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.



2130  
2131 **Figure 5-62 Mangrove wood to be used for fish smoking**

2132 **Coastal Protection Issues**

2133 The fishmongers live in the same fishing communities alongside the fishermen and hence are  
2134 affected in the same way by the rising sea levels and erosion by waves. All communities suffer  
2135 flooding – often daily in the rainy season, have lost relatives, houses and property, and are  
2136 hindered from processing and marketing fish when the community is flooded. Similarly, fish  
2137 smoking is impossible with a flooded community.

2138 The fish mongering focus groups put the problems of sea flooding and coastal erosion as their  
2139 primary concern ahead of other issues such as clean water, sanitation and health services. A  
2140 major concern is being forced to move if coastal erosion destroys their community or if the  
2141 design of sea defence means loss of their homes. The fishmonger’s future is inextricably  
2142 entwined with that of the fishermen and the need to be near the sea shores. They welcome  
2143 coastal protection but need to ensure that they can continue to access the beach, continue to  
2144 use the beach for business and keep their houses where they are.

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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

2173 disposal systems. The health hazards are enormous and multiplied by the high density of  
2174 buildings and high populations.

2175 West Point was particularly badly hit in the 2014/2015 Ebola epidemic where poor living  
2176 conditions combined with strong reliance on caring for sick relatives allowed the virus to  
2177 spread out of control. Public Health controls had to be enforced at gunpoint, causing riots in  
2178 very confined spaces. The area was quarantined off with a curfew and barricades, prices  
2179 rocketed and thousands were infected. West Point only had 4 toilets for 20,000 people. There  
2180 is considerable anti-establishment feeling in the area.

2181 The communities hope for development – improvements to fish related incomes, provision of  
2182 schools, clinics, roads, savings and credit schemes. Capacity building for fish mongers could  
2183 be:

- 2184 • Provision of cold rooms near to landing sites;
- 2185 • Micro loans/ savings and credit etc. for fish selling;
- 2186 • Provision/ promotion of cool boxes; and
- 2187 • Workshops on fish handling hygiene and a quality recognition system.

### 2188 **5.3.12 Small Trading Businesses**

2189 Very high proportions of working age low-income people engage in petty trading selling food,  
2190 household items, clothes, etc. from small market stalls, from basins, wheelbarrows and  
2191 hawkers on foot. The need is to reach as many potential customers as possible and make small  
2192 profit margins on which to survive. Such petty trading is a universal factor of African urban  
2193 life and is an extension of the daily/ weekly market system which takes goods to the buyers.

2194 Formal markets are run by the Liberian Marketing Association who make a small charge to  
2195 each seller for the right to sell in or near the market ground or hall. These markets take the  
2196 place of small shops in the urban economy. In Monrovia there are a number of big markets in  
2197 the city which draws huge numbers looking for bargains/ supplies.

---

### 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

2227 of unemployment is the 5.4% recorded for Montserrado, the lowest percentage is the 0.7%  
2228 reported in the North Central region.

2229 The disaggregation by consumption quintile reveals that unemployment is lowest among  
2230 poorer Liberians. This is in line with the overall low unemployment rate in the country:  
2231 unemployment is not an option. People need to find a means of income through some type of  
2232 employment, however informal or vulnerable, in order to sustain themselves, even in rural  
2233 areas.

2234 Unemployment increases as people become less poor, only to fall again in the richest quintile.  
2235 This probably is because, as poverty decreases, people have the chance to wait out for a better  
2236 employment opportunity.

2237 The informal employment rate in Montserrado (70.4%) is higher than the national average  
2238 (67.9%). The proportion in vulnerable employment is lower – 55.7% against the national  
2239 average of 74.1% but the Montserrado unemployment rate is nearly double the national  
2240 average at 5.4% against 2.8%.

2241 Reliance on informal employment disproportionately affects women more. Nationally 33.8%  
2242 of men are in informal employment whilst, 86.4% of women are in informal employment  
2243 showing that women are disproportionately at risk of informality and hence unreliable  
2244 incomes. Informal employment is highest in urban areas – 69.4% while in rural areas it is at  
2245 63.2% but this figure excludes farming on own land. There is no breakdown of these figures  
2246 to County level.

#### 2247 **5.3.13.1 Household Non-farm Business Characteristics**

2248 Table 5-32 shows that most businesses can be classified as shopkeepers or traders (65.1%),  
2249 followed by services (24.9%), and producers (10%). It should be noted that while a business  
2250 can be classified in more than one way, for example, a producer and a shopkeeper, the  
2251 questionnaire in the LFS only allowed for one main classification (LISGIS, 2011).

2252 Services are a largely urban phenomenon (they represent 30.8% of businesses in urban areas,  
2253 while only 8.9% in rural areas). Producers, on the other hand, are relatively more common in  
2254 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

2280 slums. The Disaster Victims Association operates in West Point. Under the Memorandum of  
2281 Understanding between the YMCA of Liberia and SLUMDAL, the YMCA will serve as the  
2282 technical support NGO for SLUMDAL for the purpose of enhancing its capacity to advocate  
2283 on behalf of slum dwellers.

2284 The YMCA will work with SLUMDAL to identify areas of need for leadership/capacity  
2285 building support under the project in line with the budget allotted for support to local  
2286 affiliation with Social Development Initiatives (SDI) (YMCA internal description of local  
2287 partners) under the project, while YMCA in collaboration with SLUMDAL will work to  
2288 support the establishment and growth of local association (federation) of slum dwellers for  
2289 the proactive implementation of SDI rituals (YMCA terminology) such as the formation of  
2290 saving groups in West Point and Slipway and profiling /enumeration exercises in target  
2291 communities.

2292 The YMCA of Liberia, with support from COMIC Relief and Y-CARE International, is  
2293 implementing a slums development project titled: “Young People as Agents of Change  
2294 Helping to Transform Slum Settlements”.

2295 Additionally, YMCA in collaboration with SLUMDAL will provide support in the  
2296 mobilization and strengthening of local associations of slum dwellers through exchange visits  
2297 and targeted training on savings and credit and land rights and YMCA and SLUMDAL will  
2298 collaborate to engage relevant government authorities, ministries, agencies and national and  
2299 international NGOs to provide basic social services to improve the living conditions of people  
2300 living in the informal settlement or slum communities in Monrovia.

### 2301 **5.3.16 Land Use**

2302 The slum communities are not formally planned and activities are not regulated despite  
2303 theoretically being subject to zoning laws, etc. The result is a chaotic mix of homes, businesses,  
2304 schools and clinics built as possible without regulation. Most areas have no water supply even  
2305 to a communal tap, no sanitation and very few public latrines. There is no system of waste  
2306 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

2326 provide a framework for governing informal settlements, many administrative acts affecting  
2327 their residents are based on established practice rather than formal law (Williams, 2011).

2328 For example, in some larger, more established settlements like West Point, residents paid de  
2329 facto taxes in the past (2008-09) to receive 'squatters' rights' certificates from the MCC. These  
2330 certificates constituted a use and possession right on public land valid for one year. Despite  
2331 their temporary nature and questionable legal basis, these certificates still conferred residents  
2332 with a sense of security (Williams, 2011). Since 2010, however, the MCC has refused to issue  
2333 or renew squatters' rights certificates. The Township Commissioner of West Point informally  
2334 renews certificates for the settlement, and many residents continue to believe that these are  
2335 validated by MCC. It is not known if the recently issued certificates could serve as a legal basis  
2336 for challenging potential evictions by the MCC (Stevens, 2012).

2337 One of the areas in which both the linkages and tensions between addressing the past and  
2338 shaping a better future are most clearly evident is the issue of development-induced  
2339 displacement in the capital city, Monrovia. The linkages lie in the fact that many, if not most  
2340 of the slum-dwellers threatened with eviction as the city recovers from the war were originally  
2341 displaced to Monrovia by conflict and are actively pursuing local integration as a durable  
2342 solution. The tensions lie in the fact that informal settlements continue to be seen as an obstacle  
2343 to development even as slum dwellers argue – with much justification – that they have  
2344 contributed significantly to reconstruction through both their labour and the sweat equity  
2345 represented by the neighbourhoods they have built.

2346 The last several years have seen increasing numbers of evictions and demolitions in informal  
2347 settlements in aid of both private investment and public infrastructure projects. Although the  
2348 Land Commission charged with setting post-war policy has taken up urban land use as a  
2349 priority issue in 2011, residents of informal settlements throughout Monrovia currently enjoy  
2350 little security of tenure and remain vulnerable to development-induced displacement. The  
2351 issue of development-induced displacement in Monrovia represents a concrete example of the  
2352 manner in which development best practices may be pivotal to ending the humanitarian  
2353 vulnerability caused by displacement.

2354 In both human rights and development terms, the provision of tenure security, or legal  
2355 guarantees that continued possession and use of property will not be arbitrarily interfered

2356 with, is seen as an affirmative act that governments can and should undertake by adopting  
2357 appropriate laws and policies and giving them effect. Crucially, tenure security should extend  
2358 even to those who inhabit informal settlements without any form of legal title, protecting them  
2359 from being evicted or resettled without the observance of minimum safeguards identified in  
2360 both development and human rights standards. In this sense, outright ownership of property  
2361 provides a very high degree of tenure security.

2362 Multiple institutions at the township, municipal and national level share overlapping  
2363 jurisdiction over the greater Monrovia area and have independent powers to demolish  
2364 structures and evict their residents in accordance with their respective mandates. Levels of  
2365 private investment and public infrastructure projects have increased, but investors, lenders  
2366 and donors still act according to disparate and inconsistent resettlement guidelines – or no  
2367 guidelines at all. Although slum dwellers have organized themselves quite effectively at the  
2368 neighbourhood level, they have yet to coalesce into an effective interest group with the  
2369 capability to formulate clear policy proposals and lobby for them (Bruce and Kanneh, 2011).

2370 Public servants at the municipal and national level still tend to view slums primarily as an  
2371 obstacle to development but are conscious of both the important role slum-dwellers play in  
2372 the economic life of the city and the impracticability of plans based exclusively on demolition  
2373 and resettlement. Meanwhile residents of informal settlements have in virtually all cases  
2374 organized themselves and become accustomed to paying de facto taxes to local government  
2375 in exchange for ‘squatters’ rights’ certificates. Most slum dwellers interviewed for this study  
2376 through the focus groups on community impacts (chapter 1) understood and accepted that  
2377 evictions and even large scale relocations might be inevitable in the future, and were primarily  
2378 interested in ensuring that these were accompanied by social protection measures that would  
2379 prevent the further impoverishment of those affected.

2380 Current systems are antiquated, records are missing or destroyed, and current record systems  
2381 and tools are inadequate. Maps, deeds, and other land documents are missing. The Liberian  
2382 National Archives within the Ministry of Foreign Affairs has many boxes of crumbled record  
2383 books and is working to recover other documents. Every Ministry will require technical  
2384 training and up-to-date technological systems to initiate recovery.

2385 Meanwhile, the relationship between the slums and the city and local authorities is another  
2386 area of legal ambiguity. Although informal settlements have existed in Monrovia at least since  
2387 the 1950s, they proliferated during and after the war and are now home to a majority of the  
2388 capital's inhabitants. Early on during the conflict, the practice of charging an annual  
2389 'squatters' rights' fee to slum residents became widespread among the various local  
2390 authorities in Monrovia. While ostensibly based on a provision of the 1957 Zoning Code on  
2391 non-conforming structures, the issuance of squatters' rights is, in reality, simply an  
2392 established de facto practice that is broadly accepted but not clearly legal. Regular payment  
2393 of the fee entitles the holder "to occupy the area until such time as the government fines [sic]  
2394 it necessary to use the land in which case, one month notice will be given to vacate the  
2395 premises" (Bruce and Kanneh, 2011) . Whilst in some areas households still claim to be paying  
2396 "fees" and some pay the house tax, the situation is highly variable and not uniform.

2397 Squatters' right permits also prohibited the creation of permanent structures, a rule that is  
2398 regularly flouted in practice. The fact that slum dwellers persist in building permanent  
2399 structures indicates that community understanding of "squatters' rights", despite their own  
2400 rules, have given rise to a perception of security of tenure on the part of their holders.  
2401 However, critics have noted that such rights provide no objective tenure security and that  
2402 slum dwellers that invest in permanent structures risk "becoming double losers having paid  
2403 regular annual squatters' rights renewal fees to the Local Authorities with no guarantee for  
2404 compensation or relocation assistance" (Bruce and Kanneh, 2011). Buildings of permanent  
2405 materials are usual and noted as common in all slum communities visited for this study.

2406 The precarious situation of slum dwellers in Monrovia is underscored by the lack of  
2407 transparent and consistent policies or procedures related to their involuntary relocation.  
2408 Evictions and demolitions fall within the remit of the MCC, comprising the Mayor and City  
2409 Council, as well as a number of national level ministries and agencies, such as the Ministry  
2410 for Public Works (MPW), which is responsible for applying the Zoning Law, the Ministry of  
2411 Lands Mines and Energy (MLME), the EPA and others. The approach taken by the MCC has  
2412 generally been benign, with demolitions to enforce safety codes balanced with some slum  
2413 upgrading efforts.

2414 The Mayor of Monrovia, in the past, initially sought to implement a more aggressive policy  
2415 of slum clearance, but since adopted a more cautious approach. However, the MCC has  
2416 forbidden the further sale of squatters' rights by the MCC, citing their unclear legal basis and  
2417 past failures to transparently document how the proceeds were used (Bruce and Kanneh,  
2418 2011). Meanwhile, there is some anecdotal evidence that increasing numbers of refugees are  
2419 now returning from abroad and actively seeking to reclaim or otherwise acquire urban land  
2420 in Monrovia for investment purposes. As a result, property values are likely to rise and an  
2421 increasing number of attempts to assert private property interests in occupied urban land are  
2422 to be expected.

2423 West Point is long-established, centrally-located, fully integrated into the urban economy and  
2424 situated on public land. As a result, it is treated as a de facto administrative unit within the  
2425 city and has received significant infrastructure improvements. West Point is Monrovia's best-  
2426 known informal settlement and one of its oldest. It consists of a flat, sandy spit of land abutting  
2427 the highly active Waterside market area. The area was built up in the 1940s through the  
2428 deposit of sand dredged during the construction of the new port facilities on nearby Bushrod  
2429 Island. As a result, West Point consists largely of recovered land, leaving it in relatively  
2430 unambiguous public ownership relative to virtually all other areas of Monrovia, where  
2431 historical claims cannot be ruled out. According to residents, West Point was officially made  
2432 one of Monrovia's townships in 1960 and now houses as many as 70,000 people in six  
2433 communities. As many as one-third of the area's residents arrived as displaced persons during  
2434 the conflict in an influx that led to the physical expansion of the settlement.

2435 Prior to the 1989-2003 wars in Liberia, several attempts were made to resettle the residents of  
2436 West Point and other slums in new housing estates. However, the homes in new estates were  
2437 allegedly allocated based on connections as well as need and had little impact on the informal  
2438 settlements they were meant to replace. Indeed, although the pre-war Liberian National  
2439 Housing Authority remains active, it is currently perceived as focused on market construction  
2440 and in need of significant reorientation in order to be able to play a role in alleviating current  
2441 slum conditions.

2442 In the meantime, West Point has increasingly taken on the character of a de facto  
2443 administrative unit with its own township administrative building, a court magistrate, a

2444 police station, numerous schools, churches and mosques, and the completion of an asphalt  
2445 access road. Many residents are allegedly above the poverty level based on income from jobs  
2446 in the Waterside market along with a local fishing industry. The township also takes its local  
2447 system of squatters' rights certificates quite seriously and considers itself more broadly to  
2448 have achieved a social contract of sorts with the authorities. Although residents understand  
2449 that the flat, exposed nature of the area may ultimately rule out continuation of its current  
2450 dense residential use, they consider themselves entitled to resettlement that would allow the  
2451 community to remain together and compensate for the loss of livelihoods connected with its  
2452 current location.

2453 The Peace Island settlement is a promontory surrounded by swamplands that lies within the  
2454 Congo Town neighbourhood to the east of Monrovia's central districts (outside of the project  
2455 area). The area was heavily forested and unsettled when unregistered Internally Displaced  
2456 Persons (IDPs) initially began to clear it for residential plots in 2003. The population currently  
2457 stands at nearly 30,000, with most families living on small plots laid out along access roads  
2458 and fire lanes and demarcated with rocks and trees. The land occupied by the settlement is  
2459 both valuable and contested, and tenure security has accordingly been tenuous. In 2007, faced  
2460 with a demolition threat from the Ministry of Mines, Land and Energy, residents appealed to  
2461 the President, who is said to have guaranteed that evictions would only go forward upon  
2462 provision of alternative land and housing units. However, government officials have not  
2463 extended services to Peace Island and are said to have prevented an NGO from providing  
2464 wells. There are no schools and few jobs available on the island and residents were required  
2465 to wade through a swamp to access the mainland until an aspiring politician bankrolled a  
2466 causeway.

2467 Pending completion of an urban land audit in Monrovia, the Land Commission may wish to  
2468 consider measures that would afford slum residents a minimum degree of safety and tenure  
2469 security without unnecessarily prejudicing the outcome of ownership disputes. These could  
2470 include measures such as interim lease arrangements with residents of informal settlements,  
2471 who would continue to occupy them with the possibility to access basic services subject to the  
2472 requirement that they continue to take responsibility for local administration and report  
2473 violations of zoning rules. A lease system could build on popular acceptance of squatters'

2474 rights certificates but with a clearer legal basis and transparency regarding the collection and  
2475 use of the revenues.

2476 In approaching the development of an urban land policy, the Commission should consider  
2477 carefully the balance between the equitable interests of the current slum-dwellers in the  
2478 informal settlements they have built and administered and the legal interests of holders of  
2479 valid title. While the destruction and loss of title records should not categorically disqualify  
2480 the claims of alleged private owners of land in Monrovia, the policies underlying ordinary  
2481 rules of escheat and adverse possession – e.g. that legal certainty must be balanced with  
2482 policies to promote productive use and maintenance of landed property – should be borne in  
2483 mind in assessing such claims. It is also important to note that urban land adjudication need  
2484 not always be a zero-sum process. In cases in which both owners and current possessors of  
2485 urban land can demonstrate strong interests, public authorities may be in a position to provide  
2486 incentives to both parties to negotiate over the possibility of shared use of the land in question  
2487 (Bruce and Kanneh, 2011).

### 2488 **5.3.18 Archaeological and Cultural Heritage**

2489 The study areas are located near to the Providence Island landing spot of freed American  
2490 slaves who resettled to Liberia in the early 1820s (see Figure 5-64). The site is characterized by  
2491 a cement pillar and concrete floor believed to be the 'first Concrete work in the history of the  
2492 country, an ancient water well and an old landing docking platform for incoming canoes and  
2493 ships. The rusted heavy steel bar of the dock is partly buried into the Mesurado River today.  
2494 In addition to these elements, is the oldest cotton tree, 250 years according to history of the  
2495 State. Providence Island was a major trade post for both Portuguese and ethnics of the land.  
2496 Prior to being the site of returning descendants of former slaves, the Island had been one of  
2497 the major slave embarkation sites. An application was made in 2017 to have the island  
2498 declared a UNESCO World heritage site. The site is unaffected by the proposed project.

2499 The only other site of potentially historical significance is Hotel Africa at the northern end of  
2500 the study area. In 1979, the hotel, the largest in Liberia, hosted the Organisation of African  
2501 Unity conference. The conference was led by President William Tolbert, Jr. who was the  
2502 group's chair at the time, just months before he was overthrown by Samuel Doe. The hotel  
2503 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

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## 1 **6 STAKEHOLDER ENGAGEMENT AND PUBLIC** 2 **PARTICIPATION**

### 3 **6.1 PUBLIC CONSULTATION AND ENVIRONMENTAL AND SOCIAL DISCLOSURE**

4 The ESAR includes public consultation as part of the ongoing stakeholder engagement for the  
5 project. The project was discussed with a wide range of stakeholders including relevant  
6 government departments, industry groups, NGOs, and individual community members.  
7 Extensive on-ground consultation has been undertaken during the design of the project (as  
8 well as during the earlier projects that this project is aiming to upscale) and it is essential that  
9 consultation with any affected communities will continue.

10 Ongoing consultation will be guided by a Stakeholder Engagement Plan (SEP). The SEP will  
11 build on the public information and community engagement activities conducted for the  
12 ESAR. The SEP is discussed further in Section 8.9

13 It is anticipated that, based on the communities' expressed views to date, the project will be  
14 fully accepted, provided that communities can stay where they are and are protected from  
15 eviction.

### 16 **6.2 COMMUNITY CONSULTATION UNDERTAKEN FOR ESAR**

17 An extensive community consultation exercise was undertaken for the ESAR over a three-  
18 week period in February 2019. In total, twenty communities were visited, all located in the  
19 frequently flooded zone along Monrovia's coasts. Seven of these communities are fishing  
20 communities, while 13 are not, but are all poor slums, regularly and frequently affected by sea  
21 flooding. In addition, the Disaster Victims Association in West Point, a Community Based  
22 Organisation (CBO), was consulted, thereby adding up to twenty-one meetings in total.  
23 Communities all report loss of lives, loss of structures (homes and workplaces), disruption to  
24 means of gaining a livelihood, increased uncertainty and a lack of anywhere else to go. Both  
25 fishing and non-fishing communities depend on their location for their livelihoods, and fears  
26 of loss of land, of inundation, forced relocation and lack of access to plots utilised for decades  
27 are deeply disturbing for all.

28 The Community Consultation Agenda is attached as Appendix C. The time available  
29 permitted only the conduct of one focus group discussion per non-fishing community. In  
30 fishing communities, the focus group discussion on community impacts was supplemented  
31 by two additional focus group discussions with both fishermen and fishmongers (usually  
32 women). Each consultation was arranged through the elected but unpaid Community  
33 Chairperson who called the community elders, women's and youth representatives as well as  
34 community members. Discussions with fishermen and fishmongers were arranged through  
35 the Fishing Chairman in the community and the Fishmonger Association local chairwomen.  
36 Attendance varied from 10 to 40 persons. A summary showing the communities consulted is  
37 presented in Table 6-1.

### 38 6.2.1 Impacts

39 All the communities visited have been in existence since before the civil war (1989-2003) and  
40 have seen rapid population growth since 2004 as people flocked to the capital to seek work  
41 and survival. Inhabitants of the affected communities are mostly squatters and tenants of  
42 squatter households. Approximately 50% own their building but not the land the building is  
43 on, the remainder rent rooms or buildings from others. Buildings are constructed from a  
44 variety of materials, many perishable, and are mostly in poor repair. Every community has  
45 experienced someone taking land and building a bigger permanent structure which indicates  
46 the transient nature of squatting and the likelihood of land pressures encouraging building  
47 on previously unsuitable land and relocation of residents.

48 Impacts by sea flooding are:

- 49 • Damage to beaches making canoe operations difficult;
- 50 • Damage to houses and homes;
- 51 • Displacement and family disintegration;
- 52 • Loss of business and livelihoods;
- 53 • Additional flooding caused by runoff from town side rain waters, mixing of waters;
- 54 • Washed away roads and paths and loss of land for housing;
- 55 • Increased poor health from inability to sleep in damp houses and waterborne disease  
56 vectors; and
- 57 • 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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## 59 6.2.2 Concerns about the Project

60 Communities appeal to stay where they are – relocation would mean loss of livelihoods as  
61 traveling to and from a new home site would reduce income available for survival and  
62 mean losing such opportunities as they have now. Residents did not want to break up their  
63 communities and have to live near unknown people. Fears of increased theft and violence  
64 from not being known in the new place were frequently expressed.

65 Residents feel they have looked after the coastline to date and feel that they should be  
66 rewarded for their efforts – they regularly move washed in sand to drain their sea flooded  
67 communities, piling rocks etc. rather than be evicted as a nuisance.

68 Despite being squatters for the most part – a very few plots have a legal title deed – the  
69 communities feel they have a right to live in these areas and that being forced out would  
70 require full replacement for losses, livelihood and security of tenure. All house owners,  
71 squatters or legal, pay a real estate tax previously known as a Hut Tax at a rate of 0.25%  
72 construction materials cost per year to the Monrovia City Council or other administrative  
73 body. House owners feel this should entitle them to something. Squatting is not regarded  
74 as an illegal act – more a necessity given that there is nowhere else for people to live. Most  
75 squatters in the Sinkor belt said that they were allowed to squat in these areas as a result of  
76 a People’s Redemption Council decree after the 1980 coup.

77 Communities had no clear idea about how to go about looking for a new place to live –  
78 most live with or near extended relatives and need the security of the home location from  
79 which to go out to find work and make money. The survival strategies of the very poor  
80 depend on a complex interaction of reciprocal family and neighbour support and future  
81 expectations of help based on past generosity. The breaking up of communities breaks  
82 support linkages, increase vulnerability and reduces resilience to difficulties.

83 Communities universally stated they would resist relocation as far as possible and that they  
84 would require good relocation compensation and assistance packages to enable them to  
85 move. They stressed this meant somewhere to go, security of tenure in the new location,  
86 sufficient money to rebuild a better house and support to living while they got back on  
87 their feet.

88 Concerns were expressed that if the land was protected they would be forced out by  
89 wealthier people. All communities are experiencing encroachment by outsiders building  
90 and concern is expressed about the legality of these structures and whether the community  
91 will be progressively pushed out. This is a very common concern for all communities who  
92 feel their legal status is very vulnerable.

93 Concerns were also raised about the amenity value of the beaches and that they feared they  
94 would be excluded from the beaches for recreational use – bars, entertainment cafes, sea  
95 views, palm groves, swimming and playing on the beach as well as working on the sand.  
96 The beaches are an important location for smoking weed as there is little to no police  
97 surveillance and people are free to do as they please.

### 98 **6.2.3 Project Positives**

99 Communities stated that they hoped that stopping the sea flooding would be at the start of  
100 an urban renewal programme that would add roads, mains power, water and sanitation,  
101 surface water sewers etc. for drainage and improved security for residents.

102 Improved security was wanted to both protect residents and their property but also to  
103 prevent illegal sand mining that affects communities and increases flooding when  
104 protective sand banks are removed.

105 All communities wanted local youth to be offered work on the construction and for the  
106 implementing agency to ensure smaller construction firms can tender for construction.

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## 1 7 ENVIRONMENTAL AND SOCIAL RISK ASSESSMENT AND 2 MITIGATION

### 3 7.1 SOCIAL AND ENVIRONMENTAL SCREENING POLICY REQUIREMENTS

4 As this project is supported by UNDP in its role as a GCF Accredited Entity, it has been  
5 screened against UNDP's Social and Environmental Screening Procedure (SESP) of 2016  
6 under the Social and Environmental Standards (SES) of 2014. These comply with the  
7 requirements of the GCF's Environmental and Social Policy as adopted in March 2018. GCF's  
8 policy is over-arching and essentially provides guidance for strong environmental and social  
9 safeguards within which accredited agencies may implement projects using its funding.

10 Among these safeguards, the GCF puts the responsibility for screening environmental and  
11 social risks on to the accredited agencies that prepare and propose projects for funding. The  
12 GCF's Environmental and Social Policy however requires that the risks be determined by  
13 category. Paragraph 31 of the Policy reads as follows.

14 *GCF will require accredited entities to assign the appropriate environmental and social risk*  
15 *categories to activities in a manner consistent with the accreditation framework of GCF. The*  
16 *categories are as follows:*

17 *(a) Category A. Activities with potential significant adverse environmental and/or social risks*  
18 *and impacts that, individually or cumulatively, are diverse, irreversible, or unprecedented;*

19 *(b) Category B. Activities with potential limited adverse environmental and/or social risks and*  
20 *impacts that individually or cumulatively, are few, generally site-specific, largely reversible, and*  
21 *readily addressed through mitigation measures; and*

22 *(c) Category C. Activities with minimal or no adverse environmental and/or social risks and/or*  
23 *impacts.*

24 The Social and Environmental Screening presented for the project deemed it to be a moderate  
25 risk (Category B) project. This position is substantiated in this section of the ESAR. Discussions  
26 on the risk and impact assessment are also provided in the Social and Environmental  
27 Screening Template, which provided the underlying rationale for the project being classified

28 as a moderate risk. This ESAR provides further discussion below, using the SESP checklist as  
29 part of its basis (Section 7.2).

30 The following sections then describe the approach to the risk assessment (Section 0) and the  
31 detailed risk assessment itself (Section 7.4). The mitigation of environmental and social risks  
32 is outlined in the assessment matrix in Section 7.4, and described in more detail in the  
33 Environmental and Social Management Plan in chapter 8.

## 34 **7.2 UNDP'S RISK SCREENING PROCESS**

35 This section provides an analysis of the ways in which the project fits with the UNDP's  
36 environmental and social safeguards system, as defined in the SESP and the SES.

### 37 **7.2.1 Question 1: How Does the Project Integrate the SES Overarching Principles** 38 **in Order to Strengthen Social and Environmental Sustainability?**

39 The UNDP's SES defines three overarching principles with which all interventions must  
40 conform.

#### 41 **Principle 1: Human Rights**

42 The project is based on protection of the rights of a number of ethnic groups that underpin  
43 much of the sustainable economy of Monrovia. These communities are located for the most  
44 part on the coastal fringes that are most vulnerable to the key impacts of climate change – sea  
45 level rise and greater storm wave energy. This position cannot be altered because the  
46 communities' main livelihoods are artisanal fishing and the associated processing and  
47 marketing. This underpins the city's food security, and as the socio-economic baseline in this  
48 ESAR shows, the number of fishermen has increased significantly in the last few years. It also  
49 supports the livelihoods of the wider communities linked to the fishing people – service  
50 providers, petty traders and other small entrepreneurs – who live among and near these  
51 communities. They include a number of vulnerable groups, particularly single-parent  
52 households and elderly people. Hence, in terms of human rights, the project will ensure that  
53 the coastal communities are made resilient in practicing their ways of life in the face of the  
54 changing climatic conditions.

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## 55 **Principle 2: Gender Equality and Women's Empowerment**

56 The Monrovia artisanal fisheries are traditionally segregated into gender-based tasks. All – as  
57 far as can be determined – of the actual fishers are male. However, the fish mongers are  
58 predominantly women, and there are about three times as many of them as there are  
59 fishermen. Since the women are at the heart of the trading process, it puts them into an  
60 economically powerful position. This relatively unusual empowerment of women is  
61 something that the project will seek to perpetuate. Further than this, the project will boost the  
62 capacity of the fish mongers through a number of issues, including encouragement and  
63 support in operating associations of fish processors and fish sellers; these complement the  
64 existing male-dominated Liberian Artisanal Fishermen's Association. Beyond the artisanal  
65 fishing industry, the wider society of traders and service providers appears to display the  
66 gender split of roles and income generation that is frequently found in Liberian low-income  
67 communities. While both men and women need to gain income to survive, women are still  
68 generally the carers and providers for their families, especially children, but usually need to  
69 have their own income generation activities as well. These may be co-dependent on the  
70 activity of their menfolk, or may be independent with their own businesses or at least their  
71 own income earning strategies. Women's businesses generally need to be located near to their  
72 homes so as to maximise sales and income as well as care for families. Resilience measures to  
73 be promoted by the project will consider ways of targeting women specifically.

74 The project must explore opportunities for this, such as gender-targeted vocational trainings  
75 and loan schemes for alternative livelihoods. Gender-specific impacts must also be addressed  
76 by holistic awareness-raising, so that both men and women are targeted by initiatives to  
77 increase understanding and promote amelioration of human rights in general and women's  
78 rights in particular. Issues such as awareness of disease avoidance and control will also help  
79 by reducing the broad societal impacts that are prevalent from a range of serious health  
80 problems. These would typically target a range of infectious and contagious diseases that  
81 include vector-borne diseases such as malaria, typhoid and lassa, and directly communicable  
82 diseases such as HIV / AIDS and Ebola (the latter as an awareness and preventative measure).

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### 83 **Principle 3: Environmental Sustainability**

84 The project is one of environmental sustainability. It aims at improving the resilience of the  
85 coastal environment of Monrovia against the impacts of climate change affecting it (mainly  
86 the rising sea level and increased storm wave energy) while helping to develop the security  
87 of livelihoods and access to food in ways that minimize contributing to the drivers of climate  
88 change. The project provides measures to sustain this environment on all levels, with the two  
89 aims co-mingled within the approach.

- 90 • *The physical environment will be protected* by introducing institutional management  
91 interventions and soft engineering measures, where necessary, to protect the coastal  
92 beaches from erosion.
- 93 • *The biological environment, by enhancing the protection and management of the*  
94 wetlands and mangrove ecosystems in the Mesurado River and the Saint-Paul River  
95 estuaries, which are the most important carbon stores and fish breeding grounds in  
96 the area. This improvement will be achieved through the development of capacity to  
97 regulate and beneficate the quality and integrity of these ecosystems. Also, the project  
98 particularly emphasizes land use management that restricts or even withdraws  
99 existing urban encroachment from these areas, to ensure that space is made for  
100 mangroves to migrate inland as sea level rises. This is a key nature-based component  
101 of the project that will maintain the mangroves and improve their ecology.
- 102 • *The socio-economic environment will be protected* by ensuring the sustainability of the  
103 existing long-standing, low energy, biologically and economically sustainable fishery  
104 that helps to ensure the food security of the broader coastal communities of Monrovia,  
105 through eco-based solutions that include socio-economic and institutional reforms and  
106 strategic actions coupled with soft engineering measures. These interventions will  
107 include the physical protection of the landing beaches and the settlements behind  
108 them using green infrastructure and nature-based solutions wherever possible. In the  
109 same way, settlements of the broader coastal communities, businesses and important  
110 urban infrastructure will be protected.

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## 111 7.2.2 Question 2: What Are the Potential Social and Environmental Risks?

112 The project is associated with a certain number of potential social and environmental risks  
113 that may occur even when proper mitigation measures are established. Some of these risks  
114 could be project “killers” if the mitigation is not properly designed and applied in a timely  
115 way. If these risks were to be realised without adequate mitigation, they could damage or  
116 reverse the project’s intended outcomes of environmental sustainability, and the  
117 achievements of human rights and gender balance. The main potential social and  
118 environmental risks that are associated with the project are described below.

- 119 • Even though the project aims at protecting human rights, the risk will remain of the  
120 rights of some of the stakeholders being disregarded through unintentional oversight  
121 of a vulnerable group not previously identified in the complex urban communities.  
122 This may possibly lead to conflicts or violence among the communities affected.
- 123 • Gender equality is generally poor at present, largely owing to the competition for  
124 resources. The project is intended to enhance areas where there is a pro-female balance  
125 and to equalize the balance in other areas. However, there remains a minor risk of  
126 unintended consequences.
- 127 • While it is intended to be beneficial to the natural environment, the project might cause  
128 unexpected long-term adverse impacts to the estuarine or marine habitats. Detailed  
129 studies are proposed to try to avoid this consequence.
- 130 • The project involves construction works as well as quarrying activities, during which  
131 unexpected accidents might occur and adversely affect the physical, biological or  
132 socio-economic environment, or affect the health and safety of the workforce or the  
133 community. This can happen even when all works are conducted according to best  
134 practices and standards.
- 135 • Construction works for the project’s protective measures may require a considerable  
136 amount of water, raw materials and use of energy.
- 137 • A revetment in West Point will kill the relationship between the coastal communities  
138 and the beach, because there will be hardly any beach area after the revetment has  
139 been constructed. The beaches are important locations for the leisure, sports (football)  
140 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.

171 **7.2.3 Question 3: What is the Level of Significance of the Potential Social and**  
172 **Environmental Risks?**

173 The project aims at enhancing the environmental and socio-economic resilience of the coastal  
174 environment of Monrovia against the climate change impacts on its coast. The potential social  
175 and environmental risks associated with the project are mostly insignificant or of minor  
176 significance (reversible, manageable and short-term), except for few risks which are  
177 considered of higher significance described in Section 7.2.2. However, given the solid  
178 mitigation approach allocated for each of the project's higher risk elements (Section 7.4), and  
179 the project's Environmental and Social Management Plan proposed in Chapter 8, the potential  
180 risks associated with the project are reduced to "low" without exception (residual risk:  
181 "minor" in the risk assessment matrix in Section 7.4).

182 **7.2.4 Question 4: What is the Overall Social and Environmental Risk**  
183 **Categorization of the Project?**

184 The project is one of social and environmental sustainability. However, associated with it are  
185 a certain number of risks and residual risks as discussed above. None of these should result  
186 in significant adverse social or environmental impacts or involve major displacement or  
187 resettlement. The project is not expected to affect any indigenous group or cultural heritage.  
188 It is not expected to affect critical habitats or produce considerable amounts of greenhouse gas  
189 emissions. The project is therefore considered to be of "Moderate Risk".

190 **7.2.5 Question 5: Based on the Identified Risks and Project Risk Categorization,**  
191 **What Requirements of the SES are Relevant?**

192 The requirements of the SES that are most relevant to the project are as follows.

- 193 • The early inclusion and participation of affected stakeholders and the consideration of  
194 the human rights concerns of all affected communities, groups and individuals.
- 195 • The full participation of women in all decision making and the strengthening of  
196 women's position and influence in the affected communities.
- 197 • The enhancement of the project's environmental sustainability. This will be achieved  
198 through giving special consideration to:

- 199 ○ Biodiversity conservation and the sustainable management of natural
- 200 resources (SES Standard 1);
- 201 ○ Community and occupational health and safety (SES Standard 3); and
- 202 ○ Pollution prevention and efficient use of resources (SES Standard 7).

203 **7.2.6 Question 6: What is the Level of Social and Environmental Assessment and**  
204 **Management Required to Address Potential Impacts and Risks (for**  
205 **Moderate and High Risk Projects)?**

206 According to national legislation, the project falls in the category of actions requiring the  
207 preparation of an ESIA (project listed in Annex 1 of the Environmental Protection and  
208 Management Law- see section 4.1.3 in Chapter 4). An ESIA will therefore be required.

209 For this reason, included in the ESMP are recommendations for undertaking a number of  
210 additional surveys and preparing additional detailed plans prior to the commencement of the  
211 project, which would typically be part of the ESIA. These surveys and plans are crucial to  
212 ensure that the project's potential impacts are reversible.

213 Detailed ESIA Surveys:

- 214 1. Marine and Estuarine Biological Survey;
- 215 2. Marine and Estuarine Sediment Survey;
- 216 3. Household Survey of Affected Communities; and
- 217 4. Fish Landing Survey (linked to 1 and 3 above).

218 Detailed ESMP Sub-plans:

- 219 1. Contractors' Oil Spill Response Plan (OSRP) for land and sea, including Marine Spill  
220 Contingency Plan;
- 221 2. Contractors' Emergency Response Plan;
- 222 3. Contractors' Rock Quarry Management Plan, including Blasting Plan;
- 223 4. Resettlement Action Plan for Affected Livelihoods (if the ESIA shows this to be  
224 required); and
- 225 5. Grievance Redress Mechanism.

226 Because of the need for these additional requirements, it is recommended that this ESAR be  
227 upgraded to a full ESIA that incorporates their findings and provides an updated ESMP; that

228 would include revised mitigation actions which are informed by the results of the surveys, as  
229 well as the additional sub-plans. This strategy will ensure compliance with national  
230 legislation.

### 231 7.2.7 Relevant Triggers from the UNDP Safeguards

232 The position of the project relative to the UNDP safeguards is explained in Table 7-1.

233 Table 7-1 Analysis of the project's position relative to UNDP safeguards

| Standard   | Triggered (Yes/No) | Reason   |
|--|--------------------|--|
| <b>Standard 1</b><br>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><br>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><br>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><br>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><br>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><br>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><br>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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### 234 7.3 RISK ASSESSMENT METHODOLOGY

235 The methodology adopted in this ESAR uses the UNDP's general, international risk  
236 assessment procedure, but enhanced by Earthtime's risk assessment system, which has been  
237 developed for use specifically in Liberia. This has the advantage of ensuring that the higher  
238 level and more general risks outlined in UNDP's framework are addressed, as well as the  
239 project-related, site-specific issues for which the Earthtime system was designed. It ensures  
240 that the needs of the Liberian Environmental Protection Agency (EPA) are fully addressed as  
241 well as the requirements of the UNDP and its donor partners.

242 Risks are assessed for significance of impact and likelihood of occurrence. This is a simple but  
243 effective way of assessing risk by answering the two key questions:

- 244 • What are the risks?
- 245 • How bad are the effects of the risks likely to be if they come about?
- 246 • How likely are they to happen?

247 These together give an indication of the importance of addressing the issue, and the  
248 prioritisation of resources. The fourth, related key question – What should be done about  
249 them? – is frequently addressed only in the risk control and management part of a report. In  
250 the Earthtime system, it is outlined as part of the risk assessment itself. This allows the likely  
251 residual risk to be assessed after mitigation measures have been applied. This means that the  
252 risk assessment matrix in section 7.4 contains two separate assessments of risk: the initial risk  
253 if an activity is allowed to happen with no safeguards; and the remaining risk if appropriate  
254 mitigation measures are implemented to agreed standards.

255 Significance is rated according to the severity of the risk. The various classes shown in Table  
256 7-2 are determined by how serious an incident will be if the risk occurs. The UNDP's SESP  
257 gives guidance terms on the likely impact of the risk (critical, severe, moderate, minor,  
258 negligible), and Earthtime uses similar terms (severe, serious, limited, no risk). For example,  
259 with safety risks, a fatality would be critical or severe, a major injury severe or serious and a  
260 small injury minor or limited. At this stage the "no risk" class is not used in the assessment,  
261 because current non-risk issues are not listed; but this class would be used in a future update  
262 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   |
|--|---|--|--|
| <p><b>UNDP</b><br/><b>5. Critical</b></p> <p><i>Earthtime</i><br/><i>A. Severe</i></p> | <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.<br/>Major outflow of sediment due to failure of sediment controls at a quarry site.<br/>Major fire in a protected forest area.<br/>Death of a worker or member of the public run over by a project machine.</p>  |
| <p><b>UNDP</b><br/><b>4. Severe</b></p> <p><i>Earthtime</i><br/><i>B. Serious</i></p>  | <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.<br/>Diesel drums leak into a village water supply but no one consumes the water.<br/>Outflow of sediment from earthworks due to inadequate containment.<br/>Unnecessary clearance of land beyond agreed site boundaries.<br/>A worker breaks a leg by falling off a working site.</p> |

| Significance or Impact   | UNDP definition  | Earthtime definition   | Potential examples   |
|--|--|--|--|
| <p><b>UNDP</b><br/><b>3. Moderate and 2. Minor</b></p> <p><i>Earthtime</i><br/><i>C. Limited</i></p> | <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> |
| <p><b>UNDP</b><br/><b>1. Negligible</b></p> <p><i>Earthtime</i><br/><i>D. No risk</i></p>            | <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>  |
| <p><b>N.A.</b></p>   |  | <p>Not applicable: no risk is current in this area of work.</p>  |  |

272 Table 7-3 UNDP and Earthtime risk likelihoods, with probabilities, definitions and examples

| Likelihood  | Probability | Definition   | Potential example  |
|---|-------------|--|--|
| UNDP<br>5. Expected<br><br><i>Earthtime<br/>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<br>4. Highly likely<br><br><i>Earthtime<br/>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<br>3. Moderately likely<br><br><i>Earthtime<br/>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<br>2. Not likely<br><br><i>Earthtime<br/>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<br>1. Slight<br><br><i>Earthtime<br/>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.   |

273

274 Table 7-4 UNDP risk matrix

|  |   |   |   |   |   |   |
|--|---|---|---|---|---|---|
| Impact                                     | 5 |   |   |   |   |   |
|  | 4 |   |   |   |   |   |
|  | 3 |   |   |   |   |   |
|  | 2 |   |   |   |   |   |
|  | 1 |   |   |   |   |   |
|  |   | 1 | 2 | 3 | 4 | 5 |
| Probability                                |   |   |   |   |   |   |
| Green = Low, Yellow = Moderate, Red = High |   |   |   |   |   |   |

275 As stated above, the risk assessment process covers three main questions, but with a fourth  
 276 question generated that is dealt with in the risk management and mitigation section of the  
 277 ESAR:

- 278 1. What are the risks?
- 279 2. How bad are the effects of the risks likely to be if they come about?
- 280 3. How likely are they to happen?
- 281 4. What should be done about them?

282 By providing an initial assessment of the risk mitigation approach, it is possible to  
 283 demonstrate in the risk assessment matrix whether the anticipated impacts of the risks can be  
 284 mitigated or not. This in turn helps to determine the risk category of the project, since the  
 285 reversibility of the impacts is a key determinant between Category A and Category B projects.  
 286 In respect of this project, the UNDP is not mandated to implement Category A projects, and  
 287 therefore if the risk is scored high in the impact/probability matrix and even after mitigation  
 288 is still likely to be high, then it may affect the risk categorisation of the project and make it  
 289 unsupportable. For transparency, therefore, the residual risk is recorded in the assessment  
 290 matrix (Section 7.4) rather than being left as an assumption in the risk management and  
 291 mitigation system (chapter 8).

292 The residual risk is given in terms of magnitude (large, medium, small, negligible) and  
 293 sensitivity (low, moderate, high). Sensitivity is mostly hard to quantify, and so is mainly based  
 294 on the professional judgement of the environmental and social specialists compiling this  
 295 ESAR. It covers environmental receptors and resources, incorporating aspects such as their  
 296 relative abundance, quality and regenerative capacity; and the apparent absorptive capacity  
 297 of the environment to accommodate limited impacts without a significant loss of value or  
 298 sustainability.

299 The resulting residual risk significance matrix is given in Table 7-5. It uses a simple assignation  
300 of the parameters listed above into four classes of significance (major, moderate, minor,  
301 insignificant).

302 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 |

303 It should be noted that because UNDP’s risk matrix classifies impact level and probability into  
304 only three categories, it means that each of these groups is broad. Consequently, when  
305 compared with the residual risk, the colour coding does not always show a reduction as a  
306 result of mitigation. This is particularly true where the assessed risk is at a high point in the  
307 “Moderate” category (showing as yellow in Section 7.4) but with mitigation is expected still  
308 to have minor residual impacts (also showing as yellow in Section 7.4). This is a limitation in  
309 the use of a small number of colours to denote change for a rapid visual impression from the  
310 tables.

## 311 7.4 ENVIRONMENTAL AND SOCIAL RISK ASSESSMENT MATRIX

312 The environmental and social risk assessment matrix (Table 7-6) provides a combination of  
313 both the UNDP’s high level view and Earthtime’s country- and site-specific view, as described  
314 above. It also provides an outline of the mitigation approach that is taken forward either as  
315 part of project design or against a potential impact identified and listed in the Environmental  
316 and Social Management and Mitigation Plan (chapter 8 of this ESAR), allowing an assessment  
317 of the residual risk after mitigation to be shown: this demonstrates whether a risk can be  
318 controlled or not. The linkages between the risk assessment matrix and the impacts in the  
319 Environmental and Social Management and Monitoring Matrix (ESMMM) (Table 8-2) are  
320 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. 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 7, 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<br><br>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           |
| <b>3.4</b> | <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         |
| <b>3.5</b> | <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<br>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> <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> | 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>  |                      |  |               |                          |

| 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. 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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## 1 8 PLAN FOR ENVIRONMENTAL AND SOCIAL MANAGEMENT 2 AND MITIGATION

3 This chapter identifies the key environmental and social indicators identified for the project  
4 and outlines respective management objectives, potential impacts, control activities and the  
5 environmental performance criteria against which these indicators will be judged (i.e.  
6 audited).

7 This section further addresses the need for monitoring and reporting of environmental and  
8 social performance with the aim of communicating the success and failures of control  
9 procedures, distinguishing issues that require rectification and identifying measures that will  
10 allow continuous improvement in the processes by which the project is managed.

### 11 8.1 OVERVIEW AND OBJECTIVES OF THE ENVIRONMENTAL AND SOCIAL 12 MANAGEMENT PLAN

13 The Environmental and Social Management Plan (ESMP) is a tool used to ensure that the  
14 impacts of project activities on the environment and society are minimized and that both will  
15 be safeguarded during the implementation of the proposed project, in compliance with all  
16 technical, regulatory, and institutional requirements.

17 This is the document that must be followed to ensure that identified and potential project  
18 impacts are kept within the allowable levels, unanticipated impacts are mitigated at an early  
19 stage, and the expected project benefits are realized. It has been prepared as a standalone, self-  
20 contained document so that it can be detached from the ESAR and used as a key management  
21 tool throughout the implementation of the project.

22 Therefore, the objectives of the ESMP are to:

- 23 • Draw together the measures required to mitigate environmental and social impacts,  
24 and group them logically into components with common themes;
- 25 • Define the specific actions to be taken, responsibilities for these actions, timetables for  
26 implementation and associated incremental costs; and
- 27 • Describe the arrangements for capacity building, monitoring and resourcing.

28 The ESMP is to be strictly implemented without ignoring any detail.

29 The ESMP has clearly defined actions, targets and timeframes, as well as precisely allocated  
30 responsibilities among the different organisations and personnel working on the project. The  
31 ESMP is to ensure the systematic and prompt recognition of problems and the effective actions  
32 to correct them.

33 Briefly, the execution of an ESMP is to facilitate the efficient implementation of mitigation  
34 measures to minimize impacts, prevent accidents and maximise the effectiveness of  
35 construction and subsequent operation of infrastructure, in a context of good management  
36 and information sharing among project personnel.

37 The ESMP will be updated from time to time by the implementing Project Management Unit  
38 (PMU) in consultation with the UNDP staff and the EPA to incorporate changes in the detailed  
39 design phase of the project.

## 40 **8.2 PROJECT INTERVENTIONS**

41 The following assumptions have been made in the preparation of this ESMP:

- 42 • Although the project focusses on interventions that will adapt to or protect against the  
43 effects of climate change in the immediate coastal zone, impacts from project activities  
44 might occur some way offshore or onshore, particularly with the sourcing of  
45 construction materials; and so the ESMP must cover all aspects of potential project  
46 impacts, wherever they might occur;
- 47 • All project activities will be undertaken to national and international standards of  
48 environmental and social compliance, and this requirement will be reflected in all  
49 service contracts;
- 50 • None of the interventions will require the permanent displacement of people;
- 51 • None of the interventions will be conducted in protected areas or sensitive locations;
- 52 • Appropriate erosion and sediment control will be required to be undertaken during  
53 all stages of the project's construction works; and
- 54 • There will be no tolerance of any release of pollution or chemicals as a result of the  
55 project's construction works.

56 This section summarizes project interventions. The first group of these are adaptive – mostly  
57 improvements in capacity and management to ensure the sustainability of livelihoods, and  
58 the security of food supply. The second group are protective interventions, which are typically  
59 hard engineering approaches in a strategy of direct defence against the impacts of climate  
60 change.

### 61 **8.2.1 Adaptive Interventions**

62 Adaptive interventions in the project are measures to help minimise the drivers of climate  
63 change. These exploit opportunities to safeguard currently sustainable livelihoods that are  
64 low consumers of carbon energy, and which consequently promise to give Liberia “green”  
65 living approaches for both the current and future generations. The project focuses largely on  
66 the inshore artisanal fishery of Monrovia, which contributes significantly to the city’s food  
67 security with very low carbon emissions; however, a number of interventions are required to  
68 ensure that the environment supporting this will continue to sustain it as climatic conditions  
69 change, and impacts increase as a result of higher sea levels and stronger storms.

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

- 72 • Strengthening governance:
  - 73 ○ Increase the capacity of the institutions responsible for integrated coastal zone
  - 74 management; and
  - 75 ○ Increase awareness of the importance of addressing climate change issues
  - 76 among the affected society.
- 77 • Adaptation of livelihoods and the environment:
  - 78 ○ Address the management of fishing, catches, and fish processing and storage;
  - 79 ○ Understand the biological resource and ensure its protection as necessary to
  - 80 sustain catch volumes; and
  - 81 ○ Understand and manage the pollution that threatens the biological resource in
  - 82 the urban proximity.
- 83 • Adaptation of infrastructure:
  - 84 ○ Alternative sources of construction sand; and
  - 85 ○ Options for climate-resilient infrastructure in coastal areas.

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## 86 8.2.2 Protective Interventions

87 The proposed protective interventions are:

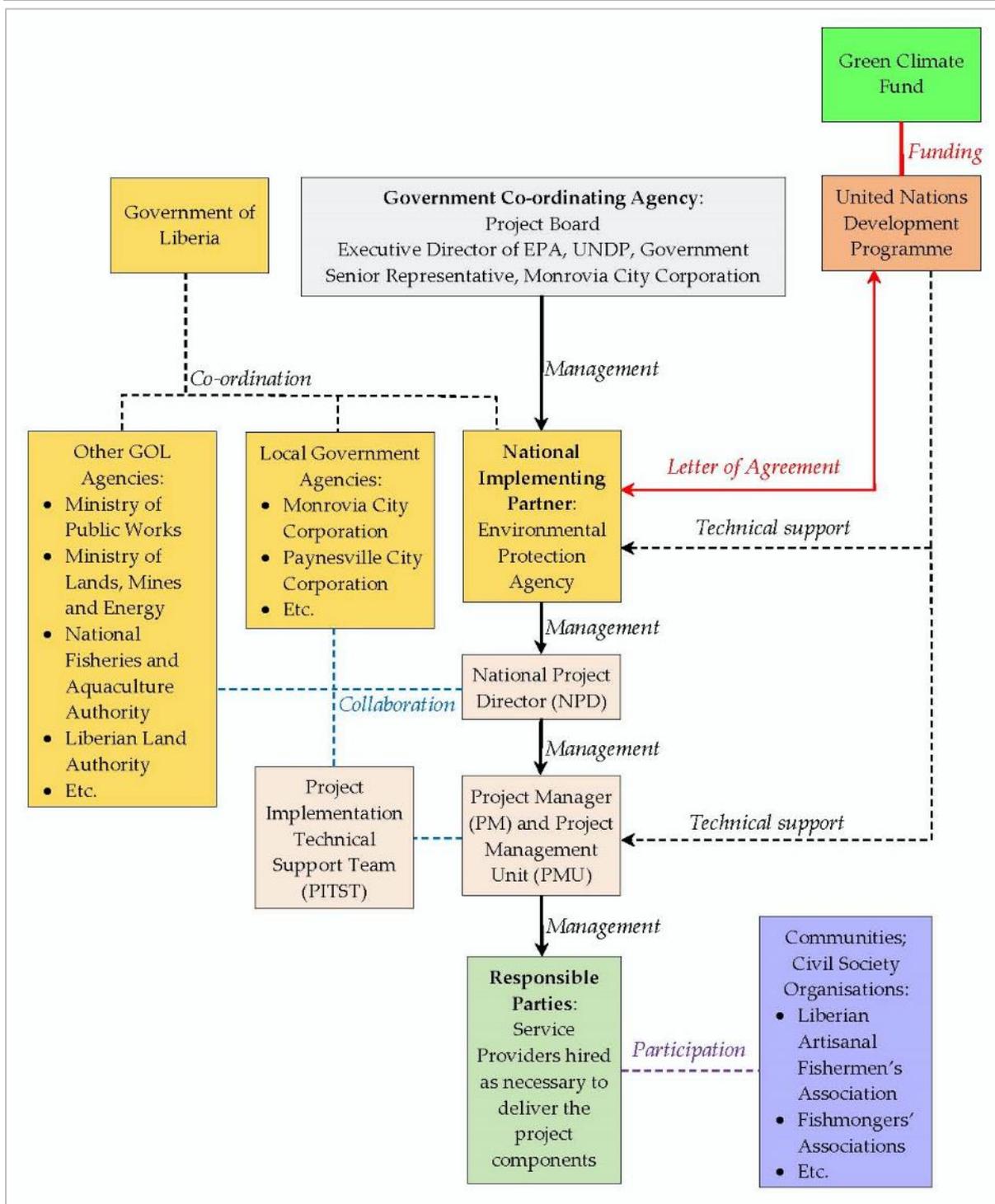
- 88 • Coastal Section 3: West Point:
  - 89 ○ Revetment Wall;

90 A revetment wall is a protective structure constructed along the shore using quarry rocks (rip-  
91 rap) of different sizes and a geotextile layer to prevent sand transport through the structure.  
92 The rip rap will be supplied from a quarry.

## 93 8.3 INSTITUTIONAL ARRANGEMENTS FOR THE ENVIRONMENTAL AND SOCIAL 94 MANAGEMENT PLAN

### 95 8.3.1 Organisation

96 The organisation of the project is shown in Figure 8-1. The EPA will act as the national  
97 implementing partner under an agreement with the UNDP, from which it will also receive  
98 technical support. The EPA's implementation of the project will be directed by a Project Board  
99 of senior government and UNDP representatives. In turn, the EPA will appoint a National  
100 Project Director, a Project Manager and a Project Management Unit (PMU); the PMU will  
101 include specialists in environment, social development, and gender and social inclusion, as  
102 well as technical specialists. The PMU will contract service providers (responsible parties) to  
103 deliver the various project interventions. The PMU will be supported by a Project  
104 Implementation Support Team (PITST) composed of representatives of the numerous  
105 governmental and municipal agencies collaborating in the components of the project. Among  
106 the advisers in the PITST will be individuals designated to support the PMU on the topics of  
107 environment, social development, and gender and social inclusion, not just in the technical  
108 areas.



109  
110 Figure 8-1 Project organisation chart

111 The ESMP will be assessed for each project intervention by the EPA and UNDP prior to any  
112 works being undertaken. The ESMP identifies potential risks to the environment and social  
113 matters from the various interventions and outlines strategies for managing those risks and  
114 minimising undesirable environmental and social impacts. Further, the ESMP provides a  
115 Grievance Redress Mechanism (GRM) for those that may be impacted by the projects that do  
116 not consider their views have been heard.

117 The PMU will be responsible for the supervision of the ESMP. It will have a small  
118 environmental team to take ownership of the ESMP and ensure that it is implemented  
119 throughout the project. This environmental team may be either directly appointed or  
120 contracted from an independent service provider. The UNDP will be required to endorse the  
121 PMU's arrangements and will ensure the ESMP is adequate and followed. The PMU will  
122 ensure timely remedial actions are taken by any deviating contractor where necessary.

### 123 **8.3.2 Administration**

124 The PMU's environmental team will be responsible for the revision or updates of this  
125 document during the course of work. It is the responsibility of the person to whom the  
126 document is issued as "owner" to ensure it is updated.

127 The site supervisor will be responsible for daily environmental inspections of the construction  
128 site. The PMU's environmental team will cross check these inspections by undertaking  
129 monthly audits.

130 All service providers and contractors will maintain and keep all administrative and  
131 environmental records which would include a log of complaints together with records of any  
132 measures taken to mitigate the cause of the complaints.

133 The service providers and contractors will be responsible for the day to day compliance of the  
134 ESMP. The ESMP must always be part of any tender documentation. The Project Manager will  
135 supervise the service providers and contractors.

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## 136 **8.4 PROJECT DELIVERY AND ADMINISTRATION**

### 137 **8.4.1 Project Delivery**

138 The project will be delivered on the ground via the EPA through its subsidiary departments  
139 and the National Project Director, Project Manager and PMU appointed for the project. In  
140 addition, collaboration with other agencies, existing NGOs and local communities is provided  
141 for through the PITST and the participation that will be required by the responsible parties  
142 (i.e. service providers) engaged to deliver the project interventions.

### 143 **8.4.2 Administration of Environmental and Social Management Plan**

144 As the implementing agency, EPA will be responsible for responsible for the implementation  
145 with the ESMP via the delivery organisations.

146 The ESMP will be part of any tender documentation. The PMU will be responsible for the  
147 revision or updates of this document during the course of work. It is the responsibility of the  
148 person to whom the document is issued as owner (a member of the PMU environmental team)  
149 to ensure it is the most up to date version.

150 The UNDP and EPA are accountable for the provision of specialist advice on environmental  
151 and social issues to the delivery organisations (e.g. service providers, contractors and NGOs)  
152 and for environmental and social monitoring and reporting. The EPA or its delegate (i.e. the  
153 PMU) will assess the environmental and social performance of the service providers in charge  
154 of delivering each component throughout the project and ensure compliance with the ESMP.  
155 During operations the service providers will be accountable for implementation of the ESMP.  
156 Personnel working on all project interventions have accountability for preventing or  
157 minimising environmental and social impacts.

158 Each service provider's environmental officer will be responsible for daily environmental  
159 inspections of the project site. Through this arrangement, the service providers will be  
160 responsible for the day to day compliance of the ESMP. The PMU environmental team will  
161 cross check these inspections by undertaking monthly audits.

162 The service providers will maintain and keep all administrative and environmental records,  
163 which would include a log of complaints together with records of any measures taken to  
164 mitigate the cause of the complaints.

#### 165 **8.4.3 Environmental Procedures, Site and Activity-specific Work Plans and** 166 **Instructions**

167 Environmental procedures provide a written method describing how the management  
168 objectives for a particular environmental element are to be obtained. They contain the  
169 necessary detail to be site- or activity-specific and are required to be followed for all  
170 construction works. Site- and activity-specific work plans and instructions are to be issued  
171 and will follow the previously successful work undertaken on similar projects by the UNDP,  
172 EPA and the Ministry of Public Works (MPW).

#### 173 **8.4.4 Environmental Incident Reporting**

174 Any incidents, including non-conformances to the procedures of the ESMP are to be recorded  
175 using an Incident Record and the details entered into a register. For any incident that causes  
176 or has the potential to cause material or serious environmental harm, the service provider's  
177 environmental officer shall notify the PMU environmental team as soon as possible. The  
178 service provider must cease work until remediation has been completed as per the approval  
179 of the PMU.

#### 180 **8.4.5 Daily and Weekly Environmental Inspection Checklists**

181 A daily environmental checklist is to be completed at each work site by the relevant service  
182 provider's environmental officer and maintained within a register. A weekly environmental  
183 checklist is to be completed and will include reference to any issues identified in the daily  
184 checklists completed by the service provider's environmental officers. The completed  
185 checklist is to be forwarded to the PMU for review and follow-up if any issues are identified.

#### 186 **8.4.6 Corrective Actions**

187 Any non-conformances to the ESMP are to be noted in weekly environmental inspections and  
188 logged into the register. Depending on the severity of the non- conformance, the service

189 provider's environmental officer may specify a corrective action on the weekly site inspection  
190 report. The progress of all corrective actions will be tracked using the register. Any non-  
191 conformances and the issue of corrective actions are to be advised to the PMU.

#### 192 **8.4.7 Review and Auditing**

193 The ESMP and its procedures are to be reviewed at least every two months by UNDP staff  
194 and the PMU environmental team. The objective of the review is to update the document to  
195 reflect knowledge gained during the course of project delivery and to reflect new knowledge  
196 and changed community values.

197 The ESMP will be reviewed and amendments made if:

- 198 • There are relevant changes to environmental conditions or generally accepted  
199 environmental practices; or
- 200 • New or previously unidentified environmental risks are identified; or
- 201 • Information from the project monitoring and surveillance systems indicate that  
202 current control measures require amendment to be effective; or
- 203 • There are changes to environmental legislation that are relevant to the project; or
- 204 • There is a request made by a relevant regulatory authority.

205 Any changes are to be developed and implemented in consultation between UNDP staff and  
206 the PMU, involving the EPA as necessary. When an update is made, all site personnel are to  
207 be made aware of the revision as soon as possible through a tool box meeting or written  
208 notification.

#### 209 **8.5 CAPACITY BUILDING AND TRAINING**

210 The proper implementation of the ESMP is highly dependent on the available existing  
211 capacity and awareness of the EPA, the UNDP, the service providers' staff, the surrounding  
212 communities and the concerned stakeholders.

213 Training workshops are required to increase environmental and social awareness of all  
214 individuals concerned with the project and to train and follow-up with the workers who are  
215 specifically involved in site operations.

216 All project personnel will attend an induction that covers health, safety, environment and  
217 cultural awareness. All workers engaged in any activity with the potential to cause  
218 environmental harm (e.g. handling of hazardous materials) will receive task-specific  
219 environmental training.

### 220 **8.5.1 Induction Workshop – Adaptive and Protective Interventions**

221 The PMU personnel, the UNDP personnel and the service providers' (especially construction  
222 contractors') professional staff involved in the site operations will be required to attend  
223 induction workshops prior to project initiation and throughout the project life. The objective  
224 of these workshops is to ensure appropriate health, safety, environmental and cultural  
225 awareness, while also providing knowledge and skills for the implementation of mitigation  
226 and monitoring measures.

227 In order to increase local awareness on these issues, the workshops can also be opened for  
228 individuals from the local community. They will be conducted twice a year during the  
229 implementation of adaptive interventions and the construction of protective interventions.  
230 The workshops will increase the environmental awareness of the participants by covering at  
231 least the following topics:

- 232 • Environmental laws, regulations, and standards;
- 233 • Project's potential impacts on the surrounding environment;
- 234 • Impact prevention and mitigation measures;
- 235 • Health and safety impacts and adequate mitigation measures;
- 236 • Community awareness, respect, gender equality, social inclusion and non-  
237 discrimination; and
- 238 • Sampling techniques and environmental monitoring guidelines.

### 239 **8.5.2 Construction Site Operation Training Workshop – Protective Interventions**

240 On-site workers should receive appropriate training to undertake the duties of implementing  
241 the necessary mitigation measures. The training workshops should cover at least the  
242 following issues:

- 
- 243 • Project's potential impacts on the surrounding environment;
  - 244 • Project's potential impacts on occupational and public health and safety;
  - 245 • Sources of impacts;
  - 246 • Mitigation measures to be applied;
  - 247 • Proper on-site behaviour expected on the environmental and social levels;
  - 248 • Proper handling and storage of hazardous material and waste;
  - 249 • Spill contingency plans; and
  - 250 • Emergency response plan.

251 This could be achieved by small workshops conducted during the construction phase of the  
252 protective interventions for one or two days on a quarterly basis.

253 Additional workshops must be provided for specific jobs, including:

- 254 • Driving safely – for all drivers; and
- 255 • Safety and pollution prevention on ships – for all personnel working on ships.

256 These workshops can also be achieved by small workshops conducted during the construction  
257 phase of the protective interventions on a quarterly basis.

## 258 8.6 COMPLAINTS REGISTER AND GRIEVANCE REDRESS MECHANISM

259 The UNDP Social and Environmental Standards (SES) requires that stakeholders who may be  
260 adversely affected by a UNDP project can communicate their concerns about the social and  
261 environmental performance of the project through various entry points, scaled appropriately  
262 to the nature of the activity and its potential risks and impacts. Potentially affected  
263 stakeholders are required to be informed about available entry points for submitting their  
264 concerns as part of the stakeholder engagement process and when necessary, UNDP  
265 mandates an effective project-level grievance mechanism be available.

266 During the construction and implementation phases of the coastal protection project, a person  
267 or group of people can be adversely affected, directly or indirectly due to the project activities  
268 over the lifetime of the project design, implementation and restoration. The grievances that  
269 may arise can be related to social issues such as eligibility criteria and entitlements, disruption  
270 of services, temporary or permanent loss of livelihoods, and other social and cultural issues.

271 Grievances may also be related to environmental issues such as excessive dust generation,  
272 damages to infrastructure due to construction related vibrations or transportation of raw  
273 material, noise, traffic congestion, decrease in quality or quantity of private or public surface  
274 or ground water resources, damage to home gardens and agricultural lands etc.

275 Should such a situation arise, there must be a mechanism available through all implementing  
276 partners by which affected parties can resolve such issues in a cordial way with the project  
277 personnel in an efficient, unbiased, transparent, timely and cost-effective manner. To achieve  
278 this objective, a project level Grievance Redress Mechanism (GRM) has been developed.

279 The Complaints Register and GRM set out in this ESMP are to be used at all stages as part of  
280 the project and will provide an accessible, rapid, fair and effective response to concerned  
281 stakeholders, especially any vulnerable group who might lack access to formal legal regimes.

282 While recognising that many complaints may be resolved immediately, the Complaints  
283 Register and GRM set out in this ESMP encourages mutually acceptable resolution of issues  
284 as they arise.

### 285 **8.6.1 Complaints Register**

286 A Complaints Register will be established as part of the project to record any concerns raised  
287 by the community during construction. All grievances must be recorded in the Complaints  
288 Register which logs all contacts and decisions, assessments, estimates, etc. required to deal  
289 with each complaint. Every time an activity related to each complaint is undertaken, this must  
290 be recorded in the register and the outcome reported in writing to the complainant, to the  
291 relevant Community Chairman and the EPA/ PMU. Action must be seen to have been taken,  
292 investigation must be proven to have been undertaken fairly, decisions proved to be fairly  
293 made and reported. A letter and verbal communication of the outcome must be made to the  
294 complainant in their preferred dialect.

295 Any grievance related to corruption or any unethical practice should be referred immediately  
296 to the Office of the Attorney General in Monrovia and the Office of Audit and Investigation  
297 (OAI) within the UNDP in New York.

298 It is the responsibility of the EPA/ PMU to monitor the nature of complaints, outcomes and  
299 resolutions on a monthly basis as part of the normal reporting process and then report to

300 UNDP Country Office. It is very common for local NGOs and CBOs to voluntarily monitor  
301 construction projects and to present themselves as intermediaries. If the management  
302 structure is aware of the complaints coming in, making measured responses that can be  
303 proven is vital. It is likely that the Township Commissioners and Borough Governor will come  
304 to discuss grievances and like to be aware of resolutions.

305 A summary list of complaints received and their disposition must be published in a report  
306 produced every six months by the EPA.

### 307 **8.7 Grievance Redress Mechanism**

308 A multi-tier GRM structure has been developed to address all complaints and grievances in  
309 the project. The GRM recommended is a system proven to work in poor communities in  
310 Liberia, is compliant with UNDP's Social Safeguards, follows customary norms and fits into  
311 the statutory administrative process of the Government of Liberia.

312 The GRM has been designed to be a problem-solving mechanism with voluntary good-faith  
313 efforts. The GRM is not a substitute for any legal process. The GRM will, as far as practicable,  
314 try to resolve complaints or grievances on terms that are mutually acceptable to all parties.  
315 When making a complaint or raising a grievance, all parties must act in good faith at all times,  
316 and should not attempt to delay or hinder any mutually acceptable resolution.

317 A grievance is any actual or perceived problem that might give grounds for a complaint. A  
318 GRM allows internal and external stakeholders to ask questions and raise issues, with the  
319 knowledge that they will be handled properly. As such it is clear proof of the commitment to  
320 deal quickly and carefully with all reasonable concerns and queries that people bring.

321 The recording, response to and reporting of grievances is a vital part of stakeholder  
322 engagement and constitutes a separate sub-activity. Grievances will be raised on a variety of  
323 issues, all must be recorded, effectively processed and reported. This section proposes a  
324 methodology for managing complaints systematically and effectively throughout the project.

325 Complaints vary widely and can include, for example, allegations of:

- 326 • Adverse environmental impact by contractors or sub-contractors – refusing access to  
327 the beach or dumping materials on canoe slipways;
- 328 • Damage to property by machinery accessing through very tight pathways;

- 
- 329 • Payments for employment access – charging youths for being given a job;
  - 330 • Disagreements over compensation assessment and payment;
  - 331 • Unfair allocation of contracts – not encouraging and enabling small contractors to
  - 332 tender for the works;
  - 333 • Poor quality of work in communities;
  - 334 • Culturally inappropriate behaviour; and
  - 335 • Others.

336 Eligibility criteria for the GRM include:

- 337 a. Perceived negative economic, social or environmental impact on an individual or
- 338 group, or concern about the potential to cause an impact;
- 339 b. Clearly specified kind of impact that has occurred or has the potential to occur; and
- 340 explanation of how the project caused or may cause such impact; and
- 341 c. Individual or group filing of a complaint or grievance impacted, or at risk of being
- 342 impacted; or the individual or group filing a complaint or grievance demonstrates that
- 343 it has authority from an individual or group that have been or may potentially be
- 344 impacted on to represent their interest.

345 Local communities and other interested stakeholders may raise a grievance or complaint at  
346 all times to the PMU and EPA. Affected local communities must be informed about the ESMP  
347 provisions, including its grievance mechanism and how to make a complaint.

348 The mechanism proposed here provides a system for recognizing and responding fairly,  
349 openly, coherently and efficiently to a complaint through identifying a person responsible for  
350 investigating the complaint and coordinating response.

351 The methodology covers:

- 352 • Receiving complaints through any of the EPA, PMU, Contractors, etc.;
- 353 • Assessing information needs;
- 354 • Allocating responsibility for investigation;
- 355 • Recording the process;

- 
- 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.

- 381 • *Tier 2* Complainant and Designated Safeguards Officer can discuss with the Town  
382 Chief, Fishing Chief or Fishmonger Chairwoman, depending on the nature of the  
383 complaint.
- 384 • *Tier 3* Community representative discusses the issue with the Contractor, PMU or  
385 EPA.
- 386 • *Tier 4* Complainant can escalate the issue to Township Commissioner or Borough  
387 Governor who will delegate an enquiry to the Administrative Officers to investigate  
388 and resolve if the issue is not related to construction.

389 If a complaint is of a sufficiently serious and extensive nature, the County Superintendent can  
390 convene a Grievance Committee consisting of Administrative Officers of the Township and  
391 includes a Civil Society representative. This is an established process in Liberia.

392 The Terms of Reference for the Grievance Redress Committee are:

- 393 a. Provide support to the affected persons in solving their problems;
- 394 b. Prioritize grievances and resolve them as quickly as possible;
- 395 c. Provide information to the PMU on serious cases at the earliest opportunity;
- 396 d. Co-ordinate with the aggrieved person or group and obtain proper and timely  
397 information on the solution worked out for their grievance; and
- 398 e. Study the normally occurring grievances and advise the PMU, and Project Board on  
399 remedial actions to avoid further occurrences.

400 The Grievance Redress Committee will hold the necessary meetings with the aggrieved party  
401 and the concerned officer, and attempt to find a solution acceptable at all levels. The  
402 committee would record the minutes of the meeting. A civil society representative may be  
403 invited as an observer or as support to the complainant.

404 The Grievance Redress Committee will communicate proposed responses to the complainant  
405 formally. If the proposed response satisfies the complainant, the response will be  
406 implemented and the complaint or grievance closed. In cases where a proposed response is  
407 unsatisfactory to the complainant, the Grievance Redress Committee may choose to revise the  
408 proposed response to meet the complainant's remaining concerns, or to indicate to the

409 complainant that no other response appears feasible to the committee. A complainant may  
410 decide to take a legal or any other recourse if they are not satisfied with the resolutions due to  
411 the deliberations of the various tiers of the GRM.

412

413 The GRM has been designed to ensure that an individual or group are not financially  
414 impacted by the process of making a complaint or grievance. The GRM will cover any  
415 reasonable costs in engaging a suitably qualified person to assist in the preparation of a  
416 legitimate complaint or grievance. Where a complaint or grievance is seen to be ineligible, the  
417 GRM will not cover these costs.

418 Information about the GRM and how to make a complaint or grievance must be placed at  
419 prominent places for the information of the key stakeholders and freely advised to all through  
420 the media and at all meetings.

421 The PMU social safeguards officer will be designated as the key officer in charge of the GRM.  
422 The Terms of Reference for this position (as amended from time to time) will have the  
423 following key responsibilities:

- 424 a. Co-ordinate formation of Grievance Redress Committees before the commencement  
425 of site activities and construction works to resolve issues;
- 426 b. Act as the focal point at the PMU on Grievance Redress issues and facilitate the  
427 resolution of issues within the PMU;
- 428 c. Create awareness of the GRM amongst all the stakeholders through public awareness  
429 campaigns;
- 430 d. Assist in the redress of all grievances by co-ordinating with the parties concerned;
- 431 e. Maintain information on grievances and their redress;
- 432 f. Monitor the activities of the PMU and service providers on grievances issues;
- 433 g. Prepare the appropriate section of monthly and quarterly progress reports; and
- 434 h. Ensure the UNDP Country Office is advised on complaints.

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### 435 8.7.1 External Resolution Mechanism

436 In addition to the project-level and national GRMs, complainants have the option to access  
437 UNDP's Accountability Mechanism, with both compliance and grievance functions. The  
438 Social and Environmental Compliance Unit investigates allegations that UNDP's standards,  
439 screening procedure or other UNDP social and environmental commitments are not being  
440 implemented adequately, and that harm may result to people or the environment. The Social  
441 and Environmental Compliance Unit is housed in the Office of Audit and Investigations, and  
442 managed by a Lead Compliance Officer. A compliance review is available to any community  
443 or individual with concerns about the impacts of a UNDP project. The Social and  
444 Environmental Compliance Unit is mandated to investigate valid requests from locally  
445 impacted people independently and impartially, and to report its findings and  
446 recommendations publicly.

447 The Stakeholder Response Mechanism offers locally affected people an opportunity to work  
448 with other stakeholders to resolve concerns, complaints and grievances about the social and  
449 environmental impacts of a UNDP project. The Stakeholder Response Mechanism is intended  
450 to supplement the proactive stakeholder engagement that is required of UNDP and its  
451 implementing partners throughout the project cycle. Communities and individuals may  
452 request a Stakeholder Response Mechanism process when they have used standard channels  
453 for project management and quality assurance, and are not satisfied with the response (in this  
454 case the project level GRM). When a valid Stakeholder Response Mechanism request is  
455 submitted, UNDP focal points at country, regional and headquarters levels will work with  
456 concerned stakeholders and implementing partners to address and resolve the concerns. Full  
457 details are posted by UNDP at the website [www.undp.org/secu-srm](http://www.undp.org/secu-srm).

458 .

459

460

### 461 8.8 GOVERNING LEGISLATION

462 The two main pieces of Liberian legislation relevant to the project are the Environmental  
463 Protection Agency Act, based on which the EPA was created, and the Environment Protection

464 and Management Law (EPML). The EPML provides the legal framework for the sustainable  
465 development, management and protection of the environment by the EPA in partnership with  
466 relevant parties. It also defines the specific requirements for performing an Environmental  
467 and Social Impact Assessment (ESIA) and other measures required to protect the environment  
468 in Liberia.

469 The project considered in this report includes building structures for erosion control, which  
470 falls under the “Land Reclamation and Land Development” category in Annex I of the EPML,  
471 and therefore is required to get a permit from the EPA before commencement of activities.  
472 This permit can be obtained by following the ESIA process defined in section 0 of this ESAR.  
473 Several environmental quality standards are partly prepared by the EPA. Some of these  
474 standards likely to be relevant for aspects of this project are: (1) Air Quality Standards; (2)  
475 Water Quality Standards; (3) Noise Level Standards; and (4) Waste Management Standards.  
476 These are presented in detail in section 4.4 of this report.

477 Liberia is a signatory of a number of international treaties, conventions and protocols relevant  
478 to the project (see section 0 of this report). These cover aspects related to biodiversity  
479 conservation, wetlands, air quality, climate change, waste transport, socio-culture, maritime  
480 activities, gender-based violence and discrimination, and other issues. In addition, the project  
481 must comply with international standards for shipping activities as defined by the  
482 International Maritime Organisation.

483 Apart from national and international provisions, the project must meet the requirements of  
484 the GCF’s Environmental and Social Policy and the UNDP’s Social and Environmental  
485 Standards, described in sections 4.8.1 and 4.8.2 of this report.

## 486 **8.9 STAKEHOLDER ENGAGEMENT AND PUBLIC PARTICIPATION**

### 487 **8.9.1 Requirements**

488 In June 2014, UNDP adopted mandatory Social and Environmental Standards (SES) for all of  
489 UNDP’s projects and programmes effective 1 January 2015, as part of the UNDP’s quality  
490 assurance process outlined in UNDP Strategic Plan Integrated Results and Resources  
491 Framework (IRRF). The objectives of the Standards are to:

- 
- 492 (i) strengthen the social and environmental outcomes of UNDP projects;  
493 (ii) avoid adverse impacts to people and the environment affected by projects;  
494 (iii) minimize, mitigate, and manage adverse impacts where avoidance is not possible;  
495 (iv) strengthen UNDP and partner capacities for managing social and environmental  
496 risks; and  
497 (v) ensure full and effective stakeholder engagement, including through a mechanism  
498 to respond to complaints from project-affected people.

499 The process to meet the objectives of the SES are required as part of the Stakeholder Response  
500 Mechanism. To fulfil these criteria the ESMP requires a UNDP-SES compliant Stakeholder  
501 Engagement and Public Participation Plan (SEP), together with process and structure, to guide  
502 information, consultation and participation of all stakeholders to the project.

503 The PMU must design and implement the SEP to build on the public information and  
504 community engagement activities conducted for the ESAR and any other initial contacts  
505 developed during the project's initial stages by UNDP, consultants, researchers etc. As the  
506 project development continues into implementation and construction, there is a need to  
507 continue to conduct public consultation both with affected communities and interested parties  
508 during the entire project cycle.

509 The SEP will build on the public information and community engagement activities  
510 conducted for the ESAR.

511 The SEP will involve the following:

- 512 • Conducting stakeholder engagement before the letting of the service and construction  
513 contracts, which will require the following elements:
  - 514 ○ Stakeholder identification and analysis with a particular emphasis to  
515 organizing dialogue with affected groups; giving special attention to  
516 vulnerable groups whose vital interests, particularly employment, can  
517 potentially be affected by the project;
  - 518 ○ Stakeholder engagement planning; engagement activities and consultations  
519 where appropriate, diverse consultation methods (meetings, roundtable  
520 discussions, public hearings, focus groups, radio, newspapers etc.);
  - 521 ○ Information disclosure;

- 522 ○ Consultation and engagement;
- 523 ○ GRM; and
- 524 ○ Recording all activities and regular reporting to interested stakeholders, EPA
- 525 and UNDP.
- 526 • Adopting and implementing the SEP prior to the letting of service and construction
- 527 contracts, proportionate to the nature and scale of the project and its potential adverse
- 528 impacts on the affected communities. It must relate to the sensitivity of the
- 529 environment and social concerns, and the level of public interest.
- 530 • Identifying and documenting the various individuals or groups who (i) are affected or
- 531 likely to be affected (directly or indirectly) by the project (affected parties), or (ii) may
- 532 have an interest in the project (other interested parties).
- 533 • Establishing an effective grievance mechanism to facilitate prevention and timely
- 534 resolution of disputes or conflicts that may arise during the project life cycle. This last
- 535 is very important and must have staffing in place before works start, see section 8.5.

## 536 8.9.2 Contents of Stakeholder Engagement Plan

537 The SEP must be written, maintained and managed by the PMU Safeguards Officer. This  
538 individual is responsible for the SEP and must regularly report through the Project Manager  
539 to the Project Director and the EPA.

540 The plan requires:

- 541 1. Identification of interested parties and stakeholders;
- 542 2. Interaction with each party to define interests, roles and responsibilities;
- 543 3. Records of the details of all contacts with all parties in the stakeholder engagement
- 544 matrix;
- 545 4. Reporting arrangements on stakeholder engagements to PMU, EPA and UNDP;
- 546 5. Planning for future engagement with each party over the lifetime of the project in a
- 547 SEP;
- 548 6. Creation of a Public Information Dissemination Plan;
- 549 7. Creation of a Community Consultation Plan;
- 550 8. Implementation plan for ongoing stakeholder engagement; and
- 551 9. A system for monitoring the SEP and for third party evaluation of its efficiency.

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### 552 8.9.3 Identifying Stakeholders, Communication Needs and Recording

553 The PMU Safeguards Officer must gather information on all groups and individuals  
554 previously contacted by the project to date from all project-related organisations, including  
555 the service providers, and record this information in a stakeholder engagement matrix. This  
556 database must be added to and updated to reflect changes in stakeholder information,  
557 interests and priorities, contact information and designated responsible contact personnel.  
558 The aim is to be able to identify all interest groups of whatever size, be able to make contact  
559 easily and to know what sort of information, consultation and participation can be expected.

560 The PMU Safeguards Officer must collect information on contacts made by other PMU staff  
561 in the course of their work. This information should consist of the circulation of meeting  
562 minutes recorded on a proforma.

563 The matrix is divided into groups of stakeholders according to their interests, roles and  
564 responsibilities, means of communication, information needs and the need for consultation.

### 565 8.9.4 Reporting

566 The PMU Safeguards Officer must report to the Project Manager weekly on all contacts  
567 generated or recorded, highlight issues arising and advise on resolutions required. There must  
568 also be a specific section on grievances received and the outcomes of the GRM.

569 The PMU shall incorporate the stakeholder engagement report in weekly and monthly reports  
570 to the EPA and UNDP.

### 571 8.9.5 The Stakeholder Engagement Plan

572 The analysis of the data on interested groups, individuals and organisations enables a plan to  
573 be developed to guide the future information requirements both by the project and by  
574 stakeholders. The plan describes the following main topics.

- 575 1. What stakeholder interactions are needed at each stage of the project to enable people  
576 to be consulted and allowed to participate according to interests at critical project  
577 points.

- 578 2. The messages that the project needs to communicate to which audience at which stage  
579 of the project, ensuring that official government and legal requirements for public  
580 notices are scheduled appropriately.
- 581 3. The activities required to undertake consultation, communication and participation.
- 582 4. A process for monitoring stakeholder activities – internal and external third party  
583 where appropriate.
- 584 5. A basis for estimating the staff required and a budget to cover stakeholder activities.

585 The SEP contains a sub-plan for Public Information Dissemination. This takes forward the  
586 analysis of which groups need to know what at each stage of the project and categorises each  
587 information need into a time-based programme. The programme sets out a hierarchy of  
588 messages required for delivery to each interest group or stakeholder to maximise information  
589 dissemination, efficiency of delivery and comprehension by the stakeholders targeted for each  
590 message.

591 For each message the choice of media and delivery process is extremely important – public  
592 announcement, newspaper advertisement, radio announcements or discussion programmes,  
593 leaflets, brochures etc. Added to this is the choice of language acceptable to the target  
594 audience. The plan lists all potential messages, design, choice of language and media, timing,  
595 repetitions required, cost of development and delivery. The budget must include a 20 percent  
596 contingency for dealing with unexpected information requirements. The plan shall include a  
597 recording and reporting mechanism that is easily shareable with project partners. The PMU  
598 social safeguards officer will include public information activities as part of the stakeholder  
599 engagement reporting process.

600 Similarly, the SEP needs a Community Consultation Plan as a further sub-plan, to ensure that  
601 communities most directly affected are properly and effectively informed and consulted  
602 about aspects of the project which will impact their homes, families and livelihoods. The PMU  
603 social safeguards officer needs to determine the format of the consultation and calculate how  
604 many meetings, surveys, focus groups etc. are required by each community group affected by  
605 the project over each project stage, and assess the format of each consultation exercise.

606 The plan must calculate the time and cost of each consultation phase and estimate the PMU  
607 staff time required to achieve each consultation, surveys, or focus group including the analysis  
608 of the information exchanged and reporting to the PMU, EPA and UNDP.

609 The SEP requires an implementation section which sets out roles and responsibilities of each  
610 actor and action required under the plan, the logistics required and the budget needed over  
611 the life of the project. This also includes the staff required to deliver an effective stakeholder  
612 engagement programme, such as the skill levels required and assessment of the work  
613 experience and cultural backgrounds needed. The plan shall define the process for agreement  
614 for and procurement of the items and staff required for implementation.

615 The SEP must include a monitoring process for its activities, and set targets and indicators for  
616 activities against which progress can be assessed, performance evaluated, lessons learned and  
617 the programme redirected if needed.

## 618 8.10 BUDGET

619 A budget has been prepared for the implementation of the ESMP as follows.

620 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> |

## 621 8.11 ENVIRONMENTAL AND SOCIAL MANAGEMENT AND MONITORING MATRIX

622 The Environmental and Social Management and Monitoring Matrix (ESMMM) is designed as  
623 a cover-all, one-stop mitigation and monitoring plan for all social and environmental impacts.  
624 As such, it incorporates elements of a range of possible sub-plans which, in some ESMPs, are  
625 listed separately. In this ESMMM, the sub-plans are combined into a single entity. This makes

626 both management and monitoring simpler, and ensures that there are no gaps between the  
627 different safeguard elements.

628 This ESMMM therefore works through a series of key environmental and social indicators,  
629 listed below. The potential impacts identified in the ESAR are listed under these indicators,  
630 so that each aspect of environmental and social protection can be easily found among the  
631 mitigation and monitoring tables. The mitigation and monitoring measures are to ensure  
632 compliance with local and international legislation, standards and guidelines (see sections 1,  
633 8.7 and Appendix D). The “Standard to be met” column of Table 8-2 shows the linkages  
634 between the ESMMM and the standards and guidelines listed in Appendix D.

- 635 1. General Environmental Protection
- 636 2. Community Protection Measures, including Gender and Social Inclusion
- 637 3. Environmental Health and Safety
- 638 4. Occupational Health and Safety
- 639 5. Labour and Working Conditions
- 640 6. Water Resources Management
- 641 7. Coastal Sediment Resources Management
- 642 8. Soil and Land Resources Management
- 643 9. Dust and Air Quality Management
- 644 10. Flora and Fauna Protection
- 645 11. Archaeology and Cultural Sites Management
- 646 12. Waste Management
- 647 13. Hazardous Materials Management

648 Table 8-2 – the ESMMM – lays out the arrangements for safeguarding the environment and  
649 society through the practical mitigation of identified impacts according to identified  
650 responsibilities, the monitoring of this and the identification of the measures to be taken, again  
651 with the defined responsibilities for action. This matrix forms the core of the ESMP, since it  
652 shows exactly what must be done, by whom, when and to what standard; and also it shows  
653 who will monitor its implementation and when, and what actions are found to be necessary.

654 It should be noted that the majority of environmental and social mitigation is required in  
655 relation to the physical construction of the project’s proposed protective interventions. Most

656 of these are in the project implementation period, during the actual construction works.  
657 Depending on the nature of the works, they might affect the marine environment, the coastal  
658 tidal environment, or the terrestrial edaphic and aquatic (land and water) environment.  
659 Because of the broad range of different environments in which the project will work there are  
660 many safeguards required, although many will only be relevant for certain activities. For  
661 example, actions such as the quarrying and transporting of rock for revetments from inland  
662 quarries are included, as they will be impacts caused by the project even though they will not  
663 affect the actual coastal fringe.

664 The ESMMM has identified additional surveys and management plans that must be  
665 conducted before any activities take place, in addition to the ESIA. These are mentioned  
666 within the ESMMM and summarized below.`

667 1. Detailed ESIA Surveys

668 1.1. Marine and Estuarine Biological Survey

669 1.2. Marine and Estuarine Sediment Survey

670 1.3. Household Survey of Affected Communities

671 1.4. Fish Landing Survey (linked to 1.1 and 1.3 above)

672 2. Detailed Sub-plans

673 2.1. Contractors' Oil Spill Response Plan (OSRP) for land

674 2.2. Contractors' Oil Spill Response Plan (OSRP) for sea, including a Marine Spill  
675 Contingency Plan

676 2.3. Contractors' Emergency Response Plan

677 2.4. Contractors' Rock Quarry Management Plan, including Blasting Plan

678 2.5. Resettlement Action Plan for Affected Livelihoods

679 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  |
| <b>1. General environmental protection</b>  |   |                                   |                                       |   |  |   |  |
| 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  |
| <b>2. Community protection measures, including gender and social inclusion</b>                              |   |                                   |                                       |  |                               |  |  |
| 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)  |   |                                   |                                       |   |                               |   |  |
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| 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  |
| <b>3. Environmental health and safety</b>   |   |                                   |                                       |   |                               |   |  |
| 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)  |  |                                   |                                       |  |  |  |  |
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| 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. |

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| <p>3.6 Noise from construction activities causes disturbance.</p> | <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. |
| <p>3.7 Noise from construction machinery (plant,</p>              | <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   |   |   |  |
|   |   |                                   |                                       | Check timing   | Responsibility for checking   | Assessment of condition   | Action required  |
| transportation activities, etc.) causes disturbance.              | ensure that noise emissions are minimised during construction, including all pumping equipment. <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. |

| 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  |
| 3.8 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. |

| 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  |
| 3.9 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. |

| 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  |
| <b>4. Occupational health and safety</b>  |   |                                   |                                       |                               |                               |  |  |
| 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. |

| 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  |
| 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. |

| 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  |
| 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. |

| 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  |
| 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. |

| 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  |
| 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. |

| 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  |
| 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. |

| 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  |
| 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. |

| 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  |
| <b>5. Labour and working conditions</b>                           |   |                                   |                                       |   |                               |  |  |
| 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. |

| 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  |
| 5.3 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. |

| 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  |
| 5.5 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. |

| 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  |
| 5.6 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. |

| 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  |
| 5.8<br>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  |
| <b>6. Water resources management</b>  |  |                                   |  |  |                             |   |  |
| 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  |
| <b>7. Coastal sediment resources management</b>   |   |                                   |                                       |  |                             |   |  |
| 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)  |  |                                   |                                       |  |                               |   |  |
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| 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. | <p><u>Provide drainage management</u></p> <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) |  |                                   |                                       |  |                             |  |  |
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| 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)  |   |                                   |   |  |                             |   |  |
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| 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)                              |   |                                   |                                       |  |                             |   |  |
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| 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  |
| <b>9. Dust and air quality management</b>   |   |                                   |                                       |                                |                             |   |  |
| 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)  |   |                                   |                                       |  |                             |   |  |
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| 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<br>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  |
| <b>11. Archaeology and cultural sites management</b>   |   |                                   |                                       |  |  |  |  |
| 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  |
| <b>12. Waste management</b>                                       |   |                                   |                                       |  |                             |   |  |
| 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) |   |                                   |                                       |  |                             |   |  |
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| 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  |
| <b>13. Hazardous materials management</b>   |  |                                   |                                       |  |                             |   |  |
| 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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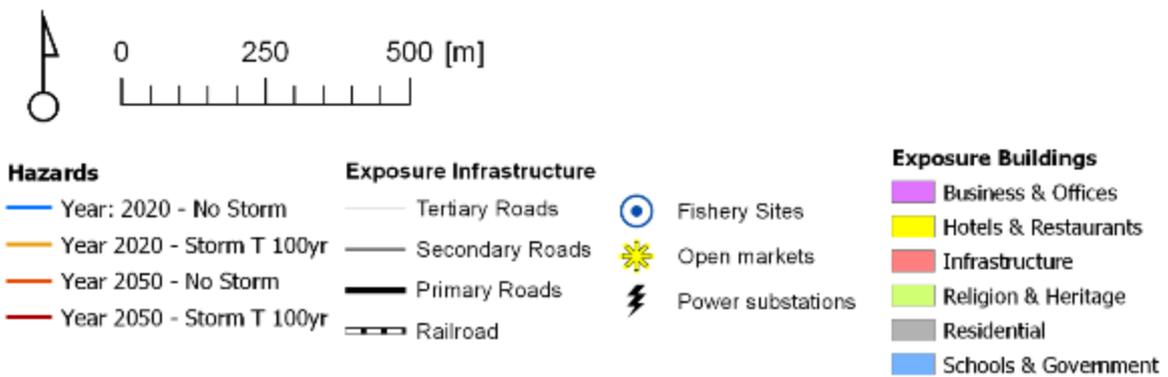
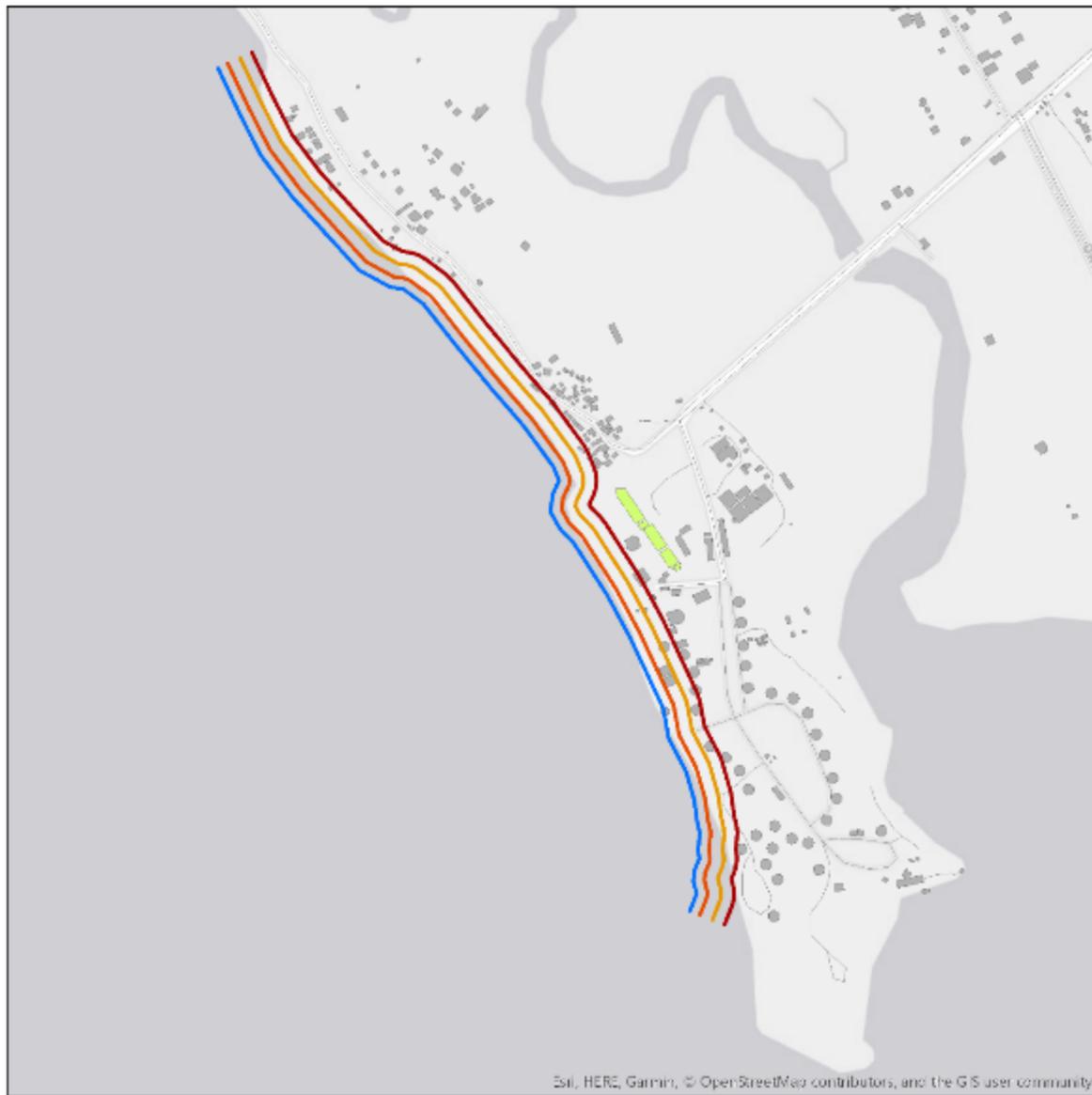
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# 1 APPENDIX A VULNERABILITY MAPS

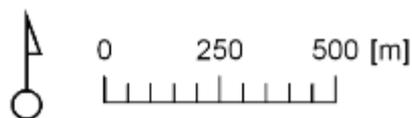
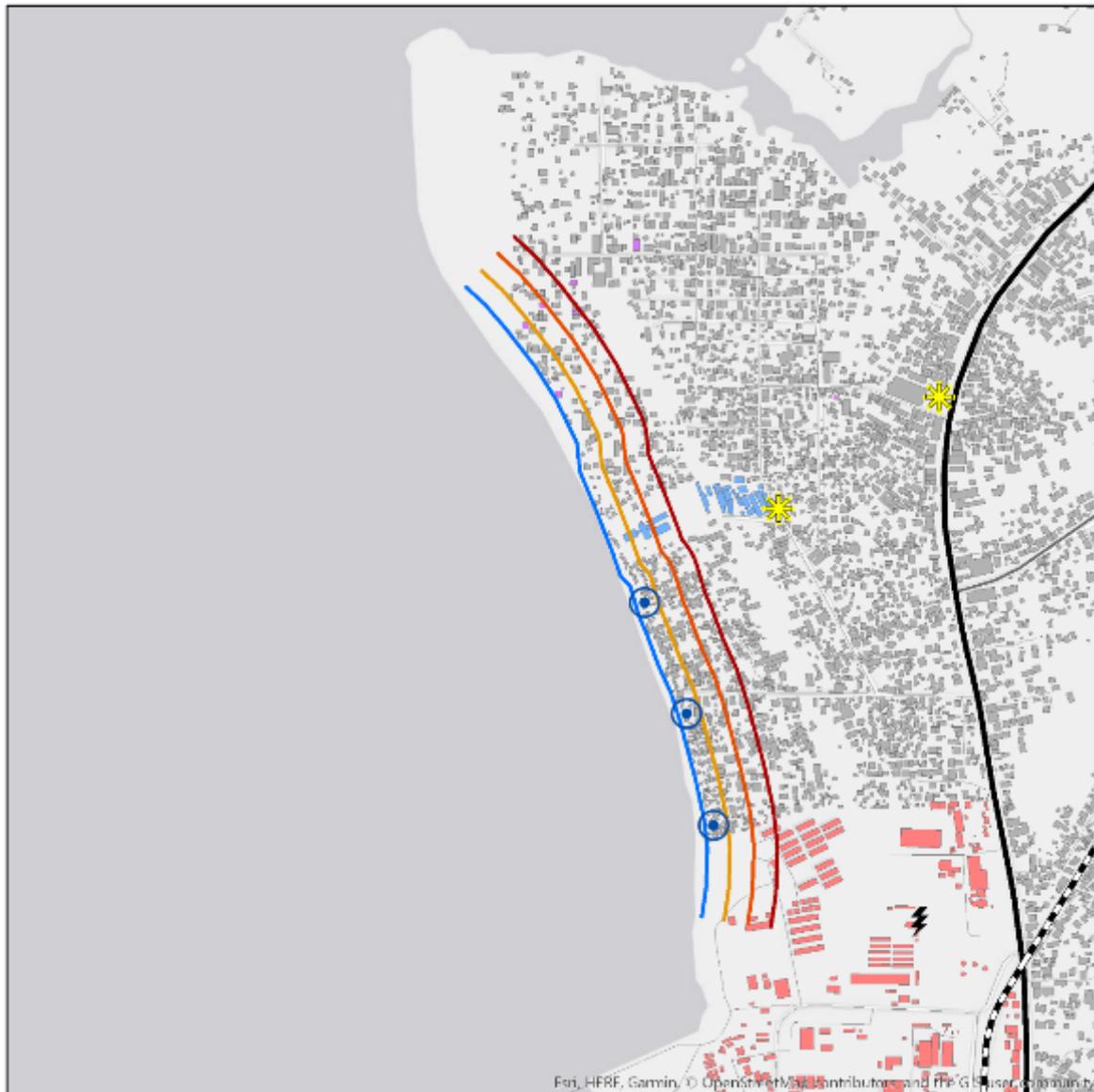
2 The following maps are taken from the Revised Interim Report (CDR International, 2019a).

### Coastal Section 1



3

## Coastal Section 2



### Hazards

- Year: 2020 - No Storm
- Year 2020 - Storm T 100yr
- Year 2050 - No Storm
- Year 2050 - Storm T 100yr

### Exposure Infrastructure

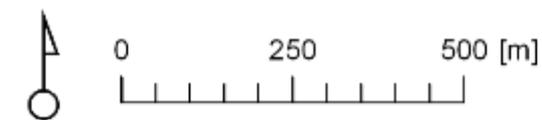
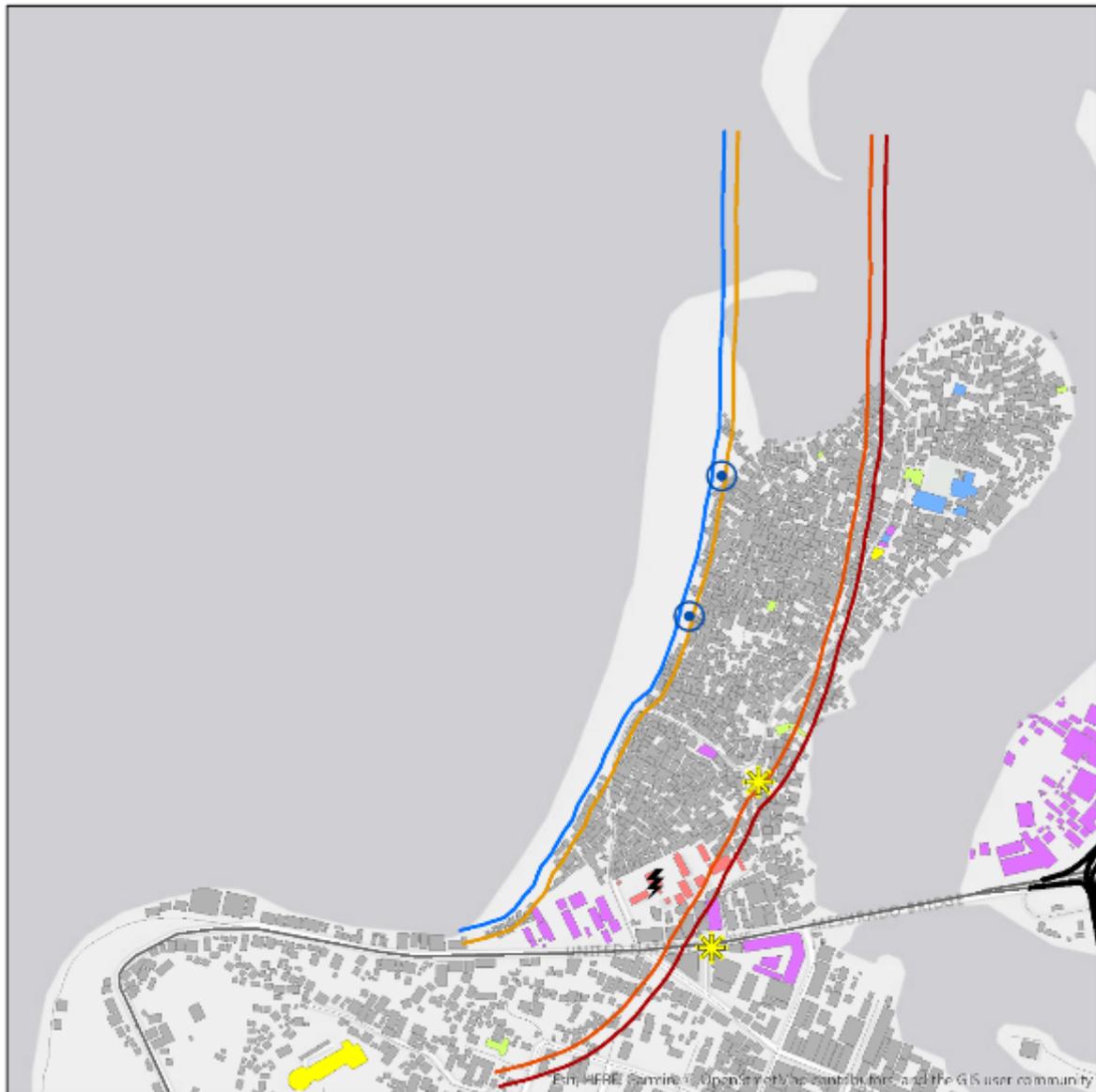
- Tertiary Roads
- Secondary Roads
- Primary Roads
- Railroad

- ⊙ Fishery Sites
- ★ Open markets
- ⚡ Power substations

### Exposure Buildings

- Business & Offices
- Hotels & Restaurants
- Infrastructure
- Religion & Heritage
- Residential
- Schools & Government

### Coastal Section 3



**Hazards**

- Year: 2020 - No Storm
- Year 2020 - Storm T 100yr
- Year 2050 - No Storm
- Year 2050 - Storm T 100yr

**Exposure Infrastructure**

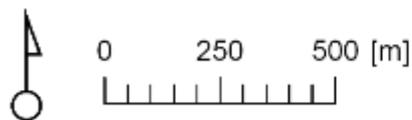
- Tertiary Roads
- Secondary Roads
- Primary Roads
- Railroad

- ⊙ Fishery Sites
- ✱ Open markets
- ⚡ Power substations

**Exposure Buildings**

- Business & Offices
- Hotels & Restaurants
- Infrastructure
- Religion & Heritage
- Residential
- Schools & Government

### Coastal Section 4



**Hazards**

- Year: 2020 - No Storm
- Year 2020 - Storm T 100yr
- Year 2050 - No Storm
- Year 2050 - Storm T 100yr

**Exposure Infrastructure**

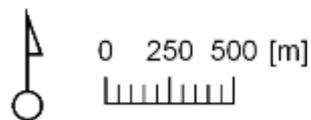
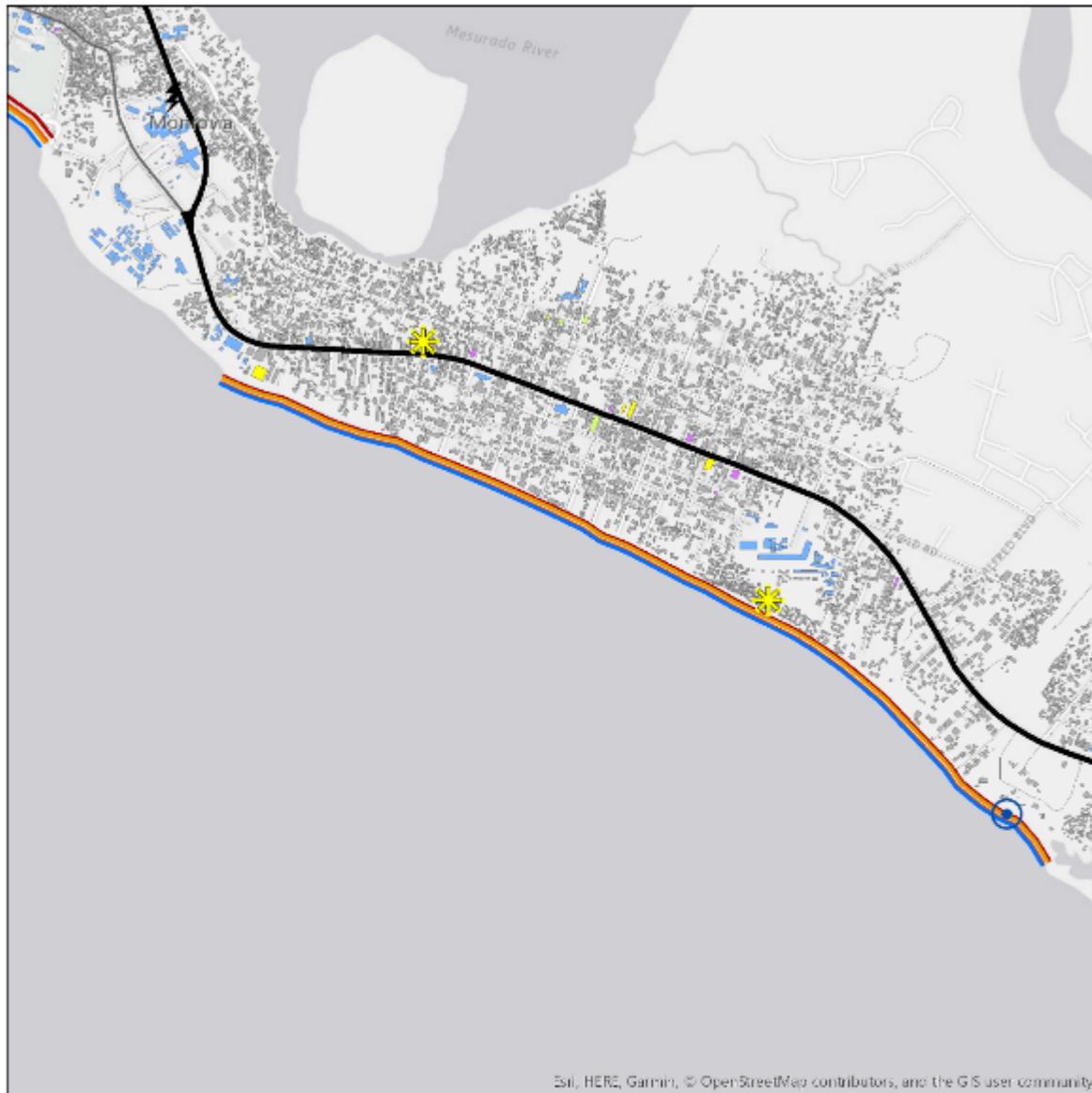
- Tertiary Roads
- Secondary Roads
- Primary Roads
- Railroad

- ⊙ Fishery Sites
- ★ Open markets
- ⚡ Power substations

**Exposure Buildings**

- Business & Offices
- Hotels & Restaurants
- Infrastructure
- Religion & Heritage
- Residential
- Schools & Government

### Coastal Section 5



**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

## 1 APPENDIX B LABORATORY RESULTS



Earthtime Inc.  
Earthtime Building  
U.N. Drive  
Clara Town  
Monrovia  
Liberia

Attention: Chinwa 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: 140216-11 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 |
|------------------|----------------------|----------|-----------|--------------|
| 18385324         | 5                    |          | 1.00      | 09/02/2019   |
| 18385055         | 2a                   |          | 1.00      | 09/02/2019   |
| 18385058         | 3a                   |          | 1.00      | 09/02/2019   |
| 18385320         | 4a                   |          | 1.00      | 09/02/2019   |
| 18385327         | 7a                   |          | 1.00      | 09/02/2019   |
| 18385690         | 8a                   |          | 1.00      | 09/02/2019   |
| 18385693         | 9a                   |          | 1.00      | 09/02/2019   |
| 18385054         | 1b                   |          | 1.00      | 09/02/2019   |
| 18385056         | 2b                   |          | 1.00      | 09/02/2019   |
| 18385059         | 3b                   |          | 1.00      | 09/02/2019   |
| 18385322         | 4b                   |          | 1.00      | 09/02/2019   |
| 18385326         | 6b                   |          | 1.00      | 09/02/2019   |
| 18385328         | 7b                   |          | 1.00      | 09/02/2019   |
| 18385601         | 8b                   |          | 1.00      | 09/02/2019   |
| 18385695         | 9b                   |          | 1.00      | 09/02/2019   |
| 18385061         | 3c                   |          | 1.00      | 09/02/2019   |
| 18385696         | SP                   |          | 1.00      | 09/02/2019   |

**Maximum Sample/Coolbox Temperature (°C) :**

**14.2**

ISO5667-3 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.**

| Results Legend  |     | Lab Sample No(s)           |   | Customer Sample Reference |   | AGS Reference           |   | Depth (m)               |  | Container               |  | Sample Type             |   |
|---|-----|----------------------------|---|---------------------------|---|-------------------------|---|-------------------------|--|-------------------------|--|-------------------------|---|
|   |     | 1965324                    |   | 1965055                   |   | 1965320                 |   | 1.00                    |  | 1.00                    |  | 1.00                    |   |
| <b>X</b> Test<br><b>ND</b> No Determination Possible<br><br>Sample Types -<br>S - Soil/Solid<br>UNS - Unspecified Solid<br>GW - Ground Water<br>SW - Surface Water<br>LT - Land Leachate<br>PL - Prepared Leachate<br>PR - Process Water<br>SA - Saline Water<br>TE - Trade Effluent<br>TS - Treated Sewage<br>US - Untreated Sewage<br>RE - Recreational Water<br>DW - Drinking Water<br>Non-regulatory<br>LNL - Unspecified Liquid<br>SL - Sludge<br>G - Gas<br>OTH - Other |     | 5                          |   | 24                        |   |                         |   | 1.00                    |  | 1.00                    |  | 1.00                    |   |
|   |     | O-SI glass bottle (ALE227) |   | 1-litric (ALE211)         |   | HINDI filtered (ALE204) |   | HINDI filtered (ALE204) |  | HINDI filtered (ALE204) |  | HINDI filtered (ALE204) |   |
|   |     | SA                         |   | SA                        |   | SA                      |   | SA                      |  | SA                      |  | UNL                     |   |
| Ammonical Nitrogen  | All | NDP: 0 Tests: 17           | X |                           | X |                         | X |                         |  |                         |  |                         |   |
| COD (unfiltered)  | All | NDP: 0 Tests: 17           | X |                           | X |                         | X |                         |  |                         |  |                         |   |
| Conductivity (at 20 deg.C)  | All | NDP: 0 Tests: 17           | X |                           | X |                         | X |                         |  |                         |  |                         |   |
| EPH (BRO) (ClO <sub>2</sub> -O4)-Aqueous (R)  | All | NDP: 0 Tests: 17           | X |                           | X |                         | X |                         |  |                         |  |                         | X |
| ORP by GG RD (R)  | All | NDP: 0 Tests: 17           |   |                           | X |                         | X |                         |  |                         |  |                         | X |
| Nitrite by Kone (a)   | All | NDP: 0 Tests: 17           | X |                           | X |                         | X |                         |  |                         |  |                         | X |
| pH Value  | All | NDP: 0 Tests: 17           | X |                           | X |                         | X |                         |  |                         |  |                         | X |
| Saline Cyanides (H)   | All | NDP: 0 Tests: 17           |   |                           | X |                         | X |                         |  |                         |  |                         | X |
| Saline Metals Unfiltered  | All | NDP: 0 Tests: 17           |   |                           | X |                         | X |                         |  |                         |  |                         | X |
| Saline TON  | All | NDP: 0 Tests: 17           | X |                           | X |                         | X |                         |  |                         |  |                         | X |
| Suspended Solids  | All | NDP: 0 Tests: 17           | X |                           | X |                         | X |                         |  |                         |  |                         | X |
| TOC (Saline)(W-TOC-R)   | All | NDP: 0 Tests: 17           | X |                           | X |                         | X |                         |  |                         |  |                         | X |
| Total Dissolved Solids (Grav)   | All | NDP: 0 Tests: 17           | X |                           | X |                         | X |                         |  |                         |  |                         | X |
| Total EP- (a)   | All | NDP: 0 Tests: 17           | X |                           | X |                         | X |                         |  |                         |  |                         | X |
| Turbidity in meters   | All | NDP: 0 Tests: 17           | X |                           | X |                         | X |                         |  |                         |  |                         | X |

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| Results Legend  | Lab Sample No(s)          | 19365320   | 19365327   | 19365590   | 19365693   |
|---|---------------------------|--|--|--|--|
|   | Customer Sample Reference | 4A   | 7A   | 8A   | 9A   |
| Sample Types -<br>S - Soil/Solid<br>LNS - Unspecified Solid<br>GW - Ground Water<br>SW - Surface Water<br>LE - Land Leachate<br>PL - Prepared Leachate<br>PR - Process Water<br>SA - Saline Water<br>TE - Trade Effluent<br>TS - Treated Sewage<br>LS - Untreated Sewage<br>RE - Recreational Water<br>DW - Drinking Water<br>Non-regulatory<br>LNL - Unspecified Liquid<br>SL - Sludge<br>G - Gas<br>OTH - Other | AGS Reference             |  |  |  |  |
|   | Depth (m)                 | 1.00   | 1.00   | 1.00   | 1.00   |
|   | Container                 | HNO3 Filtered (ALE204)<br>H2SO4 (ALE244)<br>HNO3 Filtered (ALE204)<br>H2SO4 (ALE244)<br>Tiploc (ALE221)<br>Tiploc (ALE221) | HNO3 Filtered (ALE204)<br>H2SO4 (ALE244)<br>HNO3 Filtered (ALE204)<br>H2SO4 (ALE244)<br>Tiploc (ALE221)<br>0.5l glass bottle (ALE227)<br>Tiploc (ALE221) | HNO3 Filtered (ALE204)<br>H2SO4 (ALE244)<br>HNO3 Filtered (ALE204)<br>H2SO4 (ALE244)<br>Tiploc (ALE221)<br>0.5l glass bottle (ALE227)<br>Tiploc (ALE221) | HNO3 Filtered (ALE204)<br>H2SO4 (ALE244)<br>HNO3 Filtered (ALE204)<br>H2SO4 (ALE244)<br>Tiploc (ALE221)<br>0.5l glass bottle (ALE227)<br>Tiploc (ALE221) |
|   | Sample Type               | UML  | UML  | UML  | UML  |
| Anomical Nitrogen   | All                       | NDPs: 0<br>Tests: 17   | X  | X  | X  |
| COD Unfiltered  | All                       | NDPs: 0<br>Tests: 17   | X  | X  | X  |
| Conductivity (at 20 deg C)  | All                       | NDPs: 0<br>Tests: 17   | X  | X  | X  |
| EPH (DRO) (C10-C40) Aqueous (%)   | All                       | NDPs: 0<br>Tests: 17   | X  | X  | X  |
| GRO by GC FID (%)   | All                       | NDPs: 0<br>Tests: 17   | X  | X  | X  |
| Nitro by Koro (%)   | All                       | NDPs: 0<br>Tests: 17   | X  | X  | X  |
| pH Value  | All                       | NDPs: 0<br>Tests: 17   | X  | X  | X  |
| Saline Cyanides (M)   | All                       | NDPs: 0<br>Tests: 17   | X  | X  | X  |
| Saline Metals Dissolved   | All                       | NDPs: 0<br>Tests: 17   | X  | X  | X  |
| Saline TON  | All                       | NDPs: 0<br>Tests: 17   | X  | X  | X  |
| Suspended Solids  | All                       | NDPs: 0<br>Tests: 17   | X  | X  | X  |
| TOC (Galno)(W-TOC-R)  | All                       | NDPs: 0<br>Tests: 17   | X  | X  | X  |
| Total Dissolved Solids (Grav)   | All                       | NDPs: 0<br>Tests: 17   | X  | X  | X  |
| Total EPH (M)   | All                       | NDPs: 0<br>Tests: 17   | X  | X  | X  |
| Turbidity in meters   | All                       | NDPs: 0<br>Tests: 17   | X  | X  | X  |

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| ALS   |                                  | CERTIFICATE OF ANALYSIS          |   |   |   | Validated  |
|---|----------------------------------|----------------------------------|---|---|---|--|
| SDG: 140216-11  |                                  | Client Reference: B1804-07       |   | Report Number: 497498   |   |  |
| Location: Atlantic Ocean  |                                  | Order Number:                    |   | Superseded Report: 496476   |   |  |
| <b>Results Legend</b><br> Test<br> No Determination Possible<br><br>Sample Types -<br>S - Soil/Solid<br>UNS - Unspecified Solid<br>GW - Ground Water<br>SW - Surface Water<br>LE - Land Leachate<br>PL - Prepared Leachate<br>PR - Process Water<br>SA - Saline Water<br>TE - Trade Effluent<br>TS - Treated Sewage<br>US - Untreated Sewage<br>RE - Recreational Water<br>DW - Drinking Water<br>Non-regulatory<br>UNL - Unspecified Liquid<br>SL - Sludge<br>G - Gas<br>OTH - Other | <b>Lab Sample No(s)</b>          | 19365053                         | 19365054  | 19365055  | 19365059  |  |
|   | <b>Customer Sample Reference</b> | 9a                               | 1b  | 2b  | 3b  |  |
|   | <b>AGS Reference</b>             |                                  |   |   |   |  |
|   | <b>Depth (m)</b>                 | 1.00                             | 1.00  | 1.00  | 1.00  |  |
|   | <b>Container</b>                 | NADH (ALE2451)<br>VIAL (ALE2977) | 1litreptic (ALE2211)<br>0.5l glass bottle (ALE2221)<br>VIAL (ALE2977) | 1litreptic (ALE2211)<br>0.5l glass bottle (ALE2221)<br>VIAL (ALE2977) | 1litreptic (ALE2211)<br>0.5l glass bottle (ALE2221)<br>VIAL (ALE2977) | NADH (ALE2451)<br>HNO3 Filtered (ALE2041)<br>H2SO4 (ALE2441) |
|   | <b>Sample Type</b>               | UNL                              | SA  | SA  | SA  | SA   |
| <b>Ammoniacal Nitrogen</b>  | All                              | NDFic: 0<br>Tests: 17            | X   | X   | X   |  |
| <b>CO2 (in head)</b>  | All                              | NDFic: 0<br>Tests: 17            | X   | X   | X   |  |
| <b>Conductivity (at 20 deg C)</b>   | All                              | NDFic: 0<br>Tests: 17            | X   | X   | X   |  |
| <b>DPH (DRD) (C10-C40) Aqueous (K)</b>  | All                              | NDFic: 0<br>Tests: 17            | X   | X   | X   |  |
| <b>GRD by GC FID (K)</b>  | All                              | NDFic: 0<br>Tests: 17            | X   | X   | X   |  |
| <b>Mn by Kmn (w)</b>  | All                              | NDFic: 0<br>Tests: 17            | X   | X   | X   |  |
| <b>pH Value</b>   | All                              | NDFic: 0<br>Tests: 17            | X   | X   | X   |  |
| <b>Saline Cyanide (W)</b>   | All                              | NDFic: 0<br>Tests: 17            | X   | X   | X   |  |
| <b>Saline Matrix Detected*</b>  | All                              | NDFic: 0<br>Tests: 17            | X   | X   | X   |  |
| <b>Saline TON</b>   | All                              | NDFic: 0<br>Tests: 17            | X   | X   | X   |  |
| <b>Suspended Solids</b>   | All                              | NDFic: 0<br>Tests: 17            | X   | X   | X   |  |
| <b>TOD (Solids) (W TOC) (R)</b>   | All                              | NDFic: 0<br>Tests: 17            | X   | X   | X   |  |
| <b>Total Dissolved Solids (Dry)</b>   | All                              | NDFic: 0<br>Tests: 17            | X   | X   | X   |  |
| <b>Total DPH (aq)</b>   | All                              | NDFic: 0<br>Tests: 17            | X   | X   | X   |  |
| <b>Turbidity in water</b>   | All                              | NDFic: 0<br>Tests: 17            | X   | X   | X   |  |

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| Results Legend  |  | Lab Sample No(s)               |                      | Customer Sample Reference |   | AGS Reference                              |   | Depth (m)                                   |   | Container  |   | Sample Type |  |
|---|--|--------------------------------|----------------------|---------------------------|---|--|---|---|---|--|---|-------------|--|
|   |  | Test                           |                      | No Determination Possible |   |  |   |   |   |  |   |             |  |
|   |  | <b>CERTIFICATE OF ANALYSIS</b> |                      | <b>Validated</b>          |   | SDG: 190216-11<br>Location: Atlantic Ocean |   | Client Reference: B1804-07<br>Order Number: |   | Report Number: 497498<br>Superseded Report: 496476               |   |             |  |
| Sample Types -<br>S - Soil/Solid<br>UNS - Unspecified Solid<br>GW - Ground Water<br>SW - Surface Water<br>LE - Land Leachate<br>PL - Prepared Leachate<br>PR - Process Water<br>SA - Saline Water<br>TE - Trade Effluent<br>TS - Treated Sewage<br>US - Untreated Sewage<br>RE - Recreational Water<br>DW - Drinking Water<br>Non-regulatory<br>UNL - Unspecified Liquid<br>SL - Sludge<br>G - Gas<br>O/H - Other |  |                                |                      | 19035091                  |   | 9B   |   | 1.00  |   | H3504 (ALE244)<br>Thermac (ALE221)<br>0.5l glass bottle (ALE227) |   | UNL         |  |
|   |  |                                |                      | 19035095                  |   | 9B   |   | 1.00  |   | H3504 (ALE244)<br>Thermac (ALE221)<br>0.5l glass bottle (ALE227) |   | UNL         |  |
|   |  |                                |                      | 19035061                  |   | 3C   |   | 1.00  |   | H3504 (ALE244)<br>Thermac (ALE221)<br>0.5l glass bottle (ALE227) |   | UNL         |  |
|   |  |                                |                      | 19035096                  |   | 5P   |   | 1.00  |   | H3504 (ALE244)<br>Thermac (ALE221)<br>0.5l glass bottle (ALE227) |   | UNL         |  |
| Ammoniacal Nitrogen   |  | All                            | NDFc: 0<br>Tests: 17 | X                         |   | X  |   | X   |   | X  |   | X           |  |
| COD (Unfiltered)  |  | All                            | NDFc: 0<br>Tests: 17 |                           |   | X  |   |   |   | X  |   | X           |  |
| Conductivity (at 20 deg.C)  |  | All                            | NDFc: 0<br>Tests: 17 |                           |   | X  |   |   |   | X  |   | X           |  |
| DPM (DRO) (C10-C40) Aqueous (K)   |  | All                            | NDFc: 0<br>Tests: 17 |                           |   | X  |   |   |   | X  |   | X           |  |
| GRD by GC FID (K)   |  | All                            | NDFc: 0<br>Tests: 17 |                           | X |  |   | X   |   |  | X |             |  |
| Merch by Kone (K)   |  | All                            | NDFc: 0<br>Tests: 17 |                           | X |  |   | X   |   |  | X |             |  |
| pH Value  |  | All                            | NDFc: 0<br>Tests: 17 |                           |   | X  |   |   |   | X  |   | X           |  |
| Saline Cyanide (W)  |  | All                            | NDFc: 0<br>Tests: 17 |                           | X |  |   | X   |   |  | X |             |  |
| Saline Matrix Detected*   |  | All                            | NDFc: 0<br>Tests: 17 | X                         |   |  | X |   |   | X  |   |             |  |
| Saline TON  |  | All                            | NDFc: 0<br>Tests: 17 |                           |   | X  |   |   |   | X  |   | X           |  |
| Suspended Solids  |  | All                            | NDFc: 0<br>Tests: 17 |                           |   | X  |   |   |   | X  |   | X           |  |
| TOD (Solids)(W-TOD/R)   |  | All                            | NDFc: 0<br>Tests: 17 |                           |   | X  |   |   |   | X  |   | X           |  |
| Total Dissolved Solids (Dry)  |  | All                            | NDFc: 0<br>Tests: 17 |                           |   | X  |   |   |   | X  |   | X           |  |
| Total DPH (eq)  |  | All                            | NDFc: 0<br>Tests: 17 |                           | X |  |   |   | X |  |   | X           |  |
| Turbidity in water  |  | All                            | NDFc: 0<br>Tests: 17 |                           | X |  |   |   | X |  |   | X           |  |

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| Results Legend  |     | Lab Sample No(s)          |                        |              |
|---|-----|---------------------------|------------------------|--------------|
| <input checked="" type="checkbox"/> Test  |     |                           |                        |              |
| <input type="checkbox"/> No Determination Possible  |     |                           |                        |              |
| Sample Types -<br>S - Soil/Solid<br>LNS - Unspecified Solid<br>GW - Ground Water<br>SW - Surface Water<br>LE - Land Leachate<br>PL - Prepared Leachate<br>PR - Process Water<br>SA - Saline Water<br>TE - Trade Effluent<br>TS - Treated Sewage<br>US - Untreated Sewage<br>RE - Recreational Water<br>DW - Drinking Water<br>Non-regulatory<br>LNL - Unspecified Liquid<br>SL - Sludge<br>G - Gas<br>OIH - Other |     | Customer Sample Reference |                        |              |
|   |     | AGS Reference             |                        |              |
|   |     | Depth (m)                 |                        |              |
|   |     | Container                 | HNO3 Filtered (ALE204) | UNL (ALE297) |
|   |     | Sample Type               | UNL                    | UNL          |
| Ammoniacal Nitrogen   | All | NDPs: 0<br>Tests: 17      |                        |              |
| COD Unfiltered  | All | NDPs: 0<br>Tests: 17      |                        |              |
| Conductivity (at 20 deg C)  | All | NDPs: 0<br>Tests: 17      |                        |              |
| EPH (DRO) (C10-C40) Aqueous (W)   | All | NDPs: 0<br>Tests: 17      |                        |              |
| GRD by GC PID (W)   | All | NDPs: 0<br>Tests: 17      |                        | X            |
| Nitrite by Kato (w)   | All | NDPs: 0<br>Tests: 17      |                        |              |
| pH Value  | All | NDPs: 0<br>Tests: 17      |                        |              |
| Saline Cyanides (W)   | All | NDPs: 0<br>Tests: 17      | X                      |              |
| Saline Metals Dissolved*  | All | NDPs: 0<br>Tests: 17      | X                      |              |
| Saline TON  | All | NDPs: 0<br>Tests: 17      |                        |              |
| Suspended Solids  | All | NDPs: 0<br>Tests: 17      |                        |              |
| TOC (Saline)(W TOC IR)*   | All | NDPs: 0<br>Tests: 17      |                        |              |
| Total Dissolved Solids (Grav)   | All | NDPs: 0<br>Tests: 17      |                        |              |
| Total EPH (aq)  | All | NDPs: 0<br>Tests: 17      |                        |              |
| Turbidity in water  | All | NDPs: 0<br>Tests: 17      |                        |              |

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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

| Results Legend                                 |              | Customer Sample Ref | 1             | 2             | 3             | 4          | 5          | 6          |
|--|--------------|---------------------|---------------|---------------|---------------|------------|------------|------------|
| J  | REMOVED      | Depth (m)           | 1.01          | 1.01          | 1.01          | 1.01       | 1.01       | 1.01       |
| K  | REMOVED      | Sample Type         | Saline D (SA) | Saline D (SA) | Saline C (SA) | TOC        | TOC        | TOC        |
| L  | REMOVED      | Date Sampled        | 08/02/2019    | 08/02/2019    | 09/02/2019    | 09/02/2019 | 09/02/2019 | 09/02/2019 |
| M  | REMOVED      | Sample ID           | 15107919      | 15070999      | 15070995      | 15070993   | 15070999   | 15070999   |
| N  | REMOVED      | Date Received       | 13/03/19      | 13/03/19      | 13/03/19      | 13/03/19   | 13/03/19   | 13/03/19   |
| O  | REMOVED      | Lab Sample No(s)    | 15085524      | 15085524      | 15085524      | 15085524   | 15085524   | 15085524   |
| P  | REMOVED      | Lab Sample No(s)    | 409           | 409           | 409           | 409        | 409        | 409        |
| Q  | REMOVED      | Method              |               |               |               |            |            |            |
| Cyanide Complex as CN <sup>-</sup>             | mg/l         | SUB                 |               |               |               | <0.5       | <0.5       | <0.5       |
| TOC (Saline) <sup>†</sup>                      | <2.5 mg/l    | SUB                 |               |               |               | <2.5       | <2.5       | <2.5       |
| Cyanide Free as CN <sup>-</sup>                | <0.005 mg/l  | SUB                 |               |               |               | <0.5       | <0.5       | <0.5       |
| Arsenic, Dissolved <sup>‡</sup>                | µg/l         | SUB                 |               |               |               | 1.61       | 2.89       | 2.03       |
| Cyanide as CN <sup>-</sup>                     | <0.5 mg/l    | SUB                 |               |               |               | <0.5       | <0.5       | <0.5       |
| Cadmium, Dissolved <sup>‡</sup>                | <0.05 µg/l   | SUB                 |               |               |               | <0.02      | 0.0127     | 0.0103     |
| Iron, Dissolved <sup>‡</sup>                   | <4 µg/l      | SUB                 |               |               |               | <0.004     | <0.002     | <0.002     |
| Lead, Dissolved <sup>‡</sup>                   | µg/l         | SUB                 |               |               |               | <0.1       | <0.05      | <0.05      |
| Mercury, Dissolved <sup>‡</sup>                | <0.002 µg/l  | SUB                 |               |               |               | <0.002     | <0.002     | <0.002     |
| Dissolved solids, Total (gravimetric)          | <10 mg/l     | TM021               |               |               |               | 36700      | 37900      | 38100      |
| Suspended solids, Total                        | <2 mg/l      | TM022               |               |               |               | 56.5       | 51.5       | 70.5       |
| Ammoniacal Nitrogen as N                       | <0.2 mg/l    | TM066               |               |               |               | <0.2       | <0.2       | <0.2       |
| COD, unfiltered                                | <7 mg/l      | TM107               |               |               |               | 614        | 484        | 478        |
| Conductivity @ 20 deg.C                        | <0.095 mS/cm | TM120               |               |               |               | 43.6       | 45.5       | 47.5       |
| Salinity                                       | <2           | TM126               |               |               |               | 31.6       | 33.2       | 34.8       |
| EPH Range >C10 - C40 (aq)                      | <100 µg/l    | TM172               |               |               |               | <100       | <100       | <100       |
| Total EPH (C6-C40) (aq)                        | <100 µg/l    | TM172               |               |               |               | <100       | <100       | <100       |
| Nitrite as NO <sub>2</sub> <sup>-</sup>        | <0.05 mg/l   | TM184               |               |               |               | <0.05      | <0.05      | <0.05      |
| Turbidity                                      | <0.1 ntu     | TM196               |               |               |               | 0.576      | 0.951      | 0.607      |
| pH   | <1 pH Units  | TM256               |               |               |               | 8.12       | 7.95       | 8.04       |
| Saline TCN as NO <sub>3</sub> <sup>-</sup>     | <0.3 mg/l    | TM281               |               |               |               | <0.3       | 0.386      | <0.3       |
| Saline Nitrate as NO <sub>3</sub> <sup>-</sup> | <0.3 mg/l    | TM281               |               |               |               | <0.3       | 0.351      | <0.3       |
| Cyanide Complex as CN <sup>-</sup>             | mg/l         | SUB                 | <0.5          | <0.5          | <0.5          |            |            |            |
| TOC (Saline) <sup>†</sup>                      | <2.5 mg/l    | SUB                 | <2.5          | 3.38          | 2.51          |            |            |            |
| Cyanide Free as CN <sup>-</sup>                | <0.005 mg/l  | SUB                 | <0.5          | <0.5          | <0.5          |            |            |            |
| Arsenic, Dissolved <sup>‡</sup>                | µg/l         | SUB                 | 1.75          | 1.39          | <0.5          |            |            |            |
| Cyanide as CN <sup>-</sup>                     | <0.5 mg/l    | SUB                 | <0.5          | <0.5          | <0.5          |            |            |            |
| Cadmium, Dissolved <sup>‡</sup>                | <0.05 µg/l   | SUB                 | <0.05         | <0.05         | <0.05         |            |            |            |
| Iron, Dissolved <sup>‡</sup>                   | <4 µg/l      | SUB                 | <0.004        | <0.004        | <0.004        |            |            |            |
| Lead, Dissolved <sup>‡</sup>                   | µg/l         | SUB                 | <0.3          | <0.3          | <0.3          |            |            |            |
| Mercury, Dissolved <sup>‡</sup>                | <0.002 µg/l  | SUB                 | <0.002        | <0.002        | <0.002        |            |            |            |
| Dissolved solids, Total (gravimetric)          | <10 mg/l     | TM021               | 34700         | 36300         | 10600         |            |            |            |
| Suspended solids, Total                        | <2 mg/l      | TM022               | 42.5          | 68            | 15.5          |            |            |            |

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**CERTIFICATE OF ANALYSIS**

Validated

SDG: 140216-11      Client Reference: B1804-07      Report Number: 497498  
 Location: Atlantic Ocean      Order Number:      Superseded Report: 496476

| Results Legend            |   | Customer Sample Ref           | 5             | 72            | 38            | 41         | 73         | 88         |
|---------------------------|---|-------------------------------|---------------|---------------|---------------|------------|------------|------------|
| 1                         | SDG103 unfiltered   | Depth (m)                     | 1.00          | 1.00          | 1.00          | 1.00       | 1.00       | 1.00       |
| 2                         | SDG103 filtered   | Sample Type                   | Saline D (SA) | Saline D (SA) | Saline C (SA) | Water      | Water      | Water      |
| 3                         | Agassiz (SDG103) C  | Date Sampled                  | 08/02/2019    | 08/02/2019    | 08/02/2019    | 08/02/2019 | 08/02/2019 | 08/02/2019 |
| 4                         | Described filtered sample   | Date Received                 | 15/02/2019    | 15/02/2019    | 15/02/2019    | 15/02/2019 | 15/02/2019 | 15/02/2019 |
| 5                         | Filter 1 as filtered results  | SDG Ref                       | 130216-11     | 130216-11     | 130216-11     | 130216-11  | 130216-11  | 130216-11  |
| 6                         | Reference to the filter to which the report for associated results  | Lab Sample No (if applicable) | 15085324      | 12585328      | 12985323      | 15085323   | 10085322   | 10085320   |
| 7                         | Necessity of the sample standard to check the efficiency of the method. The results of individual components will be compared against the standard for the location | ALS Reference                 |               |               |               |            |            |            |
| 8                         | Original results as filtered  |                               |               |               |               |            |            |            |
| 9                         | Sample location (see appendix)  |                               |               |               |               |            |            |            |
| Component                 | LOD/Units   | Method                        |               |               |               |            |            |            |
| Ammoniacal Nitrogen as N  | <0.2 mg/l   | TM058                         | <0.2          | <0.2          | <0.2          |            |            |            |
| COD, unfiltered           | <7 mg/l   | TM107                         | 438           | 572           | 161           |            |            |            |
| Conductivity @ 20 deg.C   | <0.005 mS/cm  | TM120                         | 44            | 46            | 15.6          |            |            |            |
| Salinity                  | <2  | TM120                         | 32            | 33.8          | 10.3          |            |            |            |
| EPH Range >C10 - C40 (aq) | <100 µg/l   | TM172                         | <100          | <100          | <100          |            |            |            |
| Total EPH (C6-C40) (aq)   | <100 µg/l   | TM172                         | <100          | <100          | <100          |            |            |            |
| Nitrite as NO2            | <0.05 mg/l  | TM184                         | <0.05         | <0.05         | <0.05         |            |            |            |
| Turbidity                 | <0.1 ntu  | TM195                         | 1.09          | 0.857         | 1.17          |            |            |            |
| pH                        | <1 pH Units   | TM256                         | 7.85          | 8.11          | 7.69          |            |            |            |
| Saline TON as NO3         | <0.3 mg/l   | TM281                         | <0.3          | 0.383         | <0.3          |            |            |            |
| Saline Nitrate as NO3     | <0.3 mg/l   | TM281                         | <0.3          | 0.387         | <0.3          |            |            |            |

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**CERTIFICATE OF ANALYSIS**

Validated

SDG: 190216-11 Client Reference: B1804-07 Report Number: 497498  
Location: Atlantic Ocean Order Number: Superseded Report: 496476

| Results Legend |         | Customer Sample Ref | 5a         | 1b            | 7c            | 3a            | 4a         | 6c         |
|----------------|---------|---------------------|------------|---------------|---------------|---------------|------------|------------|
| J              | REMOVED | Depth (m)           | 1.01       | 1.00          | 1.00          | 1.00          | 1.00       | 1.00       |
| K              | REMOVED | Sample Type         | Water      | Saline D (SA) | Saline D (SA) | Saline C (SA) | Water      | Water      |
| L              | REMOVED | Date Sampled        | 05/02/2019 | 05/02/2019    | 09/02/2019    | 09/02/2019    | 05/02/2019 | 09/02/2019 |
| M              | REMOVED | Sample ID           | 15107919   | 15000099      | 15070015      | 15070015      | 15070019   | 15070019   |
| N              | REMOVED | Date Received       | 13/03/19   | 13/03/19      | 13/03/19      | 13/03/19      | 13/03/19   | 13/03/19   |
| O              | REMOVED | Lab Sample No(s)    | 15009602   | 1226154       | 1226154       | 1226154       | 1226154    | 1226154    |
| P              | REMOVED | Lab Sample No(s)    | 409        |               |               |               |            |            |
| Q              | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| R              | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| S              | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| T              | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| U              | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| V              | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| W              | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| X              | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| Y              | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| Z              | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| AA             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| AB             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| AC             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| AD             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| AE             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| AF             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| AG             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| AH             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| AI             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| AJ             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| AK             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| AL             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| AM             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| AN             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| AO             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| AP             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| AQ             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| AR             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| AS             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| AT             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| AU             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| AV             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| AW             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| AX             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| AY             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| AZ             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| BA             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| BB             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| BC             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| BD             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| BE             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| BF             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| BG             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| BH             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| BI             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| BJ             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| BK             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| BL             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| BM             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| BN             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| BO             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| BP             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| BQ             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| BR             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| BS             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| BT             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| BU             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| BV             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| BW             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| BX             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| BY             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| BZ             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CA             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CB             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CC             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CD             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CE             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CF             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CG             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CH             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CI             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CJ             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CK             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CL             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CM             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CN             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CO             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CP             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CQ             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CR             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CS             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CT             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CU             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CV             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CW             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CX             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CY             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CA             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CB             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CC             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CD             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CE             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CF             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CG             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CH             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CI             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CJ             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CK             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CL             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CM             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CN             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CO             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CP             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CQ             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CR             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CS             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CT             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CU             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CV             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CW             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CX             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CY             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CA             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CB             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CC             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CD             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CE             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CF             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CG             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CH             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CI             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CJ             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CK             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CL             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CM             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CN             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CO             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CP             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CQ             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CR             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CS             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CT             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CU             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CV             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CW             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CX             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CY             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CA             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CB             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CC             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CD             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CE             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CF             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CG             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CH             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CI             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CJ             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CK             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CL             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CM             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CN             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CO             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CP             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CQ             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CR             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CS             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CT             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CU             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CV             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CW             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CX             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CY             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CA             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CB             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CC             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CD             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CE             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CF             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CG             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CH             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CI             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CJ             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CK             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CL             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CM             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CN             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CO             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CP             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CQ             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CR             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CS             | REMOVED | Lab Sample No(s)    |            |               |               |               |            |            |
| CT             | REMOVED | Lab Sample No(s)    |            | </            |               |               |            |            |



**CERTIFICATE OF ANALYSIS**

Validated

SDG: 140216-11 Client Reference: B1804-07 Report Number: 497498  
 Location: Atlantic Ocean Order Number: Superseded Report: 496476

| Results Legend            |                   | Customer Sample Ref            | 01        | 02            | 03            | 04            | 05        |
|---------------------------|-------------------|--------------------------------|-----------|---------------|---------------|---------------|-----------|
| 1                         | Method Accredited | Depth (m)                      | 1.00      | 1.00          | 1.00          | 1.00          | 1.00      |
| 2                         | Method Accredited | Sample Type                    | Water     | Saline D (SA) | Saline D (SA) | Saline C (SA) | Water     |
| 3                         | Method Accredited | Date Sampled                   | 08/02/19  | 08/02/19      | 08/02/19      | 08/02/19      | 08/02/19  |
| 4                         | Method Accredited | Sample ID                      | 15032019  | 15032019      | 15032019      | 15032019      | 15032019  |
| 5                         | Method Accredited | Date Received                  | 15/02/19  | 15/02/19      | 15/02/19      | 15/02/19      | 15/02/19  |
| 6                         | Method Accredited | SDG Ref                        | 130216-11 | 130216-11     | 130216-11     | 130216-11     | 130216-11 |
| 7                         | Method Accredited | Lab Sample No (L)              | 1503862   | 1503862       | 1503862       | 1503862       | 1503862   |
| 8                         | Method Accredited | Lab Sample No (R)              | 499       | 499           | 499           | 499           | 499       |
| 9                         | Method Accredited | Sample Location (see appendix) |           |               |               |               |           |
| Component                 | LOD/Units         | Method                         |           |               |               |               |           |
| Ammoniacal Nitrogen as N  | <0.2 mg/l         | TM058                          |           | <0.2          | <0.2          | <0.2          |           |
| COD, unfiltered           | <7 mg/l           | TM107                          |           | 608           | 492           | 298           |           |
| Conductivity @ 20 deg.C   | <0.005 mS/cm      | TM120                          |           | 46            | 40.3          | 25.9          |           |
| Salinity                  | <2                | TM120                          |           | 33.8          | 29            | 17.8          |           |
| EPH Range >C10 - C40 (aq) | <100 µg/l         | TM172                          |           | <100          | <100          | <100          |           |
| Total EPH (C6-C40) (aq)   | <100 µg/l         | TM172                          |           | <100          | <100          | <100          |           |
| Nitrite as NO2            | <0.05 mg/l        | TM184                          |           | <0.05         | <0.05         | <0.06         |           |
| Turbidity                 | <0.1 ntu          | TM195                          |           | 1.02          | 0.642         | 1.55          |           |
| pH                        | <1 pH Units       | TM256                          |           | 8.17          | 8.17          | 7.9           |           |
| Saline TON as NO3         | <0.3 mg/l         | TM281                          |           | <0.3          | <0.3          | 0.58          |           |
| Saline Nitrate as NO3     | <0.3 mg/l         | TM281                          |           | <0.3          | <0.3          | 0.549         |           |

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**CERTIFICATE OF ANALYSIS**

Validated

SDG: 190216-11 Client Reference: B1804-07 Report Number: 497498  
Location: Atlantic Ocean Order Number: Superseded Report: 496476

| Results Legend                        |              | Customer Sample Ref  | 7a         | 8a         | 9a         | 3a           | 8P         |
|---------------------------------------|--------------|----------------------|------------|------------|------------|--------------|------------|
| J                                     | REMOVED      | Depth (m)            | 1.01       | 1.01       | 1.01       | 1.01         | 1.01       |
| M                                     | REMOVED      | Sample Type          | Water      | Water      | Water      | Saline D. SW | Water      |
| NO                                    | REMOVED      | Date Sampled         | 05/02/2019 | 05/02/2019 | 05/02/2019 | 05/02/2019   | 05/02/2019 |
| NS                                    | REMOVED      | Sample ID            | 15107919   | 15070099   | 15070095   | 15070093     | 15070119   |
| NT                                    | REMOVED      | Date Received        | 13/03/19   | 13/03/19   | 13/03/19   | 13/03/19     | 13/03/19   |
| NU                                    | REMOVED      | Lab Sample No. (1)   | 15305528   | 15305527   | 15305525   | 15305524     | 15305526   |
| OV                                    | REMOVED      | Lab Sample No. (2)   |            |            |            |              |            |
| OT                                    | REMOVED      | Lab Sample No. (3)   |            |            |            |              |            |
| OW                                    | REMOVED      | Lab Sample No. (4)   |            |            |            |              |            |
| OX                                    | REMOVED      | Lab Sample No. (5)   |            |            |            |              |            |
| NY                                    | REMOVED      | Lab Sample No. (6)   |            |            |            |              |            |
| NY                                    | REMOVED      | Lab Sample No. (7)   |            |            |            |              |            |
| NY                                    | REMOVED      | Lab Sample No. (8)   |            |            |            |              |            |
| NY                                    | REMOVED      | Lab Sample No. (9)   |            |            |            |              |            |
| NY                                    | REMOVED      | Lab Sample No. (10)  |            |            |            |              |            |
| NY                                    | REMOVED      | Lab Sample No. (11)  |            |            |            |              |            |
| NY                                    | REMOVED      | Lab Sample No. (12)  |            |            |            |              |            |
| NY                                    | REMOVED      | Lab Sample No. (13)  |            |            |            |              |            |
| NY                                    | REMOVED      | Lab Sample No. (14)  |            |            |            |              |            |
| NY                                    | REMOVED      | Lab Sample No. (15)  |            |            |            |              |            |
| NY                                    | REMOVED      | Lab Sample No. (16)  |            |            |            |              |            |
| NY                                    | REMOVED      | Lab Sample No. (17)  |            |            |            |              |            |
| NY                                    | REMOVED      | Lab Sample No. (18)  |            |            |            |              |            |
| NY                                    | REMOVED      | Lab Sample No. (19)  |            |            |            |              |            |
| NY                                    | REMOVED      | Lab Sample No. (20)  |            |            |            |              |            |
| NY                                    | REMOVED      | Lab Sample No. (21)  |            |            |            |              |            |
| NY                                    | REMOVED      | Lab Sample No. (22)  |            |            |            |              |            |
| NY                                    | REMOVED      | Lab Sample No. (23)  |            |            |            |              |            |
| NY                                    | REMOVED      | Lab Sample No. (24)  |            |            |            |              |            |
| NY                                    | REMOVED      | Lab Sample No. (25)  |            |            |            |              |            |
| NY                                    | REMOVED      | Lab Sample No. (26)  |            |            |            |              |            |
| NY                                    | REMOVED      | Lab Sample No. (27)  |            |            |            |              |            |
| NY                                    | REMOVED      | Lab Sample No. (28)  |            |            |            |              |            |
| NY                                    | REMOVED      | Lab Sample No. (29)  |            |            |            |              |            |
| NY                                    | REMOVED      | Lab Sample No. (30)  |            |            |            |              |            |
| NY                                    | REMOVED      | Lab Sample No. (31)  |            |            |            |              |            |
| NY                                    | REMOVED      | Lab Sample No. (32)  |            |            |            |              |            |
| NY                                    | REMOVED      | Lab Sample No. (33)  |            |            |            |              |            |
| NY                                    | REMOVED      | Lab Sample No. (34)  |            |            |            |              |            |
| NY                                    | REMOVED      | Lab Sample No. (35)  |            |            |            |              |            |
| NY                                    | REMOVED      | Lab Sample No. (36)  |            |            |            |              |            |
| NY                                    | REMOVED      | Lab Sample No. (37)  |            |            |            |              |            |
| NY                                    | REMOVED      | Lab Sample No. (38)  |            |            |            |              |            |
| NY                                    | REMOVED      | Lab Sample No. (39)  |            |            |            |              |            |
| NY                                    | REMOVED      | Lab Sample No. (40)  |            |            |            |              |            |
| NY                                    | REMOVED      | Lab Sample No. (41)  |            |            |            |              |            |
| NY                                    | REMOVED      | Lab Sample No. (42)  |            |            |            |              |            |
| NY                                    | REMOVED      | Lab Sample No. (43)  |            |            |            |              |            |
| NY                                    | REMOVED      | Lab Sample No. (44)  |            |            |            |              |            |
| NY                                    | REMOVED      | Lab Sample No. (45)  |            |            |            |              |            |
| NY                                    | REMOVED      | Lab Sample No. (46)  |            |            |            |              |            |
| NY                                    | REMOVED      | Lab Sample No. (47)  |            |            |            |              |            |
| NY                                    | REMOVED      | Lab Sample No. (48)  |            |            |            |              |            |
| NY                                    | REMOVED      | Lab Sample No. (49)  |            |            |            |              |            |
| NY                                    | REMOVED      | Lab Sample No. (50)  |            |            |            |              |            |
| NY                                    | REMOVED      | Lab Sample No. (51)  |            |            |            |              |            |
| NY                                    | REMOVED      | Lab Sample No. (52)  |            |            |            |              |            |
| NY                                    | REMOVED      | Lab Sample No. (53)  |            |            |            |              |            |
| NY                                    | REMOVED      | Lab Sample No. (54)  |            |            |            |              |            |
| NY                                    | REMOVED      | Lab Sample No. (55)  |            |            |            |              |            |
| NY                                    | REMOVED      | Lab Sample No. (56)  |            |            |            |              |            |
| NY                                    | REMOVED      | Lab Sample No. (57)  |            |            |            |              |            |
| NY                                    | REMOVED      | Lab Sample No. (58)  |            |            |            |              |            |
| NY                                    | REMOVED      | Lab Sample No. (59)  |            |            |            |              |            |
| NY                                    | REMOVED      | Lab Sample No. (60)  |            |            |            |              |            |
| NY                                    | REMOVED      | Lab Sample No. (61)  |            |            |            |              |            |
| NY                                    | REMOVED      | Lab Sample No. (62)  |            |            |            |              |            |
| NY                                    | REMOVED      | Lab Sample No. (63)  |            |            |            |              |            |
| NY                                    | REMOVED      | Lab Sample No. (64)  |            |            |            |              |            |
| NY                                    | REMOVED      | Lab Sample No. (65)  |            |            |            |              |            |
| NY                                    | REMOVED      | Lab Sample No. (66)  |            |            |            |              |            |
| NY                                    | REMOVED      | Lab Sample No. (67)  |            |            |            |              |            |
| NY                                    | REMOVED      | Lab Sample No. (68)  |            |            |            |              |            |
| NY                                    | REMOVED      | Lab Sample No. (69)  |            |            |            |              |            |
| NY                                    | REMOVED      | Lab Sample No. (70)  |            |            |            |              |            |
| NY                                    | REMOVED      | Lab Sample No. (71)  |            |            |            |              |            |
| NY                                    | REMOVED      | Lab Sample No. (72)  |            |            |            |              |            |
| NY                                    | REMOVED      | Lab Sample No. (73)  |            |            |            |              |            |
| NY                                    | REMOVED      | Lab Sample No. (74)  |            |            |            |              |            |
| NY                                    | REMOVED      | Lab Sample No. (75)  |            |            |            |              |            |
| NY                                    | REMOVED      | Lab Sample No. (76)  |            |            |            |              |            |
| NY                                    | REMOVED      | Lab Sample No. (77)  |            |            |            |              |            |
| NY                                    | REMOVED      | Lab Sample No. (78)  |            |            |            |              |            |
| NY                                    | REMOVED      | Lab Sample No. (79)  |            |            |            |              |            |
| NY                                    | REMOVED      | Lab Sample No. (80)  |            |            |            |              |            |
| NY                                    | REMOVED      | Lab Sample No. (81)  |            |            |            |              |            |
| NY                                    | REMOVED      | Lab Sample No. (82)  |            |            |            |              |            |
| NY                                    | REMOVED      | Lab Sample No. (83)  |            |            |            |              |            |
| NY                                    | REMOVED      | Lab Sample No. (84)  |            |            |            |              |            |
| NY                                    | REMOVED      | Lab Sample No. (85)  |            |            |            |              |            |
| NY                                    | REMOVED      | Lab Sample No. (86)  |            |            |            |              |            |
| NY                                    | REMOVED      | Lab Sample No. (87)  |            |            |            |              |            |
| NY                                    | REMOVED      | Lab Sample No. (88)  |            |            |            |              |            |
| NY                                    | REMOVED      | Lab Sample No. (89)  |            |            |            |              |            |
| NY                                    | REMOVED      | Lab Sample No. (90)  |            |            |            |              |            |
| NY                                    | REMOVED      | Lab Sample No. (91)  |            |            |            |              |            |
| NY                                    | REMOVED      | Lab Sample No. (92)  |            |            |            |              |            |
| NY                                    | REMOVED      | Lab Sample No. (93)  |            |            |            |              |            |
| NY                                    | REMOVED      | Lab Sample No. (94)  |            |            |            |              |            |
| NY                                    | REMOVED      | Lab Sample No. (95)  |            |            |            |              |            |
| NY                                    | REMOVED      | Lab Sample No. (96)  |            |            |            |              |            |
| NY                                    | REMOVED      | Lab Sample No. (97)  |            |            |            |              |            |
| NY                                    | REMOVED      | Lab Sample No. (98)  |            |            |            |              |            |
| NY                                    | REMOVED      | Lab Sample No. (99)  |            |            |            |              |            |
| NY                                    | REMOVED      | Lab Sample No. (100) |            |            |            |              |            |
| Cyanide Complex as CN*                | mg/l         | SUB                  | <0.5       | <0.5       | <0.5       |              | <0.5       |
| TOC (Saline)*                         | <2.5 mg/l    | SUB                  | <2.5       | <2.5       | <2.5       |              | <2.5       |
| Cyanide Free as CN*                   | <0.005 mg/l  | SUB                  | <0.5       | <0.5       | <0.5       |              | <0.5       |
| Arsenic, Dissolved*                   | µg/l         | SUB                  | 1.83       | 1.85       | 1.82       |              | 0.343      |
| Cyanide as CN*                        | <0.5 mg/l    | SUB                  | <0.5       | <0.5       | <0.5       |              | <0.5       |
| Cadmium, Dissolved*                   | <0.05 µg/l   | SUB                  | <0.02      | <0.02      | <0.02      |              | 0.00408    |
| Iron, Dissolved*                      | <4 µg/l      | SUB                  | <0.004     | <0.004     | <0.004     |              | 0.00758    |
| Lead, Dissolved*                      | µg/l         | SUB                  | <0.1       | <0.1       | <0.1       |              | 0.0188     |
| Mercury, Dissolved*                   | <0.002 µg/l  | SUB                  | <0.002     | <0.002     | <0.002     |              | <0.002     |
| Dissolved solids, Total (gravimetric) | <10 mg/l     | TM021                | 36200      | 38100      | 38600      |              | 5750       |
| Suspended solids, Total               | <2 mg/l      | TM022                | 48         | 20         | 63.5       |              | 6.5        |
| Ammoniacal Nitrogen as N              | <0.2 mg/l    | TM056                | <0.2       | <0.2       | <0.2       |              | <0.2       |
| COD, unfiltered                       | <7 mg/l      | TM107                | 444        | 480        | 628        |              | 85.5       |
| Conductivity @ 20 deg.C               | <0.095 mS/cm | TM120                | 46.8       | 47.4       | 46.2       |              | 8.87       |
| Salinity                              | <2           | TM126                | 33.4       | 34.7       | 33.8       |              | 5.49       |
| EPH Range >C10 - C40 (aq)             | <100 µg/l    | TM172                | <100       | <100       | <100       |              | <100       |
| Total EPH (C6-C40) (aq)               | <100 µg/l    | TM172                | <100       | <100       | <100       |              | <100       |
| Nitrite as NO2                        | <0.05 mg/l   | TM184                | <0.05      | <0.05      | <0.05      |              | <0.05      |
| Turbidity                             | <0.1 ntu     | TM196                | 0.641      | 0.581      | 0.578      |              | 2.79       |
| pH                                    | <1 pH Units  | TM256                | 7.87       | 8.03       | 8.23       |              | 7.5        |
| Saline TDN as NO3                     | <0.3 mg/l    | TM281                | <0.3       | <0.3       | <0.3       |              | 0.300      |
| Saline Nitrate as NO3                 | <0.3 mg/l    | TM281                | <0.3       | <0.3       | <0.3       |              | <0.3       |
| Cyanide Complex as CN*                | mg/l         | SUB                  |            |            |            | <0.5         |            |
| TOC (Saline)*                         | <2.5 mg/l    | SUB                  |            |            |            | <2.5         |            |
| Cyanide Free as CN*                   | <0.005 mg/l  | SUB                  |            |            |            | <0.5         |            |
| Arsenic, Dissolved*                   | µg/l         | SUB                  |            |            |            | 1.62         |            |
| Cyanide as CN*                        | <0.5 mg/l    | SUB                  |            |            |            | <0.5         |            |
| Cadmium, Dissolved*                   | <0.05 µg/l   | SUB                  |            |            |            | <0.05        |            |
| Iron, Dissolved*                      | <4 µg/l      | SUB                  |            |            |            | <0.004       |            |
| Lead, Dissolved*                      | µg/l         | SUB                  |            |            |            | <0.3         |            |
| Mercury, Dissolved*                   | <0.002 µg/l  | SUB                  |            |            |            | <0.002       |            |
| Dissolved solids, Total (gravimetric) | <10 mg/l     | TM021                |            |            |            | 27400        |            |
| Suspended solids, Total               | <2 mg/l      | TM022                |            |            |            | 48           |            |

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**CERTIFICATE OF ANALYSIS**

Validated

SDG: 140216-11      Client Reference: B1804-07      Report Number: 497498  
 Location: Atlantic Ocean      Order Number:      Superseded Report: 496476

| Results Legend |        | Customer Sample Ref       | 70         | 80         | 90         | 10         | 60         |
|----------------|--------|---------------------------|------------|------------|------------|------------|------------|
| 1              | 0.0000 | Depth (m)                 | 1.00       | 1.00       | 1.00       | 1.00       | 1.00       |
| 2              | 0.0000 | Sample Type               | Water      | Water      | Water      | Surface SW | Water      |
| 3              | 0.0000 | Date Sampled              | 08/02/2019 | 08/02/2019 | 08/02/2019 | 08/02/2019 | 08/02/2019 |
| 4              | 0.0000 | Sample Time               | 15:00:00   | 15:00:00   | 15:00:00   | 15:00:00   | 15:00:00   |
| 5              | 0.0000 | Date Received             | 13/02/19   | 13/02/19   | 13/02/19   | 13/02/19   | 13/02/19   |
| 6              | 0.0000 | SDG Ref                   | 130216-11  | 130216-11  | 130216-11  | 130216-11  | 130216-11  |
| 7              | 0.0000 | Lab Sample No (if any)    | 1503332    | 1503331    | 1503330    | 1503329    | 1503328    |
| 8              | 0.0000 | Lab Reference No          |            |            |            |            |            |
| 9              | 0.0000 | Method                    |            |            |            |            |            |
| 10             | 0.0000 | LOD/Units                 |            |            |            |            |            |
| 11             | 0.0000 | Component                 |            |            |            |            |            |
| 12             | 0.0000 | Ammoniacal Nitrogen as N  |            |            |            | <0.2       | µ          |
| 13             | 0.0000 | COD, unfiltered           |            |            |            | 330        |            |
| 14             | 0.0000 | Conductivity @ 20 deg.C   |            |            |            | 33.1       | µ          |
| 15             | 0.0000 | Salinity                  |            |            |            | 23.3       |            |
| 16             | 0.0000 | EPH Range >C10 - C40 (µg) |            |            |            | <100       |            |
| 17             | 0.0000 | Total EPH (C6-C40) (µg)   |            |            |            | <100       |            |
| 18             | 0.0000 | Nitrite as NO2            |            |            |            | <0.06      | 2 µ        |
| 19             | 0.0000 | Turbidity                 |            |            |            | 0.942      | µ          |
| 20             | 0.0000 | pH                        |            |            |            | 8.05       | µ          |
| 21             | 0.0000 | Saline TON as NO3         |            |            |            | <0.3       | µ          |
| 22             | 0.0000 | Saline Nitrate as NO3     |            |            |            | <0.3       | µ          |

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| ALS                                 |           | CERTIFICATE OF ANALYSIS |   |                                   |  |                            |                            | Validated                  |
|-------------------------------------|-----------|-------------------------|---|-----------------------------------|--|----------------------------|----------------------------|----------------------------|
| SDG: 14<br>Location: Atlantic Ocean |           | 190216-11               | Client Reference: B1804-07<br>Order Number: |                                   | Report Number: 497498<br>Superseded Report: 496476 |                            |                            |                            |
| GRO by GC-FID (W)                   |           | Customer Sample Ref     | 1   | 2                                 | 3  | 4                          | 5                          | 6                          |
| Component                           | LOD/Units | Method                  | 1.01<br>Date D (SA)<br>08/02/2019           | 1.02<br>Date D (SA)<br>08/02/2019 | 1.03<br>Date C (SA)<br>09/02/2019                  | 1.04<br>Date<br>09/02/2019 | 1.05<br>Date<br>09/02/2019 | 1.06<br>Date<br>09/02/2019 |
| Methyl tertiary butyl ether (MTBE)  | <3 µg/l   | TM245                   |   |                                   |  | <3                         | <3                         | <3                         |
| Benzene                             | <7 µg/l   | TM245                   |   |                                   |  | <7                         | <7                         | <7                         |
| Toluene                             | <4 µg/l   | TM245                   |   |                                   |  | <4                         | <4                         | <4                         |
| Ethylbenzene                        | <5 µg/l   | TM245                   |   |                                   |  | <5                         | <5                         | <5                         |
| m,p-Xylene                          | <8 µg/l   | TM245                   |   |                                   |  | <8                         | <8                         | <8                         |
| o-Xylene                            | <3 µg/l   | TM245                   |   |                                   |  | <3                         | <3                         | <3                         |
| Sum of detected BTEX                | <28 µg/l  | TM245                   |   |                                   |  | <28                        | <28                        | <28                        |
| GRO >C5-C10                         | <10 µg/l  | TM245                   |   |                                   |  | <10                        | <10                        | <10                        |
| EPH (C5-C10)                        | <100 µg/l | TM245                   |   |                                   |  | <100                       | <100                       | <100                       |
| Methyl tertiary butyl ether (MTBE)  | <3 µg/l   | TM245                   | <3  | <3                                | <3   |                            |                            |                            |
| Benzene                             | <7 µg/l   | TM245                   | <7  | <7                                | <7   |                            |                            |                            |
| Toluene                             | <4 µg/l   | TM245                   | <4  | <4                                | <4   |                            |                            |                            |
| Ethylbenzene                        | <5 µg/l   | TM245                   | <5  | <5                                | <5   |                            |                            |                            |
| m,p-Xylene                          | <8 µg/l   | TM245                   | <8  | <8                                | <8   |                            |                            |                            |
| o-Xylene                            | <3 µg/l   | TM245                   | <3  | <3                                | <3   |                            |                            |                            |
| Sum of detected BTEX                | <28 µg/l  | TM245                   | <28   | <28                               | <28  |                            |                            |                            |
| GRO >C5-C10                         | <10 µg/l  | TM245                   | <10   | <10                               | <10  |                            |                            |                            |
| EPH (C5-C10)                        | <100 µg/l | TM245                   | <100  | <100                              | <100   |                            |                            |                            |

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| ALS  |           | CERTIFICATE OF ANALYSIS                     |                           |  |                           |                           |                           | Validated                 |
|--|-----------|---|---------------------------|--|---------------------------|---------------------------|---------------------------|---------------------------|
| SDG: 190216-11<br>Location: Atlantic Ocean |           | Client Reference: B1804-07<br>Order Number: |                           | Report Number: 497498<br>Superseded Report: 496476 |                           |                           |                           |                           |
| GRO by GC-FID (W)                          |           | Customer Sample Ref                         | 5a                        | 1b   | 7c                        | 3a                        | 4a                        | 6c                        |
| Component                                  | LOD/Units | Method                                      | 101<br>Date<br>05/02/2019 | 120<br>Date<br>05/02/2019                          | 100<br>Date<br>09/02/2019 | 100<br>Date<br>09/02/2019 | 101<br>Date<br>05/02/2019 | 100<br>Date<br>09/02/2019 |
| Methyl tertiary butyl ether (MTBE)         | <3 µg/l   | TM246                                       | <3                        |  |                           |                           | <3                        | <3                        |
| Benzene                                    | <7 µg/l   | TM246                                       | <7                        |  |                           |                           | <7                        | <7                        |
| Toluene                                    | <4 µg/l   | TM246                                       | <4                        |  |                           |                           | <4                        | <4                        |
| Ethylbenzene                               | <5 µg/l   | TM246                                       | <5                        |  |                           |                           | <5                        | <5                        |
| m,p-Xylene                                 | <8 µg/l   | TM246                                       | <8                        |  |                           |                           | <8                        | <8                        |
| o-Xylene                                   | <3 µg/l   | TM246                                       | <3                        |  |                           |                           | <3                        | <3                        |
| Sum of detected BTEX                       | <28 µg/l  | TM246                                       | <28                       |  |                           |                           | <28                       | <28                       |
| GRO >C5-C10                                | <10 µg/l  | TM246                                       | <10                       |  |                           |                           | <10                       | <10                       |
| EPH (C5-C10)                               | <100 µg/l | TM246                                       | <100                      |  |                           |                           | <100                      | <100                      |
| Methyl tertiary butyl ether (MTBE)         | <3 µg/l   | TM246                                       |                           | <3   | <3                        | <3                        |                           |                           |
| Benzene                                    | <7 µg/l   | TM246                                       |                           | <7   | <7                        | <7                        |                           |                           |
| Toluene                                    | <4 µg/l   | TM246                                       |                           | <4   | <4                        | <4                        |                           |                           |
| Ethylbenzene                               | <5 µg/l   | TM246                                       |                           | <5   | <5                        | <5                        |                           |                           |
| m,p-Xylene                                 | <8 µg/l   | TM246                                       |                           | <8   | <8                        | <8                        |                           |                           |
| o-Xylene                                   | <3 µg/l   | TM246                                       |                           | <3   | <3                        | <3                        |                           |                           |
| Sum of detected BTEX                       | <28 µg/l  | TM246                                       |                           | <28  | <28                       | <28                       |                           |                           |
| GRO >C5-C10                                | <10 µg/l  | TM246                                       |                           | <10  | <10                       | <10                       |                           |                           |
| EPH (C5-C10)                               | <100 µg/l | TM246                                       |                           | <100   | <100                      | <100                      |                           |                           |

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**CERTIFICATE OF ANALYSIS**

Validated

SDG: 190216-11 Client Reference: BT804-07 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 872  | Determination of total suspended solids in waters  |
| TM051     | 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 Lango Kit   |
| TM120     | Method 2510B, AWWA/APHA, 20th Ed., 1999 / BS 2530: 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: 190216-11 Client Reference: BT804-07 Report Number: 497498  
Location: Atlantic Ocean Order Number: Superseded Report: 496476

**Test Completion Dates**

| Lab Sample No(s)<br>Customer Sample Ref.                   | 19065324      | 19065355      | 19065358      | 19065320    | 19065327    | 19065890    | 19065893    | 19065054      | 19065058      | 19065059      |
|--|---------------|---------------|---------------|-------------|-------------|-------------|-------------|---------------|---------------|---------------|
|  | 1             | 2             | 3             | 4           | 5           | 6           | 7           | 8             | 9             | 10            |
| AGS Ref.<br>Depth<br>Type                                  | 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   |
| COD Unfiltered   | 21-Feb-2019   | 20-Feb-2019   | 20-Feb-2019   | 20-Feb-2019 | 20-Feb-2019 | 20-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 | 21-Feb-2019   | 21-Feb-2019   | 21-Feb-2019   |
| ORP (DRD) (ClO <sub>2</sub> -ClO <sub>2</sub> 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 (w)  | 18-Feb-2019   | 19-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 | 22-Feb-2019   | 21-Feb-2019   | 22-Feb-2019   |
| Saline Cyanides (W)  | 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   |
| TOC (Saline)(W-TOC (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 EP (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   | 19-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)<br>Customer Sample Ref.                   | 19065322    | 19065328    | 19065328    | 19065891    | 19065895    | 19065091      | 19065856    |
|--|-------------|-------------|-------------|-------------|-------------|---------------|-------------|
|  | 1           | 2           | 3           | 4           | 5           | 6             | 7           |
| AGS Ref.<br>Depth<br>Type                                  | 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 |
| COD 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 |
| ORP (DRD) (ClO <sub>2</sub> -ClO <sub>2</sub> 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 (w)  | 19-Feb-2019 | 19-Feb-2019 | 19-Feb-2019 | 19-Feb-2019 | 19-Feb-2019 | 19-Feb-2019   | 19-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 (W)  | 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 |
| TOC (Saline)(W-TOC (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 EP (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   | 19-Feb-2019 | 19-Feb-2019 | 19-Feb-2019 | 19-Feb-2019 | 19-Feb-2019 | 19-Feb-2019   | 19-Feb-2019 |

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### CERTIFICATE OF ANALYSIS

|                     |   |                              |   |
|---------------------|---|------------------------------|---|
| <b>Work Order</b>   | <b>PR1915169</b>  | <b>Issue Date</b>            | 22-Feb-2019   |
| <b>Customer</b>     | <b>ALS Life Sciences Ltd</b>  | <b>Laboratory</b>            | ALS Czech Republic, s.r.o.                                  |
| <b>Contact</b>      | Reporting   | <b>Contact</b>               | Client Service  |
| <b>Address</b>      | Unit 7-8 Hawarden Business Park<br>Manor Road, Hawarden<br>CH5 3US Deeside United Kingdom | <b>Address</b>               | Na Harfe 336/9 Prague 9 - Vysocany<br>190 00 Czech Republic |
| <b>E-mail</b>       | euhdmsubconresults@ALSGlobal.com  | <b>E-mail</b>                | customer.support@alsglobal.com                              |
| <b>Telephone</b>    | ---   | <b>Telephone</b>             | +420 226 226 228  |
| <b>Project</b>      | 190216-11   | <b>Page</b>                  | 1 of 3  |
| <b>Order number</b> | 190216-11   | <b>Date Samples Received</b> | 19-Feb-2019   |
| <b>Site</b>         | ---   | <b>Quote number</b>          | PR2018ALSAL-GB0004<br>(CZ-256-18-0022)                      |
| <b>Sampled by</b>   | Client  | <b>Date of test</b>          | 20-Feb-2019 - 22-Feb-2019                                   |
|                     |   | <b>QC Level</b>              | ALS CR Standard Quality Control<br>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

Signature  
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      | Result | MU      |
|-----------------------------|----------|------|------|--------|---------|--------|---------|--------|---------|
| <b>Aggregate Parameters</b> |          |      |      |        |         |        |         |        |         |
| Total Organic Carbon        | W-TOC-IR | 0.50 | mg/L | 3.13   | ± 20.0% | 3.38   | ± 20.0% | 2.60   | ± 20.0% |

|                      |                             |                   |                   |                   |
|----------------------|-----------------------------|-------------------|-------------------|-------------------|
| Sub-Matrix: SEAWATER | Client sample ID            | 19370282          | 19370099          | 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  | Result | MU  |
|-----------------------------|----------|------|------|--------|---------|--------|-----|--------|-----|
| <b>Aggregate Parameters</b> |          |      |      |        |         |        |     |        |     |
| Total Organic Carbon        | W-TOC-IR | 0.50 | mg/L | 2.61   | ± 20.0% | <2.50  | --- | <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  | Result | MU  |
|-----------------------------|----------|------|------|--------|-----|--------|-----|--------|-----|
| <b>Aggregate Parameters</b> |          |      |      |        |     |        |     |        |     |
| Total Organic Carbon        | W-TOC-IR | 0.50 | mg/L | <2.50  | --- | ---    | --- | ---    | --- |

|                   |                             |                   |                   |                   |
|-------------------|-----------------------------|-------------------|-------------------|-------------------|
| Sub-Matrix: WATER | Client sample ID            | 19376006          | 19376053          | 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  | Result | MU      |
|-----------------------------|----------|------|------|--------|-----|--------|-----|--------|---------|
| <b>Aggregate Parameters</b> |          |      |      |        |     |        |     |        |         |
| Total Organic Carbon        | W-TOC-IR | 0.50 | mg/L | <2.50  | --- | <2.50  | --- | 2.68   | ± 20.0% |

|                   |                             |                   |                   |                   |
|-------------------|-----------------------------|-------------------|-------------------|-------------------|
| Sub-Matrix: WATER | Client sample ID            | 19373416          | 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  | Result | MU  |
|-----------------------------|----------|------|------|--------|-----|--------|-----|--------|-----|
| <b>Aggregate Parameters</b> |          |      |      |        |     |        |     |        |     |
| Total Organic Carbon        | W-TOC-IR | 0.50 | mg/L | <2.50  | --- | <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      | Result | MU  |
|-----------------------------|----------|------|------|--------|-----|--------|---------|--------|-----|
| <b>Aggregate Parameters</b> |          |      |      |        |     |        |         |        |     |
| Total Organic Carbon        | W-TOC-IR | 0.50 | mg/L | <2.50  | --- | 2.76   | ± 20.0% | <2.50  | --- |

|                   |                             |                   |     |     |
|-------------------|-----------------------------|-------------------|-----|-----|
| 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  | 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

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 Hviezde 336/9 Prague 9 - Vysocany Czech Republic 190 00 |   |
| W-TOC-IR   | CZ_SOP_D08_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.

## Report

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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      | 0.375           | 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 |  |

ALS Scandinavia AB  
Auroxum 10  
977 75 Luleå  
Sweden

Web: [www.alsglobal.se](http://www.alsglobal.se)  
Email: [info.lu@alsglobal.com](mailto:info.lu@alsglobal.com)  
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| 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 |

ALS Scandinavia AB  
Auroxum 10  
977 75 Luleå  
Sweden

Web: [www.alsglobal.se](http://www.alsglobal.se)  
Email: [info.lu@alsglobal.com](mailto:info.lu@alsglobal.com)  
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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 |

ALS Scandinavia AB  
Auroxum 10  
977 75 Luleå  
Sweden

Web: [www.alsglobal.se](http://www.alsglobal.se)  
Email: [info.lu@alsglobal.com](mailto:info.lu@alsglobal.com)  
Tel: + 46 920 28 8900  
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| 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 |

ALS Scandinavia AB  
Auroxum 10  
977 75 Luleå  
Sweden

Web: [www.alsglobal.se](http://www.alsglobal.se)  
Email: [info.lu@alsglobal.com](mailto:info.lu@alsglobal.com)  
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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 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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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.

ALS Scandinavia AB  
Auroxum 10  
977 75 Luleå  
Sweden

Web: [www.alsglobal.se](http://www.alsglobal.se)  
Email: [info.lu@alsglobal.com](mailto:info.lu@alsglobal.com)  
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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: V2BAS

| Your ID                                   | 19375262   |                 |      |        |        |      |
|---|------------|-----------------|------|--------|--------|------|
| Sampled                                   | 2019-02-09 |                 |      |        |        |      |
| LabID                                     | U11568720  |                 |      |        |        |      |
| 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                                   | 19375243   |                 |      |        |        |      |
|---|------------|-----------------|------|--------|--------|------|
| Sampled                                   | 2019-02-09 |                 |      |        |        |      |
| LabID                                     | U11568721  |                 |      |        |        |      |
| 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 |

ALS Scandinavia AB  
Auroxum 10  
977 75 Luleå  
Sweden

Web: [www.alsglobal.se](http://www.alsglobal.se)  
Email: [info.lu@alsglobal.com](mailto:info.lu@alsglobal.com)  
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| 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 | 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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Auroxum 10  
977 75 Luleå  
Sweden

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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 |

ALS Scandinavia AB  
Auroxum 10  
977 75 Luleå  
Sweden

Web: [www.alsglobal.se](http://www.alsglobal.se)  
Email: [info.lu@alsglobal.com](mailto:info.lu@alsglobal.com)  
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| 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      | 0.064           | 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 |

ALS Scandinavia AB  
Auroxum 10  
977 75 Luleå  
Sweden

Web: [www.alsglobal.se](http://www.alsglobal.se)  
Email: [info.lu@alsglobal.com](mailto:info.lu@alsglobal.com)  
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L1904722

10Z9TMPMLA9



| Your ID                                   | <b>19371093</b>   |                 |      |        |        |      |
|---|-------------------|-----------------|------|--------|--------|------|
| Sampled                                   | <b>2019-02-09</b> |                 |      |        |        |      |
| 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              | 0.63            | 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                                   | <b>19371111</b>   |                 |      |        |        |      |
|---|-------------------|-----------------|------|--------|--------|------|
| Sampled                                   | <b>2019-02-09</b> |                 |      |        |        |      |
| 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 |

ALS Scandinavia AB  
Auroxum 10  
977 75 Luleå  
Sweden

Web: [www.alsglobal.se](http://www.alsglobal.se)  
Email: [info.lu@alsglobal.com](mailto:info.lu@alsglobal.com)  
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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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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>

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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.

ALS Scandinavia AB  
Auroxum 10  
977 75 Luleå  
Sweden

Web: [www.alsglobal.se](http://www.alsglobal.se)  
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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)

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.

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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: 004314018      Sampled on: 9-Feb-19 @ (Time not supplied)  
 Comments: 19375241 1b  
 Quote No: 15266      Matrix: Saline Water

| <u>Analyte</u>          | <u>Result</u> | <u>Units</u> | <u>Flag</u>   | <u>MRV</u> | <u>Accred</u> | <u>Lab ID</u> | <u>Testcode</u> |
|-------------------------|---------------|--------------|---|------------|---------------|---------------|-----------------|
| Cyanide : Complex as CN | <0.500        | mg/l         |   |            | None          | NLS           | 864             |
| Cyanide : Free as CN    | <0.500        | mg/l         | OR DR   | 0.005      | None          | SX            | 183             |
|                         |               |              | ELEVATED_MRVL100 : Dilution required (result accuracy may be reduced) |            |               |               |                 |
| 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: 004314019 Sampled on: 9-Feb-19 @ (Time not supplied)  
 Comments: 19375087 2a  
 Quote No: 15266 Matrix: Saline Water

| <u>Analyte</u>          | <u>Result</u> | <u>Units</u> | <u>Flag</u>   | <u>MRV</u> | <u>Accred</u> | <u>Lab ID</u> | <u>Testcode</u> |
|-------------------------|---------------|--------------|---|------------|---------------|---------------|-----------------|
| 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_MRVL100 : Dilution required (result accuracy may be reduced) |            |               |               |                 |
| 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: 004314020 Sampled on: 9-Feb-19 @ (Time not supplied)  
 Comments: 19370371 2b  
 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    | <0.500        | mg/l         | OR DC   | 0.005      | None          | SX            | 183             |
|                         |               |              | ELEVATED_MRVL100 : Dilution required (result accuracy may be reduced) |            |               |               |                 |
| 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: 004314021      Sampled on: 9-Feb-19 @ (Time not supplied)  
 Comments: 19370466 3a  
 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    | <0.500        | mg/l         | OR DR   | 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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## 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

| <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    | <0.500        | 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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## 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: 004314023      Sampled on: 9-Feb-19 @ (Time not supplied)  
 Comments: 19370419 3c  
 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    | <0.500        | mg/l         | OR DR   | 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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## 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

| <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    | <0.500        | mg/l         | OR DR  | 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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## 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

| <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    | <0.500        | mg/l         | OR 00   | 0.005      | None          | SX            | 183             |  |
|                         |               |              | ELEVATED_MRVL100 : Dilution required (result accuracy may be reduced) |            |               |               |                 |  |
| 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: 004314026 Sampled on: 9-Feb-19 @ (Time not supplied)  
 Comments: 19373519 5  
 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    | <0.500        | mg/l         | OR DR   | 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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## 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

| <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    | <0.500        | mg/l         | OR DR   | 0.005      | None          | SX            | 183             |
|                         |               |              | ELEVATED_MRVL100 : Dilution required (result accuracy may be reduced) |            |               |               |                 |
| 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: 004314028      Sampled on: 9-Feb-19 @ (Time not supplied)  
 Comments: 19373546 7a  
 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    | <0.500        | 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             |

NLS Leeds  
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NLS Starcross  
Staplake Mount  
Starcross  
Exeter  
EX6 8FD



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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: 004314029 Sampled on: 9-Feb-19 @ (Time not supplied)  
 Comments: 19373542 7b  
 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    | <0.500        | mg/l         | OR DR   | 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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## 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      Sampled on: 9-Feb-19 @ (Time not supplied)  
 Comments: 19370498 8a  
 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    | <0.500        | 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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## 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 Sampled on: 9-Feb-19 @ (Time not supplied)  
 Comments: 19370502 8b  
 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    | <0.500        | mg/l         | OR DC   | 0.005      | None          | SX            | 183             |
|                         |               |              | ELEVATED_MRVL100 : Dilution required (result accuracy may be reduced) |            |               |               |                 |
| 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: 004314032 Sampled on: 9-Feb-19 @ (Time not supplied)  
 Comments: 19371102 9a  
 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    | <0.500        | mg/l         | OR 00   | 0.005      | None          | SX            | 183             |
|                         |               |              | ELEVATED_MRVL100 : Dilution required (result accuracy may be reduced) |            |               |               |                 |
| 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: 004314033 Sampled on: 9-Feb-19 @ (Time not supplied)  
 Comments: 19371087 9b  
 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    | <0.500        | mg/l         | OR DR   | 0.005      | None          | SX            | 183             |
|                         |               |              | ELEVATED_MRVL100 : Dilution required (result accuracy may be reduced) |            |               |               |                 |
| 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: 004314034      Sampled on: 9-Feb-19 @ (Time not supplied)  
 Comments: 19371101 SP  
 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    | <0.500        | mg/l         | OR DR   | 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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## Analytical Report

Final Report

Report ID - 20129483 - 1

Batch description: Job ID 190216-11 Cyanide analysis

Reported on:  
12-Mar-2019

### 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
- 864 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.

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: Superseeded Report:

**Appendix**

**General**

- 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 NH4 by the BRE method, VOC TICs and SVOC TICs.
- Samples will be run in duplicate upon request, but an additional charge may be incurred.
- 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.
- 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.
- 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.
- 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.
- 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.
- If appropriate preserved bottles are not received preservation will take place on receipt. However, the integrity of the data may be compromised.
- NDP - No determination possible due to insufficient/unusable sample.
- Metals in water are performed on a filtered sample, and therefore represent dissolved metals - total metals must be requested separately.
- Results relate only to the items tested.
- LoDs (Limit of Detection) for wet tests reported on a dry weight basis are not corrected for moisture content.
- 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 70-100%. 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.
- Product analyses** - Organic analyses on products can only be semi-quantitative due to the matrix effects and high dilution factors employed.
- 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).
- Total of 6 specified phenols by HPLC includes Phenol, 2,3,5-Trimethyl Phenol, 2-Isopropylphenol, Cresols and Xylenols (as detailed in 15).
- Stones/debris are not routinely removed. We always endeavour to take a representative sub-sample from the received sample.
- 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.
- Mercury results quoted on soils will not include volatile mercury as the analysis is performed on a dried and crushed sample.
- For leachate preparations other than Zero Headspace Extraction (ZHE) volatile loss may occur.

- 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.
- We are accredited to MCERTS for sand, clay and loam/silt/clay, 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.
- 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 C6-C12 range, the total area of the chromatogram is integrated and expressed as ug/l 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.
- 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 (Howards) 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 (Howards) in-house method of transmitted/polarised light microscopy and central stop dispersion staining, based on HSG 248 (2005).

| Asbestos Type        | Colour/Shape |
|----------------------|--------------|
| Crocidolite          | White/needle |
| Amosite              | Dark/needle  |
| Chrysotile           | Blue/curved  |
| Talcus Asbestos      | -            |
| Phenyl Nickel Silate | -            |
| Fibrous Talcite      | -            |

**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.



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



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Version: 2.2 Version Issued: 13/03/2019



**CERTIFICATE OF ANALYSIS**

Validated

SDG: 150222-130 Client Reference: B1804-07 Report Number: 496657  
 Location: Mesurado Estuary Order Number: Superseded Report: 496745

**Received Sample Overview**

| Lab Sample No(s) | Customer Sample Ref. | AGS Ref. | Depth (m) | Sampled Date |
|------------------|----------------------|----------|-----------|--------------|
| 19419478         | 8A                   |          |           | 19/02/2019   |
| 19419475         | MR1                  |          |           | 19/02/2019   |
| 19419476         | MR2                  |          |           | 19/02/2019   |
| 19419477         | MFC3                 |          |           | 19/02/2019   |

**Maximum Sample/Coolbox Temperature (°C) :** **8.2**  
 ISO5667-3 Water quality - Sampling - Part 3 - 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 coolbox with 4 frozen ice packs is capable of maintaining pre-chilled samples at a temperature of 4.5±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><br><input checked="" type="checkbox"/> Test<br><input type="checkbox"/> No Determination Possible<br><br><b>Sample Types -</b><br>S - Soil/Solid<br>UNS - Unspecified Solid<br>GW - Ground Water<br>SW - Surface Water<br>LE - Land Leachate<br>PI - Prepared Leachate<br>PR - Process Water<br>SA - Saline Water<br>TE - Trade Effluent<br>TS - Treated Sewage<br>US - Untreated Sewage<br>RE - Recreational Water<br>DW - Drinking Water Non-regulatory<br>UNL - Unspecified Liquid<br>SL - Sludge<br>G - Gas<br>OTH - Other | Lab Sample No(s)          |                   |                |                         |              |              |
|--|---------------------------|-------------------|----------------|-------------------------|--------------|--------------|
|  | Customer Sample Reference |                   |                |                         |              |              |
|  | AGS Reference             |                   |                |                         |              |              |
|  | Depth (m)                 |                   |                |                         |              |              |
|  | Container                 | Standard (ALS221) | 10204 (ALS244) | 1-NH3 Filtered (ALS291) | NH3 (ALS297) | NH3 (ALS297) |
|  | Sample Type               | SA                | SA             | SA                      | SA           | SA           |
| Ammonical Nitrogen   | AI                        | NDP: 0<br>Test: 4 |                | X                       |              |              |
| COD Unfiltered   | AI                        | NDP: 0<br>Test: 4 | X              |                         |              |              |
| Conductivity (at 25 deg C)   | AI                        | NDP: 0<br>Test: 4 | X              |                         |              |              |
| EPH (DRO, C/D/CMS Agrees (%)   | AI                        | NDP: 0<br>Test: 4 |                |                         |              |              |
| GPC by GC-FID (W)  | AI                        | NDP: 0<br>Test: 4 |                |                         |              | X            |
| Nitrate by Cms (a)   | AI                        | NDP: 0<br>Test: 4 | X              |                         |              |              |
| pH Value   | AI                        | NDP: 0<br>Test: 4 | X              |                         |              |              |
| Saline Oxides (W)  | AI                        | NDP: 0<br>Test: 4 |                |                         | X            |              |
| Saline Metals Dissolved*   | AI                        | NDP: 0<br>Test: 4 |                | X                       |              |              |
| Saline TCN   | AI                        | NDP: 0<br>Test: 4 | X              |                         |              |              |
| Suspended Solids   | AI                        | NDP: 0<br>Test: 4 | X              |                         |              |              |
| TCC (Saline)(W-TCC-IR)*  | AI                        | NDP: 0<br>Test: 4 | X              |                         |              |              |
| Total Dissolved Solids (Cms)   | AI                        | NDP: 0<br>Test: 4 | X              |                         |              |              |
| Total EP-N (ug)  | AI                        | NDP: 0<br>Test: 4 |                |                         |              |              |
| Turbidity in meters  | AI                        | NDP: 0<br>Test: 4 | X              |                         |              |              |

15:55:39 13/03/2019

| ALS  |              | CERTIFICATE OF ANALYSIS                    |        |  |         | Validated |  |
|--|--------------|--|--------|--|---------|-----------|--|
| SDC: 150222-130<br>Location: Mesurado Estuary  |              | Client Reference: B1804-07<br>Order Number |        | Report Number: 496657<br>Superseded Report: 496745 |         |           |  |
| Component                                      | LOG/Units    | Method                                     | SL     | MR   | MR      | MR        |  |
| Cyanide Complex as CN <sup>-</sup>             | mg/l         | SLB  | <0.5   | <0.5   | <0.5    | <0.5      |  |
| TOC (Solids) <sup>a</sup>                      | <2.5 mg/l    | SLB  | 4.74   | 3.21   | <2.5    | <2.5      |  |
| Cyanide Free as CN <sup>-</sup>                | <0.005 mg/l  | SLB  | <0.005 | <0.005   | <0.005  | <0.005    |  |
| Acetic, Dissolved <sup>a</sup>                 | µg/l         | SLB  | 0.624  | 1.50   | 1.07    | 1.43      |  |
| Cyanide as CN <sup>-</sup>                     | <0.5 mg/l    | SLB  | <0.5   | <0.5   | <0.5    | <0.5      |  |
| Calcium, Dissolved <sup>a</sup>                | <0.05 µg/l   | SLB  | <0.05  | <0.05  | 0.0065  | <0.05     |  |
| Iron, Dissolved <sup>a</sup>                   | <4 µg/l      | SLB  | 0.0101 | 0.00554  | 0.00806 | 0.00524   |  |
| Lead, Dissolved <sup>a</sup>                   | µg/l         | SLB  | <0.3   | <0.3   | <0.3    | <0.3      |  |
| Mercury Dissolved <sup>a</sup>                 | <0.002 µg/l  | SLB  | <0.002 | <0.002   | <0.002  | <0.002    |  |
| Dissolved solids, Total (gravimetric)          | <10 mg/l     | TM021                                      | 4700   | 4000   | 2620    | 3000      |  |
| Suspended solids, Total                        | <2 mg/l      | TM022                                      | 73     | 53.5   | 56      | 49        |  |
| Ammoniacal Nitrogen as N                       | <0.2 mg/l    | TM059                                      | <0.2   | <0.2   | <0.2    | <0.2      |  |
| COB, unfiltered                                | <2 mg/l      | TM107                                      | 512    | 1090   | 608     | 433       |  |
| Conductivity @ 20 deg C                        | <0.005 mS/cm | TM120                                      | 46.1   | 49.9   | 46.3    | 45.0      |  |
| Salinity                                       | ‰            | TM150                                      | 33.7   | 33.5   | 33.8    | 33.7      |  |
| SPH Range >D10 - D40 (µg)                      | <100 µg/l    | TM172                                      | <100   | <100   | <100    | <100      |  |
| Total SPH >C5 - C40 (µg)                       | <100 µg/l    | TM172                                      | <100   | <100   | <100    | <100      |  |
| Nitrate as NO <sub>3</sub> <sup>-</sup>        | <0.05 mg/l   | TM184                                      | <0.05  | <0.05  | <0.05   | <0.05     |  |
| Turbidity                                      | <0.1 NTU     | TM155                                      | 2.49   | 3.79   | 4.41    | 4.00      |  |
| pH   | <1 pH Units  | TM206                                      | 8.11   | 8.04   | 8.08    | 8.01      |  |
| Saline Nitrate as NO <sub>3</sub> <sup>-</sup> | <0.3 mg/l    | TM281                                      | <0.3   | 0.651  | <0.3    | <0.3      |  |
| Saline Nitrite as NO <sub>2</sub> <sup>-</sup> | <0.3 mg/l    | TM281                                      | <0.3   | 0.660  | <0.3    | <0.3      |  |

15:55:39 13/03/2019





**CERTIFICATE OF ANALYSIS**

Validated

SDG: 150222-130 Client Reference: B1804-07 Report Number: 496657  
Location: Mesurado Estuary Order Number: Superseded Report: 496745

**Table of Results - Appendix**

| Method No | Reference   | Description   |
|-----------|---|---|
| SUB       |   | Subcontracted Test  |
| TM021     | Method 2540C, AWWA/APHA, 20th Ed., 1998   | Determination of total dissolved solids in waters by gravimetry   |
| TM022     | Method 2540C, AWWA/APHA, 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-FID (C10-C10)                                     |
| TM089     | BS 2690 Part 1: 1981 BS 6010 Part 2: 11:1994  | Determination of Ammonium in Water Samples using the Koro Analyser  |
| TM107     | ISO 6010-1985   | Determination of Chemical Oxygen Demand using COD (r Large Kit)   |
| TM120     | Method 2510B, AWWA/APHA, 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 Anions in Aqueous Matrices using the Koro Spectrophotometric Analyser                  |
| TM185     | Colour and Turbidity of water: Methods for the Examination of Waters and Associated Materials. -HMSO, 1961, ISBN 0 11 751955 0                              | Determination of Turbidity in Waters & Associated Matrices  |
| TM245     | By GC-FID   | Determination of GRO 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-12-H Meter  |
| TM281     |   | The Determination of Total Dissolved Nitrogen in Saline Matrices using the Koro Spectrophotometric Analyser |

NA = not applicable;  
Chemical testing (unless subcontracted) performed at ALS Life Sciences Ltd Haverden (Method codes TM) or ALS Life Sciences Ltd Aberdeen (Method codes SX)



**CERTIFICATE OF ANALYSIS**

Validated

SDG: 150222-130 Client Reference: B1804-07 Report Number: 496557  
Location: Mesurado Estuary Order Number: Superseded Report: 496745

**Test Completion Dates**

| Lab Sample No(s)              | 19419478      | 19419479      | 19419476      | 19419477      |
|-------------------------------|---------------|---------------|---------------|---------------|
| Customer Sample Ref.          | NA            | NA            | NA            | NA            |
| AGS Ref.                      |               |               |               |               |
| Depth                         |               |               |               |               |
| Type                          | Saline D (SA) | Saline D (SA) | Saline D (SA) | Saline D (SA) |
| American 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   |
| CHL (Pb) (G) (AAS) (A)        | 27-Feb-2019   | 27-Feb-2019   | 27-Feb-2019   | 27-Feb-2019   |
| CHL by (G) (AAS) (A)          | 01-Mar-2019   | 01-Mar-2019   | 01-Mar-2019   | 01-Mar-2019   |
| Chloride (Mn) (A)             | 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 (M)            | 05-Mar-2019   | 05-Mar-2019   | 05-Mar-2019   | 05-Mar-2019   |
| Saline Nitrite (Distilled)    | 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 IR)        | 04-Mar-2019   | 04-Mar-2019   | 04-Mar-2019   | 04-Mar-2019   |
| Total Dissolved Solids (Dist) | 26-Feb-2019   | 26-Feb-2019   | 26-Feb-2019   | 26-Feb-2019   |
| Total DP (Wag)                | 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**

|                     |   |                              |   |
|---------------------|---|------------------------------|---|
| <b>Work Order</b>   | <b>PR1918386</b>  | <b>Issue Date</b>            | 04-Mar-2019   |
| <b>Customer</b>     | <b>ALS Life Sciences Ltd</b>  | <b>Laboratory</b>            | ALS Czech Republic, s.r.o.                                  |
| <b>Contact</b>      | Reporting   | <b>Contact</b>               | Client Service  |
| <b>Address</b>      | Unit 7-8 Hawarden Business Park<br>Manor Road, Hawarden<br>CH5 3US Deeside United Kingdom | <b>Address</b>               | Na Harfe 336/9 Prague 9 - Vysocany<br>190 00 Czech Republic |
| <b>E-mail</b>       | euhdnsbconresults@ALSGlobal.com   | <b>E-mail</b>                | customer.support@alsglobal.com                              |
| <b>Telephone</b>    | ---   | <b>Telephone</b>             | +420 226 226 228  |
| <b>Project</b>      | 190222-130  | <b>Page</b>                  | 1 of 2  |
| <b>Order number</b> | ---   | <b>Date Samples Received</b> | 27-Feb-2019   |
| <b>Site</b>         | ---   | <b>Quote number</b>          | PR2018ALSAL-GB0004<br>(CZ-256-18-0022)                      |
| <b>Sampled by</b>   | ---   | <b>Date of test</b>          | 28-Feb-2019 - 04-Mar-2019                                   |
|                     |   | <b>QC Level</b>              | ALS CR Standard Quality Control<br>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**

**Signature**  
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<br>6A    | 19433087<br>MR1   | 19433086<br>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                | Result            | MU  |
| <b>Aggregate Parameters</b> |          |      |      |                             |         |                   |                   |                   |     |
| Total Organic Carbon        | W-TOC-IR | 0.50 | mg/L | 4.74                        | ± 20.0% | 3.21              | ± 20.0%           | <2.50             | --- |

| Sub-Matrix: SALINE WATER    |          |      |      | Client sample ID            |     | 19433074<br>MR3   | --- | ---    |     |
|-----------------------------|----------|------|------|-----------------------------|-----|-------------------|-----|--------|-----|
|                             |          |      |      | Laboratory sample ID        |     | PR1918386-004     | --- | ---    |     |
|                             |          |      |      | Client sampling date / time |     | 19-Feb-2019 00:00 | --- | ---    |     |
| Parameter                   | Method   | LOR  | Unit | Result                      | MU  | 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 780 00 |   |
| W-TOC-IR   | CZ_SOP_D08_02_056 (CSN EN 1484, CSN EN 18192, 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.

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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  
 Quote Description: Saline Water  
 Folder No: 004321892      Sampled on: 19-Feb-19 @ (Time not supplied)  
 Comments: 6A  
 Quote No: 15266      Matrix: Saline Water

| <u>Analyte</u>          | <u>Result</u> | <u>Units</u> | <u>Flag</u> | <u>MRV</u> | <u>Accred</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         | DE, DC, DD  | 0.005      | None          | SX            | 183             |
| Cyanide as CN           | <0.5          | mg/l         | DD          | 0.5        | None          | SX            | 182             |

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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: 004321903 Sampled on: 19-Feb-19 @ (Time not supplied)  
 Comments: MR1  
 Quote No: 15266 Matrix: Saline Water

| <u>Analyte</u>          | <u>Result</u> | <u>Units</u> | <u>Flag</u> | <u>MRV</u> | <u>Accred</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         | DE, DC, DD  | 0.005      | None          | SX            | 183             |
| Cyanide as CN           | <0.5          | mg/l         | DD          | 0.5        | None          | SX            | 182             |

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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

| <u>Analyte</u>          | <u>Result</u> | <u>Units</u> | <u>Flag</u> | <u>MRV</u> | <u>Accred</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         | DE, DC, DD  | 0.005      | None          | SX            | 183             |
| Cyanide as CN           | <0.5          | mg/l         | DD          | 0.5        | None          | SX            | 182             |

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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

| <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         | DE DC DD    | 0.005      | None          | SX            | 183             |
| Cyanide as CN           | <0.5          | mg/l         | DD          | 0.5        | None          | SX            | 182             |

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**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
- 864 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.

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.

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Analytical Report

Final Report - Amended - Issue 2

Report ID - 20129539 - 2

Batch description: 190222-130

Reported on:  
04-Mar-2019

---

END OF TEST REPORT

---

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## Report

Page 1 (3)



**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                                   | <b>19433060</b>   |                 |      |        |        |      |
|---|-------------------|-----------------|------|--------|--------|------|
| Sampled                                   | <b>2019-02-19</b> |                 |      |        |        |      |
| LabID                                     | U11573507         |                 |      |        |        |      |
| Analysis                                  | Results           | Uncertainty (±) | Unit | Method | Issuer | Sign |
| Filtrated with 0,45µm before the analysis | No                |                 |      | 1      | I      | ASAP |
| Fe  | <b>0.0101</b>     | 0.0025          | mg/l | 1      | H      | FIWU |
| As  | <b>0.624</b>      | 0.208           | µg/l | 1      | H      | FIWU |
| Cd  | <b>&lt;0.05</b>   |                 | µg/l | 1      | H      | FIWU |
| Hg  | <b>&lt;0.002</b>  |                 | µg/l | 1      | F      | EVRI |
| Pb  | <b>&lt;0.3</b>    |                 | µg/l | 1      | H      | FIWU |

| Your ID                                   | <b>19433059</b>   |                 |      |        |        |      |
|---|-------------------|-----------------|------|--------|--------|------|
| Sampled                                   | <b>2019-02-19</b> |                 |      |        |        |      |
| LabID                                     | U11573508         |                 |      |        |        |      |
| Analysis                                  | Results           | Uncertainty (±) | Unit | Method | Issuer | Sign |
| Filtrated with 0,45µm before the analysis | No                |                 |      | 1      | I      | ASAP |
| Fe  | <b>0.00564</b>    | 0.00213         | mg/l | 1      | H      | FIWU |
| As  | <b>1.58</b>       | 0.62            | µg/l | 1      | H      | FIWU |
| Cd  | <b>&lt;0.05</b>   |                 | µg/l | 1      | H      | FIWU |
| Hg  | <b>&lt;0.002</b>  |                 | µg/l | 1      | F      | EVRI |
| Pb  | <b>&lt;0.3</b>    |                 | µg/l | 1      | H      | FIWU |

| Your ID                                   | <b>19433056</b>   |                 |      |        |        |      |
|---|-------------------|-----------------|------|--------|--------|------|
| Sampled                                   | <b>2019-02-19</b> |                 |      |        |        |      |
| LabID                                     | U11573509         |                 |      |        |        |      |
| Analysis                                  | Results           | Uncertainty (±) | Unit | Method | Issuer | Sign |
| Filtrated with 0,45µm before the analysis | No                |                 |      | 1      | I      | ASAP |
| Fe  | <b>0.00806</b>    | 0.00311         | mg/l | 1      | H      | FIWU |
| As  | <b>1.07</b>       | 0.71            | µg/l | 1      | H      | FIWU |
| Cd  | <b>0.0583</b>     | 0.0239          | µg/l | 1      | H      | FIWU |
| Hg  | <b>&lt;0.002</b>  |                 | µg/l | 1      | F      | EVRI |
| Pb  | <b>&lt;0.3</b>    |                 | µg/l | 1      | H      | FIWU |

ALS Scandinavia AB  
Auroxum 10  
977 75 Luleå  
Sweden

Web: [www.alsglobal.se](http://www.alsglobal.se)  
Email: [info.lu@alsglobal.com](mailto:info.lu@alsglobal.com)  
Tel: + 46 920 28 9900  
Fax: + 46 920 28 9940

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## Report

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**L1906115**

1F5T003WPU0



| Your ID                                   | <b>19433064</b>   |                 |      |        |        |      |
|---|-------------------|-----------------|------|--------|--------|------|
| Sampled                                   | <b>2019-02-19</b> |                 |      |        |        |      |
| 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 |

ALS Scandinavia AB  
Auroxum 10  
977 75 Luleå  
Sweden

Web: [www.alsglobal.se](http://www.alsglobal.se)  
Email: [info.lu@alsglobal.com](mailto:info.lu@alsglobal.com)  
Tel: + 46 920 28 9900  
Fax: + 46 920 28 9940

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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.

ALS Scandinavia AB  
Auroxum 10  
977 75 Luleå  
Sweden

Web: [www.alsglobal.se](http://www.alsglobal.se)  
Email: [info.lu@alsglobal.com](mailto:info.lu@alsglobal.com)  
Tel: + 46 920 28 9900  
Fax: + 46 920 28 9940

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**CERTIFICATE OF ANALYSIS**

|                  |                  |                          |          |                           |        |
|------------------|------------------|--------------------------|----------|---------------------------|--------|
| <b>SDG:</b>      | 190222-130       | <b>Client Reference:</b> | B1804-07 | <b>Report Number:</b>     | 490667 |
| <b>Location:</b> | Mesuraco Estuary | <b>Order Number:</b>     |          | <b>Superseded Report:</b> | 495745 |

**Appendix**

1. Results are expressed on a dry weight basis (dried at 30°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 lost 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 material 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 at 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 reduced 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 listed.

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 organic 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 monochloride 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-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.

**General**

21. For the BSEN 12457-3 hot 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 volatile GC/MS/GCMS and all subcontracted analysis.

22. We are accredited to ISO17025 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 materials 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 esters 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, vehicles by GCMS 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 slip dispersion staining, based on HSG 248 (2005).

The results for identification of asbestos in soils are obtained from a homogenised soil 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 slip dispersion staining, based on HSG 248 (2005).

| Asbestos type   | Colouration      |
|-----------------|------------------|
| Chrysotile      | White/colourless |
| Amosite         | Dark/brown       |
| Crocidolite     | Blue/black       |
| Talcus Asbestos | -                |
| Phyllosilicates | -                |
| 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 284.

The identification of asbestos containing materials and soil 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.

# 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.

29 An appropriate vegetation green belt of a minimum width of two hundred metres shall be  
30 maintained around the perimeter of crushing and screening plants, batching plants, stockpile  
31 and loading areas, quarry working areas and so on. Green belts should be maintained  
32 particularly if these sites are located in close proximity to villages and residential areas.

33 Operators' cabins in all mobile and fixed plant shall be provided with dust proof enclosures.  
34 Persons working in dust prone areas shall be provided with suitable dust masks.

#### 35 **D.1.1.2 Ambient Air Quality Tolerance Limits**

36 Operations involving any dust- or gaseous-generating activity must not exceed the standards  
37 given in the tables below. These limits apply to all machinery, vehicle and power generation  
38 emissions, as well as to the generation of dust from earthworks, ore and rock crushing, and  
39 vehicle movements.

40 The tables below present both international and national standards. The most stringent of the  
41 two should be achieved. Both are given in this standard because measurement techniques  
42 vary and the differences of averaging periods may mean that one table can be used for  
43 interpretation rather than the other.

44 In practice, emission fluctuations, meteorological conditions and baseline concentrations  
45 mean that in many cases compliance with the standard for 90 percent of the time can be  
46 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                          |                        |

\* Annual arithmetic mean of minimum 104 measurements in a year taken twice a week 24 hourly at uniform interval.  
\*\* 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.  
\*\*\* Not to be exceeded more than once per year average concentration  
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.

## 48 D.1.2 Water Quality

49 The supervising consultant and contractor are to ensure that the standards in the table below  
50 are maintained as far as is possible in any water flows affected by its operations. Where the  
51 ambient water quality is lower than the standard, then the water shall be restored to the  
52 ambient quality.

53 Liberian primary water quality standards for coastal water marine outfalls, class SW-II (EPML – Water Quality  
54 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 |   |

55 Categories of water use

- 56 • Class I: Drinking water; water supply for industry requiring drinking water.
- 57 • Class II: Natural and cultivated fisheries, public bathing places, recreational water  
58 sports.
- 59 • Class III: Industrial supplies (other than for drinking); irrigation of agricultural land.

60 The Liberian water quality standard table also gives the World Health Organisation (WHO)  
61 guideline standard where it is available. The absence of a WHO guideline value usually  
62 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.

95 **D.1.3.2 Acceptable Noise Levels**

96 No operations of the project or its contractors should exceed the levels of, or exposures to,  
97 noise as given in the tables below.

98 Where it is not feasible to reduce noise levels to those given below, suitable earth bunds or  
99 other barriers to the lateral spreading of noise shall be designed and installed to ensure  
100 compliance.

101 Noise impacts should not exceed the levels given in the tables below. These are given as façade  
102 levels at the wall of a property (e.g. just outside a window). Façade level is 3 dB(A) higher  
103 than the free-field level due to reflection from the façade.

104 Maximum permissible noise levels for general environment (EPML - Noise Pollution Control and Standards  
105 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><br><i>Day: 6.00 a.m. to 10.00 p.m.</i><br><i>Night: 10.00 p.m. to 6.00 a.m.</i><br><i>The time frame takes into consideration human activity</i>                       |                           |       |

106 Maximum permissible noise levels (continuous or intermittent noise) from a factory or workshop (EPML -  
107 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><br><i>(i) Factory/Workshops 85 dB (A)</i><br><i>(ii) Offices 50 dB (A)</i><br><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    |

*Time Frame:*  
*Day: 6.00 a.m. to 10.00 p.m.*  
*Night: 10.00 p.m. to 6.00 a.m.*  
*The time frame takes into consideration human activity*

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)           |

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## 116 D.1.4 Limitation of Vibrations and Air Overpressure

### 117 D.1.4.1 Ground Vibrations: Introduction and Measurement

118 When an object is in contact with a vibrating surface it is displaced about its reference  
119 (stationary) position. Displacement (in mm) is therefore one parameter that can be used to  
120 describe the magnitude of a vibration. For sinusoidal signals, displacement, velocity (mms-1)  
121 and acceleration (mms-2) amplitudes are related mathematically by a function of frequency  
122 and time. If phase is neglected (as is always the case when making time-average  
123 measurements), then the velocity can be obtained by dividing the acceleration signal by a  
124 factor proportional to frequency (measured in Hertz, Hz) and the displacement can be  
125 obtained by dividing the acceleration signal by a factor proportional to the square of  
126 frequency. Modern electronic integrating meters are capable of providing a wide range of  
127 measurement parameters during any single vibration measurement.

128 For a complex acceleration signal giving rise to a complicated time history, there are several  
129 additional quantities which can be used to describe the vibration:

- 130 • The root mean square value (rms) is obtained by taking the square root of the means  
131 of the sum of the squares of the instantaneous acceleration measured during the total  
132 measurement time (T);
- 133 • The peak value is the maximum instantaneous acceleration measured during the  
134 measurement time, T. It is a useful indicator of the magnitude of short duration shocks;  
135 and
- 136 • The peak particle velocity (ppv) is the maximum instantaneous velocity of a particle  
137 at a point during a given time interval.

### 138 D.1.4.2 Context

139 In general, buildings are reasonably resilient to ground-borne vibration and vibration-  
140 induced damage is rare. Vibration-induced damage can arise in different ways, making it  
141 difficult to arrive at universal criteria that will adequately and simply indicate damage risk.  
142 Damage can occur directly due to high dynamic stresses, due to accelerated ageing or  
143 indirectly, when high quasi-static stresses are induced by, for example, soil compaction.

144 Given the construction of many of the residential properties in rural Liberia (sun-dried clay  
145 blocks, with a very thin concrete skim direct on to the clay) and the likely levels of ground  
146 borne vibration, it is considered that these types of properties will not suffer from cosmetic  
147 damage due to vibration. Measurements are therefore recommended only for short duration  
148 vibrations (such as from blasting) or for particular, very sensitive receptors.

149 The British Standard BS 7385-2:1993 (Evaluation and measurement for vibration in buildings  
150 – Part 2: Guide to damage levels from ground borne vibration) provides guidance on vibration  
151 levels likely to result in cosmetic damage (e.g. plaster cracks). Limits for transient vibration,  
152 above which cosmetic damage could occur, are given in the table below, taken directly from  
153 that standard.

#### 154 D.1.4.3 Transient Vibration Levels for Cosmetic Damage

155 The vibration velocities given in the table below must be adhered to in relation to project  
156 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<br>Industrial and heavy commercial buildings         | 50 mms <sup>-1</sup> at 4 Hz and above                                      |  |
| Un-reinforced or light framed structure<br>Residential or light commercial buildings | 15 mms <sup>-1</sup> at 4 Hz increasing to<br>20 mms <sup>-1</sup> at 15 Hz | 20 mms <sup>-1</sup> at 15 Hz increasing to<br>50 mms <sup>-1</sup> at 40 Hz and above |

157 Notes. 1. Values referred to are at the base of the building.  
158 2. For un-reinforced or light framed structures and residential or light commercial buildings, a maximum  
159 displacement of 0.6 mm (zero to peak) is not to be exceeded.  
160

161 The guide values relate predominantly to transient vibration which does not give rise to  
162 resonant responses in structures. Where the dynamic loading caused by continuous vibration  
163 is such as to give rise to dynamic magnification due to resonance, especially at the lower  
164 frequencies where lower guide values apply, then the guide values in the table may need to  
165 be reduced by up to 50%.

#### 166 D.1.4.4 Air Overpressure Limits

167 Air overpressure (or blast overpressure) is the pressure or high energy impulse noise caused  
168 by a shock wave over and above normal atmospheric pressure.

169 Based on a review of international standards, the figure of 133 dB (L) is adopted at 500 metres  
170 from the blast site (the standard evacuation zone) or at the nearest non-quarry-related  
171 structure if closer.

172 **D.1.4.5 Standard Measures to Reduce Ground Vibrations and Air Overpressure in**  
173 **Blasting**

174 The following standard measures shall be used in all blasting operations by or on behalf of  
175 the project, to reduce ground vibrations and air overpressure. It is recognised that these are  
176 difficult to predict owing to the many factors involved in ground conditions, distance to  
177 receptor, atmospheric conditions and the intention of individual blasting operations.

- 178 • Explosive quantities shall be minimised to the least amount required to accomplish  
179 the required task.
- 180 • The spacing of blast holes shall be optimised so as to accomplish the required task with  
181 the least amount of explosive possible.
- 182 • Detonator timings shall be optimised to minimise ground vibrations. Normally the  
183 standard 8 millisecond rule between blast holes shall apply, unless the use of electronic  
184 timers allows for better patterns.
- 185 • Burden depth and blast hole diameter shall be optimised to obtain the best balance  
186 between reduced ground vibrations and reduced air overpressure.

187 It is expected that the quarry operator will undertake a series of trials to reach the optimal  
188 reduced ground vibration and air overpressure impacts over the first five blasts at a particular  
189 site.

190 **D.1.5 Bushmeat Hunting, Dealing, Transporting and Use**

191 **D.1.5.1 Statutory Regulations**

192 The Draft Hunting Regulations of Liberia, drawn up under the National Forestry Law (2006)  
193 proposed the following provisions.

- 194 1. A person with a valid hunting licence issued by the Forestry Development  
195 Authority may hunt during the Open Hunting Season, from 1 October to 31 March.
- 196 2. No hunter may take more than 3 wild animals per week.

197 3. No bush meat trader may carry more than 20 pieces (quarters) of meat at a time.

198 **D.1.5.2 Permitted Bushmeat**

199 No person is permitted to hunt for bushmeat on project land, including the road right-of-way.

200 The legally permitted take per licensed hunter on non-project land of common non-protected  
201 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               |

202 **D.1.5.3 Prohibited Bushmeat**

203 The following animals are fully protected and may not be hunted at all. All project staff and  
204 contractors' employees are absolutely forbidden from hunting, dealing in, transporting and  
205 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. Guineafowl (white-breasted guineafowl)                   |
| 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                              |                           |

---

## 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.

---

## 240 D.2.2 Bush Clearance

241 The clearance of vegetation is permitted in certain areas in preparation of earthworks or for  
242 access to facilities. The swathe that may be cut is limited to the minimum required for the  
243 purpose in hand. In the case of roads, the swathe is to cover only the width of the road and its  
244 immediate drainage works.

245 No vegetation may be cleared unless it is explicitly covered in the conditions of the relevant  
246 Environmental Permit. This may be allowed for in the ESIA Report or the Environmental and  
247 Social Management Plan.

248 Vegetation shall normally be cleared only by cutting. The use of fire, herbicides or other  
249 poisons is not permitted. The use of earth-moving equipment is permitted only if the works  
250 require the grubbing out of plant roots. Otherwise all roots and stumps shall be left in the  
251 ground.

252 Vegetation may be cut using either hand or machine tools. In all cases, appropriate personal  
253 protective equipment shall be used by the workers involved.

254 The vegetative debris shall be laid down to rot, thereby acting as mulch and helping to  
255 mitigate damage to the soil. Where clearance is for construction, then the debris may be  
256 removed to a suitable approved dump site.

257 If a bare sloping area is created by vegetation clearance, then appropriate erosion control  
258 measures shall be implemented. Separate guidelines are provided to cover this.

259 No tree of more than five metres in height should be felled using a standard bulldozer or  
260 excavator. An axe or saw should be used. Chainsaws should only be used by trained operators  
261 (see guidance below). Even with manual saws, trees taller than 8 metres in height should be  
262 felled only by experienced workers. Where specialist large machines (see below) are available  
263 and slopes are less than 20 degrees and tree roots are to be grubbed out, then trees more than  
264 five metres in height may be felled by machine. However, no tree greater than 25 metres in  
265 height may be felled except by use of a chainsaw.

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## 266 D.2.3 Procedure for Unexpected Cultural Sites and Archaeological Finds

### 267 D.2.3.1 Introduction

268 This guideline describes the actions required when project work for or by the project  
269 encounters sites of cultural heritage value, archaeological remains, graves and human  
270 remains. The purpose of this chance finds procedure is to ensure that a protocol is in place for  
271 identification, data collection, reporting; and, if necessary, salvage of significant chance finds.  
272 The National Museum of Liberia, in consultation with the EPA will determination the level of  
273 significance for purposes of salvage.

274 In its ESIA studies, the EPA's consultants have encouraged communities to identify and map  
275 sacred sites – forests, groves, bushes, stones and rocks, caves, sites of archaeological or  
276 ancestral history and graves, and areas for African Traditional Religions. It is possible that  
277 some sites have been forgotten, missed or are important to people still displaced. It is also  
278 possible that there may be the discovery of human remains left from the civil war or more  
279 recent incidents.

### 280 D.2.3.2 Possible Sites

281 A site of importance is defined as any of the following.

- 282 • Any physical place or geographical feature identified by local people as culturally  
283 important – usually these will be identified by local people working on the site as they  
284 are found.
- 285 • Any archaeologically significant structure or artefact. These may be difficult to identify  
286 but may be, for example, stone circles or unusual mounds that only appear as brush is  
287 cut back.
- 288 • Graves – these may be stone markers only revealed on cutting back brush.
- 289 • Exposed human remains – these may be recent, related to civil war incidents or much  
290 older.

291 Cultural sites may be difficult to identify without explanation by local people. Features to look  
292 out for include signs of human activity or artefacts around large or unusual trees, bushes and  
293 rocks, particularly in remote locations. Contractors must be sensitive to comments by Liberian

294 staff regarding cultural sites. Sometimes these may sound derogatory because of differences  
295 between Liberia’s ethnic cultures; but all cultural sires are valuable to someone.

296 An archaeological site is a place in which evidence of past human activities is preserved. Sites  
297 that are buried or not identified by prior surveys may be discovered during project land  
298 clearing and in the first few metres of excavation. They may exhibit features such as scatters  
299 of broken pottery, flakes of worked stone, bones, discarded shellfish, walls of former  
300 buildings, or iron smelting works. These artefacts usually have no commercial value but are  
301 of value in defining a history of human occupation.

### 302 D.2.3.3 Action Required

303 The Community Liaison Unit will include physical cultural resource awareness training for  
304 all staff and contractors during site induction and follow-up with reminder information on  
305 responsibility and respect for such resources in the event of a chance find, and the appropriate  
306 procedure to follow. In order to prevent vandalism, the Contractor, the Contractor’s staff and  
307 the Project staff must keep confidential the location of the suspected find

308 The procedure below states the steps that must be undertaken to report, investigate and deal  
309 with chance finds in the concession area and associated works.

### 310 D.2.3.4 Procedure

| Step                         | Responsibility                          | Action   |
|------------------------------|---|--|
| 1. Realisation               | Worker                                  | Report find to supervisor.   |
| 2. Halt action               | Supervisor/<br>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. |
|                              |   |  |

| 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                         | 1. Contact the University of Liberia, Liberia College of Social Science and Humanities, Anthropology Department   |
|   |   | 2. Request rapid appraisal visit to site by a competent specialist.   |
|   |   | 3. Commission specialist investigation with a view to researching, preserving or relocating the find if it is of archaeological significance.   |
|   |   | 4. Liaise with the project design team to avoid the site either temporarily or permanently.   |
|   |   | 5. Costs of the specialist visit, appraisal and any conservation or relocation activities will be met from the project's resettlement compensation budget.  |
| d) In the case of a site of cultural value  | Community Liaison Officer                                       | 1. Contact the local community, elders, Poro and Sande leaders, and the Leader of the Animals to investigate claims to cultural significance.   |
|   |   | 2. Liaise with the project design team to avoid the site either temporarily or permanently.   |
|   |   | 3. If not possible to avoid, agree a relocation package and timetable with costs met from the project's resettlement compensation budget.   |
|   |   | 4. Oversee and monitor the relocation to the agreed timetable and cost.   |
| 6 <b>Reporting</b><br>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:<br>a) Location – GPS co-ordinates.<br>b) Conditions in which the discovery occurred.<br>c) Type – principle evidence for suspected archaeological sites, or informant declaration in the case of cultural sites.<br>d) Area – horizontal and vertical.<br>e) Work stopped – task and schedule. |

#### 311 D.2.4 Code of Practice for Staff, Worker and Visitor Behaviour

312 All contractors' managers must ensure that their staff uphold this Code of Practice at all times.

313 Project contractors are guests of the communities in which they are living and working. They  
314 must fit with local customs and laws. Many staff are from other parts of Liberia and from  
315 other countries, and some will be in the project area for only short periods. Cultural  
316 differences and poor behaviour of workers can lead to tension between local communities and  
317 workers housed in camps. This Code of Practice demands moderate and tolerant behaviour  
318 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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## 346 D.2.5 Control of Water Pollution

### 347 D.2.5.1 General

348 No person shall discharge or apply any poisonous, toxic, noxious or obstructing matter,  
349 radioactive waste or other pollutants unless the discharge of such material is treated to  
350 permissible standards as defined in the project's environmental permit.

351 No person shall:

- 352 • Generate and discharge any form of effluent on to land or into any water resource  
353 without compliance with an approved Environmental Management Plan and a valid  
354 Environmental Certificate;
- 355 • Discharge wastewater or effluent off an operational site, which does not meet the  
356 water quality requirements stipulated in the appropriate licence for effluent discharge;  
357 or
- 358 • Discharge into any water resource effluent from a sewage treatment plant, trade or  
359 industrial facility without both treatment and a valid effluent discharge license.

360 In rural Liberia, all surface water courses are used for drinking water supplies at some point  
361 during the agricultural year.

### 362 D.2.5.2 Prevention of Water Pollution

363 Surface run-off from earthworks, waste dumps and other areas shall be properly controlled,  
364 collected and treated before discharging into natural water courses. Silt traps and check dams  
365 of appropriate sizes shall be constructed at all strategic points to control surface run-off. All  
366 run-off water shall be diverted through a series of sedimentation basins to remove suspended  
367 particles and chemicals as necessary.

368 Entrained sediment shall be collected as close to the source as possible. In particular, coarse  
369 sediment (sand- and coarse silt-sized particles) should be removed from water courses at the  
370 point where they leave the source of supply. Coarse sediment can destroy riverine biotic  
371 systems that can otherwise thrive close to earthworks sites.

372 Sedimentation ponds and check dams shall be de-silted at regular intervals, as required to  
373 maintain effectiveness.

374 Re-vegetation of exposed surfaces shall be done as far as possible in the earthworks and other  
375 operational sites, and around all ancillary infrastructure and access tracks. A separate series  
376 of guidelines covers these works.

377 All efforts shall be made to re-use and re-cycle treated effluents to the maximum possible  
378 extent in order to achieve zero effluent discharge.

379 Domestic effluents shall be treated in properly designed oxidation ponds or by any other  
380 suitable sewage treatment method. Outfalls should be allowed to discharge into the  
381 environment only where the quality standards are met. The supervising consultant shall be  
382 responsible for monitoring this, but may require a contractor to undertake monitoring on its  
383 behalf. Where camps are operated by contractors, then the operator is responsible for  
384 monitoring outfalls.

385 Workshops, fuelling stations and other areas handling fuels, lubricants and other hazardous  
386 substances shall be subject to special provisions. These are covered in detail by separate  
387 guidelines.

#### 388 **D.2.5.3 Protection and Conservation of Riparian and Estuarine Peripheral Areas**

389 Riparian land is the area along the banks of rivers and creeks, and edges of swamps, where  
390 there is a dynamic complex of plant, animal and micro-organism communities and their non-  
391 living environment adjacent to and associated with a watercourse. Estuarine peripheral areas  
392 are around the edges of tidal inlets, immediately outside the zone of saline water intrusion,  
393 and where there are also particular ecosystems. Although both of these bands of land vary, a  
394 practical guideline is to take them as occupying 50 metres on each side of a watercourse for  
395 riparian zones, and 50 metres from the highest point of tidal water ingress in the case of  
396 estuarine areas. In specific conditions, where there is a strong case for a narrower width, this  
397 may be reduced to a minimum of 15 metres.

398 The following activities shall not be permitted on riparian or estuarine peripheral land except  
399 as provided in the following two paragraphs:

- 400 • Tillage or cultivation;
- 401 • Clearing of trees or other vegetation;
- 402 • Building of permanent or temporary structures;

- 
- 403 • Disposal of any form of waste;
  - 404 • Excavation of soil or development of borrow pits or quarries; or
  - 405 • Any other activity that may degrade the water resource.

406 If any of the above activities must take place within a 50-metre riparian or estuarine peripheral  
407 zone, a full environmental management plan must be prepared that demonstrates how any  
408 impacts will be mitigated, with control measures put in place before any other site works start.

409 Where it is essential that tracks or roads must cross a riparian zone, they shall be aligned to  
410 cross at right angles, thereby minimising disruption to this valuable habitat. The area cleared  
411 for them shall be kept as narrow as possible and special provision shall be made for soil  
412 erosion control measures. Culverts shall be installed so that vehicles do not drive through the  
413 water.

414 Riparian and estuarine peripheral zones should be considered as key areas in all work site  
415 environmental monitoring. Water quality assessment or the health and diversity of indicator  
416 insect species such as dragonflies shall be used to judge the effectiveness of mitigation  
417 measures.

#### 418 D.2.5.4 Spillage

419 No person shall wilfully and deliberately allow any substance to spill out into any water  
420 resource (fresh or saline) or on to land where such spillage may contaminate either soil or a  
421 body of surface or groundwater, or the sea.

422 In the event of accidental spillage where such spillage may contaminate either soil or a body  
423 of surface or groundwater, the following actions shall be taken.

- 424 • The person responsible for or causing or finding the spilt substance shall immediately  
425 inform the supervising consultant of the accident.
- 426 • The supervising consultant shall take immediate and adequate measures to prevent  
427 spread of the spillage and its likely adverse effects to soil and water resources.
- 428 • The supervising consultant shall take measures to notify the public of the spillage and  
429 also to cause action to be taken to deal with the spillage.

430 In this context the supervising consultant is represented by the Manager responsible for that  
431 overall site.

## 432 **D.2.6 Topsoil Stripping, Stockpiling and Restoration**

### 433 **D.2.6.1 Overview**

434 This guideline provides guidance on the management of topsoil and subsoil in engineering  
435 operations. Topsoil is an important resource, both ecologically and economically, since it is  
436 the source of all terrestrial life. Topsoil is therefore classed as an asset and must be treated as  
437 a living entity. Under no circumstances is topsoil a waste material. Subsoil is an essential  
438 foundation to topsoil and where possible should also be saved to aid later rehabilitation.

439 The recommended sequence for stripping, stockpiling and restoring of topsoil from a borrow  
440 area or other site, is as follows. The paragraphs below give details on how each step should  
441 be undertaken.

- 442 1. Delineate borrow (or other) area.
- 443 2. Delineate topsoil storage area.
- 444 3. Complete land access procedure.
- 445 4. Construct access tracks.
- 446 5. Clear vegetation and dispose.
- 447 6. Install drainage and silt traps.
- 448 7. Grub roots and stumps.
- 449 8. Strip topsoil from borrow area.
- 450 9. Place topsoil on designated storage.
- 451 10. Stockpile unusable subsoil if present.
- 452 11. Remove approved earthfill to construction site.
- 453 12. Replace subsoil if available.
- 454 13. Replace topsoil and rehabilitate.
- 455 14. Undertake revegetation works to restore habitat.

### 456 **D.2.6.2 Field Identification of Topsoil**

457 Topsoil is the darker coloured surface layer that varies in depth depending on location, but in  
458 general is 100 to 150 mm in depth. It is the soil layer with the greatest proportion of organic

459 matter (in the form of fine roots, decomposing plant material and microbial animals). Where  
460 there is any leaf litter on the soil surface, this should be considered part of the topsoil. Topsoil  
461 depth and quality generally increases from a hilltop to the toe of a slope. Swamps may contain  
462 considerable thicknesses of topsoil that are highly fertile if managed correctly.

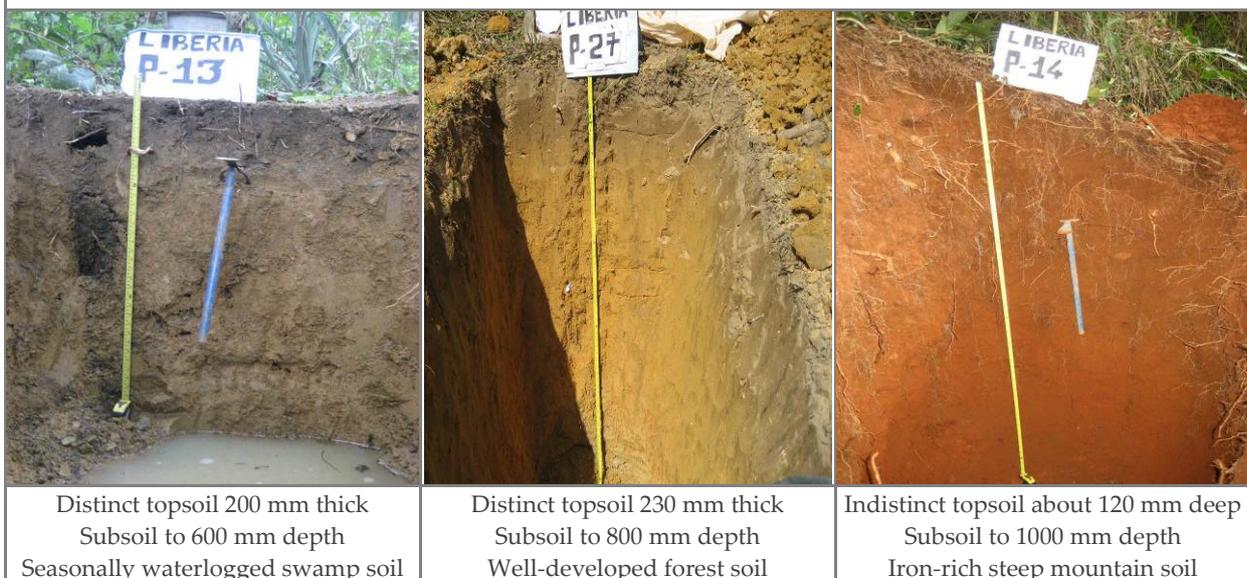
463 With depth in the soil profile, the material becomes increasingly less weathered and thus of  
464 decreasing value as plant-growing material. This is the subsoil. The downward change is often  
465 gradual and thus it is a matter of judgement as to where to make the cut-off. However, the  
466 subsoil horizon from 150 to 500 or 600 mm contains soil that is of value in restoration, as it  
467 contains some organic material and raised nutrient levels, and is weathered to a consistency  
468 that will help facilitate later regrowth when it is re-laid as a foundation below the topsoil.  
469 Note, however, that lack of cleared land for storage space means that the contractor will not  
470 normally need to take subsoil for storage unless it is found between the topsoil and the  
471 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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472 **D.2.6.3 Storage of Topsoil**

473 The location for a soil stockpile shall be in a place where it will not erode, block drainage, or  
474 interfere with work on the site. The stockpile location must be selected to avoid steep slopes  
475 (gentler than 1:4 to avoid slippage), flood plains and natural channels. It shall be at least 30  
476 metres from a water course, pond or swamp to prevent sedimentation and damage to riparian  
477 habitat.

478 Topsoil should not be stored on another topsoil or subsoil of highly contrasting texture. Sandy  
479 topsoil over clay subsoil is a particularly poor combination, especially on slopes: water may  
480 creep along the junction between the soil layers and cause the topsoil layer to slip or slough.

481 Subsoil should not be stored on top of topsoil. If necessary, the topsoil at a stockpile location  
482 must be stripped off and the subsoil laid down, before the topsoil is replaced on top of it.

483 On large sites, re-spreading may be easier and more economical when soil is stockpiled in  
484 small piles located near the areas where it will be re-used. One approach appropriate for some  
485 borrow areas, is for removal and replacement of topsoil in successive strips as the borrowing  
486 moves across the area.

487 Before any topsoil is stored in a designated area, vegetation must be cut and a full drainage  
488 and sediment control system installed. The grubbing of stumps and roots may also be  
489 necessary to aid the processes of topsoil placement, management and later recovery for use in  
490 rehabilitation works.

491 As far as the terrain allows, storage areas should be gently convex in design so that run-off is  
492 managed and does not lead to erosion and instability. The slopes used should be at a  
493 maximum angle of 18 to 20° to enable working, and subject to final assessment and sign-off  
494 by the authorised engineer to ensure that the slopes are stable in the short and long term.

495 Where stockpiles are on slopes, the downward slope shall be adapted to retard run-off water  
496 and prevent erosion. Erosion control berms and appropriate drainage channels may be used  
497 to achieve this. An alternative is to create “moonscape” indentations to retard run-off, placed  
498 in a staggered manner to ensure they do not form continuous lines

---

499 **D.2.6.4 Management of Topsoil (and Subsoil) Stores**

500 The management of topsoil storage areas shall be determined on an area-by-area basis and an  
501 appropriate plan agreed. All storage areas will be in approved locations, with sites prepared  
502 as described above. The main management options are as follows.

- 503 • Temporary storage of topsoil, with it replaced to site within the same dry season.
- 504 • Longer term storage requiring management interventions, including revegetation,  
505 periodic aeration, erosion controls and other work.
- 506 • Initial stabilisation followed by handover for approved use by the landowner under  
507 an agreement in line with the Resettlement Action Plan.

508 Topsoil stockpile height shall not exceed 1 metre. If space permits, where topsoil is being  
509 stockpiled on areas where agriculture will remain active as part of the management plan, then  
510 it should be limited in height to 0.5 m to retain topsoil characteristics (significant biological  
511 activity really continues only to a depth of 300 mm). Gentle compaction is necessary, but  
512 should be as light as possible, such as one pass by a tracked excavator or small bulldozer; but  
513 never by a roller or vibrating compactor.

514 Soil stockpiles shall be protected against erosion and soil loss by temporarily planting or  
515 seeding with a locally collected species of grass. This must be done as soon as possible, but  
516 only when there is enough moisture in the soil for germination and growth. In the wet season,  
517 no stockpile shall be unprotected for more than 30 days after its formation. While vegetation  
518 is becoming established, the stockpile may need additional protection by a silt fence or other  
519 sediment barrier on the down-gradient sides.

520 If stockpiles will not be removed within the same dry season as they were created, they should  
521 be stabilised with permanent vegetation to control erosion and weed growth. This will involve  
522 the planting of fast-growing pioneer shrubs or trees.

523 No seeds or plants from sources outside of the County where activities are taking place may  
524 be used on any revegetation sites. Invasive plants also must not be used. This is on account of  
525 the need to protect the local biodiversity to the greatest extent possible.

526 Fine-textured topsoil may need aeration periodically if there is a risk of waterlogging and the  
527 generation of anaerobic conditions. This can be achieved by turning down the stockpiles once

528 a year, or using a chisel plough or tines on a small bulldozer, but the most suitable method  
529 will be dependent on the height of the stockpile. Revegetation may be required after the  
530 aeration operations.

531 The depth of a subsoil stockpile is limited by stability concerns. As it is laid, the soil should be  
532 compacted in layers of 1 metre thickness. Usually a height of 3 metres is the maximum that  
533 should be permitted without stabilisation measures being required. Compaction is to ensure  
534 integrity, not to create a full engineering fill specification, and should be achieved using a few  
535 passes by a tracked machine.

#### 536 **D.2.6.5 Replacement of Topsoil (and Subsoil) in Land Rehabilitation**

537 Before spreading soil back on to a site, erosion and sedimentation control practices such as  
538 run-off water diversions, berms, and sediment basins shall be put in place. The slopes and  
539 elevations should be graded smooth for the receipt of soil. Slopes steeper than 1v:3h should  
540 not normally be considered for re-soiling, but instead should be protected by direct planting  
541 with suitable pioneer species.

542 Topsoil shall be spread evenly over freshly laid subsoil in a layer of 150 to 200 mm depth (or  
543 as otherwise approved by the appropriate supervising consultant representative). When the  
544 soil is dry, light compaction shall be provided, such as by one pass by a tracked excavator or  
545 small bulldozer. When the soil is moist or wet, then it should be harrowed using standard  
546 agricultural implements, or raked by hand, to form a fine tilth. No topsoil operations shall be  
547 undertaken while it is muddy or when the subgrade is saturated. The running of vehicles over  
548 newly spread topsoil shall be minimised to avoid excessive compaction.

549 Where embankments are being constructed (such as part of a permanent drainage system),  
550 the slope, ground and climatic conditions may reduce the ability of the topsoil layer to bind  
551 well with the subsoil layer. In these situations, offsetting lifts of material to create an uneven  
552 surface prior to topsoil placement should be considered.

553 Where subsoil is available, its use should be considered as part of the rehabilitation process.  
554 Where the substrate has the characteristics of subsoil, particularly in terms of allowing root  
555 penetration and plant growth (i.e. similar physical and chemical properties to natural subsoil  
556 in a similar site), then it may be appropriate only to add topsoil and not to expend energy and

557 resources in re-laying subsoil unnecessarily. Available subsoil may be better retained for the  
558 rehabilitation of sites with very poor substrate.

559 Immediately prior to spreading any available subsoil, the subgrade should be loosened by  
560 disking or scarifying to a depth of at least 150 mm to ensure bonding between the layers.

561 Subsoil shall be distributed uniformly to a minimum compact depth of 500 mm and  
562 compaction achieved using a few passes by a tracked machine. No soil shall be spread while  
563 it is muddy or when the subgrade is saturated. Any irregularities in the surface shall be  
564 corrected that result from stockpiling or other operations, to prevent the formation of  
565 depressions or water pockets.

#### 566 **D.2.6.6 Placement of Topsoil on Engineered Structures**

567 The placement of topsoil on engineered structures shall be at the discretion of the appropriate  
568 supervising consultant representative. In some cases, especially on embankment slopes, it is  
569 better to plant vegetation straight on to the earthfill structure rather than to attempt to stabilise  
570 a veneer of topsoil. This is because unconsolidated topsoil can become saturated in heavy rain  
571 due to the discontinuity below it to a compacted and impermeable substrate; in extreme  
572 conditions this can lead to a small mud flow of the topsoil. In some cases topsoil may be  
573 specified in porous bags, especially at the toe of a slope, to allow vegetation to grow, while  
574 the bags provide temporary stability and protection from scour erosion.

#### 575 **D.2.6.7 Rehabilitation of Topsoil**

576 Simply replacing topsoil back on top of an altered surface does not constitute rehabilitation.  
577 In the best cases, following topsoil placement, the only rehabilitation required is revegetation  
578 using planted grasses, as described in the next sub-section, and tending for a period of a few  
579 years to allow the processes of nature to aid the rehabilitation process. But in certain cases  
580 other work may be needed to ensure that the topsoil returns to a good condition. After  
581 stockpiling for periods of more than about six months, the topsoil characteristics will have  
582 altered so that only the surface 300 mm or so retains real topsoil characteristics, and the lower  
583 700 mm or so starts to have characteristics more like subsoil.

584 In many site rehabilitation cases it is difficult to establish the right drainage regime for the  
585 soil. Sometimes it may be necessary to alter the compaction or the drainage system to achieve

586 this. Compaction can be reduced by ripping or ploughing the soil, or increased by running  
587 machines over it. Frequently the problem lies in the discontinuity between a relatively loose  
588 replaced topsoil and the hard substrate below, which does not have the same physical  
589 characteristics of naturally occurring subsoil, or the same physical continuity with the topsoil.  
590 Therefore the surface conditions and drainage network in a re-engineered site may need to be  
591 quite different from what was there before disturbance.

592 Compost or manufactured organic soil amendments can be added to topsoil to increase its  
593 organic content and assist in rebuilding soil micro-organism populations. Undecomposed  
594 organic materials such as wood bark or fibre, grass hay or grain straw should not be mixed  
595 into topsoil unless nitrogen fertiliser is included (organic material uses nitrogen to break down  
596 and decompose the fibres). Compost derived from livestock or green urban waste (cut brush)  
597 is far superior to non-composted manure or wood fibre.

598 Some borrow areas may be utilised to introduce improved agricultural methods with  
599 members of the local communities. If this is done, an agreement may be made to take the area  
600 under the control of the livelihoods restoration component of the Resettlement Action Plan  
601 before rehabilitation is complete.

#### 602 **D.2.6.8 Revegetation of Topsoil**

603 All topsoil surfaces must be revegetated as soon as there is enough moisture at the start of the  
604 rainy season to allow plant growth. In many cases, the seeds and residual plant parts in the  
605 topsoil will grow, giving the initiation of natural revegetation. However, some areas of topsoil  
606 require special treatment. These include, but may not be limited to, the following.

- 607 • Alongside drains.
- 608 • Alongside roads.
- 609 • On slopes above water courses.
- 610 • On steep slopes.
- 611 • Around the crest of cut slopes.

612 In these locations, intensive revegetation measures are essential. The appropriate supervising  
613 consultant representative will make a specific instruction as to the extent of revegetation on

614 site, but as a general rule, at least four lines of planted grasses are required on all peripheries  
615 of topsoil stockpiles and rehabilitated borrow areas.

616 The use of hydro-seeding or other mechanical applications of seeds or plants is not permitted.  
617 This is because abundant native species of grass are available locally, and their planting by  
618 hand is an excellent way to increase local employment opportunities. The main revegetation  
619 technique is therefore the use of planted grass slips (see appropriate guideline). Other  
620 revegetation techniques that may be required are as follows.

- 621 • Brush layers, made of hardwood cuttings of certain shrubs or small trees. These can  
622 be used to create stronger, more substantial barriers to erosion where run-off tends to  
623 be concentrated. This technique is described in a separate guideline below.
- 624 • Tree or shrub seedling planting. Plants raised from seed in a nursery are planted on to  
625 a site to start the process of restoration of the forest vegetation community. This  
626 technique is described in a separate guideline below.

#### 627 **D.2.7 Constructing and Maintaining Earth Access Tracks**

628 Earth tracks shall be aligned to follow the best possible route. Wherever feasible, they shall  
629 avoid steep slopes and swamps. The amount of cut and fill shall be minimised.

630 The adequate provision of culverts shall be ensured, both for capacity and frequency, and  
631 scour protection shall be provided as necessary. Catch pits shall be used to capture sediment  
632 at pipe culvert inlets and turnouts. The routine emptying of the catch pit sumps shall be  
633 included in the maintenance schedule.

634 Soil conservation measures shall be provided as appropriate, including grassed and vegetated  
635 cut and fill slopes, grassed longitudinal road drains, check dams in drains for shallow  
636 gradients, and concrete or masonry lined drains for steep gradients.

637 The creation of flattening gradients along roadside drains shall be avoided. A reduction in  
638 gradient causes sediment to settle and block the drain: this particularly applies in dips  
639 approaching an outfall to a watercourse because the gradient of the vertical alignment of the  
640 road flattens here. As far as it is possible ditches shall be formed with a constant or increasing  
641 gradient moving downstream.

642 Silt traps shall be used where required on drainage outfalls.

643 When carrying out machine maintenance, particularly when a grader is used, it must be  
644 ensured that vegetated drains are left intact, and silt is removed from the drains using an  
645 appropriate ditching machine or by hand.

646 Graders and dozers must not be used to push waste material on to surrounding land  
647 (windrow). This material shall be recycled on to the track or disposed of at a suitable waste  
648 dump.

649 Routine environmental monitoring shall be undertaken of the water quality downstream of  
650 all earth tracks.

## 651 **D.2.8 Selection of Revegetation Techniques for Erosion Prevention**

### 652 **D.2.8.1 Selection of Technique**

653 Revegetation techniques should normally be used to cover bare soil slopes, to begin the  
654 process of restoring the natural habitat, to control soil erosion or to stabilise or prevent shallow  
655 landslips (i.e. where the depth to the sliding surface is shallow, up to 0.5 m).

656 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,

673 horizontal lines of grass planted at intervals across a field can be used to avoid loss of soil and  
674 to help conserve moisture, as a standard soil conservation measure.

675 Diagonal lines are used on poorly drained materials on steep slopes (35° to 50°) where an  
676 increase in infiltration can lead to liquefaction of the soil. It is also useful on damp sites, where  
677 moisture needs to be shed.

678 **Timing.** Planting work should only be done in the wet season. The slope should be moist  
679 when the planting is done. If it does not rain within 24 hours of the work being done, water  
680 the plants every day until it does rain. On small sites this may be done by hand but on large  
681 sites it will require a water truck and spray cannon.

682 **Spacing of plants.** Line spacing depends largely on the steepness of the slope.

- 683 • Within rows: plants at 100-mm centres.
- 684 • Row spacings: rows at 500-mm centres for diagonal lines;
- 685 • For contour lines:
  - 686 ○ slope < 30°: 1,000 mm;
  - 687 ○ slope 30-45°: 500 mm;
  - 688 ○ slope > 45°: 300 mm.

689 **Materials.** Grass slips are small sections of a grass plant, made by splitting up a large clump.  
690 The stems are cut down to a height of 100 to 200 mm and the roots cut back to 40 to 80 mm.  
691 There should be 2 or 3 stems per slip. The clumps must be obtained locally (i.e. from similar  
692 terrain within 15 km of the planting site) where their loss will not cause soil erosion to start.  
693 The source location should have similar environmental characteristics (altitude and soil  
694 particularly) to the destination site. The material must be between 6 and 18 months old. Grass  
695 clumps must be dug up and brought to site on the same day that the slips are made and  
696 planted, and kept cool and moist.

697 **Construction.** Prepare the site well in advance of planting. Slopes should be trimmed to an  
698 even grade. Trimming should achieve a slope that meets the appropriate design for the  
699 material. If there is no design, it should be cut or finished with a straight profile, without  
700 undulations that give over-steep portions that are steeper than the grade appropriate for the  
701 material.

702 After slope trimming, remove all debris and either remove or fill in surface irregularities so  
703 that there is nowhere for erosion to start. If the site is on backfill material, it should be  
704 thoroughly compacted, preferably when moist.

705 Always start grass planting at the top of the slope and work downwards.

706 Mark out the lines with string, using a tape measure and spirit level. Make sure the lines run  
707 exactly as required by the specification.

708 Split the grass plants out to give the maximum planting material. Trim off long roots and cut  
709 the shoots off at about 100-mm above ground level. Wrap the plants in damp hessian to keep  
710 them moist until they are planted.

711 With a planting bar (typically a 500-mm section of re-bar with a flattened end), make a hole  
712 just big enough for the roots. Place the grass into the hole, taking care not to tangle the roots  
713 or have them curved back to the surface. Fill the soil in around them, firming it gently with  
714 your fingers. Take care to avoid leaving an air pocket by the roots.

715 If it looks dry and there is no prospect of rain for a day or two, consider watering the plants  
716 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.



## 717 **D.2.10 Revegetation Using Hardwood Cuttings (Brush Layers)**

718 **Function.** Woody (or hardwood) cuttings are laid in lines across the slope, usually following  
719 the contour. Brush layers protect and reinforce a slope in weak soil. They catch debris and  
720 provide a strong and low-cost barrier to erosion, especially on debris slopes, however loose.

721 **Sites.** This technique can be used on a wide range of sites up to about 45°. It is particularly  
722 effective on debris sites, fill slopes and high embankments.

723 **Timing.** Planting work should only be done in the wet season. The slope should be moist  
724 when the planting is done. If it does not rain within 24 hours of the work being done, water  
725 the plants by hand every day until it does rain.

726 **Spacing.** Spacing between brush layers depends on the steepness of the slope. The following  
727 spaces should be used.

- 728 • Slope less than 30° 2-m interval;
- 729 • Slope 30 to 45° 1-m interval.

730 Within the brush layers, cuttings should be at 50 mm centres, in the double layer described  
731 below.

732 **Materials.** Cuttings made from woody material of shrubs or trees that coppice well. They  
733 must be obtained locally (i.e. within 3 km of the planting site). The material must be between  
734 6 and 18 months old. Cuttings shall be 20 to 40 mm in diameter and 450 to 600 mm long. When  
735 taking the cuttings, cut the top at right angles to the stem and the bottom at 45° to make it  
736 clear as to which way they should be inserted. Cuttings must be taken the same day that they  
737 are to be planted, and kept cool and moist.

738 **Construction.** Prepare the site well in advance of planting. Slopes should be trimmed to an  
739 even grade. Trimming should achieve a slope that meets the appropriate design for the  
740 material. If there is no design, it should be cut or finished with a straight profile, without  
741 undulations that give over-steep portions that are steeper than the grade appropriate for the  
742 material.

743 After slope trimming, remove all debris and either remove or fill in surface irregularities so  
744 that there is nowhere for erosion to start. If the site is on backfill material, it should be  
745 thoroughly compacted, preferably when moist.

746 Using string, mark the lines to be planted, starting 500 mm from the base of the slope.

747 Always install brush layers from the bottom of the slope, and work upwards. Form a small  
748 terrace, with a 20% fall back into the slope. The terrace should be 400 mm wide. If you are  
749 brush layering a gravel-filled road embankment you should lay a 50-mm thick layer of soil  
750 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.

772 **Timing.** Planting work should only be done in the wet season. The slope should be moist  
773 when the planting is done. If it does not rain within 24 hours of the work being done, water  
774 the plants by hand every day until it does rain.

775 **Spacing.** The spacing of plants is important. The main considerations are cost and the speed  
776 with which a full cover is required. In typical forestry sites, a spacing of 2 × 1 metres is normal,  
777 requiring 2,500 plants per hectare. However, in revegetation sites a spacing of 1 × 1 metre is  
778 usually necessary, requiring 10,000 plants per hectare. Plants should be planted in off-set rows  
779 unless a different pattern is needed for specific erosion control or landscaping effects.

780 **Construction.** Prepare the site well in advance of planting. Remove all debris and remove or  
781 fill surface irregularities. If the site is on backfill material, thoroughly compact it, preferably  
782 when it is moist. Cut all weeds.

783 If possible, dig pits for the shrubs or trees in advance of the planting programme, but refill  
784 them the same day. Pits should be 300-mm deep and 300-mm in diameter if this is possible  
785 without causing excessive damage to the slope.

786 When the ground is wet enough to support reasonable growth, plant out good quality  
787 seedlings from a nursery. The bigger the hole made, the better it is for the plant; but there  
788 must be a compromise between helping the plant and avoiding excessive disturbance to the  
789 slope.

790 Carefully remove the pot. If it is a polythene bag, do this by slicing it down the side with a  
791 razor blade. Take care not to cut the roots.

792 Plant the seedling in the pit, filling the soil carefully around the cylinder of roots and soil from  
793 the pot. Ensure there are no cavities. Firm the soil all around the seedling with gentle foot  
794 pressure.

795 If available, mix a few handfuls of well-rotted compost with the soil around the roots when  
796 you are backfilling the hole. Remove any weeds around the plant. Add mulch around the  
797 seedling, but with a slight gap so that it does not touch the stem.

798 **Main advantages.** Planting shrubs and trees reinforces and restores a slope by establishing a  
799 community of larger plants.

800 Main limitations. Seedlings take about 5 years (or more) to provide a canopy, produce useful  
801 materials or contribute significantly to slope strengthening. Care and protection are required  
802 in the first three years.

## 803 **D.2.12 Management of Waste**

### 804 **D.2.12.1 Waste Management in General**

805 The principles of pollution prevention includes the following key messages.

- 806 • Everyone should minimise waste production to save money and resources.
- 807 • A review of the options for minimising waste will usually help to find ways to save  
808 money on raw materials and waste disposal costs.
- 809 • Reuse your waste or buy in products that can be reused many times – it will save  
810 money in the long term.
- 811 • Recycle as much waste as possible.

812 A waste management strategy is to be managed on the principles of reduction, recovery,  
813 recycle and reuse. Recycling and waste reduction campaigns shall be conducted whenever  
814 there is evidence of unnecessary waste generation.

815 A distinction will be made between waste materials that have a potential commercial value –  
816 which shall be classed as assets – and those with no value – which shall be considered non-  
817 assets.

818 Waste materials shall be collected and segregated at the source. Care shall be taken to avoid  
819 spills during storage and handling. Workers must use appropriate personal protective  
820 equipment when handling all forms of waste.

821 Full records shall be maintained of the types and quantities of waste generation, storage,  
822 transfers and disposals.

823 Landfill sites should be selected with care and the location and details approved by the  
824 Environmental Protection Agency. They should be in areas that are not prone to slippage,  
825 cannot leach to surface water and groundwater, and are a suitable distance (at least 400  
826 metres) from settlement. They should be located down gradient of any water supply  
827 boreholes. The base of a landfill site should be lined with an impermeable membrane and

828 seepage water piped to a sewage treatment plant. As it is filled, the site should be  
829 progressively compacted and buried with soil. Always ensure that landfill sites are in secure  
830 compounds.

831 **D.2.12.2 Waste Materials that are Assets**

832 **Topsoil.** Waste topsoil generation should be minimised by disturbing the soil only where it is  
833 necessary to do so. Topsoil is to be removed carefully, by scraping it off in thin layers. It will  
834 be stored in shallow stockpiles, which must not be compacted. Stockpiles shall be planted  
835 with grass to prevent erosion and maintain soil quality. Once the work has been completed,  
836 the topsoil must be returned to rehabilitated areas.

837 Under no circumstances shall topsoil be sent to spoil tips, allowed to erode or be contaminated  
838 with other substances. Traffic must not be allowed to run on topsoil, causing it to become  
839 compacted, either in its natural state or in stockpiles. Topsoil is the source of almost all food,  
840 and its protection means the protection of life itself.

841 **Scrap metals.** Metallic objects and components should be re-used as far as it is practicable and  
842 safe to do so. Scrap items shall be segregated and kept in safe, dry locations, such as shipping  
843 containers. Aluminum items, especially used drink cans, shall be crushed to reduce storage  
844 volume. Once accumulated, batches of scrap metals shall be sold to an authorised dealer.

845 **Used commercial and industrial machines (vehicles, trucks, generators etc.).** Wastage  
846 should be reduced by using machines for their full design life, and repairing rather than  
847 replacing them. Once defunct, they should be stripped of re-usable parts and stored securely,  
848 in a bunded and covered area. Machines shall be decommissioned thoroughly, all fuel and  
849 lubricants removed, moving parts degreased and components with valuable materials such  
850 as copper and lead removed for separate disposal as described above. Remaining usable scrap  
851 shall then be sold as an asset, as described above.

852 Under no circumstances shall machines be placed into landfill sites, allowed to be stolen by  
853 informal scrappers or sold to unauthorised companies, uncertified small enterprises or  
854 individuals who might re-use their components without proper disposal of unwanted parts.

855 **Used oil drums.** Used oil drums shall be stored securely, in a bunded and covered storage  
856 area. They shall be recycled for waste oil or other appropriate uses. They are not to be sold to

857 unauthorised companies or uncertified small enterprises. If they need to be cleaned, they shall  
858 be washed in an area with a full oil separator drainage system.

859 **D.2.12.3 Non-asset Waste**

860 **Vegetation.** The cutting of vegetation shall be minimised by only cutting plants or plant parts  
861 that are in the way of approved activities. This means plants that are in the direct area required  
862 for access tracks, quarry areas or other purposes. Vegetation shall be cut into small pieces and  
863 stacked beside the working area to decompose slowly. It shall not be burnt, either standing or  
864 cut.

865 Plantation trees and agricultural plants shall not be cut without following the procedures  
866 given in the Resettlement Action Plan.

867 **Spoil (overburden).** Damage to land and wasted energy shall be minimised by removing spoil  
868 only where it is essential to do so. Spoil shall be placed only in designated and approved spoil  
869 tip sites, which must be prepared in advance. Preparation shall include the installation of  
870 drainage blankets and slope toe retaining walls as necessary to ensure permanent stability.  
871 Spoil shall be placed in shallow layers, not more than 2 metres in thickness, compacted and  
872 shaped as they are developed. Erosion protection shall be provided as necessary to ensure  
873 that there is no sediment washed into water courses; this will usually be done using planted  
874 grasses. The water regime and stability of spoil tips shall be monitored and action taken as  
875 required to resolving any problems that are identified. Spoil tips will be kept away from  
876 watercourses and seasonal drainage channels unless adequate through-flow has been  
877 provided. The use of any spoil tip will be discontinued when the designated area has been  
878 used up.

879 **Contaminated soils.** The contamination of soil will be avoided by adhering to the hazardous  
880 materials storage and handling guidelines. Any soil that has become contaminated will be  
881 excavated and removed to a level and secure area, surrounded by an earth bund. The  
882 contaminated soil shall be treated fully using an approved bioremediation agent. The area  
883 affected will be fully rehabilitated, either using appropriate topsoil from a stockpile, or by  
884 replacing the remediated soil as soon as it has been decontaminated. This process will be used  
885 in every case where there has been any spill of hydrocarbons or other chemicals. Under no  
886 circumstances will contaminated soils be dumped untreated.

887 **Used lubricants.** Waste from excessive used oils shall be reduced by using lubricants for their  
888 full design life. Used lubricants shall be stored securely, in strong, leak-proof drums in either  
889 a double-walled container or in a bunded and covered storage area. Spill kits will be  
890 maintained ready and serviceable in all storage and handling areas, and carried in  
891 transporting vehicles. Used oil may be sold to large rubber factories for use in the boilers, or  
892 to disposal companies with valid certification from the Environmental Protection Agency.  
893 Under no circumstances may any form of used lubricant be poured away, either into the soil  
894 or into water, or sold to chain saw operators.

895 **Oily water from workshops and fueling stations.** Industrial oil-water separators shall be  
896 installed as part of the drainage system at every mechanical workshop and every fueling  
897 station. Drainage shall be arranged such that all spillages and rainwater drain through the  
898 separator. All separators shall be maintained according to the manufacturer's instructions.

899 **Used grease.** Waste from excessive used grease shall be reduced by using it for its full design  
900 life. Used grease shall be stored securely, in strong, leak-proof drums in a bunded and covered  
901 storage area. Grease shall be incinerated at a high temperature in a proper industrial  
902 incinerator.

903 **Used engine filters (fuel and oil filters).** Waste from excessive used filters shall be reduced  
904 by using them for their full design life, and if possible ensuring this is reached by appropriate  
905 cleaning. Used filters shall be stored securely, in strong, leak-proof drums in a bunded and  
906 covered storage area. Used filters may be sold to disposal companies with valid certification  
907 from the Environmental Protection Agency. Alternatively, filters may be crushed to remove  
908 residual fuel or oil, and incinerated at a high temperature in a proper industrial incinerator.

909 **Used hazardous containers (paint tins, pesticide containers, etc).** Used containers shall be  
910 stored securely, in strong, leak-proof drums in a bunded and covered storage area. Used paint  
911 tins and pesticide containers shall be crushed as far as possible and sent to an approved  
912 landfill site. Under no circumstances shall containers or any parts of them be sold to  
913 unauthorised companies or uncertified small enterprises. Containers must not be washed in  
914 open water courses or areas that do not drain to a proper sewage treatment plant.

915 **Used tyres.** Wastage shall be reduced by using tyres for their full design life (usually until the  
916 tread is less than 1.2 mm for road vehicles). Used tyres shall be stored securely, in a recognised

917 storage area. They may be sold to companies that will recycle them for non-road uses. Where  
918 there is doubt about the future use of tyres, they should be slashed before sale to make them  
919 useless for road vehicles. Tyres should also not be sold to people who will use them for  
920 quarrying, since this involves air pollution from low temperature burning. Tyres may also be  
921 chipped and sent to approved companies that can burn them in furnaces at high temperatures  
922 or sent to an approved landfill site.

923 **Used batteries (12-volt lead-acid and gel-filled batteries).** Where possible, batteries should  
924 be purchased under a buy-back policy from the suppliers to avoid the storage and handling  
925 of waste batteries. Wastage should be minimised by using batteries for their full design life,  
926 servicing and recharging them where feasible. Used batteries shall be stored securely, in  
927 strong, leak-proof containers in a bunded and covered storage area. Batteries containing lead  
928 shall be sold for recycling by companies with valid certification from the Environmental  
929 Protection Agency. Under no circumstances shall batteries be sold to unauthorised  
930 companies, uncertified small enterprises or individuals who might re-use their components  
931 without proper disposal of acid or other unwanted parts.

932 **Used personal protective equipment (PPE).** Wastage should be reduced by using PPE for its  
933 full design life. Used PPE should be stored securely, in strong, leak-proof containers in a  
934 bunded and covered storage area. PPE shall be sorted into chemically contaminated (e.g.  
935 overalls and gloves stained with creosote from handling rail ties) and non-contaminated  
936 items. Chemically contaminated PPE shall be incinerated at high temperature in an industrial  
937 incinerator or, if this is not possible, in a purpose-dug pit. Residues shall be placed into an  
938 approved landfill site. Non-contaminated PPE shall be placed into an approved landfill site.

939 **Used workshop clothing and rags (i.e. oily waste).** Wastage should be reduced by using  
940 clothing and rags for as long as it is safe to do so. Oily waste should be stored securely, in  
941 strong, leak-proof containers in a bunded and covered storage area. It shall be incinerated at  
942 high temperature in an industrial incinerator or, if this is not possible, in a purpose-dug pit.  
943 Residues shall be placed into an approved landfill site.

944 **Household waste.** Awareness programmes shall be undertaken to encourage waste  
945 minimisation. The use of throw-away plastic bags shall be discouraged inside the concession.  
946 Households shall be given the necessary waste bins to segregate their waste into aluminium

947 (e.g. foil and drink cans), steel (e.g. food tins), glass, plastics, cardboard, compostable and  
948 other waste. The segregated waste shall be collected for disposal as follows.

- 949 • Aluminium, steel, glass, plastics and cardboard shall be sold for recycling by  
950 companies with valid certification from the Environmental Protection Agency.
- 951 • Compostable waste shall be composted and, once fully decomposed and sterile,  
952 spread to land as fertiliser or mulch.
- 953 • The remaining waste shall be sent to an approved landfill.

954 **Food waste.** Wastage shall be minimised by ensuring that canteens do not over-cook. Canteen  
955 staff shall be encouraged to use uneaten food for themselves and their families if it is still safe.  
956 Arrangements shall be made for farmers of domesticated animals to collect food waste for  
957 feeding to their stock. Any unused vegetable material shall be composted and unused animal  
958 products sent to an approved landfill site. All food waste shall be stored and transported in  
959 containers that are proof against dogs, crows and rodents.

960 **Clinic waste.** All biomedical waste shall be stored in appropriate sealed containers. Wastes  
961 shall be segregated in the hospital or clinic into different categories, in the appropriate colour  
962 bins; it is important to ensure staff involved in the handling of waste are equipped with  
963 appropriate PPE. Biomedical waste shall be incinerated at a temperature of 800 to 1600°C in  
964 an approved specialist incinerator. Incinerator ash and residues shall be placed into an  
965 approved landfill site. Only appropriately trained staff shall handle hospital wastes and  
966 operate incinerators.

967 **Used Domestic Machines (refrigerators, air conditioners, washing machines etc.) and IT**  
968 **Equipment (computers, printers, UPS etc.).** Wastage shall be reduced by using machines for  
969 their full design life, and repairing rather than replacing them. Used machines shall be stored  
970 securely, in a bunded and covered storage area. Re-usable parts should be stripped out for  
971 repairing other equipment. Machines shall be sold for recycling by companies with valid  
972 certification from the Environmental Protection Agency. Under no circumstances shall  
973 machines be sold to unauthorised companies, uncertified small enterprises or individuals who  
974 might re-use their components without proper disposal of unwanted parts.

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975 **D.2.12.4 Recording Hazardous Waste Management and Disposal**

976 Workshops, operational departments and contractors are required to record the  
977 accumulation, storage and transfer of potentially hazardous waste (including materials that  
978 may be used for environmentally unsound purposes after transfer). This shall include, but not  
979 necessarily be limited to, the following:

- 980 • Used commercial and industrial machines (vehicles, trucks, generators, etc.);
- 981 • Used lubricants;
- 982 • Oily water of any kind;
- 983 • Used engine filters (fuel and oil filters);
- 984 • Used hazardous containers (paint tins, pesticide containers, etc.);
- 985 • Used tyres;
- 986 • Used batteries (12-volt lead-acid and gel-filled batteries); and
- 987 • Hospital waste (biomedical and clinical).

988 The unit generating the waste must keep a Waste Materials Record Book. This must contain  
989 as a minimum, full records of the following:

- 990 • Weekly or monthly estimate of the quantities of each type of hazardous waste;
- 991 • The location of storage and any special storage measures employed;
- 992 • Each disposal of waste, including the type, quantity, date and location of each transfer;
- 993 • The destination of all disposed waste, including the details of any waste management  
994 contractor, the method of transport and the point of transfer of responsibility;
- 995 • Where a waste contractor is involved, a copy or details of the contractor's  
996 Environmental Permit for waste handling and disposal; and
- 997 • Any accident or loss involving hazardous or potentially hazardous waste materials.

998 Waste Materials Record Books may be inspected at any time as part of environmental audits.

999 **D.2.13 Storage, Dispensing and Disposal of Hazardous Materials**

1000 The contractor shall take full responsibility for the use and effects of any hazardous materials  
1001 that are required for operations that are part of the project. The contractor is further  
1002 responsible for complying with the supervising consultant's policies and procedures as may

1003 from time to time be communicated, and will ensure that all aspects of the spill clean-up plan  
1004 are followed in the event of a spill (see appropriate guideline).

1005 All materials that are potentially hazardous to the environment must be stored or disposed of  
1006 in accordance with this guideline. Hazardous materials include, but are not limited to,  
1007 substances such as fuels, lubricants, preservatives, herbicides, pesticides, explosives, cement,  
1008 lime, slurry clays, bentonite, catalysts or other chemicals, in solid or liquid form, or sewage  
1009 and foul waste water.

1010 Approval by the supervising consultant for the use, storage and disposal of hazardous  
1011 materials shall not reduce the contractor's responsibility to prevent all leaks and spillages, nor  
1012 his liability to remedy the damages which may be caused should such incidents occur.

1013 **Prevention:** Every effort will be made to prevent spills and leaks of any kind. All hazardous  
1014 materials will be stored in appropriate ways, in line with international safety practices. All  
1015 operators and supervisors will be trained in appropriate inspection procedures and checks.  
1016 All problems detected during inspection must be passed on to the relevant superior officer.  
1017 Appropriate repairs will be made immediately.

1018 **Storage:** Hazardous materials shall be stored at least 400 metres from the sea, a water course,  
1019 spring, swamp, drain or well, and at least 400 metres from a dwelling. Storage areas shall have  
1020 barriers and impervious surfaces preventing leakages of spilt material outside the storage area  
1021 or into the underlying soils. They shall be protected from rainfall and secure against intrusion  
1022 by people other than the contractor's personnel.

1023 **Fuelling operations:** Fuel tanks will be bunded: i.e. there must be secondary containment for  
1024 the full capacity of the tank in the event of a leak from the tank. A trained attendant will  
1025 always be in control of fuelling nozzles during refuelling operations. Designated fuelling  
1026 areas will be bunded (diked) and lined to capture any unexpected releases of fuel. Oil and  
1027 lubricant dispensing drums will have spill containment trays and liners, or both, to catch and  
1028 contain material.

1029 **Disposal:** All used oils, lubricants, solvents, and filters will be recycled whenever possible.  
1030 Where excess quantities of a hazardous material need to be disposed of, then the contractor  
1031 shall prepare a disposal plan and seek the approval of the supervising consultant before

1032 implementing it. In general, hazardous solids that need to be disposed shall be buried in a  
1033 location proposed by the contractor and approved by the supervising consultant. Disposal  
1034 sites must be situated at least 400 metres from any dwelling and at least 400 metres from a  
1035 water body or water course. They should not be on cultivated land. Wherever possible, they  
1036 should be on a permeable but not sandy soil. Holes shall be a minimum of 2 metres deep when  
1037 first excavated and all materials must be buried under at least 1 metre of soil.

1038 **Sewage disposal:** Sewage and foul waste water shall be disposed into a covered underground  
1039 septic tank. If this is a permanent feature, then it shall have an underground soakaway so that  
1040 water does not seep on to the surface. All parts of the system shall be at least 100 metres from  
1041 a water body or water course. The contractor shall present his plans for such facilities to the  
1042 supervising consultant for approval prior to their implementation.

1043 **Fuel contamination of water:** Where there is a significant risk of water becoming contaminated  
1044 with any form of fuel, such as in port areas, then appropriate containment equipment (e.g.  
1045 floating bunds or barriers, absorbent pads etc.) will be kept in readiness at fuel dispensing  
1046 areas to assist in cleaning up any spills that may occur.

1047 **Cleaning up spills:** In the event of a spill or release of any material, the spill will be stopped  
1048 and the incident reported to the nearest representative of the supervising consultant. The  
1049 substance will then be cleaned up immediately, disposed of in an approved manner and the  
1050 contaminated environment cleaned to the satisfaction of the supervising consultant. A  
1051 separate guideline covers this in detail.

#### 1052 **D.2.14 Cleaning-up of Pollution by Hazardous Materials**

1053 This guideline covers the action to be taken in the event of the leakage or spillage of any  
1054 environmentally hazardous material, such as fuel, oil, chemicals of any kind, or drilling slurry,  
1055 into either a water course or standing water body, or into soil. It contains the minimum details  
1056 that must be included in spill clean-up plans of all contractors to the supervising consultant,  
1057 and any Sub-contractors that may be engaged by the contractors. Before bringing any  
1058 hazardous materials to the site, the contractor must prepare a spill clean-up plan in accordance  
1059 with this guideline and gain the approval of the supervising consultant.

1060 The purpose of a spill clean-up plan is to provide guidelines to prevent environmental  
1061 contamination, and the procedures to be followed should hazardous materials enter the  
1062 environment. It applies to all working areas of the project.

1063 The contractor must prepare on-site spill clean-up plans for all hazardous materials to be used  
1064 on the site. This is a regulatory requirement of the Government of Liberia, and the minimum  
1065 details that must be in the plan are as follows: (a) how incidents will be contained and  
1066 controlled so as to minimise the effects and to limit danger to persons, the environment and  
1067 property; (b) how the necessary measures will be implemented to protect people and the  
1068 environment; (c) a description of the actions that will be taken to control the conditions and  
1069 to limit their consequences, including a description of the safety equipment and resources  
1070 available; and (d) arrangements for training staff in the duties they will be expected to  
1071 perform. The emergency plan shall be simple and straightforward.

1072 The following principles must apply in the plan: (a) the source of the leak or spill must be  
1073 stopped immediately it is discovered; (b) the alarm must be raised throughout the site; (c)  
1074 work on the site must be stopped and all available resources directed into resolving the  
1075 problem; (d) emergency measures must be taken to contain all remaining material; (e) where  
1076 appropriate, measures must be taken to neutralise hazardous substances; (e) the supervising  
1077 consultant representative shall be informed immediately; and (f) site-specific and material-  
1078 specific details will be given for the disposal of contaminated soil and water, and mitigation  
1079 of the damage caused.

1080 The contractor shall ensure that all site supervision staff are aware of the plan and capable of  
1081 implementing it. In the event of a leak or spillage, the contractor shall bear all liability whether  
1082 the plan is implemented or not.

1083 Spill response procedure: Every spill clean-up plan must contain, as a minimum, details of the  
1084 following emergency procedures:

1085 The person who discovers any spill must notify fellow workers and inform the supervisor that  
1086 a spill has occurred. If anyone is injured or in danger, they must be rescued if it is safe to do  
1087 so, and appropriate rescue and medical assistance called if required. All site staff must be  
1088 informed if there is a risk of fire or explosion, or of a collapse of infrastructure, and in these  
1089 cases all unnecessary personnel must be evacuated to a safe location.

1090 All staff will react promptly to all spills, no matter how insignificant they may appear.  
1091 Whatever resources are available will be diverted immediately to assist in resolving the spill.  
1092 The supervising consultant's representative will both be notified immediately if any spill or  
1093 release occurs, however small. As much information as possible should be provided about the  
1094 spill location, type of material, approximate quantity, and extent of damage.  
1095 The area surrounding the spill will be secured and contained to minimise additional  
1096 contamination, for example by building an earth bund or the deployment of floating bunds.  
1097 Emergency containment should be started as soon as possible. This will give time for a full  
1098 pollution-control strategy to be designed, agreed and implemented.

## 1099 **D.2.15 Prevention of Pollution from Refuelling Facilities**

### 1100 **D.2.15.1 General**

1101 Oil is the most common water pollutant, with the potential to harm watercourses and  
1102 groundwater. In addition, certain fuels, such as petrol, are highly flammable and are tightly  
1103 regulated for safety reasons. This guidance is applicable to all refueling facilities and should  
1104 be consulted regardless of the type of facility.

### 1105 **D.2.15.2 Types of Drainage System**

1106 Clean water. All clean, uncontaminated rainwater should be channeled to:

- 1107 • a surface water drainage system;
- 1108 • a combined drainage system downstream of the oil separator;
- 1109 • directly to a local watercourse or soak-away.

1110 This includes roof water and uncontaminated drainage from those areas of the site where  
1111 vehicles are not stored, repaired, refueled or washed. Such discharges may require prior  
1112 permission from the EPA or the local sewer provider.

1113 Contaminated water. The entire area where fuel is delivered, stored and dispensed should be  
1114 isolated from the surface water drainage system, open ground or other porous surfaces. This  
1115 can be achieved using drainage grids, gullies or kerbs in conjunction with surfaces  
1116 impermeable to the products used. Potentially contaminated water and spills should be  
1117 directed through an oil separator and prevented from seeping into the soil and groundwater

1118 below the site. The separator should be of an adequate size to serve the surface area catchment  
1119 of the site.

1120 Sustainable drainage systems. The use of sustainable drainage systems (SUDS) should be  
1121 considered. SUDS such as constructed wetlands or reed beds may offer an environmentally  
1122 sound alternative to traditional methods of treating drainage effluent. Wetland or equivalent  
1123 technology can be used for a variety of wastewater treatment purposes at refueling facilities.  
1124 It may also be suitable as a replacement for on-site separators for oily water run-off, provided  
1125 the system is compatible with local groundwater conditions. Wetlands systems can offer an  
1126 acceptable level of environmental protection provided they are properly designed, installed  
1127 and maintained. In some situations, they may provide better environmental protection than  
1128 conventional drainage systems.

1129 Washing activities. All washing and cleaning operations, including the washing of all vehicles  
1130 or plant, should be carried out in a designated area clearly marked on the ground and in any  
1131 plans. The cleaning area should be isolated from both the surface water drainage system and  
1132 unmade ground or porous surfaces (e.g. using drainage grids, gullies or kerbs). Wash water  
1133 should be re-circulated whenever possible. Otherwise it should drain to, or be disposed of,  
1134 via the foul sewer (where available).

1135 Cleaning agents such as detergents (including biodegradable ones) should never be allowed  
1136 to enter the surface water system or to soak into groundwater unless specifically permitted  
1137 after appropriate treatment. They should not enter oil separators because they reduce their  
1138 effectiveness (the oil will be dispersed and washed through).

1139 Training in dealing with emergencies. Staff should be trained to deal with an environmental  
1140 incident. Set up a system of written training records and make these available for inspection.  
1141 Training should include a background to environmental sensitivities around the site and a  
1142 formal emergency procedure that details actions to be taken in the event of:

- 1143 • a spillage;
- 1144 • a fire;
- 1145 • a collision with equipment;
- 1146 • odours being detected off-site;
- 1147 • a suspected leak being identified.

1148 Make this procedure available on-site in case an emergency arises.

1149 Waste management. To avoid pollution, all waste (including separator waste and oil spill  
1150 adsorbent materials) must be handled, stored and disposed of correctly. Waste producers and  
1151 holders must ensure that waste:

- 1152 • does not escape from their control;
- 1153 • is passed only to a registered waste carrier for recycling or disposal at a suitably  
1154 licensed facility;
- 1155 • is accompanied by a transfer note with a full written description of the waste.

1156 **D.2.15.3 Fuel Tank Bund Rain Water Discharge Procedure**

1157 Diesel fuel is a hazardous substance which can cause extensive pollution to soil and water.  
1158 Fuel tanks must be banded to ensure that if a tank leaks, the fuel does not escape into the  
1159 environment. However, if the banded area is not roofed, rain water will accumulate in the  
1160 bund. This needs to be drained out under controlled conditions.

1161 The supervisor is responsible for ensuring that no leaked fuel within the bund is allowed to  
1162 get out of the bund. Should there be an accidental spill or leakage, then the supervisor is  
1163 responsible for ensuring that it is cleaned up immediately and the matter reported to his  
1164 manager. In any event, the fuel must be cleaned before any water is drained from the bund.

1165 The following procedure shall be followed.

- 1166 1. The supervisor shall be present throughout the process of draining the bund.
- 1167 2. The valve on the bund outlet must be kept closed at all times except when it is being  
1168 drained.
- 1169 3. At a designated time on each working day, the supervisor must inspect the bund and  
1170 assess: (a) whether there has been any spillage or leakage of water from any tank; and  
1171 (b) whether any rain water has accumulated and needs to be drained off.
- 1172 4. If any fuel has leaked, then the cause of the leak must be investigated immediately and  
1173 the leak stopped if possible. This might be done using a tank repair compound such  
1174 as "Plug Pattie", which is contained in the re-fueling station's fuel and oil spill kit.  
1175 After this it must be reported to the manager. The leaked fuel must then be mopped  
1176 up using appropriate pads from the spill kit. Once used, these must be placed in the

- 1177 polythene bags provided in the spill kit and disposed of correctly.
- 1178 5. If there is water in the bund that appears uncontaminated with fuel, it may be drained  
1179 off. This is done by opening the valve at the outlet, and allowing the water to flow out  
1180 through the filter or water-oil separator. The supervisor must watch this process  
1181 carefully, and must ensure that the flow from the valve is adjusted so that it does not  
1182 flood the filter. Normally the filter will not cope with the full flow from a valve opened  
1183 completely.
- 1184 6. Once the bund has been drained, the valve must be screwed shut again.
- 1185 7. All other staff, including security guards, are to be instructed that it is forbidden for  
1186 them to drain water from the bund except when the supervisor is present.

1187 **D.2.15.4 Re-fuelling Spill Prevention Procedure**

1188 Diesel fuel is a hazardous substance which can cause extensive pollution to soil and water. It  
1189 is also a valuable asset.

1190 The supervisor is responsible for ensuring that no fuel is spilt. Should there be an accidental  
1191 spill, then the supervisor is responsible for ensuring that it is cleaned up immediately and the  
1192 matter reported to his manager.

1193 Only a trained pump operator may use a fuel pump. Drivers are not permitted to do this.

1194 The following procedure shall be followed.

- 1195 1. The hard standing in front of the fuel pump must be kept clean at all times. It must be  
1196 swept at least once per working day.
- 1197 2. Vehicles must be positioned on the hard standing, with the fuel filling location  
1198 between 1 and 2 metres from the pump.
- 1199 3. The fuel filler cap must be removed from the vehicle before the hose is taken from the  
1200 pump.
- 1201 4. When moving the hose from the pump, the nozzle must be kept upright at all times.
- 1202 5. The nozzle is to be inserted carefully into the vehicle filler pipe, and pushed in as far  
1203 as it will go.
- 1204 6. Only when the nozzle is fully inserted may the pump be started.
- 1205 7. While filling the vehicle, the pump operator must watch the nozzle and reduce the  
1206 pump speed if there is any splashing from the filler pipe.

- 1207 8. If the nozzle does not have an automatic shut-off valve, the filling must be done slowly  
1208 and the filler pipe watched carefully to ensure that the pump is stopped well before  
1209 the tank overflows.
- 1210 9. Once filling is complete, the pump must be switched off before the nozzle is moved.
- 1211 10. The nozzle must be removed slowly and carefully, and held in an upright position as  
1212 it is moved back to its cradle on the pump. The hose must then be stowed neatly beside  
1213 the pump.
- 1214 11. The filler cap is then to be replaced on the vehicle, and screwed down firmly.
- 1215 12. If any fuel has been spilt, it must be mopped up immediately using appropriate pads  
1216 from the re-fueling station's fuel and oil spill kit. Once used, these must be placed in  
1217 the polythene bags provided in the spill kit and disposed of correctly.

## 1218 **D.2.16 Pollution Prevention in Vehicle and Plant Workshops**

### 1219 **D.2.16.1 Introduction**

1220 Workshops and service centres carry out a number of operations and processes that have the  
1221 potential to damage the environment. These include the cleaning of vehicles, the storage, use  
1222 and disposal of polluting liquids such as oils, paints, solvents, coolant additives, brake fluids  
1223 and solid waste such as oil filters, exhaust systems, batteries and tyres. Unless the site drainage  
1224 is correct, waste is properly managed and spillage control procedures are in place,  
1225 environmental harm could occur.

### 1226 **D.2.16.2 Vehicle and Plant Maintenance Areas**

1227 Internal gullies or grids must not drain to the surface water system. If the workshop pit is  
1228 subject to water infiltration, and is served by a gully and pump, then this should be directed  
1229 to the foul sewer. Areas where maintenance or dismantling activities are carried out must  
1230 have an impermeable surface and a raised edge with drainage to a sealed sump or via an oil  
1231 separator to the foul sewer.

1232 Disposal of waste liquids. Used liquids, such as lubricating oil, hydraulic fluid, coolant and  
1233 solvents from degreasing activities, must not be disposed of into surface water systems. They  
1234 should be collected in a suitably bunded tank. This oil can be taken for use in the furnaces of  
1235 rubber factories until such time as Liberia has recycling facilities.

1236 Batteries. Batteries containing acid should be stored intact and upright in an acid resistant  
1237 bunded compound or purpose built bin. Both the lead and the plastic cases can be recycled,  
1238 so they should be collected for sale to an authorised contractor. Storage can be minimised by  
1239 the use of one-for-one exchange schemes, whereby old batteries are collected when new ones  
1240 are delivered.

1241 Tyres and other discarded dry parts. Tyres must never be burnt on site. They can be treated  
1242 as a dry material for storage, but if burnt, release compounds that are extremely polluting.  
1243 Tyres should be disposed of by a suitably licensed tyre incinerating or recycling company.

1244 Oil filters and other oil contaminated components. There are certified contractors for used oil  
1245 filters, and so these should be stored. Alternatively, discarded oil filters can be crushed on site  
1246 and the oil and metal recovered. Intact or crushed filters and other oil contaminated parts such  
1247 as engines, gearboxes and axles should be stored either in a sealed container or within an  
1248 impermeable bunded area, preferably roofed to prevent the entry of rain.

1249 Other wastes. Skips should have a designated use and be clearly marked to indicate what  
1250 materials they may be used for. Material stored in skips should be drained or dry and the  
1251 skips covered to prevent the entry of rainwater and kept watertight to prevent leakage. If any  
1252 contaminated liquid does accumulate, it should be removed and suitably disposed of. Note  
1253 that scrap metal is a potential asset.

#### 1254 **D.2.16.3 Oil, Fuel and Chemical Storage**

1255 Above ground storage tanks. All oil storage tanks and drums, including waste oil, must be  
1256 sited on an impermeable base within an oil-tight bund wall. Any fill and draw pipes, valves  
1257 and sight gauges should be enclosed within its curtilage and tank vent pipes should be  
1258 directed downwards into the bund, so that in the event of overfilling the discharge is  
1259 contained. Bunds should be examined on a regular basis and any rainfall that accumulates  
1260 removed by bailing or by pumping under a manually controlled system. This water may be  
1261 contaminated and should be disposed of with care.

1262 Internal storage tanks should also be bunded as above and, if served by a remote fill point,  
1263 the drainage from the area should pass through a suitably sized oil separator. A high level  
1264 alarm, which provides an additional safeguard against overfilling, is recommended for all  
1265 storage tanks.

1266 Underground storage tanks. Underground tanks and pipelines are susceptible to damage and  
1267 corrosion, and above ground facilities are preferred. In areas of high groundwater  
1268 vulnerability, the EPA may object to the installation of underground storage tanks. Where  
1269 underground storage is necessary, a number of protective measures, such as double skinned  
1270 tanks and piping, and leak detection, may be required. Regular inspection, stock reconciliation  
1271 and pressure testing are essential, especially where groundwater pollution could occur. The  
1272 location of underground piping should be identified and clearly marked in order to avoid  
1273 damage through excessive surface loading.

1274 Chemical storage. Chemicals such as detergents, degreasers, solvents and hydraulic fluids  
1275 should be securely stored with storage vessels labelled to show their contents and should be  
1276 kept as close to the point of use and as far from surface water drains as possible.

1277 Refueling facilities. These are covered by a separate guideline. The risk of pollution from  
1278 refueling areas is especially high. Such areas should be isolated from general yard drainage,  
1279 (for example by using a raised kerb or roll-over bund). Particular care should be taken in the  
1280 cleaning of such areas.

#### 1281 **D.2.16.4 Degreasing and Cleaning**

1282 The cleaning and degreasing of vehicles and components must be carried out in a designated  
1283 wash-bay and not on unmade ground or in areas which discharge to surface water drains,  
1284 watercourses or soak-away. A wash water recycling system will reduce water use and  
1285 associated costs. The wash-bay should be impermeable and isolated from the surrounding  
1286 area by a raised kerb or roll-over bund, with the effluent directed to foul sewer. Particular care  
1287 should be taken when using hydrocarbons such as paraffin and white spirit as degreasers, as  
1288 these substances are toxic to river life. In no circumstances should these substances be  
1289 discharged to surface water drains.

### 1290 **D.2.17 Sanitation and Sewage Disposal**

#### 1291 **D.2.17.1 Pit Latrines**

1292 Where temporary toilets are required on site, earth pit latrines are the preferred option. These  
1293 shall consist of a simple pit with a well-ventilated shelter over the top.

1294 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.

- 1323 • Select an area for the soakaway that is at least 50 metres down gradient, at least 250
- 1324 metres laterally and at least 500 metres up gradient of any boreholes or water supplies.
- 1325 • Excavate a trench for the underground soakaway (2 metres deep by 1.5 metres wide
- 1326 by 50 metres long).
- 1327 • Line the large trench for the soakaway with permeable geotextile.
- 1328 • Place a layer of clean stone of 50 to 100 mm size to 100 mm that is 600 mm thick
- 1329 throughout the trench.
- 1330 • Lay a UPVC pipe of 150 mm diameter perforated with at least 100 holes of 8 mm
- 1331 diameter per metre of pipe. The upper end shall be connected to the outlet from the
- 1332 septic tank and the lower end shall be covered over with permeable geotextile.
- 1333 • Fill the trench with clean stone of 50 to 100 mm size to 1 metre below ground level.
- 1334 • Place a sheet of permeable geotextile over the stone and then backfill the trench to
- 1335 ground level with 1 metre thickness of soil. This shall be lightly compacted by running
- 1336 an excavator track over the backfilled trench.

1337 Other designs and sizes are permitted if supported by appropriate civil engineering  
1338 calculations and design.

#### 1339 **D.2.17.3 Soakaway for “Grey” Water Only**

1340 “Grey” water is used water derived from kitchens, showers, laundries and other washing  
1341 areas, but not from toilets. It should normally be sent to a sewage treatment plant or septic  
1342 tank. If no sewerage system is available or the soil has low permeability (making it difficult to  
1343 dispose of large volumes of water in a soakaway), then a reed bed system may be used.

1344 A reed bed system uses a minimum of three and preferably five separate ponds in series, for  
1345 the biological treatment of water. Water should be resident in the system for at least 7 days.  
1346 This usually requires 3 m<sup>2</sup> of reed bed surface area per person using the system, with an outlet  
1347 pipe height of 0.5 metre.

1348 When the pond series is constructed, local swamp reeds should be transplanted into the  
1349 ponds. During use, it must be ensured that the reeds are healthy and growing vigorously. If  
1350 the reeds are dead, the system must be stopped until new reeds have been established.

1351 Discharge from the final pond may go into an open water course. Samples should be tested  
1352 regularly for bacterial quality if there is a water supply known to exist downstream.

#### 1353 **D.2.17.4 Chemical Toilets**

1354 The use of chemical toilets is strongly discouraged. They may only be used at project sites  
1355 where it is proven that neither a standard water closet and septic tank system, nor a pit latrine,  
1356 are practical. There are two main risks involved in chemical toilets: (a) damage to soils, plants,  
1357 animals and water from the chemicals used in the toilets; and (b) health dangers to people in  
1358 the vicinity from the sewage being disposed.

1359 Waste from chemical toilets shall not be poured into a foul drain leading into a sewage  
1360 treatment plant that relies on biological aerobic digestion, since the bacteria would be killed  
1361 by the discharge from chemical toilets; and this would ruin the treatment process. Chemical  
1362 toilets should also not be discharged into septic tanks, since the chemical used in toilets can  
1363 have an adverse effect on the sewage digestion process in this situation as well.

1364 A disposal hole must be excavated to receive waste from chemical toilets. A suitable hole must  
1365 be situated at least 100 metres from any dwelling and at least 100 metres from a water course,  
1366 spring or well. Wherever possible, it should be on a permeable but not sandy soil. Holes shall  
1367 be two metres deep when first excavated.

1368 When full or nearly full, chemical toilets shall be transported to the approved emptying point  
1369 for careful disposal under proper supervision. Once emptied, the toilet shall be sluiced down  
1370 with plenty of water. The toilet receptacle shall also be well washed out with water and  
1371 disinfectant, all of which shall also be discharged into the disposal hole.

1372 Each time a toilet is emptied into the hole, the waste shall be covered with 100 mm of soil.  
1373 When the hole has only 0.5 metre of depth remaining, it shall be completely filled and a new  
1374 hole started.

#### 1375 **D.2.18 Use of Explosives in Quarries**

##### 1376 **D.2.18.1 Legislative Background**

1377 The Minerals and Mining Act (2000) makes the following provisions, which must be complied  
1378 with under all circumstances.

1379 “The conditions for the import, export, manufacture, storage, handling, purchase, sale and  
1380 use of explosives shall be as strictly prescribed by the laws of Liberia.” [Section 16.11]

1381 “All Quarry operators shall apply to the Ministry of State for Presidential Affairs, or to such  
1382 other agency of Government as required by the laws of Liberia, for permission to import,  
1383 export, buy, sell, manufacture, store handle, purchase, use, dispose of or otherwise deal in or  
1384 with explosives.” [Section 16.12]

#### 1385 **D.2.18.2 Meanings of Terms**

1386 In this guideline, the following meanings shall apply.

1387 (a) “Operator” in relation to a site where blasting is taking place means the person in overall  
1388 control of the working of the quarry.

1389 (b) “Shot” means a single shot or a series of shots fired as part of one blast.

1390 (c) “Shotfirer” means a person appointed to be responsible for shotfiring operations.

1391 (d) “Shotfiring operations” include:

1392 (i) checking to ensure that the blasting specification is still appropriate for the site  
1393 conditions at the time the blasting is to take place;

1394 (ii) mixing explosives;

1395 (iii) priming a cartridge;

1396 (iv) charging and stemming a shothole;

1397 (v) linking or connecting a round of shots;

1398 (vi) withdrawal and sheltering of persons;

1399 (vii) inspecting and testing a shotfiring circuit;

1400 (viii) firing a shot; and

1401 (ix) checking for misfires.

#### 1402 **D.2.18.3 Transport and Storage of Explosives**

1403 Explosives shall be transported in escorted convoys, in accordance with all prevailing  
1404 transport and safety rules.

1405 Explosives shall be stored in locked shipping containers in a secure compound sealed from  
1406 the rest of the quarry site, and with permanent guards to ensure no unauthorised access.

1407 Separate containers shall be used for different components (detonators, fuses, charges etc.)  
1408 and shall be placed at least 10 metres apart with earthen bunds in between.

1409 **D.2.18.4 Clearance of the Site and Safety Zone**

1410 a. The contractor shall not permit any blasting to take place without a 500-metre safety zone  
1411 cleared around the site. This zone shall be cleared of people, structures and all other  
1412 infrastructure.

1413 b. Warning notices shall be posted around the site, giving at least 24 hours warning of a blast.

1414 c. The Operator shall notify the CLO in good time to allow deployment of its staff at least  
1415 one week before a blast or series of blasts, to prepare communities for the blasting and to  
1416 notify them of the times of blast(s). The signalling system shall also be explained.

1417 d. A siren shall be sounded 30 minutes, 10 minutes, 5 minutes and 1 minute before a blast  
1418 takes place. The siren shall be loud enough to be heard clearly throughout the site and  
1419 safety zone. This shall include persons operating machines or required to use ear  
1420 protection.

1421 e. Where farms occur within the 500-metre safety zone, patrols shall be sent out to ensure  
1422 they are cleared of people in good time. The warning signal sequence for the blast shall  
1423 not be started until the patrols have reported that the farms are clear to the best of their  
1424 knowledge and that they themselves are in places of safety.

1425 f. Where a footpath runs into the safety zone, guards shall be posted at least one hour before  
1426 the blast to prevent people from entering the safety zone.

1427 g. The site is to be cleared of personnel as soon as the first warning siren is sounded.

1428 **D.2.18.5 Operator's Duties**

1429 (a) The operator shall:

1430 (i) ensure, so far as is reasonably practicable, that all explosives are stored, transported  
1431 and used safely and securely;

1432 (ii) appoint one or more competent individuals to organise and supervise all work  
1433 involving the use of explosives ("the Explosives Supervisor");

1434 (iii) ensure that at no time is there more than one person acting as the Explosives  
1435 Supervisor at the site; and

1436 (iv) keep a copy of the written statement of duties of the person or persons appointed  
1437 under paragraph (a)(ii) for at least twelve months after the date on which the appointment  
1438 ceased to have effect.

1439 (b) It shall be the duty of the operator to ensure that:

1440 (i) there are suitable and sufficient written rules and procedures for:

- 1441 • shotfiring operations;
- 1442 • appointing shotfirers and storekeepers;
- 1443 • authorising other persons who will be involved with the storage, transport or use of  
1444 explosives;
- 1445 • dealing with misfires; and
- 1446 • ensuring, so far as is reasonably practicable, that such rules and procedures are  
1447 complied with;

1448 (ii) an adequate written specification (whether produced by or for the operator) is  
1449 prepared for each shotfiring operation to ensure, so far as is reasonably practicable, that  
1450 when such firing occurs it will not give rise to danger; and

1451 (iii) a copy of the specification referred to in sub-paragraph (b) is given to any person upon  
1452 whom it imposes duties.

1453 (c) The operator shall ensure that operations involving the storage, transport or use of  
1454 explosives are carried out by

- 1455 (i) a duly authorised and competent person; or
- 1456 (ii) a trainee under the close supervision of a duly authorised and competent person.

1457 (d) The operator shall ensure that:

1458 (i) such facilities and equipment as are necessary to enable shotfiring operations to be  
1459 carried out safely are provided;

1460 (ii) any vehicle which is provided for use in relation to shotfiring operations is so marked  
1461 as to be readily identifiable from a distance;

1462 (iii) detonators are stored in separate containers from other explosives; and

1463 (iv) explosives are kept at all times either in a locked explosives store or under the constant  
1464 supervision of a suitable person.

1465 (e) The operator shall ensure, so far as is reasonably practicable, that each shotfiring operation  
1466 is carried out safely and in accordance with the rules required to be made in pursuance of

1467 paragraph (b)(i) and any specification required to be prepared in pursuance of paragraph  
1468 (b)(ii).

1469 **D.2.18.6 Supervision of Shotfiring and Records of Appointment**

1470 (a) The operator shall take all reasonable steps to ensure that:

1471 (i) a trainee shotfirer does not fire shots and is not required to fire shots, except when he  
1472 is under the close personal supervision of a shotfirer, until the operator is satisfied that he  
1473 has completed a suitable period of training and has appropriate practical experience; and

1474 (ii) all shotfiring operations are carried out under the close personal supervision of the  
1475 shotfirer.

1476 (b) The operator shall ensure that a record of the appointment of any shotfirer or trainee  
1477 shotfirer is kept at a suitable place until three years after that shotfirer's employment or trainee  
1478 shotfirer's employment ends.

1479 **D.2.18.7 Shotfirer's Duties**

1480 Before a shot is fired, a shotfirer shall:

1481 (i) check that the procedure has been followed for clearing the site and the 500-metre safety  
1482 zone;

1483 (ii) check the shotfiring system or circuit to ensure that it has been connected correctly;

1484 (iii) where electrical detonators are used, ensure that they have been correctly connected  
1485 to the shotfiring system or circuit and that the shotfiring system or circuit is tested with an  
1486 instrument suitable for the purpose from a position of safety;

1487 (iv) where appropriate, ensure that the electrical integrity of the shotfiring system or  
1488 circuit is such as to make a misfire unlikely; and

1489 (v) ensure that the shot is fired from a safe place.

1490 **D.2.18.8 Misfires**

1491 In the event of a misfire the operator shall ensure, so far as is reasonably practicable, that:

1492 (i) apart from himself, no person other than the Explosives Supervisor, shotfirer, trainee  
1493 shotfirer or any other person authorised by him enters the danger area until a period of  
1494 five minutes has elapsed since the misfire and any shotfiring apparatus has been  
1495 disconnected from the shot;

- 1496 (ii) appropriate steps are taken to determine the cause of and to deal with the misfire;  
1497 (iii) a suitable record is kept of the misfire for at least three years; and  
1498 (iv) appropriate steps are taken to prevent theft of the explosives and detonators or their  
1499 initiation by an unauthorised person.

1500 **D.2.18.9 Use of ANFO**

1501 Where an ANFO (ammonium nitrate / fuel oil) mixture is used, special precautions shall be  
1502 taken to ensure that there is no pollution. Both of the ingredients can be extremely damaging  
1503 if they are leached into water courses. For this reason, the following precautions shall be taken  
1504 when ANFO is used as an explosive.

- 1505 (a) Ammonium nitrate shall be stored in sealed bags in a dry location.  
1506 (b) Fuel oil shall be stored and transported as per the fuel guidelines.  
1507 (c) Mixing of ANFO shall be done in such a way that there is no spillage or contamination of  
1508 the ground. Should any spillage occur, then the spilt material shall be cleaned immediately  
1509 and all contaminated soil shall be removed for remediation.  
1510 (d) The filling and blasting of holes shall be done in the same day to avoid the leaching of  
1511 ANFO into the water table and polluting of groundwater.

1512 **D.2.18.10 Prohibited Activities**

- 1513 (a) A person other than a person appointed by the Ministry of Lands, Mines and Energy as an  
1514 Explosives Inspector, a person engaged in the transport of explosives to or from the work site,  
1515 a shotfirer, a trainee shotfirer, a person authorised to handle explosives at a work site or a  
1516 person appointed to be in charge of the explosives store shall not handle explosives.  
1517 (b) A person shall not bring any substance or article (other than explosives) likely to cause an  
1518 unintended explosion or fire within ten metres of any explosives or take any naked flame  
1519 within ten metres of any explosives.  
1520 (c) A person shall not forcibly remove any detonator lead or other system for initiating shots  
1521 from a shothole after the shothole has been charged and primed.  
1522 (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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## 1539 **D.2.20 Community Consultation**

1540 This guideline provides the procedure for the ways in which communities of affected persons  
1541 including project near neighbours, that must be followed to ensure compliance with UNDP  
1542 policy, Liberian law, current socially acceptable practice in Liberia as well as international  
1543 best-practice. It provides a brief overview of the project's approach to all forms of community  
1544 Consultation by the Project Management Unit, its officers, contractors and Sub-Contractors.

1545 UNDP Social safeguards require adequate, effective and recorded consultation and  
1546 information exchanges with community stakeholders interested in the project. The PMU is  
1547 required to have a Stakeholder Engagement Plan which contains plans for managing and  
1548 recording contacts with communities, grievances and a plan for regular community  
1549 consultation and information over the project life.

1550 Each organisation must have a Safeguards Officer to manage the community and stakeholder  
1551 engagement process. Each organisation may employ a Community Liaison Officer to  
1552 undertake this activity, in smaller organisations the CLO may also have the safeguarding  
1553 responsibilities. The Safeguard Officer / Community Liaison Officer must have experience in  
1554 community consultation in slum communities in Liberia. Safeguard Officers and CLOs of  
1555 Contracting bodies must be aware of and use the same processes to organise and record/  
1556 report community interactions as set out in the PMU Stakeholder Engagement Plan.

### 1557 **D.2.20.1 Principles**

1558 Communities have the right to clear, timely information about project activities which will  
1559 affect their community in some way. Relations between project components and communities  
1560 are most positive when there is a Stakeholder Engagement Plan defining actions and process.

### 1561 **D.2.20.2 Scope**

1562 This guideline is to assist all project actors to undertake community consultation. It applies to  
1563 all aspects of work by Contractors and Sub-Contractors in relation to the project.

### 1564 **D.2.20.3 Background**

1565 If communities are informed about project activities in advance and are offered the  
1566 opportunity to raise issues and offer suggestions to mitigate negative impacts, relationships  
1567 are less tense, accommodations negotiated more easily, international and national NGO

1568 scrutiny is easier to manage and the recording requirement allows for proof of consultation  
1569 and participation.

- 1570 • Communities have the right to be informed and consulted about asset acquisition and  
1571 to be treated fairly and considerately.
- 1572 • Information must be made available at the right times, in the right languages and  
1573 media to be effective.
- 1574 • All organisations must have a delegated safeguards Officer and/or Community  
1575 Liaison Officer (CLO) responsible for Community interaction and a budget for  
1576 community meetings, information materials, radio announcements etc.
- 1577 • There must be an effective Grievance Redress Mechanism in place.
- 1578 • Each organisation must take on board the need for a Safeguards Officer or CLO to  
1579 front community contact whilst training all staff on community awareness and the  
1580 protocols mandated for community contact.
- 1581 • All community interactions must be recorded and reported weekly to the PMU and  
1582 UNDP.
- 1583 • The PMU will make the Stakeholder Engagement Plan available to all contractors etc.  
1584 and monitor compliance on a weekly basis.

1585 **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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## 1586 **D.2.21 Safeguarding of Local People’s Livelihoods**

1587 This guideline provides the procedure for ensuring that the mostly negative project impacts  
1588 on local people’s livelihoods during construction are recognised, are mitigated as soon as  
1589 possible and appropriately. This guideline does not cover restoration of livelihoods caused by  
1590 formal resettlement and displacement of economic activities as this is covered in the  
1591 Resettlement guideline. This guideline provides a brief overview of the project’s approach to  
1592 all forms of impact on livelihoods by the Project, its officers, contractors and Sub-Contractors.

1593 The affected slum communities are densely populated, physically overcrowded and are a  
1594 complex interaction of people’s economic activities associated with their home locations. The  
1595 communities are dominated by the fishing industry – launching canoes, catching fish,  
1596 repairing equipment, processing fish, marketing fish and fish products interweaved with the  
1597 provision of support services, tailors, food stores, market stalls selling everything, street  
1598 hawking of goods, sellers of street food in a myriad of small scale interactions dependent on  
1599 proximity of manufacture or processing with the sales market. Any action by the PMU or the  
1600 Contractor that competes for space in these communities or which affects employment  
1601 opportunities risks increased impoverishment of the affected person, risks project reputation  
1602 and increases the likelihood of negative attention by the media and politicians.

1603 Each organisation must have a Safeguards Officer to manage community and stakeholder  
1604 impacts. Each organisation may employ a Community Liaison Officer (CLO) to undertake this  
1605 activity, in smaller organisations the CLO may also have the safeguarding responsibilities.  
1606 The Safeguard Officer / Community Liaison Officer must have experience in community  
1607 consultation in slum communities in Liberia. Safeguard Officers and CLOs of Contracting  
1608 bodies must be aware of and use the same processes to organise and record/ report  
1609 community impacts to the PMU Stakeholder Engagement Plan.

### 1610 **D.2.21.1 Principles**

1611 People have the right to have the potential impact of project activities on their livelihoods  
1612 considered at all stages of the project planning and design process, to have negative impacts  
1613 mitigated effectively and for potential positive impacts to be promoted through project  
1614 implementation.

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1615 **D.2.21.2 Scope**

1616 This guideline is to assist all project actors to undertake impact assessment and mitigation  
1617 outside of the formal Resettlement Action Plan process which is the correct protocol for  
1618 dealing with identifiable in advance, major, temporary or permanent economic displacement  
1619 issues. This guideline applies to all aspects of daily work by Contractors and Sub-Contractors  
1620 in relation to the project.

1621 The sorts of impacts on livelihoods considered to be regulated by this guideline are:

- 1622 • Loss of market stall site caused by the need to run trucks through areas used by  
1623 marketers.
- 1624 • Loss of canoe landing sites through ill-considered materials storage sites that force  
1625 fishermen out of their beaches.
- 1626 • Construction organisation which prevents access to workplaces, storage sites or  
1627 processing facilities.
- 1628 • Unintentional damage to income generation activities through dumping materials in  
1629 certain places, spillages.
- 1630 • Blocking access to shop fronts/ warehouses or go-down yards.
- 1631 • Forcing changes in economic activities leading to lack of daylight to undertake income  
1632 earning tasks at times available to the worker, e.g., construction schedules restricting  
1633 access to areas until after dark when women have to be caring for their families and  
1634 have no time to make/ process/ sell goods to gain an income.

1635 **D.2.21.3 Background**

1636 Economic survival in slum communities is always a desperate juggling of activities with low  
1637 profit margins, poor understanding or analysis of opportunities for change in an insecure and  
1638 potentially dangerous environment. Levels of violence are higher than in wealthier  
1639 communities, attitudes to the safety of others are poor, basic survival and family care  
1640 dominate daily life. Survival in these communities is heavily dependent on reciprocal  
1641 assistance and support offered between households. Damaging these dependencies and  
1642 interactions has a high potential for increased poverty and decreased survival. The project  
1643 must therefore work hard to prevent negative impacts by clear planning, effective

1644 communication with communities and placing real emphasis on understanding how daily  
1645 activities impinge on local people.

1646 • All organisations must have a delegated safeguards Officer and/or Community  
1647 Liaison Officer (CLO) responsible for Community interaction a remit to understand  
1648 the complexities of economic life around the project site.

1649 • There must be an effective Grievance Redress Mechanism in place.

1650 • Each organisation must review the job card protocol for each activity and conduct an  
1651 appraisal of how the activity may affect local people and implement procedures to  
1652 mitigate negative impacts –

1653 ○ By rescheduling deliveries to non-peak times;

1654 ○ Discussing with marketers how best not to disrupt their activities;

1655 ○ Considering the livelihood activities around each site or activity, revisit this  
1656 analysis over time;

1657 ○ Discuss with communities;

1658 ○ Regularly review the work plan and discuss ways of reducing impacts; and

1659 ○ Look for positive ways of assisting local livelihoods

1660 ▪ Employ youth especially as unskilled labour;

1661 ▪ Purchase supplies locally from local sellers; and

1662 ▪ Contribute to community initiatives.

1663 • All actions responding to mitigating negative and enhancing positive impacts must be  
1664 recorded and reported weekly to the PMU and UNDP.

1665 **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. |

## 1666 **D.2.22 Resettlement and Relocation Guidelines**

1667 This guideline provides the procedure for the displacement of any person, property or  
 1668 livelihood that must be followed to ensure compliance with UNDP policy and Liberian laws,  
 1669 current socially acceptable practice as well as international best-practice. It provides a brief  
 1670 overview of the project's approach to all forms of resettlement. UNDP Policy on Involuntary  
 1671 Resettlement and Displacement requires a Resettlement Action Plan to ensure adequate  
 1672 consultation, information exchanges and adherence to due process through the planning and  
 1673 implementation of any resettlement to ensure that the affected persons are not disadvantaged  
 1674 by the relocation of their houses and displacement of their livelihoods.

1675 The communities and households living in the project affected slums are some of the most  
 1676 vulnerable Monrovia residents and whose livelihood depends on living and working close to  
 1677 their work areas i.e. fishing beaches. Given the very low-incomes, poor access to resources to  
 1678 relocate and the difficulty of finding another house plot in which to live in these communities,  
 1679 it is imperative that the full Resettlement Action Plan process is undertaken when any  
 1680 relocation is required. Abiding by the RAP process protects the Contractor, the Project  
 1681 Implementation Consultant, the Liberia UNDP County Office from criticism and objections  
 1682 and complaints arising from the need to relocate very vulnerable people away from their  
 1683 livelihoods and communities. A formal RAP ensures that the Affected Persons are properly  
 1684 treated and recompensed to the point of being able to rebuild their lives to a better standard.  
 1685 This requirement is non-negotiable.

### 1686 **D.2.22.1 Principles**

1687 Land potentially used or owned by communities cannot be accessed until ownership and use  
 1688 has been researched and clarified, a Resettlement Action Plan produced and full and fair  
 1689 compensation has been made for losses and livelihood restoration commenced. The payment  
 1690 and livelihood restoration must be verified by a third party organisation with resettlement  
 1691 verification experience.

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1692 **D.2.22.2 Scope**

1693 This guideline is to assist the Project Management Unit to hire a competent resettlement  
1694 consultancy or similar body with Liberian resettlement experience to research and write a  
1695 Resettlement Action Plan (RAP). The Project Management Unit can then use the RAP to  
1696 negotiate for and make payment or other forms of compensation to communities and  
1697 individuals for loss of land, assets, usage rights or access routes, and to design and implement  
1698 mitigation measures for loss of livelihoods. It applies to all work in relation to the project.

1699 **D.2.22.3 Background**

1700 Whilst the project as a government entity has the right to use public land in its designated  
1701 areas, that land is densely populated. People have legal title to parts of the area and very many  
1702 communities have “squatter” customary rights to use of the land and resources in the area.  
1703 Under all international agency policies on resettlement and in Liberian law:

- 1704 • Squatters and displaced persons have equal right to compensation for losses at full  
1705 market value to be able to rebuild to at least the same if not better standards than  
1706 before and restoration of incomes.
- 1707 • Communities have the right to be informed and consulted about asset acquisition and  
1708 to be treated fairly and considerately.
- 1709 • There must be an effective Grievance Redress Mechanism in place
- 1710 • Community and household interviews are required to assess losses and impacts on  
1711 livelihoods, and these take some time to undertake. The internationally recognised  
1712 process for researching impacts and losses must be adhered to.

1713 Under Liberian law, acquisition and payment of compensation can be made by the project or  
1714 can be delegated to an agent, but land ownership is devolved back to the government. The  
1715 procedures below are required to be followed.

1716 A single project resettlement and compensation policy applies throughout its areas of activity,  
1717 which must be defined in a Resettlement Action Plan (RAP) prepared alongside the  
1718 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 <b>only after</b> 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.  |

## 1723 D.2.23 Temporary Land Access Procedure

### 1724 D.2.23.1 Overview

1725 The Project will occupy and use land for storage, labour camps, laydown areas and as work  
1726 areas. Some areas will be needed for less than 6 months – others such as laydown, helipads  
1727 and storage, may be taken on a voluntarily agreed long lease/rental and arranged between the  
1728 Contractors and the Owners for periods longer than 6 months. If left unmitigated, such  
1729 temporary access could potentially have a major adverse impact on local communities and  
1730 the environment. To ensure adequate mitigation is applied, the following measures are  
1731 proposed, that adhere to national regulations, UNDP’s guidelines and the IFC Performance  
1732 Standards.

### 1733 D.2.23.2 Minimum Requirements

1734 The following general principles will apply to all temporary access sites throughout all project  
1735 activities:

- 1736 • The procedure covers all land use for less than one year;
- 1737 • Homestead areas and cultural sites will be avoided to the extent feasible;
- 1738 • Temporary land access will minimize the extent and duration of land requirement  
1739 wherever feasible;
- 1740 • Where there is more than one option, the preference will be first for barren government  
1741 land, followed by fallow land. Cultivated land will be selected only as a last resort;
- 1742 • If the land is cultivated, then avoid such lands where there is standing crop;
- 1743 • The land footprint will include area required for access/entry; laydown areas for  
1744 equipment; temporary storage needs; and the core work area. This footprint will be  
1745 physically demarcated and fenced;

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- 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.

1759 Assets under the scope of the temporary land access process include the following:

- 1760
- 1761
- 1762
- 1763
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- 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 plotheadholder 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.

1770 **D.2.23.3 Site Demarcation**

1771 Temporary land access must meet the following siting criteria:

- 1772
- 1773
- 1774
- 1775
- 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

1805 the access to the land parcel and avoid any safety concerns for the local community. Where  
1806 appropriate, signage shall be put up to inform the local community of the activities being  
1807 undertaken and to restrict access to the area.

#### 1808 **Restoration**

1809 Once the construction phase activities are complete, the Contractor will undertake the  
1810 following:

- 1811 • Restore the affected land parcel to its pre-activity status (i.e. refilling of top soil; and to  
1812 any other state as agreed with the land owner);
- 1813 • Ensure that all personnel and equipment that were in use are moved out;
- 1814 • Ensure that any temporary structures have been dismantled;
- 1815 • Ensure that the affected individual/community group has validated closure of the  
1816 activity on the land parcel; and
- 1817 • Get a written sign-off from the owner/owners.

1818 The final compensation amount for any due rental/access amount and for any unintended  
1819 damage shall then be paid and the final receipt of acknowledgement shall be taken from the  
1820 landowner.

#### 1821 **D.2.23.4 Documentation and Record Keeping**

1822 All communication and interaction with external stakeholders regarding temporary land  
1823 access activities, before, during and after handover, will be clearly documented. Records will  
1824 include the location, people consulted, summary of key points discussed, concerns, action  
1825 items etc. Consensus and agreements reached will be documented and signed by the relevant  
1826 stakeholders.

1827 Key documents to be maintained by a Contractor seeking land access will include:

- 1828 • Records of key meetings;
- 1829 • Demarcated Land Compensation Form for temporary land access compensation;
- 1830 • Permission for land access;
- 1831 • Payment Receipt;
- 1832 • 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> <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> <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

1849 employing local youth to work on the project is an important benefit that will create  
1850 community participation and so should be encouraged.

1851 This guideline provides suggestions on the project's approach to ensuring employment of  
1852 those 16 or older by the Project, its officers, contractors and Sub-Contractors.

### 1853 **Principles of Liberian Labour Law**

- 1854 1. There cannot be discrimination for employment based on age, race, sex, tribal origins
- 1855 2. Working hours, conditions, pay and benefits are regulated by law
- 1856 3. Labour Offices are available to assist in the recruitment of workers should this be  
1857 needed and can help with vetting for age and names.

1858 The employing Contractor must:

- 1859 1. Verify the name and age of the employee using the national identity card, social  
1860 security and welfare registration card, voter's registration card etc. with a photograph  
1861 incorporated.
- 1862 2. In the absence of such a card – which can be an indicator of being under 16, the  
1863 employee can be asked to produce a birth certificate and school reports from which  
1864 age can be estimated.
- 1865 3. Photographic identity cards are most useful as the photograph can possibly verify the  
1866 identity of the applicant.
- 1867 4. Employees whose ages or identity are in doubt can be referred to the Labour Office for  
1868 verification

1869 Children are not allowed on site for any reason – bringing food, selling food and drinks,  
1870 playing, passing through, carrying messages. The prevention of such activity is rightly the  
1871 concern of the Health and Safety requirements for working.