



GOVERNMENT OF SIERRA LEONE



SMALLHOLDER COMMERCIALISATION AND AGRIBUSINESS DEVELOPMENT PROJECT

CONTRACT NO: SL – MAFS - 121003 - CS - QCBS

**Preparation of Conceptual Design, Procurement Support Services, Monitoring and Contract Supervision
of 4No Bridges in Sierra Leone**



DRAFT ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) REPORT

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ACRONYMS

ALARP	As Low as Reasonably Practicable
AOI	Area of Influence
ARAP	Abbreviated Resettlement Action Plan
dB	Decibel
DSL	Department of Surveys and Lands
EA	Environmental Assessment
EIA	Environmental Impact Assessment
ESIA	Environmental and Social Impact Assessment
ESS	Environmental Safeguards Specialist
ESSS	Environmental and Social Safeguards Specialist
EMP	Environmental Management Plan
ESMP	Environmental and Social Management Plan
ESO	Environmental and Social Officer
EPA-SL	Environment Protection Agency of Sierra Leone
ERM	Environmental Resource Management
FSU	Family Support Unit
FGD	Focus Group Discussions
GBV	Gender-Based Violence
GDP	Gross Domestic Products
GoSL	Government of Sierra Leone
GRM	Grievance Redress Mechanism
IFC	International Finance Corporation
JSS	Junior Secondary School
LC	Local Council
LGA	Local Government Act
MOF	Ministry of Finance
MAF	Ministry of Agriculture and Food Security
NACSA	National Commission for Social Action
NEAP	National Environmental Action Plan
NGO	Non-Government Organization
NWRMA	The National Water Resources Management Agency
ONS	Office of the National Security
PA	Protected Area
PAP	Project Affected Person
PCD	Public Consultation and Disclosure
PCDP	Public Consultation and Disclosure Plan
PCMP	Paramount Chief Member of Parliament
PCU	Project Coordinating Unit
PGC	Project Grievances Committee (PGC)
RPF	Resettlement Policy Framework
RAP	Resettlement Action Plan
ROW	Right of Way
SALWACO	Sierra Leone Water Company
SCADeP	Smallholder Commercialization and Agribusiness Development Project
SIA	Social Impact Assessment
SLEPA	Sierra Leone Environmental Protection Agency Act 2008
SLP	Sierra Leone Police
SLRA	Sierra Leone Roads Authority
SMEs	Small and Medium Enterprises
SSS	Senior Secondary School
ToR	Terms of Reference
WASH	Water, Sanitation and Hygiene
WB	The World Bank
WFP	World Food Programme
WHO	World Health Organisation

EXECUTIVE SUMMARY

The Government of Sierra Leone received financing from the International Development Association (IDA) of the World Bank Group (WBG) towards the cost of the Smallholder Commercialization and Agribusiness Development Project (SCADeP), to promote smallholder commercialization by fostering productive linkages between smallholder farmers and selected agribusiness firms in Sierra Leone.

The Smallholder Commercialization and Agribusiness Development Project (SCADeP) is a project that seeks to promote agricultural productivity and commercialization through improved access to markets, improved access to finance as well as the development of inclusive smallholder farmer agribusiness linkages in the targeted project areas of Sierra Leone. This support will help to link high agricultural production areas to markets. The specific focus will be on those rural roads and connecting bridges that link markets to production areas with high volumes of perishable crops and produce.

The Government of Sierra Leone in support of the Smallholder Commercialization and Agribusiness Development Project (SCADeP) requested additional financing (AF) of US\$30 million and an extension of the Closing Date from November 30, 2021, to June 30, 2024. The additional finance (AF) would address the project's financing gap for its feeder roads sub-component due to: (a) the withdrawal of the United Kingdom Department of International Development (DfID) from the financing of the project and (b) higher costs than anticipated at appraisal for this sub-component. The additional financing was accompanied by a Level 2 restructuring to enhance the achievement of the Project Development Objective (PDO) and strengthen the development impact of SCADeP. In particular, the AF would fund the construction of strategic bridges. The Government of Sierra Leone has proposed the construction of composite bridges at the four (4) -ferry river crossings to replace the current unmotorized cable ferry being used to cross the rivers. In their current state, the ferries are unsafe, and unreliable and do not provide all-year-round access. This mode of operation limits connectivity and economic opportunities. Farm produce cannot get to market on time, while access to social services is limited by a lack of regular crossing. Based on the strategic importance of the connectivity of these ferry crossings, the AF will be used to construct bridges in priority locations.

This Environmental and Social Impact Assessment (ESIA) has been prepared for the construction of the proposed 4-Bridges project in the Bonthe, Kenema, Kailahun, and Karene Districts in Sierra Leone. The proposed construction of bridges has been evaluated using a thorough environmental and social impact assessment methodology comprising the following:

- Review of compliance with the Sierra Leone legislation and institutional framework and international guidelines,
- Description of the project,
- Determination of the project area's physical (environmental) and social baseline conditions,
- Assessment of potential environmental and social impacts that may arise as a result of the construction and operation of the bridges. Mitigation measures were also developed to mitigate the impact,
- Development of an Environmental Management and Monitoring Plan.

Summary Table of the Four Bridges

No.	Ferry Crossing Name	District & Region	Route	River	Crossing Length (m)	Connecting Districts
1	Mattru Jong	Bonthe /Southern Region	Mattru-Rutile (B4)	Jong	160.0	Bonthe/Moyamba
2	Gendema	Kenema /Eastern Region	Blama-Boajibu-Gendema (B19)	Sewa	121.5	Kenema/Tonkolili

3	Manowa	Kailahun /Eastern Region	Manowa-Pendembu (B31)	Moa	161.5	Kailahun/Kono/
4	Tomparie	Kambia /Northern Region	Tomparie-Kamakwie (A12)	Kabba	161.5	Kambia/Karene

The bridge structures are an expensive investment, as most feeder roads do not have bridges and are interrupted or end at large river crossings. A few important, strategic, and high-traffic volume feeder roads are serviced by cable ferries which are managed by the Sierra Leone Roads Authority (SLRA). The rest of the roads are left to rely on dugout canoes and boats for connectivity or they just end at the river crossing. SLRA is currently managing motorized and non-motorized ferries at 14 major crossing points scattered on different roads and districts across the country. These ferry crossings create bottlenecks along the roads. They are unsafe, unreliable, and do not provide year-round access.

Furthermore, cable ferries operate only in the daytime with limited operation during the rainy season. The Government of Sierra Leone's priority is to replace all the unmotorized cable ferries. Usually, the strategic feeder roads are cut off during the rainy season and road users are forced to take uneconomical, long, and winding routes to get to their destinations. All this disrupts farmers' access to markets and ordinary citizens' access to essential services such as retail, hospitals/clinics, and education institutions to mention a few. The farm produce cannot get to market on time while access to social services is limited due to the lack of regular ferry crossing. Hence, there is an urgent need to replace unsafe cable ferries and dugout canoes by way of providing a safer and more reliable option of transportation.

The GoSL will use the proceeds of the Additional Finance to finance the construction of additional rural bridges to improve connectivity. The proposed bridges are to replace the current unmotorized cable ferry being used to cross rivers, very vital for connecting remote and vulnerable populations, to increase access to markets and services as well as increase people's adaptive capacity and resilience to shocks (health and natural disasters such as flooding; conflict, etc.). Considering the strategic importance of these cable ferry crossings, the additional finance will fund the construction of four of these bridges. The Additional Finance will prioritize crossing points that are critical to the economy and connectivity of districts with huge agricultural potential. SCADeP intends to use this Additional Finance for the consulting services and construction of four bridges at existing ferry crossings across the country.

The environmental and social impact assessment approach commenced with the collection of baseline data from each of the four bridge project sites and surroundings. This includes information about the local ecology, water resources, air quality, land use, cultural heritage, etc. The study also considered social and health aspects such as the demographics of the affected communities, potential displacement or resettlement issues, and the overall health and well-being of the population of the affected communities.

Following the data collection, the assessment identified potential negative impacts that may arise during the different stages of the bridge construction project. These impacts range from habitat destruction and loss of biodiversity to noise pollution, increased traffic, and disruption of local communities, amongst others. The assessment evaluated the magnitude, duration, and significance of these impacts, taking into account local regulations, international standards, and best practices.

Based on the identified impacts, the assessment then proposed mitigation measures and management strategies to minimize or eliminate adverse effects. These measures include implementing environmentally friendly construction techniques, establishing protective buffer zones, conducting regular monitoring and audits, and implementing community engagement and compensation programs. During the assessment, several factors were identified to be common to all four bridge project sites; however, some factors were site-specific and therefore treated as such.

Throughout the assessment process, stakeholders, including local communities, government agencies, environmental organizations, and experts, were consulted and their inputs were taken into account. This

participatory approach ensures that the concerns and perspectives of all relevant parties are considered in the decision-making process.

The confidence placed in the baseline data and results collected during the ESIA study of a bridges project is influenced by factors such as the quality of data collection methods, the expertise of the individuals involved, the implementation of quality assurance measures, transparency, peer review, adherence to established standards, and stakeholder engagement.

The ESIA also compared and analysed various alternatives for the construction of bridges. Based on the comparison of the different bridge deck options, the steel composite deck (Option 1) is recommended to be adopted as the superstructure and the multiple circular column piers (Option 1) founded on a spread footing or piles also be adopted for the substructure; the selected options are based not only on minimizing cost but also minimizing the environmental footprint of the project. The construction method takes less time to implement and therefore reduces the duration of negative environmental impacts during construction. The following main environmental and social risks and impacts have been identified:

Impact on Water Resources

Construction of the bridges will temporarily and permanently alter surface water flow patterns both upstream and downstream of the bridges including (i) restriction of flow due to bridge piers and abutments, (ii) modification of upstream and downstream flow depth and velocity, (iii) change in roughness due to clearance of vegetation and sediments, (iv) creation of eddies and vortices, (v) alteration of sediment and nutrients load of the surface waters, and (vi) impact on water availability. The drivers or sources of impact on water resources include: (i) cofferdam construction, (ii) bridge piers and abutment construction, (iii) clearing of riverine vegetation, and (iv) water extraction for construction purpose.

Impact on Surface Water Quality

Bridge and broader construction activities at project locations affect the quality of surface water resources. Since surface water and groundwater (particularly unconfined aquifers) are interrelated, water quality issues in surface water may be transmitted to the groundwater. Vegetation and land clearing for approach roads, cofferdams, bridge piers and abutment construction, and activities at construction material sites (borrow pits and quarries) exposes soil to erosion, leading to increased sediment and turbidity in surface waters. Disturbances to the riverbeds during construction can lead to increased turbidity and downstream sedimentation, affecting water clarity. Materials used in cofferdams, or failure of silt ponds, can wash sediments into the river, increasing turbidity and introducing contaminants. Excavation and grading of riverbanks may heighten erosion, introducing additional sediments into the river. Poorly managed solid waste and work yard runoff can contaminate nearby water bodies. Runoff from the construction site can introduce pollutants like oils, greases, and chemicals, negatively impacting water quality and aquatic organisms. Accidental spills pose contamination risks to local drainage systems and farmlands adjacent to water bodies.

Impact on Aquatic Habitats and Biodiversity

Clearing of aquatic and riverine vegetation at bridge construction sites may eliminate the effect on aquatic habitats and pose an impact on the biodiversity of the project area of influence. Cofferdams temporarily alter the natural flow of rivers and streams, affecting aquatic flora and fauna. Bridge construction can disrupt the river's natural flow and habitat continuity, which affects ecosystem function and biodiversity. Construction noise and vibration may interfere with aquatic species, affecting their behaviour, communication, and nocturnal patterns. The construction of bridges, particularly through piers installation (e.g., pier, abutments, and cofferdam construction), can temporarily affect the benthic environment of the rivers.

Impact on Fisheries

Construction of cofferdams, bridge piers, and abutments may affect aquatic organisms including fish. The baseline assessment shows that fisheries are available at the project bridge locations and thus the

planned construction activities may affect fisheries on which the livelihood of the local communities depend. The impact on fisheries include: (i) damage to aquatic and riparian habitats which are feeding and breeding places for fishes; the habitats could be damaged through loss of submerged and emergent aquatic vegetation, loss of riparian vegetation, and undesirable change in river morphology and hydrology, (ii) pollution of rivers, (iii) introduction of invasive species, and (iv) interference with movement of fishes including through improper design and construction of cofferdams, piers, and abutments, insufficient water depth at bridge locations, and alteration of the physical characteristics of the bridges.

Impact on Terrestrial Habitats and Biodiversity

Flora: No rare, threatened, or endangered species was found during the survey within the proposed locations for the four bridges. This could have been a result of the intense vegetation clearance for building developments, especially at the Mattru bridge location; extensive clearing by artisanal miners at the Gendema bridge location; shift cultivation, timber logging, and other ongoing human activities at Tompari and Manowa bridge locations. The clearing of secondary-growth vegetation for the proposed bridge construction project at the four sites is unlikely to have a significant impact on the flora of the affected areas.

Fauna: Ongoing land clearance by artisanal miners, forest timber harvest, farming, and other human activities in the proposed bridge locations disturb the faunal population through habitat loss and fragmentation. The proposed project activities (especially borrow-pits and quarries) would affect remaining sensitive animals and potentially result in their temporary displacement from their current habitats. Access tracks and other associated infrastructure construction also cause fragmentation of terrestrial habitats, causing disturbance and displacement. Construction workers may engage in fauna hunting. Also, construction traffic may hit and kill fauna.

Impact on Soil and Erosion

During the construction and operation of the four bridges and associated approach roads, several potential impacts on soil/land may arise. These include: compacted soils from roads and construction activities may lead to increased surface runoff and soil erosion, affecting nearby land and water bodies; oil spills from machinery and construction equipment can lead to soil contamination, impacting soil health and agricultural potential; and salvaged topsoil intended for reclamation may be compromised, increasing the risk of flooding, siltation, and inundation in low-lying areas. The bridge construction projects may also result in soil erosion. Activities such as excavation, and earthwork activities like the use of borrow pits, quarry sites, and sand pits will give rise to a heavy concentration of particulate load that will lead to soil erosion.

Air

Air quality impacts comprising both dust and exhaust emissions arising from land clearance, stockpiles, vehicles, and machinery have been identified as primary emission sources. The implementation of standard mitigation measures involving adequate dust suppression by water spraying, covering of stockpile, and machinery selection will result in no major impacts.

Noise and Vibration

Noise sources vary from machinery operation and transport noise is considered to be potentially the most significant. If occupational noise limits are maintained within operational areas (communities), then it is predicted that appropriate environmental noise standards will be met at a distance from the core operational area.

Impact from Construction Waste

During the construction of the four bridges and approach roads, significant amounts of construction debris were generated. This includes materials such as concrete, steel, wood, and other construction-related waste. The disposal of this debris can increase waste production in the project areas if proper waste management practices are not followed. The bridge construction activities, particularly the construction of the approach roads, will involve extensive excavation work, which generates soil and

rock debris. If not managed appropriately, this waste can contribute to increased waste production in the surrounding project areas.

Impact from Hazardous Materials and Waste

During the construction period, a wide range and substantial volumes of hazardous waste may be generated including oils, fuel, grease, and chemicals from plants, equipment, and vehicle servicing. Hazardous materials and waste will pollute the environment and affect the health of workers and the local communities.

Impact from Construction Camps

Construction camps usually comprise office building, workers' accommodations, catering and eating areas, water and energy supply, clinics, laboratory facilities, garages, workshops, storage areas, parking spaces, etc. These facilities will utilize resources, generate waste, and expose workers to occupational health and safety risks. Further, the construction camps and workers' interaction with the surrounding communities will result in environmental pollution, resources competition, and community health and safety risks.

Occupational Health and Safety Risks

Occupational health and safety risks and impacts during the construction of the project bridges and approach roads arise from hazardous work sites, construction equipment and machinery, transport vehicles, lack of signs (informative and warning), etc. These result in physical, chemical and biological hazards. Physical hazards include being struck by moving machine and equipment, noise and vibration, working environment temperature, electrical hazards, eye hazards, work at height, excavation hazards, traffic hazards, ergonomic and manual handling, housekeeping, and lone/isolated worker. Chemical hazards include hazardous materials, poor air quality, fire and explosion. Biological hazards include wastewater or gray water from construction camps and garages, in drainage channels in/near urban centres or settlement areas, airborne pathogens such as common cold, influenza, and COVID-19, stinging insects and venomous animals, poisonous plants, and contaminated sharps in solid wastes.

Traffic and Road Safety Risks

Heavy vehicular movement between the worksite, campsite, work yard, and along materials haulage routes will significantly increase due to the construction activities. This intensified traffic, especially on shared haul roads, will impact local communities, travellers, and project employees. The concurrent use of these roads by project vehicles, public vehicles, and regular community motorists will lead to vibration and noise impacts, particularly near work sites, borrow areas, and quarries. Additionally, pedestrians, livestock, and commercial bike riders along these routes face increased risks from construction traffic.

Impact of Construction Materials Transport

Environmental impacts of construction materials transport include air pollution and dust from trucks degrade air quality, impacting nearby homes, crops, and water sources; soil erosion and contamination occur as unpaved roads degrade, with possible material spills affecting local soils and agriculture; and noise pollution disrupts village tranquillity and can disturb local wildlife. Socioeconomic impacts of construction materials transport include increased safety risks for villagers, particularly pedestrians, cyclists, children, and livestock; repeated heavy traffic damages community infrastructure, leading to more frequent road repairs and access challenges; daily life is disturbed by noise, dust, and road congestion, affecting schools, markets, and social gatherings; higher road maintenance costs may strain local government or community budgets; local businesses may experience reduced foot traffic due to noise, dust, and safety concerns; and agricultural productivity can decline as the dust settles on crops, impacting farmers' livelihoods.

Impact of Bridge Construction on River Traffic

Bridge construction near river crossing sites can create temporary hazards for small wooden boats, canoes, and ferries. Construction may obstruct typical routes, increasing the risk of collisions and forcing operators to navigate around unfamiliar barriers. Construction may lead to temporary changes

in the river channel, including alterations in water depth, width, or flow patterns, which can restrict navigation. These changes increase the risk of boats getting stuck, grounding, or capsizing, especially if the channel is not clearly marked or if navigation aids are lacking. Bridge construction activities, such as temporary cofferdams, may alter river flow, resulting in increased water velocity or turbulence. This can make navigation more challenging, particularly for small boats or inexperienced operators, increasing the likelihood of accidents.

Impact of Borrow Pits and Quarry Sites

Borrow pits and access roads are often developed in highly erodible materials, which can lead to increased erosion, especially in sensitive landscapes, potentially degrading surrounding areas. Deep pits created during quarrying or removal of soil materials can pose safety risks, especially if they fill with water during the wet season, becoming potential drowning hazards and breeding grounds for disease-carrying insects. The movement of vehicles and machinery to and from borrow pits can raise dust levels, potentially impacting air quality and visibility for nearby communities, especially during the dry season. Borrow pits and quarry sites, particularly those in elevated areas, can leave visible scars on the landscape, diminishing the visual quality of otherwise pleasant views.

Visual Impacts

Visual impact can be both temporary and permanent. During the construction phase, activities such as clearing vegetation, excavation, and other preparatory work can alter the appearance of the site. Once the bridge is completed, it may have a lasting impact by obstructing or altering important views, such as landforms or landmarks.

Socio-Economic Impacts

The Subproject will generate employment opportunities and create accessibility which will inadvertently enhance access to essential services, like healthcare, police, education, trade, and most importantly safe transportation. Locals will also have the opportunity to enhance their skills in various areas of construction and engineering. Procurement from local suppliers will increase and payment to the Government of Sierra Leone in the form of taxes, royalties, and duties. The economic opportunities created by the project are expected to lead to an influx of local migrants from surrounding areas which might also increase social ills, such as crime, alcoholism, drug abuse, and prostitution. On the other hand, people such as traders selling along these crossing points, boats and canoes operators, ferry operators, and labourers might permanently lose their livelihoods, and these people need to be supported either with cash to start up with other sources of livelihoods or are to be helped with employment opportunities. Fishermen, especially those fishing downstream might be affected temporarily during the construction phase of the project and need to be supported with other livelihood sources. The compensation of project-affected persons (PAPs) is comprehensive and duly addressed in the project Resettlement Action Plan (RAP).

A key element and outcome of the ESIA process is to explore and develop practical mitigation measures for avoiding or reducing potential impacts associated with the proposed bridge construction project. The mitigation measures will be incorporated into the project either as direct design measures or as commitments to be implemented during the construction period. The approach taken to identify and incorporate mitigation measures into the project is based on a typical hierarchy of avoiding, minimizing, mitigating, and compensation. The full list of the environmental and social impacts and proposed mitigation measures can be found in Chapters 9 and 10.

The implementation of the measures necessary to minimize or offset adverse E&S impacts and enhance beneficial impacts, mitigation and benefit enhancement measures are identified in this ESIA, which is to provide a basis for shaping the Subproject so that overall E&S performance is enhanced. For this to be effective, E&S management must be fully integrated with the overall project management effort at all levels, which itself should be aimed at providing a high level of quality control, leading to a project that has been properly designed and constructed and functions efficiently throughout its life.

For the implementation of the Environmental and Social Management and Monitoring Plan, during the construction, decommissioning and operation phases of the Subproject, it is indicated an estimated budget of USD 370,000.

1 GENERAL BACKGROUND

1.1 INTRODUCTION

The Republic of Sierra Leone is a country on the southwest coast of West Africa. It is bordered by Liberia to the southeast and Guinea to the northeast. Two-thirds of the population of Sierra Leone is directly involved in agriculture. Agriculture is the largest employer. Rice is the most important staple crop with 85% of farmers cultivating rice during the rainy season. The Government of Sierra Leone received financing from the International Development Association (IDA) of the World Bank Group (WB) and the UK Department for International Development (DFID) towards the cost of the Smallholder Commercialization and Agribusiness Development Project (SCADeP), to promote smallholder commercialization by fostering productive linkages between smallholder farmers and selected agribusiness firms in Sierra Leone.

Sierra Leone has a road network of about 11,311km classified into Class A (primary), class B (secondary), and Class F (feeder roads). The classified feeder roads network is 4,152 km, but recent surveys put it at about 7,500km which includes community roads. Feeder roads alone account for more than class A and class B roads combined and are mostly located in the rural areas of Sierra Leone constituting about 60% of the total population (SSL, 2016). Sierra Leone has relatively high rainfall (about 3,000-3,500 mm/year) and a rainy season that lasts for at least six (6) months per year. With its hilly and valley landscape and that much rainfall, Sierra Leone has a road network that is crisscrossed by many rivers and streams which cause bottlenecks. Bridges are required to connect the road network along river crossings.

The Smallholder Commercialization and Agribusiness Development Project (SCADeP) is a five-year project that seeks to promote agricultural productivity through improved access to markets, improved access to finance as well as the development of inclusive smallholder farmer agribusiness linkages in the targeted project areas of Sierra Leone. This support will help to link high agricultural production areas to markets. The specific focus will be on those rural roads and connecting bridges that link markets to production areas with high volumes of perishable crops and produce.

Bridges have several economic aspects attached to them, the transporting of materials would be much faster and give a socio-economic boost to the project area. The bridges give better connectivity to the agricultural markets. The adverse climatic conditions like the flooding of rivers will not hinder the movement. At present, ferries are plying across these rivers, and during the rainy season, the ferry services are suspended. Some of the local rural population used country-made boats to cross the swollen rivers and were met with accidents and their lives. The objective of the present study is to develop a conceptual design for the four bridges, which requires an Environmental Social Impact Assessment Report (ESIA) and a Resettlement Action Plan (RAP) to identify and assess the potential environmental and social impacts of the Subproject activities with mitigation measures and to also make payment of compensation to project affected persons (PAPs) in the four bridge sites. People such as traders selling along these crossing points, boats and canoe operators, ferry operators, and labourers might permanently lose their livelihoods, and these people need to be supported either with cash to start up with other sources of livelihoods or to be helped with employment opportunities. Fishermen, especially those fishing downstream might be affected temporarily during the construction phase of the Subproject and need to be supported with other livelihood sources.

The key benefits expected from the rural connectivity investments under the project include economic diversification and growth in production and related increase in agricultural incomes,

market linkages, and greater commercialization as well as associated benefits of access to social services such as health and education by the rural population.

1.2 REQUIREMENT FOR ESIA

In Sierra Leone, ESIA is a legal and regulatory requirement for any sound project development and is also a key criterion for international lending institutions including the World Bank. The purpose of the ESIA is to document existing environmental and social conditions, describe the proposed construction and alternatives, identify potential impacts, develop mitigation measures to reduce or limit the impacts of the proposed construction activities to acceptable levels and develop the environmental and social safeguards tools needed to enhance performance. The ESIA also addresses activities through all stages of the Project; including pre-construction, construction, camp and works yard development, site rehabilitation, and reclamation of borrow pits, quarries, and other affected areas.

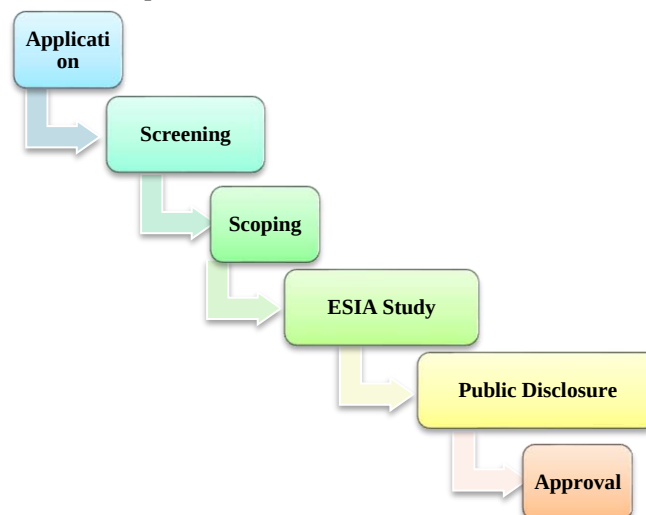
This ESIA will be made available to appropriate government agencies, departments, the World Bank, and all interested parties; it will also be made available to the public for review through public disclosure and consultation workshops. Public input is welcome and will be considered in the decision-making processes of both the Government of Sierra Leone and SCADeP.

1.3 THE ESIA PROCESS

The effectiveness of the ESIA process in this study is based on integrity to meet internationally and nationally accepted requirements and standard practices provide the information that is sufficient and relevant for decision-making and ensure that environmental and social safeguards are sufficient to mitigate identified potential impacts and avoid irreversible loss of resources and ecosystem functions.

The ESIA process of this study followed the requirements of the legislation of the Environment Protection Agency Act, 2022, and the World Bank's Safeguards policies (Operational Policies). These include Environmental Assessment OP/BP 4.01, Natural Habitats OP/BP 4.04, Forests OP/BP 4.36, Physical Cultural Resources OP/BP 4.11, Involuntary Resettlement OP/BP 4.12 that are triggered for the 4No Bridges in Sierra Leone with the Additional Financing (AF) under the SCADeP project. The EPA- SL ESIA process begins with the application and submission of the completed screening form of the project for an environmental permit from the Environment Protection Agency of Sierra Leone. The under-mentioned flowchart indicates the ESIA process the developer went through to develop the ESIA.

Figure 1. EPA-SL Environmental Impact Assessment Process



1.4 OBJECTIVES AND SCOPE OF THE ESIA

The main objective of the ESIA process is to enable stakeholders to make informed decisions on the activities and impacts associated with the proposed bridge construction project. Additionally, this

process also allows stakeholders to obtain information and give feedback on the Resettlement Action Plan (RAP) that was being carried out alongside the ESIA study. The scope of this impact assessment is to assess the potential impacts of the Subproject on various environmental, social, and socio-economic receptors in the four bridge locations. This ESIA addresses all predicted potential impacts within the immediate worksite, adjacent communities, and other areas where there is potential for both primary and secondary impacts. Specifically, the ESIA report has the following objectives:

- Give an overview of the proposed project.
- Inform, consult, and engage relevant stakeholders on the proposed project activities.
- Describe the existing environmental and socioeconomic baseline
- Identify key areas of potential impacts associated with the project and suggest possible mitigation measures to address them
- Describe the ESIA approach to be adopted
- Identify and define an appropriate program for future consultation with stakeholders.
- Literature review that includes identification of legal frameworks, legislations, and policies pertinent to infrastructural development in Sierra Leone. This will capture data from articles, publications, and other secondary sources that may provide additional information for the study and project in general.
- Evaluate the predicted impacts on the various environmental attributes in the study area by using scientifically developed and widely accepted Environmental Impact Assessment Methodologies.
- Prepare an Environmental and Social Management Plan (ESMP) outlining the measures for improving the environmental quality, and also identify sensitive ecological settings that may require additional monitoring and reporting.

Public consultations and disclosure meetings will be held with all stakeholders including the affected communities at the chiefdom, district, and regional levels. These consultations will be held to present the findings of the ESIA and to solicit feedback and concerns from stakeholders. Mitigations for potential impacts will also be presented. Suggestions and inputs collected will form part of the public disclosure report.

1.5 NECESSITY OF THE PROJECT

The bridge structures are an expensive investment, most feeder roads do not have bridges and are interrupted or end at large river crossings. A few important, strategic, and high-traffic volume feeder roads are serviced by cable ferries which are managed by the Sierra Leone Roads Authority (SLRA). The rest of the roads are left to rely on dugout canoes and boats for connectivity or they just end at the river crossing. SLRA is currently managing motorized and non-motorized ferries at 14 major crossing points scattered on different roads across the country and in different districts. These ferry crossings create bottlenecks along the roads. They are unsafe, unreliable, and do not provide year-round access.

Furthermore, cable ferries operate only in the daytime with limited operation during the rainy season. The Government of Sierra Leone's priority is to replace all the un-motorized cable ferries. Usually, the strategic feeder roads are cut off during the rainy season and road users are forced to take uneconomical, long, and winding routes to get to their destinations. All this disrupts farmers' access to markets and ordinary citizens' access to essential services such as retail, hospitals/clinics, and education institutions to mention a few. The farm produce cannot get to market on time while access to social services is limited due to the lack of regular ferry crossing. Hence, there is an urgent need to replace unsafe cable ferries and dugout canoes by way of providing a safer and more reliable option of transportation.

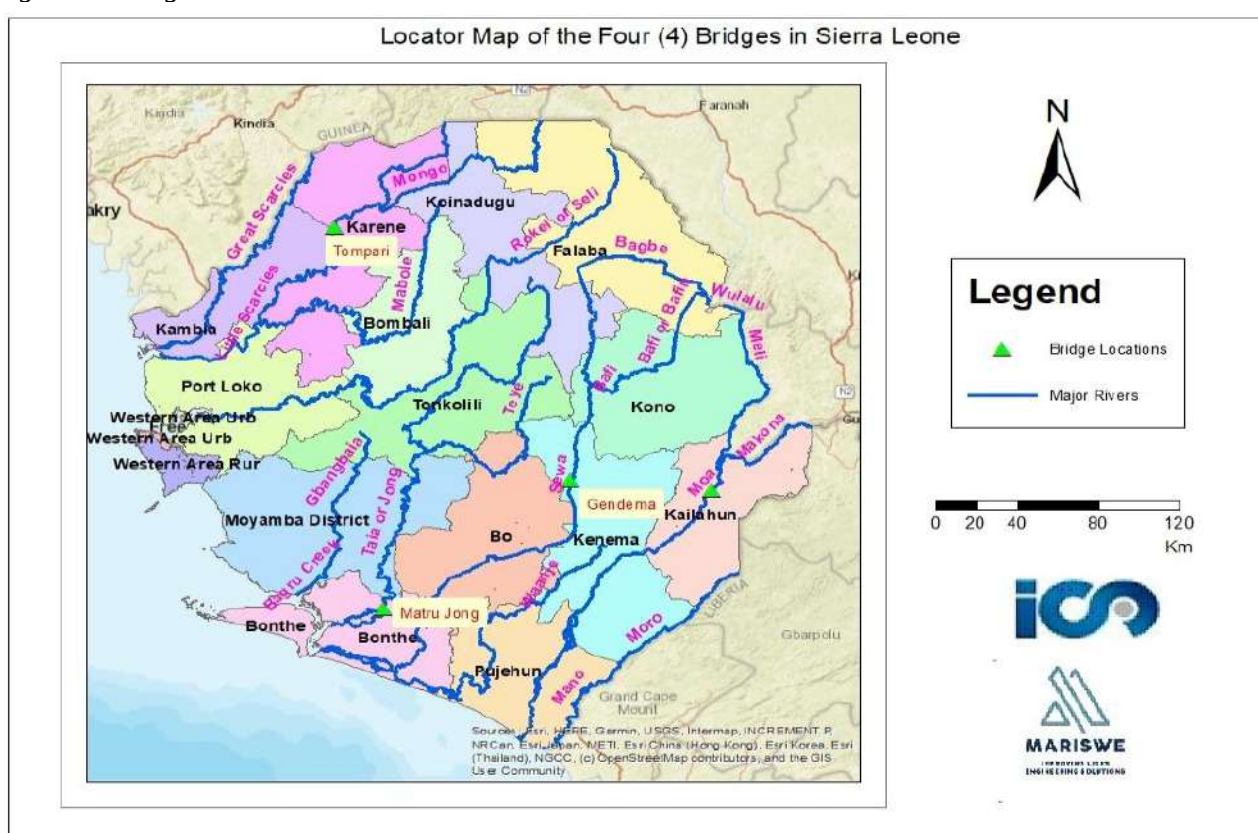
The Government of Sierra Leone will use the Additional Finance under SCADeP to finance the construction of four rural bridges to improve connectivity. The proposed bridges are to replace the current unmotorized cable ferry being used to cross rivers, very vital for connecting remote and vulnerable populations, to increase access to markets and services as well as increase people's adaptive

capacity and resilience to shocks (health and natural disasters such as flooding; conflict, etc.). Considering the strategic importance of these cable ferry crossings, the additional finance will fund the construction of some of these bridges, the number of which will be confirmed upon completion of technical designs. The additional finance will prioritize crossing points that are critical to the economy and connectivity of districts with huge agricultural potential. SCADeP intends to use this Additional Finance for the consulting services and construction of four bridges at existing ferry crossings across the country.

1.6 PROJECT LOCATIONS

The proposed four bridges are scattered across the country in 4-different districts and add vital connectivity with the areas in Sierra Leone. They are at the following locations: Mattru Ferry Crossing in Bonthe District, Gendema Ferry Crossing in Kenema District, Manowa Ferry Crossing in Kailahun District, and Tomparie Ferry Crossing in Karene District. The proposed bridge locations are shown on the map below.

Figure 2: Bridge locations within Sierra Leone



1.7 PROJECT PROPONENT

The SCADeP project is a part of the Ministry of Agriculture, Sierra Leone, which was formulated under the World Bank fund. So far, the SCADeP project has supported the rehabilitation and maintenance of 166 km of feeder roads and the construction of 192 culverts and 6 bridges, thereby providing year-round access to farms, markets, schools, and health centers for 77 communities in nine districts across the country. Average travel time on these roads has seen a significant reduction from 20min/km to about 2min/km. Another key accomplishment is a study to assess the agribusiness/out-grower landscape in Sierra Leone. This framework serves as a guideline for the creation of effective and mutually beneficial long-term partnership arrangements between farmers, nucleus commercial farmers, agro-processors, and exporters.

This additional financing for the Smallholder Commercialisation and Agribusiness Development Project (SCADeP) will support the construction of 250M of approach roads on each approaching road of the bridge, (500m in total) making it a total length of 2km of roads. Through these roads and bridges, the Project (SCADeP) will contribute to the improvement of rural connectivity thereby providing access to more remote areas of high agricultural production. Specifically, it will help build critical bridges across key river crossing points currently served by manual cable ferries. These manual ferries are mostly out of service due to increasing risks of accidents particularly during the rainy season when water levels are high. This framework serves as a guideline for the creation of effective and mutually beneficial long-term partnership arrangements between farmers, nucleus commercial farmers, agro-processors, and exporters.

1.8 ESIA REPORT STRUCTURE

This ESIA Report comprises twelve (12) chapters, as described in Table 1 below.

Table 1: ESIA Report Structure

Section	Title	Content
Executive Summary	Executive Summary	Overview of significant findings and recommended actions
Chapter 1	General Background	A brief overview of the project, deposit history and ownership, purpose and need for ESIA, and structure of the report.
Chapter 2	Approach and method	Description of the environmental impact assessment process
Chapter 3	Legal, Policy and Institutional Framework	Regulatory framework relevant to the project: Sierra Leonean legislation and policies, international policies, and best practices.
Chapter 4	Project Description	Location, description of construction operation, and its various components.
Chapter 5	Project Alternatives	Description and comparison of reasonable alternatives including the “no-go” option
Chapter 6	Environmental Baseline Conditions	Description of the current biophysical environmental conditions including climate, relief and topography, geology and stratigraphy, air quality, noise, soils, land capability, land use, surface hydrology, water quality, geochemistry, traffic, and transport. Biological: vegetation, mammals, birds, reptiles and amphibians
Chapter 7	Socioeconomic and Cultural Baseline and Living Conditions	Description of the socioeconomic and health environment, archaeology, cultural heritage, livelihood, education, transportation, etc.
Chapter 8	Consultation, Stakeholder Engagement, and Grievance Redress Mechanism	Describes stakeholder’s consultation and participation process, concerns and needs, and a summary of the SCADeP project-wide GRM
Chapter 9	Environmental and Social Risks and Impacts and Mitigation Measures	Describe potential impacts on the biophysical environment (intensity, area, severity, duration, frequency); and the principle of mitigation
Chapter 10	Environmental and Social Management and Monitoring Plans	Details the management actions to be put in place to mitigate environmental and social impacts. Describes principles of management, and management measures to be implemented to address significant impacts.

Section	Title	Content
	Appendices	Attendance lists, minutes of consultation meetings, pictures of field study, questionnaire instrument, and any other item of importance to the study.

2 APPROACH AND METHODOLOGY

2.1 INTRODUCTION

The Environment Protection Agency Act of 2022 established clear guidelines and procedures for the acquisition of an Environmental Impact Assessment (EIA) License and the necessary environmental standards and requirements that must be followed before setting up businesses, industries, and other non-industrial operations like infrastructural development that may have a direct or indirect impact on the environment and communities adjacent to its proposed project location. The mandate of the EPA-SL also includes the enforcement of compliance with relevant environmental impact assessment procedures laid down in the planning and execution of such development projects.

However, the stages leading to the acquisition of an EIA license are guided by laid-down standards and procedures which are the same for all sectors, including agriculture, mining, manufacturing, infrastructural projects, etc.

2.2 THE ESIA STAGES AND PROCESS

Typically, a standard ESIA study in Sierra Leone is broadly divided into five (5) discrete phases, each building upon the previous one as follows:

- Stage 1: Screening
- Stage 2: Scoping
- Stage 3: Baseline (Environmental and Social) studies
- Stage 4: Impact Assessment (Environmental Impact Assessment (EIA), Social Impact Assessment (SIA)), Analysis and Reporting
- Stage 5: Environmental and Social Management Plan (ESMP), Development of a Community Development Action Plan (CDAP) for commercial-based projects, and if applicable a Resettlement Action Plan (RAP) or an Abbreviated Resettlement Action Plan (ARAP).
- Stage 6: Public Disclosure and Consultation, and
- Stage 7: ESIA Review and Decision-Making for the EIA License

Stage 1: Screening

The screening was carried out to determine whether an ESIA study was required for the proposed development. It involved a preliminary determination of expected impacts on the environment and the relative significance of such impacts. Furthermore, the screening stage also gave a preliminary view of the category and scale of the proposed bridge construction. This information was used to make an informed decision on the type of study or studies that was required.

The EPA-SL has adopted a post-screening verification called “Ground-Truthing”. This process is typically carried out to confirm the GIS coordinates of the proposed location and the environmental and social features (receptors) of the proposed development. After this approval is issued, the ESIA proceeds to the next stage if found suitable. If the location is not suitable, then stop work or a request for an alternative is issued.

Stage 2: Scoping

During this stage, synoptic identification of possible issues and impacts that could arise in the development and operation of the proposed bridge project was done. At this point, stakeholder engagement and consultation were initiated and sustained. On the determination of the scope of the various environmental and social issues, this was used as a platform for subsequent impact assessments and possible mitigation measures to manage or ameliorate the likely negative impacts associated with the proposed development. In a nutshell, this is the stage where the terms of reference for the impact study and content of the ESIA report are documented in the scoping report for EPA-SL approval.

Stage 3: Baseline (Environmental and Social) studies

This stage included the following activities: Desk review; assessment of the Physical environment; Socio-economic survey; Development of GIS and Preparation of Social Base Maps; and Consideration of Project Alternatives/Design Options. Information on this will be part of the scoping report.

Stage 4: Impact Assessment (Environmental Impact Assessment (EIA), Social Impact Assessment (SIA)), analysis and Reporting

An assessment of the potential environmental and social impacts associated with the proposed construction project was done, and various mitigations and procedures for addressing these impacts have been suggested in the ESMP.

Stage 5: Development of Project specific Environmental Management Plan (ESMP), Community Development Action Plan (CDAP), and where applicable Resettlement Action Plan (RAP)

This aspect involved the description of procedures and standards that can be used in the prevention, management, and mitigation of potential environmental and social impacts. The proposed construction activities have been predicted with a potential for resettlement. Hence, a Resettlement Action Plan (RAP) was prepared to address the resettlement impact and compensation regime.

Stage 6: Public Disclosure and Consultation

Public disclosure and consultation will be held across all project communities to get feedback from affected and interested persons, and other agencies and departments of government. The views, comments, and suggestions that will be obtained from this process will be compiled and presented in a public disclosure report. The Disclosure Report will be submitted to EPA-SL as a document reporting to the ESIA.

Stage 7. ESIA Review and Decision-Making

Upon satisfactory completion of the above stages, the technical Staff team of the EPA-SL will review the ESIA and Disclosure Report, and if the Board of the EPA-SL is convinced that the ESIA is adequate and meets the requirements for the proposed project, the EIA License application will be approved and issued.

2.3 IDENTIFICATION OF IMPACTS

Identification of impacts starts with scoping and continues through the impact assessment. The core activity is the prediction, evaluation, and mitigation of impacts.

Prediction of impacts is essentially an objective exercise to determine what could potentially happen due to the development of the project and any associated activities. The diverse range of potential impacts considered in the ESIA process results in a wide range of prediction methods being used including quantitative, semi-quantitative, and qualitative techniques. The types of impacts considered have been categorized according to their various characteristics (for example, are they detrimental or beneficial, direct or indirect, etc.).

Impact arises as a result of Project activities either through direct interaction or by causing changes to existing conditions such that an indirect effect occurs. Accurate identification of potential impacts is the critical first step within the impact assessment process.

At this stage within the assessment process, all issues are screened and a judgment is made as to whether their potential impacts are of sufficient magnitude to cause a measurable impact. Where an impact is deemed to be so small as to be irrelevant, no further consideration will be given to them during the assessment process.

It is important to note that impact prediction takes into account any mitigation or control measures that are part of the Project design as described in chapter four. Additional mitigation measures aimed at further reducing predicted impacts are proposed where necessary or appropriate.

The tables below define the terminology used for the impact assessment methodology utilized within the ESIA concerning impact magnitude, nature, type, duration, extent, and likelihood.

Table 2: Impact Assessment Terminology

Impact Magnitude	Definition
Magnitude	Estimate the size of the impact (e.g., the size of the area damaged or impacted, the % of a resource that is lost or affected, the number of individuals affected, etc.)
Impact Nature	
Negative impact	An impact that is considered to represent an adverse change from the baseline, or introduces a new undesirable factor
Positive impact	An impact that is considered to represent an improvement on the baseline or introduces a new desirable factor
Neutral impact	An impact that is considered to represent neither an improvement nor deterioration in baseline conditions. Impacts identified as neutral are not subjected to further assessment.
Impact Type	
Direct Impact	Impacts that result from a direct interaction between a planned Project activity and the receiving environment (e.g., between the occupation of a plot of land and the habitats that are lost)
Indirect Impact	Impacts that result from other activities that are encouraged to happen as a consequence of the Project (e.g., the presence of the Project promotes service industries in the region)
Cumulative impact	Impacts that act together with other impacts to affect the same environmental resource or receptor. These are assessed in a separate standalone chapter.
Residual impact	Impacts that remain after mitigation measures have been designed into the intended activity
Impact Duration	
Short-term	Construction: impacts duration is shorter than the length of construction/and or a low frequency Operation: Impacts last a short period and/or low frequency
Medium-term	Construction: Impacts last within the construction period and/or intermittent frequency Operation: Impacts last over an extended period and/or intermittent frequency
Long-term/irreversible	Construction: Impacts last over the construction period, constant frequency (daily) Operation: Impacts last over an extended period; are irreversible and/or constant frequency (daily)
Impact Extent	
Local	Impacts are on a local scale (e.g., restricted to the vicinity of the mine sites or the immediate concession areas.
Regional	Impacts are on a broader scale (effects extend well beyond the immediate vicinity of the construction sites and affect the entire locality, chiefdom, and the rest of the provinces in which the bridges will be constructed).
International / Transboundary	Impacts are on a global scale (e.g., could extend beyond regional and national boundaries or affect the existence of species)

2.4 EVALUATION OF IMPACT SIGNIFICANCE

Assessment of the level of significance requires consideration of the likelihood and magnitude of the environmental and social effect, its geographical scale and duration to the sensitivity of the key receptors and resources. The process and definitions utilized in determining overall significance are described below.

2.4.1 Magnitude

Magnitude describes the actual changes predicted to occur in the resource or receptor and encompasses all the dimensions of the identified impact such as:

- The nature of the change
- The size or scale of intensity
- Its geographical extent and distribution
- Its duration, frequency and reversibility.

Magnitude criteria for the biophysical and socio-economic environment can be defined as follows:

Biophysical Environment: Magnitude can be considered in terms of the sensitivity of the physical and biodiversity receptors (i.e., air, soil, water, habitats, biodiversity, etc.).

- **Negligible** - the impact on the environment is not detectable
- **Low** - the impact affects the environment in such a way that natural functions and processes are not affected
- **Medium** - where the affected environment is altered but natural functions and processes continue, albeit in a modified way
- **High** - where natural functions or processes are altered to the extent that it will temporarily or permanently cease.

Socio-economic Environment: Magnitude can be considered in terms of the ability of project-affected people/communities to adapt to changes brought about by the project.

- **Negligible** – there is no perceptible change to people’s livelihood
- **Low** - People/communities are able to adapt with relative ease and maintain pre-impact livelihoods
- **Medium** - able to adapt with some difficulty and maintain pre-impact livelihoods but only with a degree of support.
- **High** - those affected will not be able to adapt to changes and continue to maintain impact livelihoods.

2.4.2 Likelihood

For planned events, a fundamental component of the impact assessment process, it is assumed that a particular impact will occur. Therefore, the likelihood (probability) that the identified impact will occur (based upon experience and/or evidence that such an outcome has previously occurred) for planned events is certain, that is, a 100% likelihood of occurring. For unplanned events, the likelihood (probability) of an event occurring has been ascribed using a qualitative scale of probability categories as described in Table 3.

Table 3: Likelihood categories

Impact likelihood	Description
Unlikely	The impact is unlikely to occur
Likely	The impact is likely to occur under most conditions.
Definite	The impact will occur.

The likelihood is estimated based on experience and/or evidence that such an outcome has previously occurred. Impacts resulting from routine/planned events (i.e., normal operations) are classified as having a definite likelihood of occurrence.

2.4.3 Assessment of Significance

The evaluation of impact significance is determined by assessing impact magnitude against the likelihood of the impact occurrence as shown in the table below. The significance and magnitude of the impacts have been evaluated according to the following significance classifications and definitions:

Table 4: Evaluation of Impact Significance (in the context of Magnitude and Likelihood)

SIGNIFICANCE (in the context of Magnitude and Likelihood)				
		LIKELIHOOD		
		Unlikely	Likely	Definite
MAGNITUDE	Negligible	Negligible	Negligible	Minor
	Low	Negligible	Minor	Minor
	Medium	Minor	Moderate	Moderate
	High	Moderate	Major	Major

The importance of impact is evaluated according to three criteria:

➤ **Negligible Importance**

The magnitude of impact is almost nil (negligible). It is far below the prescribed standards or laws and regulations in force. The effects are temporary and mostly remain at the level of natural variation.

➤ **Minor Importance**

The magnitude of impact is low. It is below the prescribed standards or laws and regulations in force. The effects are temporary and remain at the level of natural variation.

➤ **Moderate Importance**

The magnitude of impacts is moderate span a wide spectrum of impacts, from the point where the impact is considered as minor to the point where the magnitude of impact is close to exceeding an established (legal) standard or limit. Reversibility is only possible over several years.

➤ **Major Importance**

The impact is above the prescribed standard limits and is mostly irreversible.

2.4.4 Mitigation Measures

A key element and outcome of the ESIA process is to explore and develop practical measures for avoiding or reducing potential impacts associated with the proposed bridge construction project. These are commonly referred to as mitigation measures and will be incorporated into the project either as direct design measures or as commitments to be implemented. Mitigation is aimed at preventing or managing significant negative impacts on ALARP and optimizing and maximizing any potential benefits of the project, where applicable. For this ESIA, ALARP is defined as the point at which the cost and effort (time and trouble) of further risk reduction is grossly disproportionate to the risk reduction achieved.

The approach taken to identifying and incorporating mitigation measures into the Project is based on a typical hierarchy of decisions and measures, as outlined in Table 5:

Table 5: Mitigation Hierarchy

The Mitigation Hierarchy for planned project activities	
<i>Avoid at source; reduce at source.</i>	
Avoiding or reducing is essentially “designing” the project so that a feature causing an impact is designed out (e.g. a waste stream is eliminated) or altered (e.g. reduced waste volume) – often called minimization.	
<i>Abate at site</i>	
This involves adding something to the basic design or procedures to abate the impact – often called ‘end-of-pipe’	
<i>Abate at receptors</i>	
If an impact cannot be abated on-site then measures can be implemented off-site	
<i>Repair or remedy</i>	
Some impacts involve unavoidable damage to a resource e.g., land disturbance or pollution arising from poor erosion and sediment control management. Repair essentially involves restoration and reinstatement type measures, such as base camp closure or, in the case of surface erosion that has reached the ocean.	
<i>Compensate in kind</i>	

Where other mitigation approaches are not possible or fully effective, then compensation, in some measures, for loss, damage, and general intrusion might be appropriate. An example could be compensation for loss of earnings or where direct resettlement and compensation payments are required.

For the impact assessment presented within the ESIA, the final impact significance is deduced assuming that the proposed mitigation measures are to be implemented.

2.4.5 Identification and Evaluation of Residual Impacts

Following the identification of potential environmental and social impacts, their significance is assessed taking into account proposed mitigation measures. Mitigation measures are applied to reduce impacts to as low as reasonably practicable and as such may not be eliminated. These remaining impacts are thus termed residual impacts.

The primary objective of the ESIA is to understand the significance of these residual impacts that will remain after mitigation measures have been designed into the project such that some form of monitoring or measurement may be required.

The evaluation of the significance of residual impacts has taken into account all mitigation measures developed during Project Design; commitments made by PCU, and recommended additional measures developed to counter specific impacts.

2.5 TOOLS AND METHODS USED FOR THE ESIA PREPARATION

The approach and methodology adopted for this ESIA follow the established pattern for infrastructure projects that meet the requirements of EPA's Act of 2022 and WB's safeguards operational policies (OPs). Below are details of the approach, tools and methods adopted for the production of this ESIA on the construction of the 4 bridges in Sierra Leone with the Additional Financing (AF) under the SCADeP Project.

Definition of the Study Area: In consideration of the nature and the location of the potential future conditions and consequences, the Study Area has been identified. Therefore, the Project Area is the area in which implementation will bring about measurable and substantial direct changes to the physical environment and ecology, as well as the social and economic conditions.

The proposed four bridges construction are scattered across the country in 4-different districts that can add vital connectivity with the areas in Sierra Leone. These include Mattru Ferry Crossing in Bonthe District, Gendema Ferry Crossing in Kenema District, Manowa Ferry Crossing in Kailahun District, and Tomparie Ferry Crossing in Karene District. In this respect, the main bridge construction sites (in-land and water), working areas, campsites, material sources (areas identified for borrow-pit or quarry locations), approach and access roads, detours, storage areas, and waste disposal sites have been the principal areas of focus for fieldwork and data collection.

Collection and review of Available Information: The available project design information including the Feasibility Study has been reviewed with the objective to identify potential sources of E&S impact of the Subproject on the environment and socio-economic conditions.

Various published documents, regulations, and census reports were collected and reviewed. Information on existing environmental and social conditions, necessary to provide the background for impact identification and assessment has been obtained from these published sources.

The national legislative and institutional framework, policies, procedures, guidelines, etc. have also been reviewed. Moreover, WB's safeguards operational policies and other internationally recognized best practice materials were also scrutinized for the purpose.

Maps and Images: Topographic maps were used as resource material to select and indicate the different study sites in the proposed bridge locations. The walk-in survey was conducted in all of the sites visited across the four bridge locations. Maps were also used to identify and delineate villages, resources and facilities that could potentially be affected when the proposed Subproject activities are realized. GIS and Social Base Maps have also been used to assess the land use, vegetation cover, infrastructure, settlements and other environmental and socio-economic conditions within the Subproject's area of influence.

Field Investigation: Members of the ESIA Team have carried out site investigations whereby information on physical resources, ecological resources, socio-economic aspects, health, cultural and other values in the Subproject area have been collected. Various quantitative and qualitative data collection and information-gathering techniques were used during this ESIA undertaking.

Public Consultations: The field investigation also included extensive consultations with various community members as well as different stakeholders and local authorities in the project-affected area along the proposed four bridge construction sites. The consultations were carried out to obtain the views of the project-affected communities on various aspects of the proposed Subproject, background information relevant to impact assessment (identify any areas of specific concern which needed to be addressed in this assessment) and identification of mitigation measures.

Description of the Baseline Environment: Information on the existing natural and socio-economic resources is of fundamental importance for the evaluation of environmental and social impacts. Therefore, the baseline data on the physical, biological and social, cultural & socio-economic settings of the Subproject areas have been assembled, evaluated and presented.

Identification of Environmental and Social Impacts: Key potentially beneficial as well as adverse impacts on the physical, biological and socio-economic environment associated with the construction and operation phases of the Subproject have been identified and quantified where possible.

Environmental and Social Mitigation and Benefit Enhancement Measures: Feasible and cost-effective mitigation and benefit enhancement measures that may avoid or reduce potentially adverse environmental and social impacts to acceptable levels are identified and recommended.

Preparation of ESIA Report: The development of the ESIA report has concentrated on key issues and impacts, which are of importance in terms of affecting the overall environmental and social performance of the Subproject. This report also answers the essential questions needed to establish whether the Subproject as conceived is environmentally and socially viable or should be modified during the construction phase so as to become acceptable.

Disclosure: The ESIA report will be disclosed after the final draft has been reviewed and approved by the World Bank. Disclosure shall be made via Workshop(s) and public and stakeholder meetings at national, district and village levels, media outlets (including newspapers), uploading on the official websites of the Ministry of Finance, Ministry of Agriculture and Food Security (MAF), and SCADeP PCU but also other notable websites, disseminating to and displaying the document (hard and/or soft copies) at strategic locations including in MAF, SCADeP PCU, District Councils and other relevant public institutions including libraries in which the public could easily have access to, and local Radio stations at project locations and TV to broadcast excerpts of the document.

3 LEGAL POLICY AND INSTITUTIONAL FRAMEWORKS

3.1 INTRODUCTION

This Chapter provides a preliminary identification of the Sierra Leone regulatory and administrative framework and describes relevant legislation, international treaties, and industrial standards and guidelines that the proposed Project will follow. Specifically, this Chapter provides a summary of:

- Sierra Leone administrative and legislative organization,
- National environmental and social legislation deemed applicable to the Project,
- International conventions to which Sierra Leone is a signatory; and
- International standards and guidelines to which the Project will also align.

3.2 NATIONAL POLICIES AND LEGISLATIONS

There are many legislations, policies, and regulations governing the use of the Environment in Sierra Leone. These various acts, policies, and regulations are aimed at achieving sustainable development through the implementation of prudent environmental management systems that will enhance balanced productivity between man and the environment with minimum damage to the environment. These policies and legislations also have the prime aim of preventing or eliminating damage to the environment and biosphere and promoting the health, safety, and welfare of the nationals in general.

3.2.1 The Constitution of Sierra Leone, 1991

Section 15 of the Constitution states that: “... every person in Sierra Leone is entitled to the fundamental human rights and freedoms of the individual.” This includes protection from deprivation of property without compensation. Section 21(1) further stipulates that no property of any description shall be compulsorily taken possession of, and no interest in or right over property of any description shall be compulsorily acquired, except where land is required by the GoSL in the public interest.

For development activities, the Constitution makes provision for the protection of the rights of individuals to private property, and also sets principles under which citizens may be deprived of their property in the public interest as described in Section 21 (1) “No property of any description shall be compulsorily taken possession of, and no interest in or right over property of any description shall be compulsorily acquired, except where the following conditions are satisfied, that is to say:

- (a) the taking of possession or acquisition is necessary in the interests of defense, public safety, public order, public morality, public health, town and country planning, and the development or utilization of any property in such a manner as to promote the public benefit or the public welfare of citizens of Sierra Leone,
- (b) the necessity, therefore, is such as to afford reasonable justification for the causing of any hardship that may result from any person having any interest in or right over the property; and
- (c) Provision is made by law applicable to that taking of possession or acquisition:
 - i. for the prompt payment of adequate compensation; and
 - ii. securing to any person having an interest in or right over the property, a right of access to the court or other impartial and independent authority for the determination of his interest or right, the legality of the taking of possession or acquisition of the property, interest or right, and the amount of any compensation to which he is entitled and to obtain prompt payment of that compensation.

3.2.2 Environment Protection Agency Act, 2022

The Environment Protection Agency Act, 2008 (Act No. 11 of 2008) and the Environment Protection Agency Amendment Act 2010 have been repealed and replaced by the Environment Protection Agency

Act, 2022 under PART XII- MISCELLANEOUS PROVISIONS of the new EPA Act of 2022. The EPA Act, 2022, is the government of Sierra Leone's overarching environmental legislation and provides for the continuation of the Agency for more effective and efficient protection and management of the environment and other related matters relating to climate change and effective control and management of chemicals, toxic and hazardous substances. The regulations made under the repealed Act of 2008 shall continue to remain in force as if they were regulations made under the 2022 Act until they are revoked by the Minister of Environment. Also, any license issued under the repealed Act shall continue in force until expiration by the passage of time and shall be subject to renewal.

The Environment Protection Agency was established with a Board of Directors set up as its governing body. Subject to this Act, the control and supervision of the Agency is the responsibility of the Board, whose administrative functions as stipulated by the EPA Act, 2022 include the following:

- promoting effective planning and the management of the environment,
- coordinating and monitoring the implementation of national environmental policies relating to Sierra Leone,
- providing policy guidance and advice to ensure the efficient implementation of the functions of the Agency to enhance its overall performance,
- facilitating cooperation and collaboration among Government Ministries, local authorities and other bodies and government institutions, to control pollution and generally protect and improve the environment,
- coordinating environmentally related activities as well as serving as the focal point of national and international environmental matters, relating to Sierra Leone.
- Providing effective supervision of the generation, treatment, storage, transportation, and disposal of waste,
- Ensuring compliance with prescribed environmental impact assessment procedures in the planning and execution of development projects,
- Coordinate, all aspects relating to climate change to enhance consistency in policies, laws, and their implementation,
- Ensuring the development of standards and guidelines for the importation, transportation, storage, and use of all types of chemicals.

3.2.3 The Sierra Leone Roads Authority (Amendment) Act, 2010

The Sierra Leone Roads Authority (Amendment) Act of 2010 provides for the establishment of the Authority. The object for which the Authority was established was for the control, development, maintenance, efficient planning, and reliable management of the national road network to provide safe, reliable, and sustainable means of transport. The following are some of the responsibilities of the Authority among others:

- develop a national policy on the maintenance, rehabilitation, improvement, and management of the national road network and exercise control over its implementation,
- specify the national road network and determine a functional classification scheme,
- set the width of the right-of-way for roads that form part of the national road network,
- develop technical instructions and standards on roads forming part of the national road network,
- commission engineering, traffic, and economic studies for the maintenance, safety and improvement of the national road network,
- propose vehicle weight and dimension limits for the protection of roads, bridges and ferries and ensure their enforcement in collaboration with the relevant enforcement body,
- Provide technical guidance and support to local councils in the maintenance of roads devolved to them under the Local Government Act, of 2004,
- Support specialist road-related training organized or provided by anybody or person; the commission applied road-related research.

3.2.4 The Road Transport Authority Act (1996) (Amended to the Roads Safety Authority Act, 2016)

This is an Act to provide for the establishment of an authority for the regulation and development of the road transport industry, including the registration and licensing of vehicles, the licensing of drivers, the prescription of routes for passenger and goods transportation, and other related matters. The objectives for which the Authority is established are to regulate, coordinate, and promote efficiency in all activities within the road transport sector, and to enhance or improve the contribution of the sector to the economic development of Sierra Leone:

Responsibilities of the Authority include the following:

- to design and regulate rules and regulations regarding:
- registration and licensing of vehicles
- testing vehicle and driver fitness
- licensing of drivers
- the routing and monitoring of passenger and goods transportation
- to promote road safety through:
- the establishment and dissemination of a code of conduct, to be known as a Highway Code for drivers and other users of roads and highways
- to establish and maintain a data bank of relevant information on vehicles and the transportation industry as a whole
- The Authority has the power to impose and levy fines including vehicle licensing and registration fees with the approval of parliament.

3.2.5 The Road Maintenance Fund Administration Act, 2010

This is an Act to establish a Road Maintenance Fund and an administration for financing the maintenance of the core road network and to provide for other related matters. The object for which the Administration was established is the proper, efficient, economic, and sustainable management and administration of the Fund. The functions of the Administration include:

- Management and administration of the Fund
- Subject to this Act, approval of the amount of funding to be made available to the Authority from the Fund for the performance of the Authority's functions.
- Effective monitoring of the use of monies allocated from the Fund
- Approval of any application from any local council or body for funding from the Fund, of any road-related activity.

3.2.6 The Road Traffic Act, 2007

The Road Traffic Act of 2007 serves to consolidate, with amendments, the law relating to road traffic and to provide for other related matters. The Act provides guidelines on:

- The registration and licensing of motor vehicles and trailers
- Licensing of drivers
- Registration of driving schools
- Establishment of vehicle examination centers and stations
- General provision and offenses.

3.2.7 National Environmental Policy, 2013

This National Environmental Policy seeks to achieve sustainable development in Sierra Leone through the implementation of sound environmental management systems that will encourage productivity and harmony between man and his environment. It also promotes efforts that will prevent or eliminate damage to the environment and biosphere and stimulate the health and welfare of nationals and serve to enrich the understanding of ecological systems and natural resources important to the Nation. Thus, the key objective of the policy is to secure for all Sierra Leoneans a quality environment that can adequately provide for their health and well-being. The policy indicates inter-sectorial synergies in major areas for policy formulation. It takes into consideration major sector goals and policies for enhancing sustainability in environmental management systems.

Applicability to the Project: The ESIA will be carried out to comply with the obligatory requirements of the NEP. In the construction of roads, degradation, and other significant impacts may likely occur on the environment. The following sectorial policies are highlighted within the NEP:

- Land Tenure, Land Use, and Soil Conservation
- Water Resources Management
- Forestry and Wildlife
- Biodiversity and Cultural Heritage
- Air Quality and Noise
- Sanitation and Waste Management
- Toxic and Hazardous Substances
- Mining and Mineral Resources
- Coastal and Marine Resources
- Working Environment (Occupational Health and Safety)
- Energy Production and Use
- Settlements, Recreational Space, and Greenbelts
- Public Participation
- Quality of Life
- Gender Issues and the Environment
- Institutional and Government Arrangements
- Legal Arrangement.

3.2.8 National Lands Policy of Sierra Leone, Version 6, 2015

To address this situation, in 2015, Sierra Leone launched the National Land Policy, the first-ever comprehensive land policy reform since 1966. The policy aimed to safeguard access to land, set the framework for large-scale land investments, and improve tenure security for marginalized groups such as women and youth.

At the provincial level, the policy introduced Chiefdom Land Committees (CLCs) to administer land in the chiefdoms of Sierra Leone. As land in rural areas is the most valuable household asset, policymakers hoped the reform would boost economic activity--households could commercialize their lands. The security of tenure would allow people to use their land more successfully as collateral for business loans. Additionally, policymakers hoped the reforms would allow households to increase profits from land lease agreements and other transactions. To reduce conflicts, CLCs were to mediate disputes arising between individuals, stakeholders, and marginalized groups over the land in the chiefdom.

This policy brief examines the economic and social impact of the CLCs in the chiefdoms ahead of the impending parliamentary revision to the 2015 National Land Policy.

Applicability to the Project: During the implementation of this project, land may be acquired for excavation, construction of a campsite, works yard, installation of machinery, and other equipment. Contractors will implement the necessary measures described in the ESIA report to ensure proper reclamation work.

3.2.9 National Biodiversity and Strategic Action Plan, 2017-2026

Sierra Leone's Second National Biodiversity Strategy and Action Plan 2017-2026 is a cross-sectorial national strategy whose main objective is to conserve Sierra Leone's biodiversity well through sound and holistic national legislation and policy implementation across all sectors. The main themes are Wildlife, Forest Biodiversity, Agricultural Biodiversity, Freshwater, Marina, and Coastal Biodiversity. The cross-sector strategies and crosscutting issues include financial resources, policies, regulations and legislation, research and training, capacity building, public participation, planning, monitoring, conservation of protected areas, sustainable use, incentive measures, public education, impact assessment, access to technology, information exchange, sharing of benefits and indigenous knowledge.

3.2.10 The National Disaster Management Agency (Amendment) Act, 2020

Being an Act to provide for the establishment of the National Disaster Management Agency to manage disasters and similar emergencies throughout Sierra Leone, to establish offices of the Agency throughout Sierra Leone, to establish national, regional, district, and chiefdom disaster management committees, to establish a National Disaster Management Fund to provide finances for the prevention and management of disasters and similar emergencies throughout Sierra Leone and to provide for other related matters. The Agency also implements government policy on disaster prevention, disaster risk reduction, and climate risk management; and national, regional, district, and chiefdom disaster management plans; disseminate information and conducts public education on human activities most likely to cause disasters in Sierra Leone; the hazards and natural disasters likely to affect any region, district or chiefdom in Sierra Leone; control the action and relief measures to be taken by the government in the event of a disaster; and ensure public co-operation with designated authorities in the event of a disaster. The Agency also facilitates the development of communities and community-based organizations to respond effectively to disasters and improve social mobilization, employment generation, and poverty reduction.

The Policy document emphasizes the following:

- Ensure the integration of disaster risk management into sustainable development programs and policies to ensure a holistic approach to disaster management
- Ensure priority and requisite institutional capacities for disaster risk reduction at all levels
- Enhance the use of knowledge, education, training, innovation, and information sharing to build safe and resilient societies
- Improve the identification, assessment, monitoring, and early warning of risks
- Improve the effectiveness of response through stronger disaster preparedness.

3.2.11 Disaster Risk Policy 2018

The disaster management Policy is a comprehensive approach that enhances increased political commitment to disaster risk management thereby encouraging government agencies to take the lead and be supported by non-governmental organizations. It also promotes public awareness and the incorporation of disaster risk management into development planning. The policy highlights the sources of funding and the reduction of bureaucracies in accessing such funds for effective disaster coordination.

3.2.12 Child Act, 2007

Part III of the Act stipulates the Employment of Children, the minimum age at which free education ends, when children can engage in full-time employment or apprenticeship at fifteen (15 years) though the Act allows children to engage in light work (non-strenuous and non-hazardous work) at the age of thirteen (13) but only persons eighteen (18) years and above can engage in hazardous work such as civil works. The Act which prohibits children from working at night also set conditions for apprenticeship.

3.2.13 Sierra Leone Meteorology Agency (Amendment) Act, 2022

The Sierra Leone Meteorological Agency Act, of 2022, is an Act to amend the Sierra Leone Meteorological Agency Act, 2017 aimed at establishing the Sierra Leone Meteorological Agency to serve as the sole authority for the provision of meteorological and climatological services throughout Sierra Leone. The agency will be responsible for informing the public about weather patterns based on the recordings of credible and reliable weather data for agriculture, marine, and disaster preparedness relating to early warning signs. The act also emphasizes some functions of the agency as follows:

- Promote the use of meteorology in agriculture; food monitoring; and the monitoring of flood, drought, desertification, and other related activities.
- Establish, organize, and manage both surface and upper air observational station networks throughout Sierra Leone as approved by the board.
- Collect, process, store, and disseminate meteorological and climatological information both nationally and internationally following rules and practices, and procedures established under various conventions.

3.2.14 Conservation and Wildlife Policy 2010

The vision of the policy document was to establish “an integrated wildlife sector that achieves sustainable, rights-based management of wildlife resources for biodiversity conservation inside and outside wildlife conservation areas.” The policy presents a plan for biodiversity conservation based on a set of “policy statements” outlining concrete policy goals and develops the necessary institutional arrangements for policy implementation. The Conservation and Wildlife Policy (2010) was developed in recognition that the previous wildlife conservation policy required modernization. Current legislation based on the 1972 Wildlife Conservation Act (as was the case of the previous wildlife conservation policy) does not reflect the advances made in biodiversity conservation in the past four decades nor, does it take into account international obligations that arose after it entered into force, such as the Convention on Biological Diversity (CBD), the Convention on International Trade in Endangered Species (CITES) and the United Nations Framework Convention on Climate Change (UNFCCC). The Conservation and Wildlife Policy identifies those challenges to biodiversity conservation in Sierra Leone that result from a lack of knowledge due to “recent conflict, land use change, uncontrolled exploitation of natural resources, and a lack of recent comprehensive inventory”.

3.2.15 The National Protected Area Authority and Conservation Trust Fund Amendment Act, 2022

National Protected Area Authority and Conservation Trust Fund Amendment Act, 2022, being an Act to amend the National Protected Area Authority and Conservation Trust Fund Act of 2012 is to provide continuation of the established Authority to exercise oversight authority over National Parks and Protected Areas designated for conservation purposes to protect the fauna and flora in its natural state, promote sustainable land use practices and environmental management. The Authority has amongst others the responsibility to:

- ensure the protection of natural ecosystems and threatened biodiversity in Sierra Leone including the establishment and maintenance of representative and sustainable samples
- oversee the management of local and private nature reserves and sanctuaries throughout Sierra Leone including zoos and wildlife rescue and rehabilitation centres
- supervise the management of wildlife outside conservation areas
- regulate wildlife conservation and management throughout Sierra Leone following the Wildlife Conservation Act, of 1972 (Act No. 27 of 1972)
- promote eco-tourism in Protected Areas
- develop and implement wildlife conservation education and training programs throughout Sierra Leone
- promote biodiversity research
- formulate and implement awareness activities for local communities, schools, and local administration to promote knowledge of and participation in programs and services, relating to socioeconomic and environmental issues including, fisheries, agricultural and forestry best practices, forest management, land, soil, and water conservation in Protected Areas ‘and buffer zones; operate, manage the National Protected Areas in line with national conservation policies and laws
- enter into public-private partnership agreements for the management of National Protected Areas
- development and approval of management plans, zoning and National Protected Area regulations; development of national biodiversity and conservation policies in line with international best practices.

3.2.16 Monuments and Relics Ordinance, 1946 (upgraded into an Act in 1962)

The Act provides for the Preservation of Ancient, Historical, and Natural Monuments, Relics and other Objects of Archaeological, Ethnographical, Historical or other Scientific Interest. The Monuments and Relics Commission was set up as a semi-autonomous corporate body, with its members appointed by the government. An amendment to the Act in 1967 gave the power to the Monuments and Relics Commission to have the responsibility of ensuring the preservation cultural heritage assets. This is achieved by identifying important aspects of our heritage and culture that can be preserved, shared,

enjoyed and studied by present and future generations.

3.2.17 The Integrated Transport Policy, Strategy, and Investment Plan, 2013

The objective of the ITPSIP is to anticipate and respond appropriately to the growing and changing transport needs of the country in a sustainable manner. “Sustainable” has both physical (infrastructure and transportation services) and organizational (industry structure) dimensions: The transport solution must address a real and not perceived need by matching the service provided to the nature of the demand, including the selection of appropriate modes. Initially, the minimum qualities required of the service are safety and predictability. Later on, sustainability is ensured by introducing choice (competition). The specific transport solution must be managed by the entity best equipped to understand and address the question involved, and that entity must not be conflicted. That entity must be self-supporting in terms of funding, skills, and other resources. These attributes will ensure an efficient, least-cost transport system that can endure over time. The ITPSP must unpack this understanding into discrete principles that the Strategy can convert into practical actions. The Policy section of the ITPSIP underpins the more exhaustive Strategy. It briefly reviews the transport needs of the country and shows how well these are addressed by the transport system today. Based on this understanding, the basic attributes of the required national transport system are identified and converted into clear guiding principles that then direct the Strategy. The Strategy converts the overall policy objectives into tangible interventions for which responsibility can be assigned and the results monitored. It is divided into two parts. Part A addresses the physical transport system comprising transport infrastructure and transportation services, in other words, the desired type and level of service required by the users and beneficiaries of the transport system. The physical transport interventions contained in the Strategy are shown on a pull-out map at the end of this document. Whereas part A represents the “function” of the transport system, part B addresses the organizational “form” the sector should take to achieve the desired transport outputs and outcomes.

3.2.18 National Water Resource Management Agency Act, 2017

This is an Act to provide for the equitable, beneficial, efficient, and sustainable use and management of the country’s water resources through the establishment of a National Water Resources Management Agency. It also provides for the establishment of a Water Basin Management Board and Water Catchment Area Management Committees for the management of water resources and other related matters. The National Water Resources Management Agency shall be responsible for ensuring that the water resources of the country are controlled sustainably.

3.2.19 Local Government (Amendment) Act, 2017

Being an Act to amend the Local Government Act, 2004, to provide for the addition of new districts created under the provinces (Administrative Division) Order, 2017, and other related matters. This Act in its First Schedule includes the new districts of Falaba and Karene. Part II of this schedule also establishes the number of Paramount Chiefs in each Local Council.

Applicability to the Project: Public consultation and community involvement constitute a core element of World Bank and SCADeP’s operations. The implementation of the Community Development Action Plan will be done in collaboration with the affected communities, local councils, and other relevant stakeholders.

3.2.20 The Explosives Ordinance Of 1955

The Explosives Ordinance of 1955 is the main legal instrument regulating explosives in the country and makes provision for the manufacture, import, and export of explosives. The Ordinance provides for the licensing of the importation of explosives by the Inspector General of the Police Force. The Ordinance also makes provision for the licensing of:

- Purchase of explosives
- Transportation of explosives within the country; and
- Storage facilities for explosives.

Despite the provisions of the Ordinance, the importation and transportation of explosives into the country involves several arms of the government who all have to be informed and must individually issue clearance certificates. These include:

- The Sierra Leone Police Force
- The National Security Coordinator
- The National Revenue Authority
- The Ministry of Defense; and
- The Republic of Sierra Leone Armed Forces, Engineering Regiment.

Specific liability dealing with the importation of explosives is provided for in section 8 of the Ordinance and stipulates that “any person who imports or exports any explosive into or from Sierra Leone except by sea at a prescribed port or by air at a prescribed aerodrome shall be guilty of an offense.”

3.2.20.1 Requirements for Importation of Explosives

The Explosives Ordinance of 1955 is the main legal instrument regulating explosives in the country and makes provision for the manufacture, import, and export of explosives. The Act provides for the licensing of the importation of explosives by the Chief Inspector. In addition, the Act states in section 8 that “Subject to the provisions of the Arms and Ammunition ordinance of 1955, any person who imports or exports any explosive into or from Sierra Leone except by sea at a prescribed port or by air at a prescribed aerodrome shall be guilty of an offense.”

3.2.21 Fisheries Legislations

National Fisheries Regulations such as the Fisheries Act 1988 and Fisheries Amendment Act 1990 respectively, have evolved to address specific matters relating to the conservation and management of natural resources within the marine environment. The 1994 Decree further established sufficient provisions for the conservation of Marine Resources. These range from monitoring, control, and surveillance provisions, as well as those relating to enforcement.

The Maritime Zone (Establishment) Decree of 1996 sets the limits of the sovereignty of Sierra Leone’s maritime for which the government has absolute jurisdiction, in conformity with the United Nations Convention on the Law of the Sea. Such jurisdictions may be extended over the establishment and use of installations and other structures.

Section 9 (1&2) of the Decree gives the government sovereign rights over the Economic Exclusion Zone. They include rights for the exploitation, exploration, conservation, and management of its natural resources. It further stresses the requirement for written consent to be provided by the government for any form of activities to be undertaken within this zone by states, international organizations, or persons.

Other forms of empowerment as provided by the decree include controls necessary to prevent infringement as well as maintaining sanitary and environmental regulations.

The Decree also provides for specific punishments to be imposed out for any breach of the regulations.

The Fisheries Act of 2007 protects both freshwater and marine species as classified by the International Union for Conservation of Nature and Natural Resources (IUCN) within the Sierra Leone waters. It clearly defines where commercial vessels are to harvest that is the Exclusive Economic Zone (EEZ) and where artisanal fishing is to exploit, that is the Inshore Exclusive Zone (IEZ). It also stipulates the gears tolerable in Sierra Leone and even the quality and quantity to be harvested are stated in this Act.

3.3 THE INSTITUTIONAL FRAMEWORK

3.3.1 Ministry of Agriculture and Food Security (MAF)

The Ministry of Agriculture and Forestry (MAF) is mandated with the implementation of government's agricultural, forestry and food security policies. The SCADeP implementation will be the responsibility of the SCADeP Project Coordinating Unit (PCU) housed in the Ministry of Agriculture and Forestry (MAF) in collaboration with multiple ministries and agencies, including MAF, SLRA, Ministry of Local Government and Rural Development, EPA-SL and other implementing partners.

3.3.1 Sierra Leone Roads Authority (SLRA)

This is a semi-autonomous institution responsible for managing and maintaining the national road network. SLRA plays a key development role by upgrading and extending Sierra Leone's Road network. The Authority's vision is to provide well-maintained road access to all communities to achieve over 3,500 km of tarmac roads to major towns and communities and a network of roads connecting them. The SLRA is one of the implementing partners of this project and will oversee the day-to-day implementation of the project.

3.3.2 Ministry of Transport and Aviation (MOTA)

This is the government ministry with overall responsibility for transport. The transport sector consists of three modes, namely, road, maritime and air transportation. All of these modes are being regulated by statutory bodies whilst the Ministry handles policy matters for the effective execution of the mandate of the under-mentioned parastatals and departments supervised by the Ministry:

- Sierra Leone Ports Authority
- Sierra Leone Maritime Administration
- Sierra Leone Airports Authority
- Sierra Leone Civil Aviation Authority
- Sierra Leone Road Safety Authority
- Sierra Leone Road Transport Corporation
- Sierra Leone National Shipping Company
- Meteorological Agency
- Airport Transfer Unit (ATU)
- Transport Infrastructure Development Unit (TIDU).

The overall goal of the Ministry is to increase access through the provision of transport services to connect the rural farming population and urban poor to market centers and provide social and economic services through, efficient, affordable, and sustainable transport systems through the effective coordination of the above-mentioned implementing agencies resonated by policy directives and effective monitoring of the activities of these agencies. The Ministry's mandate is as follows:

- To create an integrated and safe transportation network that incorporates all modes of transportation that reflects regional priorities and provides a strong foundation for economic growth.
- Maintain and improve the provincial highway system by ensuring safe, affordable and efficient movement of people and goods provincially, nationally, and internationally.

Policy objectives of the Ministry include to:

- Ensure safe and smooth everyday travel and maintain competitiveness in the transport sectors
- Achieve a transport system that supports and assists long-term economic growth and improves economic and social well-being.
- Ensure the development of the transport system in light of the realities of the global economy and the national fiscal situation.
- Deliver the public transport investment programs in line with the policy set down.
- Enhance the achievement of providing a policy framework, regulation and implementation models.
- Enhance transport safety in coordination with key stakeholders.
- Develop and implement programs for the development of maritime and inland waterway transport.
- Enhance the provision of inland ferry services on the Provinces' Rivers and lakes.
- This ministry is the implementing ministry and will be responsible for project oversight, during all phases of the project.

3.3.3 Ministry of Works and Public Assets

The government ministry is responsible for the maintenance of the main road system through the SLRA. The Ministry is responsible for the construction and maintenance of all Government Buildings including the Airport. Its key functions include:

- developing regulations for buildings and civil engineering standards
- identifying Quarrying sites
- registration of all civil works Contractors
- developing and implementing a National Housing Policy
- providing housing for public servants and low-cost housing for the communities
- approving Building Plans and issuing Building permits
- ensuring compliance with building regulations
- collaborating with other MDAs/Institutions to develop a National Infrastructural Policy
- providing professional advice to all MDAs/Institutions/Non-state involved in infrastructural development (These include for example electricity, water, sewage, and sanitation)
- Providing oversight responsibilities for the Sierra Leone Roads Authority (SLRA).

The ministry will work with MoTA to provide oversight for the design and construction safety of the road features. MoWPA will also be directly involved in overseeing the design and construction.

3.3.4 Ministry of Environment and Climate Change

The Ministry of Environment and Climate Change was established in November 2019 with the mandate to formulate and facilitate the implementation of appropriate policies and programs for the conservation and sustainable management of the environment and coordinate climate change issues to contribute to the national aspirations for poverty alleviation and sustainable development in Sierra Leone. The main responsibilities of the Ministry are to:

- Provide leadership in the development and supervision of the legal and policy frameworks for promoting sound environmental governance and natural resources management and building national environmental resilience as it relates to climate change and vulnerability,
- Ensure effective environmental disaster management governance
- Supervise five government agencies and departments regulating activities in the Environment Sector Ensure environmental compliance and enforcement in Sierra Leone through EPA-SL
- Strengthen cooperation and collaboration with all relevant Ministries, Departments, and Agencies working on environmental-related issues and climate change
- Mobilize resources in support of strengthening national environmental resilience, and
- Interface with national and international organizations responsible for multilateral environmental agreements and climate change.

The Ministry supervises the following agencies and departments:

- Environment Protection Agency –Sierra Leone
- Sierra Leone Meteorological Agency
- National Protected Area Authority and Conservation Trust Fund
- Nuclear Safety and Radiation Protection Agency; and
- Forestry Division.

3.3.5 Environment Protection Agency (EPA-SL)

The Environment Protection Agency was set up to replace the National Commission for Environment and Forestry (NaCEF), which was mandated to oversee issues about the environment and forestry. The Environment Protection Agency was established with a Board of Directors set up as its governing body. This Board consists of a Chairman and representatives from the various line Ministries and a Unit as stated in section 3 of part II of the Environmental Protection Agency Act. Subject to this Act, the Board shall have the control and supervision of the Agency. The Agency shall act in liaison and cooperation with government agencies to control pollution and the general protection of the environment. The Agency, subject to this Act, shall promote effective planning in the management of the environment

and coordinate and monitor the implementation of national environmental policies, relating to Sierra Leone. The EPA-SL will ensure that the project meets and maintains the local requirements of EIA License holders. On approval of the ESIA studies, a license will be issued which will be subject to annual renewal, based on compliance with the license terms and conditions.

3.3.6 Ministry of Water Resources

This Ministry has the mandate for the development of policies and programs for the provision of safe drinking water on a constant and sustainable basis to the entire population of Sierra Leone by carrying out activities under the following major headings:

- Guma Valley water company (GVWC)
- Sierra Leone Water Company (SALWACO)
- Development of Dams and other water supply schemes
- Protection and management of water resources

In relation to:

- International Hydrological Association
- Collaboration with relevant Government Ministries and national and international organizations/Institutions.

3.3.7 National Water Resources Management Agency

The National Water Resources Management Agency (NWRMA) of Sierra Leone is responsible for the sustainable management of the country's water resources. Its key functions include adopting natural boundaries for river basins and aquifers as management units, protecting water resources and aquatic systems while applying the polluter-pays principle, and respecting customary water uses while preventing harm to other users. The agency also promotes the efficient and beneficial use of water in the public interest, encourages community participation and ensures gender equity in water allocation, and advocates for water conservation while recognizing its economic value. Additionally, the NWRMA is tasked with preventing pollution and degradation of water resources and fulfilling international obligations for managing transboundary water bodies. These functions aim to ensure the sustainable and equitable use of water resources in Sierra Leone.

3.3.8 Ministry of Lands Housing and Country Planning

This Ministry develops appropriate policies and programmes for lands, country planning, and the environment (a role now limited by the formation of the EPA-SL) and carries out activities under the following major headings:

- Land and Land Tenure
- State Lands
- Surveys, Mapping, and Triangulations
- Relations with the Directorates outside Sierra Leone
- Geodetic and Topographical Surveys
- Enforcement of planning and building control
- Demolition of unauthorized structures
- Collaboration with relevant Government Ministries and with national and international organizations and Institutions.

3.3.9 Other Institutional Bodies

Other institutional bodies in the transport sector include:

- The Road Maintenance Fund Administration: administers revenue collected to fund road maintenance from road user charges (fuel) and international donors.
- Sierra Leone Road Safety Authority (SLRSA): SLRSA is responsible for testing and licensing all vehicles and drivers in and for road management and road safety.
- Sierra Leone Road Transport Corporation (SLRTC): a government-owned organization established to provide passenger transport services.

- **Local Councils:** The Local Government Act empowers local councils to provide commercial vehicle parks, designate parking areas, and charge for parking.
- **Sierra Leone Police:** The police report to the Ministry of Internal Affairs. Every local command has its traffic section. The Family Support Unit (FSU) of the SLP is responsible for handling GBV issues
- **Transport Owners Association and Drivers' Unions:** The unions represent the interests of their members and play a role, in liaison with relevant government agencies, in allocating operators to routes, and controlling the informal transport sector generally. Informal transport terminals are managed by representatives of the drivers' unions.
- **Sierra Leone Traders Union (SLeTU)** represents the members of the country's main five traders' unions. It is led by a Trader's Council. Several unions represent the owners and drivers of commercial passenger and freight transport vehicles in Sierra Leone.
- **Ministry of Social Welfare, Gender, and Children's Affairs:** the ministry is directly involved in cases involving child labor and gender-based violence.

3.4 INTERNATIONAL TREATIES, CONVENTIONS, POLICIES, CODES, PROTOCOLS AND GUIDELINES

Sierra Leone has endorsed and signed several International Conventions and Protocols. These Conventions and Protocols are at different stages of implementation but in general, Implementation is slow as many have not been ratified or harmonized with the laws, policies, and programmes of Sierra Leone.

Table 6: International Agreements and Conventions Ratified by Sierra Leone

Agreement	Adopted	Ratified	Focal Point	Focus Area
UN Convention on Law of the Sea (UNCLOS)			Fisheries dept.	Fisheries and continental shelf
UN Convention on Biological Diversity (UNCBD)	June 1994	12 th Dec. 1994	EPA-SL	Biodiversity Conservation and sustainable use of biological resources.
Cartagena Protocol on Bio safely. to the Convention on Biological Diversity (Cartagena Protocol)	Jan 2000	2003	Ministry of Environment and Climate Change	Protection from the effects of modern technology
Convention on Wetlands of International Importance (RAMSAR Convention)		June 2005	Forestry and wildlife management	Wetlands
Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)			Forestry and Wildlife Management	Endangered species
Convention on the Conservation of Migratory Species of Wild Animals (CMS Convention)			Forestry and Wildlife Management	Migratory species
UN Convention to Combat Desertification (UNCCD)	June 1994	25 th September 1995	Lands, country, and the environment	Desertification
UN Framework Convention on Climate Change (UNFCCC)	May 1992	April 1996	Meteorological department	Climate change
Kyoto Protocol to the UN Convention on Climate Change (Kyoto Protocol)	Dec. 1997	Advanced stage	Meteorological department	Climate change

Agreement	Adopted	Ratified	Focal Point	Focus Area
Bamako Convention on the Ban of the Import into Africa and the Control of Transboundary Movement and Management of Hazardous Wastes within Africa. (BAMA KO Convention)	Jan 1991	April 1993	EPA -SL	Trans-boundary Movement and Management of Hazardous Wastes within Africa
Convention for Cooperation of the Protection of the Marine and Coastal Environment of West and Central Africa region. (ABIDJAN Convention)		7 th June 2005	EPA -SL	Marine and Coastal Management
Basel Convention on the Control of Transboundary Movements of Hazardous wastes. (BASEL Convention)	Mar. 1989	April 1993	EPA -SL	Trans-boundary Movements of Hazardous wastes
Convention on the Prior Informed Consent procedure for Certain Hazardous Chemicals and Pesticides in International trade. (Rotterdam (PIC) Convention.)			EPA -SL	Hazardous Chemicals and Pesticides
Convention on Persistent Organic Pollutants. (Stockholm (POPs) Convention)		9 th Sept. 2003	EPA-SL	Persistent Organic Pollutants.
Convention on the Protection of the Stratospheric Ozone Layer. (Vienna Convention)	Sept 1987	April 1993	EPA-SL	Protection of the Ozone Layer
Montreal Protocol on Substances that Deplete the Ozone Layer (MONTREAL Convention)	Sept 1987	April 1993	EPA-SL	Protection of the Ozone Layer
Convention on the Protection of Cultural and Natural Heritage (World Heritage Convention)			National Council of Arts and Culture	Protection of Heritage sites

3.4.1 The World Bank Safeguard Policies

The World Bank Environmental and Social Safeguard Policies seek to address potential environmental risks and benefits associated with Bank lending operations. These safeguards policies are designed to avoid, mitigate, or minimize adverse environmental and social impacts of projects supported by the Bank. The screening of each proposed project and sub-project is carried out to determine the appropriate extent and type of Environmental Assessment to be undertaken and whether or not the project may trigger other safeguard policies. The safeguard policies triggered by this sub-project include OP 4.01, OP 4.04, OP 4.36, OP 4.11, and OP 4.12.

The World Bank categorized the parent project's environmental and social risks as Category B. This is based on the nature and scale of the bridge construction, the sensitivity of the environmental and social context, and the capacity and track record of the client in managing and mitigating environmental and social risks and impacts of such projects.

The summary of the safeguard policies triggered by this sub-project is presented in the table below:

Table 7. World Bank Operational Policies Triggered by the Project

Safeguard Policies	Triggered?	Explanation
Environmental Assessment OP/BP 4.01	Yes	The sub-project triggers OP/BP 4.01 from the expected impacts from the construction of bridges and 250m approach roads for which an ESMF has been prepared with guidelines to prevent as a first option or mitigate any adverse impacts.
Natural Habitats OP/BP 4.04	Yes	The sub-project triggers OP/BP 4.04 as a result of the bridge construction activities affecting land and water resources.
Forests OP/BP 4.36	Yes	OP4.36 has also been triggered as all bridge sites are located surrounding secondary forests and on existing farms and plantations.
Physical Cultural Resources OP/BP 4.11	Yes	The sub-project has also triggered OP4.11 (Physical Cultural Resources) out of precaution to have a management framework in place in case of chance finds during Subproject implementation (See Annex 11.19).
Involuntary Resettlement OP/BP 4.12	Yes	The sub-project will result in the resettlement of people and the provision of livelihood restoration assistance. OP4.12 has been triggered to ensure that an appropriate Resettlement Action Plan is put in place to guard against any unexpected effects on people or their livelihoods as a result of the project.

The Safeguard Policies pursue three objectives: (i) ensuring that environmental and social issues are evaluated in the preparation and decision-making process; (ii) reducing and mitigating the environmental and social risks of Bank-financed programs or projects; and (iii) providing mechanisms for consultation and information disclosure. Both the ESMP and RAP will be developed to include specific considerations for the Subproject activities. These safeguard instruments entail extensive consultation and disclosure during the study and in the Bank before appraisal.

3.4.1.1 Summary of OP/BP 4.04 – Natural Habitats and Its Application to the Project

OP/BP 4.04 is a policy document from the World Bank that outlines their approach to natural habitat conservation and protection in their economic and sector work, project financing, and policy dialogue. The Bank supports the protection, maintenance, and rehabilitation of natural habitats and their functions, and promotes the use of a precautionary approach to natural resource management. The policy requires the Bank to identify natural habitat issues and special needs for conservation in its economic and sector work and to finance projects that integrate natural habitat conservation and improved land use. The Bank does not support projects that involve significant conversion or degradation of critical natural habitats, and mitigation measures must be in place for projects that would significantly convert or degrade natural habitats. The Bank encourages borrowers to incorporate natural habitat issues into their development and environmental strategies and to involve affected groups in planning, designing, implementing, monitoring, and evaluating projects involving natural habitats.

Table 8. Application of OP/PB 4.04 to the Project (Natural Habitats)

Natural Habitat	Matru-Senehun	Gendema-Garwama	Manowa-Pendembu	Tompari-Kamakwie
River	YES	YES	YES	YES
Swamp/Wetland/Ramser Sites	NO	NO	NO	NO
Riparian Forest	NO	NO	YES	NO
Mountain	NO	NO	NO	NO
Valley	NO	NO	NO	NO
Protected Areas (within 50m)	NO	NO	NO	NO
Desserts/Tundra	NO	NO	NO	NO
Grassland	NO	NO	NO	NO

Oceans	NO	NO	NO	NO
Lakes	NO	NO	NO	NO
Coral Reefs	NO	NO	NO	NO

3.4.2 Other Applicable International Conventions

Sierra Leone is a party to many international agreements, conventions, and protocols that seek to protect the environment and ensure sustainable development that applies to such a project. These include the following:

3.4.3 Paris Convention

This is a convention for the protection of Marine Pollution from land-based sources, established in 1974 and amended by the protocol of 26 March 1986. The convention emphasizes the use of non-waste technology, if available, and the use of the best available techniques (latest stages of development of processes, facilities, or methods of operation). Substances that shall be subjected to programmes and measures include:

- heavy metals and their compounds
- organ halogen compounds (and substances that may for such compounds in the marine environment)
- organic compounds of phosphorus and silicon
- biocides such as pesticides, fungicides, herbicides, insecticides, slimicides and chemicals used, inter alia, for the preservation of wood, timber, wood pulp, cellulose, paper hides, and textiles
- oil and hydrocarbons of petroleum origin
- nitrogen and phosphorus compounds
- radioactive substances, including waste
- Persistent synthetic materials may float, remain in suspension, or sink
- recognized that the marine environment and the fauna and flora which it supports are of vital importance to all nations
- are mindful that the ecological equilibrium and the legitimate uses of the sea are increasingly threatened by pollution
- considered the recommendations of the United Nations Conference on the human environment, held in Stockholm in June 1972
- recognized that concerted action at national, regional, and global levels is essential to prevent and combat marine pollution
- are convinced that international action to control the pollution of the sea from land-based sources can and should be taken without delay, as part of progressive and coherent measures to protect the marine environment from pollution, whatever its origin, including current efforts to combat the pollution of international waterways
- considered that the common interests of States concerned with the same marine area should induce them to cooperate at regional or sub-regional levels; and
- recalled that the Convention for the Prevention of Marine Pollution by Dumping from ships and aircraft concluded in 0510 on February 15, 1972.

This convention covers the Northeast Atlantic and the North Sea. The objectives of the convention are to prevent pollution from almost all types of substances and all land-based sources.

3.4.4 The United Nations Convention on Biological Diversity, 1992

Signed by 150 government leaders at the 1992 Rio Earth Summit, the Convention on Biological Diversity (CBD) is the first global agreement to cover all aspects of biological diversity and is dedicated to promoting sustainable development. The objectives of this Convention are the conservation of biological diversity; the sustainable use of its components for the benefit of present and future generations; and the fair and equitable sharing of the benefits arising out of the utilization of

genetic resources, including appropriate access to genetic resources and by appropriate transfer of relevant technologies, taking into account all rights over those resources and to technologies, and by appropriate funding.

The 15th Conference of Parties to the UN Convention on Biological Diversity adopted the Kunming – Montreal Global Biodiversity Framework (GBF) to halt and reverse nature and biodiversity loss as there has been a dangerous decline in nature threatening the survival of one million species and impacting the lives of billions of people. The Framework consists of global targets to be achieved by 2030 and beyond to safeguard and sustainably use biodiversity.

3.4.5 Ramsar Convention

The Convention on Wetlands came into force for Sierra Leone on 13 April 2000. Sierra Leone presently has one site designated as a Wetland of International Importance, with a surface area of 295,000 hectares. Sierra Leone is now the 118th signatory to the Ramsar convention. The criteria for selection of the Sierra Leone River Estuary as a Ramsar site (i.e..... Wetlands of International Importance especially as habitat for water birds) are based on those set by the Ramsar Bureau and therefore reflects global standards:(a) The site is known to hold regularly, at least 1% of the biogeographic population of at least eight water bird species. (b)The site is also known to hold regularly, more than 20,000 water birds. The project area is close to a Ramsar wetland site and whilst not being directly subject to its requirements could affect the site indirectly. The Convention on Wetlands came into force for Sierra Leone on 13 April 2000. Sierra Leone is now the 118th signatory to the Ramsar convention.

3.4.6 Convention Concerning the Protection of Workers against Occupational Hazards in the Working Environment due to Air Pollution, Noise, and Vibration (ILO No148)

Sierra Leone became a signatory to this convention in 1961. Participating parties may accept the obligations of this convention separately in respect of air pollution, noise, and vibration. Measures instituted to occupational hazards associated with these impacts shall be prescribed by national laws and regulations as outlined in the Factories Act of 1974.

3.4.7 Convention on International Trade of Endangered Species (CITES)

The Convention on the International Trade of Endangered Species (CITES) requirements went into effect in Sierra Leone on 16 January 1995. CITES is a convention that provides for the elimination and/or reduction in the trade of certain species, including endangered species. CITES provides a list of species that are required for protection against trade. Species listed in CITES are also those for which trade is strictly prohibited except in exceptional circumstances. The majority of the species listed in CITES are also listed as endangered or threatened by the International Union for Conservation of Nature and Natural Resources (IUCN). CITES also includes species that are not necessarily threatened but for which trade must be controlled to avoid the species becoming threatened or endangered. While several species exist in the project area, there are no specific issues related to them.

3.4.8 World Conservation Union (IUCN) Protected Areas Categories, 1994

This initiative was established to facilitate the collection and dissemination of comparable data and to improve communication between countries on the management of comparable ecosystems. The objective of the protection status is to maintain biodiversity and natural resources and there must be a specific legal or social basis for the protection activities. All protected areas have been classified into 6 categories (remote, national park, natural monument, habitat/species management area, protected landscape/seascape, and managed resource protected area). This initiative does not provide specific management criteria for activities in Protected Areas. However, there are useful guidelines for working with local communities (and protecting their rights and supporting their livelihoods) in protected areas.

4 PROJECT DESCRIPTION

4.1 INTRODUCTION

This chapter describes the 4-Bridges Project. It provides details of the design and its associated activities and infrastructure leading to the construction and operation of the 4 bridges. Information contained in this section was obtained from the project conceptual design, but it also includes the design options proposed by the design and build contractor and approved by the client.

4.2 PROJECT BACKGROUND

Through its implementing agency, the Ministry of Agriculture and Food Security (MAF) the Government of Sierra Leone received financing from the International Development Association (IDA) of the World Bank Group towards the cost of the Smallholder Commercialization and Agribusiness Development Project (SCADeP, WB project P153437). SCADeP, hereafter referred to as the Client, was launched on 14 January 2017 and has been under implementation since February 2017. The project development objective is to: *“Promote smallholder commercialization by fostering productive business linkages between smallholder farmers and selected agribusiness firms in Sierra Leone.”*

UK Department for International Development (DfID) initially supported Component B (Market access improvement) of SCADeP but later withdrew their financial support due to changing priorities in DfID’s assistance program in Sierra Leone. This created a shortfall for Component B resulting in downscaling of the project targets. In addition, during the implementation of Component B of SCADeP, a need to replace hand-operated ferry crossing points with bridge structures was identified. To fill the funding gap and to finance the construction of at least three bridges on feeder roads, the SCADeP project was restructured, and the Government of Sierra Leone signed an agreement for a grant with the International Development Association (IDA) of the World Bank Group for Additional Financing (AF) of US\$30 million (SCADeP Additional Financing, WB Project P170604).

The development of the concept designs for bridges to replace hand-operated ferries, and the procurement of the construction works for the same, as described in this Inception Report for Contract SL-MFAS-121003-CS-QCBS forms part of Component B1 of the SCADeP.

Key benefits expected from the rural connectivity investments under the project include economic diversification, growth in production and related increase in agricultural incomes, and market linkages. And greater commercialization as well as associated benefits of access to social services such as health and education by the rural population.

Sierra Leone has five provinces (Northern, Southern, Eastern, North-Western, and Western area provinces) which are connected by a road network of about 11,311km. This extensive road network is managed by the Sierra Leone Roads Authority (SLRA) which is the statutory institution responsible for the management of all classes of roads in Sierra Leone. The road network is classified into Class A (Primary roads), Class B (Secondary roads), and Class F (Feeder roads). Feeder roads are of critical importance because they are mostly located in the rural areas of Sierra Leone where about 60% of its population reside. Furthermore, the feeder roads network is about 7500km in total which is more than the total length of Class A and Class B roads combined.

Figure 3: Map of Sierra Leone showing the Districts



4.3 PROJECT IDENTIFICATION BY THE CLIENT

In Sierra Leone, a combination of high rainfall, a long rain season (6 months per year), and a hilly valley topography results in the road network being crisscrossed by many rivers and streams. Consequently, bridge structures are required along the roads at river crossing points. However, because bridge structures are an expensive investment, most feeder roads do not have bridges and are interrupted or end at large river crossings. A few important, strategic, and high-traffic volume feeder roads are serviced by cable ferries which are managed by the Sierra Leone Roads Authority (SLRA). The rest of the roads are left to rely on dugout canoes and boats for connectivity or they just end at the river crossing.

SLRA is currently managing motorized and non-motorized ferries at 14 major crossing points scattered on different roads across the country and in different districts. These ferry crossings create bottlenecks along the roads. They are unsafe, unreliable, and do not provide year-round access. Furthermore, cable ferries operate only in the daytime with limited operation during the rainy season. The Government of Sierra Leone's priority is to replace all the unmotorized cable ferries. Usually, the strategic feeder roads are cut off during the rainy season and road users are forced to take uneconomical, long, and winding routes to get to their destinations. All this disrupts farmers' access to markets and ordinary citizens' access to essential services such as retail, hospitals/clinics, and education institutions to mention a few. The farm produce cannot get to market on time while access to social services is limited due to the lack of regular ferry crossings.

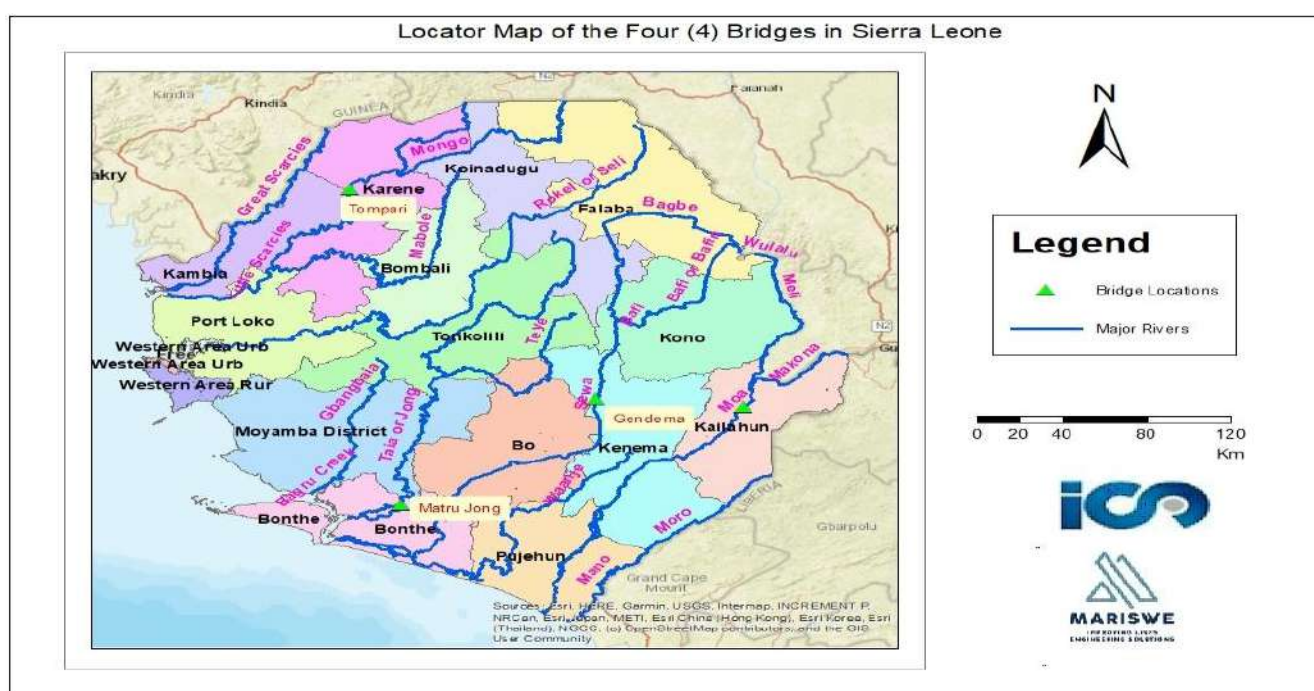
The Government of Sierra Leone will use the proceeds of the Additional Financing (AF) to finance the construction of four rural bridges to improve connectivity. The proposed bridges are to replace the current unmotorized cable ferry being used to cross rivers, very vital for connecting remote and vulnerable populations, to increase access to markets and services as well as increase people's adaptive capacity and resilience to shocks (health and natural disasters such as flooding; conflict, etc.). The Client identified the following four (4) ferry crossings to be replaced with bridge structures:

Table 9: List of Ferry crossings to be replaced with bridge structures

No.	Ferry Crossing Name	District & Region	Route	River	Crossing Length (m)	Connecting Districts
1	Tomparie	Kambia /Northern Region	Tomparie-Kamakwie (A12)	Kabba	205	Kambia/Karene
2	Mattru Jong	Bonthe /Southern Region	Mattru-Rutile (B4)	Jong	160.0	Bonthe/Moyamba
3	Gendema	Kenema /Eastern Region	Blama-Boajibu-Gendema (B19)	Sewa	121.5	Kenema/Tonkolili
4	Manowa	Kailahun /Eastern Region	Manowa-Pendembu (B31)	Moa	161.5	Kailahun/Kono/

Considering the strategic importance of the existing cable ferry crossings in Sierra Leone, the AF will fund the construction of four of these bridges. The AF will prioritize crossing points that are critical to the economy and connectivity of districts with huge agricultural potential. The below map shows the location of the existing four (4) ferry crossing points to be replaced by bridge structures.

Figure 4: Locality map showing the location of the ferry crossing to be replaced with bridges



The initial project execution approach followed the detailed methodology included in the Technical Proposal (Section TECH 4) submitted by Mariswe / ICS JV on 16 October 2019. However, during the Contract negotiations between the Client and Consultant, dated 6 July 2020, it was agreed that the initial project approach must be modified for the reasons that the bridges be divided into two groups because the Client currently have funding for the construction of 4 to 5 bridges only. The first group of bridges must be prioritized to expedite the commencement of construction.

The need for this project was identified by the Sierra Leone Roads Authority (SLRA) in conjunction with the Smallholder Commercialisation and Agribusiness Development Project (SCADeP) and the implementation of this concept design report is an essential part of the implementation. The upgrade of these rudimentary gravel roads to an acceptable standard does not form part of this project. The upgrade of the roads and the construction of the proposed bridge will enable pedestrians across the two towns and road traffic, including heavy transportation trucks to move across and transport agricultural produce to the various parts of the country.

In the engagements with the locals, it was brought to our attention that the river floods breach the embankments during the rainy season and flood the surrounding land. This necessitates the elevation of the road to provide the required and necessary clearance above the flood waters as well as providing extensive anti-scour provisions along the embankment upstream and downstream of the bridge crossing. The locality maps below indicate the position of the proposed new bridge and the approach roads on either side of the riverbanks.

This section discusses the three possible bridge designs and construction methods to replace the existing ferries for the proposed rivers, specifically the Little Scarcies River at the Tomparie crossing, the Tai River at the Mattru crossing, the Sewa River at Gendema crossing and the Moa River at the Manowa crossing. Also, the site conditions, geometric constraints, structural requirements, and financial aspects are all considered, as they have a bearing on the feasibility of the three proposed bridge designs and construction methods.

4.4 GENERAL SITE DESCRIPTION

4.4.1 Tomparie River Bridge

The Tomparie River Bridge is the proposed new river crossing over the Little Scarcies River connecting Tomparie village with Kamakwie Town across the river. The proposed Tomparie River Bridge will connect Karene District and Kambia District. The access road is a rudimentary gravel road and currently terminates at the banks of the Little Scarcies River, in the vicinity of the existing ferry crossing.

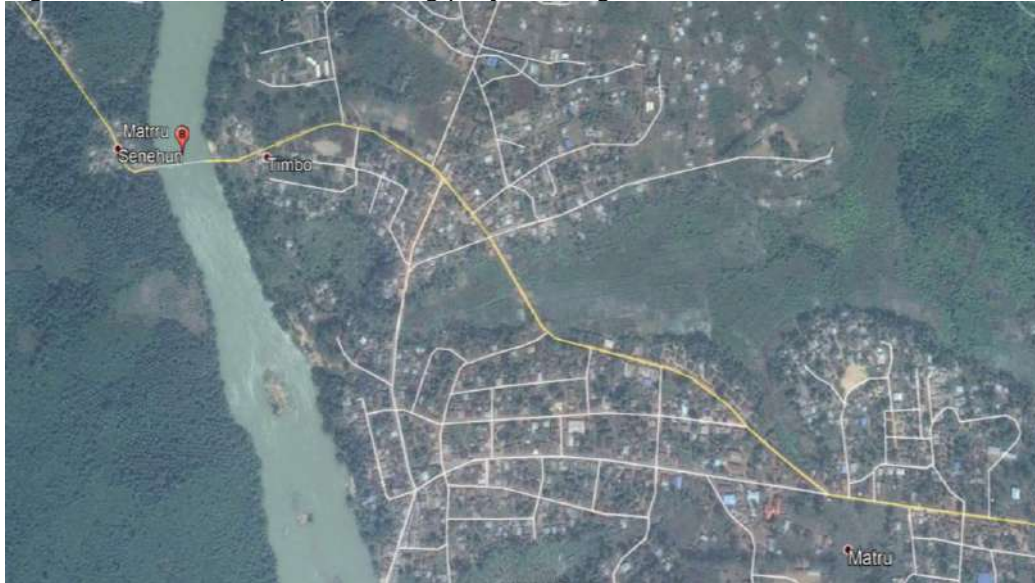
Figure 5: Aerial view of Tomparie Ferry crossing point



4.4.2 Mattru Jong River Bridge

The Mattru Jong River Bridge is the proposed new river crossing over the Jong River connecting Timbo village with Senehun village in the Bonthe Districts (Southern Region). The proposed Mattru River bridge will connect the Bonthe District with Moyamba District along the Mattru – Rutile route (B4). The access road is a rudimentary gravel road and currently terminates at the banks of the Jong River, in the vicinity of the existing Mattru vehicle ferry crossing. This simple ferry transport is the only means by which the local people with vehicles can cross this wide river to access the two villages across the river.

Figure 6: Aerial view of Matru Jong ferry crossing



4.4.3 Gendema Bridge

The Gendema Bridge is the proposed new river crossing over the Sewa River connecting Gendema village with Garwama village across the river in the Kenema district. The proposed Gendema River Bridge will connect the Kenema and the Tonkolili Districts along the Blama – Boajibu to Gendema route (B19). The access road is a rudimentary gravel road and currently terminates at the banks of the Sewa River, in the vicinity of the existing Gendema ferry crossing. This simple ferry transport is the only means by which the local people can cross this wide river to access the two villages of Gendema and Garwana across the Sewa River.

Figure 7: Aerial view of Gendema Ferry Crossing



4.4.4 Manowa River Bridge

The Manowa River Bridge is the proposed new river crossing over the Moa River near Manowa town in Kailahun District. The proposed Manowa River Bridge will connect the Kailahun and the Kono Districts along the Manowa junction to the Pendembu route (B31). The access road is a rudimentary gravel road and currently terminates at the banks of the Moa River, in the vicinity of the existing

Manowa ferry crossing. This simple ferry transport is the only means by which the local people can cross this wide river to access the two villages of Manowa and Pendembu across the Moa River.

Figure 8: Aerial view of Manowa Ferry Crossing



4.5 GENERAL BRIDGE CONCEPTUAL DESIGN

At the Inception stage, the consultant proposed six possible bridge superstructure (deck) options and conducted a comparative study of the best three options of these six options. The comparative study with recommendations was presented to the Client on 27 January 2021 and the Client agreed in principle with the recommended deck option. In this Chapter, a detailed comparative study of superstructure and substructure options will be presented as part of the bridge conceptual design. The consultant proposes that a similar bridge superstructure and substructure concepts be recommended for all bridge sites which are, Matru Jong, Gendema, Manowa, and Tomparie. It is proposed that the spans for the different bridges be standard as much as possible. Standardizing the span makes bridge construction to be faster and more economical. This Chapter, therefore, discusses the design criteria, and structural considerations and compares different structural solutions applicable to all 4 bridge sites.

4.5.1 Design Criteria

The conceptual design criteria are based on the following design manuals and codes:

- Draft Bridge Design Manual (Sierra Leone Roads Authority (SLRA), 2012) which is mainly based on the American Association of State Highway and Transportation Officials (AASHTO) LRFD Bridge Design Specifications, 2nd edition, 1998.
- BS EN 1990 Eurocode: Basis of Structural Design
- BS EN 1991 Eurocode1: Actions on Structures
- BS EN 1992 Eurocode 2: Design of Concrete Structures.
- BS EN 1993 Eurocode 3: Design of Steel Structures.
- BS EN 1994 Eurocode 4: Design of Composite Steel and Concrete Structures
- BS EN 1997 Eurocode 7: Geotechnical Design
- BS EN 1998 Eurocode 8: Design of Structures for Earthquake Resistance
- Annex A2 for Bridges of EN 1990:2002 + A1-2005
- NA to BS EN 1990:2002 + A1:2005
- BS EN 1991-1-5:2003 Eurocode 1: Actions on structures-General actions.
- BS EN 1991-2:2003 Eurocode 1: Actions on structures-Traffic Loads on Bridges.

The draft Bridge Design Manual (SLRA, 2012) is mainly applicable to small and medium-sized bridges. These specifications correspond with the Eurocode philosophy hence is possible to substitute the AASHTO LRFD Bridge Design Specifications with corresponding Eurocodes.

4.5.2 Superstructure Options

The main consideration for the optimal structural solution is the requirement to provide a "function", which consists of a complete bridge across a river that should be able to carry certain specified loads for a design working life period of 100 years. One of the important functions is to withstand the overtopping condition which then demands heavy robust forms of construction to enhance stability and reduce buoyancy effects. In addition, considering the remoteness of the site simple structural forms which are straightforward to construct are considered desirable. Construction of river crossings of this nature presents inherent risks mainly in the construction of the foundations, piers, and abutments. Consequently, bridge deck solutions have been chosen to limit the number of piers required.

The following six (6) possible options were considered at the high-level design stage:

- Option 1: Steel Composite bridge
- Option 2: Steel Truss bridge
- Option 3: Reinforced Concrete Box Girder bridge
- Option 4: Pre-cast Concrete Composite bridge
- Option 5: Reinforced Concrete Voids Deck bridge
- Option 6: Cable Stayed bridge

From the above possible structural solutions, three (3) options were then chosen for detailed investigation and conceptual design. Further optimisation of solutions was then undertaken, and three options were then chosen for cost comparison. Where a Contractor wishes to submit an alternative design, it will be specified that no spans may be shorter than 30.0 meters to minimize debris accumulation.

Other construction options such as balanced cantilevers and construction forms such as voided decks, precast beams, and cable stay-type structures have been ruled out based on complexity and cost. The cable-stayed bridge would be structurally unsuitable for the highly probable overtopping condition.

For this project, the choice and selection of bridge superstructure options are influenced by the following factors:

- **Cost of construction:** The Client reiterated the limitations on the budget therefore this is the most important factor. A significant portion of the total construction cost on large river bridges is consumed by the substructure construction. Therefore, it is important to consider bridge options with the minimum possible number of substructures and funding options with the minimum costs
- **Speed of construction:** Given that Sierra Leone has a six (6) month-long rainy season, the construction window period is very limited, especially for construction activities in the river. Fast construction methods and methods that do not require setting up formwork in the river are preferred
- **Durability and Maintenance requirements:** Options with high durability and minimum maintenance requirements are preferred; and
- **Employment creation and -skilling opportunities:** Different bridge options create a different number of opportunities for the local community's unskilled and skilled labourers. Bridge options that create more opportunities for the local community to be trained and unskilled in different artisanal trades are preferable. This empowers the local community and creates more job opportunities.

It is proposed that the spans for the different bridges be standard as much as possible. Standardizing the span makes bridge construction to be faster and more economical. The following span configuration is proposed.

Table 10: Proposed bridge span configurations for different bridges

Bridge Name	Lots	No. of Spans	Length of each span (m)	Overall Length (m)
Mattru Jong	2	4	40	161.5

Gendema	3	3	40	121.5
Manowa	4	5	Outer spans=30, Inner spans =40	180.0
Tomparie	1	4	-	161.5

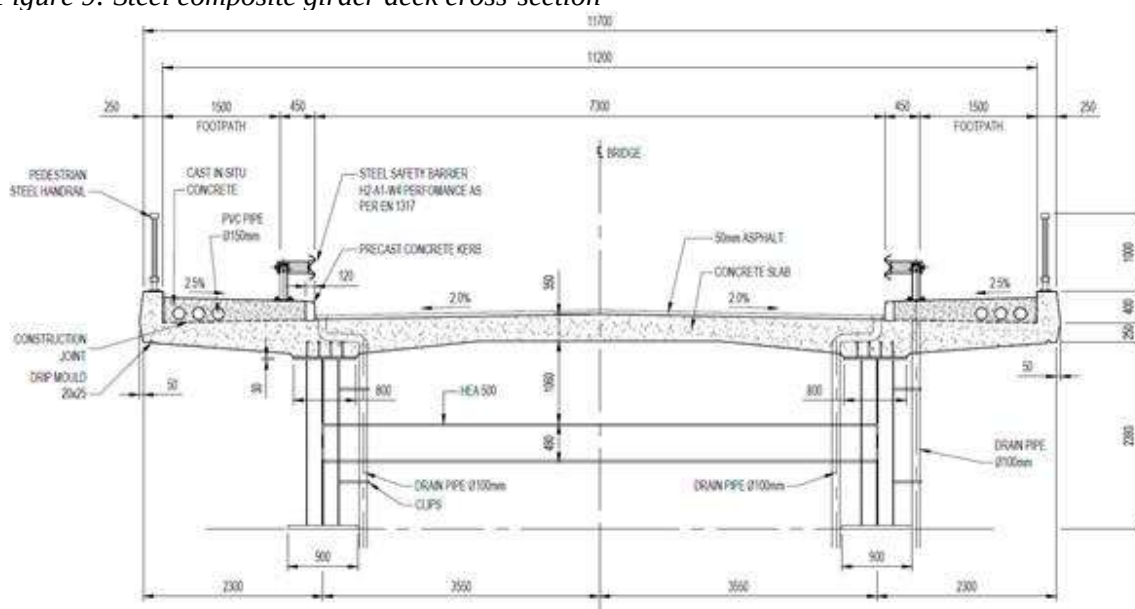
4.5.3 Option 1: Composite Girder

A steel Beam and Slab bridge was built using a built-up steel beam launching girder with the span configuration as specified in the conceptual design report. The bridge is of simple construction with clean straight lines of superstructure and substructure providing a pleasing visual aspect.

4.5.3.1 Deck Cross Section

The bridge superstructure comprises a 2.7m deep simply supported composite steel Beam and Slab deck supported on reinforced concrete piers and abutments. The steel beam is 2.2m deep and the average depth of the deck is 2.7m. The thickness of the reinforced concrete slab varies from 350mm in the centre to 493mm at the point where the steel beam connects with the slab. The deck cross-section is shown in the following figure.

Figure 9: Steel composite girder deck cross-section



4.5.3.2 Fabrication Yard and Launching Bed

There is adequate space behind the bridge abutment site locations to establish an accessible steel fabrication yard for the steel beams manufacture ready for launching installation over the river.

Figure 10: Fabrication of steel beams on site and launching nose secured



4.5.3.3 Minimizing Expansion Joints

Expansion joints are inherently and continuously a source of problems as far as bridge maintenance is concerned. This steel beam and slab bridge deck potentially has seven expansion joints with inherent maintenance problems. A mitigating measure to obviate the above problem is to make as many spans as possible continuous over the joints. This is achieved by joining the top slabs together with special slip surfaces over the end diaphragms which allows longitudinal movement and minimises the longitudinal moments from traffic loading. A suggested arrangement would be to join pairs of spans together by the top slab and have an expansion joint between them – this would reduce the number of expansion joints on this option to 4 joints.

4.5.3.4 Construction Sequence

The Bridge construction typically follows the sequence given below and includes the following:

- Construct the piling platforms including providing access to the platform for the piling rig.
- Install the piles which must be socketed into biotite granite rock.
- Construct the pier pile-caps in the river bed above the dry season water level.
- Construct the pier shafts on top of the pile caps up to the capping beam.
- Cast the capping beam on top of each of the pier stems/shafts.
- Construct the Abutment foundations (Piles), pile caps, and abutment seating beam.
- Install the Bearings complete with bearing plinths.
- Install the launching Nose
- Connect the launching nose to the steel beams using an acceptable connection system.
- Launch the steel girder beams
- Install the permanent formwork slabs between the steel girders
- Install the reinforcement and formwork for the end diaphragms.
- Cast the end diaphragms
- Install the top slab reinforcement for the first span
- Cast the first span top slab.
- Repeat the above procedure for the construction of the complete second span.
- Continue to build the third, fourth, fifth sixth similarly.
- Cast the abutment breast walls and install the expansion joints between the breast walls and the deck end.

4.5.3.5 Advantages and Disadvantages of Structural Solution

The following advantages were noted:

- Lighter and faster to construct the deck particularly when launching the deck superstructure
- Easier and faster to launch due to the relatively low weight of the deck superstructure
- Most economic options due to lower labour, material, and construction equipment costs
- The bridge superstructure is built from one end and adequate space for launching and a casting yard on one end is available from which the bridge can be built
- Span to depth ratio and depth of girders are reasonably shallow compared to the reinforced concrete deck option
- No constraints are demanding unusual span arrangements
- There are no constraints on the positioning of the abutments apart from the necessity of having an adequate waterway opening and an economical project combination of protected embankments and bridge opening
- There is adequate space and suitable ground for providing a casting yard for the construction of the precast beams behind the abutment; and
- Reduced construction time and likely to be the cheapest option.

The following disadvantages were noted:

- Maintenance costs for the steel girders required though reasonably low compared to the other 2 options
- Should the girders be welded and not bolted, quality control for inspection of welding is likely to be an issue in identifying competent and experienced welding inspectors

- Heavy lifting equipment is required for the beam installation with access bridges on either side of the bridge or expensive precast beam launching equipment
- Special provision needs to be made for holding down the bridge deck in case of flood overtopping.

4.5.4 Option 2: Steel Truss

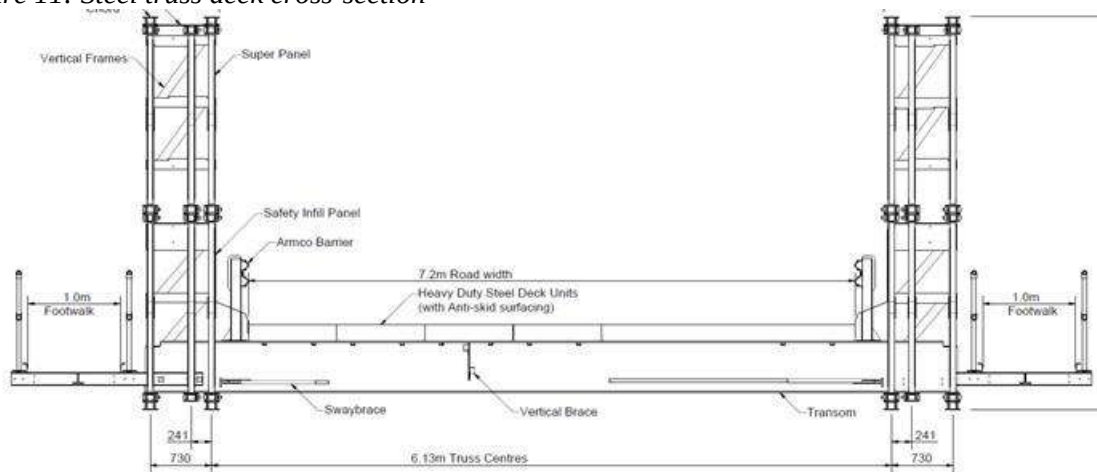
A steel truss deck built using prefabricated steel members or supplied by a specialist bridge truss manufacturer with the span configuration as specified in the conceptual design report.

A steel bridge option in the form of an open truss section was considered a plausible option. The bridge is of simple construction with clean straight lines of superstructure and substructure providing a pleasing visual aspect.

4.5.4.1 Deck Cross-Section

The bridge superstructure comprises a 2.7m deep simply supported steel truss deck supported on reinforced concrete piers and abutments. The trusses can be prefabricated by the contractor or supplied by specialist Bailey bridge manufacturers. The typical steel truss deck cross-section is shown in the following figure.

Figure 11: Steel truss deck cross-section



4.5.4.2 Fabrication Yard and Launching Bed

There is adequate space behind the bridge abutment site locations to establish an accessible steel fabrication yard for the steel trusses and beams manufacture ready for launching installation over the river.

4.5.4.3 Minimizing Expansion Joints

Expansion joints are inherently and continuously a source of problems as far as bridge maintenance is concerned. The proposed steel truss bridge deck potentially has seven expansion joints with inherent maintenance problems. A mitigating measure to obviate the above problem is to make as many spans as possible continuous over the joints. A suggested arrangement would be to make adjacent spans continuous and subsequently reduce the number of expansion joints on this option to 4 joints.

4.5.4.4 Construction Sequence

The Bridge construction typically follows the sequence given below and includes the following:

- Construct the piling platforms including providing access to the platform for the piling rig.
- Install the piles which must be socketed into biotite granite rock.
- Construct the pier pile-caps in the river bed above the dry season water level.
- Construct the pier shafts on top of the pile caps up to the capping beam.
- Cast the capping beam on top of each of the pier stems/shafts.
- Construct the Abutment foundations (Piles), pile caps, and abutment seating beam.
- Install the Bearings complete with bearing plinths.

- Install the launching Nose
- Connect the launching nose to the steel main beams/truss using an acceptable connection system.
- Launch the steel girders beams / trusses
- Continue to build the third, fourth, fifth sixth similarly.
- Cast the abutment breast walls and install the expansion joints between the breast walls and the deck end.

4.5.4.5 Advantages and Disadvantages of Structural Solution

The following advantages were noted:

- Lighter and easier to launch and likely to reduce the costs of launching or construction and after all the steel trusses can be fabricated and assembled off-site
- Easier to transport and assemble on site when sections are bolted and therefore likely to have a lower construction period and costs compared to the box girder option
- The Steel Truss can be prefabricated and transported to the site
- The original cost of the prefabrication and installation of the steel truss bridge may well be competitive or even an initially cheaper solution
- The time for construction would probably be less than that for a concrete bridge; and
- The steel truss bridge can be a 'bottom loaded' truss with the road traffic and pedestrian traffic passing inside the truss structure allowing the top of road alignment to be less than a metre above the bridge soffit and allowing a reduced depth of approach fills.

The following disadvantages were noted:

- High maintenance costs such as rusting, and fatigue are likely to be an issue compared to the concrete option
- Controlling the weld quality on this 'out of the way site' would be very difficult and costly as qualified weld inspectors would be required for this important procedure
- Rusting/corrosion needs to be mitigated thus increasing cost compared to the prestressed box girder option
- A more expensive option compared to the composite deck option due to higher steel quantities for this option and higher materials costs
- Longer construction period compared to the composite deck option due to the required time frames for steel assembly
- Quality controlling and checking of the bolt connections are likely to be an issue and require strict quality control on site
- The spans of the steel truss bridge would be too long to transport in one piece to this inaccessible site. Therefore, it would have to be prefabricated in portions and re-connected on-site – by bolting or welding
- Quality controlling and checking of the bolt connections (if applicable) is also difficult in these out-of-the-way locations and is often not done
- Corrosion is the main reason for the rejection of this steel truss form of construction in this remote location;
- Maintenance of steel bridges is costly and usually does not happen in these out-of-the-way places. Whilst the steel can be galvanized as well as painted, in the long term the bridge will require repainting; and
- Without proper maintenance in the form of protection against corrosion steel bridges fall into an unacceptable form of disrepair in quite a short time.

4.5.5 Option 3: Prestressed Concrete Box Girder Bridge

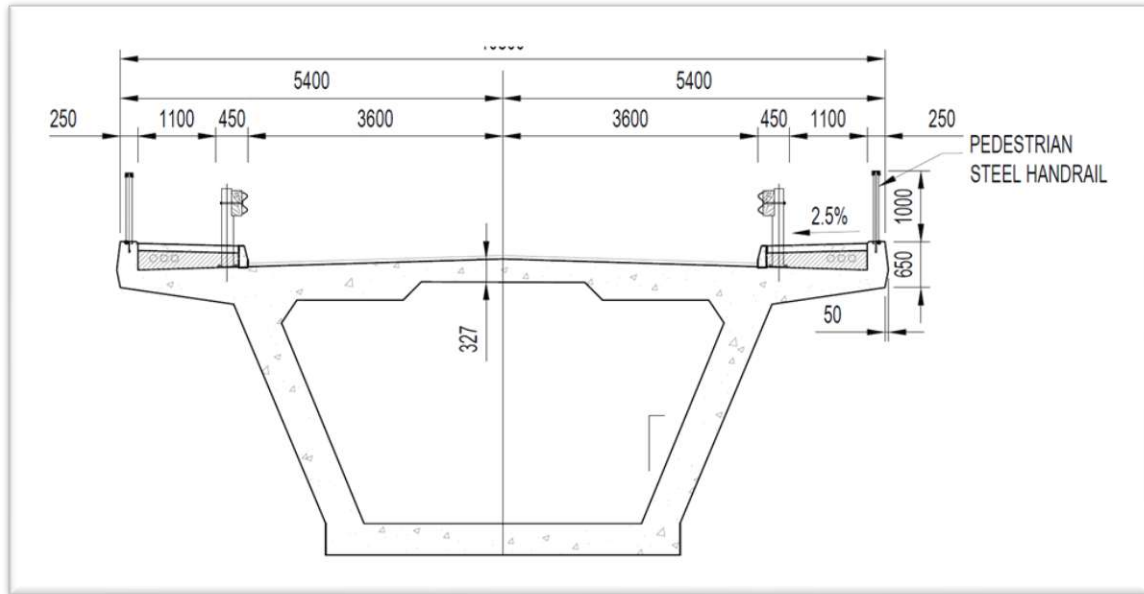
An incrementally launched reinforced concrete box girder with the span configuration as specified in the conceptual design report.

4.5.5.1 Deck Cross Section

The deck structure for this option is a constant depth prestressed concrete box girder with a constant bottom slab built using the incremental launching method of construction. The bridge shall in its

completed state be continuous from abutment to abutment with expansion joints only confined to the abutments. An overall deck thickness of 2.0m is proposed.

Figure 12: Prestressed concrete box girder deck cross-section



4.5.5.2 Construction Sequence

The Bridge construction typically follows the sequence given below and includes the following:

- Install the piles, foundations, and substructures sufficiently far ahead of the incremental launching progress to ensure adequate structural support (Concrete strength and age) for resisting the deck launching forces when the launching nose arrives at their position.
- Set up the formwork in the casting bed to the correct line and level
- Install the launching Nose
- Fix the segment reinforcement in the formwork (prefabricated reinforcing cages are often used).
- Install the prestressing ducts.
- Place the concrete in the prepared segment.
- Wait for the concrete to gain the necessary strength to allow the segment to be prestressed (The minimum cube strength of the concrete to adequately withstand the prestressing force at the anchorages is 35MPa). The contractor may consider using a higher strength concrete for the deck segments than prescribed to consistently reach the 35MPa in 3 or 4 days.
- Stress the appropriate prestressing cables
- Connect the launching nose to the first segment using an acceptable prestressing system.
- Launch the segment
- Repeat the above procedure until all the segments have been cast and launched into their final position.
- Remove the launching nose and cast the diaphragms

Figure 13: Typical bridge under construction using Incremental launching method



4.5.5.3 Advantages and Disadvantages of Structural Solution

The following advantages were noted:

- Low maintenance costs of concrete deck compared to the steel deck option
- The box girder section offers better torsional rigidity properties compared to the other 2 options
- A closed continuous structure is considered to be the best solution for this environmentally unfriendly location (from the durability point of view)
- This span arrangement economically fits all the construction constraints of the ILM method with no requirement for temporary piers
- No constraints are demanding unusual span arrangements
- There are no constraints on the positioning of the abutments apart from the necessity of having an adequate waterway opening and an economical project combination of protected embankments and bridge opening; and
- There is adequate space and suitable ground for providing a casting yard for the ILM construction method to be used.

The following disadvantages were noted:

- The inherently complex and complicated option that requires design expertise and stringent quality control during the construction stages
- Availability of prestressing expertise and local materials likely to pose challenges
- The option requires significantly more construction time for the casting of each segment. An extra 4 months to 6 months of construction time is estimated as compared to Options 1 and 2
- The box girder section is heavier compared to the other proposed 2 options and therefore the costs for the launching are likely to be higher and the option is likely to be the most expensive
- Overall construction costs are likely to be higher compared to the other two options
- The launching process requires a construction team to be given access to the top of each of the piers for feeding the launching pads over the launching bearings during the segment launching process; and
- Incremental launching is a fairly complex construction method that requires in-depth analysis and construction supervision including a very experienced contractor and has disastrous consequences if not executed properly.

4.5.6 Substructure Options

The bridge substructure consists of Abutments, Piers, and their foundations. In all cases reinforced concrete will be used for the substructure for durability reasons. The following piers options were considered:

- Multiple columns with capping beam
- A single column with hammerhead
- Solid wall; and
- V-shaped solid wall.

The Solid wall and V-shaped solid wall options were not considered for further study because they take longer to construct and require more effort in terms of steel fixing, formwork, and concreting requirements.

The foundations of all the abutments and piers substructures shall be founded on solid rock and the large diameter auger piles be socketed into rock. All the bridge foundations shall be designed to withstand the 500-year flood forces. Each Pier Foundation will comprise a pile cap cast above a low water level in the dry season founded on 6 No 1.5m diameter auger piles.

4.5.6.1 Option 1: Multiple Columns with Capping Beam Piers

Two reinforced concrete circular piers with a rectangular capping beam on top are proposed for each internal support. The Piers will be positioned in line with bearings connected to the deck. Circular columns solid type piers offer the best option, both from a functional as well as aesthetic point of view. Circular piers act at every level as rounded ‘water cutting’ ends and improve performance under flood conditions. Formwork, concreting and steel fixing of circular columns are easier to set up and therefore the columns are faster to construct. The circular shape also facilitates the pier heads to be orientated at right angles to the deck thus avoiding the high torsion forces created by a skew bearing arrangement. The following figure illustrates this type of Pier.

Figure 14: Typical Multiple Circular Columns Pier



4.5.6.2 Option 2: Single Column with Hammerhead Pier

This option consists of one reinforced concrete circular pier with a beam on top to form a “T” shape. This option is also aesthetically pleasing but is not robust. A single pier does not provide enough redundancy required for large river bridges. Also, if it is going to be used to support a deck with twin beams such as the one recommended under the superstructure section, prestressing of the top pier beam will be required.

Figure 15: Single column with hammerhead Pier



4.5.6.3 Abutments Option

The following options were considered for the Abutments:

- Cantilever solid wall
- Spill through abutment; and
- Perched abutment.

Because the bridges are over rivers the only practical solution for Abutments will be of the closed cantilever type with straight return walls. This type of abutment prevents fill material from being undermined.

Figure 16: Cantilever solid wall abutment



4.6 STRUCTURAL CONSIDERATIONS FOR ALL ALTERNATIVES

4.6.1 Construction Methods

The construction method will be dictated by the prospective bidders/ contractor's experience and the specialized equipment that the contractors have. The above will determine the most cost-effective solution to be adopted for construction. The construction methods described in this report though not fully exhaustive are those most likely to be used under the particular site conditions though as discussed above not necessarily the only or even the most cost-effective solutions.

Cofferdams will be constructed, which are water-retaining structures that allow builders to dewater work sites. It aids in the preservation of a dry work environment when erecting structures in flooded areas. Notwithstanding, there will be the construction of 250m of embankments for approach roads at each end of the bridges.

4.6.2 Bridge Bearings

Bridge Bearings require regular inspection and maintenance and therefore an adequate provision for access to allow jacking and possible replacement is essential, which otherwise may be extremely difficult or even impossible to replace. Only proprietary pot bearings have been allowed for the deck structure options subject to the Engineer's approval.

4.6.3 Expansion Joints

Expansion joints are inherently expensive to maintain, and a minimum number of joints ought to be adopted. The inherent problems associated with expansion joints call for the minimization of joints and therefore the adoption of continuous superstructures. Failed expansion joints are the single major contributor to the deterioration of concrete bridge structures. Most failed expansion joints are not so much mechanically failed as "failed" in their ability to contain water. The leakage of failed joints allows the passage of water over the concrete edges, which often have inadequate cover in the vicinity of the joints due to difficult on-site reinforcement fixing conditions in this area. Leaking Expansion Joints are often the major contributor to the failure of the Bridge Bearings. A typical example of an expansion joint type proposed on this project is shown below.

Figure 17: Typical Expansion joint



4.6.4 Scour Protection and Protection against Flood Damage

Erosion protection to the road approaches will comprise gabion boxes along the toe line of the embankment and gabion mattresses on the side slopes.

Figure 18: Typical erosion protection at Abutment



4.6.5 Bridge Parapets or Handrails

A provision for a steel handrail along the pedestrian walkway has been made with a guardrail for vehicle containment along the road carriageway. The vehicle parapet shall have a minimum containment level equivalent to containment level H4b specified in the European code IS EN1317 for Road Restraint Systems.

Figure 19: Typical bridge parapet and handrails



4.6.6 Service Requirements

Although no existing services were identified on each site, it was deemed prudent to make a provision of three 150 mm dia. ducts along the walkway for future services should the need arise over the full length of the bridge structure.

4.6.7 Aesthetic Requirements

Being a river bridge in a rural environment, the aesthetic requirements are important but not as onerous as they would be if it was located in or near a major city. The application of good engineering principles to the design and construction will ensure a pleasing aesthetic impact coming from this large river bridge. The proposed solutions are considered to blend in with the existing surroundings at the chosen locations without obvious detrimental visual impact.

4.6.8 Drainage of Structure

A cross falls along the roadway and the bridge of 2% cross falls in either direction has been made to allow adequate drainage of the structure with 150mm diameter downpipes/scuppers at regular intervals. The spacing of the drainage outlets must accommodate the design water flow defined in the detailed road drainage calculations such that the roadway does not get flooded at any time. The bridge is also on a 1% longitudinal fall. Down chutes are also proposed just before the abutment so that runoff water from the road does not go over the abutment.

Figure 20: Typical down chute



4.6.9 Construction Materials

In safeguarding the environment, all sand and aggregate for the project's concrete work will be sourced from licensed suppliers outside the project area, avoiding any impact on local riverbanks and natural resources. By sourcing sand externally, the project helps to preserve local ecosystems and prevent issues relating to riverbank erosion, sediment disruption, or harm to aquatic life. Hence. In line with this commitment, there will be no extraction or processing of natural materials from the riverbanks or any local water sources. If water is abstracted for testing or potential use in concrete production, it will be managed through a regulated abstraction regime, with all necessary water abstraction permits obtained from the relevant government agency. Monitoring of river flow and discharge levels will be implemented to ensure that water availability for local communities remains unaffected.

To ensure construction quality, all materials will meet the required standards for durability and safety, including specific guidelines for alkali reactivity. The figures below include the quarry sites and borrow pits identified within the project area.

Figure 21: Quarry and Borrow pit in Tomparie

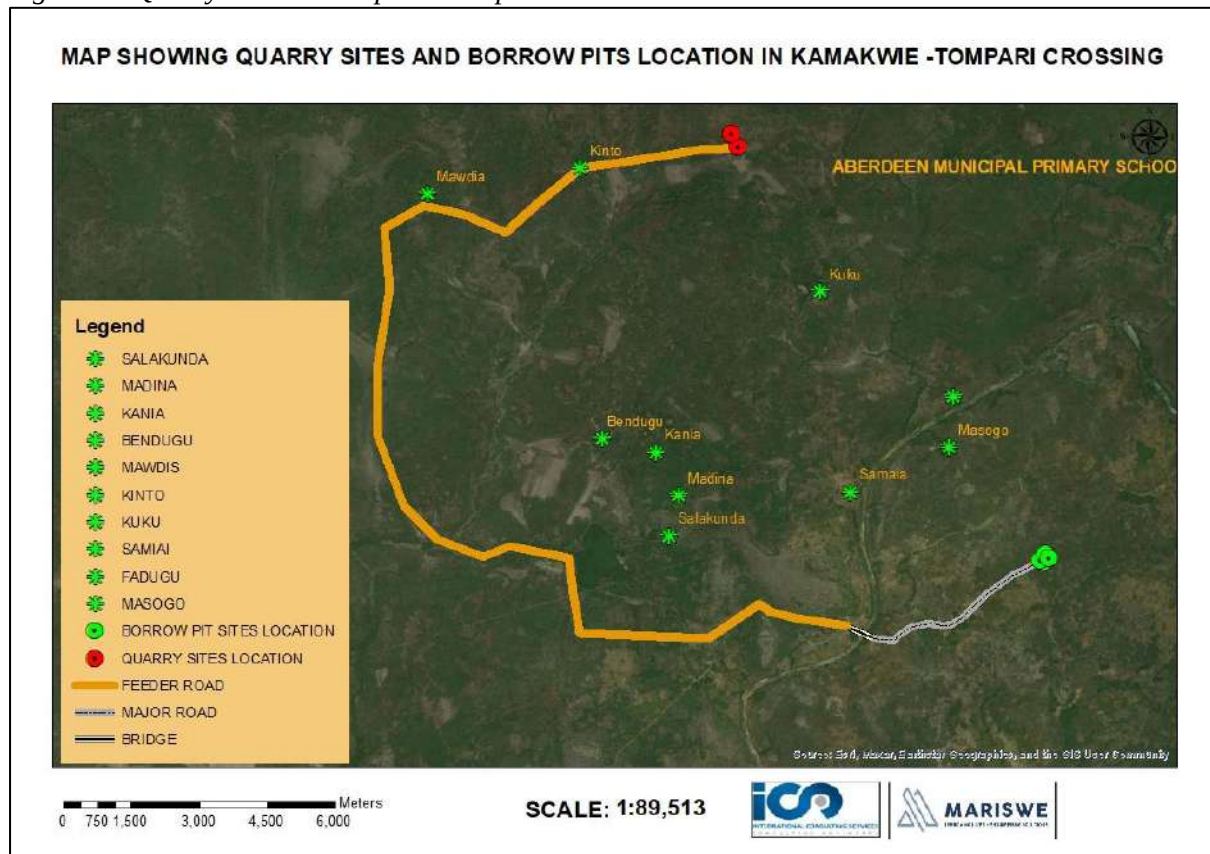


Figure 22: Quarry and Borrow pit in Matru Jong

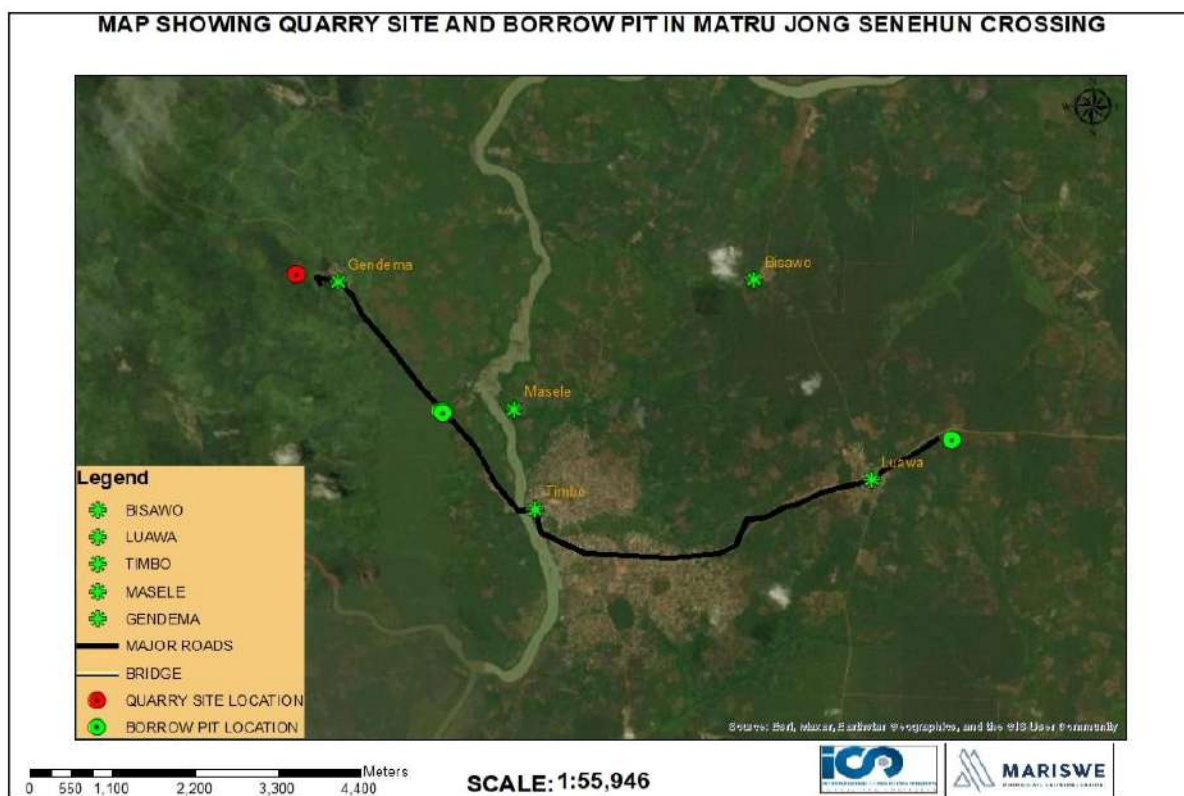


Figure 23: Quarry and Borrow pit in Gendema

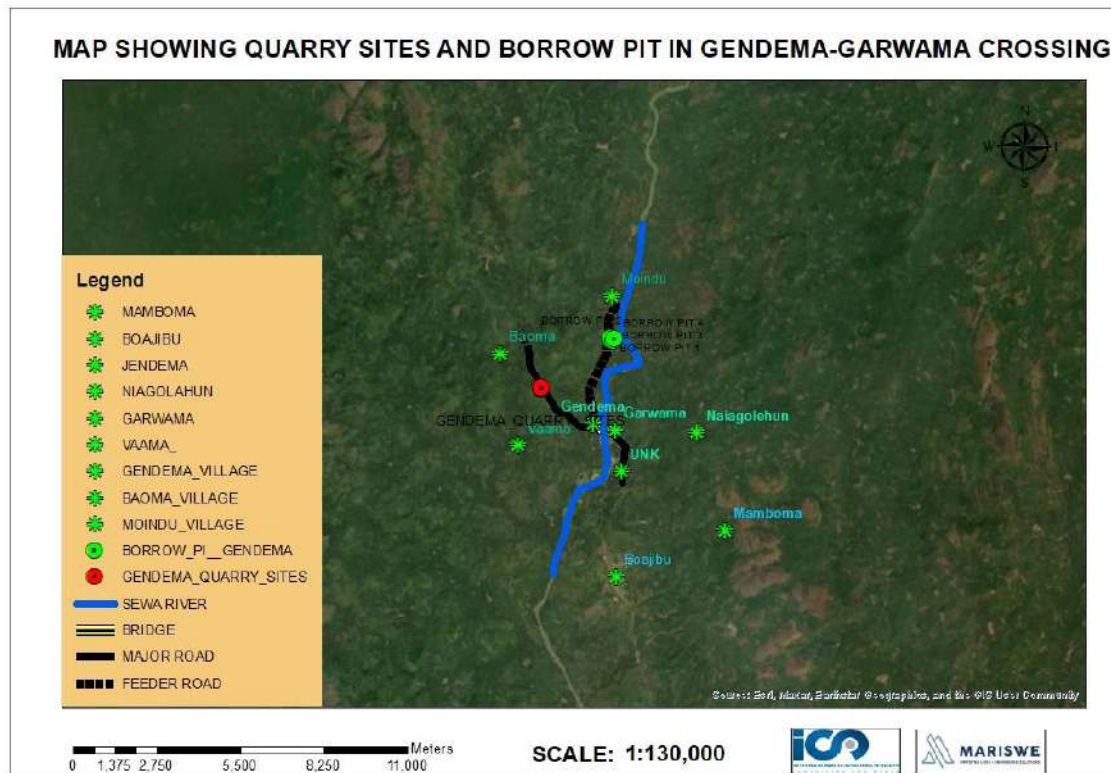
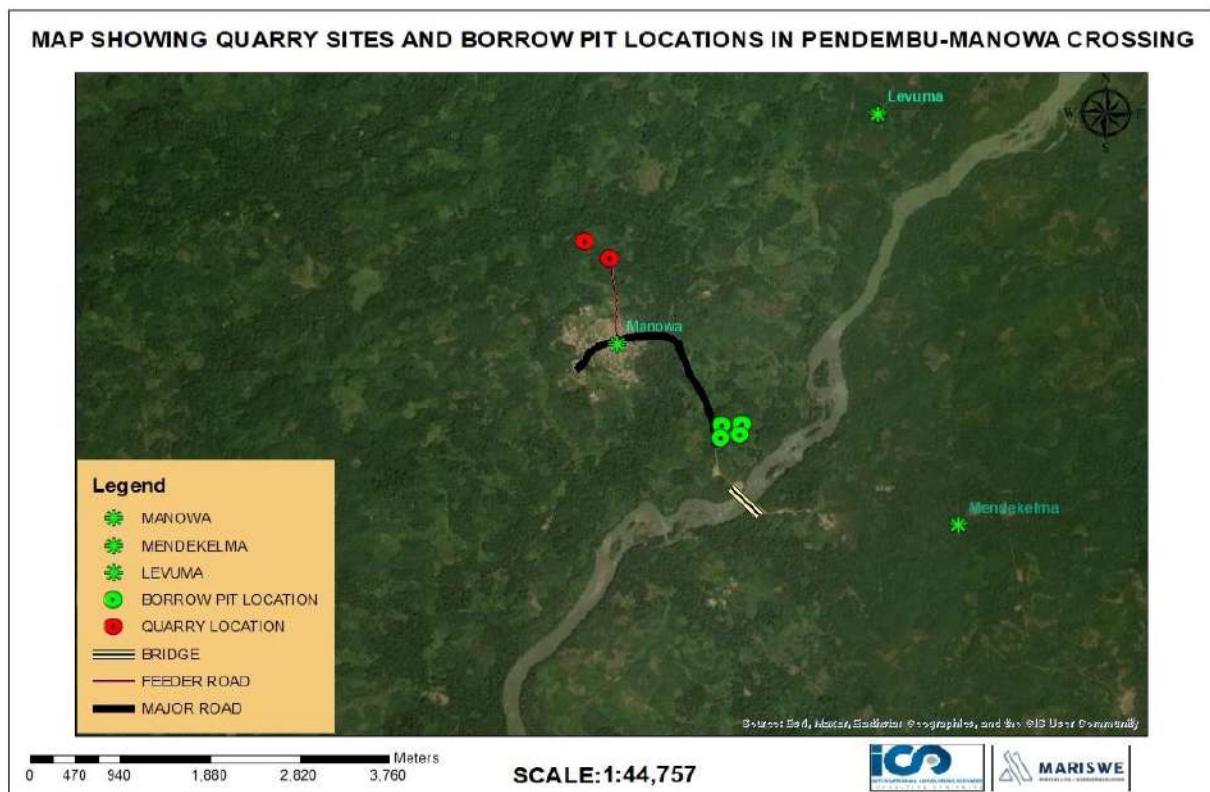


Figure 24: Quarry and Borrow pit in Manowa



4.6.10 Conclusion and Recommendation

Based on the comparison of the different bridge deck options, the Steel composite deck (Option 1) is recommended to be adopted as the superstructure and the Multiple circular column piers (Option 1) founded on a spread footing or piles also be adopted for the substructure.

The steel composite girder deck, Option 1, will be constructed using the incremental launching method. The limited construction window dictated by the rainy season in Sierra Leone including the construction costs dictates that the bridge be constructed as incremental launching and of steel composite deck to deliver the bridge on time.

5 PROJECT ALTERNATIVES

5.1 INTRODUCTION

This chapter evaluates the technically and financially feasible alternatives identified during the Environmental and Social Impact Assessment (ESIA) process. The goal is to inform project design, construction, and operational decisions, enhancing the project's alignment with the objectives of the 4-bridges initiative, as well as the requirements of the World Bank (WB) as the funding agency and the Government of Sierra Leone. This analysis forms the basis for selecting optimal project alternatives that promote sustainable development, social upliftment, and environmental stewardship in line with the aspirations of all stakeholders.

5.2 THE “NO PROJECT” ALTERNATIVE

The “No Project” alternative implies that bridge construction activities would not proceed, leaving localities in their current state. Without this development, the social and economic goals of the government and donor partners would remain unachieved. Key anticipated benefits, including job creation, infrastructure improvement, enhanced connectivity, and community development, would be forfeited, slowing regional and national progress. This scenario could also contribute to continued out-migration, perpetuating local economic stagnation and degraded public services.

Consequently, the “No Project” alternative does not present a viable option when weighed against the socio-economic and developmental benefits of constructing the bridges.

If the “No Project” alternative is chosen, existing socio-economic and environmental challenges in these bridge localities will continue, unless alternative safe and accessible transportation options are implemented. Mariswe/ICS therefore concludes that the “No Bridge” alternative does not provide comparable benefits to those achieved through bridge construction, which promises significant improvements in connectivity, local development, and quality of life for communities.

5.3 ALTERNATIVE ANALYSIS FOR RIVER CROSSINGS

Technically feasible alternative river crossing points were identified for each proposed bridge site through detailed technical feasibility studies and conceptual designs. These initial studies informed subsequent field assessments, which provided a comprehensive understanding of potential environmental, economic, and safety considerations associated with each alignment option. This analysis covers the following bridge locations: Mattru Jong - Senehun, Gendema - Garwama, Manowa - Pendembu, and Tomparie - Kamakwei.

Key factors considered for each bridge structure include construction costs for approach roads, bridge length and alignment, presence of rock outcrops, potential social impacts such as encroachment into homes, schools, and farming areas, as well as accessibility for pedestrians from nearby settlements. Detailed analyses of these options are presented below for each location.

5.3.1 Analysis of Alternatives and Options for Mattru Jong-Senehun Bridge Crossing

This section presents a comprehensive comparison of bridge alignment alternatives for the Mattru Jong - Senehun Crossing. This analysis evaluates each option through a detailed assessment of environmental, social, and economic impacts. These considerations have been used to aid in identifying the optimal alignment, minimizing adverse impacts on both local ecosystems and social amenities.

Option 1: This new alignment is almost perpendicular to the river, resulting in the shortest bridge length, which minimizes construction time and reduces overall environmental and social disruption.

- **Environmental Impact:** This alignment requires minimal land take and results in lower dust, noise, and vibration levels due to the reduced construction footprint. It avoids sensitive areas such as nearby community facilities.

- **Social Impact:** Requires the relocation of 3 houses, including a sacred house, with consultations held to gain the affected community's agreement. The approach road deviates from existing pathways, thus reducing potential conflicts with community activities.
- **Economic Impact:** This is the most cost-effective option due to the shorter bridge length and reduced foundation needs, resulting in lower material, labor, and maintenance costs.

Option 2: This alignment follows the existing crossing path, with a sharp curve on the western approach road, requiring complex engineering.

- **Environmental Impact:** The deep crossing point necessitates deep or pile foundations, increasing environmental disturbance, including higher dust, noise, and vibration levels over a prolonged construction period. This may affect nearby residents along the western approach.
- **Social Impact:** No relocation is needed, reducing social disruption; however, the ferry service will be interrupted, necessitating an alternative transit arrangement to maintain community connectivity.
- **Economic Impact:** Due to the complex foundation needs and associated higher construction costs, this option is less cost-effective than Option 1. Extended construction time also adds to labor and equipment expenses.

Option 3: This alignment is similar to option 1 but traverses a wider river section, resulting in a longer bridge.

- **Environmental Impact:** The extended bridge length increases environmental impact, requiring a larger construction footprint and causing higher levels of dust, noise, and resource use. The alignment's placement affects local natural resources, particularly farming land and vegetation.
- **Social Impact:** The alignment affects community resources, such as farming land and the Centenary school's playing fields, directly impacting livelihood and recreational spaces. The ferry operation can continue during construction, minimizing transportation disruption.
- **Economic Impact:** The increased bridge length requires more materials and labor, raising overall costs. Ongoing maintenance would also be higher due to the larger structure and affected land use.

The recommended option is Option 1 (highlighted in blue on the figure 25 below) because this alignment option improves the existing substandard geometry, minimizes resettlement, and reduces potential motorized and pedestrian conflict on the bridge approaches. Overall, the level of environmental and social impact is medium magnitude.

Table 11. Summary of Environmental, Social, and Economic Impacts for Bridge Alignment Options at the Mattru – Senehun Crossing

Factors	Option 1 (Recommended)	Option 2	Option 3
Bridge Length	Shortest bridge length (approx. X meters) minimizes environmental footprint and reduces costs.	Moderate bridge length (approx. Y meters); increases foundation needs.	Longest bridge length (approx. Z meters) with higher costs and impact on resources.
Relocation and Land Take	Relocation of 3 houses; one is sacred (consulted community). Limited land take on eastern side.	No relocation; minor land impact. Curve on approach road.	Affects farming land and school fields; higher land take needed.
Ferry Operation	Ferry can operate during construction, ensuring transportation and movement of people and goods across the river.	Ferry operation halts; alternative transit required.	Ferry can operate, limiting transportation disruption.
Environmental Impact	Lower dust, noise, and vibration impact due to compact construction area.	Higher dust and noise from complex foundation work; prolonged timeline.	Higher dust, noise, and resource use due to larger footprint and extended timeline.

Factors	Option 1 (Recommended)	Option 2	Option 3
Economic Cost	Lowest cost due to shorter bridge span, minimal land take, and reduced labor and time required for construction.	Higher cost due to pile foundations and increased labor/materials.	Highest cost due to longest bridge and extensive land impact.

Figure 25: Options considered for the Matru Jong River Crossing



5.3.2 Analysis of Alternatives and Options for Gendema - Garwama Crossing

The Gendema River Crossing connects the communities of Gendema and Garwama, providing essential access for residents, farmers, and traders. Current reliance on a ferry service poses challenges, especially during high water levels. Proposed bridge alignments were evaluated to enhance connectivity, reduce environmental impacts, and ensure cost-effectiveness. This analysis compares each alignment to identify the most sustainable and community-friendly option.

Option 1: This alignment follows the existing crossing, remaining almost perpendicular to the river, resulting in the shortest bridge length.

- **Environmental Impact:** The alignment requires backfilling to elevate the road to the design flood level, with limited environmental impact beyond filling activities. It avoids extensive land take and tree uprooting, preserving existing vegetation and minimizing disruption to natural habitats.
- **Social Impact:** Houses and other affected assets such as hand dug wells close to the existing road will require resettlement, but this alignment preserves the connection between communities on either side of the river, maintaining accessibility for pedestrians and other road users.
- **Economic Impact:** This is the most cost-effective option due to minimal new road construction and the shortest bridge length, which reduces both construction and long-term maintenance costs. Additionally, backfilling requirements are relatively low compared to extensive realignment.

Option 2: This alignment utilizes rock outcrops to support bridge foundations, requiring significant deviation from the existing alignment and necessitating a longer new road section.

- **Environmental Impact:** This route requires clearing farming land, diamond mining fields, and plantations, which will result in significant land use changes and the uprooting of trees. It could also introduce increased soil erosion and sedimentation risks due to the required land clearing.

- **Social Impact:** This alignment is farther from existing settlements, creating accessibility challenges for pedestrians and increasing commute times. Although resettlement is minimized, the reduced accessibility could disrupt daily activities and community connectivity.
- **Economic Impact:** The longer bridge and road alignment increase construction and maintenance costs. Additional land acquisition and the impact on agricultural and artisanal mining land will attract further economic and social costs.

The recommended option for the Gendema - Garwama Crossing is Option 1, as it best meets the project's objectives of enhancing connectivity while managing environmental and social impacts. Though it requires the resettlement of some houses near the existing road, this alignment maintains community access, minimizes disruption, and achieves the shortest bridge length, resulting in lower construction and maintenance costs. Overall, Option 1 is the most viable and sustainable choice, aligned with World Bank standards for cost-effectiveness and community benefit.

Table 12. Summary of Environmental, Social, and Economic Impacts for Bridge Alignment Options at Gendema - Garwama Crossing

Factors	Option 1 (Recommended)	Option 2
Bridge Length	The shortest bridge length (approx. X meters) minimizes cost and environmental footprint.	Longer bridge length (approx. Y meters) increases both cost and maintenance needs.
Land Take and Resettlement	Resettlement required for houses close to the existing road; minimal land take.	Affects farming land, diamond mining fields, and plantations; no resettlement but significant land take needed.
Community Access	Maintains accessibility for pedestrians and vehicles; supports community connectivity.	Distance from settlements reduces accessibility, creating challenges for community connectivity.
Environmental Impact	Limited to backfilling; minimizes habitat disruption and tree removal.	Significant vegetation clearing is required; higher potential for erosion and disruption of local agricultural and natural resources.
Economic Cost	Lowest cost due to the shortest bridge length and minimal new road requirements.	Higher costs due to increased bridge length and extensive new road construction; impacts on agricultural and mining land.

Figure 26: Options considered for the Gendema Garwama Crossing



5.3.3 Analysis of Alternatives and Options for Manowa Crossing

The Manowa - Pendembu Crossing is a crucial access point for communities in neighboring Liberia, as well as for local farms and the transport of agricultural commodities and goods. The proposed bridge alignments seek to replace the current cable ferry, which often proves unreliable, especially during seasonal flooding. Each alignment option has been thoroughly evaluated to optimize connectivity, minimize environmental and social impacts, and ensure cost-effectiveness. This analysis examines the potential impacts of each option to identify the most sustainable and beneficial choice for constructing the bridge at this important crossing.

Option 1: This alignment is nearly perpendicular to the river, resulting in the shortest bridge length. Rock outcrops on the western riverbank provide potential for shallower and cost-effective foundations.

- **Environmental Impact:** The alignment affects cocoa and cacao plantation areas on the eastern approach but limits additional land take by reconnecting quickly to the existing road, thus preserving adjacent farmlands and natural habitats.
- **Social Impact:** No resettlement is necessary, which minimizes disruption to the local community. Additionally, the shorter bridge length maintains accessibility for nearby residents.
- **Economic Impact:** This option is cost-effective due to the shortest bridge span and minimal need for new road construction, reducing overall construction and maintenance expenses.

Option 2: This alignment uses rock outcrops for foundations but deviates significantly from the existing road, resulting in a longer bridge and requiring an extended new road.

- **Environmental Impact:** Significant clearing of farming land and cocoa and cacao plantation areas is required, leading to potential soil erosion and habitat disturbance due to land use changes.
- **Social Impact:** While no resettlement is necessary, the greater distance from local settlements creates accessibility challenges for community members who rely on the crossing.
- **Economic Impact:** Higher costs are associated with the longer bridge span and new road construction, as well as the economic impact on agricultural areas due to land clearing.

Option 3: This alignment follows the existing route, with the approach roads in a cut that requires backfilling to meet the design flood level. The river depth necessitates deep or pile foundations.

- **Environmental Impact:** The deep foundation requirements and backfilling increase environmental disruption, with heightened dust, noise, and habitat impact during construction.
- **Social Impact:** Resettlement of nearby homes is necessary, which could disrupt the community layout and affect local residents.
- **Economic Impact:** This option is the least cost-effective due to the high costs associated with deep foundation work, extensive backfilling, and resettlement requirements

Option 1 is the recommended alignment for the Manowa - Pendembu Crossing. It achieves project goals by enhancing connectivity with minimal environmental and social impacts. This alignment utilizes rock outcrops to lower foundation costs, avoids resettlement, and maintains community access. By quickly reconnecting to the existing road, it minimizes new road construction and reduces impacts on nearby farmlands and cocoa plantations, making it the most cost-effective and sustainable choice.

Table 13. Summary of Environmental, Social, and Economic Impacts for Bridge Alignment Options at Manowa - Pendembu Crossing

Factors	Option 1 (Recommended)	Option 2	Option 3
Bridge Length	Shortest bridge length, perpendicular to the river, minimizes cost and impact.	Longer bridge length due to deviation from existing alignment.	Existing alignment, requires deep foundations and extended backfilling.

Land Take and Resettlement	No resettlement: minimal land take, affects some cocoa plantations.	No resettlement but significant land clearing of farming land and cocoa plantations.	Resettlement required; major land take and community impact.
Community Access	Maintains accessibility for locals, supports community connectivity.	Increased distance from community, reducing accessibility for locals.	Maintains existing access but disrupts residents due to resettlement.
Environmental Impact	Limited disturbance; uses rock outcrops, affecting only plantation areas.	High disturbance from clearing of farmlands, and potential erosion.	High impact due to deep foundation work, backfilling increases dust and noise.
Economic Cost	Most cost-effective due to short bridge and minimal new road construction.	Higher costs from longer bridge, extensive new road construction, and land impact.	Highest cost due to deep foundations, backfilling, and resettlement expenses.

Figure 27: Options considered for the Manowa – Pendembu Crossing



5.3.4 Analysis of Alternatives and Options for Tompari Crossing

The existing crossing faces significant challenges, particularly during high river flow periods, which disrupts local mobility and access to essential services. Proposed bridge alignments have been assessed for their environmental, social, and economic impacts, with an emphasis on reducing disruption and improving connectivity and road safety. This analysis examines each alignment option to determine the most practical, cost-effective, and community-focused solution for the Tomparie River Crossing.

Option 1: The shortest alignment at 630 meters, following the existing alignment with minor deviations to bypass the current crossing. The bridge crossing length is approximately 130 meters, with both approaches featuring S-bends that may present road safety risks.

- **Environmental Impact:** Minimal removal of vegetation is required due to the shorter alignment, reducing direct environmental disruption. However, it may impact existing houses on both riverbanks.
- **Social Impact:** Some resettlement of houses is likely due to the road alignment near communities, with potential safety implications due to the S-bend geometry.
- **Economic Impact:** Cost-effective due to the shorter bridge and minimal new road construction, but potential safety concerns may lead to higher long-term maintenance needs.

Option 2: Approximately 860 meters in length, this alignment avoids resettlement entirely. The bridge crossing is about 150 meters, with improved road geometry that ties back to the existing alignment, minimizing new construction.

- Environmental Impact: Significant vegetation clearance is required, and some affected vegetation may include cash crops and economic trees, necessitating compensation.
- Social Impact: No resettlement required, but potential impacts on local plantations due to land clearing.
- Economic Impact: Higher construction costs due to the longer bridge and Significant vegetation clearance, though long-term safety benefits from improved road geometry.

Option 3: Approximately 165 meters in length, this alignment minimizes resettlement while providing a 125-meter bridge crossing. The route maintains road geometry that ties back into the existing alignment, reducing the need for extensive new road construction.

- Environmental Impact: Minimal vegetation clearance required; appears to have minimal impact on plants and regrowth vegetation.
- Social Impact: No resettlement required, thus minimizing disruption to the community. Some farms areas may be affected, requiring compensation.
- Economic Impact: Moderately cost-effective due to minimized new road construction and shorter bridge length. The alignment meets project objectives while balancing environmental and social considerations.

Option 4: At 1405 meters, this alignment maintains straighter bridge approaches (over 100 meters) on both sides to improve road safety. The bridge crossing length is 125 meters, but this option impacts more houses and economic trees and crops than Option 3.

- Environmental Impact: Requires Significant vegetation clearance, affecting regrowth vegetation and some farms.
- Social Impact: Minimal resettlement, though more impact on plants and residences than Option 3.
- Economic Impact: Higher costs due to additional land acquisition and increased bridge length, with some long-term safety benefits from the improved approach geometry.

Option 5: At 1015 meters, this alignment shares the initial path with Option 3 and terminates in a T-junction with the Tambi/Samaia road, which could limit continuous movement. The bridge crossing length is 125 meters.

- Environmental Impact: Limited vegetation clearance is required, with minimal impact on crops at the start of the alignment.
- Social Impact: No resettlement is required, but the T-junction limits continuous access and mobility for road users.
- Economic Impact: Moderately cost-effective, but the T-junction may affect traffic flow, impacting long-term usability and increasing maintenance needs.

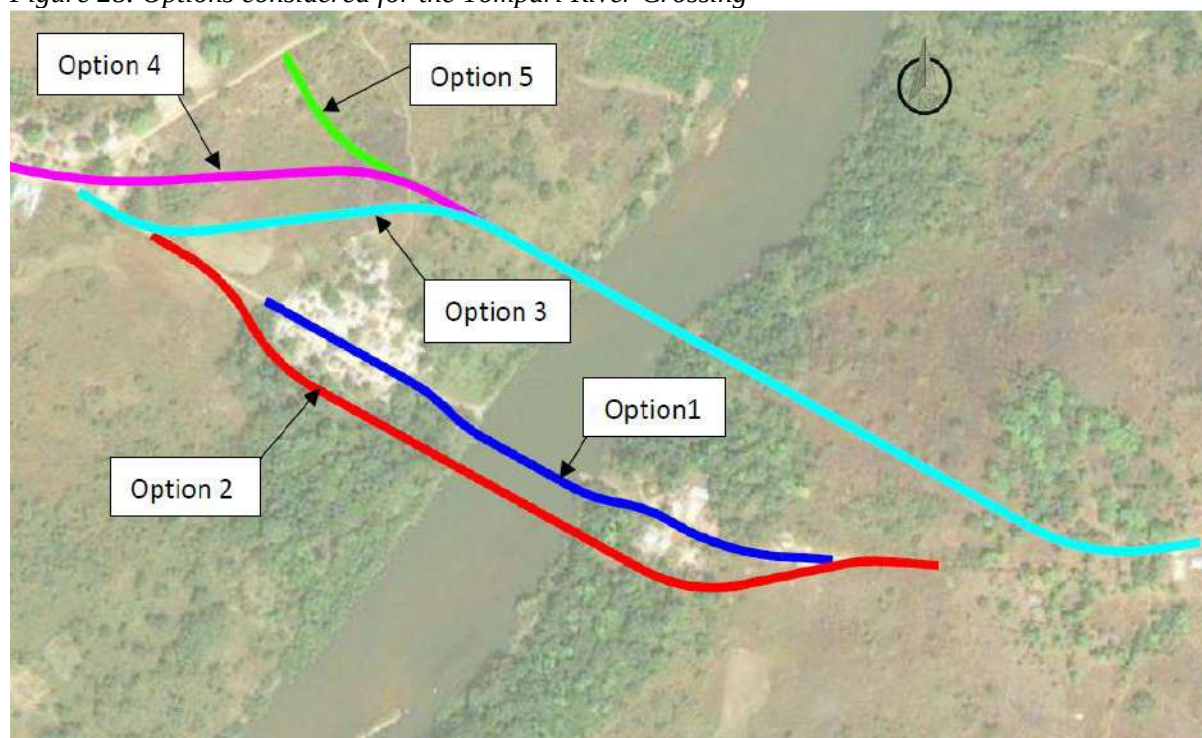
Option 3 is recommended for the Tomparie River Crossing as it balances safety, social impact, and environmental considerations effectively. With minimal resettlement requirements, limited vegetation clearance, and a moderately cost-effective alignment, Option 3 meets the project's objectives by preserving community connectivity and managing environmental impact.

Table 14. Summary of Environmental, Social, and Economic Impacts for Bridge Alignment Options at Tomparie - Kamakwei Crossing

Factors	Option 1	Option 2	Option 3 (Recommended)	Option 4	Option 5

Bridge Length	630m alignment, 130m river crossing	860m alignment, 150m river crossing	1165m alignment, 125m river crossing	1405m alignment, 125m river crossing	1015m alignment, 125m river crossing
Land Take and Resettlement	Some resettlement; minor deviations impact nearby houses	No resettlement; loss of cops and economic trees	No resettlement; minimal impact on crops and economic trees	Minimal resettlement; affects more houses and economic trees than Option 3	No resettlement; limited impact on crops and economic trees
Community Access	S-bend approach; safety concerns	Improved geometry; maintains community access	Direct access with minimal new road; optimal for connectivity	Straight approach; safer but impacts more houses	T-junction limits continuous movement
Environmental Impact	Minimal vegetation removal; shorter alignment	Significant vegetation clearance; impact on crops	Minimal impact on vegetation cover	Significant vegetation removal; affects crops and economic trees	Minimal vegetation clearance; minor impact on economic trees
Economic Cost	Cost-effective; minimal new road required	Higher cost due to longer bridge and extensive removal of vegetation cover	Moderate cost; reduced construction needs	Higher cost due to added land acquisition and bridge length	Moderate cost; T-junction may increase maintenance needs

Figure 28. Options considered for the Tompari River Crossing



The affected persons and properties within the selected alignments have been surveyed and recorded in the Resettlement Action Plan (RAP). Only properties impacted within these alignments were surveyed and captured in the RAP for compensation. A table summarizing the areas affected in each lot is provided below.

Table 15. Summary of Property Acquisition for Project-Affected People

Item No.	Description	Total Counts			
		Mattru Crossing	Jor Gendema Crossing	Manowa Crossing	Tomparie Crossing
1	Affected Properties (dwelling houses)		26	1	41
2	Livelihood Restoration Assistance	47	10	11	10
3	Community Structures	1(toilet)			1(drying floor)
4	Business Structures		5	1	
5	Mixed (dwelling and business)	8			
6	Economic Crops/ Trees (Owners)	2	8	1	3
7	Fence		3		
8	Water well		2		1
9	Kitchen				2
10	Grave /Cultural Heritage	1	1		
11	Barray		1		
12	Land take	1.2(acre)		1(acre)	7.8(acre)
13	Vulnerable	8	12	1	15

(Source: Resettlement Action Plan)

6 ENVIRONMENTAL BASELINE CONDITIONS

6.1 INTRODUCTION

This section presents the existing baseline conditions within the vicinity of the various footprints of the proposed bridges against which the predicted impacts and identification of mitigation measures of the projects are analysed. It is divided into two main sections: physical and biological environmental attributes of the area. The baseline data presented in this ESIA is, therefore, based on various rapid field assessments, primary data collection, and other surveys undertaken by MARISWE/ICS.

6.2 CLIMATIC INFORMATION

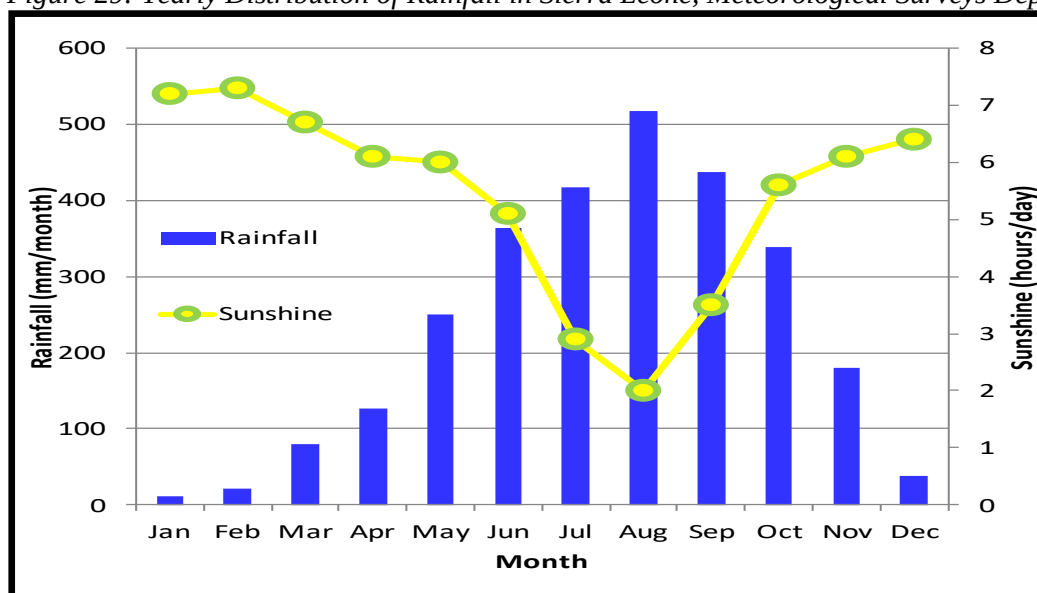
Sierra Leone is located in western Africa on the Atlantic Coast. At latitudes of 7 to 10°N, Sierra Leone has a tropical monsoon climate which is strongly influenced by the West African Monsoon. Of the land area, about 60% has a tropical rainforest climate, while the remaining 40% has a tropical wet and dry/savanna climate (Climateemps.com, 2021). The climate could also be described as a climate that is transitional between a continually wet tropical rainforest climate and a tropical savanna climate.

6.2.1 Rainfall

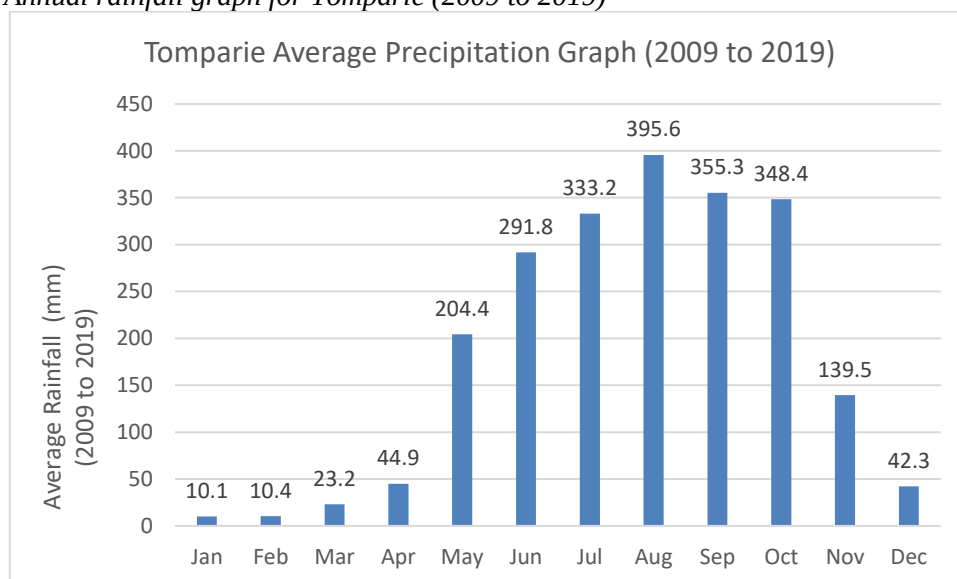
Two seasons determine the agricultural cycle in Sierra Leone i.e. the rainy/wet season and the dry season. The rainy/wet season is between May and October, peaking between July and September. During this rainy season, the sky is cloudy, the winds are south-westerly, sunshine is minimal, and rain falls almost daily, especially during July and August (SLMet, 2021). The dry season stretches from December to May, which includes harmattan when cool, dry winds blow in off the Sahara Desert (SLMet, 2021). The rainfall season will directly influence the construction programme. The ideal construction window period is from mid-November to mid-May which is about 6 months in total. The consultant recommends that the appointment of a contractor, the commencement of the contract, and the design phase be completed before mid-November.

The annual rainfall for the four bridge sites is illustrated in the graphs below.

Figure 29: Yearly Distribution of Rainfall in Sierra Leone, Meteorological Surveys Department; 2009

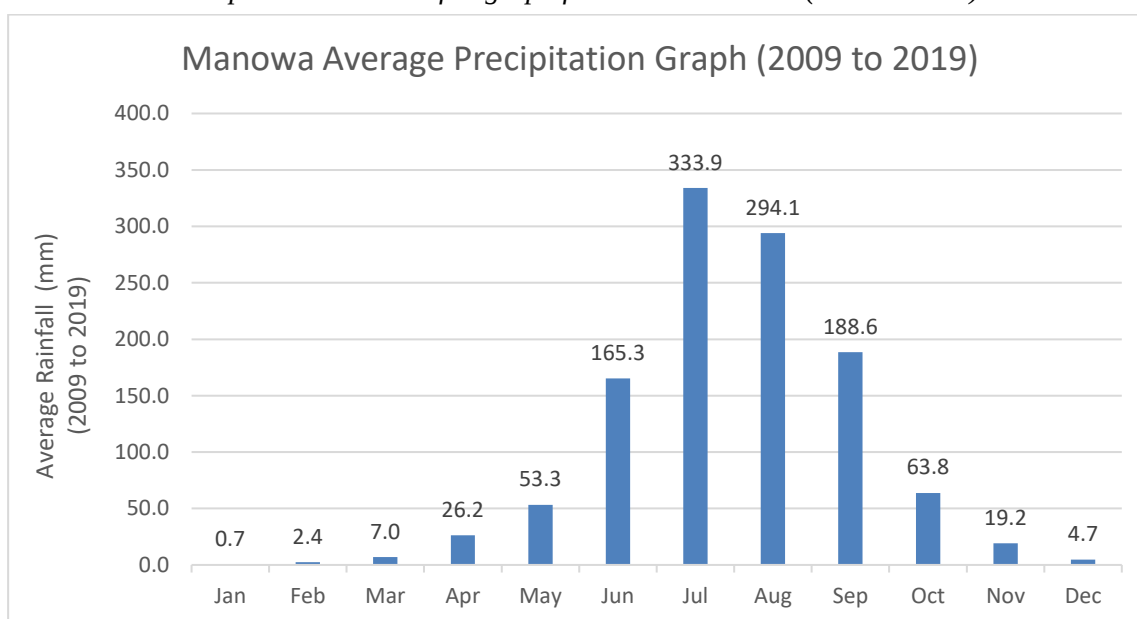


Graph 1: Annual rainfall graph for Tomparie (2009 to 2019)



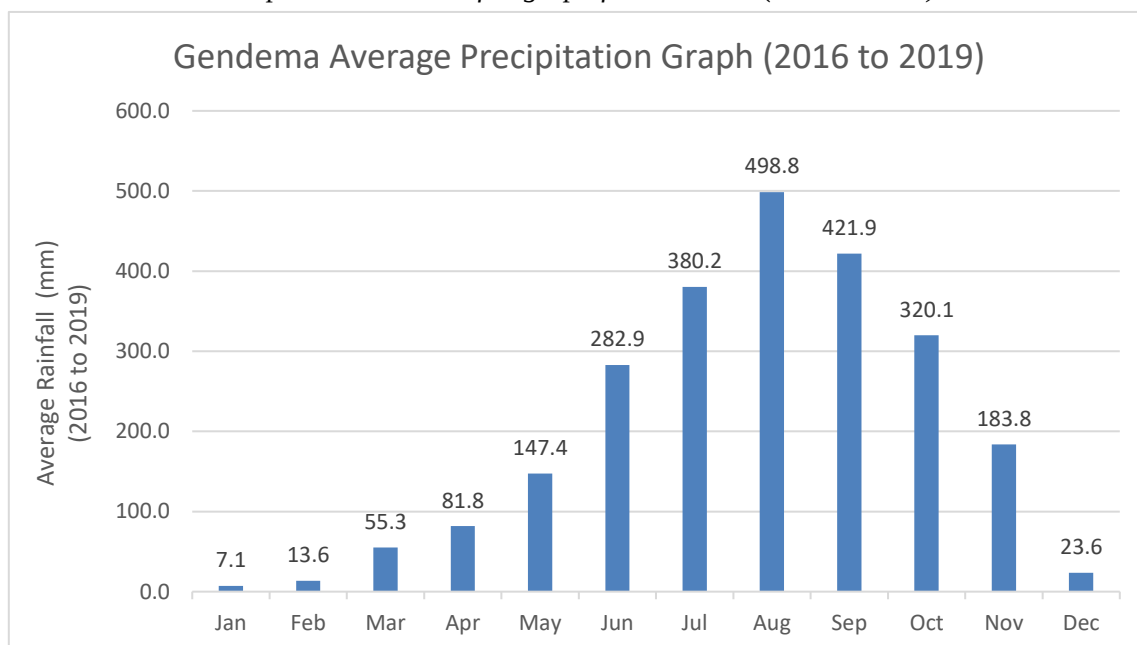
(Sierra Leone Meteorological Agency, 2021)

Graph 2: Annual rainfall graph for the Manowa site (2009 to 2019)



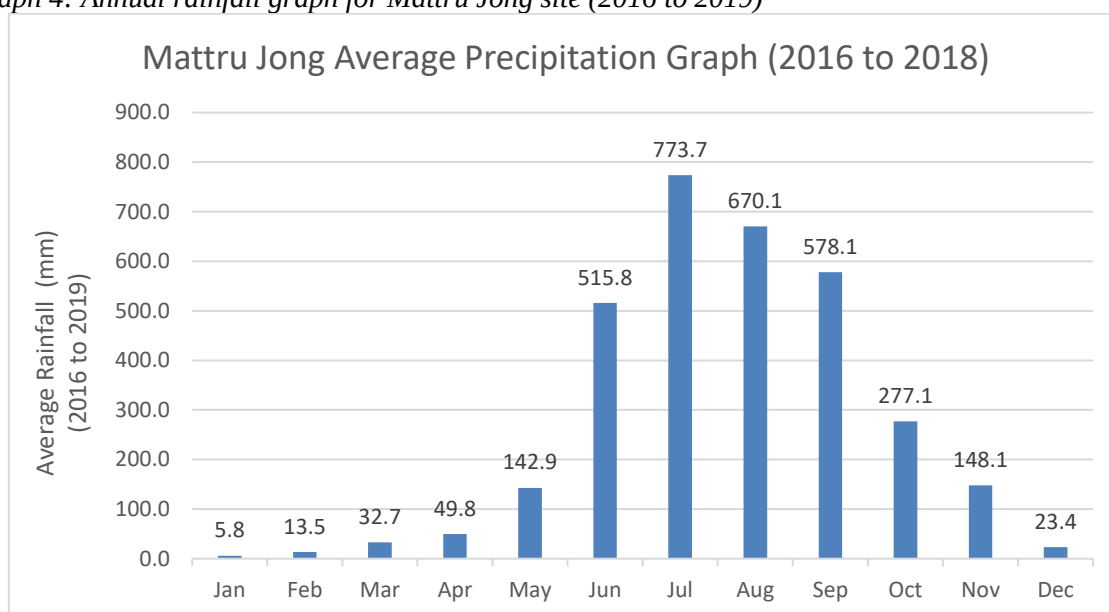
(Sierra Leone Meteorological Agency, 2021)

Graph 3: Annual rainfall graph for Gendema (2016 to 2019)



(Sierra Leone Meteorological Agency, 2021)

Graph 4: Annual rainfall graph for Mattru Jong site (2016 to 2019)

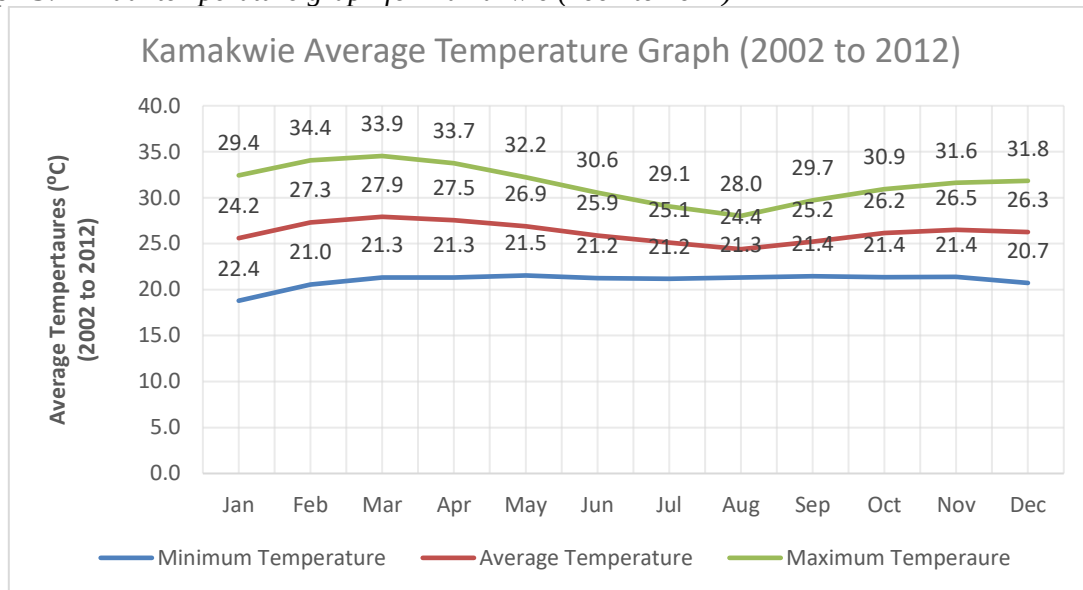


(Sierra Leone Meteorological Agency, 2021)

6.2.2 Temperature

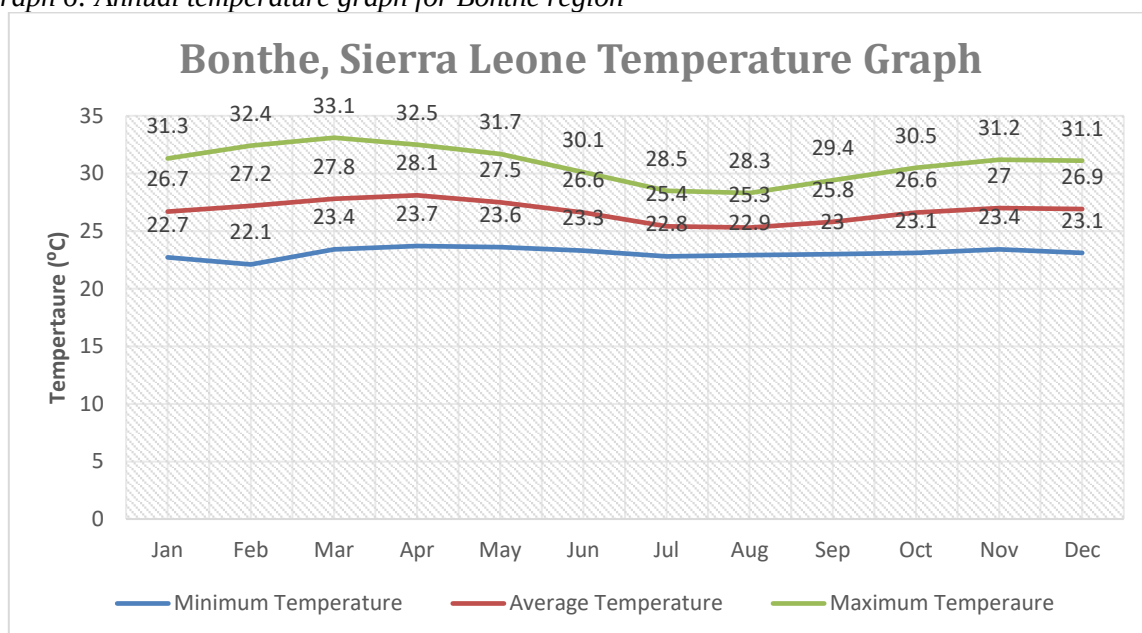
Conditions are generally hot and humid. Mean monthly temperatures range from the mid-20s °C to the upper 20s °C in low-lying coastal areas; inland they may average low 20s °C. In the northeast, where extremes of temperature are greater, mean daily minimums fall too low to mid-10s °C in January and mean daily maximums rise to the low 30s °C in March. The following graphs show how temperature varies in different regions annually.

Graph 5: Annual temperature graph for Kamakwie (2002 to 2012)



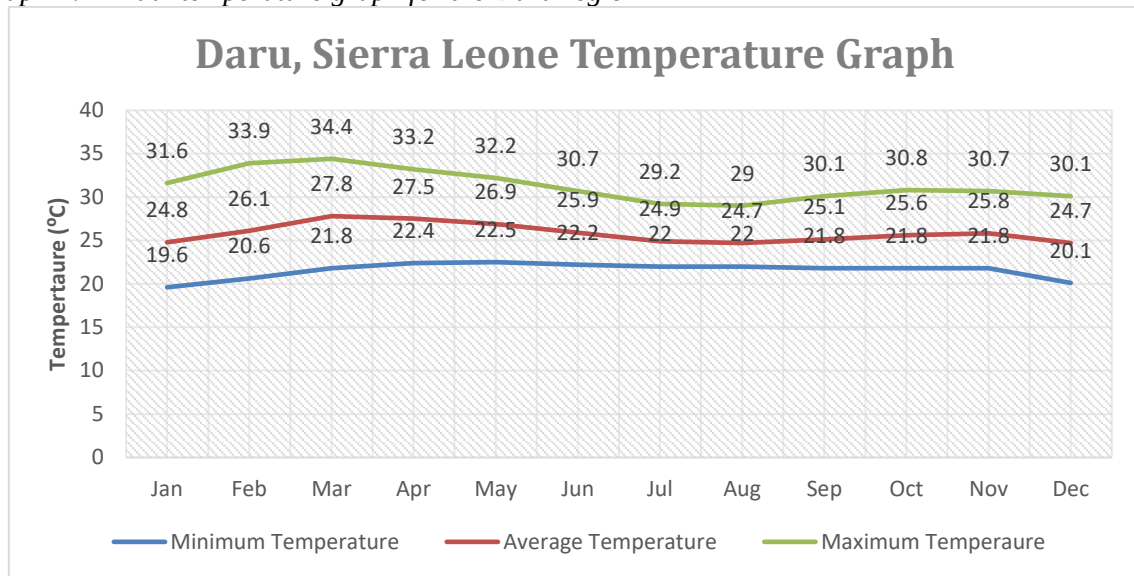
(Sierra Leone Meteorological Agency, 2021)

Graph 6: Annual temperature graph for Bonthe region



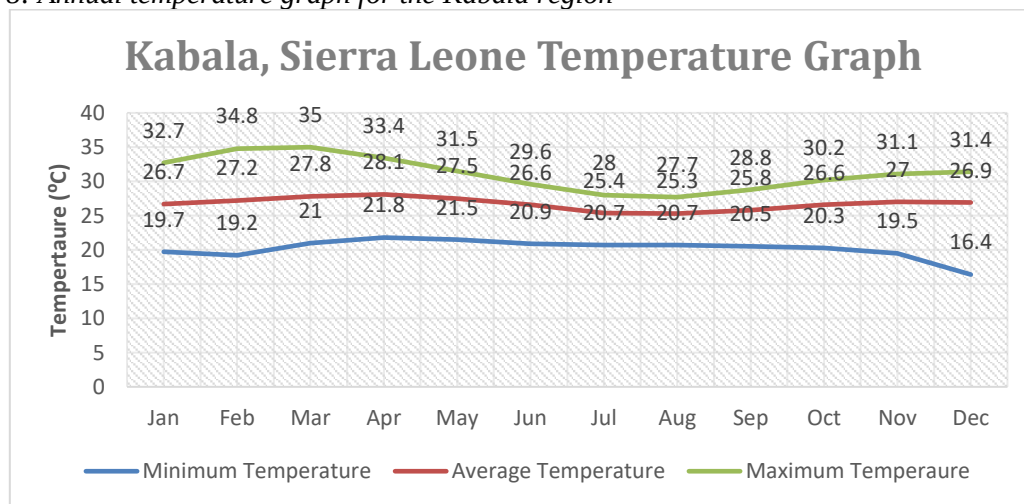
(Climatemps.com, 2021)

Graph 7: Annual temperature graph for the Daru region



(Climatemps.com, 2021)

Graph 8: Annual temperature graph for the Kabala region



(Climatemps.com, 2021)

During the rainy season, from May to October, humid air masses from the Atlantic dominate (Britannica, 2021). The rainy season tends to have cooler daily maximum temperatures than the dry season by about 6°C (Britannica, 2021). The relative humidity, however, may be as high as 90 percent for considerable periods, particularly during the wettest months, from July to September.

6.2.3 Climate Change

Since bridges are designed for a 100-year life span, climate change needs to be factored in during the detailed design of the bridges to ensure that the service level of bridges does not deteriorate and that the bridges are climate resilient. Climate change primarily influences the design of flood levels which are used to determine the bridge minimum deck soffit levels and freeboard. Since current hydrology and flood quantification methods do not cater to climate change, on this project, the contractor during detailed design will need to factor in the changes in flood quantity which result from projected climate change.

The mean annual temperature has increased by 0.8°C since 1960, an average rate of 0.18°C per decade. The mean annual temperature is projected to increase by 1.0°C to 2.6°C by the 2060s, and 1.5°C to 4.6°C by the 2090s. The range of projections by the 2090s under any one emission scenario is 1.0°C to 2.0°C. The projected rate of warming is more rapid in the northern inland regions of western Africa than in the coastal regions (UNDP, 2020). Although there is insufficient data to determine trends in daily temperature extremes for all seasons, available data indicate a significant increase in trends in the frequency of “hot” nights (UNDP, 2020).

Mean annual rainfall over Sierra Leone has decreased since 1960, but it is difficult to determine whether this is part of a long-term trend because of the variable nature of rainfall in this region. The rainfall record is punctuated by wetter and drier periods; the 1960s and late 1970s were particularly wet, whilst the early 1970s and 1980s were very dry. Rainfalls in 2005 and 2006 were very low (UNDP, 2020). Projections of mean annual rainfall averaged over the country from different models in the ensembles project a wide range of changes in precipitation for Sierra Leone, but tend towards overall increases, particularly in July-August-September and October-November-December. Rainfall in July-August-September is projected to change by -27% to +29% by the 2090s, and -19% to +33% in October-November-December (UNDP, 2020). The proportion of total annual rainfall that falls in heavy events tends to increase in the ensemble projections. Seasonally, this varies between tendencies to decrease in January-February-March and to increase in July-August-September and October-November-December. 1-day and 5-day rainfall maxima in projections all tend towards increases, particularly in July-August-September. The range of changes in projections from the model ensemble covers both increases and decreases in all seasons (UNDP, 2020).

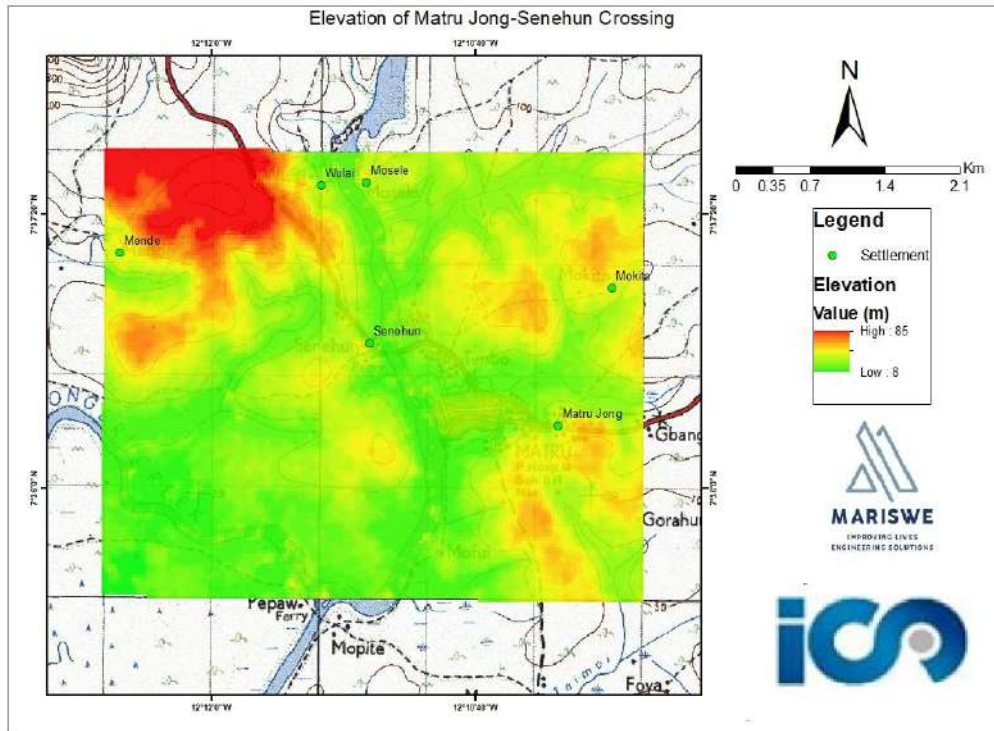
6.3 TOPOGRAPHY

The topography and the landscape of the proposed bridge locations will be impacted by the construction and operation of the bridges. However, there are notable human-induced impacts on the banks of these rivers and the land to be used for the 250M of approach road on each end of the bridges to be constructed. It is also important to note that these areas mostly practice slash-and-burn agricultural cultivation. The community land use for shift cultivation will be lost as a result of the operation of the bridge, implying that there will be a high demand for non-agricultural land. Based on the requirements of the RAP to be developed and implemented for the Subproject, all the necessary compensation shall be paid for any damaged or destroyed crops and propriety that belongs to the affected persons prior to the commencement of any physical works in all the sites.

6.3.1 Topography of Matru Jong-Senehun Crossing

The project area is generally located on a gently undulating plain with isolated hill remnants and dissected by a well-defined valley. The hills are usually rising with an extremely low relief from fairly broad interfluves. The gently to moderately sloping interfluves side slopes have commonly been dissected by broad gullies giving rise to narrow, uneven crests. There is usually a well-defined break of slope between the interfluves and valley, except where gentle, narrow foot slopes and terraces occur. Adjacent to the Jong River there are continuous alluvial plains of variable width. There are four main landforms occurring within the project area, which are: (i) isolated hills, the highest being 85 m above sea level, which could be found on the northwest part of the project area, (ii) interfluves, (iii) valley swamps, and (iv) floodplains, the flattest area being 8 m above sea level.

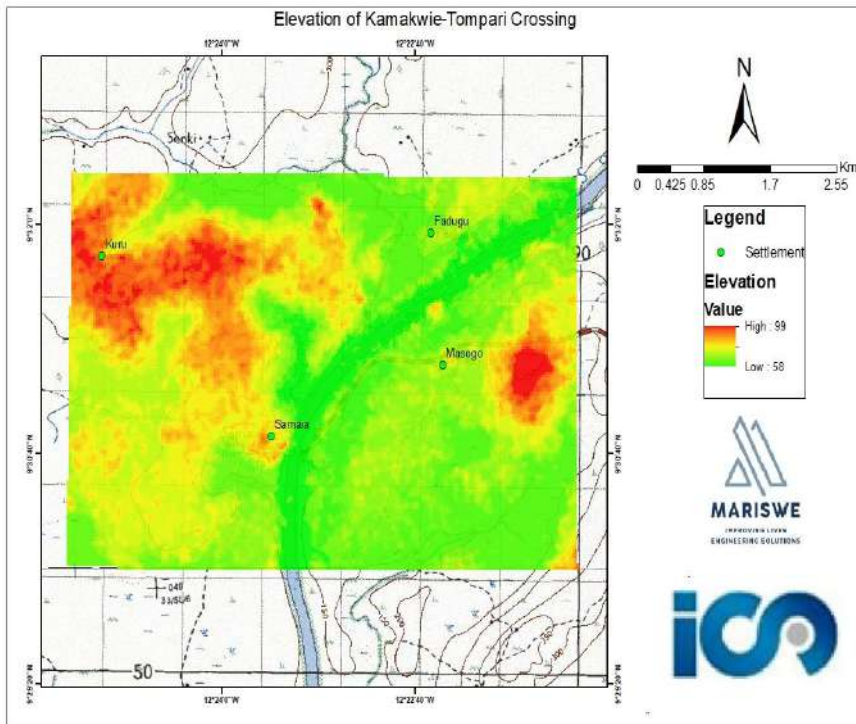
Figure 30: The topography/landforms of Matru-Senehun Crossing



6.3.2 Topography of Tomparie-Kamakwie Crossing

The project area is generally located on a gently undulating plain with isolated low to moderate hills remnants and dissected by a well-defined valley. The hills are usually rising with an extremely low to moderate relief from fairly broad interfluvies. The gently to moderately sloping interfluvies side slopes have commonly been dissected by broad gullies giving rise to narrow, uneven crests. There is usually a well-defined break of slope between the interfluvies and valley swamps, except where gentle, narrow foot slopes and terraces occur. Adjacent to the crossing, there is continuous alluvial plains of variable width. There are four main landforms occurring within the project area, which are: (i) isolated hills, the highest being 99 m above sea level, which could be found on the northwest part of the project area, (ii) interfluvies, (iii) valley swamps, and (iv) floodplains, the flattest area being 58 m above sea level.

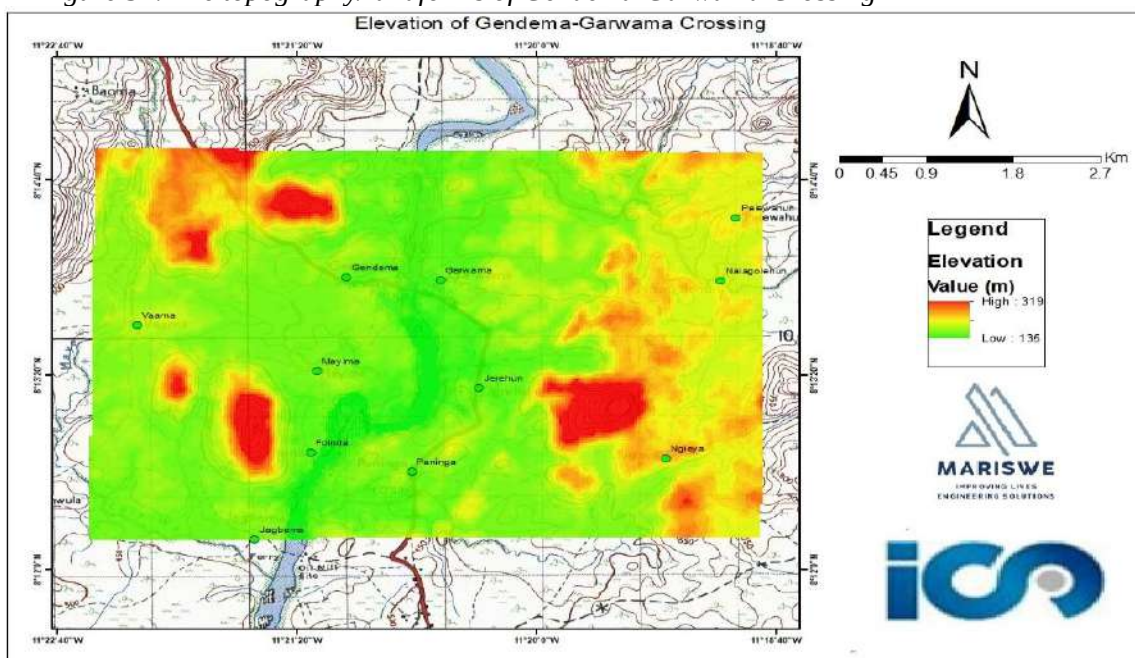
Figure 31: The topography/landforms of Tomparie-Kamakwie Crossing



6.3.3 Topography of Gendema-Garwama Crossing

The project area is generally located on a gently undulating plain with isolated moderate to high hills remnants and dissected by a well-defined valley. The hills are usually rising with an extremely low to moderate relief from fairly broad interfluvies. The gently to moderately sloping interfluvies side slopes have commonly been dissected by broad gullies giving rise to narrow, uneven crests. There is usually a well-defined break of slope between the interfluvies and valley swamps, except where gentle, narrow foot slopes and terraces occur. Adjacent to the crossing, there is continuous alluvial plains of variable width. There are three main landforms occurring within the project area, which are: (i) isolated hills, the highest being 319 m above sea level, which could be found on the northwest part of the project area, (ii) interfluvies, and (iii) floodplains, the flattest area being 135 m above sea level.

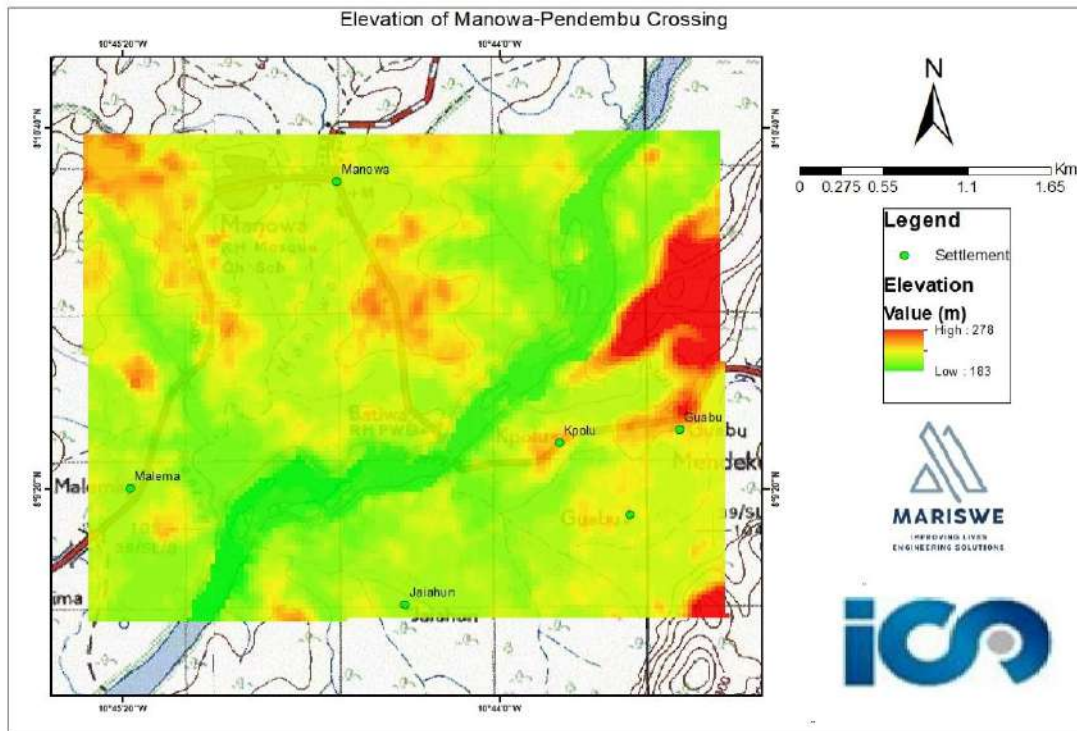
Figure 32: The topography/landforms of Gendema-Garwama Crossing



6.3.4 Topography of Manowa-Pendembu Crossing

The project area is generally located on a gently undulating plain with isolated moderate to high hills remnants and dissected by a well-defined valley. The hills are usually rising with an extremely low to moderate relief from fairly broad interfluvial valleys. The gently to moderately sloping interfluvial side slopes have commonly been dissected by broad gullies giving rise to narrow, uneven crests. There is usually a well-defined break of slope between the interfluvial valleys and valley swamps, except where gentle, narrow foot slopes and terraces occur. Adjacent to the crossing, there is continuous alluvial plains of variable width. There are three main landforms occurring within the project area, which are: (i) isolated hills, the highest being 278 m above sea level, which could be found on the northwest part of the project area, (ii) interfluvial valleys, and (iii) floodplains, the flattest area being 183 m above sea level.

Figure 33. The topography/landforms of Manowa-Pendembu Crossing



6.4 GEOLOGY

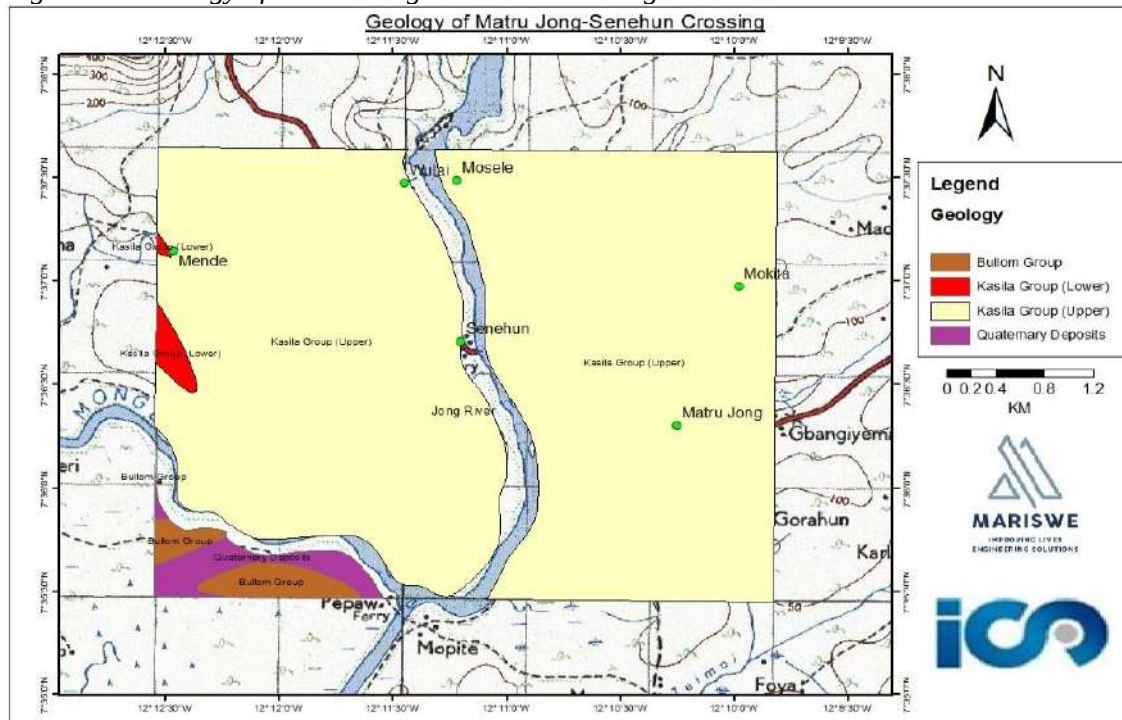
This section describes the local geological units and geological structures that will inform the study of the various rock types that are found in the localities of the proposed bridges.

6.4.1 Geology of Matru Jong-Senehun Crossing

The project area consists of 95% of the Kasila Group of rocks of Sierra Leone. The Kasila Group is an NW-SE trending strip of highly deformed and metamorphosed amphibolite- to granulite-facies metasedimentary and meta-igneous rocks of Palaeo-Proterozoic age (De Waele et al., 2015).

The Kasila Group is generally not well exposed but can be studied in many quarries/ borrow pits including two visited on this trip, along the Matru-Bo Highway. In the Gbangbama Hills, adjacent to the Sierra Rutile mine, natural exposures of both amphibolite- and granulite-facies gneisses can be found (Mackenzie, 1961). Away from the hilly areas, the best exposures are likely to be found in quarries and river valleys.

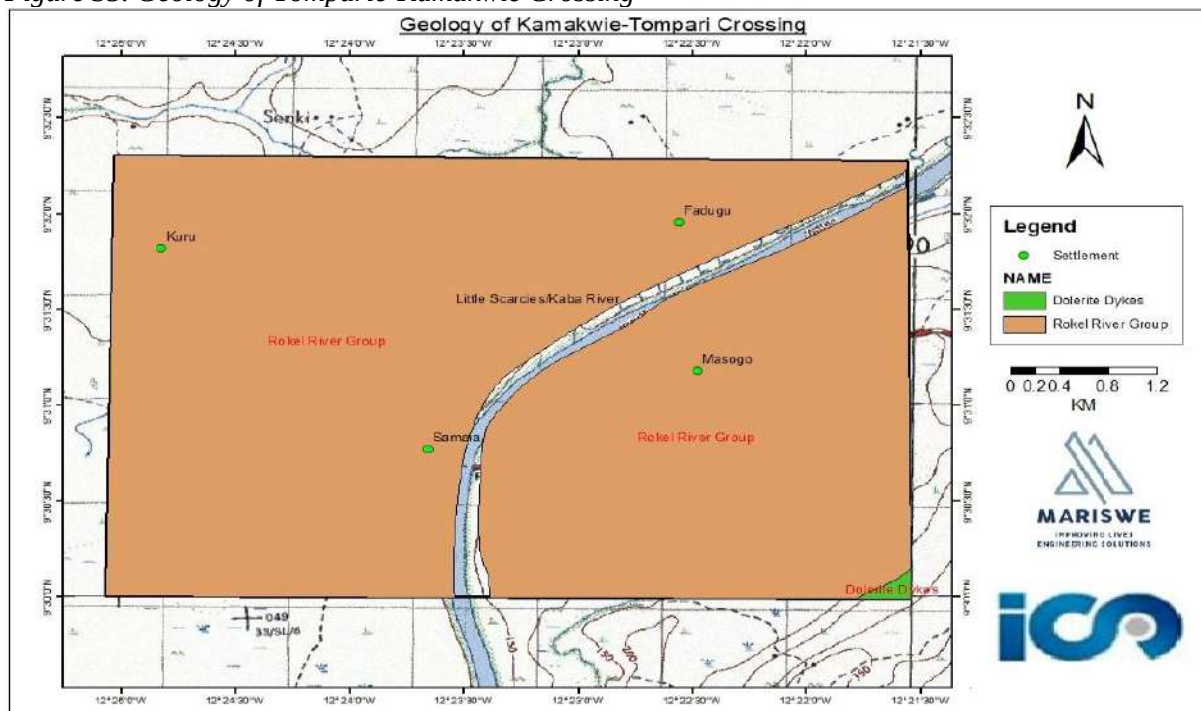
Figure 34: Geology of Matru Jong - Senehun Crossing



6.4.2 Geology of Kamakwie-Tompari Crossing

The Rokel River Group of rocks predominantly (100%) underlies the project area. The Rokel River Group is a volcano-sedimentary succession, metamorphosed to low grade, which was described in some detail by MacFarlane et al. (1981) and is relatively well-exposed in the northern part of its outcrop, chiefly in river exposures. It rests uncomfortably upon the Marampa Group and the basement gneisses. Away from the river (Little Scarcies), the rock types typically form flat laterite plains with no exposures seen.

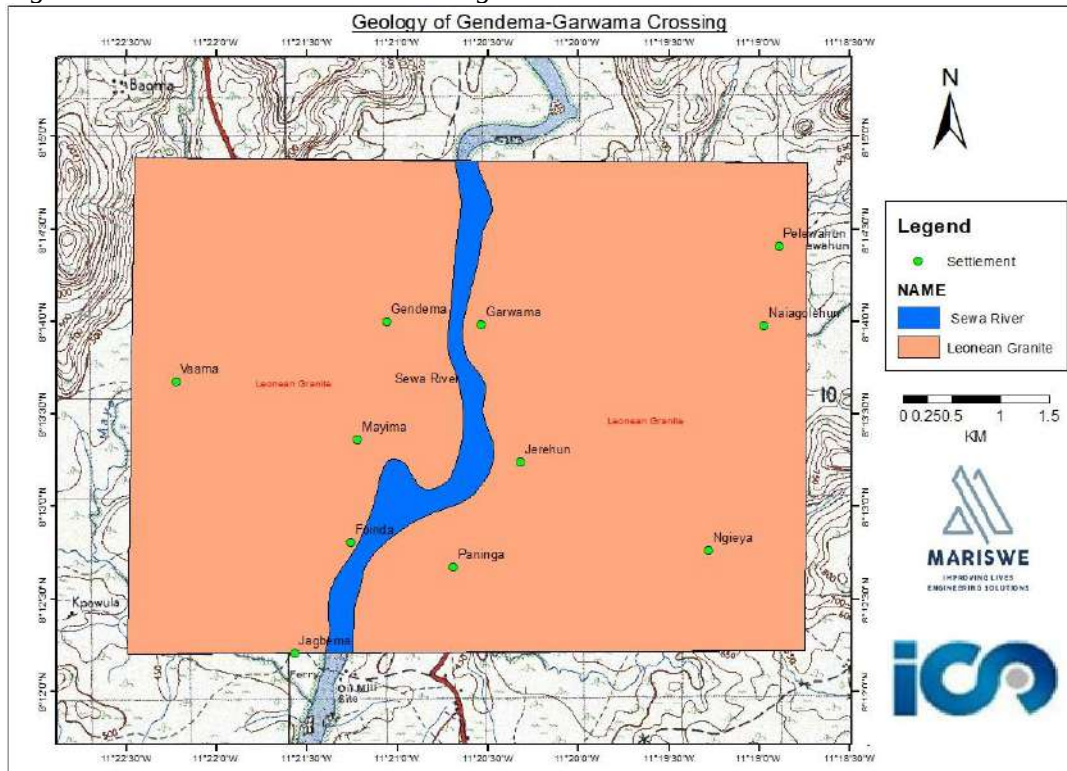
Figure 35. Geology of Tomparie-Kamakwie Crossing



6.4.3 Geology of Gendema-Garwama Crossing

The project area is underlain predominantly (100%) by Leonean Synkinematic Granites with fewer intrusions of late-kinematic granites. It is made up of Porphyroblastic banded Gneiss, Migmatite gneiss, Granitoids, Amphibolite, Granitic Gneiss, and Metamorphic sediment. Some of the gneisses contain garnet. The minor intrusion of Mesozoic dolerite dykes can also be observed. Alluvial diamonds and gold were produced historically and are still being produced at many locations close to the project area, some indicating potential local sources, especially within the river (i.e., Sewa). Gravel reserves in the channel and the bank are consequently very large. Extensive illicit mining is being carried out in the project area.

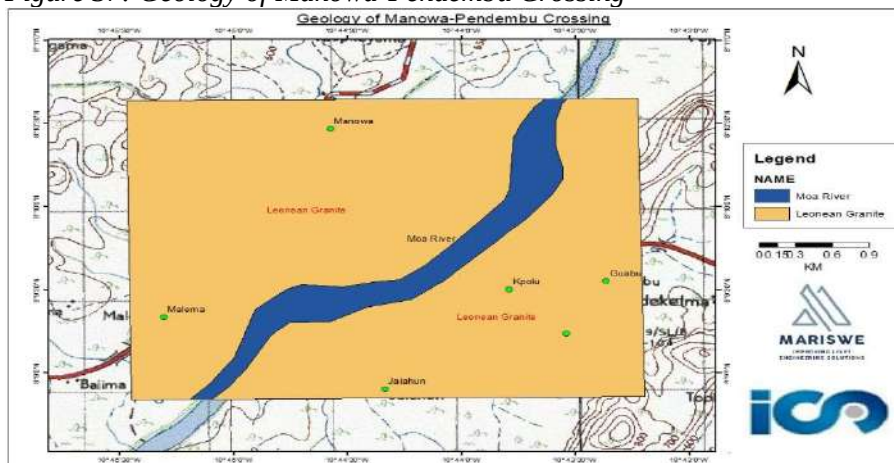
Figure 36: Gendema-Garwama Crossing



6.4.4 Geology of Manowa-Pendembu Crossing

Most of Sierra Leone is underlain by a series of ancient, folded, crystalline rocks of varying lithology, belonging to the Archean subdivision of the Precambrian period. The project area in its entirety is of the Leonean Granites.

Figure 37: Geology of Manowa-Pendembu Crossing



6.5 AIR QUALITY

Air quality monitoring was conducted across various points within the bridge project areas to assess baseline air quality conditions. This analysis aimed to provide accurate data on particulate matter (PM) levels and gaseous pollutants, offering insights into ambient air quality and its potential effects on human health and environmental conditions. Using advanced equipment, including the AEROCET 531 and YES Plus LGA, enabled precise measurements of particle mass concentrations and multiple gas levels, ensuring reliable data collection for comprehensive analysis across all monitored areas.

The AEROCET 531, a handheld, rechargeable unit, provides real-time measurements across six mass ranges, including PM1, PM2.5, PM4, PM7, PM10, and TSP. This device's sensitivity allows for comprehensive particulate matter profiling, capturing variations in both particle counts and mass concentrations throughout the day. Complementing this, the YES Plus LGA unit is designed for multi-gas detection and delivers high-accuracy readings on various gaseous pollutants, providing a complete air quality profile. Data collection was performed both in the morning and evening to capture potential fluctuations associated with daily human and environmental activities.

Despite the presence of minimal pollutants, results from these monitoring activities indicated that the surrounding air quality remains relatively clean and suitable for human intake.

Methodology

Air quality monitoring was conducted using handheld, battery-operated devices renowned for their high accuracy and reliability: the AEROCET 531 and the YES Plus LGA. These units were chosen to capture a detailed profile of both particulate matter and gaseous pollutants across the project areas. The AEROCET 531, capable of measuring six mass ranges (PM1, PM2.5, PM4, PM7, PM10, and TSP), provided real-time data on particulate levels. Concurrently, the YES Plus LGA, designed for multi-gas detection, enabled comprehensive monitoring of pollutants with high precision, offering simultaneous readings for multiple gases.

Data was collected at fixed points across the project areas in both morning and evening sessions to capture diurnal variations potentially linked to human activity, traffic, or environmental conditions. Measurements were taken at multiple monitoring points, with data captured at intervals that allowed for a thorough trend analysis over time. Both particulate matter concentrations and gaseous pollutant levels were recorded for subsequent analysis to assess baseline conditions and to provide insights for future monitoring needs.

6.5.1 Air Quality Baseline Analysis of Matru-Senehun Crossing

The air quality at Matru - Senehun Crossing maintains a largely stable baseline, with slight evening increases in NO, CO2, H2S, PM2.5, and PM10 levels. These evening trends may reflect increased human, vehicular, or organic activities, although the overall impact is low. The consistent presence of zero values for several pollutants, including CO, O3, and VOCs, highlights minimal industrial or heavy traffic influence, supporting an overall clean air profile in the study area. In examining the baseline data for potential areas of concern, the following monitoring points were observed:

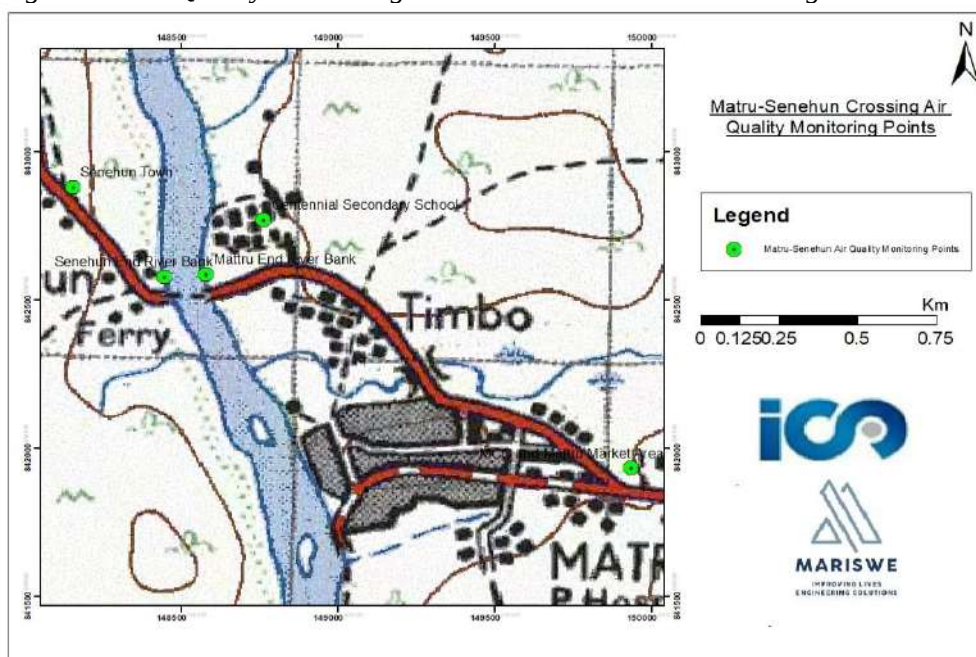
Senehun Town shows the highest evening increase in NO (1.1 ppm) and H2S (0.5 ppm), suggesting localized sources that might intermittently contribute to these pollutants. This rise, while moderate, could reflect activities such as waste processing or human activity spikes in the area.

Matru riverbank and Centennial Secondary School present slightly elevated readings for PM10 and PM2.5 in both morning and evening. Although still within limits, these levels indicate potential sources of particulate matter, possibly due to nearby dust or minor combustion sources. These locations merit continued monitoring as part of future assessments, especially if activities or emissions in the area intensify. The overall air quality remains stable and within regulatory thresholds, establishing a low-impact baseline for the study area.

Table 16. Air Quality Baseline Data for Mattru - Senehun Crossing (morning/evening)

Parameter	Senehun Riverbank (x=810561, y=842295)	MCC and Mattru Market Area (x=812060, Y=841670)	Mattru River Bank (x=810694, y=842305)	Centennial Secondary School (x=810875, y=842491)	Senehun Town (x=810266, y=842592)	WHO Standard
NO (ppm)	0.5 / 0.9	0.5 / 0.2	0.6 / 0.8	0.8 / 0.9	0.5 / 1.1	0.2 ppm (annual mean)
HCl (ppm)	3.2 / 4.2	3.0 / 2.7	4.7 / 4.2	6.8 / 6.2	3.0 / 4.3	Not specified
CO (ppm)	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	10 mg/m ³ (8-hr mean)
NH3 (ppm)	0 / 0.1	0 / 0	0 / 0	0 / 0	0 / 0.2	Not specified
O3 (ppm)	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0.1 ppm (8-hr mean)
CH2O (ppm)	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	Not specified
CO2 (ppm)	348 / 418	341 / 445	388 / 341	397 / 406	345 / 344	Not specified
SO2 (ppm)	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0.02 ppm (24-hr mean)
H2S (ppm)	0.3 / 0.4	0.4 / 0.3	0.3 / 0	0.3 / 0.3	0.3 / 0.5	Not specified
VOC (ppm)	0.0 / 0.0	0 / 0	0 / 0	0 / 0	0 / 0	Not specified
PM2.5 (µg/m ³)	13.1 / 16.3	18.4 / 11.5	19.4 / 19.9	16.0 / 17.1	20.2 / 20.4	15 µg/m ³ (annual mean)
PM10 (µg/m ³)	17.9 / 20.8	12.7 / 26.2	21.1 / 22.7	17.2 / 17.3	29.7 / 31.9	45 µg/m ³ (24-hr mean)
RH (%)	81 / 48	36 / 39	80 / 57	77 / 50	76 / 39	Not applicable

Figure 38. Air Quality Monitoring Points at Matru-Senehun Crossing



6.5.2 Air Quality Baseline of Gendema-Garwama Crossing

The baseline air quality at Gendema - Garwama Crossing reflects stable conditions, with pollutant levels largely within acceptable limits. Minor fluctuations between morning and evening measurements align with typical local activities rather than significant industrial or vehicular pollution. However, there are small evening increases in NO and HCl levels across most locations, likely due to routine activities such as local traffic or minor combustion sources. Consistent zero levels for CO, O₃, and VOCs further underscore the absence of significant combustion-related emissions, reinforcing a clean air profile in the area.

Garwama Riverbank shows the highest levels of PM₁₀, peaking at 32.2 µg/m³ in the evening. This may be attributed to dust from commuters on bikes, vehicles returning from farms, artisanal mining activities, or minor combustion sources. Gendema Riverbank and Gendema Town show slight increases in H₂S, up to 0.5 ppm in the evening, suggesting intermittent contributions from organic waste or minor waste management issues.

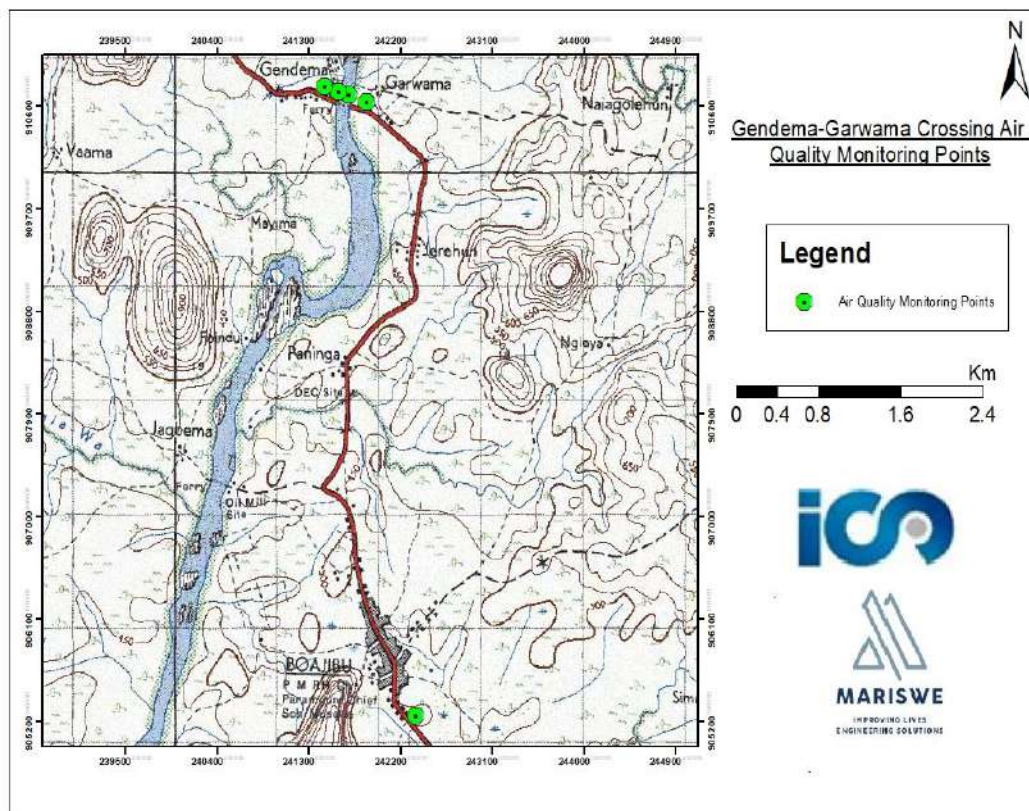
Overall, the baseline remains stable and within safe limits. Continued monitoring at the noted locations is recommended to track any potential shifts in pollutant levels over time.

Table 17. Air Quality Baseline Data for Gendema - Garwama Crossing (morning/evening)

Parameter	Boajibu Town Police Station	Garwama Town	Garwama Riverbank	Gendema Riverbank	Gendema Town	WHO Standard
NO (ppm)	0.6 / 0.6	0.3 / 0.5	0.5 / 0.6	0.5 / 0.7	0.6 / 0.7	0.2 ppm (annual mean)
HCl (ppm)	0.3 / 0.48	3.0 / 3.0	3.1 / 3.0	2.9 / 3.1	3.0 / 3.1	Not specified
CO (ppm)	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	10 mg/m ³ (8-hr mean)
NH ₃ (ppm)	0 / 0.1	0 / 0	0 / 0	0 / 0.1	0 / 0.0	Not specified
O ₃ (ppm)	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0.1 ppm (8-hr mean)
CH ₂ O (ppm)	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	Not specified
CO ₂ (ppm)	362 / 378	351 / 361	326 / 366	299 / 377	333 / 364	Not specified
SO ₂ (ppm)	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0.02 ppm (24-hr mean)
H ₂ S (ppm)	0.2 / 0.3	0.2 / 0.4	0.7 / 0.6	0.3 / 0.5	0.3 / 0.5	Not specified
VOC (ppm)	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	Not specified
PM _{2.5} (µg/m ³)	20.7 / 17.8	21.3 / 22.7	12.3 / 12.9	13.6 / 12.2	15.1 / 15.3	15 µg/m ³ (annual mean)
PM ₁₀ (µg/m ³)	25.6 / 26.3	16.9 / 31.3	29.7 / 32.2	19.7 / 21.4	16.9 / 26.9	45 µg/m ³ (24-hr mean)
RH (%)	41 / 52	41 / 48	40 / 47	36 / 59	40 / 50	Not applicable

Figure 39. Trend Analysis of Baseline Air Quality Parameters at Gendema - Garwama

Figure 40. Air Quality Monitoring Points at Gendema-Garwama Crossing



6.5.3 Air Quality Baseline of Manowa-Pendembu Crossing

The baseline air quality at Manowa - Pendembu Crossing shows pollutant levels generally within safe limits, with minimal indications of significant industrial or vehicular emissions. Key observations include small evening increases in nitrogen oxide (NO) and hydrogen chloride (HCl) levels, likely from routine evening activities such as local traffic or minor combustion sources. Notably, NO levels reach 0.9 ppm and HCl 5.9 ppm, though these remain low overall. Consistent zero levels of carbon monoxide (CO), ozone (O₃), and volatile organic compounds (VOCs) reinforce a clean air profile, while minor evening fluctuations in hydrogen sulfide (H₂S), up to 0.4 ppm, may be associated with waste decomposition or organic material.

Particulate matter (PM_{2.5} and PM₁₀) also shows slight evening increases, with PM₁₀ readings as high as 28.3 µg/m³, likely from dust resuspension due to local activities. Relative humidity varies naturally between morning and evening, consistent with typical environmental conditions.

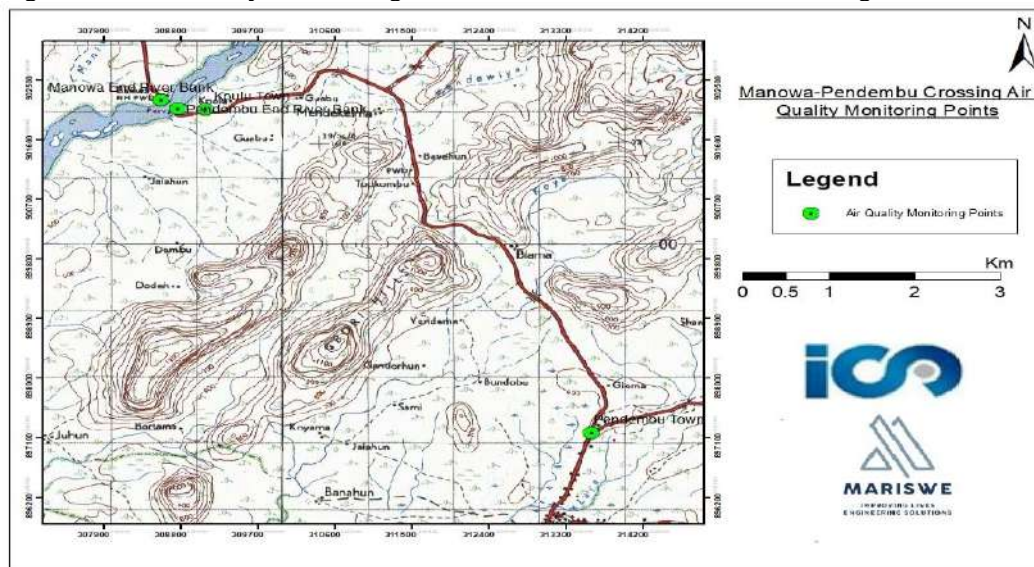
Pendembu and Manowa Riverbanks show the highest evening levels for both NO and HCl. These locations would benefit from ongoing monitoring to identify any emerging trends. Overall, the air quality remains within safe limits, with localized, time-of-day variations suggesting sources that warrant periodic observation to track potential shifts in pollutant levels.

Table 18. Air Quality Baseline Data for Manowa - Pendembu Crossing (morning/evening)

Parameter	Pendembu Town	Kpulu Town	Pendembu Riverbank	Manowa Riverbank	WHO Standard
NO (ppm)	0.6 / 0.7	0.3 / 0.5	0.7 / 0.9	0.7 / 0.9	0.2 ppm (annual mean)

Parameter	Pendembu Town	Kpulu Town	Pendembu Riverbank	Manowa Riverbank	WHO Standard
HCl (ppm)	4.1 / 4.4	3.0 / 3.0	6.0 / 5.9	4.2 / 4.7	Not specified
CO (ppm)	0 / 0	0 / 0	0 / 0	0 / 0	10 mg/m ³ (8-hr mean)
NH ₃ (ppm)	0 / 0.1	0 / 0	0 / 0	0 / 0.0	Not specified
O ₃ (ppm)	0 / 0	0 / 0	0 / 0	0 / 0	0.1 ppm (8-hr mean)
CH ₂ O (ppm)	0 / 0	0 / 0	0 / 0	0 / 0	Not specified
CO ₂ (ppm)	326 / 366	351 / 361	342 / 358	324 / 334	Not specified
SO ₂ (ppm)	0 / 0	0 / 0	0 / 0	0 / 0	0.02 ppm (24-hr mean)
H ₂ S (ppm)	0.2 / 0.3	0.2 / 0.4	0.1 / 0.3	0.2 / 0.4	Not specified
VOC (ppm)	0.0 / 0.0	0 / 0	0 / 0	0 / 0	Not specified
PM _{2.5} (µg/m ³)	17.2 / 20.6	21.3 / 22.7	11.1 / 12.6	11.4 / 11.9	15 µg/m ³ (annual mean)
PM ₁₀ (µg/m ³)	26.7 / 28.3	16.9 / 31.3	18.9 / 21.9	18.9 / 27.8	45 µg/m ³ (24-hr mean)
RH (%)	44 / 50	41 / 48	41 / 55	41 / 48	Not applicable

Figure 41. Air Quality Monitoring Points at Manowa-Pendembu Crossing



6.5.4 Air Quality Baseline of Kamakwie-Tompari Crossing

Pollutant levels at Tompari - Kamakwie Crossing generally remain within acceptable limits, with minimal indications of vehicular or machinery emissions. Key observations include small evening increases in nitrogen oxide (NO) and hydrogen chloride (HCl) levels across several locations, likely linked to routine evening activities such as local traffic or minor combustion sources. These increases reach up to 2.4 ppm for NO and 10.5 ppm for HCl at Kamakwie Town, although they remain moderate overall.

Carbon monoxide (CO), ozone (O₃), and volatile organic compounds (VOCs) consistently show zero levels across all monitoring points, underscoring a clean air profile with minimal contributions from combustion-related sources. Slight fluctuations in hydrogen sulfide (H₂S), peaking at 0.5 ppm in the evening, suggest minor contributions from waste decomposition or organic materials.

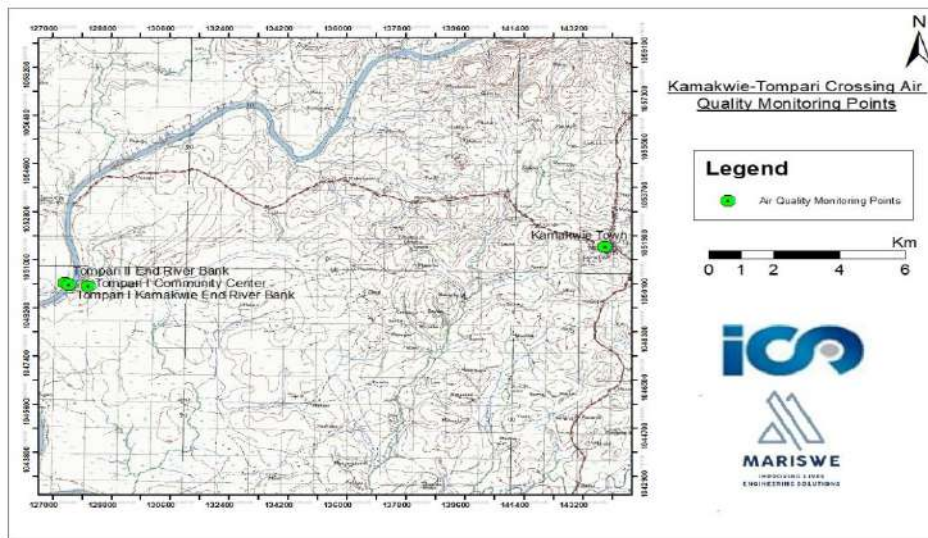
Particulate matter (PM_{2.5} and PM₁₀) levels show some evening increases, with PM₁₀ reaching a high of 30.0 µg/m³, possibly due to dust resuspension from local activities. Relative humidity (RH%) varies naturally between morning and evening, consistent with normal environmental patterns rather than pollution influences.

Kamakwie Town shows the highest evening readings for both NO and HCl, making it a location that may benefit from continued monitoring to identify potential trends over time. Overall, the air quality remains within safe limits, with localized, time-of-day variations pointing to sources that merit periodic observation to track any shifts in pollutant levels.

Table 19. Air Quality Baseline Data for Manowa - Pendembu Crossing (morning/evening)

Parameter	Tompari II Riverbank	Tompari I Kamakwie Riverbank	Tompari I Community Centre	Kamakwie Town	WHO Standard
NO (ppm)	0.9 / 1.1	1.0 / 1.2	1.2 / 1.4	1.9 / 2.4	0.2 ppm (annual mean)
HCl (ppm)	4.2 / 5.1	4.9 / 5.6	6.6 / 8.2	8.3 / 10.5	Not specified
CO (ppm)	0 / 0	0 / 0	0 / 0	0 / 0	10 mg/m ³ (8-hr mean)
NH ₃ (ppm)	0 / 0.0	0 / 0	0 / 0	0 / 0.0	Not specified
O ₃ (ppm)	0 / 0	0 / 0	0 / 0	0 / 0	0.1 ppm (8-hr mean)
CH ₂ O (ppm)	0 / 0	0 / 0	0 / 0	0 / 0	Not specified
CO ₂ (ppm)	300 / 356	399 / 422	366 / 427	333 / 372	Not specified
SO ₂ (ppm)	0 / 0	0 / 0	0 / 0	0 / 0	0.02 ppm (24-hr mean)
H ₂ S (ppm)	0.4 / 0.5	0.4 / 0.4	0.3 / 0.4	0.3 / 0.5	Not specified
VOC (ppm)	0.0 / 0.0	0 / 0	0 / 0	0 / 0	Not specified
PM _{2.5} (µg/m ³)	12.1 / 22.6	16.9 / 19.4	13.4 / 13.6	14.3 / 18.6	15 µg/m ³ (annual mean)
PM ₁₀ (µg/m ³)	21.9 / 30.0	22.1 / 23.6	16.9 / 27.4	22.1 / 19.2	45 µg/m ³ (24-hr mean)
RH (%)	26 / 29	26 / 31	32 / 29	24 / 24	Not applicable

Figure 42. Air Quality Monitoring Points at Kamakwie-Tompari Crossing



6.6 AMBIENT NOISE

The proposed bridge construction project will inevitably introduce noise pollution due to activities such as drilling for bridge piers, operation of heavy-duty equipment, batching and dewatering plants, generator use, and movement of vehicles. Baseline noise assessments were conducted at all four bridge locations to establish current noise levels, which are relatively low due to the remote, rural setting, absence of industrial activity, and minimal traffic. To mitigate potential noise impacts on the environment and nearby communities, comprehensive noise management measures have been outlined in this ESIA for implementation by contractors throughout the construction period.

To minimize disruption to adjacent communities, the project will adhere to established noise standards from the World Health Organization and the International Finance Corporation, keeping daytime noise levels under 70 dB(A) and nighttime levels below 45 dB(A). These limits are intended to prevent undue stress from construction activities, especially during nighttime hours. The ESIA includes detailed mitigation strategies, such as planned construction schedules, PPEs, and active community communication, which will assist contractors in managing noise impacts effectively and in alignment with recognized international guidelines.

Methodology

The baseline noise study at the bridge sites was designed to focus on monitoring points that best capture the primary noise sources and ambient conditions specific to each crossing. By selecting both ends of each bridge and key points on the river, we effectively encompass noise variations due to transportation, community movement, and natural riverine activity, creating a comprehensive sound profile relevant to bridge users and surrounding communities. This strategic choice excludes less significant areas, concentrating instead on locations that directly influence noise exposure at the crossings.

Baseline noise data collection included L10, L50, and L90 levels to capture a comprehensive sound profile. L10 recorded peak noise events, L50 represented typical ambient levels, and L90 indicated background noise. Together, these metrics provided an accurate baseline for assessing noise exposure at the bridge sites.

To ensure data accuracy, all measurements were taken using the Bruel and Kjaer Precision Integrating Sound Level Meter, Type 2230, with a Bruel and Kjaer Type 4155 Microphone and windscreen. Field calibration was completed prior to each measurement session using a 01dB Sound Level Calibrator (Cal01), guaranteeing that readings accurately reflect ambient noise conditions and provide a reliable baseline for ongoing noise assessment and management.

6.6.1 Ambient Noise in the Matru Jong-Senehun Crossing

The Matru Jong - Senehun crossing, a rural cable ferry site with occasional pedestrian and vehicular traffic, serves as an essential link for residents traveling between both ends. Noise monitoring at this location captures both daytime and nighttime conditions, reflecting the relatively quiet ambient environment typical of rural areas, with occasional peaks from ferry operations and pedestrian movement. Daytime measurements indicate minor fluctuations due to crossing activity, while nighttime readings show reduced noise levels consistent with the area's decreased activity after hours. This assessment provides a profile of ambient noise at the Matru Jong - Senehun crossing, supporting future monitoring and management suited to the site's operational and community needs.

- Daytime Noise Analysis:** Daytime monitoring at Matru Jong - Senehun Crossing shows LAeq (average noise level) values ranging from 40.3 dB(A) to 44.1 dB(A) across the various monitoring points, reflecting low ambient noise levels typical of a rural setting. The L10 values, representing noise levels exceeded 10% of the time, are consistently higher than L50 (median noise level) and L90 (background level). Peak L10 levels reach up to 46.0 dB, indicating occasional moderate noise events likely due to environmental or incidental human activities. Overall, baseline daytime noise levels remain within acceptable limits for rural environments, with minimal impact on the local population.

Table 20: Results of Daytime Ambient Noise at Matru Jong – Senehun

Geographical Location	Coordinates	LAeq (dBA) Peak Level)	L10 (dB)	L50 (dB)	L90 (dB)	Measurement Date	Time	WBG EHS Guidelines Daytime LAeq (dBA)*
Matru Jong End	X=810701, Y=842308	44.1	46.0	43.5	41.0	05/09/2024	11:40	55.0
Up Stream	X=810616, Y=842540	40.3	42.0	40.0	38.5	05/09/2024	12:33	55.0
Middle Stream	X=810609, Y=842400	42.4	44.2	42.0	39.8	05/09/2024	13:47	55.0
Down Stream	X=810675, Y=842188	40.9	42.5	40.5	38.0	05/09/2024	14:38	55.0
Senehun End	X=810562, Y=842290	42.9	44.5	42.4	40.2	05/09/2024	15:00	55.0

*Residential, institutional, educational receptors (given the rural nature of the bridge site residential guideline noise level considered

- Nighttime Noise Analysis:** Nighttime monitoring results show a reduction in ambient noise compared to daytime levels, with LAeq values between 35.8 dB(A) and 37.5 dB(A). L10 nighttime values, which reach up to 39.0 dB, reflect quieter conditions, with fewer environmental noise sources and minimal human activity. The consistent L50 and L90 levels at night further support a low ambient noise profile, typical of a quiet rural setting.

Table 21: Results of Nighttime Ambient Noise Monitoring

Geographical Location	Coordinates	LAeq (dB(A) Peak Level)	L10 (dB)	L50 (dB)	L90 (dB)	Measurement Date	Time	WBG EHS Guidelines Night time LAeq (dBA)*

Matru Jong End	X=810701, Y=842308	37.5	39.0	37.0	35.0	05/09/2024	22:15	45.0
Up Stream	X=810616, Y=842540	35.8	37.2	35.5	33.5	05/09/2024	22:30	45.0
Middle Stream	X=810609, Y=842400	36.2	37.8	36.0	34.0	05/09/2024	22:45	45.0
Down Stream	X=810675, Y=842188	35.9	37.5	36.0	33.8	05/09/2024	23:00	45.0
Senahun End	X=810562, Y=842290	36.5	38.0	36.3	34.5	05/09/2024	23:00	45.0

** Residential, institutional, educational receptors (given the rural nature of the bridge site residential guideline noise level considered*

6.6.2 Ambient Noise in the Kamakwie-Tompari Crossing

The crossing, characterized by low ferry traffic due to challenging road conditions and limited economic activity, exhibits a quiet rural soundscape. Noise monitoring recorded daytime and nighttime ambient levels, reflecting low overall noise with minor peaks during sporadic daytime activities and further reductions at night. These updated measurements align closely with initial readings from 2021, indicating stable ambient noise levels at this location.

- Daytime Noise Analysis:** During daytime monitoring on 12th September 2024, the LAeq (average noise levels) ranged from 37.8 dB(A) to 39.8 dB(A) across various monitoring points. This reflects low ambient noise typical of a rural setting. The L10 values (noise levels exceeded 10% of the time) peaked at 41.2 dB, indicating occasional moderate noise, likely from incidental daytime activities. Overall, these noise levels are within acceptable ranges for low-activity environments, suggesting minimal impact on nearby populations.

Table 22: Results of Daytime Ambient Noise at Kamakwei – Tomparie Crossing

Geographical Location	Coordinates	LAeq (dB(A))	L10 (dB)	L50 (dB)	L90 (dB)	Measurement Date	Time	WBG EHS Guidelines Daytime LAeq (dBA)*
Kamakwie End	X=786405, Y=1049336	38.7	41.2	38.4	36.9	12/09/2024	10:39	55.0
Up Stream	X=786422, Y=1049428	38.2	40.8	37.9	36.5	12/09/2024	11:35	55.0
Middle Stream	X=786351, Y=1049410	39.8	41.5	39.5	37.2	12/09/2024	12:02	55.0
Down Stream	X=786305, Y=1049358	37.8	39.9	37.0	35.8	12/09/2024	13:31	55.0
Tompari End	X=786299, Y=1049340	39.1	41.0	38.7	36.8	12/09/2024	14:03	55.0

**Residential, institutional, educational receptors (given the rural nature of the bridge site residential guideline noise level considered*

- Nighttime Noise Analysis:** Nighttime monitoring showed reduced noise levels, with LAeq values between 33.7 dB(A) and 35.2 dB(A). L10 values at night reached up to 36.5 dB, reflecting quiet ambient conditions typical of a rural area. The L50 and L90 readings support this low noise profile, indicating stable conditions with minimal external noise. Given this quiet baseline, construction activities, especially at night, could have a more pronounced impact.

Table 23: Results of Nighttime Ambient Noise at Kamakwei – Tomparie Crossing

Geographical Location	Coordinates	LAeq (dB(A))	L10 (dB)	L50 (dB)	L90 (dB)	Measurement Date	Time	WBG EHS Guidelines Night time LAeq (dBA)*
Kamakwie End	X=786403, Y=1049336	33.7	36.5	34.1	33.0	12/09/2024	22:15	45.0
Up Stream	X=786423, Y=1049425	34.0	36.0	33.9	32.8	12/09/2024	22:30	45.0
Middle Stream	X=786346, Y=1049405	35.2	36.9	34.8	33.5	12/09/2024	22:45	45.0
Down Stream	X=786305, Y=1049356	33.5	35.7	33.6	32.5	12/09/2024	23:00	45.0
Tompari End	X=786299, Y=1049340	34.8	36.8	34.5	33.2	12/09/2024	23:00	45.0

*Residential, institutional, educational receptors (given the rural nature of the bridge site residential guideline noise level considered)

6.6.3 Ambient Noise in the Gendema-Garwama Crossing

The Gendema-Garwama crossing, located in an area of moderate activity influenced by nearby transport routes and community movements, displays ambient noise levels typical of a semi-active rural setting. Daytime noise monitoring shows moderate readings across all locations, with occasional peaks likely due to intermittent transportation and nearby activities. At night, ambient noise levels decrease consistently across the crossing, aligning with reduced human and environmental activity.

- Daytime Noise Analysis:** Daytime noise levels at the Gendema-Garwama crossing show moderate readings across all locations, with LAeq values ranging from 43 dB at the Down Stream location to 48 dB at Gendema End. This indicates a moderate level of ambient noise typical for daytime, influenced by surrounding activities and possibly transportation. The L10 levels, which represent the highest noise levels occurring 10% of the time, are consistently higher than LAeq, indicating intermittent louder events. L50 and L90, representing median and background noise levels, are notably lower, pointing to quieter periods with occasional peaks. This spread between L10 and L90 values reflects typical variability in noise levels due to daytime activities, showing a combination of background sounds with occasional louder occurrences.

Table 24. Results of Daytime Ambient Noise at the Gendema – Garwama Crossing

Geographical Location	Coordinates	LAeq (dB(A))	L10 (dB)	L50 (dB)	L90 (dB)	Measurement Date	Time	WBG EHS Guidelines Daytime LAeq (dBA)*
Gendema End	X=241691, Y=910695	48	51	47	44	07/09/2024	13:47	55.0
Up Stream	X=241669, Y=910821	45	48	43	41	07/09/2024	14:35	55.0
Middle Stream	X=241650, Y=910721	46	50	45	43	07/09/2024	15:46	55.0
Down Stream	X=241633, Y=910573	43	46	42	39	07/09/2024	16:37	55.0

Garwama End	X=241581, Y=910724	48	50	47	44	07/09/2024	17:09	55.0

**Residential, institutional, educational receptors (given the rural nature of the bridge site residential guideline noise level considered*

- **Nighttime Noise Analysis:** At nighttime, the noise levels decrease across all locations, with LAeq values generally dropping by 1 to 3 dB compared to daytime. This reduction is expected and typical of lower ambient activity during the night. The L10 levels, while slightly lower than daytime values, still indicate occasional peaks, though these are less frequent and less intense than during the day. L50 and L90 levels are lower than the nighttime LAeq across all sites, showing a quieter and more stable environment at night with minimal variability. This consistent lower noise pattern across nighttime measurements reflects reduced human and natural activity, aligning with the quieter environmental conditions usually observed during these hours.

Table 25. Results of Nighttime Ambient Noise at the Gendema – Garwama Crossing

Geographical Location	Coordinates	LAeq (dB(A))	L10 (dB)	L50 (dB)	L90 (dB)	Measurement Date	Time	WBG EHS Guidelines Night time LAeq (dBA)*
Gendema End	X=241691, Y=910695	45	47	44	42	07/09/2024	20:30	45.0
Up Stream	X=241669, Y=910821	43	45	42	40	07/09/2024	21:15	45.0
Middle Stream	X=241650, Y=910721	45	46	43	41	07/09/2024	22:00	45.0
Down Stream	X=241633, Y=910573	42	44	40	39	07/09/2024	22:45	45.0
Garwama End	X=241581, Y=910724	45	47	44	42	07/09/2024	23:30	45.0

**Residential, institutional, educational receptors (given the rural nature of the bridge site residential guideline noise level considered*

6.6.4 Ambient Noise in the Manowa-Pendembu Crossing

The noise baseline survey conducted at the Manowa-Pendembu crossing aimed to capture the ambient soundscape across key locations: Manowa End, Up Stream, Middle Stream, Down Stream, and Pendembu End. Known for its tranquil environment and limited activity, this crossing provides a representative setting for monitoring natural noise levels in the area. The study recorded both daytime and nighttime conditions to reflect typical ambient variations, offering valuable insights into the site's acoustic environment. This assessment serves as a foundation for understanding ambient noise levels specific to Manowa-Pendembu and aids in informing future noise management strategies tailored to its unique landscape.

- **Daytime Noise Analysis:** The daytime noise levels at the Manowa-Pendembu crossing are moderate, with LAeq values ranging from about 36 dB at Down Stream to around 38 dB at Manowa End. These values suggest a generally quiet environment with only occasional peaks in noise. The L10 levels, representing higher noise levels occurring 10% of the time, are slightly above the LAeq values, indicating intermittent louder activities. In contrast, the L50 and L90 levels, which represent more typical and background noise levels, remain lower, suggesting quieter intervals throughout the day with minimal noise variations between locations.

Table 26: Results of Daytime Ambient Noise at Manowa – Pendembu Crossing

Geographical Location	Coordinates	LAeq (dB(A))	L10 (dB)	L50 (dB)	L90 (dB)	Measurement Date	Time	WBG EHS Guidelines Daytime LAeq (dBA)*
Manowa End	X=308818, Y=902094	38	40	36	34	09/09/2024	08:49	55.0
Up Stream	X=308810, Y=902227	37	40	36	33	09/09/2024	09:35	55.0
Middle Stream	X=308765, Y=902175	37	39	36	33	09/09/2024	10:00	55.0
Down Stream	X=308697, Y=902101	36	38	34	33	09/09/2024	10:29	55.0
Pendembu End	X=308669, Y=902253	36	40	35	32	09/09/2024	11:01	55.0

*Residential, institutional, educational receptors (given the rural nature of the bridge site residential guideline noise level considered

- **Nighttime Noise Analysis:** At night, the noise levels decrease slightly across all locations, with LAeq values around 35 dB, reflecting a stable, quiet environment. The reduced L10 values compared to daytime indicate fewer loud peaks during the night, consistent with lower nighttime activity. The minimal spread between L10, L50, and L90 levels reflects a quiet, stable soundscape without significant noise disruptions, aligning with typical nighttime environmental conditions.

Table 27: Results of Nighttime Ambient Noise at Manowa – Pendembu Crossing

Geographical Location	Coordinates	LAeq (dB(A))	L10 (dB)	L50 (dB)	L90 (dB)	Measurement Date	Time	WBG EHS Guidelines Night time LAeq (dBA)*
Manowa End	X=308818, Y=902094	36	37	35	33	09/09/2024	08:49	45.0
Up Stream	X=308810, Y=902227	34	36	33	31	09/09/2024	09:35	45.0
Middle Stream	X=308765, Y=902175	36	38	35	33	09/09/2024	10:00	45.0
Down Stream	X=308697, Y=902101	34	36	33	31	09/09/2024	10:29	45.0
Pendembu End	X=308669, Y=902253	34	36	33	31	09/09/2024	11:01	45.0

*Residential, institutional, educational receptors (given the rural nature of the bridge site residential guideline noise level considered

6.7 LAND USE

6.7.1 Agriculture

Agriculture is a major livelihood activity practiced in all of the various communities where the bridges will be constructed, albeit, usually, at the subsistence level, indicating that produces are for both income

generation and consumption. Cultivation of annual crops is practiced on both the uplands and the swamps (inland valley swamps).

Permanent crops were evident in Manowa (Kailahun District) and Mattru Jong (Bonthe District), where oil palm and cocoa plantations were found in the majority of the surrounding towns and villages. In some instances, across communities in Tomparie (Karene District), what have been claimed to be plantations are generally orchards of mixed fruit trees including cashew, mango, pineapples, and bananas, located some meters away from settlements and often comprise the surrounding forests of fruit trees that typify villages.

The shifting cultivation pattern of slash and burn is practiced in most of the towns and villages in the localities of the proposed bridges. However, due to the unavailability of land, resulting from the mining of sand and other minerals in the Gendema – Gawama crossing, it was largely revealed during focus group discussions by farmers that they resort to repetitive cultivation on the same plots of land upland. This results in heavy use of fertilizers which can mostly be afforded by only a small number of farmers because it is claimed to be too expensive, to afford, especially the quantity that may be required. Hence, only small quantities can be afforded, which is the reason for upland crop yields remain generally poor and subsistent.

The crops are cultivated mainly for subsistence purposes. However, some of the harvests are sold to generate income to meet the welfare of the home while the rest are consumed. For example, the Palm oil that is produced in most of these localities is both for home consumption and commercial purposes. Other variable fruits in the area, when harvested are also sold and consumed.

6.7.2 Fuel Wood

Firewood is the main energy used for cooking by the majority of people in the proposed bridge locations, although charcoal is processed in these areas, its domestic use remains very minimal. Fuel wood is mainly harvested by men, (though also by women and children), largely through slash and burn, and farm clearing and preparation.

Fuel wood is mostly harvested from the bush regrowth vegetation sometimes including those at adjacent villages. These communities preferred firewood to charcoal. After all, it can be readily and/or cheaply obtained, rather than charcoal which needs processing and is also largely unaffordable because it is a form of income generation.

6.7.3 Fishing

Fishing is a common activity in over 80% of the various communities within the proposed bridge locations, as this is the major way of obtaining fish (protein) for their daily consumption and also the main source of livelihood. Fishing was particularly observed to be done in the rivers across Mattru Jong and Manowa.

Fishing is predominantly done by women, men, and especially the boy child. The method of fishing is by use of variable sizes of fishing nets, hook and line, and fish traps and also by creating and de-watering ponds/water holes in IVSs. In the absence of a fishing ground, or with the onset of very low or no catches, the communities resort to buying fish either from nearby markets, or from fishmongers buying from larger towns and cities, and peddling within the communities.

Women normally fish in streams from the banks, using small elliptical nets (locally referred to as baimbay) or an even smaller type (referred to as teba) both usually hand-woven by the women from palm fronds. The ‘baimbay’ is usually manned by two women when used but the teba is small enough to be singly manned.

Men fish mainly using large nets (referred to as chains), cast out into the bigger rivers but, the nets are cast either from the banks or boats, depending on the size. Like the boys, men also fish with hook and

line or fish traps at stream locations. The fish trap is a tapering net attached to a circular-shaped stick or a cane-woven oval-shaped contraption into which the fish swims and gets trapped.

Quite often, only small fishes are caught from the streams and these include *Chrysichthy ssp* (catfish), *tilapia zilli* (tilapia/mango page), mullet and *Noteptuni ssp* (cutlass fish), and *Anguilla species* (eel), while other aquatic species comprise *Cllinectu ssp* (crab) and *Nematoplaeb montenuipes* (brown shrimps).

Fishes caught by the women are mainly for home consumption, but excesses could be sold for income generation. Those caught by men and boys are mostly commercialized though some are saved especially by the men, for home consumption. The highest fish-catching months in the project areas are March and April in the dry season.

6.7.3.1 Common Fish Species Normally Caught along the Four Crossing Points

Pictures of the common fishes caught along the river crossings showing normal sizes are shown in Appendix 15.

1. The Mattru Jong-Senehun crossing

The Jong River is home to a wide variety of aquatic life (fishes). According to the local fishermen, the typical catches made include Catfish (Siluriformes), Eels (Anguilliformes), Makondo, Ngokeh, Kartei (Longfin tetra), *Tilapia brevipinnis*, *Tilapia louka* *Notoppterus* after, etc. They also have crabs, frogs, and shrimp.

2. The Gendema-Garwama Crossing

Some of the typical catches made in this project location are Poli, Makoka/3 bone, Ngokae, Digbi, Makondo, and Catfish.

3. The Manowa-Pendembu Crossing

Here according to the local fishermen, the typical catches include Ngokae, Poli, Goli, Kartei, Makonde, crabs, and shrimps.

4. The Tomparee-Kamakwe Crossing

The typical catch daily in this area includes Snapper, Catfish, Mackerel, and Sardine. Other fish types caught along the course of the river include Loli, Gbada, Ells Shrimps, and crab. They also get Tortoise and cuckoo.

One common factor is that the local fishermen and community people at all crossing points made it clear that they had the most catches during February and March when the water volume in the river would have reduced drastically.

Figure 43. Matru-Senehun Common Fishing Grounds

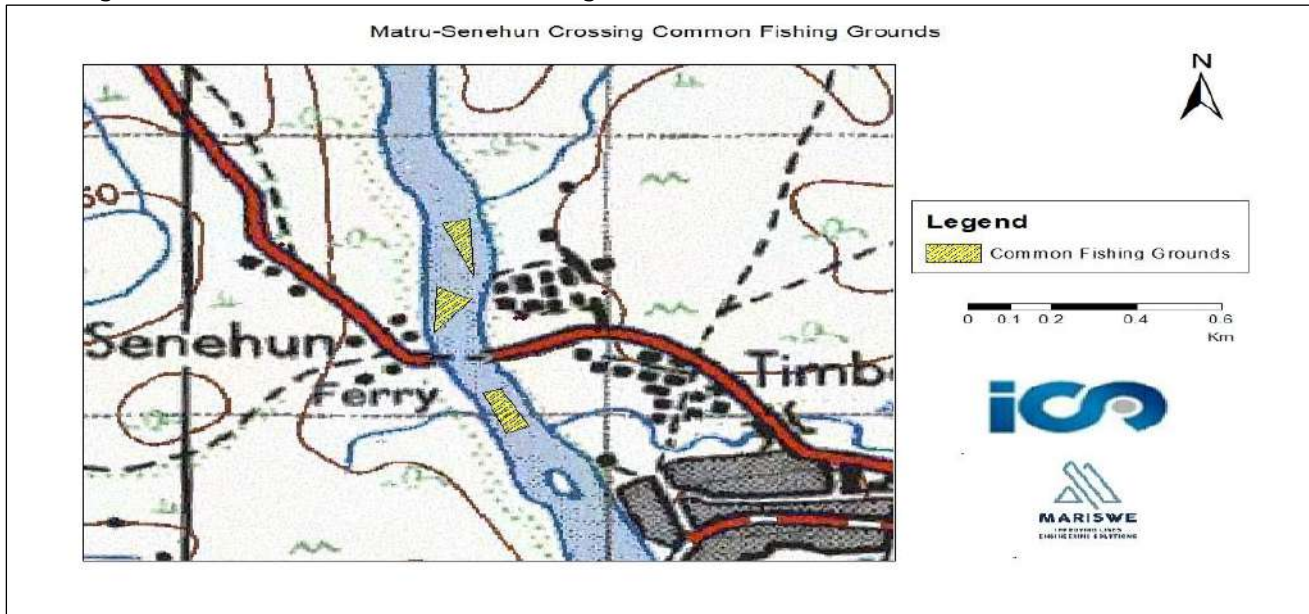


Figure 44. Gendema-Garwama Common Fishing Grounds

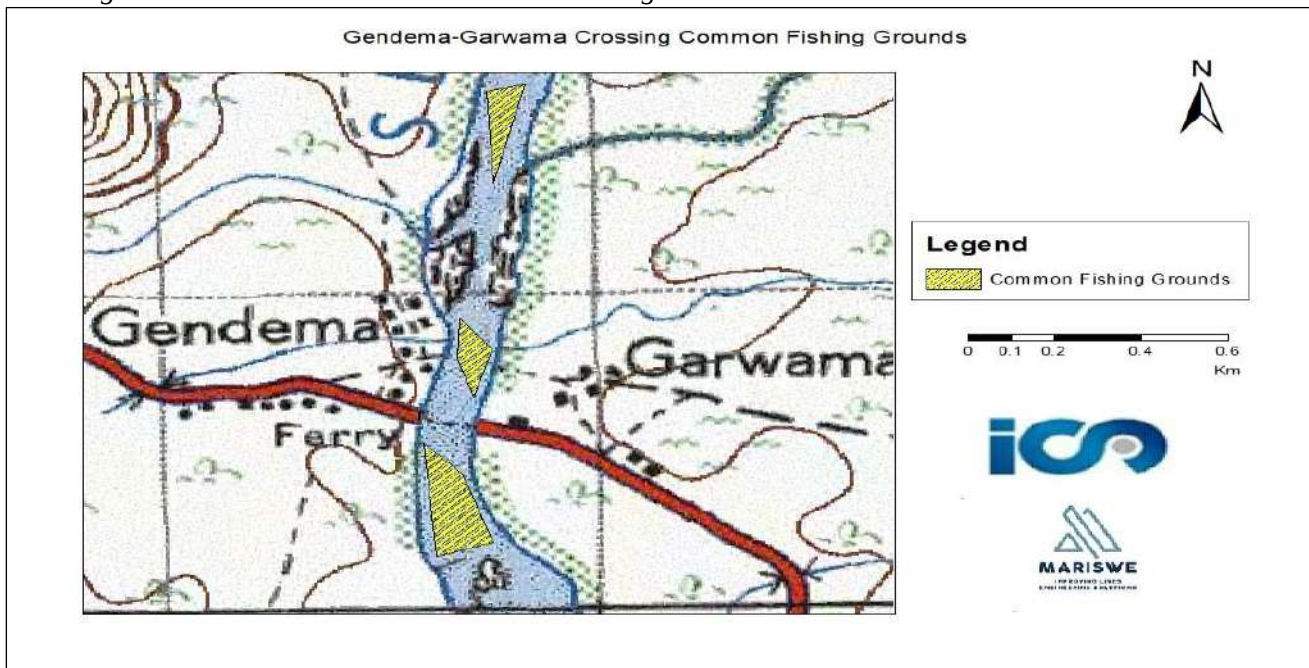


Figure 45. Manowa-Pendembu Common Fishing Grounds

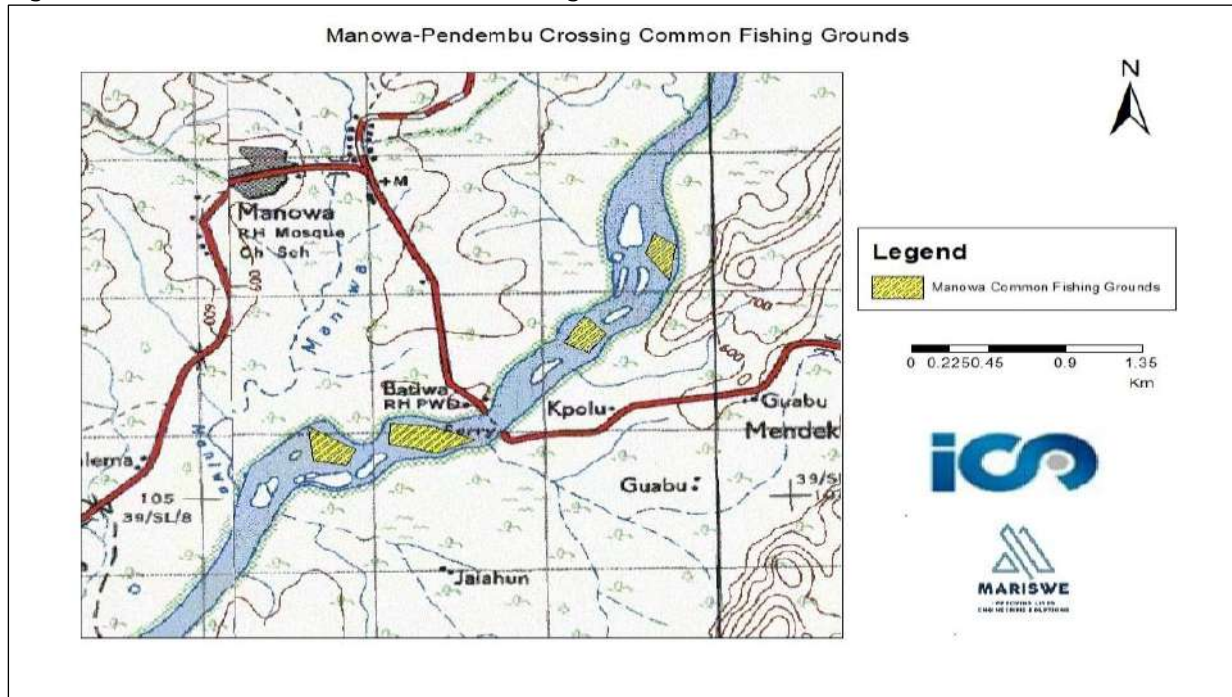


Figure 46. Tompari-Kamakwie Common Fishing Grounds

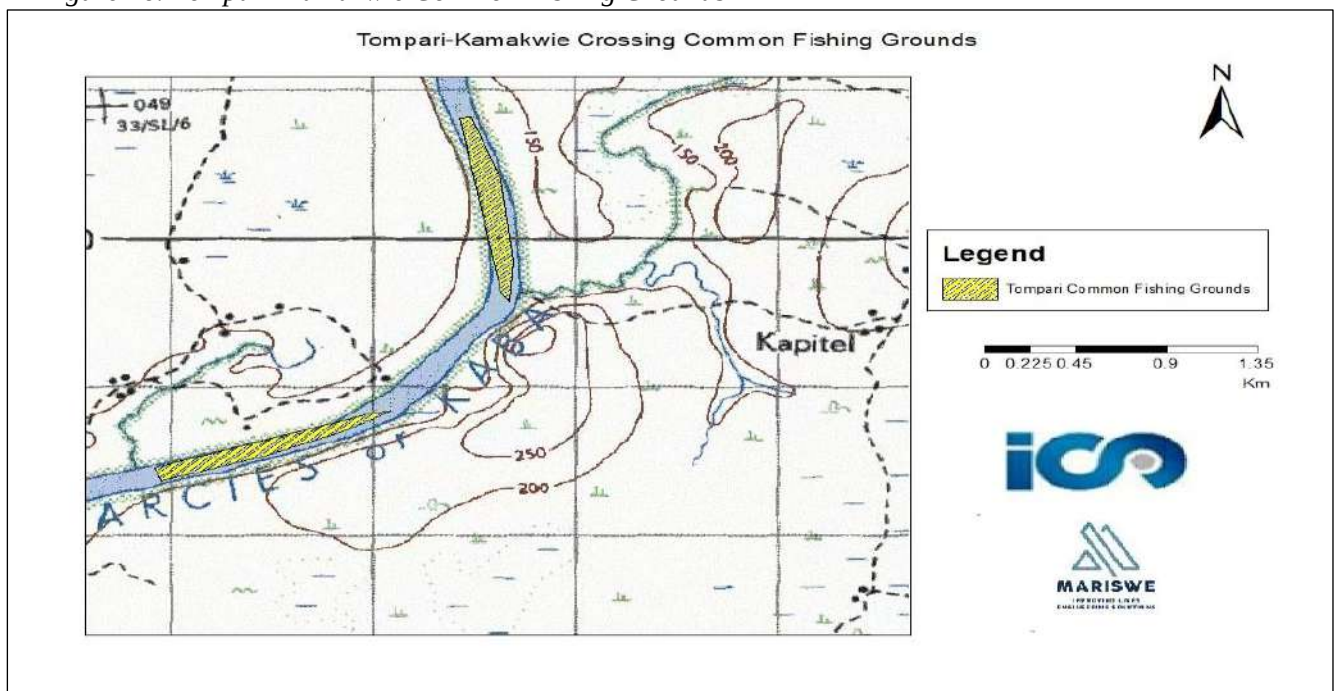


Table 28. Fishing details of the Project Areas

Bridge location	Average daily catch size (dry season) in dozen	Average daily catch size (rainy season) in dozen	Location of fishing grounds (upstream or downstream)	No. of fishermen Interview-ed	Level of impact from bridge construction (low/medium/high) Etc.
Matru-Senehun	12	5	Both Up and Downstream of the bridge location depending on the direction of the Water Flow	8	Low to Medium-Upstream
Gendema-Garwama	14	6	Both Up and Downstream of the bridge location depending on the direction of the Water Flow	10	Low to Medium-Upstream
Manowa-Pendembu	15	8	Both Up and Downstream of the bridge location depending on the direction of the Water Flow	4	Low to Medium-Upstream
Tompari-Kamakwie	18	7	Both Up and Downstream of the bridge location depending on the direction of the Water Flow	13	Low to Medium-Upstream

6.7.3.2 Impact of the Bridges construction on fishing activities upstream and downstream of the Project Areas

❖ Upstream impact on fishing activities: Medium to High

Construction of the bridge upstream of the different fishing locations can have a medium to high impact. During the construction phase, activities such as dredging, pile driving, and bank stabilization can cause sedimentation, increased turbidity, and disturbance to the aquatic environment. This can result in reduced water quality, habitat destruction, and displacement of fish populations. Fish may avoid the construction area or have difficulty navigating through the construction zone, leading to decreased fishing opportunities upstream for the fishermen.

❖ Downstream impact on fishing activities: Low to Medium

Construction of the bridge downstream of the different fishing locations generally has a lower impact on fishing activities compared to upstream. However, there can still be some medium to low impacts. The bridge construction activities can cause changes in water flow patterns, sedimentation, and alteration of river channel morphology, which can indirectly affect fish habitats downstream. For example, changes in water velocity or depth can affect fish movement, spawning, and feeding behaviours. However, the overall impact on fishing activities downstream is anticipated to be lower compared to upstream, as the downstream areas are further away from the construction site.

6.7.3.3 Mitigation measures: Medium to High

To minimize the impact of bridge construction activities on fishing by the affected communities, various mitigation measures can be implemented. These may include sediment control measures, water quality monitoring, habitat restoration, and construction scheduling to avoid critical fish life stages, such as spawning or migration periods. The impact of the bridge's construction on fishing activities can vary depending on the location of the bridge (upstream or downstream) to the fishing location, the nature, and scale of construction activities, and the effectiveness of mitigation measures. While upstream impacts are generally higher, downstream impacts are usually lower. Proper planning, coordination, and implementation of mitigation measures can help minimize the impact on fishing activities and protect the aquatic environment.

For medium to long-term mitigation of the impacts of the bridge construction, the Fisheries and Marine Resources Ministry should operationalize the recently produced Fisheries Management Plan (FMP) of Sierra Leone; 2020 – 2025. Extension services with stakeholder engagement sessions and capacity building will be required from the Ministry to implement the FMP. Over-fishing by medium to large-scale fishers (licensed and unlicensed) in the coastal waters could also be responsible for the reduction of fish stock in the rivers of these communities; another reason for such reduction could also be caused by the use of harmful gear used by these community members; therefore, the stakeholder engagement of these communities is strongly recommended as part of a Small Scale Fisheries (SSF) management plan for them. Both top-down (governmental) and bottom-up (communitarian) approaches to SSF must work together to mitigate medium to long-term impacts on fisheries for the communities along the rivers of the bridge crossings. Because of this, SCADeP is committed to ensuring that each contractor develops a fisheries management plan in compliance with the amended National Fisheries Management Act and involves the local communities and hiring a consultant. Each Fisheries management plan will ensure the maintenance of fish passages by avoiding changing flow or water level and obstructing or interfering with the movement and migration of fish. It will also ensure proper sediment control by installing effective erosion and sediment control measures during abutment and cofferdams and drilling pile construction. Regular inspections will be undertaken to ensure the fisheries management plan is implemented to limit the effect in local waters around the cofferdams and last only a shorter time.

6.7.4 Hunting

Currently, the communities in which these bridges will be constructed have ceased all gun-related hunting activities, due to the guns and small arms policies in the country. However, they continue to hunt small animals by way of bush traps.

This previously hunted fauna continues to thrive and flourish in their habitat in the secondary regrowth vegetation. They include; grass-cutters (*Thryonomys swinderianus*), antelopes, deer, monkeys, muskrats, squirrels, porcupines, wild pigs, monkeys, iguanas, rabbits, and giant rats. Other animals not usually hunted but evident in the area, comprise snakes including cobras, tree snakes, puff adders, boa constrictors, other smaller reptiles, and turtles.

Birds evident in the area are terrestrial species including weaverbirds, hawks, wild chickens, doves, wild pigeons, and guinea fowls. Aquatic species include egrets and water ducks.

6.7.5 Forestry

Forests reserves and protected forests do exist in the districts where the following crossings are found; Gendema-Gawama, Kenema District (Gola Forest Reserve); Tomparie-Kamakwei, Karene District (Otamba Killimi National Park) as shown in the maps below. It is important to note that the proposed bridge locations are only found within the districts listed above, but are not close to the locations, neither are they in the same chiefdoms or the immediate environment.

Agro forestry was only found in Tonkolili District, where Miro Forestry operates a non-forest timber industry that mainly grows pinewood. This forest cover has been largely cleared for various infrastructural, commercial, and developmental projects. The first four crossings are the group A bridges.

Table 29. Bridge Location and Distance to the Protected Areas (Forest Reserve) and Wetlands

NO	Bridge Location	Protected Area (Forest Reserve)/Wetlands	Distance to Bridge (Km)
1	Matru-Senehun Crossing	1. Lake Mabesi & Mape Wetlands 2. Tabe Forest Reserve 3. Yawri Swamps & Bay Site 5	59.80 54.25 67.45

2	Tompari-Kamakwie Crossing	1. Matete Forest Reserve 2. Outambi Kilimi National Park 3. Kandesuri Forest Reserve 4. Kuru Hills Forest Reserve	7.38 10.24 13.84 31.97
3	Gendema-Garwama Crossing	1. Gboi Hills 2. Kambui Hills 3. Dodo Hills 4. Gola Forest North 5. Gola Forest East 6. Kambui Hills South 7. Tiwai Islan Sanctuary	14.21 27.44 20.97 72.39 91.18 63.80 72.24
4	Manowa-Pendembu Crossing	1. Gboi Hills 2. Lhei Hills 3. Gola Forest Northern Extension	4.94 14.92 38.91

Figure 49. Gendema-Garwama Crossing Showing the Protected Area (Forest Reserve)/Wetlands

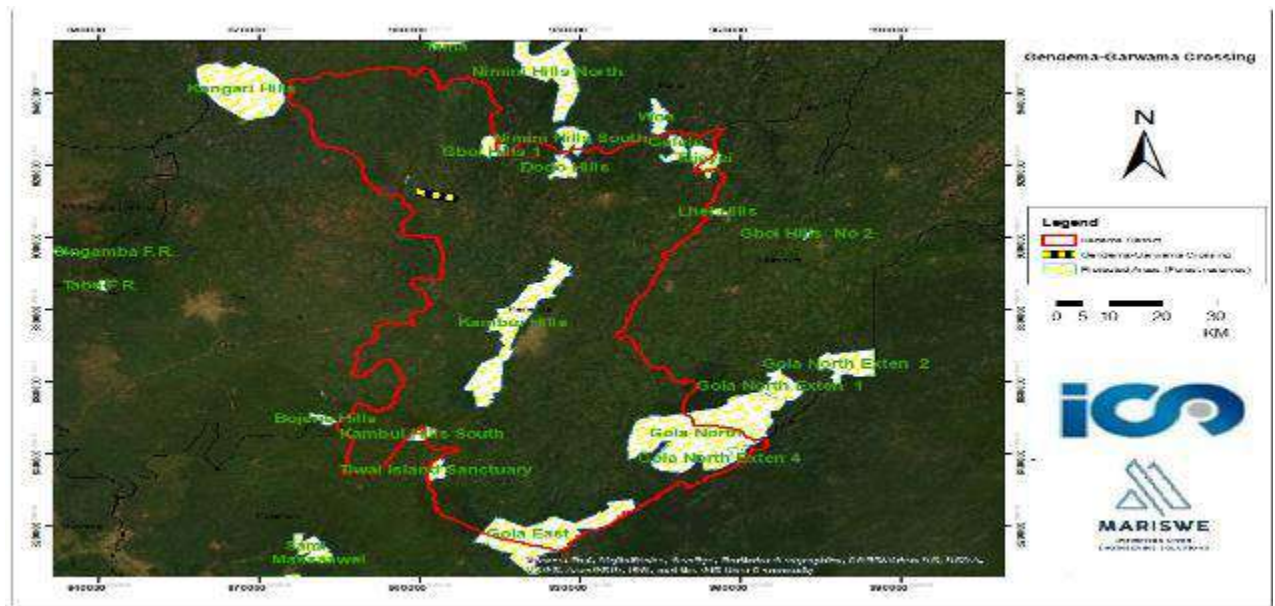
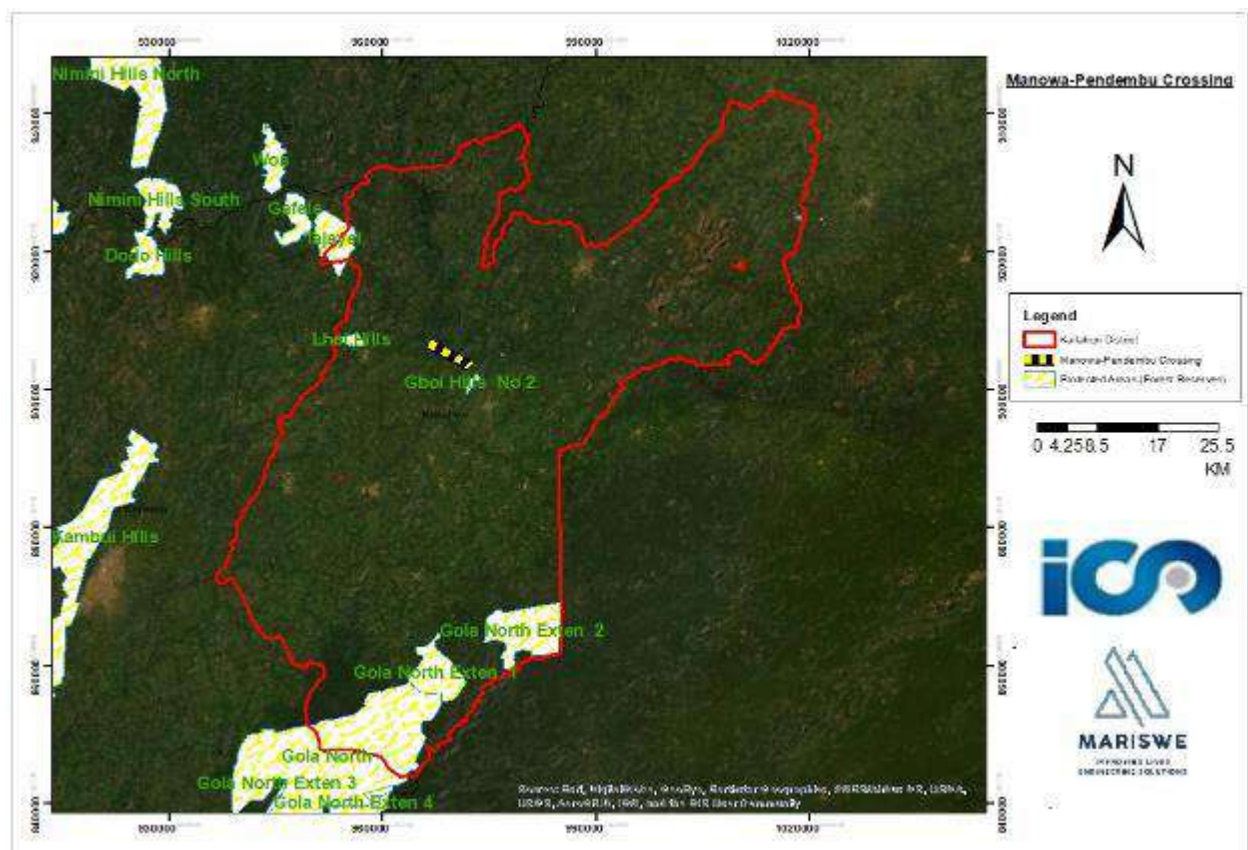


Figure 50. Manowa-Pendembu Crossing Showing the Protected Area (Forest Reserve)/Wetlands



6.7.6 Logging

Logging is a common land-use activity in the project areas. It is practiced in almost all of the surveyed communities. The trees logged for boards, are mainly *Melinda arborea* (Yemani) and *Terminalia ivorensis* (Ronko). The cotton tree is a highly targeted species for the timber trade.

Bush poles are also harvested as they form one of the major building materials necessary for the construction of houses, especially the mud houses (Wattles) common in the area. The species *Anisophyllealaurina* (monkey apple), is the tree most commonly felled for bush poles because of its favourable attributes. This tree is generally assessed to be termite resistant and usually comprises the precise structure of a straight trunk, which is adequate for the framework of the mud houses commonly built in the localities of the 4-Bridges. It is also adequate for roofing joists and scaffolding.

Logging for boards is done with power saws while cutlass and axe are used for bush pole felling. More often than not, logging is done for house construction and for making furniture but it is also sometimes commercialized.

6.8 SOIL QUALITY AND LAND CAPABILITY

Representative soil samples were collected from various locations where the proposed bridges will be constructed during the dry season at the subsurface level to determine soil characteristics and chemistry. Soil association in the proposed bridge locations was done according to the FAO Classification and is characterized and shown in the figures below.

The soils of the flood plains are generally good for agricultural purposes due to their alluvial nature. However, in the plateau and hill slopes the soil depth is very low, and large tracts of land are uncultivable. The hill slopes are extensively used for upland rice cultivation in the traditional shifting cultivation farming system practiced in most parts of the country. The flood plains and the valley soil are primarily sandy alluvial deposits where rice is grown.

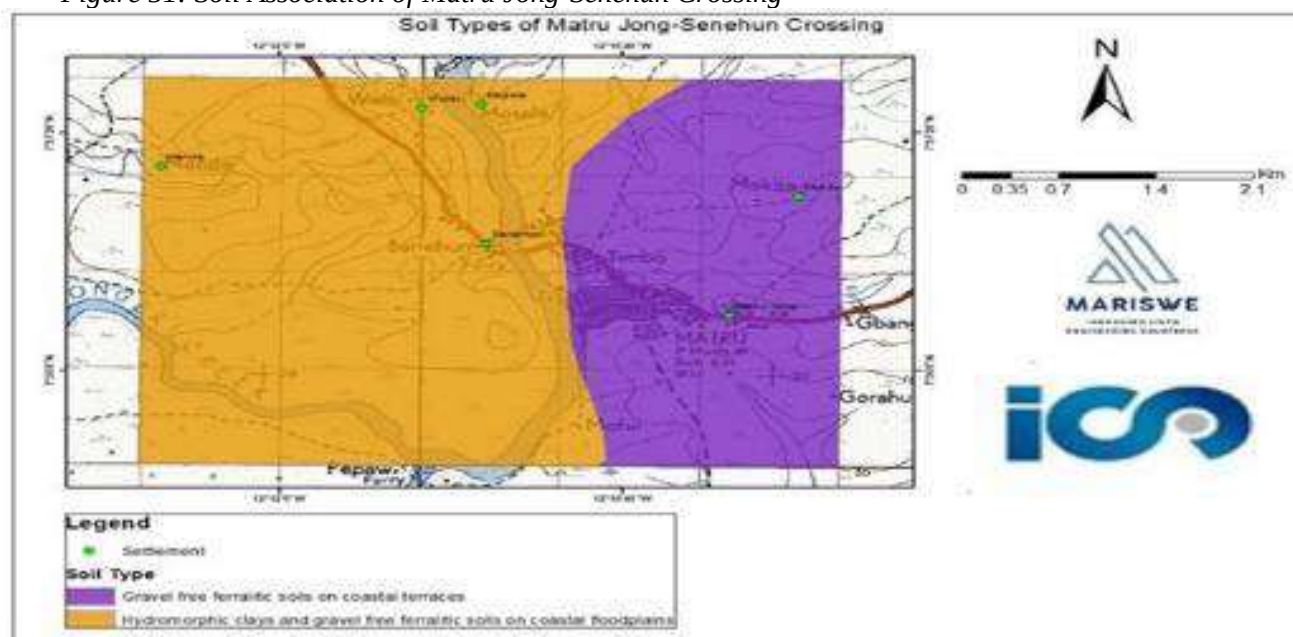
During the soil survey, soil samples were collected at different locations in the project area and analyzed to evaluate the contamination status. The soil analysis results indicate:

- The historic and current artisanal mining activities have resulted in elevated concentrations of several trace elements such as Ag, As, Cd, Co, Mo, Sb, and Se which are also above soil screening values. Other constituents that are significantly elevated above baseline concentrations but not above screening values are Cr, Cu, Mn, Ni, Ti, and V;
- The elevated concentrations of all of these constituents seem to be related to waste material due to the artisanal mining activities and seepage from these areas;
- These concentrations may hold risk to receptors but current and potential impacts as well as offsite impacts are unclear with the available information; and
- Background concentrations of trace elements in the soils are generally low except for Iron (Fe) and Aluminium (Al) which have accumulated naturally in the Plinthosols and Ferralsols.

6.8.1 Matru Jong-Senehun Crossing

Soil association in the project area according to the FAO Classification is characterized by two types; (1) Gravel-free ferralitic soils on coastal terraces, which is over 40% of the project area, and (2) Hydromorphic clays and gravel-free ferralitic soils on coastal floodplains.

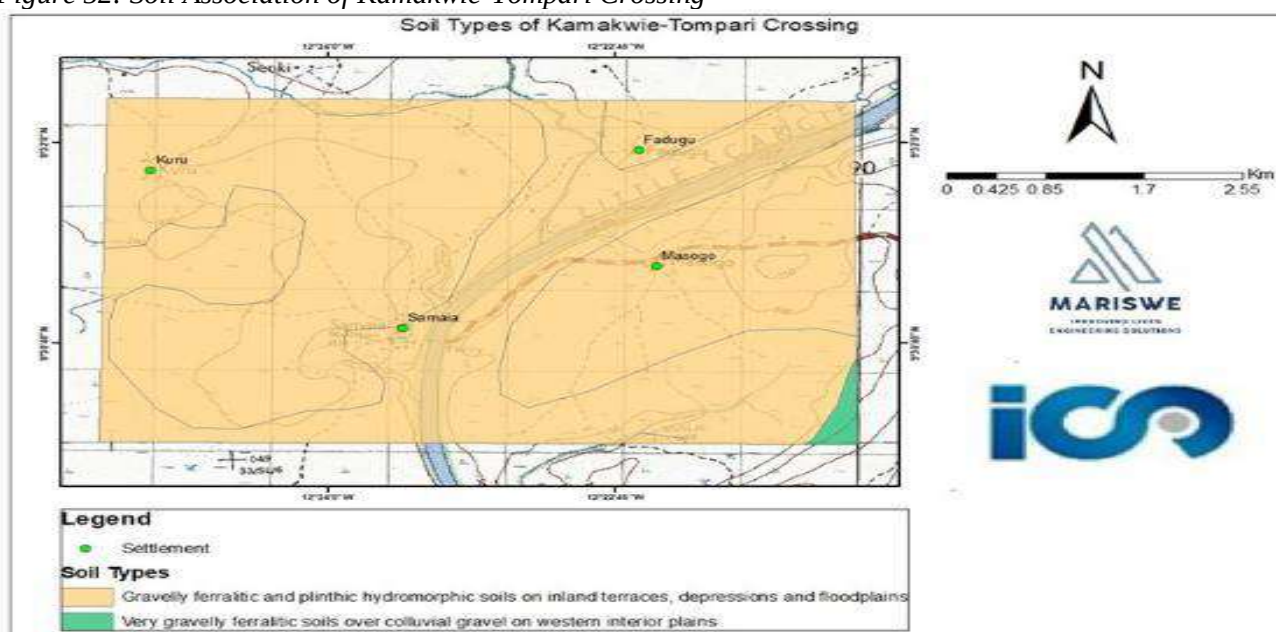
Figure 51: Soil Association of Matru Jong-Senehun Crossing



6.8.2 Kamakwie-Tompari Crossing

Soil association in the project area according to the FAO Classification is characterized by two types; (1) Gravelly ferrallitic and plinthic hydromorphic soils on inland terraces, depressions and floodplains, and (2) very gravelly ferrallitic soils over colluvial gravel on western interior plains.

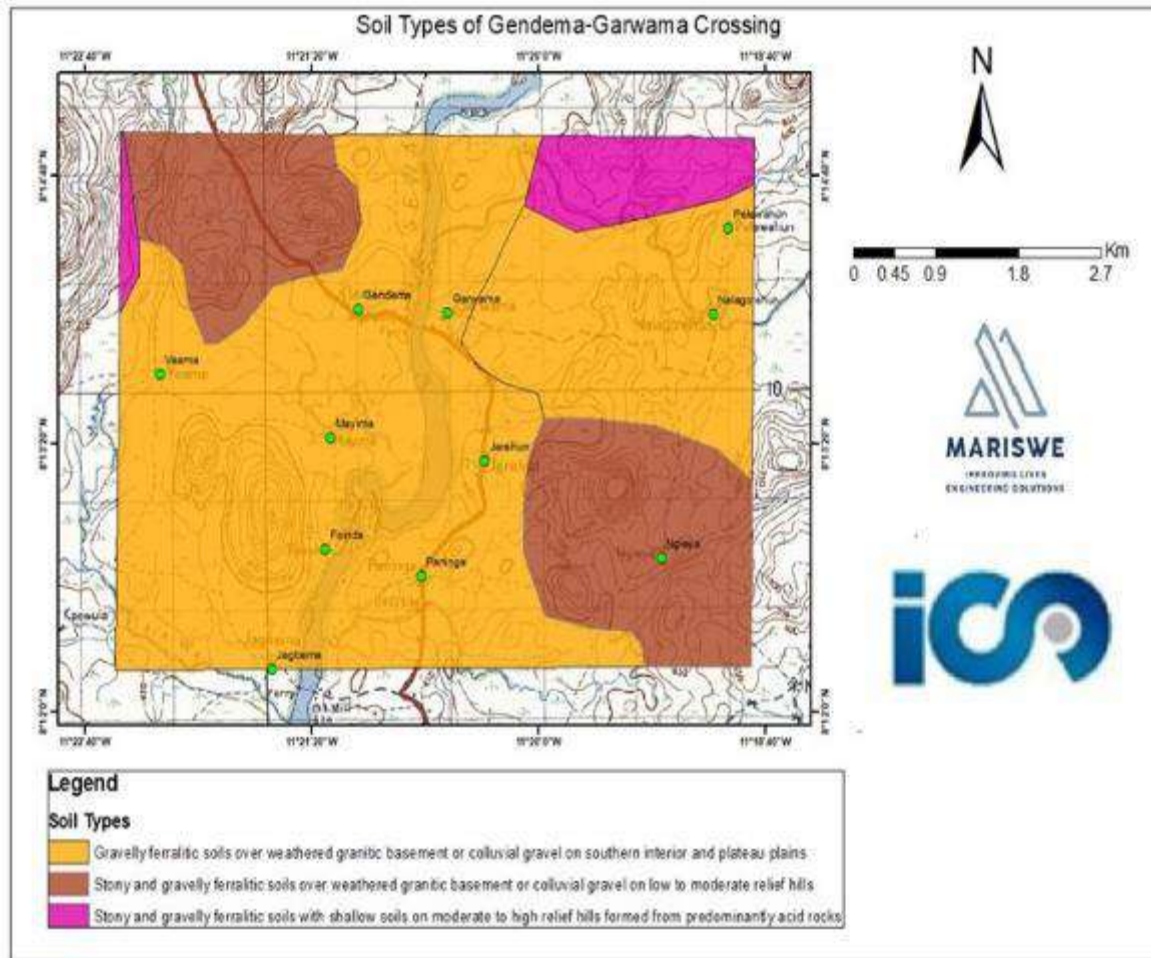
Figure 52: Soil Association of Kamakwie-Tompari Crossing



6.8.3 Gendema-Garwama Crossing

Soil association in the project area according to the FAO Classification is characterised by three types; (1) Gravelly ferrallitic soils over weathered granitic basement or colluvial gravel on southern interior and plateau plains, which occupies over 70% of the project area (2) stony and gravelly ferrallitic soils over weathered granitic basement or colluvial gravel on low to moderate relief hills, and (3) stony and gravelly ferrallitic soils with shallow soils on moderate to high relief hills formed from predominantly acidic rocks.

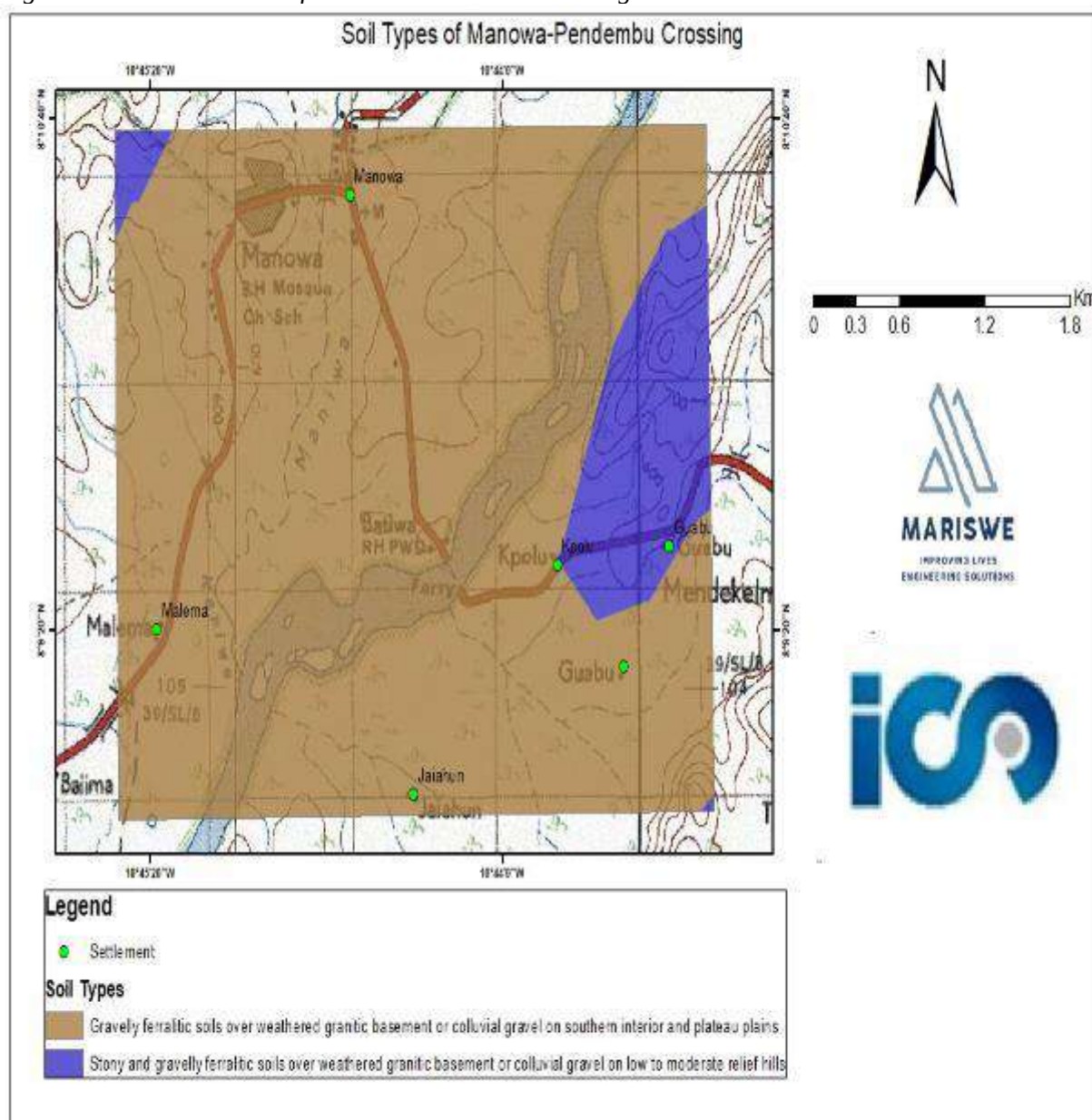
Figure 53: Soil Association of Gendema-Garwama Crossing



6.8.4 Manowa-Pendembu Crossing

Soil association in the project area according to the FAO Classification is characterized by two types; (1) Gravelly ferrallitic soils over a weathered granitic basement or colluvial gravel on southern interior and plateau plains, which occupies over 80% of the project area (2) stony and gravelly ferrallitic soils over a weathered granitic basement or colluvial gravel on low to moderate relief hills.

Figure 54: Soil Association of Manowa-Pendembu Crossing

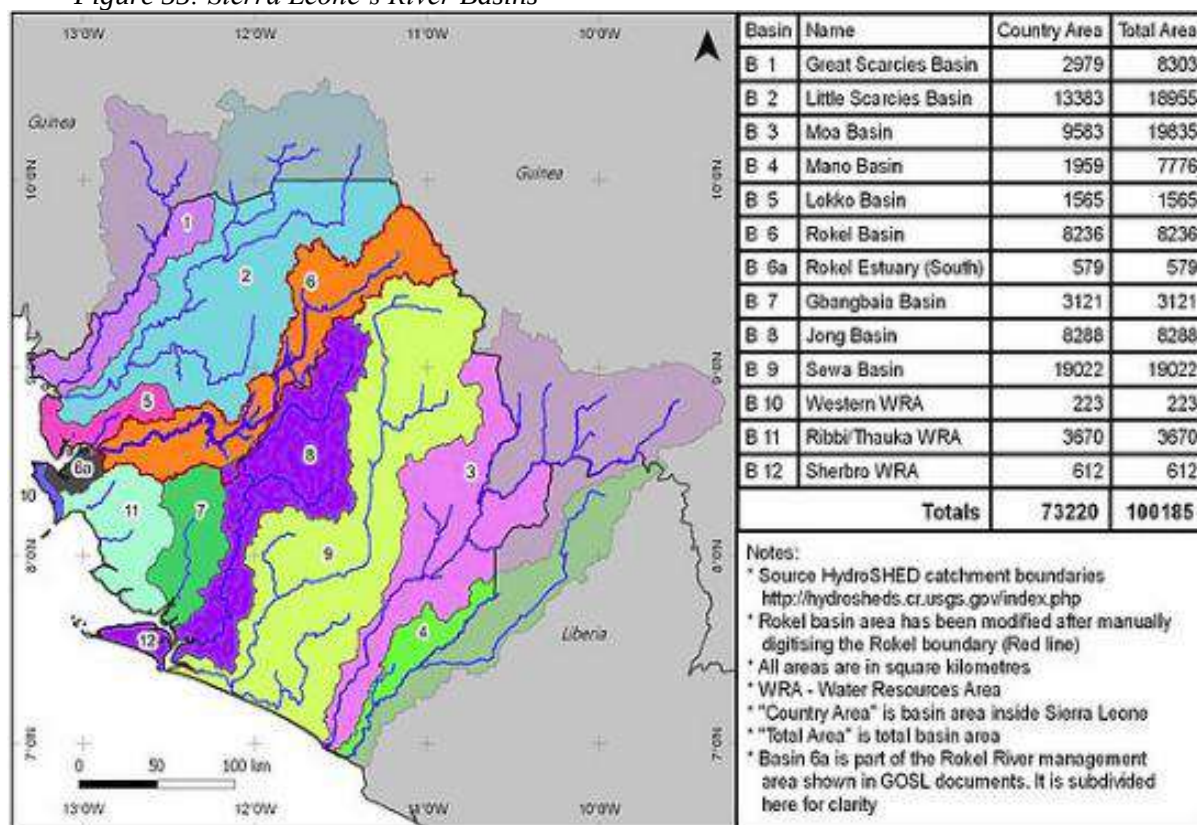


6.9 SURFACE HYDROLOGY

The Republic of Sierra Leone is drained by nine major rivers; Rokel/Seli, Pampana/Jong, Sewa, Waanje, and the Coastal Streams and Creeks which originate inside the country. The rest are the Great and Little Scarcies and Moa Rivers which originate from the Fouta Jallon Plateau in the Republic of Guinea, and the Mano River which originates from the Republic of Liberia.

There are also twelve river basins in Sierra Leone, namely; Kolenten (Great Scarcies), Kaba (Little Scarcies), Rokel, Pampana (Jong), Sewa, Moa, and Mano. The Sewa River basin is the largest in Sierra Leone with a total catchment area of approximately 19022 Km² (see figure 57). The Sewa River, one of the most important commercial streams in Sierra Leone originates in Kono District.

Figure 55: Sierra Leone's River Basins



6.9.1 Water Quality Analysis

Water is a vital resource that must be maintained and preserved to remain potable. Water is essential to all aspects of our lives. The monitoring of surface water quality will aid in the protection of waterways from pollution caused by the Subproject activities. As a result, development practitioners must engage in activities that protect water resources within local communities that rely solely on these sources for survival. The purpose of this study was to collect water quality data on the upstream, middle stream, and downstream of all four crossings affected by the four bridges Subproject during construction and operations, as well as to analyse the potential impacts of the proposed activity on water resources. Samples were collected and some physical parameters such as temperature, pH, electrical conductivity, turbidity, and total dissolved solids were tested in situ the remaining samples were transported to the Sierra Leone Water Company (SALWACO) for further laboratory analysis of physical, chemical, and biological tests.

6.9.2 Sample Collection Methodology

Plastic containers were used to collect samples and they were washed clean and boiled, after which they were labeled as required by the location of the various points of collection. This was done to avoid contamination of the samples. At each sampling point, the plastic bottles were rinsed thrice with the sample to be collected before the actual sample was collected and tightly closed before being taken to the "field cooler" (with ice packs). Samples were transported to the Sierra Leone National Water Quality Laboratory at Sierra Leone Water Company (SALWACO) within the shortest possible time after collection. Samples were collected on 1st March 2021 for Matru Crossing, 8th March for Gendema Crossing, 12th March for Manowa Crossing, and 24th March for Tompari Crossing.

6.9.2.1 Matru Jong-Senehun Crossing

Three water samples were collected from the crossing's upstream (MJU_01), middle stream (MJM_02), and downstream (MJD_03) (figure 1) and preserved and taken to the Sierra Leone Water Company

(SALWACO) for laboratory analysis. Thirty-one (35) parameters (including physical, chemical, and biological) were analyzed to ascertain the current water quality of the river before operations.

From the Upstream, Middle Stream, and Downstream Water Quality Comparison graph (figure 2) it is observed that the downstream is more deteriorated than the other two parts of the river. The most evident of it is seen in the faecal coliform level as well as the turbidity and electronic conductivity.

The highest of the parameters in this crossing is the Faecal Coliform. Faecal Coliforms are a type of microbes found in the intestinal tract, and their presence in drinking water sources indicates faecal contamination. According to the World Health Organization (WHO), these bacteria should not be found in drinking water regularly. As a result, they recommend a count of zero faecal coliforms per 100 ml of water.

The turbidity of the river crossing average (26.67 NTU) is far above the WHO standard of <5 NTU. The high rate of soil erosion and sedimentation from sloped terrain, as well as the decaying of plants and animals, may be the causes of such high value. These have the potential to alter the water's natural clarity.

Fluoride is below the WHO standard. The analyses also show that the concentrations of iron on average in the river (0.34mg/l) are above the WHO recommended value (0.3mg/l) for drinking water. This may be due to the geology of the base rocks. High Fe³⁺ content may be associated with high oxidation and corrosion, as well as the destruction of ferry metals equipment.

The analyses show that on average, manganese concentration (0.89mg/l) is far above the WHO recommendation of the standard of 0.4 mg/l. Iron and manganese are non-harmful elements that can cause problems in water. Iron and manganese have similar chemical properties and cause similar problems. Iron is the more common of the two contaminants found in water, while manganese is typically found in iron-bearing water. Water percolating through soil and rock can dissolve and retain minerals containing iron and manganese. Iron pipes can occasionally be a source of iron in water. Water's flavor and color can be affected by iron and manganese. Laundry, porcelain, dishes, utensils, and even glassware will be stained reddish-brown by iron. Manganese acts similarly but results in a brownish-black stain.

The water quality test results show that most parameters meet the WHO standards. However, turbidity, iron, manganese, chromium, and faecal coliform exceed the WHO reference values. The presence of high values for these parameters could be due to the discharge of wastes from artisan mining.

Table 30: Laboratory Results from three locations along Matru Jong-Senehun

Parameters		Measured Values			WHO recommended Permissible Limits
		Matru Jong-Senehun Upstream	Matru Jong-Senehun Middle Stream	Matru Jong-Senehun Downstream	
1	Water Temperature (oC)	24.5	24.3	24	No. Value
2	pH	6.6	7.3	6.4	6.5 – 8.5
3	Turbidity (NTU)	10	18	52	<5.0
4	Conductivity (µS/cm)	26	28	31	<450
5	TDS (mg/l)	14.5	14	15.5	<248
6	Salinity (ppt)	-	-	-	<0.4
7	Residual Chlorine (mg/l)	0.01	0.01	0.01	0.3 – 0.5 after 30min. disinfections
8	Aluminium (mg/l)	0.05	0.04	0.05	<0.2

Parameters		Measured Values			WHO recommended Permissible Limits
		Matru Jong-Senehun Upstream	Matru Jong-Senehun Middle Stream	Matru Jong-Senehun Downstream	
9	Ammonia (mg/l)	0.03	0.04	0.04	No. Value
10	Bromine (mg/l)	-	-	-	No. Value
11	Calcium Hardness (mg/l)	1.27	4	5.3	<250
12	Copper (mg/l)	0.71	0.73	0.56	<1.0
13	Fluoride (mg/l)	1.17	1.49	1.33	<1.5
14	Iron (mg/l)	0.37	0.33	0.31	<0.3
15	Magnesium (mg/l)	0.02	0.01	0.01	<200
16	Manganese (mg/l)	0.84	0.99	0.84	<0.4
17	Molybdenum (mg/l)	0.09	0.08	0.1	0.25
18	Nitrite (mg/l)	0.04	0.06	0.05	3
19	Nitrate – (mg/l)HR	1	1	2	<10
20	Potassium (mg/l)	1.5	2.4	2.3	<6.0
21	Phosphate (mg/l) LR	2.1	3.7	2.2	<20
22	Silica (mg/l)	0.01	0.01	0	<15
23	Sulphate (mg/l)	1.82	2.5	1.81	<400
24	Sulphide (mg/l)	0.04	0	0	<0.5
25	Sulphite (mg/l)	0	0	0	No. Value
26	Chloride (mg/l)	1	1.7	0.9	<250
27	Arsenic (mg/l)	0	0	0	0.01
28	Chromium	0.43	0.54	0.97	<0.05
29	Bicarbonate (mg/l)	0	0	0	No. value
30	Zinc (mg/l)	0	0	0	<5.0
31	E. Coli	20	Nil	Nil	Zero
32	Faecal Coliforms	90	101	101	Zero
33	Non-Faecal Coliforms	Nil	Nil	Nil	<10
34	Vibro-parahaemolyticus	-	-	-	Zero
35	Salmonella sp.	-	-	-	Zero

Figure 56: Matru Jong-Senehun Showing the crossing point, water and Noise Sampling points, and the crossing span



6.9.2.2 Tompari-Kamakwie Crossing

Three water samples were collected from the crossing's upstream (TOU_01), middle stream (TOM_02), and downstream (TOD_03) and preserved and taken to the Sierra Leone Water Company (SALWACO) for laboratory analysis. Thirty-one (31) parameters (including physical, chemical, and biological) were analyzed to ascertain the current water quality of the river before operations.

From the Upstream, Middle Stream, and Downstream Water Quality Comparison graph (figure 20) it is observed that the TOD_03 is more deteriorated, followed by TOM_02 and then TOU_01. The most evident of it is seen in the Electronic Conductivity, Total Dissolved Solids, and Faecal Coliform.

The turbidity of the river crossing is above the WHO standard of <5 NTU for two of the three samples.

Fluoride slightly exceeds the WHO guideline value in one of the three samples. Chromium (0.05 mg/l) was also found to be the same or slightly above the accepted value of <0.05 mg/l by WHO. It slightly exceeds the WHO reference value in one of the three samples. Chromium is a potentially toxic metal occurring in water and groundwater as a result of natural and anthropogenic sources. Microbial interaction with mafic and ultramafic rocks together with geogenic processes release Cr (VI) in the natural environment by chromite oxidation. It also occurs naturally in the environment from the erosion of natural chromium deposits. It can also be produced by industrial processes. There are demonstrated instances of chromium being released to the environment by leakage, poor storage, or inadequate industrial waste disposal practices.

In this river, it was found that the faecal coliform is on average 51.67 as opposed to WHO's permissible recommendations of zero.

The crossing does not show the presence, or it meet the permissible WHO standards for Residual Chlorine, Ammonia, Magnesium, Molybdenum, Nitrate, Silica, Sulphur, Sulphite, Arsenic, Bicarbonate, Zinc, etc., and other parameters. However, the slightly higher fluoride and chromium contents and presence of faecal coliform should be given due attention while using the water for construction purposes.

Table 31: Laboratory Results from three locations along Tompari-Kamakwie

Parameters		Measured Values			WHO recommended Permissible Limits
		Tompari-Kamakwie Upstream	Tompari-Kamakwie Middle Stream	Tompari-Kamakwie Downstream	
1	Water Temperature (oC)	26	26.4	26.2	No. Value
2	pH	7.5	7.4	7.6	6.5 – 8.5
3	Turbidity (NTU)	6	9	0	<5.0
4	Conductivity (µS/cm)	70	61	55	<450
5	TDS (mg/l)	35	30.5	27.5	<248
6	Salinity (ppt)	-	-	-	<0.4
7	Residual Chlorine (mg/l)	0	0	0	0.3 – 0.5 after 30min. disinfections
8	Aluminium (mg/l)	0.03	0.02	0.02	<0.2
9	Ammonia (mg/l)	0	0.01	0	No. Value
10	Bromine (mg/l)	-	-	-	No. Value
11	Calcium Hardness (mg/l)	6.6	4.7	5	<250
12	Copper (mg/l)	0.24	0.2	0.24	<1.0
13	Fluoride (mg/l)	1.7	1.43	0.93	<1.5
14	Iron (mg/l)	0.07	0.13	0.14	<0.3
15	Magnesium (mg/l)	0.1	0.08	0	<200
16	Manganese (mg/l)	0	0	0	<0.4
17	Molybdenum (mg/l)	0.01	0.18	0.1	0.25
18	Nitrite (mg/l)	0	0	0.03	3
19	Nitrate – (mg/l)HR	1	1	1	<10
20	Potassium (mg/l)	0.8	0.7	0.7	<6.0
21	Phosphate (mg/l) LR	0	0.2	0	<20
22	Silica (mg/l)	0.1	0.2	0.01	<15
23	Sulphate (mg/l)	8.6	0	6	<400
24	Sulphide (mg/l)	0	0	0	<0.5
25	Sulphite (mg/l)	0.1	0.3	0.3	No. Value
26	Chloride (mg/l)	1.2	5.4	0.01	<250
27	Arsenic (mg/l)	0	0	0	0.01
28	Chromium	0.02	0.08	0.04	<0.05
29	Bicarbonate (mg/l)	0	0	0	No. value
30	Zinc (mg/l)	0	0	0	<5.0
31	E. Coli	Nil	Nil	Nil	Zero
32	Faecal Coliforms	35	90	30	Zero
33	Non-Faecal Coliforms	Nil	Nil	Nil	<10

Parameters		Measured Values			WHO recommended Permissible Limits
		Tompri-Kamakwie Upstream	Tompri-Kamakwie Middle Stream	Tompri-Kamakwie Downstream	
34	Vibro-parahaemolyticus	-	-	-	Zero
35	Salmonella sp.	-	-	-	Zero

Figure 57: Tompari-Kamakwie showing the crossing point, water and Noise Sampling points, and the crossing span



6.9.2.3 Gendema-Garwama Crossing

Three water samples were collected from the crossing's upstream (GU_01), middle stream (GM_02), and downstream (GD_03) (figure 7) and preserved and taken to the Sierra Leone Water Company (SALWACO) for laboratory analysis. Thirty-one (35) parameters (including physical, chemical, and biological) were analyzed to ascertain the current water quality of the river before operations.

From the Upstream, Middle Stream, and Downstream, Water Quality Comparison graph (figure 8) it is observed that the GD_03 is more deteriorated, followed by GM_02 and the GU_01. The most evident of it is seen in the faecal coliform level, non-faecal coliforms as well as the TDS, turbidity, and electronic conductivity.

The highest of the parameters in this crossing is the faecal and Non-Faecal Coliforms. In this river, it was found that the faecal coliform is on average 7 and non-faecal coliform is on average 56 as opposed to WHO's permissible recommendations of zero and <10 respectively. E. coli is also found in one of the three samples.

The turbidity of the river crossing average (25.33 NTU) is far above the WHO standard of <5 NTU. The high rate of soil erosion and sedimentation from sloped terrain, as well as the decaying of plants and animals, maybe the causes of such high value. These have the potential to alter the water's natural clarity.

Fluoride is also found to be on average 1.73 mg/which is above the WHO standard of <1.5. Fluoride in water is mostly of geological origin. Waters with high levels of fluoride content are mostly found at the foot of high mountains and in areas where the sea has made geological deposits.

The analyses also show that the concentrations of Manganese on average (0.65 mg/l) of the river are above the WHO recommended value (0.3 mg/l) for drinking water.

Chromium (0.4 mg/l) was also found to be above the accepted value of <0.05 mg/l by WHO.

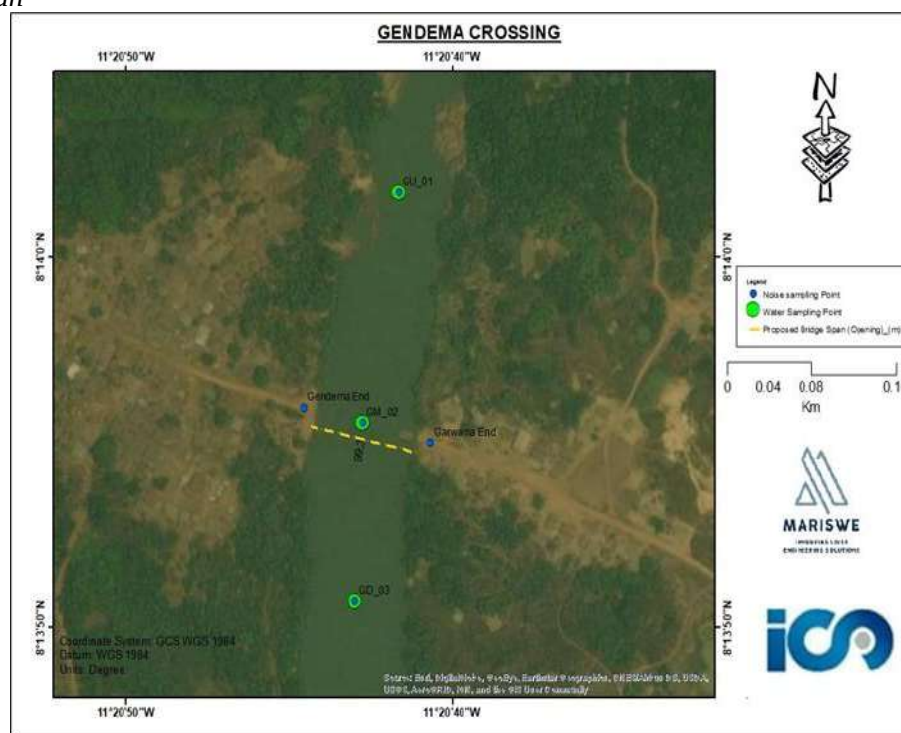
The crossing does not show their presence, nor does they meet the WHO standards for Residual Chlorine, Ammonia, Aluminum, Magnesium, Molybdenum, Nitrate, Silica, Sulphur, Sulphite, Arsenic, Bicarbonate, and Zinc. This clearly shows that the river is not polluted by heavy metals and other pollutants.

Table 32: Laboratory Results from three locations along Gendema-Garwama

Parameters		Measured Values			WHO recommended Permissible Limits
		Gendema-Garwama Upstream	Gendema-Garwama Middle Stream	Gendema-Garwama Downstream	
1	Water Temperature (oC)	26.6	26.5	25.8	No. Value
2	pH	6.8	6.8	7.4	6.5 – 8.5
3	Turbidity (NTU)	20	26	30	<5.0
4	Conductivity (µS/cm)	51	39	40	<450
5	TDS (mg/l)	25.5	19.5	20	<248
6	Salinity (ppt)	-	-	-	<0.4
7	Residual Chlorine (mg/l)	0.01	0.01	0	0.3 – 0.5 after 30min. disinfections
8	Aluminium (mg/l)	0.04	0.04	0.04	<0.2
9	Ammonia (mg/l)	0.08	0.08	0.08	No. Value
10	Bromine (mg/l)	-	-	-	No. Value
11	Calcium Hardness (mg/l)	6.6	4.8	7.8	<250
12	Copper (mg/l)	0.26	0.41	0.49	<1.0
13	Fluoride (mg/l)	2	2	1.5	<1.5
14	Iron (mg/l)	0.2	0.25	0.26	<0.3
15	Magnesium (mg/l)	0.01	0	0.01	<200
16	Manganese (mg/l)	0.55	0.57	0.65	<0.4
17	Molybdenum (mg/l)	0.1	0.01	0.11	0.25
18	Nitrite (mg/l)	0.03	0.03	0.04	3
19	Nitrate – (mg/l)HR	1	1	1	<10
20	Potassium (mg/l)	4.2	5	6.2	<6.0
21	Phosphate (mg/l) LR	1.2	1.4	1.4	<20
22	Silica (mg/l)	0	0	0.01	<15
23	Sulphate (mg/l)	1.11	1.35	1.35	<400

Parameters		Measured Values			WHO recommended Permissible Limits
		Gendema-Garwama Upstream	Gendema-Garwama Middle Stream	Gendema-Garwama Downstream	
24	Sulphide (mg/l)	0	0	0	<0.5
25	Sulphite (mg/l)	0.05	0.6	0.7	No. Value
26	Chloride (mg/l)	2.2	1.7	2.5	<250
27	Arsenic (mg/l)	0	0	0	0.01
28	Chromium	0.33	0.37	0.5	<0.05
29	Bicarbonate (mg/l)	0	0	0	No. value
30	Zinc (mg/l)	0	0	0	<5.0
31	E. Coli	Nil	2	Nil	Zero
32	Faecal Coliforms	5	8	8	Zero
33	Non-Faecal Coliforms	101	17	50	<10
34	Vibro-parahaemolyticus	-	-	-	Zero
35	Salmonella sp.	-	-	-	Zero

Figure 58: Gendema-Garwama Showing the crossing point, water and Noise Sampling points and the crossing span



6.9.2.4 Manowa-Pendembu Crossing

Three water samples were collected from the crossing's upstream (MAU_01), middle stream (MAM_02), and downstream (MAD_03) (figure 10) and preserved and taken to the Sierra Leone Water Company (SALWACO) for laboratory analysis. Thirty-one (35) parameters (including physical, chemical, and biological) were analyzed to ascertain the current water quality of the river before operations.

From the Upstream, Middle Stream, and Downstream Water Quality Comparison graph (figure 11) it is observed that the MAD_03 is more deteriorated, followed by MAM_02 and the MAU_01. The most evident of it is seen in the faecal coliform level and non-faecal coliforms.

The highest of the parameters in this crossing is the faecal and Non-Faecal Coliforms. In this river, it was found that the faecal coliform is 57 and non-faecal coliform is 39.33 as opposed to WHO's permissible recommendations of zero and <10 respectively.

There is the presence of Ecoli (1.33) on average in this river. It is above the WHO permissible amount of zero. This could be a result of private wells that have been contaminated with feces from infected humans or animals. This waste could have entered the river in different ways, including sewage overflows, sewage systems that are not working properly, polluted stormwater runoff, and agricultural runoff.

Chromium (0.24 mg/l) was also found to be above the accepted value of <0.05 mg/l by WHO.

The crossing does not show their presence nor does they meet the permissible WHO standards for Residual Chlorine, Ammonia, Aluminum, Magnesium, Molybdenum, Nitrate, Silica, Sulphur, Sulphite, Arsenic, Bicarbonate, Zinc, etc. of the other parameters. This clearly shows that the river is not polluted with heavy metals and other pollutants and it is not turbid. Only four parameters (Chromium, Faecal Coliforms, Non-Faecal Coliforms, and Ecoli) do not meet the WHO permissible pollution level.

Table 33: Laboratory Results from three locations along Manowa-Pendembu

Parameters		Measured Values			WHO recommended Permissible Limits
		Manowa-Pendembu Upstream	Manowa-Pendembu Middle Stream	Manowa-Pendembu Downstream	
1	Water Temperature (oC)	24	23.9	23.2	No. Value
2	pH	6.8	6.8	7.1	6.5 – 8.5
3	Turbidity (NTU)	0	0	0	<5.0
4	Conductivity (µS/cm)	43	64	42	<450
5	TDS (mg/l)	22.5	32	21	<248
6	Salinity (ppt)	-	-	-	<0.4
7	Residual Chlorine (mg/l)	0.01	0.01	0.01	0.3 – 0.5 after 30min. disinfections
8	Aluminium (mg/l)	0.03	0.03	0.05	<0.2
9	Ammonia (mg/l)	0	0	0	No. Value
10	Bromine (mg/l)	-	-	-	No. Value
11	Calcium Hardness (mg/l)	6.3	1.99	6.4	<250
12	Copper (mg/l)	0.11	0.14	0.23	<1.0
13	Fluoride (mg/l)	0.99	1.27	1.01	<1.5
14	Iron (mg/l)	0.18	0.06	0.13	<0.3
15	Magnesium (mg/l)	0	0	0	<200
16	Manganese (mg/l)	0.05	0.07	0.08	<0.4
17	Molybdenum (mg/l)	0.02	0	0	0.25
18	Nitrite (mg/l)	0.02	0.03	0.02	3

Parameters		Measured Values			WHO recommended Permissible Limits
		Manowa-Pendembu Upstream	Manowa-Pendembu Middle Stream	Manowa-Pendembu Downstream	
19	Nitrate – (mg/l)HR	1	1	1	<10
20	Potassium (mg/l)	1.9	2.4	0.9	<6.0
21	Phosphate (mg/l) LR	1.1	1.2	0.9	<20
22	Silica (mg/l)	0	0	0	<15
23	Sulphate (mg/l)	1.61	4.9	5	<400
24	Sulphide (mg/l)	0	0	0	<0.5
25	Sulphite (mg/l)	0	0	0	No. Value
26	Chloride (mg/l)	2.6	1.99	0	<250
27	Arsenic (mg/l)	0	0	0	0.01
28	Chromium	0.29	0.22	0.22	<0.05
29	Bicarbonate (mg/l)	0	0	0	No. value
30	Zinc (mg/l)	0	0	0	<5.0
31	E. Coli	Nil	4	Nil	Zero
32	Faecal Coliforms	50	20	101	Zero
33	Non-Faecal Coliforms	101	17	Nil	<10
34	Vibro-parahaemolyticus	-	-	-	Zero
35	Salmonella sp.	-	-	-	Zero

Figure 59. Manowa-Pendembu Showing the crossing point, water and Noise Sampling points, and the crossing span



6.10 GROUNDWATER

Groundwater refers to the water that is found beneath the surface of the earth, in the pores and crevices of rocks, soils, and sediment layers. It is an important natural resource that plays a vital role in supporting human, animal, and plant life, as well as many other activities such as agriculture, industry, and recreation.

Groundwater is constantly replenished by rainfall that percolates through the soil and rock layers, eventually collecting in underground aquifers. The rate of recharge depends on several factors such as the amount and intensity of precipitation, the type of soil and geology, and the vegetation cover. In some regions, groundwater can take hundreds or even thousands of years to replenish, making it a non-renewable resource.

Groundwater is typically extracted using wells, which are drilled into the aquifers and equipped with pumps to bring the water to the surface. The quantity and quality of groundwater can vary widely depending on the location and depth of the well, as well as the natural and human factors that affect the aquifer. Some common factors that can affect groundwater quality include natural contaminants such as minerals and salts, as well as human activities such as agriculture, industry, and waste disposal.

Groundwater management is a complex and ongoing challenge that requires a multidisciplinary approach. It involves balancing the needs of various stakeholders such as farmers, households, and businesses, while also protecting the ecological and environmental integrity of the aquifers. This requires careful monitoring of groundwater levels, quality, and use, as well as the development and implementation of policies and regulations that ensure sustainable and equitable use of this vital resource.

Overall, groundwater is a crucial resource that provides water to millions of people around the world. Its importance cannot be overstated, and we must take steps to protect and manage this precious resource for future generations.

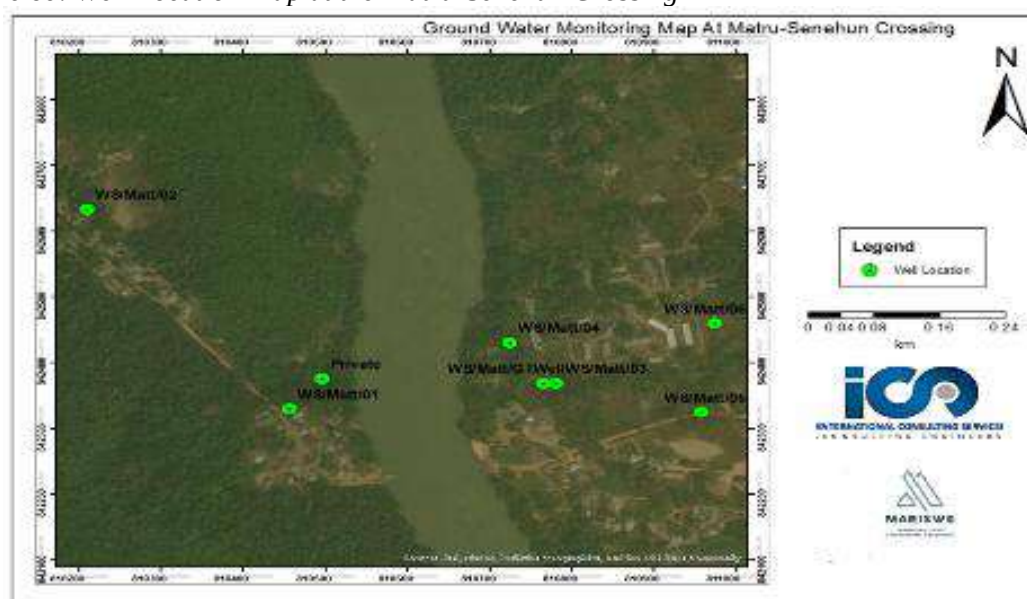
A total of 29 wells were assessed, of which 25 are existing community wells and four were dug by the consultant (one at each bridge location) in February 2023. The water quality of the wells was measured, and the distance of the wells to the bridge locations was measured, maps of the monitored wells were plotted, and pumping tests and drawdown analyses of the four wells dug by the consultant was also done. The water quality data is annexed in Appendix 12, and all other data is tabulated in the respective sections below. Most of the water quality test results show fluoride, manganese, chromium, and faecal coliform exceeds the WHO guideline values.

6.10.1 Matru-Senehun Crossing

Table 34. Well Details of Matru-Senehun Crossing

Well ID	X	Y	Distance to Bridge (m)	Depth (m)	SWL (m)	Type	Water Quality analysis Status
WS/Matt/01	810457	842330	123.04	17.5	6.6	Existing Well	Yes
WS/Matt/02	810211	842634	518.6	15.4	5.5	Existing Well	Yes
Private	810497	842376	147.14	15.1	5.1	Existing Well	Yes
WS/Matt/03	810782	842369	132.53	14.5	6.3	Existing Well	Yes
WS/Matt/04	810725	842431	135.48	13.5	5.5	Existing Well	Yes
WS/Matt/05	810958	842325	297.74	10.5	5.0	Existing Well	Yes
WS/Matt/06	810975	842460	349.21	11.1	4.9	Existing Well	Yes
WS/Matt/GTWell	810766	842369	121.76	32	5.5	New	No

Figure 60: Well Location Map at the Matru-Senehun Crossing



6.10.2 Pumping Test and Drawdown

A pumping test is a procedure used to determine the hydraulic properties of an aquifer, such as its transmissivity, hydraulic conductivity, and storativity. The test involves pumping water out of a well (WS/Matt/GTWell) at a constant rate and measuring the resulting changes in water levels in the well and surrounding observation wells.

During the test, water is pumped out of the well at a constant rate, and the water level in the pumped well and surrounding observation wells is measured over time. The initial water level in the pumped well is called the static water level, and the water level after pumping is called the dynamic water level. The difference between the two is the drawdown.

The drawdown results can be used to calculate the transmissivity of the aquifer, which is a measure of how easily water can flow through the aquifer. Transmissivity is calculated by dividing the pumping rate by the drawdown and the hydraulic conductivity of the aquifer, which is a measure of how easily water can flow through the aquifer and can be calculated using Darcy's Law.

Additionally, the drawdown results can also be used to estimate the storativity of the aquifer, which is a measure of how much water the aquifer can store. Storativity is calculated by dividing the volume of water pumped by the drawdown and the cross-sectional area of the aquifer.

Overall, the pumping test and drawdown results provide important information about the hydraulic properties of an aquifer and can help in the management and conservation of groundwater resources.

6.10.2.1 Results and Interpretation

The depth of the well is 32m and the Static Water Level (SWL) is 5.5m. The pump was set at 24m and the Dynamic Static Water Level is 25.81m. The maximum drawdown is 20.30m and the recovery is 90%, which is 6.09m. The step test is 4 hours. The time of recovery is 1 hour 30 minutes. This means that the recovery rate (recharge) of the aquifer is good. The pumping test data is found in the table below.

Table 35. Pumping Test Results Showing Drawdown and Recharge (Recovery Rate) at Matru-Senehun Crossing

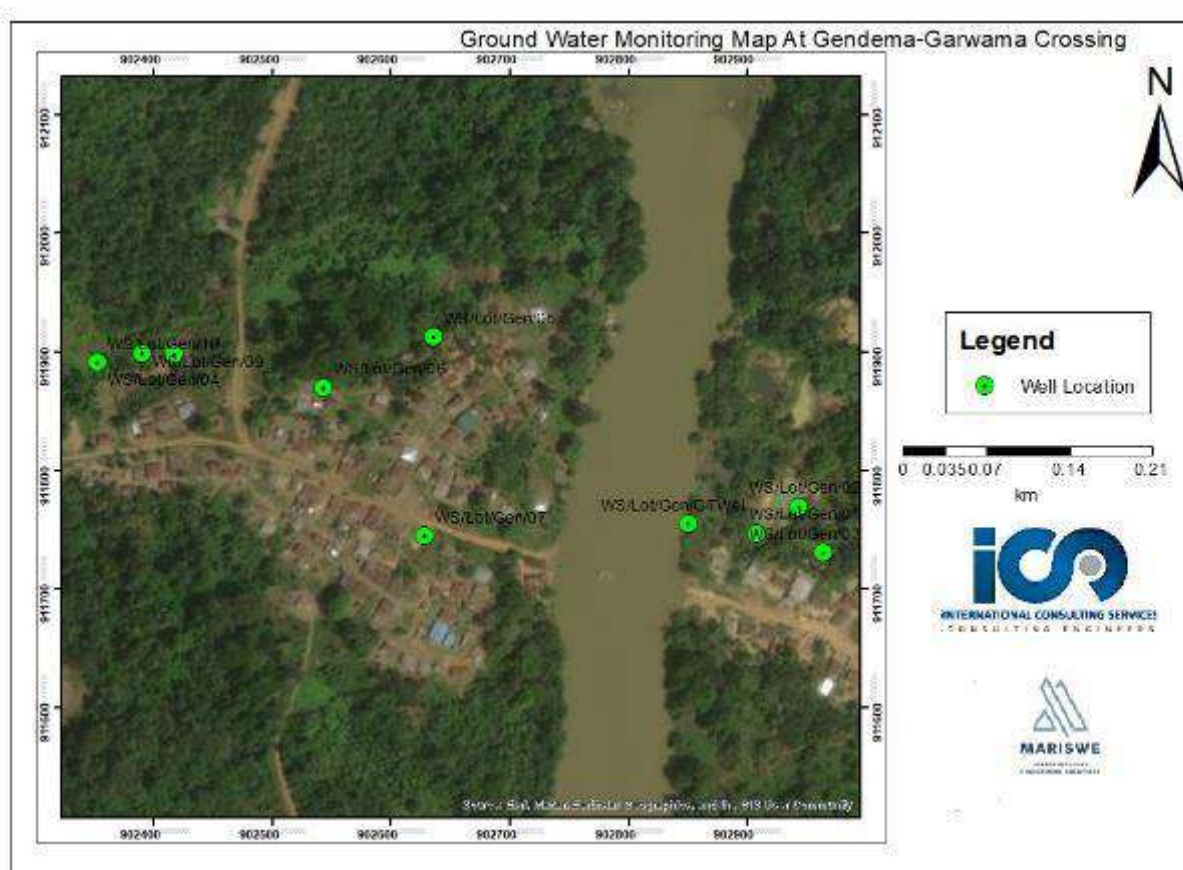
Matru-Senehun Crossing														
Locality			Bonthe District											
Well Depth			32											
Pump setting			24m						Pump on		0600, 28.02.2023			
SWL				5.51 m						Pump off		1000, 28.02.2023		
Pumping												Recovery		
Step 1	1.4	l/s	Step 2	1.9	l/s	Step 3	2.3	l/s	Step 4	2.8	l/s	Time	Water level	Residual draw down
Time	Water level	Draw down	Time	Water level	Draw down	Time	Water level	Draw down	Time	Water level	Draw down			
min	m	m	min	m	m	min	m	m	min	m	m			
1	7.30	1.79	61	18.00	12.49	121	24.30	18.79	181	25.42	19.91	241	20.72	15.21
2	8.90	3.39	62	18.70	13.19	122	24.32	18.81	182	25.42	19.91	243	16.12	10.61
3	9.50	3.99	63	19.58	14.07	123	24.38	18.87	183	25.43	19.92	245	12.31	6.80
4	10.35	4.84	64	19.98	14.47	124	24.39	18.88	184	25.45	19.94	250	9.26	3.75
5	10.95	5.44	65	20.70	15.19	125	24.40	18.89	185	25.47	19.96	255	8.35	2.84
6	11.70	6.19	66	20.85	15.34	126	24.41	18.90	186	25.50	19.99	260	7.92	2.41
7	13.10	7.59	67	21.35	15.84	127	24.47	18.96	187	25.53	20.02	270	7.34	1.83
8	13.75	8.24	68	21.67	16.16	128	24.51	19.00	188	25.58	20.07	280	7.10	1.59
9	14.00	8.49	69	21.89	16.38	129	24.58	19.07	189	25.60	20.09	290	6.85	1.34
10	14.20	8.69	70	22.29	16.78	130	24.60	19.09	190	25.63	20.12	300	6.67	1.16
12	14.60	9.09	72	22.57	17.06	132	24.62	19.11	192	25.64	20.13	315	6.49	0.98
14	14.98	9.47	74	22.86	17.35	134	24.69	19.18	194	25.65	20.14	330	6.09	0.58
16	15.05	9.54	76	22.99	17.48	136	24.78	19.27	196	25.66	20.15	345	6.00	0.49
18	15.17	9.66	78	23.07	17.56	138	24.80	19.29	198	25.66	20.15			
20	15.25	9.74	80	23.25	17.74	140	24.82	19.31	200	25.68	20.17			
22	15.45	9.94	82	23.33	17.82	142	24.84	19.33	202	25.72	20.21			
24	15.66	10.15	84	23.40	17.89	144	24.88	19.37	204	25.74	20.23			
26	15.78	10.27	86	23.43	17.92	146	24.93	19.42	206	25.77	20.26			
28	15.81	10.30	88	23.48	17.97	148	24.96	19.45	208	25.77	20.26			
30	15.94	10.43	90	23.59	18.08	150	24.97	19.46	210	25.79	20.28			
32	16.04	10.53	92	23.63	18.12	152	24.99	19.48	212	25.79	20.28			
34	16.18	10.67	94	23.70	18.19	154	25.05	19.54	214	25.79	20.28			
36	16.20	10.69	96	23.75	18.24	156	25.09	19.58	216	25.80	20.29			
38	16.25	10.74	98	23.79	18.28	158	25.10	19.59	218	25.80	20.29			
40	16.27	10.76	100	23.83	18.32	160	25.11	19.60	220	25.80	20.29			
42	16.45	10.94	102	23.84	18.33	162	25.11	19.60	222	25.80	20.29			
44	16.48	10.97	104	23.87	18.36	164	25.13	19.62	224	25.81	20.30			
46	16.50	10.99	106	23.94	18.43	166	25.15	19.64	226	25.81	20.30			
48	16.53	11.02	108	23.95	18.44	168	25.19	19.68	228	25.81	20.30			
50	16.55	11.04	110	23.98	18.47	170	25.20	19.69	230	25.81	20.30			
52	16.61	11.10	112	23.99	18.48	172	25.25	19.74	232	25.81	20.30			
55	16.54	11.03	115	24.00	18.49	175	25.27	19.76	235	25.81	20.30			
57	16.67	11.16	117	24.09	18.58	177	25.28	19.77	237	25.81	20.30			
60	16.70	11.19	120	24.10	18.59	180	25.29	19.78	240	25.81	20.30			

6.10.3 Gendema-Garwama Crossing

Table 36. Well Details of Gendema-Garwama Crossing

Well ID	X	Y	Distance to Bridge (m)	Depth (m)	SWL (m)	Type	Water Quality Status
WS/Lot/Gen/01	241747	910662	76.47	18.2	5.5	Existing Well	Yes
WS/Lot/Gen/02	241783	910684	119.1	15.5	6.0	Existing Well	Yes
WS/Lot/Gen/03	241803	910645	125.05	16.4	5.6	Existing Well	Yes
WS/Lot/Gen/04	241195	910814	421.76	14.5	6.3	Existing Well	Yes
WS/Lot/Gen/05	241478	910831	225.21	12.3	5.4	Existing Well	Yes
WS/Lot/Gen/06	241385	910790	247.31	15.3	4.9	Existing Well	Yes
WS/Lot/Gen/07	241468	910664	107.93	13.7	5.3	Existing Well	Yes
WS/Lot/Gen/08	241260	910820	387.54	19.5	5.2	Existing Well	Yes
WS/Lot/Gen/09	241233	910821	367.45	13.5	7.3	Existing Well	Yes
WS/Lot/Gen/10	241195	910814	421.76	14.4	6.2	Existing Well	Yes
WS/Lot/Gen/GTWell	241690	910671	54.99	32.0	6.0	New	No

Figure 61. Well Location Map of Gendema-Garwama Crossing



6.10.3.1 Results and Interpretation

A pumping test is a procedure used to determine the hydraulic properties of an aquifer, such as its transmissivity, hydraulic conductivity, and storativity. The test involves pumping water out of a well (WS/Lot/Gen/GTWell) at a constant rate (2.8 L/S) and measuring the resulting changes in water levels in the well and surrounding observation wells.

The depth of the well is 32m and the Static Water Level (SWL) is 6.0m. The pump was set at 24m and the Dynamic Static Water Level is 25.85m. The flow rate is 2.8 liters per second. The maximum drawdown is 19.85m and the recovery is 90%, which is 6.55m. The constant test is 24 hours. The time of recovery is 1 hour 30 minutes. This means that the recovery rate (recharge) of the aquifer is good. The pumping test data is found in the table below.

Table 37. Pumping Test Results Showing Drawdown and Recharge (Recovery Rate)

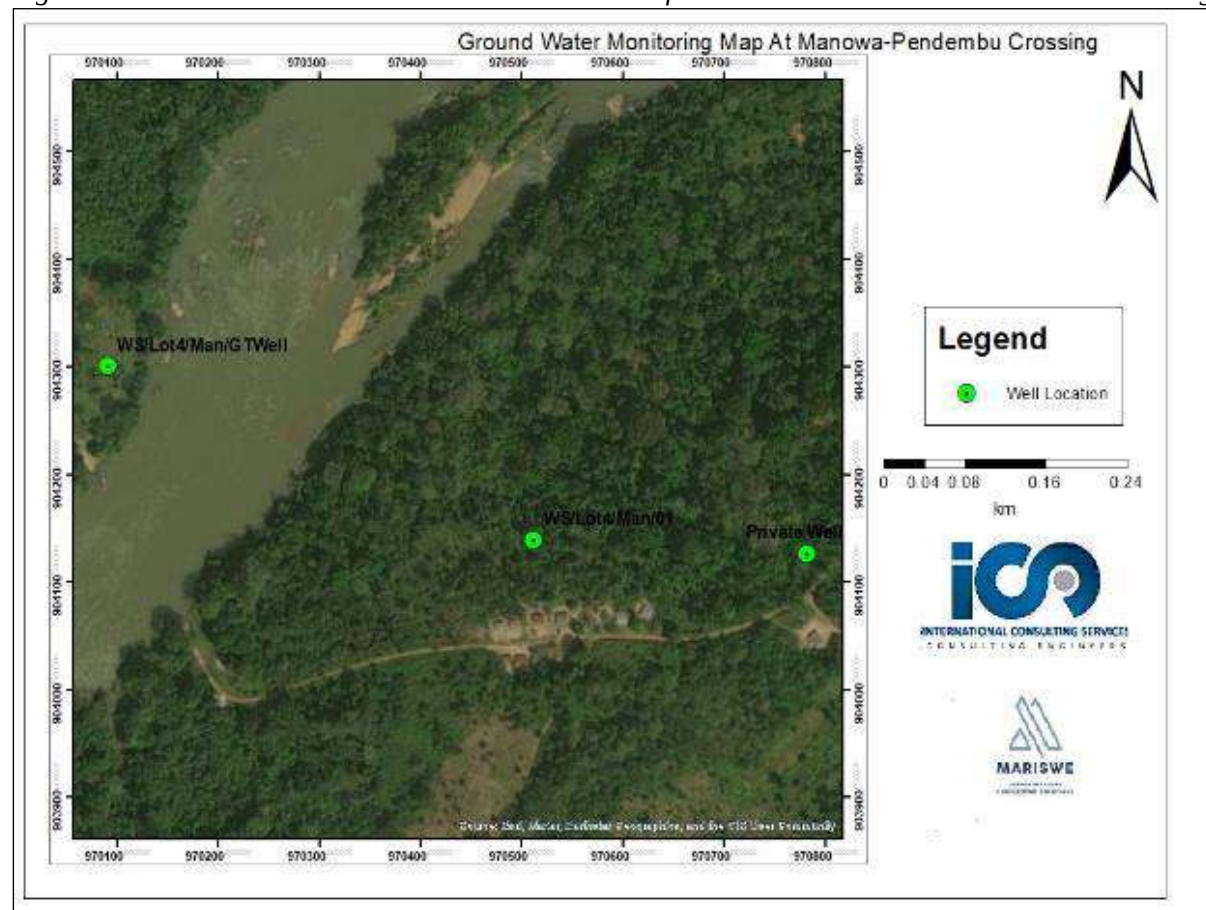
Gendema-Garwama Crossing							
Locality		Kenema District					
Well depth		32			Flow rate	2.78 l/s	
Pump setting		24m			Pump on	12:00 pm, 02.03.2023	
SWL		6.00	m		Pump off	12:00 pm, 03.03.2023	
Pumping				Recovery			
Time	Pumping time	Water level	Draw-down	Time	Pumping time	Water level	Draw-down
	mins	m	m		mins	m	m
12:00 PM	0	6.00	0.00	12:00 PM	0	25.85	19.85
12:03 PM	3	9.53	3.53	12:01 PM	1	24.40	18.40
12:05 PM	5	10.85	4.85	12:03 PM	3	20.73	14.73
12:10 PM	10	14.00	8.00	12:05 PM	5	16.50	10.50
12:15 PM	15	14.98	8.98	12:10 PM	10	12.90	6.90
12:20 PM	20	15.39	9.39	12:15 PM	15	9.30	3.30
12:30 PM	30	15.90	9.90	12:20 PM	20	8.35	2.35
12:40 PM	40	16.80	10.80	12:30 PM	30	7.82	1.82
12:50 PM	50	16.88	10.88	12:40 PM	40	7.25	1.25
1:00 PM	(1 hr) 60	16.90	10.90	12:50 PM	50	7.00	1.00
1:20 PM	80	20.00	14.00	1:00 PM	(1 hr) 60	6.93	0.93
1:40 PM	100	20.98	14.98	1:15 PM	75	6.85	0.85
2:00 PM	(2 hrs) 120	21.70	15.70	1:30 PM	90	6.55	0.55
2:20 PM	140	22.10	16.10				
2:40 PM	160	23.85	17.85				
3:00 PM	(3 hrs) 180	24.90	18.90				
3:30 PM	210	25.60	19.60				
4:00 PM	(4 hrs) 240	25.80	19.80				
4:30 PM	270	25.80	19.80				
5:00 PM	(5 hrs) 300	25.81	19.81				
5:30 PM	330	25.81	19.81				
6:00 PM	(6 hrs) 360	25.81	19.81				
7:00 PM	(7 hrs) 420	25.82	19.82				
8:00 PM	(8 hrs) 480	25.82	19.82				
9:00 PM	(9 hrs) 540	25.84	19.84				
10:00 PM	(10 hrs) 600	25.84	19.84				
11:00 PM	(11 hrs) 660	25.84	19.84				
12:00 AM	(12 hrs) 720	25.85	19.85				
1:00 AM	(13 hrs) 780	25.85	19.85				
2:00 AM	(14 hrs) 840	25.85	19.85				
4:00 AM	(16 hrs) 960	25.85	19.85				
6:00 AM	(18 hrs) 1080	25.85	19.85				
8:00 AM	(20 hrs) 1200	25.85	19.85				
10:00 AM	(22 hrs) 1320	25.85	19.85				
12:00 PM	(24 hrs) 1440	25.85	19.85				

6.10.4 Manowa-Pendembu Crossing

Table 38. Well Details of Manowa-Pendembu Crossing

Well ID	X	Y	Dist to Bridge	Depth	SWL	Type	Water Quality Status
WS/Lot4/Man/01	309113	902060	338.85	13.6	4.5	Existing Well	Yes
Private Well	309382	902043	604.68	10.8	5	Existing Well	Yes
WS/Lot4/Man/GTWell	308696	902227	85.85	32	5.36	New	No

Figure 62. Well Location of Maonowa-Pendembu Crossing



6.10.4.1 Results and Interpretation

A pumping test is a procedure used to determine the hydraulic properties of an aquifer, such as its transmissivity, hydraulic conductivity, and storativity. The test involves pumping water out of a well (WS/Lot4/Man/GTWell) at a constant rate and measuring the resulting changes in water levels in the well and surrounding observation wells.

The depth of the well is 32m and the Static Water Level (SWL) is 5.36m. The pump was set at 26m and the Dynamic Static Water Level is 21.76m. The flow rates are 1.4L/S, 2.1L/S, 2.7L/S, and 3.3 liters per second. The maximum drawdown is 16.4m and the recovery is 90%, which is 9.5m. The step test is 24 hours. The time of recovery is 1 hour. This means that the recovery rate (recharge) of the aquifer is good. The pumping test data is found in the table below.

Table 39. Pumping Test Results Showing Drawdown and Recharge (Recovery Rate)

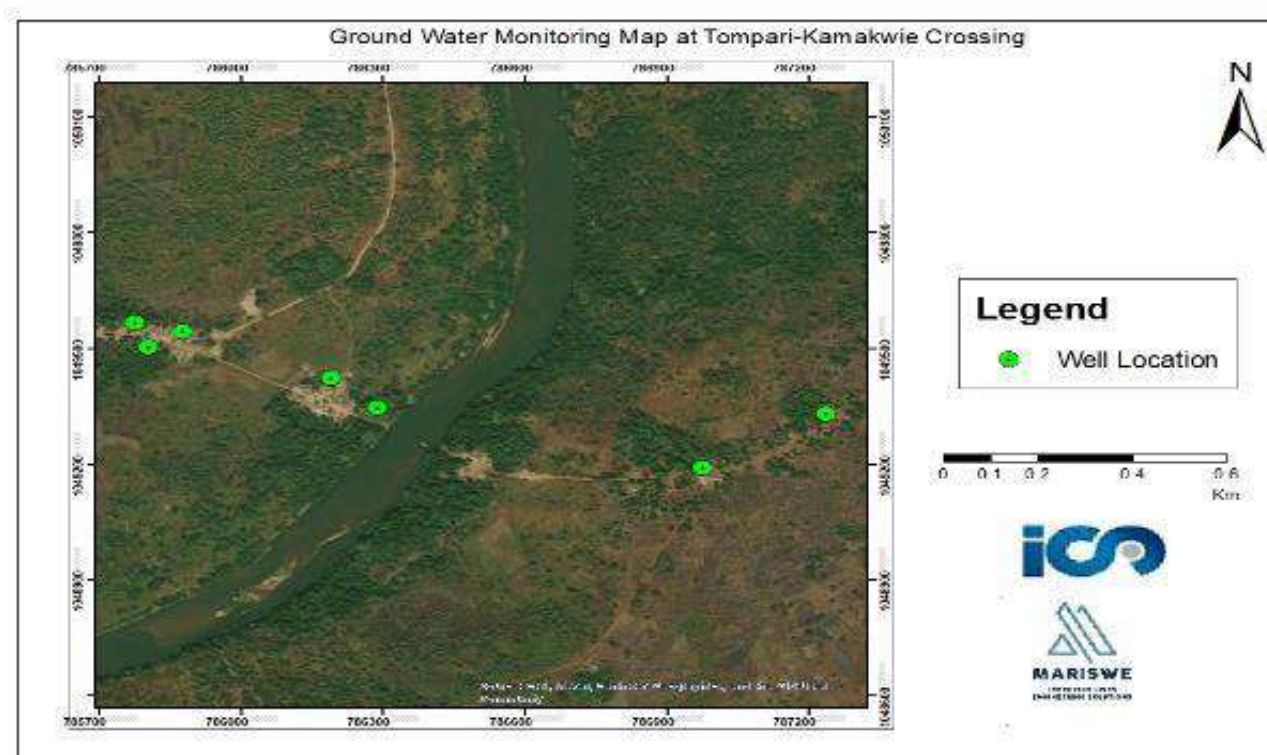
Manowa Pendembu Crossing														
Locality			Kailahun District											
Well depth			32											
Pump setting			26m						Pump on		4:00 pm, 05.03.2023			
SWL			5.36	m					Pump off		4:00 pm , 06.03.2023			
Pumping												Recovery		
Step 1	1.4	l/s	Step 2	2.1	l/s	Step 3	2.3	l/s	Step 4	2.8	l/s	Time	Water level	Residual draw down
Time	Water level	Draw down	Time	Water level	Draw down	Time	Water level	Draw down	Time	Water level	Draw down			
min	m	m	min	m	m	min	m	m	min	m	m	min	m	m
1	7.40	2.04	61	13.90	8.54	121	16.90	11.54	181	21.48	16.12	241	17.43	12.07
2	7.98	2.62	62	13.93	8.57	122	17.30	11.94	182	21.48	16.12	243	13.35	7.99
3	8.55	3.19	63	13.99	8.63	123	17.85	12.49	183	21.49	16.13	245	9.87	4.51
4	8.88	3.52	64	14.20	8.84	124	18.30	12.94	184	21.50	16.14	250	7.31	1.95
5	9.74	4.38	65	14.35	8.99	125	18.75	13.39	185	21.50	16.14	255	6.76	1.40
6	10.10	4.74	66	14.44	9.08	126	19.00	13.64	186	21.52	16.16	260	6.49	1.13
7	10.89	5.53	67	14.60	9.24	127	19.55	14.19	187	21.53	16.17	270	6.22	0.86
8	11.15	5.79	68	14.87	9.51	128	19.95	14.59	188	21.53	16.17	280	6.06	0.70
9	11.79	6.43	69	14.93	9.57	129	20.38	15.02	189	21.54	16.18	290	6.00	0.64
10	12.33	6.97	70	14.99	9.63	130	20.63	15.27	190	21.54	16.18	300	5.88	0.52
12	12.64	7.28	72	14.99	9.63	132	20.70	15.34	192	21.56	16.20			
14	12.71	7.35	74	15.02	9.66	134	20.78	15.42	194	21.58	16.22			
16	12.71	7.35	76	15.02	9.66	136	20.85	15.49	196	21.60	16.24			
18	12.80	7.44	78	15.02	9.66	138	20.88	15.52	198	21.63	16.27			
20	12.81	7.45	80	15.02	9.66	140	20.90	15.54	200	21.64	16.28			
22	12.83	7.47	82	15.02	9.66	142	20.93	15.57	202	21.64	16.28			
24	12.95	7.59	84	15.02	9.66	144	20.96	15.60	204	21.65	16.29			
26	12.92	7.56	86	15.02	9.66	146	20.96	15.60	206	21.65	16.29			
28	12.96	7.60	88	15.02	9.66	148	20.99	15.63	208	21.66	16.30			
30	12.98	7.62	90	15.02	9.66	150	21.00	15.64	210	21.67	16.31			
32	13.00	7.64	92	15.02	9.66	152	21.00	15.64	212	21.67	16.31			
34	13.04	7.68	94	15.02	9.66	154	21.10	15.74	214	21.67	16.31			
36	13.07	7.71	96	15.02	9.66	156	21.10	15.74	216	21.67	16.31			
38	13.10	7.74	98	15.02	9.66	158	21.10	15.74	218	21.67	16.31			
40	13.10	7.74	100	15.02	9.66	160	21.10	15.74	220	21.70	16.34			
42	13.13	7.77	102	15.02	9.66	162	21.10	15.74	222	21.71	16.35			
44	13.13	7.77	104	15.02	9.66	164	21.10	15.74	224	21.71	16.35			
46	13.16	7.80	106	15.02	9.66	166	21.15	15.79	226	21.73	16.37			
48	13.16	7.80	108	15.02	9.66	168	21.19	15.83	228	21.75	16.39			
50	13.16	7.80	110	15.02	9.66	170	21.21	15.85	230	21.76	16.40			
52	13.19	7.83	112	15.02	9.66	172	21.22	15.86	232	21.76	16.40			
55	13.19	7.83	115	15.02	9.66	175	21.22	15.86	235	21.76	16.40			
57	13.22	7.86	117	15.02	9.66	177	21.23	15.87	237	21.76	16.40			
60	13.22	7.86	120	15.02	9.66	180	21.24	15.88	240	21.76	16.40			

6.10.5 Tompari-Kamakwie Crossing

Table 40. Well Details of Tompari-Kamakwie Crossing

Well ID	X	Y	Distance to Bridge	Depth	SWL	Type	Water Status	Quality
WS/Lot1/Tom/01	786170	1049545	279.42	14.2	5	Existing Well	Yes	
WS/Lot1/Tom/02	785855	1049574	531.65	12.3	5.2	Existing Well	Yes	
WS/Lot1/Tom/03	785834	1049635	578.98	15	4.9	Existing Well	Yes	
WS/Lot1/Tom/04	785790	1049593	595.05	14	5.5	Existing Well	Yes	
Well not functional	786966	1049257	542.2	10.3	6.2	Existing Well	Yes	
WS/Lot1/Tom/05	787274	1049417	871.09	11.2	5.5	Existing Well	Yes	
WS/Lot1/Tom/GTWell	786502	1049463	241.15	32	5.88	New	No	

Figure 63. Well Location of Tompari-Kamakwie Crossing



6.10.5.1 Results and Interpretation:

A pumping test is a procedure used to determine the hydraulic properties of an aquifer, such as its transmissivity, hydraulic conductivity, and storativity. The test involves pumping water out of a well (WS/Lot1/Tom/GTWell) at a constant rate and measuring the resulting changes in water levels in the well and surrounding observation wells.

The depth of the well is 32m and the Static Water Level (SWL) is 5.88m. The pump was set at 26m, and the Dynamic Static Water Level is 21.80m. The flow rate is 3.3 litres per second. The maximum drawdown is 15.92m and the recovery is 90%, which is 6.48m. The constant test is 24 hours. The time of recovery is 20 minutes. This means that the recovery rate (recharge) of the aquifer is very good. The pumping test data is found in the table below.

Table 41. Pumping Test Results Showing Drawdown and Recharge (Recovery Rate)

Tompuri-Kamakwie Crossing							
Locality		Karene District					
Well depth		32m			Flow rate	3.33	l/s
Pump setting		26m			Pump on	9:00 pm, 07.03.2023	
SWL		5.88	m		Pump off	9:00 pm, 08.03.2023	
Pumping				Recovery			
Time	Pumping time	Water level	Draw-down	Time	Pumping time	Water level	Draw-down
	mins	m	m		mins	m	m
9:00 PM	0	5.88	0.00	9:00 PM	0	21.80	15.92
9:03 PM	3	8.40	2.52	9:01 PM	1	18.60	12.72
9:05 PM	5	9.88	4.00	9:03 PM	3	14.32	8.44
9:10 PM	10	11.50	5.62	9:05 PM	5	10.26	4.38
9:15 PM	15	12.33	6.45	9:10 PM	10	8.90	3.02
9:20 PM	20	12.80	6.92	9:15 PM	15	7.75	1.87
9:30 PM	30	12.90	7.02	9:20 PM	20	6.48	0.60
9:40 PM	40	13.15	7.27	9:30 PM	30	6.21	0.33
9:50 PM	50	13.19	7.31	9:40 PM	40	6.00	0.12
10:00 PM	(1 hr) 60	13.25	7.37	9:50 PM	50	5.98	0.10
10:20 PM	80	14.55	8.67	10:00 PM	(1 hr) 60	5.91	0.03
10:40 PM	100	15.00	9.12				
11:00 PM	(2 hrs) 120	15.20	9.32				
11:20 PM	140	15.85	9.97				
11:40 PM	160	16.70	10.82				
12:00 AM	(3 hrs) 180	17.34	11.46				
12:30 AM	210	18.00	12.12				
1:00 AM	(4 hrs) 240	18.35	12.47				
1:30 AM	270	18.95	13.07				
2:00 AM	(5 hrs) 300	19.55	13.67				
2:30 AM	330	20.38	14.50				
3:00 AM	(6 hrs) 360	20.84	14.96				
4:00 AM	(7 hrs) 420	20.79	14.91				
5:00 AM	(8 hrs) 480	21.03	15.15				
6:00 AM	(9 hrs) 540	21.42	15.54				
7:00 AM	(10 hrs) 600	21.55	15.67				
8:00 AM	(11 hrs) 660	21.69	15.81				
9:00 AM	(12 hrs) 720	21.74	15.86				
10:00 AM	(13 hrs) 780	21.80	15.92				
11:00 AM	(14 hrs) 840	21.80	15.92				
1:00 PM	(16 hrs) 960	21.80	15.92				
3:00 PM	(18 hrs) 1080	21.80	15.92				
5:00 PM	(20 hrs) 1200	21.80	15.92				
7:00 PM	(22 hrs) 1320	21.80	15.92				
9:00 PM	(24 hrs) 1440	21.80	15.92				

6.10.6 Overview National & Regional Hydrogeology

As Sierra Leone has an abundance of surface water, groundwater has so far received little attention. Existing data and research have been analysed to extract hydrogeologic characteristics at the national scale. Similarly, research in the wider African region provided additional insights. A national study in 1980 used geophysical soundings, identifying five geological units whose resistivity can be considered as a reference for many areas of the country (UNDP/FAO, 1080).

Table 42. Geological units identified through geophysical soundings (UNDP/FAO, 1980)

Layer type	Resistivity ($\Omega \times m$)
Lateritic crust	1200 – 1700
Clay and sand (regolith)	20 - 30
Hard clay	80 – 400
Clay	20 – 30
Basement rock	>900

6.10.7 Water Wells and Water-Table Fluctuations

Hand-dug wells in Sierra Leone range in depth from less than 10 m to over 20 m. Boreholes in fractured rock and sediments are drilled to depths of 46 – 100 m. Borehole depths recorded from 359 locations varied from 9 - 63 m with a mean of 33.6m. Most wells recorded groundwater levels within 10 m of the ground surface and exceeded 20 m in some locations.

Table 43: Source of Drinking Water in the Subproject Sites

Location	The main source of drinking water (from PAPs)
Mattru	Four (44.5%) of the affected people use community boreholes for drinking and the remaining five (5) (55.6%) use private wells/boreholes as a source of drinking water.
Gendema	All 23 Subproject-affected persons (100%) use community boreholes for drinking water.
Manowa	71.4% of the affected people use spring water for drinking and other domestic purposes and 28.6% use community boreholes/water wells.
Tomparie	47.6% of the affected people use spring water for drinking and other domestic purposes and 52.4% use community boreholes.

6.10.8 Groundwater Recharge and Discharge

Groundwater recharge is the downward flow of the water from the surface driven by the hydraulic gradient from the ground surface to the aquifer below and again to surface points at the lower piezometric level. Groundwater discharge is the loss of water from an aquifer.

In the humid areas of Sierra Leone, recharge is more related to peak rainfall events and drops during the dry season, while discharge continues for two to three months after the end of the rainy season. Recharge areas occupy the interior zones with greater elevation and larger outcrops of fractured rocks found northeast of a fictitious line joining Makeni and Kenema towns. Discharge can occur by leakage into the ocean, rivers, or another aquifer. It may also occur from depths through narrow breaks in a low permeability layer (e.g. mound springs). In this map, however, discharge is represented primarily as occurring on the land surface from a shallow water table. Discharge areas along the flat and swampy area immediately southwest of the Makeni-Kenema line and approximately correspond to the Rokel River formation. Another discharge area is close to the coast, between the two estuaries of Great Scarcies and Mano Rivers.

6.10.9 Potential Water Sources Available to the Contractor

When it comes to bridge construction, water sources are essential for a variety of purposes, including mixing concrete, curing concrete, dust suppression, and other construction activities. Here are some potential water sources that may be available to the bridge construction contractors:

1. **Surface Water:** Surface water sources such as lakes, rivers, and streams can be a viable source of water for the bridge's construction. However, obtaining permits and adhering to environmental

regulations can be a challenging process. Contractors may also have to install treatment systems to remove sediment and other contaminants before using surface water.

2. **Groundwater:** Groundwater is another potential source of water for bridge construction. Contractors can drill wells on the construction site to access groundwater. However, the quantity and quality of groundwater can vary depending on the location and depth of the well.
3. **Rainwater Harvesting:** Rainwater harvesting is an increasingly popular method for collecting and storing rainwater for construction purposes. Contractors can install rainwater harvesting systems on the construction site to collect and store rainwater for various construction activities. This option can be particularly useful in the rainy season and areas with limited water resources or where water is expensive.
4. **Trucked Water:** If none of the above sources are available or feasible, contractors may have to resort to trucked water. Water delivery trucks can be used to transport water to the construction site, but this option can be expensive and can create logistical challenges.

In conclusion, there are various potential water sources available to the bridge's construction contractors, each with its advantages and disadvantages. The choice of water source will depend on various factors such as location, accessibility, cost, national environmental regulations and policies, World Bank's Safeguards operational policies, Good International Industry Practices (GIIP), and the contractors' choice. Contractors need to consider all available options carefully to ensure a reliable cost-effective and environmentally friendly water supply method for the bridge's construction Subproject.

6.11 ECOLOGICAL RESOURCES

The overall aim of the ecological survey was to assess the different habitats, vegetation types, flora composition, and diversity, as well as assess which of the different types of habitats and vegetation could be removed without compromising the availability of habitats to both flora and fauna especially those species of conservation concern.

The specific objectives of the survey were:

- To identify any key species and/or habitat types that should be conserved or require protection.
- Determine the potential impacts on vegetation and floral diversity in the area.
- Describe the impacts of current land use
- To provide recommendations and mitigation measures that will reduce negative impacts on vegetation and ecological processes, and where possible optimize conservation benefits.

6.11.1 Survey Design and Methodology

Maps were used as resource material to select the different survey sites in the proposed bridge locations. The walk-in survey was conducted in all of the sites visited across the four bridge locations to document species composition and assess habitat integrity.

Survey techniques such as transect lines, along with other observational techniques such as tracks, feeding calls and scat (faecal) signs, baited traps, pitfalls, and mist netting for birds and bats, and interviews were employed.

In the interviews conducted as part of the assessment, interviewees were asked to identify the animals from pictures taken of animals seen within the Subproject area. Animals identified by the majority of the interviewees were assessed as the most common and present within the study area.

6.11.2 Biological Environment

6.11.2.1 Mattru Jong-Senehun

❖ Flora

The majority of the area is covered by various stages of forest regrowth from abandoned farm bush to secondary forest. The farm bush is generally overgrown by shrubby. This develops into a thicket with numerous woody climbers. Scattered large forests and tree-crop species left standing after clearing are a common feature. Trees can be up to 20 m and above tall.

The flora in the Subproject area is a mix typical of riparian vegetation types influenced by soil, river water, topography, and Savannah grasslands. The vegetation type has been greatly disturbed by illegal logging and artisanal mining activity in some places. The common floral species compositions in the Subproject area:

TREES: *Parkia bicolor*, *Parinera excels*, *Gmelina arborea*, *Daniella thurifera*, *Lovoa trichilliodes*, *Amphimas pterocarpoides*, *Newtonia species*, *Psidium guajava*, *Pycnantu anglolensis*, *Mangifera indica*, *Ficus reticulate*, *Cocos nucifera*, *Elusine indica*, *Tectona grandis*, *Terminalia*.

SHRUBS: *Acacia intsia*, *Cajanus cajan*, *Calamus erectus*, *Carica papaya*, *Urena lobata*, *Solanum ssp*, *Dioscorea alata*, *Dioscorea belophylla*, *Piper nigrum*, *Holboellia latifolia*.

HERBS: *Mimosa pudica*, *Drymeria cordata*, *Imperata cylindrical*, *Zingiber officinale*, *Tridax procumbens*, *Ageratum conyzoides*.

❖ Terrestrial Fauna

Studies undertaken by MARISWE/ICS identified common faunal species in the Subproject area;

MAMMALS - *Phacochoerus aethiopicus* *Cephalophus niger*, *Tragelaphus scriptus*, *Piliocolobus badius badius* *Papio papio*, *Pan troglodytes veru*, *Genetta ssp*, *Felis sylvestris*

BIRDS - *Scotopelia ussheri*, *Ceratogymna cylindricus*, *Ceratogymna cylindricus*, *Criniger olivaceus*, *Prinia leontica*.

REPTILES - *Naja melanoleuca*, *Naja nigricollis*, *Dendroapsis viridis*, *Bufo xeros*, *Ptychadena oxyrhynchus*.

❖ Aquatic Fauna

In the course of the study, eight (8) species of fish were recorded in the Subproject area. Also, of the 50 species of amphibians recorded in Sierra Leone, about 12 species are found along the Sewa River. Also, several frogs, toads, and lizards were observed.

FISHES - *Sarotherodon paugyi* *Caudomarginatus*, *S. occidentalis*, *Tilapia brevimanus*, *Tilapia louka* *Notoppterus afer*, *Lewa abeo coupei*, *Clarias gariepenus*.

6.11.2.2 Tomparie -Kamakwei Crossing

Flora

The vegetation comprises mixed-tree savanna, some secondary gallery forest, and patches of cultivation. Fruit trees and economic tree crops are mostly found close to the settlements in the bridge location.

TREES - *Gmelina arborea*, *Ceiba pentandra*, *Musanga cecropioides*, *Azizia bella*, *Albizia adianthifolia*, *Albizia zygia*, *Bombax bounopogense*, *Elaies guineensis*, *Ceiba pentandra*, *Dialum guineensis*, *Parkia biglobosa*.

SHRUBS - *Alchornea cordifolia*, *Ageratum conyzoides*, *Solanun torvum*, *Combretum grandiflorum*, and *Selaginella myosorus*, *Anisophylla laurina*, *Anthcleista nobilis*, *Aspilla latifolia*, *Calapogonium muconoides*, *Borreria verticulata*, *Imperata cylindricum*, *Chromelina odorata*, *Combretun sp*, *Croton hirtus*, *Dissotis sp*, var *maclaudi*, *Tetracera alnifolia*, *Nauclea latifolia*, *Pentadesma butyracea*.

HERBS - *Imperata cylindrica* var *Africana*, *Pennisetum purpureum*, *Zonnia latifolia*, *Aspilla latifolia*, and *Dissotis* spp.

Terrestrial Fauna

MAMMALS – *Thryonomysgregorianus*, *Tragelaphusscriptus*, *Aethomyskaiseri*, *Xerusutilus*, *Sylvicapragrimmia*, *Pan troglodytesverus*, *Cercocebusatys*, *Procolobusbadiusbadius*, *Cercopithecuspetaurista*, *Synceruscaffer*.

REPTILES – *Najanigricollis*, *Dendroaspisaugusticeps*, *Pilothonnussp*, *Python sebae*, *Caususrhombeatus*, *Agama agama*, *Chamaeleo senegalensis*.

BIRDS – *Apusaffinis* *Apodidae*, *Apusapus* *Apodidae*, *Aquila Africana*, *Bubulcus ibis*, *Caprimulgusclimacurus* *Cerotogymnaelata* *Chrysococcyxcureus* *Coccycolius iris* *Corvusalbus* *Ceuthmocharesaereus* *Francolinusahantensis* *Euplectesardens* *Gypohieraxangolensis* *Lamprotornischalcurus* *Illadopsisfulvescens* *Halcyon malimbica*.

FISHES - *Caudomarginatus*, *S. occidentalis*, *Tilapia brevipinnis*, *Tilapia louka* *Notoppterus afer*, *Notoppterus afer*, *Auchenoglanis occidentalis*, *Chrysichthys nigrodigitatus*, and crustaceans *Macrobrachium rosenbergi*, *Tylochromis jentiki*.

6.11.2.3 Gendema-Garwama

Flora

The survey determined that the flora in the Subproject area is a mix of typical riparian vegetation types. The vegetation has been greatly disturbed by mining activities and illegal logging in some places, especially along the floodplains of creeks and rivers. These activities have greatly influenced the forest structures/status in the areas where they occur. There are no threatened or endemic species specific to the Subproject area.

TREES - *Parkia bicolor*, *Parinera excelsa*, *Gmelina arborea*, *Daniella thurifera*, *Lovoa trichillodes*, *Amphimas pterocarpoides*, *Newtonia species*, *Psidium guajava*, *Pycnanthus angolensis*, *Mangifera indica*, *Ficus reticulata*, *Cocos nucifera*, *Elusine indica*, *Tectona grandis*, *Terminalias*, *Chlophora* spp

SHRUBS - *Acacia intsia*, *Cajanus cajan*, *Calamus erectus*, *Carica papaya*, *Piper nigrum*, *Holboellia latifolia*

HERBS - *Mimosa pudica*, *Drymeria cordata*, *Imperata cylindrica*, *Zingiber officinale*, *Ageratum conyzoides*

Fauna

The Faunal Assessment determined the species richness of the mammals, birds, reptiles, and amphibians within the Subproject area based on surveys along transect lines in the areas studied, along with other observational techniques. Information obtained in the field as well as available secondary data indicates that there are no threatened or endemic species specific to the Subproject area.

MAMMALS - *Phacochoerus aethiopicus*, *Cephalophus niger*, *Tragelaphus scriptus*, *Piliocolobus badius badius*, *Papio papio*, *Pan troglodytes verus*, *Genetta ssp*, *Felis sylvestris*, *Phacochoerus aethiopicus*,

BIRDS - *Scotopelia ussheri*, *Ceratogymna cylindricus*, *Ceratogymna cylindricus*, *Criniger olivaceus*, *Prinia leontica*

REPILES - *Naja melanoleuca*, *Naja nigricollis*, *Dendrooapsis viridis*, *Bufo xeros*, *Ptychadena oxyrhynchus*

Aquatic Fauna

A total of 7 species of hill stream fish have been recorded in the rivers of Sierra Leone. In addition, records of freshwater pond fish could be noted in the literature and from the information obtained from local people.

FISHES - *Sarotherodon paugyi*, *Caudomarginatus*, *S. occidentalis*, *Tilapia brevimanus*, *Tilapia louka*, *Notoppterus afer*, *Labeo coupei*, *Clarias gariepinus*.

6.11.2.4 Manowa-Pendembu

Flora

Recent studies indicate that the natural thick rainforest of the Kailahun region has been largely destroyed by decades of alluvial mining and subsistence farming (mostly cocoa), and present-day vegetation is largely thick secondary growth. Primary forest is now found only in the forms of secret society bushes and sacred grounds. To a larger extent, the Subproject area and its immediate vicinity are relatively intact except for the gradual infrastructural expansion and on-going road projects.

The flora in the Subproject area is a mix typical of riparian vegetation types influenced by soil, river water, and topography. Much of the vegetation types are intact in the Subproject vicinity. The common floral species compositions in the Subproject area:

TREES - *Dichrostachys glomerata*, *Harungana madagascariensis*, *Nauclea latifolia*, *Alchornea cordifolia*, *Mangifera indica*, *Ficus reticulate*, *Cocos nucifera*, *Elusine indica*, *Tectona grandis*, *Terminalia*.and *Trema guineensis*

SHRUBS - *Lantana camara*, *Cissus afzelli*, *Manniophytum fulvum*, *Abrus precatorius*, *Smilax krausiana*, *Dioscorea bulbifera*,

HERBS - *Mimosa pudica*, *Drymeria cordata*, *Imperata cylindrical*, *Zingiber officinale*, *Tridax procumbens*, *Ageratum conyzoi*

Terrestrial Fauna

The most common mammals, reptiles and amphibian species recorded in around the Moa River axis were as follows:

MAMMALS – *Funisciurus pyrropus* (Fire footed), *Cephalopus spp* (duiker), *Pan troglodytes verus*(chimp), *Phataginus tricuspis* (pangolin), *Cercocebus atys* (mangabay), *Cercopithecus patas*, *Xerus rutilus* (ground squirrel), *Aethomys kaiseri* (rat), *Tragelaphus scriptus* (Bush buck), *Thryonomys gregorianus*(cane rats), *Phacochoerus aethiopicus* *Cephalophus niger*, *Tragelaphus scriptus*, *Piliocolobus badius badius* *Papio papio*, *Pan troglodytes veru*, *Genetta ssp*, *Felis sylvestris*



Cephalopus spp



Tragelaphus scriptus was Hunted by Locals for domestic and commercial purposes

BIRDS - *Scotopelia ussheri*, *Ceratogymna cylindricus*, *Ceratogymna cylindricus*, *Criniger olivaceus*, *Prinia leontica*

Reptiles - *Naja samarensis* (cobra), *Bitis* sp (Snake), *Causus maculatus* (snake), *Philothamnus irregularis* (Snake), *Philothamnus irregularis* (Snake), *Thrasops* sp (snake), *Psammophis elegans* (snake), *Varanus ornatus*, *Trachylepis affinis*, *Agama agama*.

Amphibians - *Bufo latifrons*, *Bufo maculatus*, *Hylarana occidentalis*, *Hyperoliidae*, *Hyperolius zonatus*, *Ptychadena* spp, *Ptychadena tournieri*, *Ptychadena longirostris*, *Petropedetes natator*

Aquatic Fauna

Four (4) species of fish were recorded from a previous study in the Moa River close to the Subproject area. Also, of the 50 species of amphibians recorded in Sierra Leone, about 6 species were recorded along the Moa River during the study. Also, many frogs, toads, and lizards were observed.

FISHES - *Sarotherodon paugyi*, *Caudomarginatus*, *S. occidentalis*, *Tilapia brevimanus*, *Tilapia louka*, *Notoppterus afer*, *Lewa abeo coupei*, *Clarias gariepinus*.

7 SOCIO-ECONOMIC AND CULTURAL BASELINE AND LIVING CONDITIONS

7.1 DATA SOURCES AND ESIA METHODOLOGY

The socioeconomic impact assessment is based on a detailed examination of the existing social and economic situation of the various “study areas”. The framework developed for the study used primary and secondary data sources to obtain information about demographics, health, employment, income and expenditure, education, sources of energy, water and sanitation, food security, land tenure and use planning, etc. Primary data were collected through household and community surveys conducted in the field. Secondary sources, including a variety of existing literature and data sources, were used to supplement the survey information. These secondary sources provided the best available socioeconomic data, which allowed for consistency and comparisons.

❖ Survey implementation

As appropriate, the project team uses a combination of qualitative interviews and quantitative surveys of local communities/households, local decision makers/community leaders, potentially marginalized groups, local NGOs, and government authorities. Community meetings to determine the concerns and expectations concerning the proposed bridge Subproject.

❖ Community meetings/village survey:

Community surveys were conducted in several towns and villages across the proposed bridge construction area. A diverse group of community members participated in the surveys, which generally consisted of focus group meetings with traditional leaders, opinion leaders, village headmen, local decision-makers, and all other interested parties, and a mix of males and females. At the community meeting, the survey team used the questionnaire as a guide to obtain detailed information from as many respondents as possible. The community surveys gathered consensus information about the existing conditions. As such, these surveys had a broader scope of inquiry than the household surveys, which focused on household-level data. The questions in the community survey covered the following areas:

- Settlement characteristics, demographic information, economic activities, health care facilities, education
- Infrastructure indicators
- Gender issues
- Subproject impact
- Community concerns and community development needs.

7.2 FOCUS GROUP DISCUSSION AND KEY INFORMANTS’ INTERVIEWS

This was among activities done in some of the sample villages, towns, or settlements. At least 5 people in each sample settlement participated in the focus group discussions and key informant interviews. The participants included village headmen/elders, vulnerable groups, youths, men and women. During the FGDs and Key Informant Interviews, a checklist of variables was used to guide the discussions. The variables included:

- General village background information, including demographics, household members, etc.
- Socioeconomic services such as schools, health facilities, water supply
- Economic activities
- Subproject impacts
- Migration

For photographs taken during the FGDs and names of stakeholders, refer to Appendices 7 and 8.

7.3 HOUSEHOLD SURVEY

The household questionnaires were administered to randomly selected households. The purpose of the socioeconomic baseline study was to establish a detailed understanding of the characteristics of the

communities within the geographical scope of work. The sampling design for the household survey aimed at securing representative data to provide information on the socioeconomic situations of local inhabitants using the following type of indicative content:

- Socio-demographic profile of the population (gender, age, marital status, religion, ethnicity, education, occupation, family structure etc.)
- Sources and use of energy
- Housing conditions and distribution of settlements
- Access to public services and utilities (sanitation, water, health services, information and communication technology, etc.)
- Household income and expenditure profile
- Access to credit
- Household livelihood strategies – for subsistence and income generation
- Food production and food security
- Land use, ownership, and use rights
- Resettlements
- Community-level institutions
- Community needs and development priorities
- Living cultural heritage and community usage of sacred sites e.g., forests
- Transportation and traffic survey

A team of enumerators and field supervisors executed the household questionnaires. The enumerators were selected from a pool of undergraduate and graduate students, Teachers, and Local Councillors. Selected criteria included performance during the training, ability to speak the local language, and ability to work under harsh field conditions involving extensive walking distances, crossing rivers with boats, and use of bikes on unpaved and dusty bypasses.

Prior to the implementation, the social research team spent a lot of effort to train the enumerators and pre-testing the surveys to minimize various biases such as interviewer compliance bias. Several pilot tests were carried out in the various bridge locations. During both training and pilot testing, the Team took special care to stress the importance of confidentiality and the importance of proper behaviour of the enumerators in local communities and/or villages.

Interviews were conducted in private, and the interviewees were given assurance that their answers would be anonymous. Each questionnaire took about 35 to 40 minutes to complete. These surveys were conducted between March and April 2021.

The data collected for this baseline are unique for several reasons. First, detailed household data covering a large number of settlements, villages, towns, and respondents. Second, the quality of the data is high, as non-response rates are low; virtually none of the randomly selected households refused to take part in the interview, and item non-response was low as well (however for some attitudinal questions, respondents said they didn't know). Similarly, community members actively participated in the focus group session and indicated that the surveys were well understood and communicated.

7.4 DATA ANALYSIS AND REPORTING

All questionnaires for the baseline survey were given to the supervisors for quality checks and onward transmission to the data manager (s) for data entry. The data captured were entered into SPSS 2019 v26 software and Excel (graphs), cleaned, and analysed and a draft report was submitted to PCU, World Bank, and other stakeholders for review. Comments that were received from the stakeholders were used to enrich the analysis further and hence preparation of the final ESIA document for submission to SCADeP.

The conclusions and assessments of the existing situation reflect the interpretation of responses from the surveyed households and individuals in the surveyed communities. A sufficiently large number of households and individuals were surveyed to conclude that the survey results are likely, with a 95% confidence level, to reflect that of the population of the survey area as a whole. This statistical

confidence is due to the randomness of the sample selection, which attempted to ensure that no bias was introduced, as well as to the relatively large numbers of households and individuals surveyed.

7.5 MATTRU JONG-SENEHUN CROSSING

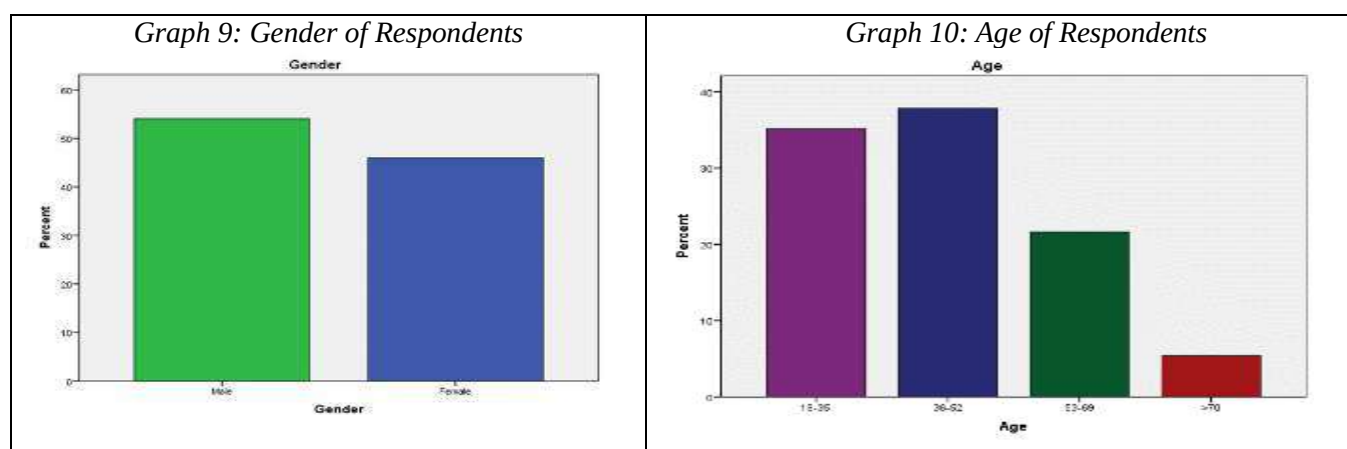
The main economic activities in this location are subsistence rice, cassava, Palm Oil farming, and fishing. The Mattru Jong crossing to Senehun also leads to Rutile town as the road is under pavement. Mattru which is the District Headquarter Town of Bonthe District has a population of around 20,000 and over 3500 houses.

The communities have hundreds of Hectares of palm tree plantations and many arable lands for rice farming; pepper is usually cultivated after the harvest of the rice. There are also many cassava farms in the town and its surrounding villages. The Paramount Chief is called PC Alie Badara Sheriff iii. The communities are largely inhabited by the native Sherbro and Mende people.

According to the 2015 Population and Housing Census carried out by Statistic Sierra Leone, the community's (Mattru Jong-Senehun Crossing) population of around 34,000 comprises of which 60% female and 40% male. There are more than 70% of youths (18-35 years), 5% elderly (70 years and above), and 25% children (1-17 years)- (SSL, PHC-2015).

7.5.1 Demographic and Population Structure of Survey Respondents

Out of the 37 questionnaires administered in the Subproject area, 20 respondents are male (54.1%) and 17 are female (45.9%). Most of the people interviewed are in the range of 36-52 years old which is 37.8 % of the total. From the survey conducted, 56.8% have households between 6-10, 24.3% between 3-5 people, and 18.9% equal to or greater than 10 people. 86.5% of the population are married, 10.8% widows and widowers, and 2.7% are single.



7.5.2 Ethnicity and Religion

78.4% of the inhabitants in the communities practice Islam and the remaining 21.6% practice Christianity. This means that communities value high religious practices like Christmas, Easter, New Year, Eid-ul-Fitr, and Ramadan festivals. Both Muslims and Christians in the area observe these occasions.

The most common language spoken in the community is Krio and Mende due to Mattru Jong being a major settlement and all the communities are very close to the town. The majority of the tribes in the communities are either Mende or Sherbro at around 90% of the combined household.

7.5.3 Housing in the Subproject Area

The increase in population has influenced an increase in the demand for housing and land in the communities especially in Mattru Jong town. This is due to the town being the District Headquarter Town of Bonthe District. Every development activity in the district is first enjoyed by the Mattru Jong, this has influenced rapid population increase due to the migration of people from villages around to

seek employment. Hence government infrastructural development, and the establishment of many offices in the town and the opening of new bank branches have all contributed to the surge in the population and increased demand for housing. Due to the socioeconomic living conditions and poor earning ability of households in the study area, most of the houses are built with either corrugated iron sheets, wood, or mud dressed in concrete. However, there are notably outstanding concrete structures in the affected communities, which are either unoccupied or under active construction. In some of these houses, the occupants are caretakers and relatives of the owners. Four house types were observed, of which, 2.7% are Corrugated Iron Sheaths (Pan Bodi), 75.7% are Mud Dressed with Concrete, 16.2% are wooden, and 5.4% concrete. There are three roof types for these houses; 48.6% corrugated metal, 48.6% thatched roof, and 2.7% plastic roofs. 91.9% of them have wooden window type and 8.1% are made of Aluminium. 83.8% own houses and 16.2% do not. 10.8% of those who do not own a house are on rent.

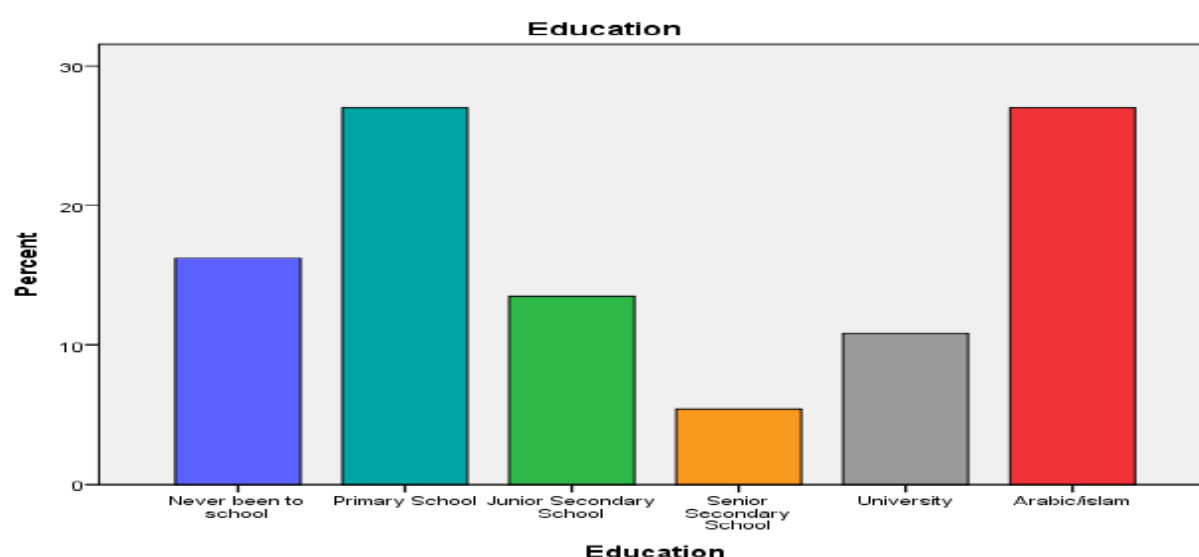
7.5.4 Education and Literacy

As the government and its development partners are mounting efforts to improve education across the country, access to educational facilities continues to pose serious challenges in the study areas. Among the communities, only two communities have primary school(s) but only Matru Jong has secondary schools. The other communities have either crossed the Jong River or travelled around 3 to 5 miles to find the nearest school which is mostly in Matru Jong. The communities benefit from the ten (10) Primary Schools and nine (9) Secondary Schools, which are mostly found in Matru Jong. Most of the Schools have trained and qualified teachers who are being paid by the government. Some of the high school graduate students in these communities attend the Nursing College in Matru Jong. The Nursing College has reduced the rate of dropouts in primary and secondary schooling as many families can now send their children to higher education, without which need to move and settle to Bo or Freetown.

The government has tried to make the ferry crossing free to the inhabitants and the government does pay the workers. The communities that are over the Jong River Crossing have serious challenges to attend school. During the raining season, crossing with the ferry is difficult and mostly impossible to use due to the heavy tide of the Jong River. Most primary school pupils are forced to end the schooling calendar immediately as the rainy season begins. The secondary school pupils are forced to use the boat, for which they pay one thousand Leones (le 1,000) even though it is risky to use. Therefore, schools during the raining season are difficult for pupils living in communities across the river.

The majority of the respondents in all communities attained some form of education (both English and Arabic). 27.0% of the population have primary school education, 27.0% have Arabic education, 16.2% have never been to school, 13.5% acquired junior secondary school education, 10.8% acquired university education and 5.4% acquired senior secondary school education. The overall analysis concludes that the literacy rates of respondents in the study area were found to be moderate. 78.4% of the respondents' children are in school and 21.6% of respondents' children are not in school. The reasons for not attending school are that 62.5% said the school is far from their villages and 37.5% said because of finance. Of the towns/villages around the Subproject area, 86.5% have schools in their communities and 13.5% have no schools in their communities. Of the 86.5% available schools in communities, 51.4% have only primary schools, 32.4% have both primary and secondary schools, and 2.7% have secondary schools.

Graph 23: Education and literacy in the Subproject Area



7.5.5 Healthcare

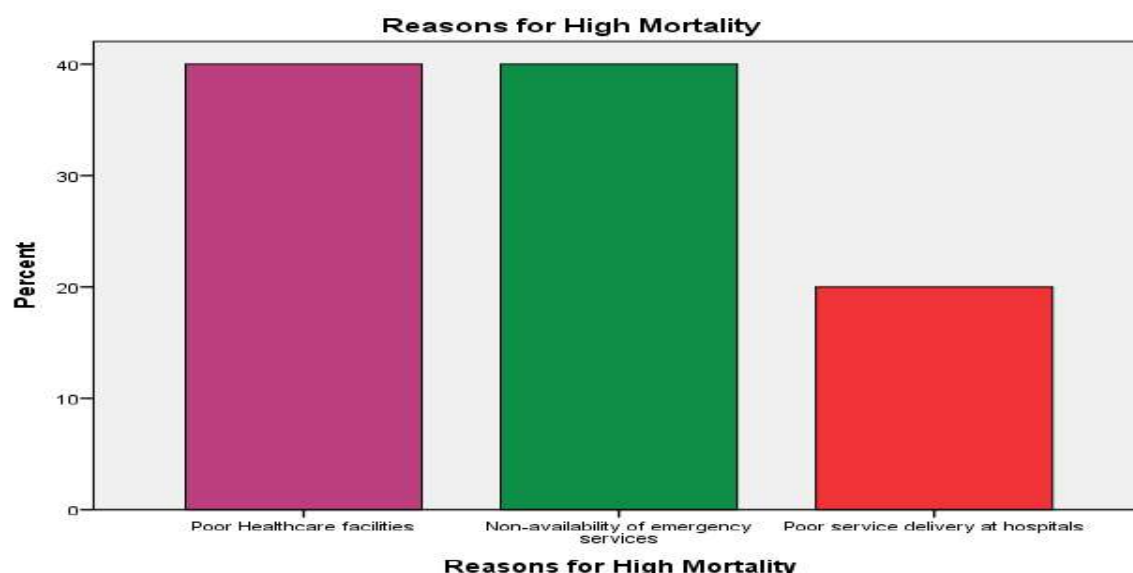
Since the end of the war in 2001, the government and its development partners (WHO, EU, USAID, IFC, CSOs, World Bank, etc.) have undertaken several reforms in the health sector that are designed to improve service delivery and enhance decent lives for its citizens. For instance, there is free medical insurance for pregnant women and lactating mothers as well as under- five kids across the country. Despite these measures, life expectancy in Sierra Leone is astonishingly low. For instance, according to the Human Development Report published by the United Nations Development Programme, Life expectancy (which is used as a proxy for good health) stood at roughly 48 years (UNDP, 2018). According to the report, this is attributable to poor nutrition, fragile health infrastructure, poorly equipped medical facilities, lack of trained health personnel, and prevalence of degenerative diseases among others. Worse still, maternal and infant mortality are also above desired international limits. Unsurprisingly, health infrastructures in the Subproject area and its surrounding communities are sparse, ill-equipped, and poorly managed.

All the communities in the Mattru Jong crossing benefit from the Mattru Jong hospitals. The town has three hospitals and the biggest was founded by United Brethren in Christ. The hospital provides health services in paediatrics, obstetrics, surgical, and outpatient units. The Hospital had been provided with two emergency ambulances to transport sick and pregnant women from all the other surrounding communities.

However, communities that are across the river from Mattru Jong town face difficult challenges since they do not have either a hospital or a community health center. Pregnant women are faced with the most difficult challenge to seek for medical needs when the ferry is not in operation. Hence seeking medical care at night or during the raining season is almost difficult. Hence, family members who can afford to rent a room in Mattru Jong migrate their pregnant family members when the pregnancy is almost nine months or due for delivery. This is difficult for family members who cannot offer to rent a room in Mattru Jong leaving the pregnant women in danger to only deliver to traditional birth attendants in the villages. Many are left to die when in need of emergency medical care during the night or raining season as the crossing poses a difficult challenge to these villages. Some children under five are even forced to skip some vaccination dates during the raining season, which poses a serious risk to the health of the babies. Vaccination of under-fives stands at 91.9% and 8.1% not vaccinated. The high infant mortality rate stands at 29.7% and low mortality at 70.3%. According to the respondents, the reasons for the 29.7% high mortality rate are: 45.5% said it is due to poor healthcare facilities, 36.4% said it is because of non-availability of emergency services, and 18.2% said it is a result of Poor service delivery at hospitals.

48.6% of the population have health clinics in their villages and 51.4% do not. 97.3% of the people would have preferred the hospital mode of treatment and 2.7% traditional herbs way. Some of the major challenges in accessing medical treatment are that; 43.2% said because of finance, 24.3% non-availability of drugs and equipment, 18.9% because of distance to the clinic, 8.1% because of lack of healthcare facilities, and 5.4% said it is because of non-availability of trained and qualified health personnel. 97.3% of the respondents is aware of HIV/AIDS and COVID-19 viruses and 2.7% do not. All the respondents are aware of and know about family planning.

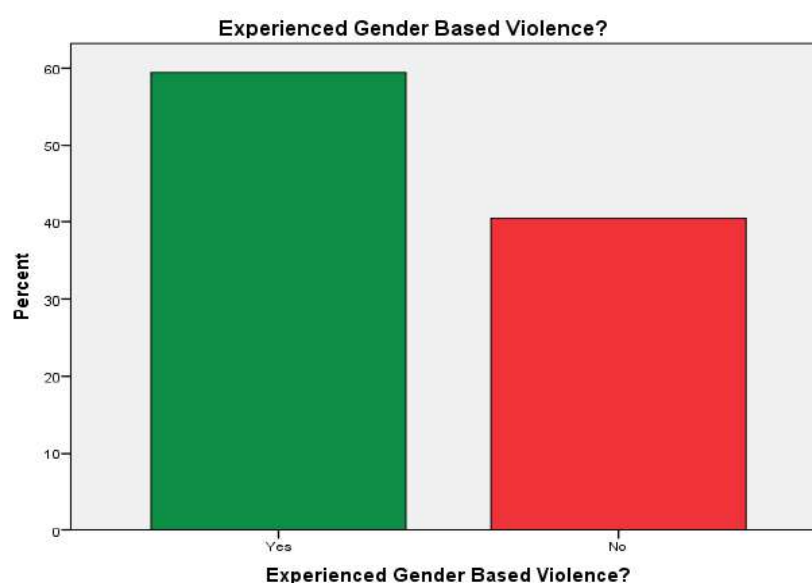
Graph 24: Reasons for High Mortality in the Subproject Area



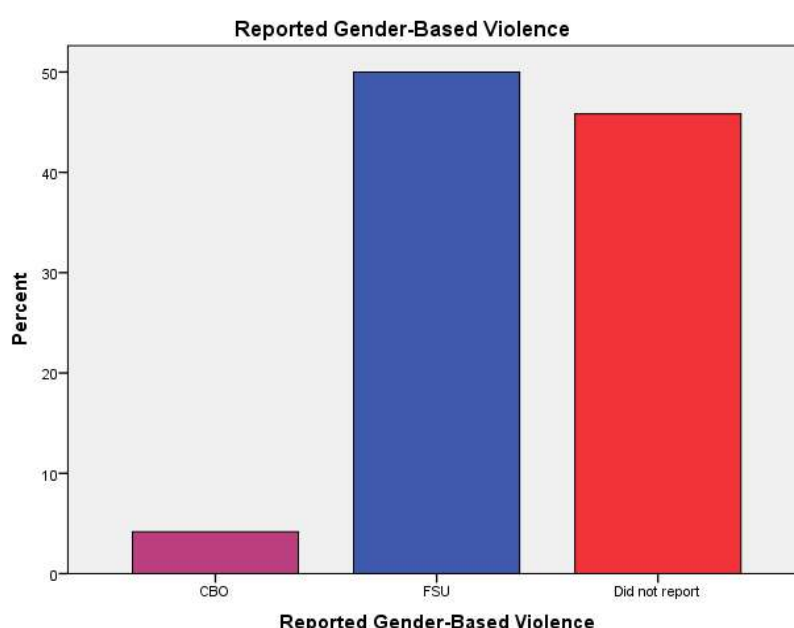
7.5.6 Gender-Based Violence (GBV)

83.8% of the population have knowledge of gender-based violence and 16.2% do not. 59.5% of them are survivors of GBV and 50% of them reported to the Family Support unit (FSU) for settlement, 4.5% to CBO and 45.5% did not report as they preferred family settlement. 91.7% of the ones that reported were satisfied with the verdict of the settlement and 8.3% did not.

Graph 25: Experience of Gender-Based Violence



Graph 26: Reported Gender-Based Violence in the Subproject Area



7.5.7 Archaeology and Cultural Heritage

Traditional and cultural values and practices are held in high esteem in the Subproject area. Society shrines and other secret cultural practices are prevalent and well protected. The sacred sites of cultural importance include male and female secret society bushes, graves, ancestral cemeteries, etc. Some of the traditional/secret societies practiced in the proposed Subproject area are Poro society and Bondo society.

These secret societies play a dominant role in the social life of these communities. Ancient ancestral symbols in the study area include cemeteries/ burial grounds, shrines, sacred trees, bushes, etc. These symbolic items are highly preserved by the indigenes and special occasions are marked periodically in commemoration of certain deities. People who do not belong to these societies, when fall victims, will be seriously dealt with and initiated to be members. Because of these and in line with international best practices, appropriate measures should be taken to avoid infringing on the cultural heritage of people in the Subproject area.

7.5.8 Livelihood Sources

According to the household survey conducted, there are various sources of livelihood and income-related activities in the Subproject area. They include 64.9% subsistence farming, 16.2% trading, 8.1% paid employment, and 5.4% each of labour and fishing.

Most of the farms have not been utilized due to the poor road network (the Jong River crossing) and difficulty in accessing the Bo market. Most of the arable farmlands are found in communities across the river. Most farmers have the ability and willingness to pay for tractors and other equipment for farming. However, because of the poor river crossing, makes access to equipment difficult and almost impossible as the machines are difficult to take across the river. The communities have over a thousand acres of Boli land and swamps suitable for rice farming and cassava plantations, which are not properly utilized. Around 50% of the farmers claimed that most of the pineapples harvested got spoiled before they were taken to the Bo Town market due to the delay in delivery.

45.9% have enough food throughout the year and 54.1% do not. 37.8% said food production increased over the years and 62.2% said it decreased. 78.4% own livestock and 21.6% do not. 86.5% own lands for cultivation and other purposes and 13.5% do not, but by consultation, everyone has access to land. 94.6% of women have access to land and 5.4% do not

40.5% have access to credit and 59.5% do not. 53.3% of those that have access to credit have access to private lending, 33.3% micro-credit, and 13.3% bank loan.

7.5.9 History of Settlement

62.2% of the respondent's ancestors were born in the Subproject area, 29.7% of parents migrated, and 8.1% of grandfathers/grandmothers migrated. The reasons for migration are; 18.9% said it is due to marriage, 16.2% of education, job, and trade, 13.5% because of mining, 10.8% because of civil war, and 8.1% because of traditional medicines.

7.5.10 Knowledge of the Bridge Construction & use of Ferry Crossing

94.6% of the population are aware of the upcoming bridge Subproject and 5.4% are not aware. All (100%) of the respondents are in full support of the Subproject. 18.9% of the population uses the ferry daily, 37.8% weekly, 35.1% monthly, 5.4% annually, and 2.7% have never used the ferry crossing.

7.5.11 Sanitation and Toilet Facilities

62.2% of Survey respondents use pit latrines, 32.4% use the bush and 5.4% use flush toilet facilities. The houses that have very close proximity shared one toilet facility. Bonthe District Council provides sewage collection service to surrounding communities as the council has a truck provided by the government. Communities that are hard to reach, cover their pits after they have been full. The farmers use the decomposed sewage as manure in their farms. The towns and the villages that are close to the riverbank have an improper discharge of material especially areas that are close to the bank of the river and many also use the bush. Hence, the few areas that have poor sewage discharge have increased exposure of households and the inhabitants to the risk of diseases like dysentery, diarrhea, cholera, and typhoid fever.

7.5.12 Refuse Disposal

Bonthe District Council has three trucks for use to collect refuse in the township and the surrounding communities. They demand each house to pay around two thousand (2,000 SL Leones) per bag. However, proper collection of refuse is only done in Mattru Jong Town, as many households in other villages are not able to pay for the collection of garbage. Hence Poor refuse disposal practices contribute to the spread of diseases. Three types of refuse disposal practices are done in the surrounding communities, namely: throw in the bush, throw in the pit, and burn. Some communities dispose of their refuse by using one or more of these three means of waste disposal.

7.5.13 Drinking Water Sources

According to the survey, 86.5% have access to clean drinking water and 13.5% do not. Of the ones that have access to drinking water, 59.5% benefit from community boreholes, 37.8% from spring, and 2.7% from private wells/boreholes.

7.5.14 Main Source of Energy

Most of the households in the Subproject area and its surrounding communities use torches and batteries as the main source of energy for lighting. 78.4% of the population uses rechargeable lights as the main source of energy, 18.9% national solar grid, and 2.7% use Kerosene. In terms of energy use for cooking, 83.8% use firewood, and 16.2% use charcoal.

7.5.15 Road Network and Mobile Communication

The communities are accessible from Bo using motorbikes and vehicles which people pay around fifty thousand Leones (Le 50,000) from Bo on bike. However, the communities are also accessible from Rutile through the Rutile-Senehun feeder road using vehicles and bikes. The transportation fee from Rutile to Senehun is thirty thousand Leones (Le30, 000) by bike. The common means of transportation is on land by motorbikes. 48.6% of the respondents use the ferry as the only means to get in to the other towns and 51.4% have other alternative routes.

The Subproject area has mobile communication reception, which is good as the Orange and Africell (mobile technology companies) networks are available. 83.8% of the population have access to telecommunication networks and 16.2% do not.

7.6 GENDEMA-GARWAMA CROSSING

The main economic activities in Gendema-Garwama Crossing are subsistence rice and palm oil farming and vegetables. The bridge connects Simbaru Chiefdom and Wandor Chiefdom.

Out of the 37 questionnaires administered in the Subproject area, 21 respondents are male (56.8%) and 16 are female (43.2%). Most of the people interviewed are in the range of 36-52 years old which is 37.8 % of the total. Ten people are in-between 18-35 years (27.0%), nine between 53-69 years (24.3%), and four people (10.8%) greater than 70 years. From the survey conducted, 55.6% have households between 6-10, 16.7% between 3-5 people, and 27.8% equal to or greater than 10 people. 78.4% of the population are married, 16.2% are widows and widowers, and 5.4% are single.

7.6.1 Demographic and Population Structure

According to the 2015 Population and Housing Census carried out by Statistic Sierra Leone, there are a combined total inhabitant of over 18,500 population. More than half of these are youths between the ages of 18-35 years. The rest are elderly people and children. According to the projected population data, the average family size is 10 due to the huge need for farming labour. Some of the major reasons for the rapid demographic change are high birth rates which are exacerbated by early marriages, declining death rates, customary beliefs and practices, and above all, the influx of migrants from surrounding communities /townships in the area. Among the population, 55% are female, 45% are male. There are about 11,000 household heads and a 13,200 working-class population.

7.6.2 Religion

Most people practice either Islam or Christianity; 83.8% are practicing Islam and the remaining 16.2% practice Christianity. This means that communities value high religious practices like Christmas, Easter, New Year, Eid-ul-Fitr, and Ramadan festivals.

7.6.3 Housing in the Subproject Area

Three house types were observed, of which, 78.4% are Mud Dressed with Concrete, 18.9% wooden, and 2.7% corrugated iron sheaths (Pan bodi). There are two roof types of these houses; 83.8% are corrugated metal and 16.2% are thatched roofs. 94.6% of them have wooden Window type, 2.7% steel casement, and 2.7% are made of Aluminium. 75.0% own houses and 25.0% do not. 7.1% of those who do not own a house are on rent.

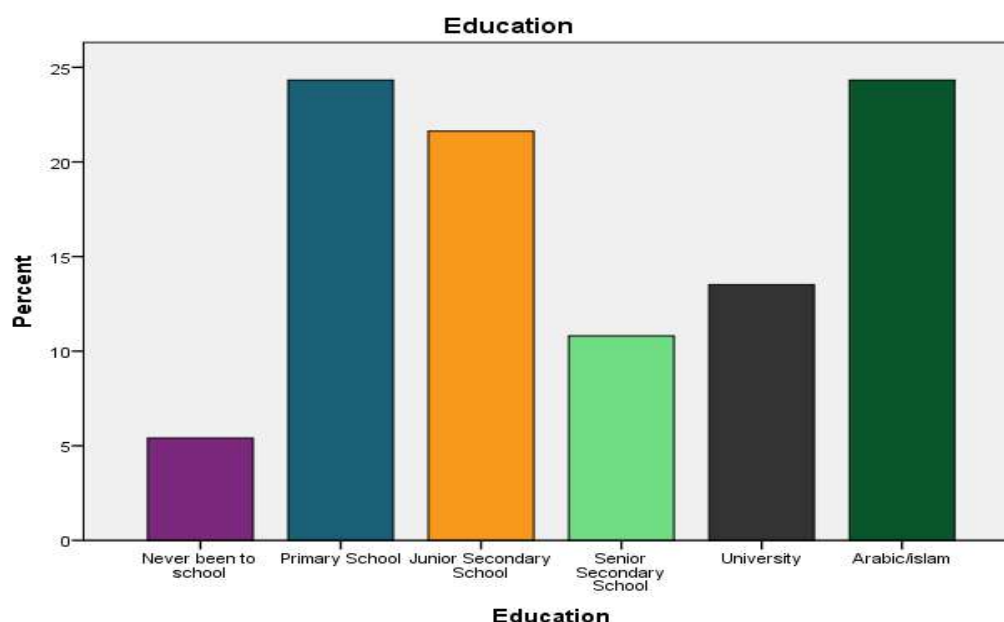
7.6.4 Education and Literacy

Only Gendema community has a primary and junior secondary school. The Garwama community uses Gendema as the nearest place to attend school, but they will have to cross the Sewa River. All the pupils either crossed the river or travelled over 7 miles to attend their education in Boajibu, which is the chiefdom, headquarters town. The river crossing and road network and other factors cripple the government's ambition to ensure quality education in the country. To address some of the education challenges, there is a need for a proper road network, highly motivated, trained, and qualified teachers to be placed in remote communities, increased incentives to work in rural areas, teaching-learning materials to every pupil and encourage school feeding programs to stem the rising tide of school dropout and low completion rates across the country.

The majority of the respondents in all communities attained some form of education (both English and Arabic). 24.3% of the population have a primary school education, 24.3% have Arabic education, 5.4% have never been to school, 21.6% acquired junior secondary school education, 13.5% acquired university education and 10.8% acquired senior secondary school education. The overall analysis concludes that the literacy rates of respondents in the study area were found to be moderate. 63.9% of the respondents' children are in school and 36.1% of respondents' children are not in school. The

reasons for not attending school are that 42.9% said the school is far from their villages and 57.1% said because of finance. Of the towns/villages around the Subproject area, 83.8% have schools in their communities and 16.2% have no schools in their communities. Of the 83.8% available schools in communities, 58.1% have only primary schools, 38.7% have both primary and secondary schools, and 3.2% have secondary schools.

Graph 11: Education and literacy in the Subproject Area



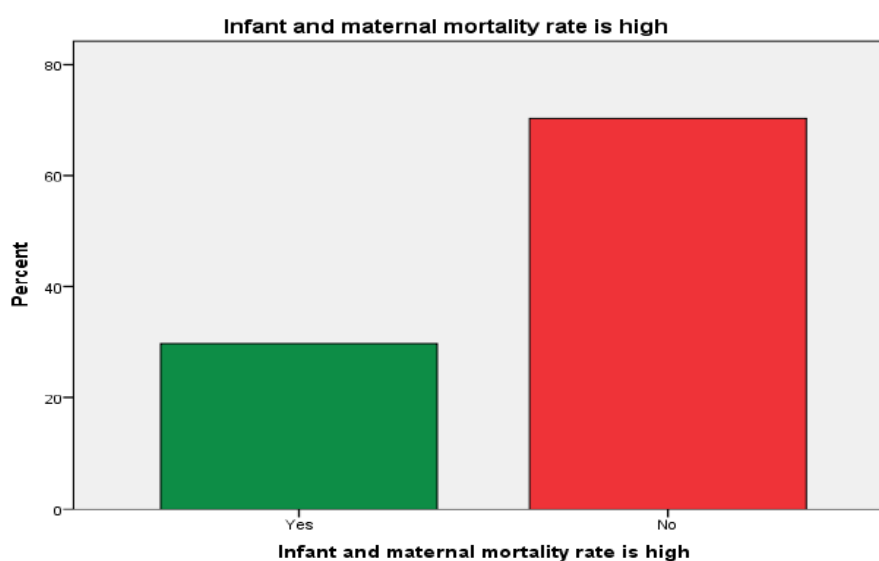
7.6.5 Healthcare

There is no health clinic in the Simbaru chiefdom communities except for those who are using the Boajibu or cross the Sewa River to get medical care in Gendema. Gendema is the nearest town for the communities to get access to clinics and medical care. This sometimes creates a lot of difficulty for pregnant women to access health care when the ferry is not crossing. We understand that maternal and infant mortalities are higher during the rainy season as the tides are most difficult during the rainy season.

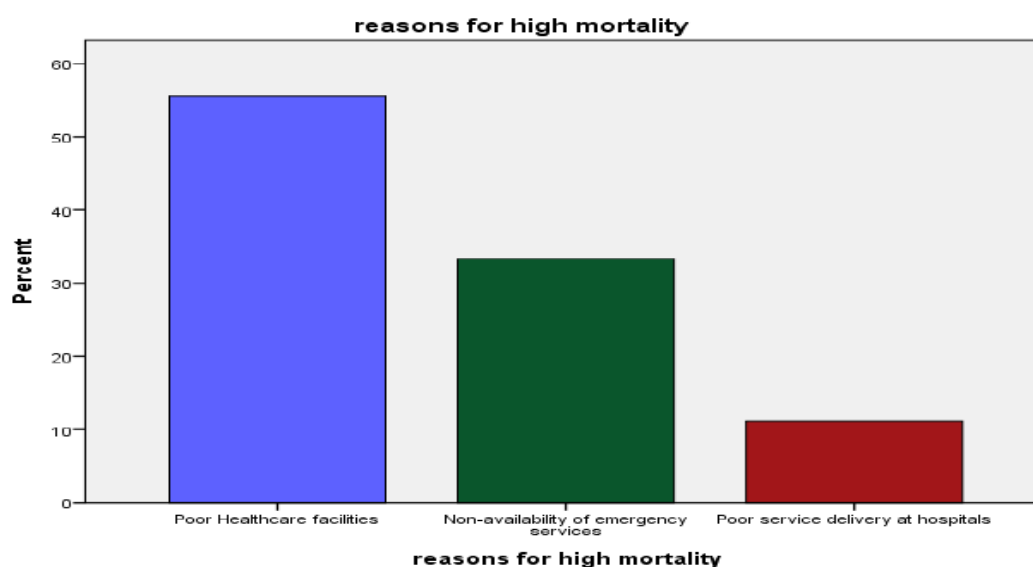
Vaccination of under-fives stands at 94.6% and 5.4% not vaccinated. The high infant mortality rate stands at 29.7% and low mortality at 70.3%. According to the respondents, the reasons for the 29.7% high mortality rate are; 55.6% said it is due to poor healthcare facilities, 33.3% said it is because of non-availability of emergency services, and 11.1% said it is a result of poor service delivery at hospitals.

51.4% of the population have health clinics in their villages and 48.6% do not. 97.3% of the people would have preferred the hospital mode of treatment and 2.7% traditional practices. Some of the major challenges in accessing medical treatment are that; 34.3% said because of shortage of finance, 28.6% non-availability of drugs and equipment, 25.7% because of distance to the clinic, 8.6% because of lack of healthcare facilities, and 2.9% said it is because of non-availability of trained and qualified health personnel. 97.3% of the population is aware of HIV/AIDS, and all the people are aware of the COVID-19 virus and 2.7% are not aware of HIV/AIDS. 97.3% of the respondents are aware and have knowledge of family planning and 2.7% do not.

Graph 28: Infant and Maternal Mortality Rate in the Subproject Area



Graph 29: Reasons for High Mortality in the Subproject Area



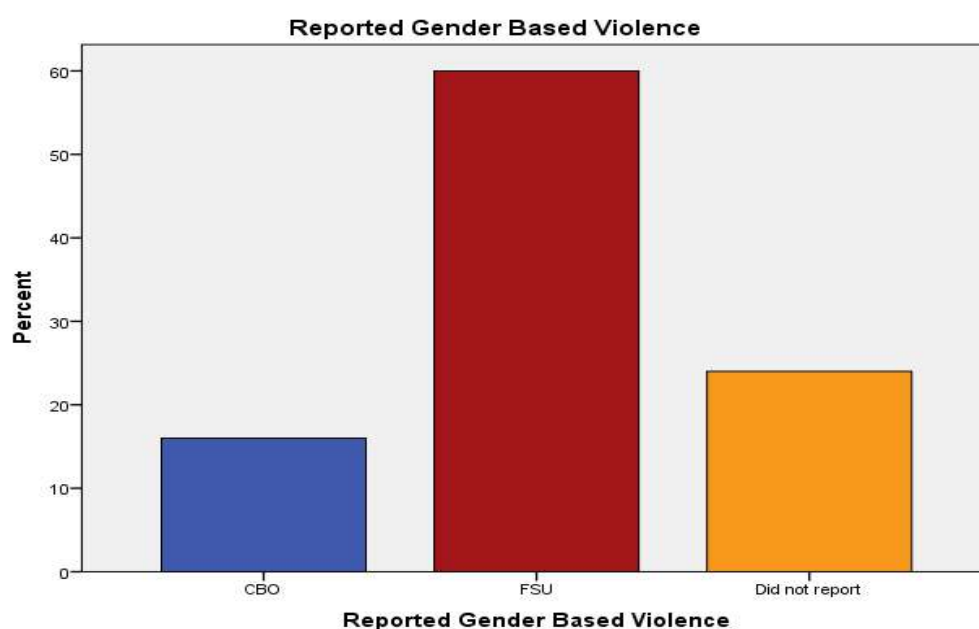
7.6.6 Gender-Based Violence (GBV)

94.6% of the population have knowledge of gender-based violence and 5.4% do not. 71.4% of them are survivors of GBV and 60.0% of them reported to the Family Support Unit (FSU) for settlement, 16.0% to CBO and 24.0% did not report as they preferred family settlement. 90.0% of the ones that reported were satisfied with the verdict of the settlement and 10.0% did not.

Graph 30: Experience of Gender-Based Violence in the Subproject Area



Graph 31: Reported Gender-Based Violence in the Subproject Area



7.6.7 Archaeology and Cultural Heritage

Traditional and cultural values and practices are held in high esteem in the Subproject area. Society shrines and other secret cultural practices are prevalent and well protected. The sacred sites of cultural importance include male and female secret society bushes, graves, ancestral cemeteries, etc. Some of the traditional/secret societies practiced in the proposed Subproject area are Poro society and Bondo society.

7.6.8 Livelihood Sources

According to the household survey conducted, there are various sources of livelihood and income-related activities in the Subproject area. As the survey reveals, they include 70.3% subsistence farming, 18.9% trading, 8.1% paid employment, and 2.7% labour.

There are 80% of the population in communities who are engaged in farming and 2% are engaged in fishing. Most of the farms have not been utilized due to the poor road network. The feeder road project has helped improve the transportation between Blama Junction and Boajibu town as most as much of the farmers can transport goods and produces. However, the road from Boajibu to Garwama is not

completed as many culverts are yet to be installed. The farmers fear that the incompletion of the road before the rains may pose difficulty in taking their products to the market. Most farmers have the ability and willingness to pay for use of tractors and other equipment for farming but because of the road construction, many operators fail to take the machines to the town. Gendema and communities to Boajibu are challenged by the Sewa River, which is a ferry crossing during the dry season.

16.2% have enough food throughout the year and 83.8% do not. 18.9% said food production increased over the years and 81.1% said it decreased. 71.4% own livestock and 28.6% do not. 94.6% own lands for cultivation and other purposes and 5.4% do not, but as informed during the stakeholder consultations, everyone has access to land. 97.3% of women have access to land and 2.7% do not

45.9% have access to credit and 54.1% do not. 66.7% of those who have access to credit have access to private lending, 20.0% to micro-credit, and 13.3% to bank loans.

7.6.9 History of Settlement

48.6% of the respondents' ancestors were born in the Subproject area, 40.5% of parents migrated, and 10.8% of grandfathers/grandmothers migrated. The reasons for migration are; 25.0% each of job and marriage, 6.3% each of education and civil war, 12.5% each of trade, mining and traditional medicines.

7.6.10 Knowledge of the Bridge

All the respondents (100%) of the population are aware of the upcoming bridge Subproject. Hence, all (100%) of the respondents are in full support of the Subproject. 13.5% of the population uses the ferry daily, 51.4% weekly, 32.4% monthly, and 2.7 have never used the boat crossing.

7.6.11 Sanitation and Toilet Facilities

Based on the survey findings, 78.4% use pit latrines, 16.2% use the bush and 5.4% use flush toilet facilities. The absence of toilet facilities and improper disposal of faecal materials increases the exposure of households and inhabitants to the risk of diseases like dysentery, diarrhea, cholera, and typhoid fever.

7.6.12 Refuse Disposal

Three types of refuse disposal practices are common in the Subproject area and its surrounding communities, namely, throw in bush, throw in pit and burn. Some communities dispose of their refuse by using one or more among those three means of waste disposal.

7.6.13 Drinking Water Sources

According to the survey, 88.9% have access to clean drinking water and 11.1% do not. Of the ones that have access to drinking water, 64.9% benefit from community boreholes, 24.3% from spring water, 2.7% from Sierra Leone Water Company (SALWACO), and 8.1% from private wells/boreholes.

7.6.14 Main Source of Energy

86.5% of the population uses rechargeable lights as the main source of energy, and 13.5% national solar grid. In terms of energy use for cooking, 94.6% use firewood, and 5.4% use charcoal.

7.6.15 Road Network and Telecommunication

The Garwama village can be accessed from Boajibu using motorbikes and vehicles. Gendema can be accessed from Garwama using a ferry/boat crossing. Gendema can be accessed using a bike from the other parts of Wandor Chiefdom. According to the local residents, the road to Gendema from most parts of Wandor Chiefdom is cut off by floods, making it inaccessible by even motorbikes during the rainy season especially from July to August. The common means of transportation is on land by motorbikes, which stands at 97.2%, and vehicles and light vans at 2.8%. 43.2% of the respondents use the ferry as the only means to get to the other towns and 56.8% have other alternative routes.

The Subproject area has mobile communication reception, which is good as the Orange and Africell networks are available. 86.1% of the population have access to telecommunication networks and 13.9% do not.

7.7 MANOWA-PENDEMBU CROSSING

The main economic activities are subsistence rice, cassava, Palm Oil farming, sand mining, artisanal diamond mining, trading, and fishing. The river crossing from Manowa Peje Bonge Chiefdom, Kailahun District leads to Pendembu Town Upper Bambara Chiefdoms Kailahun District. Manowa is the chiefdom headquarter town of Peje Bonge chiefdom, Kailahun District. Mende is the most spoken language around the two communities. Farming is the predominant occupation in the Subproject area due to the availability of rich cocoa and coffee plantations. There are also huge areas of rice farm and vegetable gardening, pepper is usually cultivated after the harvest of the rice.

7.7.1 Demographic and Population Structure

According to the 2015 Population and Housing Census carried out by Statistic Sierra Leone, the communities in the Moa River crossing have a total population of 16,000 inhabitants (SSL, PHC-2015). Some of the major reasons for the rapid demographic change are high birth rates, which are exacerbated by early marriages, declining death rates, customary beliefs and practices, and above all, the influx of migrants from surrounding communities /townships in the area.

Out of the 35 questionnaires administered in the Subproject area, 24 respondents are male (68.6%) and 11 are female (31.4%). Most of the people interviewed are in the range of 36-52 years old which is 54.3 % of the total. Two people are in-between 18-35 years (5.7%), thirteen between 53-69 years (37.1%), and one person (2.9%) greater than 70 years. From the survey conducted, 52.9% have households between 3-5, 41.2% between 6-10 people, and 5.9% equal to or greater than 10 people. 91.2% of the population are married, 5.9% are widows and widowers, and 2.9% are divorced.

7.7.2 Ethnicity and Religion

71.4% of the inhabitants in the communities practice Islam and the remaining 28.6% practice Christianity. This means that communities value high religious practices like Christmas, Easter, New Year, Eid-ul-Fitr, and Ramadan festivals.

The most common language spoken in the community is Mende as the majority of the population are Mende and Kissy. The majority of the tribes in the communities are either Mende or Kissy at around 90% of the combined household.

7.7.3 Housing in the Subproject Area

The increase in population has influenced an increase in the demand for housing and land in the communities especially in Pendembu. The continuous effort of the government to improve the agricultural sector in the Kailahun district especially communities in the Upper Bambara Chiefdom, has influenced rapid population increase. Many NGOs have also deployed their staff in the area. This has led to an increase the demand for housing and land in the communities.

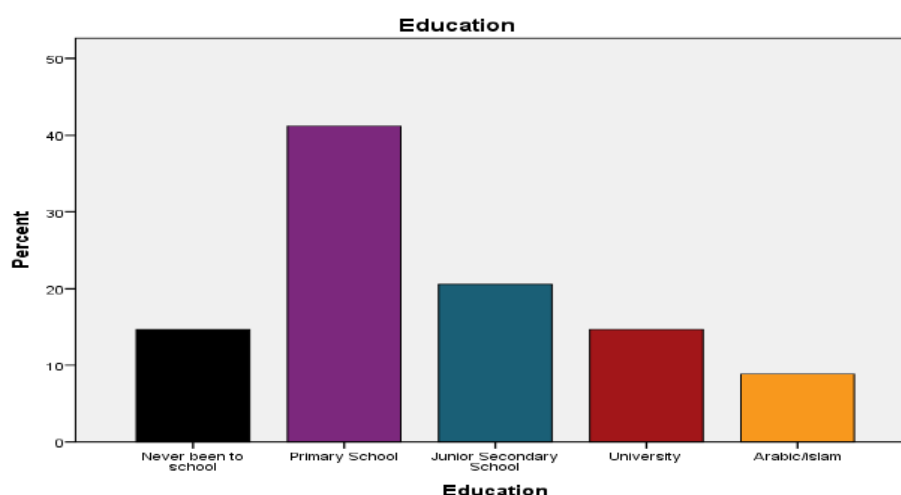
Four house types were observed, of which, 76.5% are Mud Dressed in Concrete, 14.7% wooden, 5.9% concrete, and 2.9% corrugated iron sheaths (Pan bodi). There are two roof types of these houses; 74.2% are corrugated metal and 25.8% are thatched roofs. 97.1% of them have wooden window type and 2.9% steel casement. 90.9% own houses and 9.1% do not. 4.3% of those who do not own a house are on rent.

7.7.4 Education and Literacy in the Subproject Area

Among the communities, three communities have primary schools and only two communities (Manowa and Pendembu) have secondary schools. The other communities have either crossed the Moa River or travelled around 3 to 5 miles to find the nearest school. The communities benefit from the eleven (11) primary schools and six (6) secondary schools, which are mostly found in Pendembu and Manowa. Most of the Schools have trained and qualified teachers who are being paid by the government.

The majority of the respondents in all communities attained some form of education (both English and Arabic). 41.2% of the population have a primary school education, 8.8% have Arabic education, 14.7% have never been to school, 20.6% acquired junior secondary school education, and 14.7% acquired a university education. The overall analysis concludes that the literacy rates of respondents in the study area were found to be moderate. 45.7% of the respondents' children are in school and 54.3% of respondents' children are not in school. The reasons for not attending school are that, 58.3% said the school is far from their villages and 33.3% said because of finance, 8.3% said because of work pressure at home. Of the towns/villages around the Subproject area, 85.7% have schools in their communities and 14.3% have no schools in their communities. Of the 85.7% available schools in communities, 60.0% have only primary schools, 36.7% have both primary and secondary schools, and 3.3% have secondary schools.

Graph 32: Education and Literacy in the Subproject Area



7.7.5 Healthcare

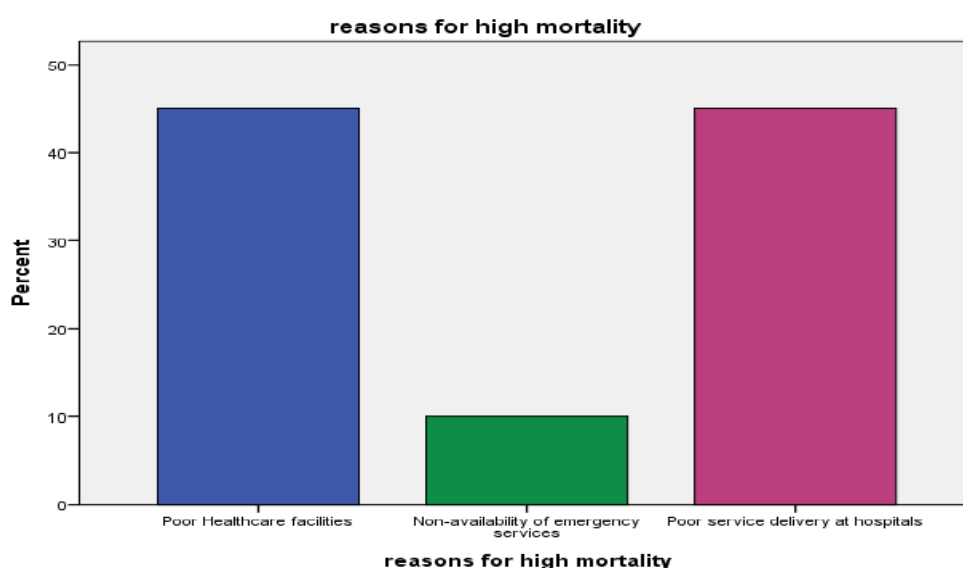
Only two communities in the Moa River crossing have hospitals but few have community health centres. The hospitals provide health services in paediatrics, obstetrics, surgical, and outpatient units. The two hospitals are providing emergency ambulances (two at Pendembu and one at Manowa) to collect sick people and pregnant women from all the other surrounding communities.

The communities that are around Manowa seek medical health from Manowa Government Hospital while the communities around Pendembu use the hospitals in Pendembu. Pregnant women are faced with little challenges of contacting the ambulance department to collect them for delivery as most of the time the number is unreachable. However, pregnant women are sometimes transported by bike to the nearest health facility. All the children under five receive their vaccination from the nearest community health centers.

Vaccination of under-fives stands at 90.9% and 9.1% are not vaccinated. The high infant mortality rate stands at 55.6% and the low mortality at 44.4%. According to the respondents, the reasons for the 55.6% high mortality rate are 45.0% said it is due to poor healthcare facilities, 10.0% said is because non-availability of emergency services, and 45.0% said it is a result of poor service delivery at the hospitals.

68.6% of the population have health clinics in their villages and 31.4% do not. 97.1% of the people would have preferred the hospital mode of treatment and 2.9% traditional way. Some of the major challenges in accessing medical treatment are that; 15.6% said because of lack of finance, 40.6% non-availability of drugs and equipment, 9.4% because of distance to the clinic, 15.6% because of lack of healthcare facilities, and 18.8% said it is because of non-availability of trained and qualified health personnel. 97.1% of the population is aware of HIV/AIDS and 2.9% do not. All people are aware of the COVID-19 virus as well as family planning services.

Graph 33: Infant and Maternal Mortality Rate in the Subproject Area



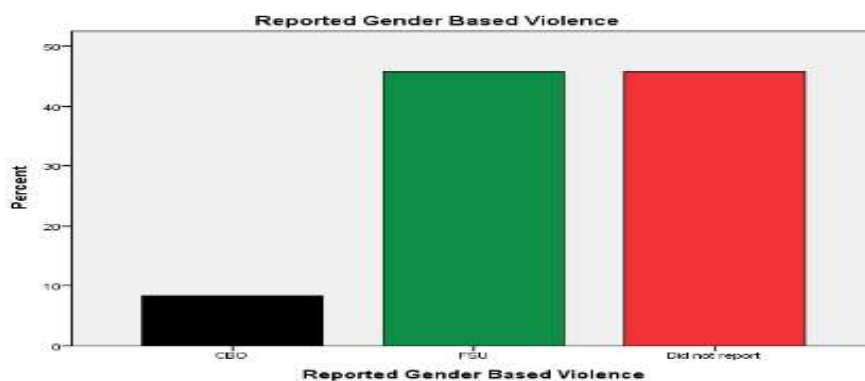
7.7.6 Gender-Based Violence (GBV)

All of the population (100%) know about gender-based violence. 70.6% of them are survivors of GBV in one way or the other, 45.8% of them reported to the Family Support Unit (FSU) for settlement, 8.3% to CBO and 45.8% did not report as they preferred family settlement. 80.0% of the ones that reported were satisfied with the verdict of the settlement and 20.0% did not.

Graph 12: Experience of Gender-Based Violence in the Subproject Area



Graph 13: Reported Gender-Based Violence in the Subproject Area



7.7.7 Archaeology and Cultural Heritage

Traditional and cultural values and practices are held in high esteem in the Subproject area. Society shrines and other secret cultural practices are prevalent and well protected. The sacred sites of cultural importance include male and female secret society bushes, graves, ancestral cemeteries, etc. Some of the traditional/secret societies practiced in the proposed Subproject area are Poro society and Bondo society.

7.7.8 Livelihood Sources

According to the household survey conducted, there are various sources of livelihood and income-related activities in the Subproject area. They include 65.7% subsistence farming, 20.0% trading, 5.7% paid employment, 8.6% labour.

Most of the farms in Moa River have not been utilized due to the poor road network and difficulty in accessing the Pendembu and Kailahun Markets. Most farmers have the ability and willingness to pay for use of tractors and other equipment for farming. However, because of the poor road network and the river crossing from Pendembu, make access to equipment difficult and almost impossible.

11.4% reported for having enough food throughout the year and 88.6% do not. 25.7% said food production increased over the years and 74.3% said it decreased. 60.6% own livestock and 39.4% do not. 91.2% own lands for cultivation and other purposes and 8.8% do not, but during stakeholder consultation, it is known that everyone has access to land. 91.4% of women have access to land and 8.6% do not

32.4% have access to credit and 67.6% do not. 54.5% of those that have access to credit have access to private lending, 27.3% micro-credit, and 18.2% bank loan.

7.7.9 History of Settlement

64.7% of the respondent's ancestors were born in the Subproject area, 20.6% of parents migrated, and 14.7% of grandfathers/grandmothers migrated. The reasons for migration are; 42.9% because of marriage, 14.3% each reported in seek of job, education, traditional medicines and avoidance of the civil war.

7.7.10 Knowledge of the Bridge

All the respondents (100%) are aware of the upcoming bridge Subproject. Hence, all (100%) of the respondents are in full support of the Subproject. 34.3% of the population uses the ferry daily, 42.9% weekly, 20.0% monthly, and 2.9 have never used the ferry crossing.

7.7.11 Sanitation and Toilet Facilities

Based on the findings of the survey, 71.4% use pit latrines and 28.6% use the bush.

There is no sewage collection facility in the communities as they cover the pits when they are full. The farmers use the decomposed sewage as manure in their farms. Hence, the few areas that have poor sewage discharge have increased exposure of households and the inhabitants to the risk of diseases like dysentery, diarrhoea, cholera, and typhoid.

7.7.12 Refuse Disposal

There is no garbage collection services in all of the communities in the Moa Rover crossing. Three types of refuse disposal practices are done in the surrounding communities, namely; throw in the bush, throw in the pit, and burn. Some communities dispose of their refuse by using one or more of those stated means of waste disposal.

7.7.13 Drinking Water Sources

. According to the survey, 73.5% have access to clean drinking water and 26.5% do not. Of the ones that have access to drinking water, 37.1% benefit from community boreholes, 48.6% from spring water, and 14.3% from private wells/boreholes.

7.7.14 Main Source of Energy

80.0% of the population uses rechargeable lights as the main source of energy, 17.1% national solar grid, and 2.9% Kerosene. In terms of energy use for cooking, 97.1% use firewood, and 2.9% use charcoal.

7.7.15 Road Network and Mobile Communication

The communities in the Upper Bandara are accessible from the Kenema- Kailahun highway and the communities in the Peje Bonge Chiefdom are accessible from the Segbwema - Pengui Chiefdom highway using bikes and vehicles which people pay around fifty thousand leones (le 50,000) from the Segbwema junction by motorbikes. The common means of transportation is on land by motorbikes. 70.6% of the respondents use the ferry as the only means to get the other towns and 29.4% have other alternative routes.

The Subproject area has mobile communication reception, which is good as Orange and Africell networks are available. 85.7% of the population have access to telecommunication networks and 14.3% do not.

7.8 KAMAKWIE-TOMPARI CROSSING

The crossing of the river is from Kamakwie town to Tompari village in Sella Limba Chiefdom. The other side of the river is Tonko Limba chiefdom in Kambia District, Northern Province of Sierra Leone. The main economic activities are subsistence rice, cassava, palm oil farming, groundnuts, and fishing.

The river crossing is just 12 miles from the Kamakwie town. The communities in the Sella Limba Chiefdom around the crossing that can directly benefit from the bridge are Kadigidigi, Mateboh, Kasamah, Kadada, Kateh, Kamsoko, Kamasoko, Kadari Kagborah, Kambunyele Kagberah, Kamawonih. The communities in the Tonko Limba Chiefdom are Tompari, Thambie, Katunyan, and Gbaneke.

The communities have hundreds of Hectares of palm tree plantations and many arable lands for rice farming. There are also many cassava farms in the communities. Farming is the predominant occupation in the Subproject area. There are also huge areas of rice farms and vegetable gardening, pepper is usually cultivated after the harvest of the rice.

7.8.1 Demographic and Population Structure

According to the 2015 Population and Housing Census carried out by Statistic Sierra Leone, the communities in the Tomparai River crossing have a total population of about 34,000 inhabitants (SSL, PHC-2015). More than half of these are youth between the ages of 18-35 years. The rest are elderly people and children. According to the projected population data, the average family size is 12 due to the need for huge labour on the farm. Some of the major reasons for the rapid demographic change are high birth rates which are exacerbated by early marriages, declining death rates, customary beliefs and practices, and above all, the influx of migrants from surrounding communities /townships in the area.

Out of the 36 questionnaires administered in the Subproject area, 29 respondents are male (80.6%) and 7 are female (19.4%). Most of the people interviewed are in the range of 36-52 years old which is 47.2% of the total. Seven people in-between 18-35 years (19.4%), ten between 53-69 years (27.8%), and two people (5.6%) greater than 70 years. From the survey conducted, 38.9% have households between 6-10, 22.2% between 3-5 people, and 38.9% equal to or greater than 10 people. 97.2% of the population are married, 2.8% widows and widowers.

7.8.2 Ethnicity and Religion

Most people practice either Islam or Christianity. 75.0% of the inhabitants in the communities practice Islam and the remaining 25.0% practice Christianity. There are around 1% of the population who practice traditional religion as they said they have their shrines where their gods live. This means that all the communities value high religious practices like Christmas, Easter, New Year, Eid-ul-Fitr, and Ramadan festivals.

The most common language spoken in the communities is Limba as the majority of the inhabitants are Limba ethnic people around 85% of the combined households.

7.8.3 Housing in the Subproject Area

The increase in population has influenced an increase in the demand for housing and land in the communities especially in Sella Limba communities. This is due to the Kamakwie town being the District Headquarter Town of the newly formed District of Karene. Since the formation of the new District and Sella Limba hosting the district headquarters town, there has been a rapid population increase due to the migration of people from communities and chiefdoms around in seek of employment. Hence, the government has built many offices in the area like the new district office, and opened new bank branches.

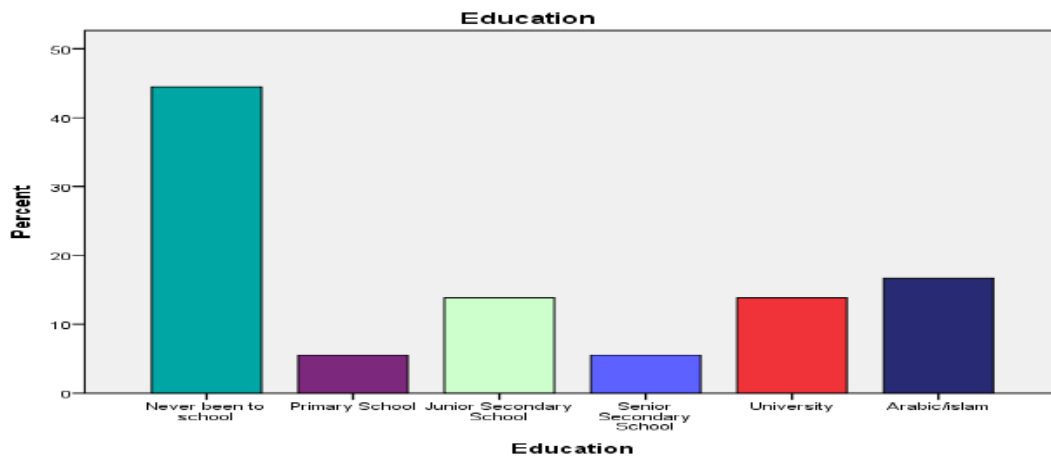
Due to the socioeconomic living conditions and poor earning ability of households in the study area, most of the houses are built with either corrugated iron sheets, wood, or mud dressed in concrete. However, there are notably outstanding concrete structures in these communities, which are either unoccupied or under active construction. In some of these houses, the occupants are caretakers and relatives of the owners. Three house types were observed, of which, 64.7% are mud dressed with concrete, 26.5% wooden, and 8.8% concrete. There are three roof types of these houses; 33.3% corrugated metal, 56.7% thatched roof, and 10% plastic roofs. 91.2% of them have wooden window type, 5.9% are made of steel casement and 2.9% are made of Aluminium. 86.1% own houses and 13.9% do not. 3.2% of those who do not own a house are on rent.

7.8.4 Education and Literacy

Among the communities, only six (6) have primary schools and two have Junior Secondary Schools but only Kamakwie has senior secondary schools. The other communities have either crossed the Tomparai River or travelled around 3 to 5 miles to find the nearest secondary school. Most of the primary schools lack trained and qualified teachers except for Kamakwie town. However, secondary schools have trained and qualified teachers who are being paid by the government. The communities in the Sella Limba chiefdom prefer to cross the Tomparai River as the nearest alternative to attend school instead of traveling over 5 miles to attend in Kamakwie town. The secondary school pupils are either to attend in the Kamakwie town in Sella Limba or Madina for Tonko Limba Chiefdom.

The majority of the respondents in all communities attained some form of education (both English and Arabic). 5.6% of the population have a primary school education, 16.7% have Arabic education, 44.4% have never been to school, 13.9% acquired junior secondary school education, 13.9% acquired university education and 5.6% acquired senior secondary school education. The overall analysis concludes that the literacy rates of respondents in the study area were found to be moderate. 69.4% of the respondents' children are in school and 30.6% of respondents' children are not in school. The reasons for not attending school are that 58.3% said the school is far from their villages and 41.7% said because of finance. Of the towns/villages around the Subproject area, 77.8% have schools in their communities and 22.2% have no schools in their communities. Of the 77.8% available schools in communities, 57.1% have only primary schools, and 42.9% have both primary and secondary schools.

Graph 36: Education and Literacy in the Subproject Area



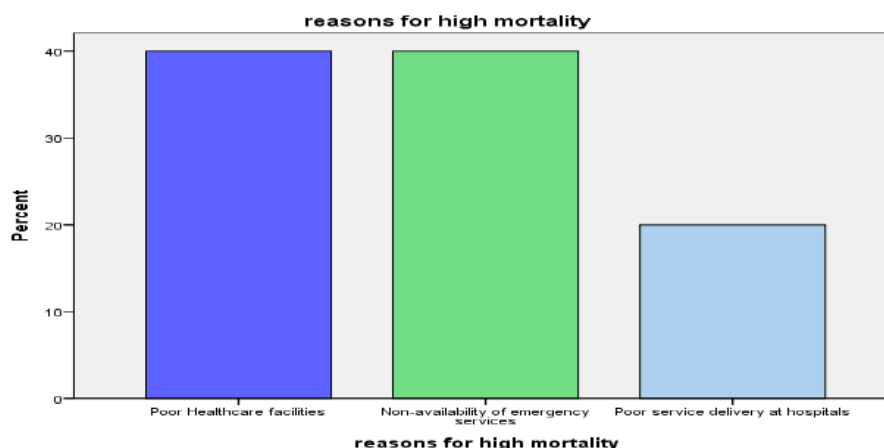
7.8.5 Health

Almost all the communities in the Tonko Limba Chiefdom seek medical needs in Tompari and all the communities in Sela Limba seek medical needs in Kamakwie. The above is only applicable during the dry season as the river crossing becomes difficult during the rainy season. However, the situation is difficult for emergency and critical cases as the Tonko Limba communities only have a community health centre in Tompari but there is no hospital in the communities. Hospitals are found in Kamakwie town and hence seeking medical needs in the rainy season is difficult. Most local people use traditional healers when in need of medical help. Some children under five are even forced to skip some vaccination dates during the rainy seasons which poses a serious risk to the health of the children.

Vaccination of under-fives stands at 91.7% and 8.3% not vaccinated. The high infant mortality rate stands at 28.6% and low mortality at 71.4%. According to the respondents, the reasons for the 28.6% high mortality rate are: 40.0% said is due to poor healthcare facilities, 40.0% said is because of the non-availability of emergency services, and 20.0% said it is a result of poor service delivery at the hospitals.

50% of the population have health clinics in their villages and 50% do not. 100% of the people would have preferred hospital mode of treatment. Some of the major challenges in accessing medical treatment are that; 46.9% said because of lack of finance, 25.0% non-availability of drugs and equipment, 18.8% because of distance to the clinic, 6.3% because of lack of healthcare facilities, and 3.1% said it is because of non-availability of trained and qualified health personnel. 82.9% of the population is aware of HIV/AIDS and 17.1% are not. 97.1% of the population are aware of the COVID-19 virus and 2.9% do not. 83.3% of the respondents are aware and have knowledge of family planning services and 16.7% are not.

Graph 37: Reasons for High Mortality in the Subproject Area



7.8.6 Gender-Based Violence (GBV)

80% of the population know about gender-based violence and 20% do not. 51.4% of them are survivors of GBV and 48.6% have not. 44% of them reported to the Family Support Unit (FSU) for settlement, 8% to CBOs, 8% to NGOs, and 40% did not report as they preferred family settlement. 87.5% of the ones that reported were satisfied with the verdict of the settlement and 12.5% were not.

Graph: 38 Knowledge of Gender Base Violence in the Subproject Area



Graph 14: Experience of Gender-Based Violence



7.8.7 Archaeology and Cultural Heritage

Traditional and cultural values and practices are held in high esteem in the Subproject area. Society shrines and other secret cultural practices are prevalent and well protected. The sacred sites of cultural importance include male and female secret society bushes, graves, ancestral cemeteries, etc. Some of the traditional/secret societies practiced in the proposed Subproject area are Poro society, Bondo society and Gbangabni society.

7.8.8 Livelihood Sources

According to the household survey conducted, there are various sources of livelihood and income-related activities in the Subproject area. They include 85.7% subsistence farming, 2.9% trading, 2.9% paid employment, 5.7% labour, and 2.9% fishing.

Most of the farms in communities of Tomparai River and its surroundings cannot be accessed and cultivated due to the poor road network (the river crossing) and difficulty in accessing the tractors due to the poor road network. Most farmers have the ability and willingness to pay for use of tractors and other equipment for farming. However, the poor road network, makes access to equipment difficult and almost impossible. The communities have thousands of Boli land and swamps suitable for rice farming and pineapple plantations, which are not properly utilized. Around 45% of the farmers claimed that most of their harvested produce is now transported to Makeni. 20% have enough food throughout the year and 80% do not. 25% said food production increased over the years and 75% said it decreased. 66.7% own livestock and 33.3% do not. 85.3% own lands for cultivation and other purposes and 14.7% do not, but by consultation, everyone has access to land. 91.4% of women have access to land and 8.6% do not. 16.7% have access to credit and 83.3% do not. 33.3% of those who have access to credit have access to private lending, 50% to micro-credit, and 16.7% to bank loans.

7.8.9 Sanitation and Toilet Facilities

Based on the findings of the survey, 68.6% use pit latrines, 31.4% use the bush. The Kamakwie council provides sewage collection service to surrounding communities as the council has two trucks, one is provided by the government, and private individuals on the other. Communities cover their pits as they get full. The farmers use the decomposed sewage as manure in their farms. The town and the village that is close to the riverbank have an improper discharge of material especially in areas that are close to the bank of the river and many also use the bush. Hence the areas that have poor sewage discharge have increased exposure of households and the inhabitants to the risk of diseases like dysentery, diarrhoea, cholera, and typhoid fever.

7.8.10 History of Settlement

91.7% of the respondent's ancestors were born in the Subproject area and 8.3% said their parents migrated. The reasons for migration are 33.3% said it is due to marriage, 33.3% for work/job, and 33.3% for trade.

7.8.11 Knowledge of the Bridge

100% of the population is aware of the upcoming bridge Subproject. 97.2% of the respondents are in full support of the Subproject while 2.8% are not in support. 55.6% of the population use the ferry daily, 16.7% weekly, 19.4% monthly, 8.3% annually.

7.8.12 Refuse Disposal

There are trucks, which are owned by the Kamakwie Council and some by individual businesspeople. They demand each house to pay around two thousand leones (le 2,000) per bag. However, the proper collection of refuse is only done in big communities as many villages around do not benefit from the collection of garbage services. Hence poor refuse disposal practices contribute to the spread of disease. Three types of refuse disposal practices are done in the surrounding communities, namely: throw in the bush, throw in the pit, and burn. Communities dispose of their refuse by using one or more of these three means of waste disposal.

7.8.13 Drinking Water Sources

According to the survey, 66.7% have access to clean drinking water and 33.3% do not. Of the ones that have access to drinking water, 42.9% benefit from community boreholes, 40.0% from spring water, 5.7% from private wells/boreholes, and 11.4% access water from SALWACO.

7.8.14 Main Source of Energy

Most of the households in the Subproject area and its surrounding communities use torches and batteries as the main source of energy for lighting. 64.7% of the population uses rechargeable lights as the main source of energy, 2.9% national solar grid, and 32.4% use Kerosene. In terms of energy use for cooking, 91.4% use firewood, and 8.6% use charcoal.

7.8.15 Road Network and Mobile Communication

The communities in the Sella Limba are accessible from Makeni using motorbikes and vehicles which people pay around one hundred thousand leones (le 100,000) from Makeni on a bike. The communities in the Tonko Limba are accessible from the Madina feeder road using vehicles and bikes. The transportation fee from Madina to Tomparai communities is thirty thousand leones (Le 30,000) by bike.

The common means of transportation is on land by motorbikes. 47.2% of the respondents use the ferry as the only means to get to the other towns and 52.8% have other alternative routes.

The Subproject area has mobile communication reception, which is good as the Orange and Africell networks are available. 82.4% of the population have access to telecommunication networks and 17.6% do not.

8 CONSULTATION, STAKEHOLDER ENGAGEMENT AND GRIEVANCE REDRESS MECHANISM (GRM)

8.1 INTRODUCTION

The public consultation process presents an opportunity for the stakeholders to raise their concerns and comments on the potential E&S impacts and merits of the proposed bridge construction Subproject. Their input was captured and informed the impact assessment process as well as a formulation of pertinent mitigation and enhancement measures to address them. The Environmental Policy of Sierra Leone recognizes public consultations as an integral part of the EIA process and that it should be ensured that the EIA procedure, includes public comments before consideration by decision-makers. MARISWE/ICS also had community meetings with relevant stakeholders including paramount chiefs, traditional rulers (headman, ceremonial chiefs), women's leaders, youth leaders, and community people in various settlements across the proposed bridge locations.

Public consultation and disclosure of information meetings with the affected community are proposed, prior to the commencement of the construction phase, as the primary platform for relaying information to project-affected communities. These meetings will continue throughout the pre-construction, construction, and decommissioning phases of the Subproject, cover the impacts, hazards, and risks associated with construction activities, and allow the community to gain an insight into planned benefits-sharing arrangements.

Whilst public meetings are linked to the project information disclosure activities prior to the construction phase, such extensive engagements may not be required during the decommissioning phase – due to the relative decrease of the project activities. Accordingly, community Project Information Disclosure meetings as a strategy of continual public consultation during the construction phase are expected to be implemented, as things unfold and the project changes from time to time.

Key messages for planned future public consultation will contain more information about Subproject development plans and construction commencement dates, handing over of bridge construction sites and introduction of contractors, schedules, workforce recruitment plans, (including local employment and training), resettlement action plan (RAP), health and safety issues, solutions and options of accessibility being cut off, the impact of heavy equipment utilization during construction phases, and most importantly the mitigation plan with target groups of significantly affected people.

The Subproject is committed to maintaining its community consultation and disclosure and will:

- Maintain regular communications with related stakeholders
- Provide local communities with regular information on the Subproject progress and related implications
- Provide local communities with information on employment opportunities and labour guidelines
- Maintain awareness of safety issues
- Maintain constructive relationships between local communities, the Development team, and contractors by continuing regular consultation meetings and information-sharing sessions
- Identify and respond to stakeholder issues and concerns by reviewing the complaints file and undertaking stakeholders' consultation
- Monitoring implementation and effectiveness of mitigation measures such as livelihood programs, and other social programs
- Ensure complaints are addressed according to the established process; and
Ensure gender-sensitive and culturally appropriate processes are used in communication and interactions.

8.2 HIGHLIGHTS OF THE PROCEEDINGS OF STAKEHOLDERS AND COMMUNITY CONSULTATIVE MEETINGS

Stakeholders and community consultative meetings provide a framework for achieving effective stakeholder involvement and promoting greater awareness. The stakeholder consultation was aimed at:

- Promoting openness and communication
- Ensuring effective stakeholder involvement in the important aspects of the Subproject
- Consulting comprehensively to disseminate information about the nature of the proposed bridge Subproject, scoping, identifying, and discussing the public concerns about the Subproject
- Identifying potential impacts (positive and negative) and offering the opportunity for alternatives or objectives to be raised by potentially affected parties, NGOs, CBOs and members of the public and other stakeholders
- Soliciting public input on preferred alternatives, mitigation measures, and similar aspects of Subproject implementation
- Responding to all stakeholders and as far as possible and feasible address the concerns and issues that are raised.

8.3 COMMUNITY MEETINGS AND HOUSEHOLD INTERVIEWS

Community and stakeholder meetings were held in various locations across the four Subproject areas. These Stakeholder meetings were held to define all those people and institutions that have an interest in the successful planning and execution of the bridge Subproject. This includes those likely to be positively and negatively affected by the construction and operation of the bridges. A wide range of stakeholders has been identified for the Subproject, comprising individuals and organizations from stakeholder groups such as:

- Subproject impacted/affected people such as stakeholders, boat owners, operators, ferry operators, traders, service providers such as health and education, motorcycle riders, labourers, transporters, etc.
- Members of Parliament representing the constituencies in which the bridges will be built
- Local Councillors and District Councils
- Chiefdom authorities (Paramount Chief, Headman, etc.)
- Civil Society
- Youth and women's groups
- Religious Leaders
- School Teachers
- Community-based organizations and non-governmental organizations.
- Boat owners, ferry operators, market women, fishermen, etc.

8.4 KEY CONSULTATION ACTIVITIES DURING ESIA PREPARATION

A series of public consultation meetings were conducted in the development of ESIA as part of the process to obtain input that influenced the ESIA. The community-level consultation process is designed to enable the affected people and related stakeholders to make meaningful contributions towards the ESIA and hence towards the overall Subproject development, particularly through the development of potential mitigation measures.

The consultation was undertaken during the baseline studies between March and April 2021. It was implemented through community meetings and personal and focus group discussions with various groups of affected people and related stakeholders who are part of the ESIA targeted consultation. It includes the vulnerable, elderly and women.

These consultations were conducted at the village level and coordinated with various village representatives to:

- a) Obtain updated information regarding the socioeconomic condition of the affected communities
- b) Understand the concerns of the disadvantaged and the vulnerable such as the disabled, women, children, girls, renters, the landless, female household heads (FHHs), etc., as well as the level of

- community knowledge regarding the proposed Subproject impact, to develop the impact analysis; and
- c) Obtain information regarding community expectations from the proposed Subproject and develop the recommended mitigation measures for the identified potential impact.

A summary of issues and concerns raised by stakeholders during the stakeholder engagement process is summarised in the Table below along with the ESIA team's response. In general, some issues and concerns were consistently raised throughout these locally based consultation activities, including:

- Employment opportunities, direct and indirect, for the local community
- Business opportunities and expectations from empowerment programmes such as microcredit and loan opportunities, training opportunities, etc., particularly for the affected people due to the land acquisition process for the Subproject
- Potential increase in the number of in-migrants, there are concerns regarding the economic competition to access employment and business opportunities, as well as security in the community; as most people see in-migration as a threat to food, employment, and labour shortage in their communities
- Issues related to the land acquisition process, including a) loss of asset, income, and access; b) compensation framework
- Some people are concerned with the obstruction of the drainage and hydrological changes by the construction project, and the potential for flooding. Particularly during construction
- Concern from the surrounding community regarding Subproject-generated dust and noise, particularly during construction and operation, which may affect community health; and
- Concern from boats and ferry operators, traders, social service seekers, transporters, loaders, fishermen, etc. about the disruption and displacement of their normal businesses and livelihoods
- Community safety due to a potential increase in the number of vehicles that will pass through the surrounding area of the Subproject, including heavy equipment traffic during construction.

Table 44: Summary of key stakeholder issues and concerns identified during the stakeholder consultative meetings

STAKEHOLDER'S CONCERNS	CONSULTANT'S TEAM RESPONSE
Employment opportunities within the Subproject	The Local Content Policy will apply to all construction sites. The Subproject will give priority to employing suitable qualified locals, directly and indirectly through its contractor, in accordance with the Subproject requirements
Damage to archaeological and cultural sites	The Subproject will do as much as it can to avoid places of cultural or archaeological significance. However, where this cannot be avoided, adequate compensation will be made for relocations and maintenance of such places. A Chance Finds Procedures shall also be applied as stipulated in Annex 11.19.
Loss of agricultural land	Arable land will be reduced by the need for the change/shift of bridge alignments and the extension of 250m approach road by each side of the bridge. This could be a permanent loss. However, this will be adequately addressed as per the requirements of the RAP to be developed and implemented for the Subproject. Thus, all the necessary compensation shall be paid for any damaged or destroyed crops and land or any other propriety that belongs to the affected persons prior to commencement of any physical works in all the sites. .
Compensation	The Subproject is developing a RAP that will provide information on project-affected persons, compensation procedures, and compensation packages of which some will be the restoration of livelihood.
Resettlement	Consultations for the development of the RAP, property surveying, and evaluation were carried out at the same time the ESIA was being developed, and concerns around resettlement came up. These concerns have been

STAKEHOLDER'S CONCERNS	CONSULTANT'S TEAM RESPONSE
	documented and addressed in the RAP report. Therefore, the studies for the ESIA and RAP were carried out concurrently.
Gender issues	The Subproject will support development opportunities for women and will enforce policies to prevent GBV issues on all its sites.
Road and traffic	A traffic survey (count) has been done on existing roads.
Water quality and monitoring	The Subproject (contractors) will undertake regular water monitoring and reporting in accordance with applicable standards and regulations of the EPA.
Ferry operation during the construction of the bridge.	In the event of construction, the current ferry will not be relocated and shall be in good working order. In a situation where the bridge alignment follows the existing road, relocation of the ferry will be done before the commencement of the construction works.

8.5 DISCLOSURE

The ESIA report will be disclosed after the final draft has been reviewed and approved by the World Bank. Disclosure shall be made via Workshop(s) and public and stakeholder meetings at national, district and village levels, media outlets (including newspapers), uploading on the official websites of the Ministry of Finance, Ministry of Agriculture and Food Security (MAF), and SCADeP PCU but also other notable websites, disseminating to and displaying the document (hard and/or soft copies) at strategic locations including in MAF, SCADeP PCU, District Councils and other relevant public institutions including libraries in which the public could easily have access to, and local Radio stations at project locations and TV to broadcast excerpts of the document.

The disclosure process is the project's opportunity to build constructive and long-term relationships with Subproject Stakeholders – offering an opportunity to communicate through both oral and written explanations of Subproject activities, implementation schedules, and associated risks, impacts, and benefits measures. SCADeP has committed to transparency regarding the Project plan, and decision-making processes, and proposes to maintain formal and open channels of communication for the sharing of project-related news and information.

8.6 SMALLHOLDER COMMERCIALIZATION FOR AGRIBUSINESS DEVELOPMENT PROJECT GRIEVANCE REDRESS MECHANISM (GRM)

Grievance redress mechanisms provide a way to provide an effective avenue for expressing concerns and achieving remedies for communities, promoting a mutually constructive relationship, and enhancing the achievement of project development objectives. Grievance redress mechanisms are increasingly important for development projects where ongoing risks or adverse impacts are anticipated. They serve as a way to prevent and address community concerns, reduce risk, and assist larger processes that create positive social change. The management of grievances is therefore a vital element of stakeholder management and an important aspect of risk management for the project. The Grievance Redress procedure will support the long-term goal of building strong and effective relationships with all those directly impacted by the proposed bridge construction project and its associated activities.

Overall, the GRM is established to grant PAPs and stakeholders the opportunity to settle their indifferences, complaints, and grievances amicably without disadvantaging any party. It therefore provides an effective means of solving grievances that may arise from the implementation of the project and its associated risks. These processes are expected to strengthen mutual respect and cooperation between the PAPs and the project.

8.6.1 Objective

The objectives of the grievance process are to:

- Provide affected people with avenues for making a complaint or resolving any dispute that may arise during implementation
- Ensure that appropriate and mutually acceptable redress actions are identified and implemented to the satisfaction of complainants; and
- Avoid the need to resort to judicial proceedings.

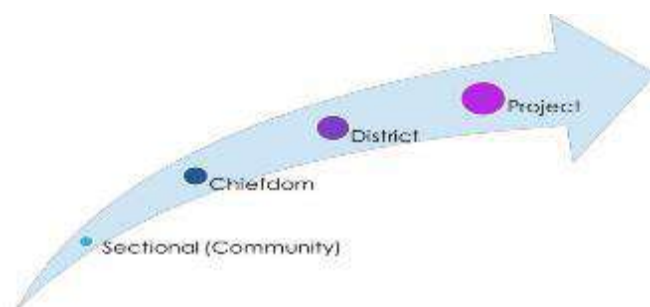
8.6.2 Potential Sources of Grievances/Disputes

In practice, grievances and disputes that arise during the implementation of a resettlement/compensation program may be related to the following issues among others:

- Siting of the project/subproject
- Mistakes in inventorying or valuing properties
- Disagreement on property boundaries, either between the affected person and the expropriation agency or between two neighbours
- Disputed ownership of a given asset (two or more affected people claim that the affected asset is theirs)
- Disagreement on asset valuation methods and compensation amounts in cash or in-kind
- Successions, divorces, and other family issues resulting in disputed ownership or disputed shares between inheritors or family members
- Disagreement with the computation of the resettlement or livelihood assistance or transportation cost
- Claims by people who relocated on their own after receiving notification from the respective Districts about the project and the likelihood of impact on their activities; and Delays in resolving complaints of PAPs.

8.6.3 Grievance Redress Mechanism Structure and Committees

The SCADeP GRM is organized into four **Grievance Redress Committees (GRC)** at the Sectional (community), Chiefdom, District, and Project levels. The membership of each committee is comprised of various key stakeholders, including local/traditional leaders, religious leaders, local government representatives, implementing partners, and PCU. A complaint is raised with the relevant GRC for assessment and can be escalated to a higher level if the complainant believes their issue has not been adequately handled or resolved. Every GRC has a registrar who is the focal person for receiving, registering, processing, and providing feedback to the affected person(s).



8.6.4 Grievance Redress Process

The general steps of the grievance process comprise:

- Uptake
- Processing
- Resolving
- Monitoring, evaluation and Feedback

8.6.4.1. Uptake

The PCU will establish a register for resettlement/compensation-related grievances and disputes. The receipt of complaints will include logging and registration as this will help with monitoring the status of the grievances and ease reporting on them. The existence and conditions of access to this register (where, when, how) will be widely disseminated within the project community/town as part of the consultation undertaken for the project in general.

It is proposed that complaints related to resettlement/compensation be lodged verbally or in writing to the PCU Social Safeguards Specialist (SSS) designated to receive all complaints. The Sectional GRC for the project area can also receive complaints from PAPs (because the Sectional GRC is within the community and is closer to the PAPs and some PAPs may prefer to route their complaints through the Committee). The Committee will ensure that such complaints reach the PCU.

SSS is designated to receive complaints within 24 hours via phone call or through any other means. The project will allocate a budget to cover expenses necessary for the GRM to function effectively. The PCU SSS shall receive all complaints and shall officially register these complaints using the first section of the proposed complaint registration and resolution form (Annex 4). The PCU SSS will inform the chair of the Project GRC within 24 hours of any complaint lodged.

8.6.4.2. Processing

When a grievance/dispute is recorded as per the above-mentioned registration procedures, the relevant Grievance Redress Committee (GRC) will be called into action, and mediation meetings will be organized with interested parties. Minutes of meetings will be recorded.

The GRC will first investigate the eligibility of the grievance and then determine the redress action in consultation with the complainant and the concerned party if necessary. Otherwise, the grievance redress committee will communicate to the complainant the acknowledgment of the grievance, the redress action proposed, and the timeframe for implementation.

The proposed redress action and the timeframe in which it is to be implemented will be discussed within 7 working days of receipt/registration of the grievance. The grievance issue should be resolved within 14 working days of receipt of complaints.

8.6.4.3. Resolving

The grievance redress committee will visit the affected property site or get in touch with the complainant to confirm that the redress action is carried out. If the complainant is dissatisfied with the outcome of the redress proposal or action, additional steps may be taken to resolve the issue or reach an amicable agreement. Verification should be completed within one week of execution of the redress action.

8.6.4.4. Monitoring and Evaluation

The GRCs have the responsibility of tracking and monitoring the process of grievance redress and the implementation of the decisions made while ensuring redress is granted to the complainant in a timely and efficient manner with regular feedback on the process. All grievances and the decision-making process should be documented.

The PCU Monitoring and Evaluation Team should monitor the activities of the Grievance Redress Committees to ensure that complaints and grievances lodged by PAPs are followed up and resolved amicably as much as possible. Also, annual evaluations of the GRM's' overall effectiveness and impact should be performed to contribute to improving the performance of the different committees and provide valuable feedback to project management.

8.6.4.5. Dissatisfaction and Additional Steps

If the complainant is not satisfied with the decision of the grievance redress committee, he/she can escalate their grievance to the next GRC i.e., Sectional to Chiefdom, Chiefdom to District, District to Project level. If the complaint is related to unresolved compensation, the complainant can bring it to the attention of the PCU Social Safeguards Specialist (SSS) to draw the attention of the PCU and Project GRC to the unresolved grievance. Otherwise, the relevant GRC should forward the unresolved issue

directly to the next GRC for further action. The PCU in consultation with the Ministry of Agriculture and Food Security (MAF) safeguards representative, who is also the Chair of the Project GRC, will set up an appropriate mediation team to resolve the issue within 2 weeks from the date of receipt of the complaint. If such a timeline is not possible, the PCU should inform the GRC and the complainant accordingly giving reasons and possible new dates.

8.6.4.6. Appeal to Court

If the complainant remains dissatisfied with the mediation effort of SCADeP PCU and MAF safeguards representative, the complainant has the option to pursue appropriate recourse via judicial process in Sierra Leone. The Constitution allows any aggrieved person the right of access to a Court of Law. The Court of Law will be a “last resort” option, because of the above mechanism.

8.6.5 Timeline for Grievance Redress and Institutional Responsibilities

The table below presents a summary of the grievance redress procedure with institutional roles and responsibilities.

Table 45: Timeline for Grievance Redress

Steps	Process	Description	Timeframe
1.	Grievance receipt and registration/ logging	-Face-to-face; phone; letter, recorded during public/ community meetings; recorded from Sectional Committee, Chiefdom Committee or District Committee, etc. -Significance assessed and grievance recorded or logged using the model complaint form and filed. - PCU SSS was notified of the logged grievance by the Committee Secretary	1-2 Days
2.	Development and implementation of response	-GRC meets or decides on the grievance -Grievance assigned to the appropriate party for resolution if necessary -Response development with input from relevant stakeholders -Redress response/action approved by GRC and logged -Redress response/update of progress on resolution communicated to the complainant -Start implementing redress action	5-14 Days
3	Verifying the implementation of redress action	-Redress action implemented and verified by GRC. -GRC satisfied with the implementation of the redress action - PCU SSS notified of redress action	7-14 Days
4	Close grievance or escalate to higher level GRC	-Completion of redress action recorded or logged -Confirm with the complainant that the grievance can be closed or determine what follow-up is necessary -Record final sign-off of grievance If the grievance cannot be closed, escalate to a higher level GRC or with PCU Project level GRC directly - PCU SSS receives regular updates on the progress and redress of the grievance registered.	15-25 Days
5	Court of Law	-if escalation to higher GRC does not address the dispute, the complainant can resort to a court of law	Unknown
6	Monitoring and Evaluation and reporting	The grievance Redress Mechanism Process is documented and monitored by GRC PCU SSS and M&E.	

8.6.6 Current Status of SCADeP GRM

SCADeP has Grievance Redress Committees (GRCs) set up and active on all four levels including Project, District, Chiefdom, and Sectional levels. District-level GRCs have been established in 13 out of 15 districts, excluding Western Area Urban, where the project does not operate.

The Chiefdom and Sectional level GRCs have been set up at the four bridge locations since November 2021 to tie in with the Resettlement Action Plan (RAP) compensation verification activities and cut-off date. These local GRCs will be vital for addressing any grievances related to the RAP implementation and throughout the bridge works. Thus, they will receive support and continuous engagement throughout the project activity. SCADeP has also introduced a toll-free line to improve the uptake of grievances and concerns from project areas.

9 ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) AND MITIGATION MEASURES

9.1 INTRODUCTION

The construction of bridges at the river crossings of Mattru Jong - Senehun, Gendema - Garwama, Manowa - Pendembu, and Tomparie - Kamakwei intends to replace existing cable ferries and it will result in various E&S risks and impacts. Potential negative impacts include vegetation clearance, impact on terrestrial and aquatic habitats and biodiversity; impact on fisheries; waste generation and disposal; air, noise, and vibration emissions; impact of construction camps, borrow pits, and quarries; occupational and community health and safety risks; and temporary disruptions to river transport. This section provides a comprehensive overview of these E&S risks and impacts along with specific mitigation measures to avoid, minimize, mitigate, and/or compensate the adverse effects. While most of the impacts are common across all four bridge construction sites, the assessment also addresses site-specific issues and proposes unique mitigation strategies, where needed, to address the distinct characteristics of each location.

9.2 BENEFITS AND OPPORTUNITIES

The key benefits and opportunities during the construction phase are within the economic environment such as direct and indirect employment as well as local business opportunities and taxes. Local employment and business opportunities are expected to receive a significant boost, which can be enhanced by extensive skills training of local workers. However, the existing local economic base, which is largely related to agriculture, will change significantly, with the likely result of those existing businesses in the areas. The key benefits and opportunities during the operational phase are the same as above including access to basic service delivery including accessibility, education and training, demography and population, public health (ambulance and emergency services), police, fire, and other security services. The benefits and opportunities, especially for the local business environment, can be optimized further with enhancement measures.

9.3 PRE-CONSTRUCTION PERIOD ADVERSE ENVIRONMENTAL AND SOCIAL IMPACTS

During the pre-construction period, the E&S conditions will remain intact as there will not be any significant physical activity. For the main E&S risks and impacts that are anticipated to occur during the construction and operational periods of the Subproject, mitigation measures (including this ESIA/ESMP) are developed during the pre-construction period. During the pre-construction period, field investigations will be conducted, and the engineering design of the bridges will be prepared. These activities may entail certain occupational health and safety risks. The significance of these risks is much lower than those that are anticipated during the construction and operation periods. Further, land requirement for the bridges and approach roads are already secured and thus the activity and associated risk is not anticipated during the pre-construction period.

9.4 CONSTRUCTION PERIOD ADVERSE ENVIRONMENTAL AND SOCIAL IMPACTS

During the construction phase, activities such as site clearing; excavation; bridge foundation, pier and deck concrete works, abutment and approach road works, and ancillary works are anticipated to affect the E&S receptors. Operation of equipment such as concrete batching plants, excavators, bulldozers, compactors, generators, and other heavy-duty plants/machines will generate air, dust, noise, vibration, waste, and other pollutants which need to be carefully managed to minimize adverse impacts on the environment, workers, and local communities. Workers and the public are exposed to health and safety risks. Further, operation of ancillary facilities such as construction camps, material sources, plants, access roads, detours, storage areas, and waste disposal sites will result in additional E&S risks and impacts. The following sections provide the identified E&S risks and impacts and associated mitigation measures.

9.4.1 Impact on Water Resources

Construction of the bridges will temporarily and permanently alter surface water flow patterns both upstream and downstream of the bridges including (i) restriction of flow due to bridge piers and abutments, (ii) modification upstream and downstream flow depth and velocity, (iii) change in roughness due to clearance of vegetation and sediments, (iv) creation of eddies and vortices, (v) alteration of sediment and nutrients load of the surface waters, and (vi) impact on water availability. The drivers or sources of impact on water resources include:

Cofferdams Construction: Bridge piers and abutments construction requires construction of cofferdams (temporary structures) to create dry zones for foundation excavation, compaction, concrete, and masonry work. Cofferdam construction methods are detailed in Chapter 4. Cofferdam construction requires clearing of the riverbed and banks, removal of river vegetation, and dewatering of the area isolated by the cofferdams. These activities will result in restriction of river flows, raising of upstream river water levels, increase in flow velocity, backflows, bank overtop, inundation, and sediments resuspension. Without proper mitigation measures during construction of cofferdams, there is a risk of elevated Total Suspended Solids (TSS) and increased siltation and sedimentation (resulting from exposed soil along riverbanks, stockpiled topsoil, and use of laterite in construction). These factors could lead to increased turbidity in the rivers, adversely impacting the quality of water.

Bridge Piers and Abutments Construction: Construction of bridge abutments (i) can disrupt the river natural flows, potentially altering upstream and downstream water levels, increasing the risk of localized flooding, and impacting drainage patterns; (ii) construction of piers and abutments could result in restriction of river flow, backwater, and raise of upstream water level, (iii) activities such as excavation and grading near the abutment site can resuspend sediments, leading to increased turbidity in the river. This can affect water clarity, reduce light penetration, and harm aquatic habitats; (iv) runoff from abutment construction may carry contaminants, including oils, lubricants, and chemicals used in construction (e.g., concrete and sealants), which can degrade water quality and pose a risk to aquatic life; (v) disturbing riverbanks to construct abutments can lead to accelerated erosion, releasing additional sediment to the river and potentially destabilizing nearby bank areas.

Clearing of Riverine Vegetation and Sediments: Clearing of riverine vegetation and sediments (including dredging at bridge locations) will decrease river roughness, which in turn increases flow velocity and water conveyance capacity. This may result in potential downstream flooding given that more water conveying capacity will be restricted along the untouched river channel downstream.

Water Extraction for Construction Purpose: Considerable volume of water is required for construction purpose including during compaction of approach road embankments, for concrete mixing and curing, and cleaning construction machines and equipment. Construction of water can be obtained either from surface waters or through groundwater extraction. It is expected that water surface water resources will be used for construction purpose. However, for potable drinking water, cooking, washing, and other domestic water supply, the contractors should consider drilling boreholes if hydrogeology of the bridge sites allows it.

Surface Water Extraction: Large volume of water extraction from the rivers, especially during dry periods, could affect flows and water availability for downstream users and the environmental water flow. Further, reduced water availability may affect aquatic habitats, feeding and breeding patterns of aquatic organisms. Surface water extraction involves use of water pumps and trucks which may lead to spill of fossil fuel and oil resulting in contamination of the water sources.

Groundwater Extraction: Drilling boreholes for domestic water supply at construction camps can have both positive and negative impacts on the environment, local communities, and the economy. One of the most significant benefits of drilling boreholes is access to a reliable source of water. This can provide the contractors with a sustainable and dedicated source of water, which is often essential for drinking and sanitation. Drilling boreholes can also have economic benefits for the contractors. For example, it can reduce the cost of purchasing drinking water from external sources, provide job opportunities for

drilling and maintenance services, and increase the value of land and property. Drilling boreholes can help reduce pressure on existing community water sources and on surface water resources such as rivers and lakes, which can be essential for preserving natural habitats and ecosystems. Boreholes drilled for camp domestic water supply are usually transferred to the community once construction is completed. This will support the communities' drinking water supply.

However, groundwater extraction will also lead into adverse E&S impacts. Overuse of groundwater resources from boreholes can lead to depletion and eventual drying up of aquifers. This can have severe impacts on the environment, local communities, and the economy. Since surface water and groundwater interact through discharge and recharge, overexploitation of groundwater from unconfined aquifers often affect surface water baseflow. Drilling boreholes can also lead to water quality issues if the well is not properly constructed or maintained. For example, drilling can introduce contaminants such as bacteria, chemicals, and minerals into the water supply. Drilling boreholes can also lead to land use conflicts between different stakeholders, such as farmers, residential communities, and businesses. This can be particularly challenging in areas where water resources are scarce and in high demand. Drilling boreholes can have impacts on ecosystems, particularly if the drilling and construction process is not carried out responsibly. For example, drilling can disrupt local wildlife habitats, cause soil erosion, and lead to increased noise pollution.

The following mitigation measures should be considered for impact on water resources due to construction of cofferdams, bridge piers, and abutments:

- Cofferdams should be constructed using non-erodible materials such as sand bags, concrete barriers, erosion control stones, and sheet piles.
- Use silt traps, sediment barriers, and other erosion control measures around the cofferdams, piers and abutment construction site. Stabilize disturbed areas and manage the timing of in-river work to minimize impacts on natural flow patterns.
- Set up sediment traps or basins to capture and settle suspended solids before runoff is discharged back into the river, thus reducing turbidity and protecting downstream water quality.
- Implement bank stabilization techniques, such as vegetative cover or erosion control mats, on exposed riverbanks around the abutment sites. This reduces the risk of erosion and helps maintain bank stability after construction.
- Cofferdams should be removed as soon as possible after they are no longer in use.
- If sediments are accumulated behind the cofferdams, remove the sediments prior removing the cofferdams. Accumulated sediments may alter the river flow regime and roughness.
- To the extent possible, avoid modification of the river channel at the bridge site. River flow should not be restricted by selecting pier and abutment designs that do not take much space in the rivers and banks.
- The Subproject temporary and permanent structures and facilities such as the bridge abutments, approach road embankments, construction camps, material storage area, and plants should be designed and located with the risk of flooding and inundation in mind. The design should consider the 100 years return period to size the bridge components and approach roads.
- Designate secure areas for fuel, oil, and chemical storage, with secondary containment to prevent spills. Ensure that spill response kits are available, and train workers in spill response procedures to address accidental discharges immediately.
- Continuously monitor water quality indicators, including turbidity and contaminant levels, during cofferdams, piers, and abutment construction.

The following mitigation measures should be considered to manage impact of groundwater extraction (i.e., drilling boreholes) for construction purpose:

- Before drilling boreholes, it is essential for the contractor to prepare site-specific E&S management plans (SS ESMPs) to identify potential impacts on the environment and local communities. This assessment should be conducted by a qualified professional and should include measures to mitigate identified risks.

- Careful planning and site selection can help to minimize the impact of drilling on the environment and local communities. For example, the site should be located away from sensitive ecosystems, water sources, and residential areas.
- Proper drilling techniques can help minimize the impact of drilling on the environment and local communities. For example, drilling should be done in a way that minimizes soil erosion and sedimentation, and drilling fluids should be properly managed to prevent contamination of groundwater.
- Proper construction techniques can help to minimize the impact of drilling on the environment and local communities. For example, the well or borehole should be properly lined to prevent contamination of groundwater, and proper sealing should be done to prevent surface water from entering the well.
- Proper maintenance and monitoring of boreholes can help to minimize the impact of drilling on the environment and local communities. For example, regular water quality testing (physical, chemical, and bacteriological) should be conducted to ensure that water is safe for drinking purpose, and boreholes should be properly maintained to prevent leaks and contamination.
- Engaging with local communities and stakeholders can help to identify potential concerns and mitigate negative impacts in relation to drilling and use of boreholes. This can include consultation on site selection, construction techniques, and monitoring programs.
- In addition to the above, the contractors should look for other alternative sources of water, particularly for construction purpose. Given that the project is located in areas endowed with considerable rainfall events, collection and use of rainwater should also be considered. Rainwater harvesting is recommended for use at the construction yards, workers' camps (other than for drinking purpose), and parking facilities around the project area.

9.4.2 Impact on Surface Water Quality

Bridge and broader construction activities at project locations affect quality of surface water resources. Since surface water and groundwater (particularly unconfined aquifers) are interrelated, water quality issues in surface water may transmit to the groundwater. Vegetation and land clearing for approach roads, cofferdams, bridge piers and abutment construction, and activities at construction material sites (borrow pits and quarries) exposes soil to erosion, leading to increased sediment and turbidity in surface waters. Disturbances to the riverbeds during construction can lead to increased turbidity and downstream sedimentation, affecting water clarity and aquatic habitats. Materials used in cofferdams, or failure of silt ponds, can wash sediments into the river, increasing turbidity and introducing contaminants. Excavation and grading of riverbanks may heighten erosion, introducing additional sediments into the river. Poorly managed solid waste and work yard runoff can contaminate nearby water bodies. Runoff from the construction site can introduce pollutants like oils, greases, and chemicals, negatively impacting water quality and aquatic organisms. Accidental spills pose contamination risks to local drainage systems and farmlands adjacent to water bodies. Improperly maintained septic systems or lack of mobile toilets for workers can lead to untreated effluent discharge, contaminating water sources. Grey water from showers, kitchens, and laundry facilities at construction camps may increase turbidity and nutrient loads if not managed properly. Untreated effluents from construction plants and workshops may introduce pollutants into surface waters, affecting water quality.

The following mitigation measure should be considered for impact on surface water quality:

- Use erosion control barriers, re-vegetate cleared areas, and minimize unnecessary clearing of vegetation at construction sites including bridges, approach roads, and construction material sites.
- Use silt traps, sediment basins, and stabilization techniques (e.g., mulching and seeding) to reduce sediment runoff.
- Install sediment filters and bio-retention basins to treat runoff before entering the rivers.
- Utilize eco-friendly construction materials, like recycled concrete, to reduce environmental harm.
- Locate waste disposal sites away from water bodies and install containment structures around work areas to capture storm water.
- Store fuels securely with containment tanks and provide spill response training for quick cleanup.
- Use eco-friendly cleaning products to reduce contamination.

- Provide mobile toilets for workstations outside of construction camps to prevent open defecation and ensure capacity sufficiency of the toilets.
- Construct watertight septic tank(s) to receive and store wastewater from camp sanitation facilities.
- Construct engineered soak-away pit(s) to partially treat wastewater, both dark and gray water. The soak-away pit(s) shall receive effluent from the septic tanks and partially treat effluent to bring it to acceptable level.
- Treat construction plant and workshop effluents in sedimentation tanks, soak-away pits, and test for compliance before release. The effluent quality should be based on the World Bank Group Environmental, Health, and Safety guidelines for wastewater.
- Divert rainwater from exposed areas and stabilize stockpiles with vegetation or covers to prevent sediment-laden runoff.
- Continuously monitor water quality, sedimentation, and aquatic ecosystem health to detect and mitigate adverse impacts.

Figure 64: Sample silt removal ponds



9.4.3 Impact on Aquatic Habitats and Biodiversity

Clearing of aquatic and riverine vegetation at bridge construction sites may eliminate affect aquatic habitats and pose impact on the biodiversity of the project area of influence. Cofferdams temporarily alter the natural flow of rivers and streams, affecting aquatic flora and fauna. Bridge construction can disrupt the river's natural flow and habitat continuity, which affects ecosystem function and biodiversity. Construction noise and vibration may interfere with aquatic species, affecting their behavior, communication, and nocturnal patterns. The construction of the bridges, particularly through piers installation (e.g., pier, abutments, and cofferdam construction), can temporarily affect the benthic environment of the rivers. Activities may temporarily alter bottom habitats, increase suspended sediments, and impact water clarity. Any change in the flow regime as a result of the bridge construction activities may potentially reduce eliminate or contaminate downstream flows, thereby potentially reducing the aquatic flora/fauna in the rivers where these bridges will be built. Thus, this may also influence the establishment of alien vegetation along the riparian zone.

Mitigation measures for impacts on aquatic habitats and biodiversity include:

- Identify aquatic habitats, biodiversity sensitive areas, aquatic organism spawning, feeding and breeding sites at the location of cofferdams, piers, and abutments, both upstream and downstream.
- Minimize environmental disturbance during construction of cofferdams, piers, and abutments to avoid of minimize elimination of aquatic habitats.
- Avoid cutting reeds or other riparian vegetation along the riverbanks, which can stabilize the bank and provide habitat for benthic organisms.
- Schedule construction activities to avoid critical periods for aquatic life such as spawning and nocturnal periods.

- Compensate for aquatic habitats loss (if any) by restoring or creating new benthic habitats, such as sea grass beds or other habitat-forming areas, to provide alternative environments for benthic species.
- Maintain natural river flow patterns to minimize disturbances to sediment transport and benthic habitats, avoiding significant changes to water flow velocity and direction.
- Ensure proper storage, handling, and disposal of construction materials to prevent pollutants from entering the benthic environment. Implement spill response plans and erosion control practices to limit runoff and pollution.
- Employ vibration-dampening techniques, and schedule activities during periods of low biological sensitivity. Employ a “soft-start” approach for piling to allow fish and mammals to flee the area before full operations.
- Clean and inspect equipment and vessels to prevent the introduction of non-native species. Use native plants in habitat restoration and implement monitoring and control measures for invasive species.
- Conduct regular monitoring during and after construction to assess the effectiveness of mitigation measures, including tracking water quality, sedimentation, and benthic populations.
- Engage stakeholders, local communities, and construction personnel in awareness campaigns about the importance of benthic environment protection and adherence to best practices.
- Use non-explosive methods for rock fracturing where feasible to minimize underwater noise and physical disturbance to the benthic environment.
- Design construction lighting to reduce light spillage beyond site boundaries, which can help protect nocturnal and sensitive aquatic species.

9.4.4 Impact on Fisheries

Construction of cofferdams, bridge piers, and abutments may affect aquatic organisms including fishes. The baseline assessment shows that fisheries are available at the Subproject bridge locations and thus the planned construction activities may affect fisheries on which the livelihood of the local communities depend on. The impact to fisheries include: (i) damage to aquatic and riparian habitats which are feeding and breeding places for fishes; the habitats could be damaged through loss of submerged and emergent aquatic vegetation, loss of riparian vegetation, and undesirable change in river morphology and hydrology, (ii) pollution of rivers, (iii) introduction of invasive species, and (iv) interference with movement of fishes including through improper design and construction of cofferdams, piers, and abutments, insufficient water depth at bridge locations, and alteration of the physical characteristics of the bridges.

Mitigation measures for impact on fisheries include:

- The contractor shall develop and implement fisheries management plan based on terms of reference provided in this ESIA.
- Timing of in river construction work should consider fish spawning periods.
- Design of cofferdams should consider providing adequate passage to fishes, avoid eliminating fish habitats, avoid spawning locations, and avoids excessive erosion and sedimentation.
- Similarly, the bridges should not damage fish habitats or create blockage of fish passage.
- To the extent possible, design of bridges should consider clear span type bridges which maximize the unabated flow of the rivers. Further, the cofferdams and bridges designs should ensure no significant alteration on existing river flow regimes.
- The existing river gradient at bridge locations should be maintained and adequate light penetration should be ensured to minimize loss in fish productivity.
- Uncured concrete can kill fishes by altering the pH of the river water around bridge piers and abutments. To the extent possible, pre-cast concrete shall be used or rapid setting and curing concrete should be considered.
- When cast in-situ concrete is used, all concrete work must be done in dry conditions or isolated from flowing water to avoid leachate of concrete into the river system.
- Sedimentation/siltation can clog fish spawning beds and juvenile fish species are susceptible to siltation. Therefore, construction driven sedimentation should be avoided or minimized.
- Silt traps and settlement ponds should be used to minimize sedimentation.

- Discharges of fuel, oil, and other hazardous chemicals are directly toxic to fishes and may lead to tainting of fish tissues, rendering fish inedible. Oil films on water can interfere with the diffusion of oxygen from the atmosphere into water and may lead to depletion of oxygen. Therefore, spill of chemicals from construction machines and equipment, and disposal of chemicals into the river should be strictly avoided. There shall be no visible oil films in any discharge from construction works. Vehicles, trucks, machines, and equipment should be maintained and routinely checked before use in the construction of the bridges.
- Oils and fuels should be stored in secure bunded areas. Temporary oil interceptor facilities should be provided.
- Waterproofing and other chemical treatment to bridge components should be applied by hand.

9.4.5 Impact on Terrestrial Habitats and Biodiversity

The four proposed bridge locations and approach roads, pass through existing alignments through populated and built-up communities. Consequently, forest or vegetation cover is not affected much. The clearing required for road works, working areas, campsites, and areas identified for borrow-pit or quarry locations is all covered with secondary forest and farm bushes. This loss will be cumulative and will affect the quality of wildlife habitat and the hydrological balance of the Subproject site. Rehabilitation of the damaged areas will, however, have the potential to reverse the adverse effects of the construction on species composition and structure.

Flora: No rare, threatened, or endangered species was found during the survey within the proposed locations for the four bridges. This could have been a result of the intense vegetation clearance for building developments, especially at the Matru bridge location; extensive clearing by artisanal miners at the Gendema bridge location; shift cultivation, timber logging, and other ongoing human activities at Tompari and Manowa bridge locations. The clearing of secondary-growth vegetation for the proposed bridge construction Subproject at the four sites is unlikely to have a significant impact on the flora of the affected areas.

Fauna: Ongoing land clearance by artisanal miners, forest timber harvest, farming, and other human activities in the proposed bridge locations disturb the faunal population through habitat loss and fragmentation. The proposed Subproject activities (especially borrow-pits and quarries) would affect remaining sensitive animals and potentially result in their temporary displacement from their current habitats. Access tracks and other associated infrastructure construction also cause fragmentation of terrestrial habitats, causing disturbance and displacement. Construction workers may engage in fauna hunting. Also, construction traffic may hit and kill fauna.

The following mitigation measures should be considered for reducing impacts on terrestrial habitats and biodiversity:

- Reduce vegetation clearing to the minimum necessary for efficient Subproject operations; flatten rather than strip vegetation if access is only required short-term.
- As much as possible, large trees and vegetative cover should be retained for its ecological role and function.
- Stockpile vegetation & topsoil in designated areas for future rehabilitation.
- Restore or replant trees in place of those removed for construction purposes.
- Materials deposition that will damage the ecosystem of rivers and streams should be discouraged;
- Monitoring assessment will be carried out to avoid direct materials deposition to the benthic layer of the bedrock.
- Approach roads should be kept within standards that are commensurate with relevant design and safety standards. Further, to the extent possible, the alignment of approach roads should follow the existing alignment.
- Establish and enforce a total ban on hunting and capture of wildlife by employees. Wildlife will be relocated where practicable.
- Limit speed of construction vehicles and trucks to avoid hitting, maiming, and killing the local fauna.

9.4.6 Impact on Soil/Land and Erosion

During the construction and operation of the four bridges and associated approach roads, several potential impacts on soil/land may arise. These include compacted soils from roads and construction activities may lead to increased surface runoff and soil erosion, affecting nearby land and water bodies; oil spills from machinery and construction equipment can lead to soil contamination, impacting soil health and agricultural potential; and salvaged topsoil intended for reclamation may be compromised, increasing the risk of flooding, siltation, and inundation in low-lying areas.

The bridge construction Subproject activities may also result in soil erosion. Activities such as excavation, and earthwork activities like use of borrow pits, quarry sites, and sand pits will give rise to the heavy concentration of particulate load that will lead to soil erosion. As a result of the excavation of topsoil during the construction phase, the impact on drainage patterns, and run-off characteristics will be restricted to the small area and may not last longer. Construction activities, such as grading and filling, drastically reduce soil quality on construction sites. Left unprotected, sites will be further degraded by erosion and begin to adversely affect the surrounding environment.

The Subproject areas have longer rainy seasons and thus some of the construction activities may be suspended. However, the contractors may use this period to produce, transport, and stockpile construction materials which involves earthworks and use of access roads to transport the produced materials. This is expected to further exacerbate soil erosion and sedimentation of surface water bodies.

The following mitigation measures should be considered for impact on soil/land and erosion:

- Use salvaged topsoil to reclaim disturbed areas, ideally during the dry season to prevent erosion and optimize soil stabilization.
- Implement agricultural practices in tandem with reclamation activities to restore soil productivity and enhance land use capability.
- In cases where siltation occurs in ponds or low-lying areas, release water through a series of outlets positioned at different elevations. This approach will effectively manage sediment levels and reduce the risk of inundation.
- Avoid constructing detours and access roads to construction material sites in areas with steep slopes.
- Minimize major earthworks during the monsoon season, to the extent feasible.
- At the end of the construction phase, re-vegetate cut slopes wherever feasible.
- Provide vegetative cover to protect the soil from eroding.
- Native varieties of vegetation should be selected, according to the soil type, climate, and ease of maintenance for revegetation purposes.
- Provide intercept ditches at the middle and bottom of slopes. Gutters and spillways are used to control the flow of the water down a slope. Provide cut-off drains to catch water before it reaches critical areas, and diverging drains, which avoids excessive concentration of flow.
- Provide riprap or rock material embedded in a slope face, combined with vegetation.
- Retaining structures such as gabions, cribs grids of wood or concrete beams filled with earth or rock), or other types of wooden barricades and grid works, usually battered back against the slope should be provided in areas susceptible to erosion.
- Reinforce earth embankment walls built up as the earth fill is placed, with anchors compacted into the fill material.
- The right season should be preferred for planting the saplings.

The following measures should be implemented for sediments treatment:

- Construct sedimentation ponds at the construction and materials extraction sites to regulate and trap sediments.
- Provide slope protection and turfing on exposed slopes to minimize soil erosion.
- Ponds should be maintained by removing the deposited material at appropriate intervals.
- Sediments removed from ponds should not be placed or disposed near the waterways
- Schedule excavation during low-rainfall periods, whenever possible.
- Excavate immediately before construction instead of leaving soils exposed for months or years.

- Cover disturbed soils as soon as possible with vegetation or other materials (mulch) to reduce erosion potential.
- Divert runoff from disturbed areas.
- Control concentrated flow and runoff to reduce the volume and velocity of water from work sites to prevent the formation of rills and gullies.
- Minimize the length and steepness of slopes (e.g., use bench terraces).
- Prevent sediment movement off-site.

9.4.7 Impact on Landscape and Visual Receptors

Impact on landscape and visual receptors from the planned bridge and approach roads construction activities and materials extraction include: increased traffic generates dust that can settle on vegetation, reducing its visual appeal, particularly during the dry season, dust accumulation can affect leaves, plants, and the general landscape, creating a visually degraded environment; the presence of borrow pits, quarry sites, stockpiled construction materials, campsites, and work yards may create visual intrusions, impacting the natural aesthetics of the area, especially for villages along approach and access roads; quarries and borrow pits operation may create visual disturbances, especially if visible from major roads or community access points, such areas can disrupt the natural landscape and may stand out as unsightly elements in the environment; and clearing vegetation for construction activities, if extensive, can disrupt the natural landscape, reducing the screening provided by vegetation and exposing construction sites to nearby residents and communities.

The following mitigation measures should be considered:

- Retain natural vegetation wherever possible to serve as a visual screen around construction areas. Limit vegetation clearing to the minimum necessary for construction efficiency, avoiding needless destruction of natural vegetation cover.
- Where possible, position quarry and borrow pit sites out of view from major roads and community access points. Use existing topographic features to shield these areas, and design landscaping to blend with the surrounding natural environment.
- Where practical, orient quarry working faces away from key vantage points and residential areas. Select working directions that naturally conceal the quarry face from critical viewpoints.
- Align access tracks and roads to minimize long lines of sight from nearby vantage points. Design camps and other ancillary facilities and work yards to visually blend with the environment, using natural colour schemes like forest green or brown to reduce their visual impact.

9.4.8 Impact on Air Quality

Diesel-powered machines and equipment used at the bridge construction sites such as trucks, cranes, and excavators emit pollutants, including carbon monoxide (CO), nitrogen oxides (NO_x), sulfur dioxide (SO₂), volatile organic compounds (VOCs), and polycyclic aromatic hydrocarbons (PAHs). These emissions are significant near populated areas and along access roads. Dust can be generated by construction vehicles traveling on unpaved roads and from activities such as loading and unloading construction materials like gravel and sand. Nearby communities may be impacted by dust settling on vegetation, homes, and water sources. Handling and transporting materials, especially aggregates for concrete batching and other construction uses, can release particulate matters. This is more prominent along access roads to construction sites in areas like Mattru Jong and Tompari, where villages are closer to construction activities. Dust and emissions increase respiratory risks for nearby residents, particularly for vulnerable groups such as children, the elderly, and individuals with respiratory conditions.

Mitigation measures for impact on air quality include:

- Conduct regular maintenance of construction vehicles and machinery to reduce emissions. Ensure diesel engines meet local emission standards to minimize CO, NO_x, SO₂, and VOC emissions.
- Turn off generators, compressors, and other equipment when not in use to prevent unnecessary emissions from idling machinery.
- Regularly apply water on unpaved roads, especially near residential areas, to control dust generated by vehicle movement. Increase the frequency of spraying during dry conditions.

- Use tarpaulins to cover the payload areas of trucks transporting loose materials to prevent dust fallout along transport routes.
- Spray water on materials such as sand and gravel during loading and unloading to reduce dust emissions, especially near community areas.
- Install dust arresters or dust control measures at material stockpiling sites near bridge sites to further limit dust dispersion.
- Enforce speed limits for vehicles on access roads to reduce dust generation, particularly in sensitive areas such as schools and hospitals. Install signs along routes to ensure drivers comply with speed restrictions.
- Train construction workers in air quality management practices, safe material handling, and equipment operation to reduce emissions and improve site safety.
- Provide workers with PPE, such as masks and respirators, especially for high-dust tasks like material handling or operating near batching plants.
- Regularly monitor air quality, including particulate matter and gaseous emissions, in areas near residential zones. Adjust dust suppression and emission controls based on monitoring results. The supervising engineer or the client shall use handheld air quality monitoring devices (at least one for each bridge site) to measure air quality parameters.
- Inspect dust control equipment regularly to ensure effectiveness and maintain access roads to minimize dust dispersion.

9.4.9 Impact of Noise

Noise levels from the bridge construction activities will vary based on the type and operation of equipment, frequency of use, and time of day. Noise impacts are typically higher during the day, but evening and night operations may still affect nearby communities and workers if not properly managed.

High-noise activities, such as drilling, hammering, concrete mixing, and pile driving, are expected to elevate noise levels, especially near populated areas such as Matru, Gendema, Garwama, and Tompari. The impact can be more disruptive at night due to lower permissible noise levels and the increased sensitivity of residents. The bridge construction site at Manowa is away from residential or active areas, except the ferry crossing point which people do not permanently occupy. Prolonged exposure to high noise levels can impact the health and well-being of construction workers, especially those working with heavy machinery. Without proper hearing protection, workers may experience hearing loss, stress, and reduced concentration, which could lead to safety risks. Temporary road closures, detours, and increased construction-related traffic along alternative routes may raise ambient noise levels in adjacent areas, causing temporary noise pollution in communities near the diverted routes. Permissible noise levels are generally higher during the day than at night. Construction activities must align with these allowable levels to limit noise impacts, with strict adherence to lower levels at night to protect nearby residents from excessive disturbances.

The following mitigation measures should be considered for impact of construction noise:

- Install temporary noise barriers, such as earth berms or high vertical walls, around construction zones to reduce noise reaching nearby communities. Use materials that can effectively absorb or reflect sound.
- Schedule high-noise construction activities during less sensitive hours, avoiding early mornings, late evenings, and weekends. Adhere strictly to permissible noise levels for day and night to minimize disruption.
- Employ quieter equipment where possible and use noise-reducing attachments such as mufflers. Alternate methods that reduce reliance on heavy machinery should be considered to control noise levels.
- Continuously monitor noise levels during construction to ensure they remain within permissible limits. Adjust or relocate equipment as needed to reduce noise levels when they exceed acceptable limits.
- Mandate hearing protection for all workers and operators exposed to high noise levels. PPE, such as earplugs or earmuffs, should be provided and always enforced for tasks involving noisy equipment.

- Communicate proactively with nearby residents about construction schedules, expected noise levels, and mitigation measures to address their concerns. This can include providing advance notice of high-noise activities.

9.4.10 Impact of Vibration

Construction activities involving pile driving, drilling, and the use of heavy machinery can produce ground vibrations that spread through the soil and decrease with distance. While most vibrations are unlikely to cause structural damage, they can be disturbing to residents and may impact buildings, especially older or historically significant structures.

Vibrations from pile driving and other impact-heavy construction activities may be perceptible in nearby residential areas. While structural damage is rare, vibrations can cause discomfort for residents and may result in low rumbling sounds or slight shaking. Operators of vibration-producing equipment may be exposed to hand-arm or whole-body vibrations, leading to discomfort and potential health risks over extended periods without proper protective measures. Buildings close to the construction site, particularly older or fragile structures, may be at increased risk of damage from sustained or high-intensity vibrations. Construction vibration is generally assessed by peak particle velocity (PPV), with higher sensitivity needed for structurally delicate areas.

Mitigation measures for impact of vibration include:

- Where feasible, employ construction methods and equipment that produce lower vibration levels to minimize the impact on nearby communities and structures.
- Regularly monitor vibration levels, especially near sensitive structures, using equipment that measures peak particle velocity (PPV). Adjust methods or reduce equipment power if vibration levels approach thresholds that may impact nearby buildings.
- During development of the site-specific ESMPs, contractors should establish vibration-sensitive zones close to fragile buildings, limiting the use of high-impact equipment within these areas. Restrict access to vibration-heavy areas and establish exclusion zones to protect both workers and residents from unnecessary exposure.
- Provide PPE and training to workers operating vibration-producing equipment to minimize exposure to hand-arm or whole-body vibrations. Regular breaks and ergonomic handling techniques should be encouraged to reduce health risks.
- Inform residents and businesses of high-vibration activities in advance to manage expectations. Address their concerns proactively, particularly if activities are near sensitive structures or in areas where vibrations may be perceptible.
- Implement traffic management plans for diverted routes to reduce heavy vehicle movement in residential areas and lower vibration impacts on local roads. Designated speed limits and vehicle restrictions can help control vibration levels from construction traffic.

Table 46: Predicted Noise Levels of Principal Construction Equipment

No.	Equipment Used for Construction	Noise Levels (dbA)
1	Bulldozer	80
2	Crane	75-77
3	Front end loader	72-84
4	Welding generator	71-82
5	Jack hammer	81-98
6	Concrete mixer	74-88
7	Crane with ball	75-87
8	Concrete pump	81-84
9	Concrete Vibrator	76
10	Air compressor	74-87

No.	Equipment Used for Construction	Noise Levels (dbA)
11	Pneumatic tools	81-98
12	Backhoe	72-93
13	Cement and dump truck	83-94
14	Scraper	80-93
15	Pavers	86-88
16	Grader	80-93
17	Roller	73-75
18	Truck	83-94

Source: U.S. Environmental Protection Agency, Noise from Construction Equipment and Operations, Building Equipment and Home Appliances, NJID. 300.1. December 31. 1971

9.4.11 Impact from Construction Waste

During construction of the four bridges and approach roads, significant amounts of construction debris will be generated. This includes materials such as concrete, steel, wood, and other construction-related waste. The disposal of this debris can increase waste production in the Subproject areas if proper waste management practices are not followed. The bridge construction activities, particularly construction of the approach roads, will involve extensive excavation work, which generates soil and rock debris. If not managed appropriately, this waste can contribute to increased waste production in the surrounding Subproject areas. The construction Subproject activities may involve the use of hazardous materials such as paints, coatings, solvents, and chemicals. If these materials are not handled and disposed of correctly, they can pose a significant risk to the environment and human health. During the construction phase, temporary facilities such as worker camps, storage areas, and offices are often set up near the construction site. The waste generated by these temporary facilities, including food waste, packaging materials, and other consumables, can increase waste production.

The following mitigation measures should be considered for impact of construction waste:

- The contractors shall develop a comprehensive waste management plan specifically tailored to the bridge construction Subproject. The plan should outline strategies for waste reduction, reuse, recycling, and proper disposal.
- For the Matru-Senehun crossing, it is recommended for the contractor to work with Bonthe District Council which is situated in Matru Town for waste collection and disposal.
- Contractors shall opt for sustainable and eco-friendly materials during the bridges construction. The contractors should consider materials with high recycled content or those that can be easily recycled or reused after the bridge's lifespan. This reduces the overall waste generated and promotes a circular economy approach.
- The contractors shall implement practices to minimize waste generation during construction activities. This can include accurate estimation of materials required to reduce over-ordering, implementing efficient construction techniques to minimize cutting and trimming waste and promoting careful handling and storage of materials to prevent damage and waste.
- The contractors shall set up designated areas on-site for the sorting and segregation of different types of waste. Prominently label recycling and waste bins to encourage proper disposal practices among workers. Educate and train construction personnel on waste segregation and ensure regular monitoring and enforcement of waste management guidelines.
- The contractors shall establish partnerships with local recycling facilities and vendors to facilitate the recycling and reuse of construction waste materials such as concrete, steel, wood, and plastics. Promote the use of recycled materials in the construction process whenever feasible, reducing the demand for virgin materials.
- The contractors shall develop and implement a robust system for handling and disposing of hazardous materials used during bridge construction. Ensure proper storage, labeling, and

disposal of hazardous waste in compliance with relevant waste disposal regulations. Educate workers about the risks associated with hazardous materials and promote safe handling practices.

- The contractors shall conduct community engagement programs to raise awareness among the local population about waste management practices during the bridge construction phase. This is mostly applicable to Matru,-Senehun, Gendema-Garwama, and Tompari Crossings. Encourage residents to participate in waste reduction and recycling initiatives. Provide information on proper disposal methods and facilitate community recycling programs if possible.
- The contractors shall regularly monitor waste management practices on-site to ensure compliance with the waste management plans and regulations. Conduct periodic audits and inspections to identify any gaps or areas for improvement. Enforce penalties or corrective actions if workers fail to adhere to waste management guidelines.
- After completing the bridge construction, conduct a thorough clean-up of the construction site to remove any remaining waste or debris. Restore the surrounding areas to their original or near-original condition, disposing of waste in an environmentally responsible manner.

9.4.12 Impact from Hazardous Materials and Waste

During the construction period, a wide range and substantial volumes of hazardous waste may be generated including oils, fuel, grease, and chemicals from plants, equipment, and vehicle servicing. Hazardous materials and waste will pollute the environment and affects the health of workers and the local communities. The following hazardous materials and waste management measures will be implemented during construction period:

- The contractors shall prepare and implement a hazardous waste management plan for the storage, handling, transport and disposal of waste oil, batteries, and other hazardous materials and waste. Ensure that hazardous waste management measures are implemented for relevant Subproject activities.
- All areas designated for the storage of fuels, oils, chemicals, or other hazardous materials shall have a compacted base and shall be surrounded by a bund to contain any spillage. These areas shall be covered by a roof structure to minimize the potential for infiltration and contamination of rainwater. Alternatively, ventilated containers and individual spill pallets could be used, dependent on the volume of hazardous materials
- Areas designed for the storage of hazardous materials are to be designated and storage of such materials outside these areas is strictly prohibited.
- An Emergency Spills Contingency Plan shall be prepared as part of the contractor's ESMP.
- Ensure that there is adequate provision of correctly marked hazardous waste containers made available at convenient locations.
- Hazardous waste disposal sites should be selected or identify in consultation with the relevant authorities. Hazardous waste shall not be disposed at locations designated for other/general waste.

9.4.13 Impact from Construction Camps

Construction camps usually comprise of office building, workers accommodations, catering and eating areas, water and energy supply, clinics, laboratory facilities, garages, workshops, storage areas, parking spaces, etc. These facilities will utilize resources, generate waste, and expose workers to occupational health and safety risks. Further, the construction camps and workers interaction with the surrounding communities will result in environmental pollution, resources competition, community health and safety risks.

Certain provisions are compulsory to be provided at the construction sites as per the labor regulations. Every construction site should have a supply of drinking water, shelters should be provided for taking meals, the equipment should be operated by workers who have received appropriate training, The drivers and operators of vehicles and materials handling equipment should be medically fit, trained and tested and should have a prescribed minimum age, the contractor should take adequate measures for the control of malaria, and the contractor should educate the workforce about HIV/AIDS and launch awareness campaign among the workforce. There should be proper demarcation of work areas with sign boards. The signboards should be in the local language. Separate accommodations for male and female workers where applicable. Code of ethics prohibiting visitors to workers' accommodation sites and

establishing curfews. Prohibition of intoxication with alcohol, drugs, and harmful substances in work and accommodation sites.

Construction camps will be placed on either side of the Subproject location (river crossing). The following mitigation measures shall be adopted at the site, some of which is compulsory according to the labor regulations:

- Every construction camp should have a supply of potable drinking water and provided with proper sanitary and washing facilities and proper toilets with flush facilities.
- Construction camps should be provided with constant supply of energy/electricity.
- Wastewater, including gray water, generated from construction camp facilities, should be retained and treated before discharge to the natural environment.
- Accommodation for taking meals and for shelters during interruption of work due to adverse weather conditions should be provided.
- If a minimum number of workers as prescribed are employed in any shift, at least one suitably equipped first aid room or station under the charge of qualified first aid personnel or a nurse should be provided at a readily accessible place for treatment of minor injuries and as a resting place for seriously sick or injured workers.
- Fire arrest equipment (such as fire extinguishers) should be provided in the construction camps with adequate quantity.
- Equipment in the construction camps should be maintained in good working condition.
- Equipment in construction camps should be operated by workers who have received appropriate training in accordance with national laws and regulations.
- Facilities for changing, for storage and drying of clothing should be provided.
- Cloakrooms should be provided to the workers at easily accessible places and should not be used for any other purpose.
- Workshops, garages, laboratories and material storage areas should be separated from office and accommodation areas.
- Emergency procedures should be provided in case of emergencies at construction camps. Drills should be done to practice the emergency procedures.

Construction Camp Solid Waste and Wastewater Management: The main waste generated from construction camps include kitchen wastes which is comprised of organic waste (eggshells, discarded foods, vegetable peels, meat, and bones), inert materials like (polyethylene bags, and mineral water bottles), and wastewater from camp facilities. Wastewater from toilets should flow into engineered septic tanks connected with soak-away pits. Poor or improper wastewater management may give rise to health problems. Also, uncontrolled solid waste dump sites could be breeding grounds for vermin, and as such could pose a vector-borne disease. Such solid waste disposal sites invariably attract casual open dumping by communities. Poor solid waste handling and disposal may pose a hazard to soil and groundwater quality. Some of the construction camp waste management techniques to be employed are given below:

- Solid waste shall be regularly collected, segregated, temporarily stored in labelled waste bins inside the camps, and disposed of in disposal sites approved by local authorities.
- Segregation of waste depending on the nature of the material should be conducted. Some of this waste could be recycled. Special attention should be given to separating hazardous wastes for proper management in accordance with applicable regulatory requirements.
- If possible, composting of organic wastes should be considered.
- Construction camp wastewater and kitchen gray water should be stored in watertight septic tanks and treated in soak-away pit before release to the environment.
- Septic tanks and soak-away pit areas should be barricaded. Further, solid waste disposal site shall be provided with a safety barricade.
- The project will not develop a project-specific solid waste disposal site. Rather, solid wastes shall be regularly collected and disposed at disposal sites approved by local authorities. Such disposal site should be away from human settlement, because of the risk to the communities' health.

Wastewater from Laboratories, Plants and Workshops: Laboratories, plants, and workshops will be established inside and outside of the construction camps. Water is used in these facilities and the wastewater generated contains suspended solids, hazardous substances, and pollutants. Discharge of untreated wastewater will have a serious impact on the water quality of the receiving water body. Turbidity, oil and grease levels will increase substantially in surface water systems; especially in dry season. Therefore, wastewater from these facilities (i) should be stored in impermeable tanks, (ii) should be provided with spill containment tanks of 110% volume capacity, (iii) should not be discharged to septic tanks and soak-away pits which are meant to biodegradable wastewater, and (iv) should be disposed at a designated location or facility approved by the local council.

9.4.14 Occupational Health and Safety Risk

Occupational health and safety risks and impacts during construction of the Subproject bridges and approach roads arise from hazardous work sites, construction equipment and machinery, transport vehicles, lack of signs (informative and warning), etc. These result in physical, chemical and biological hazards. The anticipated impacts related to these hazards are discussed below.

Impacts due to Physical Hazards

Physical hazards represent potential for accident or injury or illness due to repetitive exposure to mechanical action or work activity. Single exposure to physical hazards may result in a wide range of injuries, from minor and medical aid only, to disabling, catastrophic, and/or fatal. Multiple exposures over prolonged periods can result in disabling injuries of comparable significance and consequence. The main physical hazards and associated impacts are described below.

- **Struck by Moving Machine and Equipment:** Moving machines and equipment can be used for site clearing, earthworks for the approach roads embankments, bridge structural work, construction material sites utilization, and plants operation. Injury and death can occur from being trapped, entangled and/or struck by moving machines and equipment used for these construction activities.
- **Noise and Vibration:** Construction workers should not be exposed to noise level greater than 85 dB for a duration of more than 8 hours per day without hearing protection. Construction work involving operating machines and plants, crushing, grinding and cutting may exceed this limit. Exposure to vibration from equipment such as earthmoving machines, crushers, plants, compactors, and trucks will result in exposure of significant vibration to operators and nearby workers.
- **Working Environment Temperature:** Exposure to hot and cold conditions can result in temperature stress-related injury or death. Construction workers exposed to mid-day sun/heat or early morning cold can be affected.
- **Electrical Hazards:** Exposed or faulty electrical devices (such as grinders, drills, and welding machines), circuit breakers, panels, cables, cords and hand tools, can pose a serious risk to construction workers. Overhead wires can be struck by machines and equipment, by trucks transporting materials or by vehicles with metal booms. Machine, vehicles or grounded metal objects brought into close proximity with overhead wires can result in arcing between the wires and the object, without actual contact.
- **Eye Hazards:** Solid particles from a wide variety of construction activities, and/or a liquid chemical spray may strike a worker in the eye causing an eye injury or permanent blindness.
- **Work at Height:** Fall prevention and protection measures should be implemented whenever a construction worker is exposed to the hazard of falling more than two meters. Works such as construction of bridge piers and decks and materials extraction involve work at height.
- **Excavation Hazards:** Deep excavations pose significant hazards on construction workers and the general public in the form of falls, cave-ins, and trapped in excavations. Activities such as materials extraction involve excavations.
- **Traffic Hazard:** Poorly trained or inexperienced vehicle drivers can increase risk of accident with other vehicles, pedestrians, and equipment. Construction workers are exposed to traffic accidents due to significant use of machines (dozers, loaders, graders, rollers/compactors, and pavers), construction materials delivery trucks, and project vehicles.

- **Ergonomics and Manual Handling:** Injuries due to ergonomic factors, such as repetitive motion, overexertion, and manual handling, take prolonged and repeated exposures to develop, and typically require periods of weeks to months for recovery. Construction works involving lifting and carrying weight, use of hand tools, and uncomfortable workstations can result in ergonomic risks.
- **Housekeeping:** Poor housekeeping of work areas can result in slips, trips, and falls.
- **Lone and Isolated Worker:** A lone and isolated worker is a worker out of verbal and line of sight communication with a supervisor, other workers, or other persons capable of providing aid and assistance, for continuous periods exceeding one hour. Where construction workers may be required to perform work under lone or isolated circumstances, procedures should be developed and implemented to ensure all PPE and safety measures are in place before the worker starts work.

Impacts due to Chemical Hazards

Chemical hazards represent potential for illness or injury due to single acute exposure or chronic repetitive exposure to toxic, corrosive, sensitizing or oxidative substances. They also represent a risk of uncontrolled reaction, including the risk of fire and explosion, if incompatible chemicals are inadvertently mixed.

- **Hazardous Materials:** Hazardous materials such as fuel, oil, and used oil can be used or generated for various construction activities, particularly those involving the use of vehicles, trucks, machines, plants, and diesel power equipment. These hazardous materials, if not properly handled, stored, used, and disposed can result in exposure of construction workers.
- **Air Quality:** Poor air quality due to the release of dust and contaminants into the workplace can result in possible respiratory irritation, discomfort, or illness to construction workers.
- **Fire and Explosion:** Fires and/or explosions resulting from ignition of flammable materials or gases can lead to loss of property as well as possible injury or fatalities to construction workers.

Impacts due to Biological Hazards

Biological agents represent potential for illness or injury due to single acute exposure or chronic repetitive exposure. Biological hazards during construction period include (i) wastewater or gray water from construction camps and garages, in drainage channels in/near urban centers or settlement areas, (ii) airborne pathogens such as common cold, influenza, and COVID-19, (iii) stinging insects and venomous animals, (iv) poisonous plants, and (vi) contaminated sharps in solid wastes.

The following mitigation measures should be considered for occupational health and safety risks:

General mitigation measures for occupational health and safety impacts are:

- Induction trainings and awareness for workers on occupational health and safety must be conducted upon recruitment
- Electrical installations must be properly done
- Fire extinguishers of appropriate size (and not expired) should be placed at offices, workshops and residential quarters
- All vehicles and machinery should be serviced on regular basis as per the recommendations by the respective manufacturer
- Drivers must be given induction as well as regular trainings with emphasis to “Defensive Driving”
- The contractor shall prepare a sound traffic management plan (TMP) and implement it
- Roadway should not be reduced or blocked with stockpiles for long time
- Flagmen should be assigned to let the traffic flow safely especially at narrow/critical sites
- Slippery and other dangerous spots should be maintained or corrected frequently
- Hazardous materials such as used oil and lubricants and parts of vehicles and machinery that may catch fire should be stored separately and taken off the sites by a licensed firm
- Speed reduction/calming structures (humps, rumble strips, etc.) in towns and villages with relatively high population should be considered
- Workers should be provided with personal protective equipment (PPE)
- Regular traffic signs should be provided or installed at critical sites including: excavations for widening, structural excavations, diversions, material dumping along road sides, etc.

Mitigation measures for impact due to physical hazards include:

Recommended mitigation measures for struck by moving machine and equipment are:

- Proper work procedures should be adapted during use of moving equipment.
- When not in use, disconnect, turn off, or de-energize moving machines and equipment.
- Make sure that the safe working load of machines is known, and the weight of any load required to lift. Try the load by lifting it slightly and halting, to see if the machine can take the load. Never leave the cab whilst the load is suspended.
- Guards are fitted to plant and machinery to prevent workers from coming into contact with moving parts. Always ensure that these guards are properly replaced and secured before starting up plant and machinery. Never remove or adjust guards whilst the machinery is in motion.
- Do not interfere with any switches or safety precaution devices.
- When using a starting handle, always keep your fingers and thumb on the same side of the handle.
- Operating unguarded or badly guarded plant and machinery could result in injuries and fatalities, so use the guards properly.
- Never leave the machines unattended.
- Never travel with booms, blades or the body of a machine raised.
- Keep to the speed limits of machines and use flagmen, where necessary.
- Never carry passengers in the cab of machines, unless seating is provided.
- Machines and equipment shall be operated by competent operators.
- Moving machines and equipment should be maintained regularly.

Recommended measures for impacts due to noise and vibration:

- Workers should be rotated to reduce the impact of activities with noise level exceeding guideline values.
- Workers should use appropriate protective equipment such as ear plugs and muffs.
- Recommended measures for impacts due to working environment temperature:
- Work and rest periods should be adjusted depending on temperature and workloads.
- Providing temporary shelters to protect against the elements during working activities or for use as rest areas.
- Use appropriate protective clothing.
- Provide easy access to adequate hydration such as drinking water.
- Recommended measures for electrical hazards:
- Marking all energized electrical devices and lines with warning signs.
- Check all electrical cords, cables, and hand power tools for exposed cords and cover the exposed part with electrical tapes. Before covering the exposed cords, make sure that the electrical equipment, machines, or cord/cables are not energized.
- Protecting power cords and extension cords against damage from traffic by shielding or suspending above traffic areas.
- Electrical equipment and machines should be switched off when not in use.
- Electrical equipment and machines should be operated by competent workers.
- Construction should not be done under high-voltage power lines. A “no approach” zone should be created under high-voltage power lines.
- Conducting detailed identification and marking of all buried electrical wiring prior to any excavation work.

Recommended measures for eye hazards include:

- Use face and eye protection equipment such as safety glasses, goggles, and face visors.
- Wet dusty work areas frequently to reduce dust emission.

Recommended measures for risks associated with work at height:

- Use proper scaffolds when working at height, i.e., above 2m from the ground.
- Provide guardrails with mid-rails and toe boards at the edge of any fall hazard area.
- Proper use of ladders and scaffolds by trained employees.
- Use of fall prevention devices, including safety belts.

- Safety nets should be provided at all bridge sites 7.6 m or more above surfaces where the use of ladders, scaffolds, catch platforms, temporary floors, safety lines, or safety belts is impractical. Safety nets must extend 2.4 m beyond the edge of the surface where employees are exposed. Nets shall be hung no more than 7.6 m below the work surface with sufficient clearance to prevent the user's contact with the surfaces or structures below. Safety nets must be impact load tested prior to commencing operations.
- Oil drums, material piles, and wooden planks should not be used to work at height.

Recommended measures for excavation hazards include:

- Conduct pre-start checks including availability of excavation equipment, ground conditions, and proximity of any hazards.
- Physical barriers shall be erected around excavations.
- Any services/utilities at the site shall be identified and shall be clearly marked.
- Re-location of existing services/utilities must be completed before excavation commences.
- Excavation shall be done using appropriate equipment or plant.
- Spoil material from excavations shall be removed/carted away from the working area so that it does not apply surcharge on the sides of the excavation and to keep the area clean.
- Practice safe manual handling techniques (plan, get help if needed, place your feet firmly, bend your knees – not your back, firm grip, lift with legs, etc.).
- Check adjacent structures (if any) and assess the impact of the excavations on the stability of the structures.
- Make sure that affected adjacent structures are properly supported before commencing the excavation.
- Sides of excavation must be supported/battered where there is a risk to collapse.
- Ladders, stairs or ramps shall be provided for safe ingress/egress into excavations.
- Inspect supported excavations before work commences each day.
- Personnel must stay within protected/supported excavations at all times.

Recommended measures for traffic hazards:

- Use traffic cones or barriers to create exclusion zones around active construction work involving machines, trucks, and vehicles.
- Use safety/traffic signs to aware drivers of the work in progress.
- Construction workers should wear high visibility vests at all times. Yellow color vests are preferable for work done during night or early morning times since it is more visible against darkness. Orange color vests are preferable for work done during day time to give contrast from the blue sky, yellow sunlight, and green environment.
- Vehicles, trucks, and machines should be operated by trained and competent drivers and operators.
- Establish speed limits for vehicles and trucks.

Recommended measures for ergonomics and manual handling risks:

- Incorporating rest and stretch breaks into work processes, and conduct job rotations.
- Implementing work procedures that reduce unnecessary forces and exertions.
- Wear the right protective equipment for the job.
- Construction workers should know their physical capabilities and should be given jobs they can reasonably handle.
- Always check that the weight of the load is known before lifting.
- Know the correct way of lifting before attempting a lift, i.e., (i) stand reasonably close to the load, be sure footing is firm and feet are about 300 mm apart, (ii) squat down by bending the knees, keeping the back as straight as you can, (iii) place hands where they will not slip, and grip firmly, (iv) breathe in before lifting - inflating the lungs helps support the spine, (v) straighten up with the legs, keeping the back as straight as you can, (vi) hold the load firmly and close to the body, (vii) ensure your view is not impeded by the load whilst working with it, and (viii) lift slowly and smoothly and avoid jerking motions.

- When two or more persons lift a load, one of the team must be nominated to give instruction to ensure that each person lifts an equal share, and the team work together.
- If mechanical equipment is available, use it for lifting and transporting loads.

Recommended measures for housekeeping risks:

- Do not leave rubbish lying about - clean up as you go.
- Ensure all waste is disposed of in the correct skip / bin.
- Do not obstruct walkways with tools or materials.
- Make sure that spilled oil, grease or liquids are cleaned up from floors and the contaminated clean up material is disposed of in the correct skip / bin.
- Position all cables and hoses out of the way. Where possible do not lay them across walkways.
- Ensure the waste disposal area is kept tidy.

Recommended measure for lone and isolated risk:

- Procedure should establish, at a minimum, verbal contact with the worker at least once every hour, and ensure the worker has a capability for summoning emergency aid.

Mitigation measures for impact due to chemical hazards include:

Recommended mitigation measures for risks due to hazardous materials:

- All chemicals should be regarded as toxic. Poisoning can occur by accidentally swallowing the chemical when eating or drinking with contaminated hands. Always wash hands carefully after handling chemicals, and do not eat or drink in the same area as the chemicals.
- Always use the right protective equipment and clothing when handling hazardous materials.
- When refuelling by hand use a funnel or container to prevent any spillages. Immediately record and report any spillages.
- Train construction workers on proper handling and use of hazardous materials.

Recommended measures impact due to air quality:

- Good housekeeping and site planning will help to reduce dust and dirt created on site.
- Store dusty materials in an area that can reduce potential of wind erosion.
- During periods of dry weather, especially during the summer use, water sprays in order to dampen down materials, roads and vehicle routes.
- Keep your vehicle speed low on site especially during periods of dry weather.
- Maintaining levels of contaminant vapours and gases (such as paints and solvents) in the work environment at concentrations below those recommended by the manufacturer or in material safety data sheets.
- Use protective equipment, such as face mask, when working in dusty conditions or environment.

Recommended mitigation measures for risks due to fire and explosion:

- Maintain good housekeeping of work areas.
- Properly store flammable materials away from ignition sources and oxidizing materials.
- Workers should be aware of fire risk and know the precautions to prevent a fire and the action to be taken if fire does break out.
- Provide fire arrest equipment such as fire extinguishers, with type and volume commensurate with the volume and type of flammable materials available at the public works area.

Mitigation measures for impact due to biological hazards include:

- Construction activities should not progress near or in areas contaminated by wastewater or gray water.
- Use protective eye wear, face mask, and hand gloves when handling or cleaning wastewater, gray water, solid and other waste.
- Use face masks, hand wash and sanitizing to protect against air borne pathogens in the workplace.
- Use protective clothing in areas suspected to house stinging insects and venomous animals.

First Aid: The contractors should be responsible for ensuring that first aid, including the provision of trained personnel, is available at all times. Arrangements should be made to ensure the removal of medical attention to workers who have suffered an accident or sudden illness. How first aid facilities and personnel are provided should be prescribed by national laws or regulations and drawn up after consulting the competent health authority and the representative organizations of employers and workers concerned. First-aid kits or boxes, as appropriate, should be provided at workplaces, including isolated locations and in motor vehicles used for construction like dumpers and tippers. First-aid kits and boxes should not contain anything besides material for first-aid emergencies. First-aid kits and boxes should be simple with clear instructions to be followed, be kept under the charge of a responsible person qualified to render first aid and be regularly inspected and kept properly stocked not run short of medicines.

Fire Prevention and Response: There should be fire prevention and response facilities at construction locations. There should be adequate measures as listed below:

- Secure storage areas should be provided for flammable liquids, solids, and gases such as liquefied petroleum gas cylinders, paints, and other such materials to deter trespassers.
- Smoking should be strictly prohibited, and no smoking notices be predominantly displayed in all places containing readily combustible or flammable materials
- Only suitably protected electrical installations and equipment, including portable lamps, should be used.
- Oil rags, waste clothes, or other substances liable to spontaneous ignition should be removed without delay to a safe place.
- Adequate ventilation should be provided.
- Combustible materials such as packing materials sawdust, greasy/oily waste, and scrap wood or plastic should not be allowed to accumulate in workplaces but should be kept in closed metal containers in a safe place.
- Regular inspections should be made to places where there are fire risks. These include the vicinity of heating appliances, electrical installation, and conductors, stores of flammable and combustible material, hot welding and cutting operations
- Places where workers are employed should, if necessary to prevent the danger of fire, provide suitable and sufficient fire-extinguishing equipment, which should be easily visible and accessible
- An adequate water supply at ample pressure.
- Fire-extinguishing equipment should be properly maintained and inspected at suitable intervals by a competent person.
- Where appropriate, suitable visual signs should be provided to indicate the direction of escape routes in case of fire.
- The escape routes should be kept clear at all times.

Personal Protective Equipment (PPE): All construction workers must be provided with appropriate personal protective equipment (PPE) to control or eliminate hazardous exposures that may cause injury or illness. PPE includes all clothing and other work accessories designed to create a barrier against workplace hazards. Selection of the proper type of PPE is important for protecting employees from workplace hazards. Employees and workers should receive training on how to use the PPEs. To prevent injuries and illnesses, supervisors/foremen must implement and enforce the use of personal protective equipment on all company construction projects. The contractor shall provide all necessary PPE, at a minimum safety boots, hard hats, and high visibility vests.

9.4.15 Traffic and Road Safety Risk

Heavy vehicular movement between the worksite, campsite, work yard, and along materials haulage routes will significantly increase due to the construction activities. This intensified traffic, especially on shared haul roads, will impact local communities, travelers, and Subproject employees. The concurrent use of these roads by project vehicles, public vehicles, and regular community motorists will lead to vibration and noise impacts, particularly near work sites, borrow areas, and quarries. Additionally, pedestrians, livestock, and commercial bike riders along these routes face increased risks from

construction traffic. Major construction activities can also cause temporary disturbances to nearby communities, including: increased traffic flow may lead to road congestion and temporary detours; access to residences and businesses may be interrupted; construction may limit available parking near work zones; utility services in proximity to construction areas may be temporarily impacted; heavy equipment, materials, and staging areas (including concrete batching) may disrupt local surroundings; construction equipment and vehicular traffic will generate noise and vibration, affecting nearby residents; and movement of materials may create dust and mud, affecting road safety and air quality.

Mitigation measures for traffic and road safety risk include:

- In accordance with the contract for the construction of all four bridges, SCADeP will ensure that each contractor shall develop a Traffic Management Plan (TMP) as part of their program of performance. The TMP for each bridge construction site is to be reviewed and approved by the monitoring consultant for implementation by the contractors.
- The TMP for each site provides details of the best practicable option to mitigate against safety concerns and negative environmental effects caused by the construction should they occur. The TMP identifies how construction traffic will be managed to protect public safety; minimize delays to road users; minimize disruption to property access; and inform the public about any potential impacts on the road network that may result from the Subproject activities.
- Monitoring of the implementation of the TMP and the mitigating measures would minimize the negative impact of construction and the movement of construction traffic to road users and the communities.

Site-specific Traffic Management Measures for Tomparie - Kamakwei Crossing:

- Designate lanes for construction vehicles and install directional signage to separate local and project traffic, reducing congestion and accident risks.
- Mark pedestrian and livestock crossing points along the alignment and use traffic marshals during peak hours to ensure safe passage.
- Inform residents in advance about traffic disruptions, detours, and construction schedules to minimize inconvenience.
- Establish clear detour routes for non-construction traffic and, where possible, route heavy equipment away from residential areas.
- Restrict high-noise activities to off-peak hours and enforce speed limits on construction vehicles to reduce noise and vibration impacts.
- Regularly spray water on haul routes and clean roads to manage dust and maintain safe road conditions.
- Set up designated parking for construction vehicles and work with residents to ensure uninterrupted access to properties.
- Maintain an on-site team to respond to traffic incidents and educate the community on safety practices near the construction zone.
- Monitor traffic conditions and adjust the Traffic Management Plan as needed, incorporating community feedback for adaptive improvements.

Site-specific Traffic Management Measures for Mattru - Senehun Crossing:

- Create separate routes for construction vehicles to keep them away from populated community roads, reducing risk.
- Work with local mining companies to manage truck schedules and prevent congestion, minimizing hazards for residents.
- Install signage, enforce speed limits, and deploy traffic marshals at key intersections to protect pedestrians and high-risk areas.
- Engage the community, especially those impacted by relocations, to ensure safety awareness and cultural sensitivity.
- Apply dust suppression and limit high-noise activities during peak community hours to reduce disturbances.
- Regularly assess and adapt the Traffic Management Plan based on ongoing community and industry feedback.

Traffic Management Mitigation for Gendema - Garwama Crossing:

- Relocate the ferry to maintain traffic flow during bridge construction, as the bridge alignment follows the existing road.
- Work with local community leaders to manage impacts, ensuring clear communication on detours and ferry adjustments.
- Install signage, enforce speed limits, and deploy traffic marshals to protect bike commuters along the route.
- Use dust suppression and limit high-noise activities to reduce disruptions.
- Regularly review and adjust the Traffic Management Plan based on community feedback for safe, efficient traffic flow.

Traffic Management Mitigation for Manowa - Pendembu Crossing:

- Coordinate construction schedules to ensure continued access for trucks transporting agricultural goods.
- Install signage and enforce speed limits to protect local commuters.
- Regularly assess and repair road damage caused by heavy construction vehicles.
- Keep residents informed of construction schedules and access changes.
- Use water spraying to minimize dust on busy routes.
- Continuously assess traffic and road conditions, adapting plans as needed.

9.4.16 Impact of Construction Materials Transport

Environmental impacts of construction materials transport include air pollution and dust from trucks degrade air quality, impacting nearby homes, crops, and water sources; soil erosion and contamination occur as unpaved roads degrade, with possible material spills affecting local soils and agriculture; and noise pollution disrupts village tranquility and can disturb local wildlife. Socioeconomic impacts of construction materials transport include increased safety risks arise for villagers, particularly pedestrians, cyclists, children, and livestock; repeated heavy traffic damages community infrastructure, leading to more frequent road repairs and access challenges; daily life is disturbed by noise, dust, and road congestion, affecting schools, markets, and social gatherings; higher road maintenance costs may strain local government or community budgets; local businesses may experience reduced foot traffic due to noise, dust, and safety concerns; and agricultural productivity can decline as dust settles on crops, impacting farmers' livelihoods.

The following mitigation measures should be considered for impact of construction materials transport:

- Regularly spray roads with water and cover truckloads to prevent materials from being blown away or falling off. Use fuel-efficient vehicles to reduce emissions.
- Maintain roads to prevent erosion, designate specific loading areas to contain spills, and equip trucks with spill kits for immediate response to accidental spills.
- Restrict transport to designated hours, use noise-dampening equipment, and enforce speed limits in residential areas to reduce noise.
- Install signage, enforce speed limits, and create pedestrian crossings. Position traffic marshals at high-risk areas to protect pedestrians, cyclists, and livestock.
- Conduct regular road inspections and repairs, establish a cost-sharing maintenance plan with local authorities, and enforce compliance with traffic policies.
- Schedule transport during off-peak hours to reduce congestion near schools, markets, and social spaces. Provide advance notice of any disruptions to allow for community planning.
- Work with local authorities to set up a shared maintenance fund, reducing the financial burden on the community and ensuring timely repairs.
- Spray water near agricultural areas to protect crops from dust, cover truckloads, and communicate transport schedules with local businesses to mitigate disruptions.

9.4.17 Impact of Bridge Construction on River Traffic

Bridge construction near river crossing sites can create temporary hazards for small wooden boats, canoes, and ferries. Construction may obstruct typical routes, increasing the risk of collisions and forcing operators to navigate around unfamiliar barriers. Construction may lead to temporary changes

in the river channel, including alterations in water depth, width, or flow patterns, which can restrict navigation. These changes increase the risk of boats getting stuck, grounding, or capsizing, especially if the channel is not clearly marked or if navigation aids are lacking. Bridge construction activities, such as temporary cofferdams, may alter river flow, resulting in increased water velocity or turbulence. This can make navigation more challenging, particularly for small boats or inexperienced operators, increasing the likelihood of accidents. At locations like Gendema - Garwama, ferry relocation may be required, necessitating new diversion routes. This change introduces navigational risks for both ferries and small boats, making proper signage and clear directional markers essential to ensure safe passage. While river crossings typically occur in daylight, early morning or evening trips can face additional risks if construction zones or barriers are not clearly marked. Effective warning signals and signage are critical to ensure the safety of boats and ferries navigating near construction areas.

The number of operational boats at each of the river crossings is given in the table below.

Table 47. Number of Boats at each Crossing

No	Bridge Location	Number of Boats	Level of Risk
1	Matru-Senehun Crossing	5	Medium
2	Gendema-Garwama Crossing	5	Medium
3	Manowa-Pendembu Crossing	2	Low
4	Tompari-Kamakwie Crossing	6	Medium

Mitigation measures for safe river traffic management during bridge construction include:

- Place clear warning signs, buoys, and markers around construction zones to guide small boats, canoes, and ferries safely. Ensure these aids align with the Traffic Management Plan to maintain safe navigation.
- Limit access to construction zones strictly to authorized personnel. Enforce safe distances between boats and construction sites, using physical barriers or signage to keep unauthorized vessels away from heavy machinery and construction activities.
- Relocate the Gendema ferry, creating a clearly marked alternative crossing route away from the bridge alignment. Where necessary, provide additional crossing options, such as barges, to ensure river users maintain safe access during construction.
- Continued ferry operations at Manowa, Tomparie, and Matru. Maintain regular ferry services at these sites, where construction does not interfere with ferry routes. Establish safe, marked boat crossings upstream or downstream to minimize construction interaction.
- Conduct hydrographic surveys to establish safe, hazard-free alternative routes for boats and canoes, taking river depth and flow patterns into account. Regularly monitor these routes, making adjustments as needed based on evolving construction or river conditions.
- Require all construction personnel working over water to wear personal flotation devices (PFDs) or life jackets. Equip work areas with essential safety supplies, such as throw ropes, whistles, flashlights, and first aid kits, to enhance safety over water.
- Implement real-time communication systems, such as signage and local announcements, to inform boat operators of navigation restrictions, construction activities, and potential hazards. Regularly update local communities on river access changes and alternative routes.
- Engage with boat and ferry operators regularly to communicate construction schedules and potential navigation risks. Use local notices and broadcasts to keep communities informed of any restrictions or detours affecting river traffic.
- Follow all local navigation regulations and coordinate with relevant authorities to ensure safe passage for boats and ferries around construction areas.
- Regularly review and update the contractor's Traffic Management Plan as construction progresses, with revisions approved by the monitoring consultant to ensure safety compliance.
- Require contractors to implement an emergency response plan covering potential river accidents and hazardous material spills. Train construction personnel on safe navigation, emergency response, and environmental protection procedures.

- Maintain a dedicated emergency response team with ready access to rescue equipment, including life rafts, throw ropes, and rescue buoys, stationed at construction sites for immediate response.
- Conduct emergency response drills with both the rescue team and boat operators, practicing rescue techniques, communication protocols, and safe evacuation methods.
- Monitor weather and river conditions continuously. Prepare to suspend boat crossings during adverse conditions, such as high-water levels or strong currents, to ensure the safety of boat operators and passengers.
- The contractor's Safety Officer should oversee strict compliance with safety guidelines for river traffic, manage access control near construction zones, and ensure all personnel are equipped with appropriate safety gear and trained in emergency procedures.

9.4.18 Impact on Borrow Pits and Quarry Sites

Borrow pits and access roads are often developed in highly erodible materials, which can lead to increased erosion, especially in sensitive landscapes, potentially degrading surrounding areas. Deep pits created during quarrying or removal of soil materials can pose safety risks, especially if they fill with water during the wet season, becoming potential drowning hazards and breeding grounds for disease-carrying insects. The movement of vehicles and machinery to and from borrow pits can raise dust levels, potentially impacting air quality and visibility for nearby communities, especially during the dry season. Borrow pits and quarry sites, particularly those in elevated areas, can leave visible scars on the landscape, diminishing the visual quality of otherwise pleasant views

Mitigation measures for impact on borrow pits and quarry sites include:

- Apply soil stabilization measures such as silt fences, sediment barriers, or erosion control mats around borrow pits and access roads to prevent soil loss. Where feasible, plant fast-growing grasses or native vegetation around pit perimeters and along access roads to stabilize soil and reduce erosion.
- Install fences or barriers around deep pits to prevent unauthorized access, especially in areas frequented by residents or animals. Clearly label areas with warning signs to inform of potential hazards. Ensure proper drainage to prevent water accumulation. Where standing water cannot be avoided, consider safe mosquito control measures to limit insect breeding and reduce disease risk.
- Spray water on access roads and active areas of borrow pits during dry conditions to control dust levels, particularly near populated areas. Enforce reduced vehicle speeds on unpaved access roads to minimize dust generation. Consider creating designated routes that reduce dust exposure to nearby communities.
- Begin land rehabilitation as soon as sections of the borrow pits are no longer in use. Re-contour pits to blend with the natural landscape, creating gradual slopes where feasible. Spread stockpiled topsoil over disturbed areas in a 10 cm layer to promote natural regrowth. Water to encourage seed germination and monitor for sufficient growth. If natural regrowth is insufficient after two months, hydro-seed with a mix of indigenous grass species. Apply fertilizer as needed to support plant establishment and stabilize the landscape.

The locations of proposed borrow pits and quarry sites with the villages affected by each bridge construction are given in the table below.

Table 48: Borrow Pits and Quarry Sites

Bridge Site	Borrow Pit Location		Quarry Site Location		Villages/Towns between Borrow Pit and Bridge Site	Villages/Towns between Quarry Site and Bridge Site
	Eastings	Northings	Eastings	Northings		
Manowa	308498.61	903014.55	307101.07	905090.23	-	Manowa
Tomparie	790259.43	1050998.20	783478.21	1060461.50	Kapitel Makoto Junction Tomparie 1	Lita Kutu Samaia Tomparie 2

Bridge Site	Borrow Pit Location		Quarry Site Location		Villages/Towns between Borrow Pit and Bridge Site	Villages/Towns between Quarry Site and Bridge Site
	Eastings	Northings	Eastings	Northings		
Gendema	241969.53	913704.39	239666.06	912105.69	Gendema	Gendema
Matru Jong	630899.45	915803.46	678969.35	931206.59	Senahun	Senahun, Matru

Quarry Sites

For the quarry sites, the two contractors (Al-Own/HDF Limited Joint Venture for Lot-1 and Lot-4, and Sinohydro/ Sinohydro / Sinohydro Bureau 9 Joint Venture for Lot-2 and Lot-3) will obtain coarse aggregate materials from established quarries away from the bridge construction sites that are licensed by the EPA-SL. Al-Own/HDF will get coarse and fine aggregates from the HDF Quarry in Okro Hill (216km from the project site) while contractor Sinohydro from Well Property Co. Ltd Quarry in Okro Hill (264km from the project site) & First Tricon Quarry in Bo (95km from the project site).

9.4.19 Impact of Labor Influx

The labor problem arises with bringing an external labor force for work and likely impacts caused due to the new workforce at the site. This was given in the following paragraphs. The use of local labor during construction will increase benefits to the local community by providing employment opportunities and economic benefits. Increased traffic during construction will be managed through coordination between the contractor, and various authorities. Contractors will communicate to the public through community consultation regarding the scope and schedule of construction, as well as certain activities that cause disruptions or access restrictions.

The siting of construction camps has the potential to cause conflict with the local population if done without consideration for local traditions and customs. Job seekers may be attracted to the area and that may increase the risk of illegal hunting, logging, and encroachment of land. The influx of a large number of outside workers into small villages may lead to conflict. The employment of local labor on the Subproject will go some way to decreasing the risks but there will still need to be a sizable proportion of the workforce recruited from outside the area. Construction camps must therefore be sited well away from local communities to minimize interactions between the workforce and the local populations.

The construction sites are likely to have limited public health impacts due to their isolated location. However, contractors will ensure that no wastewater is discharged to local water bodies and that no site-specific landfills will be established at the construction camps to reduce the risk of malaria as it is the prevalent sickness in the Subproject areas according to the locals. There will be a potential for diseases to be transmitted, exacerbated by inadequate health and safety practices. Each contractor will therefore be required to recruit an environmental, health, and safety manager to address such concerns in the work sites and liaise/work with the laborers.

In-Migration: In-migration issues for the construction and operational phases of the four bridges are similar. In-migration during the construction phase can be short-lived and intermittent in many cases due to the breaks in the construction season, whilst that of the operational phase lives with the infrastructure and could be more severe because of the anticipated operational life of the bridge which is estimated at 100 years. However, with effective maintenance and upkeep, the bridge is expected to last beyond the 100years. In-migration of employees and job seekers has the potential for the following socioeconomic impacts:

- Changes in employment, livelihoods, and the local economy.
- Increased pressure on land resources; and biodiversity through the use of natural resources.
- Increased pressure on available housing.
- Increased pressure on community infrastructure and social services, including health centers, schools, water supplies, waste and sanitation, and markets.
- Spread of diseases, including sexually transmitted infections and HIV/AIDs.
- Disruption of social and cultural values of host communities.

- The potential source of dispute and conflict.
- Potential “boom and bust” economic cycles.
- Changes in community dynamics such as increased prostitution.

Prostitution and Vulnerability: As a result of the increased level of poverty in the local communities, the high level of Gender-Based Violence and the influx of relatively wealthier workers and professionals who are single men make these local communities vulnerable to GBV and prostitution. Prostitution’s negative impact can have multiple effects. For instance, the incidence of HIV/AIDs and other sexually transmitted diseases can increase particularly in impoverished towns and villages; the temporary economic benefits of it can distort the local economy. Disapproval can lead to young women, involved in prostitution, being ostracized and sent away from their families and communities thus increasing their vulnerability to more dangerous prostitution elsewhere.

Mitigation measures for impact of labor influx include:

- Provision of adequate healthcare facilities (first aid) within construction sites.
- Training of all construction workers in basic sanitation and healthcare issues, general health and safety matters, and the specific potential hazards of their work.
- Personal protection equipment for workers, such as safety boots, helmets, gloves, protective clothing, goggles and ear protection must be provided.
- Clean drinking water facilities for all workers must be provided.
- Adequate protection to the general public, including safety barriers and marking of hazardous areas.
- Ensure safe access across the construction site.
- Adequate drainage throughout the camp to ensure that disease vectors such as stagnant water bodies and puddles do not form.
- Septic tanks and garbage bins are to be set up in the construction site, which will be periodically cleared by the contractors to prevent outbreaks of diseases.
- Where feasible the contractor will arrange the temporary integration of waste collection from work sites into existing waste collection systems and disposal facilities of nearby communities.
- The implementation of a local content policy places preference on the recruitment of a qualified workforce from local communities in the proposed bridge locations, wherever possible, for construction and decommissioning. This will minimize the need for the immigration of workers from elsewhere
- Contractors will conduct thorough cultural induction briefings with all their employees on topics such as the sexual norms of the communities. Contractors will also carry out regular meetings with representatives of the local community throughout the construction, decommissioning of facilities, and commissioning of the bridges. Community relations’ (Social Safeguards Specialist) will be appointed by the contractors to liaise with the communities throughout the life of the proposed Subproject. This person will be responsible for community briefings, and dissemination of information by various media. These meetings will keep the community fully informed of the process and will give local people an opportunity to register any complaints or concerns
- Encouraged and developed sustainable income generation opportunities for women with the assistance of local councils. If these measures are taken, the risk of prostitution will be significantly minimized.

9.4.20 Impact on Cultural Heritage and Physical Cultural Resources

Physical Cultural Resources (PCR) are defined as movable or immovable objects, sites, structures or group of structures having archaeological, paleontological, historical, architectural, religious, aesthetic or other cultural significance.

The Monuments and Relics Commission is the main statutory body responsible for the protection of cultural heritage in Sierra Leone. In 1946 an ordinance was passed 'to provide for the preservation of Ancient, Historical, and Natural Monuments, Relics, and other objects of Archaeological,

Ethnographical, Historical or other Scientific Interest. This ordinance set up the Monuments and Relics Commission as a corporate body.

The World Bank recognizes the importance of cultural heritage for current and future generations. It is focused on ensuring that project proponents protect cultural heritage in the course of their project activities. The general objectives are to protect cultural heritage from the adverse impacts of Subproject activities and support its preservation; and to promote an equitable sharing of potential benefits from the use of cultural heritage.

Cultural heritage resources are normally not fully known during project preparation, but some Subproject activities such as road works, borrow pit excavations or some limited movements of earth may be located in the influence area of some sites. Such activities may have potential impacts on previously unidentified physical cultural resources; thus, chance finds procedures will be utilized to any encounter to an archaeological nature. Graves for instance, could be located along Subproject sites. Physical Cultural Resources (OP/BP 4.11) policy requires that whenever physical cultural resources are encountered an investigation and inventory of cultural resources that could potentially be affected by project activities. Annex 11.19 of this ESIA provides a clear procedure for identification, protection and treatment of archaeological artifacts discovered during construction phase of the Subproject. Chance finds procedures will include cessation of work until the significance of a “find” has been determined by the appropriate authorities and local inhabitants, and until fitting treatment of the site has been determined and carried out.

Cultural practices and society shrines play a dominant role in the lifestyles of the people in all four localities where the bridges will be constructed. The traditional sacred societies practiced in these communities are Poro (male), Bondo (Temne) Sande (Mende) for female folks, Wonde (Mende) for Males, Gbangbani, and Ojeh. Ancestral cemeteries or burial grounds, and sacred bushes and shrines were also observed in the villages and communities around the Subproject localities. Except for Gendema-Gawama and Matru Jong-Senehun where the road alignment may affect one grave, and a Sande Bush (female secret society), the proposed bridge Subproject activities at Manowa and Tompari are not located close to any cemeteries or sacred places of archaeological significance. The community leaders and owners of the grave at Gendema-Gawama Crossing will be engaged to move the grave to another safe location in the event it is unavoidably affected. Equally, the community at Senehun will be engaged in the possible relocation of the Sande Bush (hut). Notwithstanding these engagements, all rites and ceremonies will be duly observed and followed.

Specific impacts on physical cultural resources include:

- At Matru-Senehun Crossing, a Sande Bush (female secret society) will be affected by the bridge alignment.
- At Gendema-Gawama, a grave will be affected by the bridge alignment.
- The bridge construction requires the alteration of the existing landscape, including the excavation of land, installation of support structures, and modification of natural features. This can disrupt the visual and spatial integrity of the surrounding area, affecting the historic landscapes and scenic views that contribute to the cultural heritage of the Subproject areas.

Mitigation measures for impact on cultural heritage and physical cultural resources include:

- Relocate the affected female secret society (Sande Bush) in accordance with laws and local traditional norms and in consultation with the local people during resettlement and or compensation.
- Relocate the graveyard before excavation works.
- Identify and set aside a plot of land for re-burying the exhumed bodies.
- Compensations for the land and funds for rituals and reburial should be done.
- Perform burials in consultation with the traditional rulers.
- Involve the local community and relevant stakeholders in the decision-making process to ensure their concerns and perspectives are considered. Engage in open dialogue and collaborate with

heritage experts, community leaders, and cultural organizations to develop mutually beneficial solutions and preserve cultural heritage.

- Apply chance finds procedures as deemed necessary.

9.4.21 Impact on Access to Public Service

Health: An influx of employees, job seekers, and other new residents could result in the spread of diseases, such as COVID-19 and sexually transmitted diseases including HIV/AIDS. This may likely increase the number of people accessing health facilities in the Subproject localities, particularly in larger settlements and towns close to these areas. As a result of this increased pressure, there is a risk of either higher costs being charged for service or an increase in waiting times, both of which are associated with poorer health outcomes.

Existing data also shows that malaria is the most common disease in Sierra Leone. The presence of shallow and stagnant water bodies in these areas could provide suitable habitat for these vectors. Employee training programs and community education initiatives will strive to educate employees and residents on ways to avoid contact with disease vectors and to limit the potential for coming down with malaria. With appropriate training, monitoring, and mitigation measures, the potential impact on public health and safety is expected to be insignificant.

The following mitigation measures should be implemented for impact on access to health facilities:

- Provision of additional health facilities.
- Provision of health services on-site with CHO-trained medical personnel, or Nurses to treat all workers, which will avoid new demands on health services by out-of-area workers. However, cases beyond the capacity of the clinic to treat will be referred to the District Hospital or Freetown hospitals for more specialist care.
- Avoid and minimize environmental effects that have the potential to affect health including dust, noise, and any effects that may negatively affect livelihood resources, such as contamination of the rivers or farmlands.
- Contractors may include vaccination programs for preventable diseases, HIV/AIDS education and awareness campaigns, and COVID-19 sensitization.
- Encourage staff to cooperate with the health system through Voluntary, Counselling and Testing (VCT) centers and improving care and treatment programs.
- Map high-risk areas where sexual transactions occur and support intensive education and disease prevention program.
- Repeated awareness campaign targeting management, sub-contractors, locals near Subproject facilities, and risk groups (commercial sex workers, truck drivers, police and military forces, young adults).

Education: Only a few secondary schools exist in the various chiefdoms surveyed. Failure to complete secondary school education would mean early marriage, as there are no other socioeconomic pursuits other than trading or business. Women in these communities generally marry at an average age of 17 years and are liable to bear an average of 8 children during the childbearing period.

Public Utilities: Normal public utilities in these localities are almost non-existent; with the potential population rise that might come along with the Subproject, local employees and migrants may put pressure on the little community provision, in particular sanitation facilities and waste management, although the impact is likely to be short-term as systems adapt. The Subproject will maintain an active grievance mechanism to ensure that communities can report any issues with access to services.

9.4.22 Impact on Social Services and Infrastructure

With the construction of the proposed bridges, the level of social services and infrastructure of the Subproject corridor in the various localities will improve greatly. Housing in many villages is a mix of traditional and few modern structures. In-migration into the Subproject area is expected to expand some settlements with modern structures. There will be considerable pressure on the existing facilities including housing infrastructure, guesthouses, water supply, electricity, and transportation. There will

be a sudden demand for local and imported commodities, entertainment centers, etc. This will expand and diversify the economy and improve the quality of life of the people.

9.4.23 Impact on Employment and Local Economy

Direct Employment Income: Employment provides many socioeconomic benefits to employees and their dependents, including improved material wealth and standard of living, enhanced potential to invest, and improved access to social services, such as education and health services. The four bridges Subproject will have a direct positive impact by employing locals. The project (contractors) will seek to hire middle management, skilled and junior management, and semi-skilled and unskilled employees. The Government of Sierra Leone 2010 developed the local content policy, which requires corporate entities to give priority in their recruitment process in hiring indigenes of the Subproject area. SCADeP is keen on issues of local employment and will the recruitment, training, and payment of locals, although such construction activities will require technically skilled and highly specialized people. The project (contractors) preferential hiring policy will be implemented, whereby if applicants with the same experience and qualifications apply for a job, the applicant from the project locality will receive priority.

Training of local employees in construction skills will be used to build associated skills that will be useful and appropriate outside and beyond the individual's career in bridge construction.

The short-term impact of direct employment income is expected to have a significant positive economic impact. At the closure of the construction phase, the skills transfer and job training program would have benefited the local workforce and equipped them with industrial opportunities to secure employment elsewhere.

Agricultural Income and Land Pressures: Agricultural activities are the predominant sources of income and livelihood in the nearby villages to the bridge locations, and most households farm at subsistence levels. The commencement of such large-scale construction activities, coupled with continued population growth and the influx of newcomers, will increase land competition and have the potential to reduce crop yields from remaining lands and associated agriculturally derived household incomes. This may indirectly impact household food security and income derived from the sales of agricultural products. In effect, most farm households, which often produce at the subsistence levels, will likely be at risk of running short of food within a short period. Intensification of agriculture and the development of alternative sources, to diversify household livelihoods and income will be a key action for assuring household food security in the project areas. However, the proposed mitigation (restoration of livelihood) and diversification of income sources will moderate the potential impacts associated with this aspect. The net impact on income is expected to be insignificant but will be critically dependent on the effective implementation of the proposed mitigation measures.

Indirect Income Benefits: In addition to the income benefits provided by directly employing people for the construction Project and its associated activities, the various areas of influence will receive substantial short-term indirect income benefits as a result of the proposed Bridge Subproject. For example, the Project will require numerous vendors and service providers to meet the daily local operating needs of the Project. The Project will also induce secondary/tertiary economic activity due to the influx of people from outside the immediate areas where these bridges are constructed who will require housing, food, and other supplies. The multiplier effects of this order would be significant and there will be positive benefits of the project.

9.4.24 Community Networks and Social Structures

The Subproject may be impacted by changes to community networks including traditional and customary institutions and associations. These structures are major forms of social capital and constitute important support networks that supplement livelihoods, cushioning the vulnerable, maintaining law and order, and in general binding communities together creating stability and security. Therefore, any changes or weakening of these institutions is more likely to create anxiety and insecurity.

Also, employment and changes to incomes can change community dynamics by creating tension between those who are perceived to be benefitting from the construction project and those who are not. These tensions are even more likely to occur if it is thought that migrants are receiving the greatest share of benefits.

Mitigation measures include:

- Collaborate with CBOs and other stakeholders to support programs that include empowerment of women and girls, gender-based violence prevention programs (workshops), and skills training for men and women.
- Support the equitable representation of women in Subproject-related decision-making committees.
- The grievance mechanism will allow communities to raise concerns over perceived cultural insensitivities or conflicts.

Any changes to community networks will likely be gradual, but permanent throughout the lifetime of the development. It is also recognized that community structures have already proven their resilience, and will develop naturally over time, so that change per se is not necessarily a negative impact.

9.5 OPERATION PERIOD ADVERSE ENVIRONMENTAL AND SOCIAL IMPACTS

Operation of the approach roads and bridges can only be seen as part of the operation of the road networks in the Subproject areas since the project infrastructure will be part of the overall road networks. However, certain risks and impacts will affect the local environment and communities in the Subproject area. These risks and associated mitigation measures are discussed in the below sections.

9.5.1 Impact on Water Resources and Soil

During the operation period of the bridges and approach roads, it is expected that vehicular transport will increase. Vehicles traffic and the road surface are source of water and soil contamination. Operation of the project is expected to deposit pollutants from vehicle exhausts, fuel and lubricants leakage, wear and tear of tires, brakes and chassis, and road surface wear. Heavy metals and particulate matter will end up in water and soil from these contaminant sources during rainfall events and through runoff. Metals most commonly emitted from these sources include Cu, Cr, Ni, Zn, and Pb. Use of lubricant oil and incomplete combustion of fuel generate polycyclic aromatic hydrocarbons in to the environment. Water and soil contamination from road traffic leads to environmental pollution and affects the health and wellbeing of humans and animals. Mitigation measures for impact on water resources and soil include:

- Adopt overall vehicle inspection and maintenance standards at local level, and if possible at a national level so that worn out vehicle parts, oil, and fuel are not used.
- Adequacy of vehicles transporting hazardous materials should be checked at their origins.
- Appropriate traffic signs should be erected to inform and warn vehicles about the road/bridge they are using.
- Awareness/education should be given to drivers engaged in transportation of hazardous materials.
- Vehicles maintenance on the approach roads and bridges should be prohibited.

9.5.2 Impact on Air Quality

When the Subproject bridges are open for traffic, it expected that vehicle emissions will affect the ambient air in the immediate Subproject areas. Approach roads are sources of linear pollution with particulate matter (PM), CO, NO_x, and SO_x being the main pollutants. The source of these pollutants is primarily from vehicle exhausts, wear and tear of tires, and deposition of road dust from vehicles. Mitigation measures for impact on air quality during the operation period include:

- Adopt tighter fuel and vehicle emission standards.
- Strengthen vehicle emission inspections and enforcement against grossly emitting vehicles.
- Promote better vehicle maintenance practices.
- Consider planting trees by the side of the approach roads as they have a filtering effect.

9.5.3 Impact on Aquatic Habitats and Biodiversity

The Subproject bridges, particularly the piers and abutments, are expected to alter the natural flow regime of the river through channel modification (including dredging for bridge foundations, restriction of flow, and destruction of aquatic vegetation and habitats). During the operation of the bridges it is expected that the area will reach to an equilibrium. However, bridge maintenance work could lead to dredging of materials under, upstream and downstream of the bridges, and clearing of aquatic and riparian vegetation. These activities will affect the aquatic habitats and biodiversity. Therefore, it is necessary for the bridge operators to implement some of the measures proposed for impact on aquatic habitats and biodiversity during the construction period.

9.5.4 Community Health and Safety Risks

Impact due to Noise: Bridge and approach roads traffic noise affects health of the local communities. Its direct impact includes hearing loss and cardiovascular effects while the indirect impacts are annoyance and sleep disturbance. Mitigation measures to consider include lower vehicles speed through signage, particularly on the approach roads, and trees should be planted by the side of the approach roads as they contribute to reduction in noise level.

Impact due to Vehicle Emissions: Vehicle emission from exhausts can adversely affect the health and wellbeing of communities residing close to the Subproject bridges. Pollutants such as particulate matter, CO, NO_x, and SO_x will be emitted from traffic on the bridges. Mitigation measures include:

- Vehicles should be serviced regularly and adequately, at local and national level.
- Strengthen vehicle emission inspections and enforcement against grossly emitting vehicles.
- Trees should be planted along approach roadsides as they have a filtering effect.

Impact due to Traffic and Road Safety: Operation of the bridges will increase traffic and road safety risks. The drivers of traffic accidents include poor pavement conditions of the approach roads, presence of obstructions on the approach roads and bridges, increased use of the bridges by pedestrian traffic, and increased speed of vehicles. Mitigation measures for traffic and road safety risk include:

- Provide traffic calming structures such as humps and rumble strips on the approach roads to reduce the speed of approach vehicles.
- Provide road safety education programs or awareness campaigns in local schools and also in public gathering locations to create awareness among the local community on traffic risks and measures.
- The local traffic police should enforce speed restriction measures on the approach roads.
- Put traffic signs on the approach roads using local languages to minimize accident and death of pedestrians and motorists.
- Strengthen the capacity building of local traffic police for management of traffic and road safety risks.

9.6 SIGNIFICANCE OF ENVIRONMENTAL AND SOCIAL RISKS AND IMPACTS

The E&S impacts of construction of the bridges, approach roads, and associated activities are likely to be experienced across the locality where these bridges will be built. Although the contractors have to develop site-specific ESMPs for their separate Subproject sites and operations, the impacts of the proposed project in the area must be seen holistically, and appropriate management measures must be implemented to limit its cumulative negative impacts on its immediate environment and adjacent communities. The following table evaluates the significance of the E&S risks and impacts.

Table 49: Evaluation of the Significance of Environmental and Social Risks and Impacts

No.	Risks and Impacts	Impact Nature	Impact Type	Impact Duration	Impact Extent	Magnitude	Likelihood	Significance
Construction Period Adverse Environmental and Social Risks and Impacts								
1	Impact on water resources	-ve	D	S	L	H	D	Ma
2	Impact on surface water quality	-ve	D	S	L	H	D	Ma
3	Impact on aquatic habitats and biodiversity	-ve	D	S	L	H	D	Ma
4	Impact on fisheries	-ve	D	S	L	H	D	Ma
5	Impact on terrestrial habitats and biodiversity	-ve	D	S	L	M	L	Mo
6	Impact on soil/land and erosion	-ve	D	S	L	M	D	Mo
7	Impact on landscape and visual receptors	-ve	D	L	L	L	D	Mi
8	Impact on air quality	-ve	D	S	L	L	D	Mi
9	Impact of noise	-ve	D	S	L	L	D	Mi
10	Impact of vibration	-ve	D	S	L	L	D	Mi
11	Impact from construction waste	-ve	D	M	L	M	D	Mo
12	Impact from hazardous materials and waste	-ve	D	M	L	M	D	Mo
13	Impact from construction camps	-ve	D	L	L	M	D	Mo
14	Occupational health and safety risk	-ve	D	S	L	H	D	Ma
15	Traffic and road safety risk	-ve	D	S	L	H	L	Ma
16	Impact of construction materials transport	-ve	D	S	L	H	L	Ma
17	Impact of bridge construction on river traffic	-ve	D	S	L	M	L	Mo
18	Impact on borrow pits and quarry sites	-ve	D	L	L	H	D	Ma
19	Impact of labor influx	-ve	D	M	R	M	L	Mo
20	Impact on cultural heritage and physical cultural resources	-ve	D	L	L	M	L	Mo
21	Impact on access to public service	-ve	I	S	L	L	L	Mi
22	Impact on social services and infrastructure	-ve	I	M	L	L	L	Mi
23	Impact on employment and local economy	-ve	I	L	R	M	L	Mo
24	Community networks and social structures	-ve	I	M	L	L	L	Mi
Operation Period Adverse Environmental and Social Risks and Impacts								
1	Impact on water resources and soil	-ve	D	L	L	L	L	Mi
2	Impact on air quality	-ve	D	L	L	L	L	Mi
3	Impact on aquatic habitats and biodiversity	-ve	D	L	L	L	L	Mi
4	Community health and safety risks	-ve	D	L	L	M	L	Mo
Cumulative Impacts								
1	Cumulative impacts	-ve	C	L	R	L	L	Mi

Key:

Impact Nature: negative (-ve), positive (+ve), neutral (-)

Impact Type: direct (D), indirect (I), cumulative (C), residual (R)

Impact Duration: short-term (S), medium-term (M), long-term (L)

Impact Extent: local (L), regional (R), international (I)

Impact Magnitude: negligible (N), low (L), medium (M), high (H)

Impact Likelihood: unlikely (U), likely (L), definite (D)

Impact Significance: negligible (N), minor (Mi), moderate (Mo), Major (Ma)

9.7 CUMULATIVE IMPACTS

The risks and cumulative impacts of this Subproject and its associated activities must be analyzed in terms of the Subproject's area of influence, which is defined as follows:

“This area of influence encompasses, as appropriate (i) the primary Subproject site(s) and related facilities that the contractors (including its sub-contractors) develops or controls, such as power access roads, borrow and disposal areas, construction camps works yard and quarries; (ii) areas potentially impacted by cumulative impacts from future development and expansion of the roads connecting to the proposed bridges, any existing project or condition, and other project-related developments that are realistically defined at the time the Social and Environmental Assessment is undertaken; and (iii) areas potentially affected by impacts from unplanned but predictable developments caused by the proposed Subproject that may occur later or at a different location. The area of influence does not include potential impacts that would occur without the Subproject or independently of the project.”

Both biophysical and social impacts can be expected to be cumulative. Cumulative impacts are assessed over the entire lifespan of the construction and operation of the bridges and are therefore not broken down into the construction, operation, and decommissioning phases as was done for the ESIA. The most important cumulative impacts of the proposed and existing roads and cable ferries in the Subproject area of influence include:

- Impacts on air quality
- Impacts on noise
- Impacts on water quality
- Impacts on the ecology
- Impacts on the social environment

Each of these potential cumulative impacts is described below.

9.7.1 Air Quality

There is the potential for cumulative impacts on air quality. Even with mitigation, PM10 impacts at some locations as a result of the excavation and haulage of materials to and from borrow areas and construction sites, the future operation of the bridge will potentially attract more vehicle movement on surrounding roads (mostly unpaved) and subsequently creating a significant cumulative impact. The cumulative impacts associated with air quality as a result of the construction and operation of the proposed bridges include: dust emission throughout the life of the bridge, this is an additional impact in an area that already has increased dust emission from roads leading to these communities.

Management Considerations: Effective implementation of mitigation measures during construction activities should reduce air quality to negligible levels in most cases. However, during periods of particularly windy weather during the dry season, it may be necessary to temporarily reduce dust-causing activities associated with the construction until weather conditions improve. Mitigation measures are considered adequate to reduce impacts to negligible levels.

9.7.2 Geology

Cumulative impacts associated with geology as a result of the proposed operation of quarries and borrow-pits impacts include the removal of rocks and excavation of laterite material to meet the construction demands. The construction of these bridges and the operation of the above facilities will permanently alter the geology of the areas in which they will be operated.

Management Considerations: Adhere to the prescribed works program and options listed in the ESMP and ensure progressive rehabilitation works for optimal reclamation.

9.7.3 Noise

There is potential for cumulative impacts to occur from the interaction of the following operations. Haulage of materials, operation of heavy-duty machinery, and road usage for communities and settlements close to the work areas, and any other receptors within 100 meters of both the quarry and borrow pit.

Management Considerations: The Subproject will commit to noise reduction technologies and some other noise mitigation measures already prescribed, the cumulative noise impacts as a result of adjacent mining and timber logging operations will serve to exacerbate the residual noise impacts already identified for the proposed bridge construction and operation.

9.7.4 Hydrology

Impacts on the various rivers from abstraction are therefore considered Negligible. But indirectly the cumulative impacts will be the deterioration of water quality and quantity of downstream water users especially when coffer dams and diversions are done.

Management Considerations: Maintain the state of the rivers through adequate implementation of those mitigation measures described above, which are designed to minimize adverse impacts on the water quality and aquatic ecology of the rivers where these bridges will be constructed and other nearby streams.

9.7.5 Ecology

Ecosystem function in terms of terrestrial faunal and flora species is already heavily degraded. Ongoing mining, timber logging, and shift cultivation patterns have left behind a huge legacy that will contribute to further loss of ecological habitat. Thus, the proposed project development activities will compound the existing faunal and flora impoverishment due to existing land use and expansion of settlement areas.

Management Considerations: SCADeP, development partners, and other interested parties will work together to implement the following actions to safeguard biodiversity in the greater area:

- Limit Subproject footprints to areas necessary.
- Follow the progressive rehabilitation plan and wherever possible, small patches of natural vegetation containing bush clumps or thickets should be left intact.
- Other developmental, mining, or infrastructural operations in the various vicinities are encouraged to adopt species protection policies that prohibit staff and contractors from a range of activities such as Any forms of hunting or fishing of wildlife by personnel during work times; purchasing of local wildlife for any reason; collection of any animals or animal products for consumption, medicinal use. Such sellers of wildlife on development project premises should be reported to the police or protected areas office or any wildlife agencies as appropriate, and
- The intentional killing of any animals including snakes, lizards, birds, or other animals should be strictly prohibited.

9.7.6 Social Environment

The construction of the proposed bridges on positive social impacts will result in improved economic conditions in the regions or areas of the bridges. The construction and operation of the bridges will further create job opportunities, and dispersed markets for goods and services, which will significantly stimulate the local economy and act as a catalyst for future service delivery in the regions. The potential to exacerbate unemployment figures within the various districts is possible in the long term. The negative social impacts include, for instance:

- Population influx
- Changes in livelihood from agriculture to housing and road
- Increased inflation may impact those less likely to benefit such as vulnerable groups including the elderly and physically impaired communities
- Increased pressure on housing, land ecosystems, and biodiversity through the use of natural resources
- Increased social delinquency
- Changes to the disease profile and transmission of diseases; and
- Disturbance relating to access and movement of cultural heritage sites and changes to traditional structures.

In summary of the above points, the Subproject will work closely with the government, chiefdom authorities, local councils, and other stakeholders in the Subproject areas to ensure that the negative

impacts of influx are managed collaboratively and that the opportunities are enhanced contributing to the physical and economic development of affected communities.

Management Considerations for Road Safety: Conduct regular community information sessions around road safety and project-related road usage. Enforce rules on speed limits and road usage for all contractors' and sub-contractors' vehicles using community and public roads. Contractors and Subcontractors will be encouraged to install tracking technology (GPS, speed-logging equipment, etc.) to review driver performance and identify drivers with a history of unsafe Behavior. Minimize the transport of bulk equipment on public roads.

9.7.7 Cultural Heritages and Physical Cultural Resources

The matter that may have a cumulative impact is the possible relocation of one grave at the Gendema-Gawama Crossing and the potential relocation of the Sande (Bondo) Bush in Matru Jong-Senehun Crossing during the construction. It should be noted that the subterranean presence of archaeological and/or historical sites, including graves, and features of artifacts is always a distinct possibility in such construction projects. Especially in remote settings where there are no designated burial sites.

10 ENVIRONMENTAL AND SOCIAL MANAGEMENT AND MONITORING PLANS

10.1 GENERAL CONSIDERATIONS

In the context of this Subproject, E&S management is concerned with the implementation of the measures necessary to minimize or offset adverse impacts and enhance beneficial impacts. Unless the mitigation and benefit enhancement measures identified in the ESIA are fully implemented, the prime function of this ESIA, which is to provide a basis for shaping the Subproject so that overall E&S performance is enhanced, cannot be achieved. For this to be effective, E&S management must be fully integrated with the overall project management effort at all levels, which itself should be aimed at providing a high level of quality control, leading to a project that has been properly designed and constructed and functions efficiently throughout its life.

The main components of the Environmental Social Management Plan are:

- Summary of the potential impacts of the proposal
 - Description of the recommended mitigation measures
 - Statement of their compliance with relevant standards
 - Allocation of resources and responsibilities for plan implementation
 - Schedule of the actions to be taken
 - Programme for surveillance, monitoring, and auditing; and
 - Contingency plan when impacts are greater than expected.
-
- **Summary of Impacts:** The predicted adverse E&S impacts for which mitigation is required should be identified and briefly summarised. Cross-referencing to the EA report or other documentation is recommended.
 - **Description of mitigation measures:** Each mitigation measure should be briefly described regarding the impact to which it relates and the conditions under which it is required (for example, continuously or in the event of contingencies). These should be accompanied by, or referenced to, project design and operating procedures that elaborate on the technical aspects of implementing the various measures.
 - **Description of monitoring programme:** The monitoring program should indicate the linkages between impacts identified in the EIA report, measurement indicators, detection limits (where appropriate), and the definition of thresholds that will signal the need for corrective actions.
 - **Institutional arrangements:** Responsibilities for mitigation and monitoring should be clearly defined, including arrangements for coordination between the various actors responsible for mitigation.
 - **Implementation schedule and reporting procedures:** The timing, frequency, and duration of mitigation measures should be specified in an implementation schedule, showing links with overall project implementation. Procedures to provide information on the progress and results of mitigation and monitoring measures should also be specified.
 - **Cost estimates and sources of funds:** These should be specified for both the initial investment and recurring expenses for implementing all measures contained in the ESMP, integrated into the total Subproject costs, and factored into loan negotiations.

10.2 SIGNIFICANCE OF ESMP

Environmental Protection and Sustainable Development have been the cornerstones of the policies and procedures governing the industrial and other developmental activities in Sierra Leone. The Department of Environment, Government of Sierra Leone has taken several policy initiatives and enacted environmental conservation legislations to prevent indiscriminate exploitation of natural resources and to promote integration of environmental concerns in developmental projects. An ESMP is a site-specific plan developed to ensure that all necessary measures are identified and implemented to protect the environment and comply with the existing environmental legislation. The scope of an ESMP will vary depending on the scale and type of the development project.

The Environmental Social Management Plan addresses the environmental management requirements as per the Government of Sierra Leone and the Safeguard Policy of SCADeP and the World Bank. The ESMP provides the following aspects:

- Provides information on the potential E&S impacts of the proposed Subproject.
- Provides magnitude and duration of the E&S impacts.
- Provides information on required mitigation measures with a budget to minimize the impacts.
- Formulate environmental management and monitoring plan for the entire cycle of the project.
- Capacity development plan for the executing agency.
- Identifying the institutional support for effective implementation of mitigation measures.

An Environmental Social Management Plan (ESMP) is suggested based on the identified impact in the Environmental Impact Assessment. EIA is a planning tool that is now generally accepted as an integral component of sound decision-making tools.

10.3 THE PURPOSE OF ESMP

The ESMP is most effectively developed when impacts are evaluated by a detailed EIA Study supported with baseline studies for the Subproject. Impact evaluation signifies the importance of the Mitigation measures suggested during the impact analysis or assessment. The Environmental and Social Management Plan envisages the following aspects for the smooth implementation of the Subproject. The salient features are as follows:

- Encourage good management practices through planning and commitment to E&S issues concerning any developmental project
- To provide rational and practical E&S guidelines that will assist in minimizing the potential E&S impact of activities
- Helps in minimizing disturbance to the environment (physical, biological and ecological, socioeconomic, cultural, and archaeological,)
- Combat all forms of pollution by monitoring air, noise, land, water, waste, natural resources, and social issues.
- Protection of sensitive and endangered flora and fauna
- Prevent land degradation
- Comply and adhere to all applicable laws, regulations, standards, and guidelines of the Environment Protection Agency Sierra Leone (EPA-SL), for the protection of the environment and social aspects.
- Adopt the best practicable waste management for all types of waste (liquid and solid) with the objective of prevention, minimization, recycling, treatment, or disposal of wastes
- Describe all monitoring procedures required to identify impacts on the environment and social aspects
- Train and bring awareness to Employees and contractors with regard to E&S obligations and compliance.
- Reduce E&S risk and provide better Health, Safety and Environment (HS&E)
- Bring in awareness among the workers and local population about AIDs and STI
- Gender sensitization is also considered a major component in the implementation activity.

The developed ESMP addresses the E&S impacts during the design, construction, and operational phases of the Subproject. ESMP outlines the key environmental management and safeguards that will be initiated by the project proponent to manage the project's key environmental and social concerns.

The Environmental Social Management Plan (ESMP) will be the main tool with which the SCADeP will manage the E&S impacts by applying both mitigative and monitoring measures in a technically credible and timely manner. The mitigative measures are considered successful when the impacts have either been eliminated or the residual effect complies with the environmental quality standards, policies, and legal requirements set by the Department of Environment. Mitigative measures are tracked via the monitoring program.

The contractor shall be responsible for preparing the detailed Contractor Environmental and Social Management Plan (C-ESMP), related to their specific construction methodology selected in the Design Phase of this Design and Build contract. This should include information regarding the scheduling personnel, reporting and auditing requirements, training, and detailed mitigation measures related to their mode of construction for each bridge location. The Contractor's Environmental and Social Management Plan and associated work plan shall be approved by the SCADeP and the World Bank prior to the commencement of construction.

Table 50: Potential Environmental and Social Impacts /Risks and Mitigation Measures of the Subproject

No.	Potential E&S Risks and Impacts	Project Period	Mitigation Measures	Responsible Entity
1	Impact on water resources due to cofferdams construction; bridge piers and abutments construction; clearing of riverine vegetation and sediments; and water extraction for construction purpose	Construction	- Cofferdams should be constructed using non-erodible materials such as sand bags, concrete barriers, erosion control stones, and sheet piles. - Use silt traps, sediment barriers, and other erosion control measures around the cofferdams, piers and abutment construction site. Stabilize disturbed areas and manage the timing of in-river work to minimize impacts on natural flow patterns. - Set up sediment traps or basins to capture and settle suspended solids before runoff is discharged back into the river, thus reducing turbidity and protecting downstream water quality. - Implement bank stabilization techniques, such as vegetative cover or erosion control mats, on exposed riverbanks around the abutment sites. This reduces the risk of erosion and helps maintain bank stability after construction. - Cofferdams should be removed as soon as possible after they are no longer in use. - If sediments are accumulated behind the cofferdams, remove the sediments prior removing the cofferdams. Accumulated sediments may alter the river flow regime and roughness. - To the extent possible, avoid modification of the river channel at the bridge site. River flow should not be restricted by selecting pier and abutment designs that do not take much space in the rivers and banks. - The Subproject temporary and permanent structures and facilities such as the bridge abutments, approach road embankments, construction camps, material storage area, and plants should be designed and located with the risk of flooding and inundation in mind. The design should consider the 100 years return period to size the bridge components and approach roads. - Designate secure areas for fuel, oil, and chemical storage, with secondary containment to prevent spills. Ensure that spill response kits are available, and train workers in spill response procedures to address accidental discharges immediately. - Continuously monitor water quality indicators, including turbidity and contaminant levels, during cofferdams, piers, and abutment construction.	Contractor(s) through its Project Manager
2	Impact on surface water quality	Construction	- Use erosion control barriers, re-vegetate cleared areas, and minimize unnecessary clearing of vegetation at construction sites including bridges, approach roads, and construction material sites. - Use silt traps, sediment basins, and stabilization techniques (e.g., mulching and seeding) to reduce sediment runoff. - Install sediment filters and bio-retention basins to treat runoff before entering the rivers.	Contractor(s) through its Project Manager

No.	Potential E&S Risks and Impacts	Project Period	Mitigation Measures	Responsible Entity
			• Utilize eco-friendly construction materials, like recycled concrete, to reduce environmental harm. • Locate waste disposal sites away from water bodies and install containment structures around work areas to capture storm water. • Store fuels securely with containment tanks and provide spill response training for quick cleanup. • Use eco-friendly cleaning products to reduce contamination. • Provide mobile toilets for workstations outside of construction camps to prevent open defecation and ensure capacity sufficiency of the toilets. • Construct watertight septic tank(s) to receive and store wastewater from camp sanitation facilities. • Construct engineered soak-away pit(s) to partially treat wastewater, both dark and gray water. The soak-away pit(s) shall receive effluent from the septic tanks and partially treat effluent to bring it to acceptable level. • Treat construction plant and workshop effluents in sedimentation tanks, soak-away pits, and test for compliance before release. The effluent quality should be based on the World Bank Group Environmental, Health, and Safety guidelines for wastewater. • Divert rainwater from exposed areas and stabilize stockpiles with vegetation or covers to prevent sediment-laden runoff. • Continuously monitor water quality, sedimentation, and aquatic ecosystem health to detect and mitigate adverse impacts.	
3	Impact on aquatic habitats and biodiversity	Construction	• Identify aquatic habitats, biodiversity sensitive areas, aquatic organism spawning, feeding and breeding sites at the location of cofferdams, piers, and abutments, both upstream and downstream. • Minimize environmental disturbance during construction of cofferdams, piers, and abutments to avoid of minimize elimination of aquatic habitats. • Avoid cutting reeds or other riparian vegetation along the riverbanks, which can stabilize the bank and provide habitat for benthic organisms. • Schedule construction activities to avoid critical periods for aquatic life such as spawning and nocturnal periods. • Compensate for aquatic habitats loss (if any) by restoring or creating new benthic habitats, such as sea grass beds or other habitat-forming areas, to provide alternative environments for benthic species. • Maintain natural river flow patterns to minimize disturbances to sediment transport and benthic habitats, avoiding significant changes to water flow velocity and direction.	Contractor(s) through its Project Manager

No.	Potential E&S Risks and Impacts	Project Period	Mitigation Measures	Responsible Entity
			• Ensure proper storage, handling, and disposal of construction materials to prevent pollutants from entering the benthic environment. Implement spill response plans and erosion control practices to limit runoff and pollution. • Employ vibration-dampening techniques, and schedule activities during periods of low biological sensitivity. Employ a “soft-start” approach for piling to allow fish and mammals to flee the area before full operations. • Clean and inspect equipment and vessels to prevent the introduction of non-native species. Use native plants in habitat restoration and implement monitoring and control measures for invasive species. • Conduct regular monitoring during and after construction to assess the effectiveness of mitigation measures, including tracking water quality, sedimentation, and benthic populations. • Engage stakeholders, local communities, and construction personnel in awareness campaigns about the importance of benthic environment protection and adherence to best practices. • Use non-explosive methods for rock fracturing where feasible to minimize underwater noise and physical disturbance to the benthic environment. • Design construction lighting to reduce light spillage beyond site boundaries, which can help protect nocturnal and sensitive aquatic species.	
4	Impact on fisheries	Construction	• The contractor shall develop and implement fisheries management plan based on terms of reference provided in this ESIA. • Timing of in river construction work should consider fish spawning periods. • Design of cofferdams should consider providing adequate passage to fishes, avoid eliminating fish habitats, avoid spawning locations, and avoids excessive erosion and sedimentation. • Similarly, the bridges should not damage fish habitats or create blockage of fish passage. • To the extent possible, design of bridges should consider clear span type bridges which maximize the unabated flow of the rivers. Further, the cofferdams and bridges designs should ensure no significant alteration on existing river flow regimes. • The existing river gradient at bridge locations should be maintained and adequate light penetration should be ensured to minimize loss in fish productivity. • Uncured concrete can kill fishes by altering the pH of the river water around bridge piers and abutments. To the extent possible, pre-cast concrete shall be used or rapid setting and curing concrete should be considered.	Contractor(s) through its Project Manager

No.	Potential E&S Risks and Impacts	Project Period	Mitigation Measures	Responsible Entity
			• When cast in-situ concrete is used, all concrete work must be done in dry conditions or isolated from flowing water to avoid leachate of concrete into the river system. • Sedimentation/siltation can clog fish spawning beds and juvenile fish species are susceptible to siltation. Therefore, construction driven sedimentation should be avoided or minimized. • Silt traps and settlement ponds should be used to minimize sedimentation. • Spill of chemicals from construction machines and equipment, and disposal of chemicals into the river should be strictly avoided. There shall be no visible oil films in any discharge from construction works. Vehicles, trucks, machines, and equipment should be maintained and routinely checked before use in the construction of the bridges. • Oils and fuels should be stored in secure bunded areas. Temporary oil interceptor facilities should be provided. • Waterproofing and other chemical treatment to bridge components should be applied by hand.	
5	Impact on terrestrial habitats and biodiversity	Construction	• Reduce vegetation clearing to the minimum necessary for efficient project operations; flatten rather than strip vegetation if access is only required short-term. • As much as possible, large trees and vegetative cover should be retained for its ecological role and function. • Stockpile vegetation & topsoil in designated areas for future rehabilitation. • Restore or replant trees in place of those removed for construction purposes. • Materials deposition that will damage the ecosystem of rivers and streams should be discouraged • Monitoring assessment will be carried out to avoid direct materials deposition to the benthic layer of the bedrock. • Approach roads should be kept within standards that are commensurate with relevant design and safety standards. Further, to the extent possible, the alignment of approach roads should follow the existing alignment. • Establish and enforce a total ban on hunting and capture of wildlife by employees. Wildlife will be relocated where practicable. • Limit speed of construction vehicles and trucks to avoid hitting, maiming, and killing the local fauna.	Contractor(s) through its Project Manager
6	Impact on soil/land and erosion	Construction	• Use salvaged topsoil to reclaim disturbed areas, ideally during the dry season to prevent erosion and optimize soil stabilization. • Implement agricultural practices in tandem with reclamation activities to restore soil productivity and enhance land use capability.	Contractor(s) through its Project Manager

No.	Potential E&S Risks and Impacts	Project Period	Mitigation Measures	Responsible Entity
			• In cases where siltation occurs in ponds or low-lying areas, release water through a series of outlets positioned at different elevations. This approach will effectively manage sediment levels and reduce the risk of inundation. • Avoid constructing detours and access roads to construction material sites in areas with steep slopes. • Minimize major earthworks during the monsoon season, to the extent feasible. • At the end of the construction phase, re-vegetate cut slopes wherever feasible. • Provide vegetative cover to protect the soil from eroding. • Native varieties of vegetation should be selected, according to the soil type, climate, and ease of maintenance for revegetation purposes. • Provide intercept ditches at the middle and bottom of slopes. Gutters and spillways are used to control the flow of the water down a slope. Provide cut-off drains to catch water before it reaches critical areas, and diverging drains, which avoids excessive concentration of flow. • Provide riprap or rock material embedded in a slope face, combined with vegetation. • Retaining structures such as gabions, cribs grids of wood or concrete beams filled with earth or rock), or other types of wooden barricades and grid works, usually battered back against the slope should be provided in areas susceptible to erosion. • Reinforce earth embankment walls built up as the earth fill is placed, with anchors compacted into the fill material. • The right season should be preferred for planting the saplings.	
7	Impact on landscape and visual receptors	Construction	• Retain natural vegetation wherever possible to serve as a visual screen around construction areas. Limit vegetation clearing to the minimum necessary for construction efficiency, avoiding needless destruction of natural vegetation cover. • Where possible, position quarry and borrow pit sites out of view from major roads and community access points. Use existing topographic features to shield these areas, and design landscaping to blend with the surrounding natural environment. • Where practical, orient quarry working faces away from key vantage points and residential areas. Select working directions that naturally conceal the quarry face from critical viewpoints. • Align access tracks and roads to minimize long lines of sight from nearby vantage points. Design camps and other ancillary facilities and work yards to visually blend with the environment, using natural color schemes like forest green or brown to reduce their visual impact.	Contractor(s) through its Project Manager

No.	Potential E&S Risks and Impacts	Project Period	Mitigation Measures	Responsible Entity
8	Impact on air quality	Construction	• Conduct regular maintenance of construction vehicles and machinery to reduce emissions. Ensure diesel engines meet local emission standards to minimize CO, NOx, SO₂, and VOC emissions. • Turn off generators, compressors, and other equipment when not in use to prevent unnecessary emissions from idling machinery. • Regularly apply water on unpaved roads, especially near residential areas, to control dust generated by vehicle movement. Increase the frequency of spraying during dry conditions. • Use tarpaulins to cover the payload areas of trucks transporting loose materials to prevent dust fallout along transport routes. • Spray water on materials such as sand and gravel during loading and unloading to reduce dust emissions, especially near community areas. • Install dust arresters or dust control measures at material stockpiling sites near bridge sites to further limit dust dispersion. • Enforce speed limits for vehicles on access roads to reduce dust generation, particularly in sensitive areas such as schools and hospitals. Install signs along routes to ensure drivers comply with speed restrictions. • Train construction workers in air quality management practices, safe material handling, and equipment operation to reduce emissions and improve site safety. • Provide workers with PPE, such as masks and respirators, especially for high-dust tasks like material handling or operating near batching plants. • Regularly monitor air quality, including particulate matter and gaseous emissions, in areas near residential zones. Adjust dust suppression and emission controls based on monitoring results. The supervising engineer and PCU shall use handheld air quality monitoring devices (at least one for each bridge site) to measure air quality parameters. • Inspect dust control equipment regularly to ensure effectiveness and maintain access roads to minimize dust dispersion.	Contractor(s) through its Project Manager
9	Impact of noise	Construction	• Install temporary noise barriers, such as earth berms or high vertical walls, around construction zones to reduce noise reaching nearby communities. Use materials that can effectively absorb or reflect sound. • Schedule high-noise construction activities during less sensitive hours, avoiding early mornings, late evenings, and weekends. Adhere strictly to permissible noise levels for day and night to minimize disruption. • Employ quieter equipment where possible and use noise-reducing attachments such as mufflers. Alternate methods that reduce reliance on heavy machinery should be considered to control noise levels.	Contractor(s) through its Project Manager

No.	Potential E&S Risks and Impacts	Project Period	Mitigation Measures	Responsible Entity
			- Continuously monitor noise levels during construction to ensure they remain within permissible limits. Adjust or relocate equipment as needed to reduce noise levels when they exceed acceptable limits. - As part of the environmental monitoring equipment, SCADeP PCU will be equipped with portable, lightweight, hand-held monitors (Sound/ noise level meter) for ad hoc noise measurement. These robust and reliable portable meters provide instantaneous results which can be used to monitor the contractors' performance and quickly address deficiencies. The results can also be used to resolve complaints resulting from noise on the impacted communities. - Mandate hearing protection for all workers and operators exposed to high noise levels. PPE, such as earplugs or earmuffs, should be provided and always enforced for tasks involving noisy equipment. - Communicate proactively with nearby residents about construction schedules, expected noise levels, and mitigation measures to address their concerns. This can include providing advance notice of high-noise activities.	
10	Impact of vibration	Construction	- Where feasible, employ construction methods and equipment that produce lower vibration levels to minimize the impact on nearby communities and structures. - Regularly monitor vibration levels, especially near sensitive structures, using equipment that measures peak particle velocity (PPV). Adjust methods or reduce equipment power if vibration levels approach thresholds that may impact nearby buildings. - During development of the site-specific ESMPs, contractors should establish vibration-sensitive zones close to fragile buildings, limiting the use of high-impact equipment within these areas. Restrict access to vibration-heavy areas and establish exclusion zones to protect both workers and residents from unnecessary exposure. - Provide PPE and training to workers operating vibration-producing equipment to minimize exposure to hand-arm or whole-body vibrations. Regular breaks and ergonomic handling techniques should be encouraged to reduce health risks. - Inform residents and businesses of high-vibration activities in advance to manage expectations. Address their concerns proactively, particularly if activities are near sensitive structures or in areas where vibrations may be perceptible. - Implement traffic management plans for diverted routes to reduce heavy vehicle movement in residential areas and lower vibration impacts on local roads. Designated speed limits and vehicle restrictions can help control vibration levels from construction traffic.	Contractor(s) through its Project Manager
11	Impact from construction waste	Construction	The contractors shall develop a comprehensive waste management plan specifically tailored to the bridge construction Subproject. The plan should outline strategies for waste reduction, reuse, recycling, and proper disposal.	Contractor(s) through its Project Manager

No.	Potential E&S Risks and Impacts	Project Period	Mitigation Measures	Responsible Entity
			• For the Matru-Senehun crossing, it is recommended for the contractor to work with Bonthe District Council which is situated in Matru Town for waste collection and disposal. • Contractors shall opt for sustainable and eco-friendly materials during the bridges construction. The contractors should consider materials with high recycled content or those that can be easily recycled or reused after the bridge's lifespan. This reduces the overall waste generated and promotes a circular economy approach. • The contractors shall implement practices to minimize waste generation during construction activities. This can include accurate estimation of materials required to reduce over-ordering, implementing efficient construction techniques to minimize cutting and trimming waste and promoting careful handling and storage of materials to prevent damage and waste. • The contractors shall set up designated areas on-site for the sorting and segregation of different types of waste. Prominently label recycling and waste bins to encourage proper disposal practices among workers. Educate and train construction personnel on waste segregation and ensure regular monitoring and enforcement of waste management guidelines. • The contractors shall establish partnerships with local recycling facilities and vendors to facilitate the recycling and reuse of construction waste materials such as concrete, steel, wood, and plastics. Promote the use of recycled materials in the construction process whenever feasible, reducing the demand for virgin materials. • The contractors shall develop and implement a robust system for handling and disposing of hazardous materials used during bridge construction. Ensure proper storage, labeling, and disposal of hazardous waste in compliance with relevant waste disposal regulations. Educate workers about the risks associated with hazardous materials and promote safe handling practices. • The contractors shall conduct community engagement programs to raise awareness among the local population about waste management practices during the bridge construction phase. This is mostly applicable to Matru,-Senehun, Gendema-Garwama, and Tompari Crossings. Encourage residents to participate in waste reduction and recycling initiatives. Provide information on proper disposal methods and facilitate community recycling programs if possible. • The contractors shall regularly monitor waste management practices on-site to ensure compliance with the waste management plans and regulations. Conduct periodic audits and inspections to identify any gaps or areas for improvement. Enforce penalties or corrective actions if workers fail to adhere to waste management guidelines.	

No.	Potential E&S Risks and Impacts	Project Period	Mitigation Measures	Responsible Entity
			After completing the bridge construction, conduct a thorough clean-up of the construction site to remove any remaining waste or debris. Restore the surrounding areas to their original or near-original condition, disposing of waste in an environmentally responsible manner.	
12	Impact from hazardous materials and waste	Construction	- The contractors shall prepare and implement a hazardous waste management plan for the storage, handling, transport and disposal of waste oil, batteries, and other hazardous materials and waste. Ensure that hazardous waste management measures are implemented for relevant Subproject activities. - All areas designated for the storage of fuels, oils, chemicals, or other hazardous materials shall have a compacted base and shall be surrounded by a bund to contain any spillage. These areas shall be covered by a roof structure to minimize the potential for infiltration and contamination of rainwater. Alternatively, ventilated containers and individual spill pallets could be used, dependent on the volume of hazardous materials - Areas designed for the storage of hazardous materials are to be designated and storage of such materials outside these areas is strictly prohibited. - An Emergency Spills Contingency Plan shall be prepared as part of the contractor's ESMP. - Ensure that there is adequate provision of correctly marked hazardous waste containers made available at convenient locations. - Hazardous waste disposal sites should be selected or identify in consultation with the relevant authorities. Hazardous waste shall not be disposed at locations designated for other/general waste.	Contractor(s) through its Project Manager
13	Impact from construction camps	Construction	- Every construction camp should have a supply of potable drinking water and provided with proper sanitary and washing facilities and proper toilets with flush facilities. - Construction camps should be provided with constant supply of energy/electricity. - Wastewater, including gray water, generated from construction camp facilities, should be retained and treated before discharge to the natural environment. - Accommodation for taking meals and for shelters during interruption of work due to adverse weather conditions should be provided. - If a minimum number of workers as prescribed are employed in any shift, at least one suitably equipped first aid room or station under the charge of qualified first aid personnel or a nurse should be provided at a readily accessible place for treatment of minor injuries and as a resting place for seriously sick or injured workers. - Fire arrest equipment (such as fire extinguishers) should be provided in the construction camps with adequate quantity. - Equipment in the construction camps should be maintained in good working condition.	Contractor(s) through its Project Manager

No.	Potential E&S Risks and Impacts	Project Period	Mitigation Measures	Responsible Entity
			• Equipment in construction camps should be operated by workers who have received appropriate training in accordance with national laws and regulations. • Facilities for changing, for storage and drying of clothing should be provided. • Cloakrooms should be provided to the workers at easily accessible places and should not be used for any other purpose. • Workshops, garages, laboratories and material storage areas should be separated from office and accommodation areas. • Emergency procedures should be provided in case of emergencies at construction camps. Drills should be done to practice the emergency procedures.	
14	Occupational health and safety risk	Construction	• Induction trainings and awareness for workers on occupational health and safety must be conducted upon recruitment • Electrical installations must be properly done • Fire extinguishers of appropriate size (and not expired) should be placed at offices, workshops and residential quarters • All vehicles and machinery should be serviced on regular basis as per the recommendations by the respective manufacturer • Drivers must be given induction as well as regular trainings with emphasis to “Defensive Driving” • The contractor shall prepare a sound traffic management plan (TMP) and implement it. • Roadway should not be reduced or blocked with stockpiles for long time. • Flagmen should be assigned to let the traffic flow safely especially at narrow/critical sites. • Slippery and other dangerous spots should be maintained or corrected frequently. • Hazardous materials such as used oil and lubricants and parts of vehicles and machinery that may catch fire should be stored separately and taken off the sites by a licensed firm. • Speed reduction/calming structures (humps, rumble strips, etc.) in towns and villages with relatively high population should be considered. • Workers should be provided with personal protective equipment (PPE). • Regular traffic signs should be provided or installed at critical sites including: excavations for widening, structural excavations, diversions, material dumping along road sides, etc.	Contractor(s) through its Project Manager
15	Traffic and road safety risk	Construction	Site-specific Traffic Management Measures for Tomparie - Kamakwei Crossing: • Designate lanes for construction vehicles and install directional signage to separate local and project traffic, reducing congestion and accident risks. • Mark pedestrian and livestock crossing points along the alignment and use traffic marshals during peak hours to ensure safe passage.	Contractor(s) through its Project Manager

No.	Potential E&S Risks and Impacts	Project Period	Mitigation Measures	Responsible Entity
			• Inform residents in advance about traffic disruptions, detours, and construction schedules to minimize inconvenience. • Establish clear detour routes for non-construction traffic and, where possible, route heavy equipment away from residential areas. • Restrict high-noise activities to off-peak hours and enforce speed limits on construction vehicles to reduce noise and vibration impacts. • Regularly spray water on haul routes and clean roads to manage dust and maintain safe road conditions. • Set up designated parking for construction vehicles and work with residents to ensure uninterrupted access to properties. • Maintain an on-site team to respond to traffic incidents and educate the community on safety practices near the construction zone. • Monitor traffic conditions and adjust the Traffic Management Plan as needed, incorporating community feedback for adaptive improvements. Site-specific Traffic Management Measures for Mattru - Senehun Crossing: • Create separate routes for construction vehicles to keep them away from populated community roads, reducing risk. • Work with local mining companies to manage truck schedules and prevent congestion, minimizing hazards for residents. • Install signage, enforce speed limits, and deploy traffic marshals at key intersections to protect pedestrians and high-risk areas. • Engage the community, especially those impacted by relocations, to ensure safety awareness and cultural sensitivity. • Apply dust suppression and limit high-noise activities during peak community hours to reduce disturbances. • Regularly assess and adapt the Traffic Management Plan based on ongoing community and industry feedback. Traffic Management Mitigation for Gendema - Garwama Crossing: • Relocate the ferry to maintain traffic flow during bridge construction, as the bridge alignment follows the existing road.	

No.	Potential E&S Risks and Impacts	Project Period	Mitigation Measures	Responsible Entity
			• Work with local community leaders to manage impacts, ensuring clear communication on detours and ferry adjustments. • Install signage, enforce speed limits, and deploy traffic marshals to protect bike commuters along the route. • Use dust suppression and limit high-noise activities to reduce disruptions. • Regularly review and adjust the Traffic Management Plan based on community feedback for safe, efficient traffic flow. Traffic Management Mitigation for Manowa - Pendembu Crossing: • Coordinate construction schedules to ensure continued access for trucks transporting agricultural goods. • Install signage and enforce speed limits to protect local commuters. • Regularly assess and repair road damage caused by heavy construction vehicles. • Keep residents informed of construction schedules and access changes. • Use water spraying to minimize dust on busy routes. • Continuously assess traffic and road conditions, adapting plans as needed.	
16	Impact of construction materials transport	Construction	• Regularly spray roads with water and cover truckloads to prevent materials from being blown away or falling off. Use fuel-efficient vehicles to reduce emissions. • Maintain roads to prevent erosion, designate specific loading areas to contain spills, and equip trucks with spill kits for immediate response to accidental spills. • Restrict transport to designated hours, use noise-dampening equipment, and enforce speed limits in residential areas to reduce noise. • Install signage, enforce speed limits, and create pedestrian crossings. Position traffic marshals at high-risk areas to protect pedestrians, cyclists, and livestock. • Conduct regular road inspections and repairs, establish a cost-sharing maintenance plan with local authorities, and enforce compliance with traffic policies. • Schedule transport during off-peak hours to reduce congestion near schools, markets, and social spaces. Provide advance notice of any disruptions to allow for community planning. • Work with local authorities to set up a shared maintenance fund, reducing the financial burden on the community and ensuring timely repairs. • Spray water near agricultural areas to protect crops from dust, cover truckloads, and communicate transport schedules with local businesses to mitigate disruptions.	Contractor(s) through its Project Manager

No.	Potential E&S Risks and Impacts	Project Period	Mitigation Measures	Responsible Entity
17	Impact of bridge construction on river traffic	Construction	• Place clear warning signs, buoys, and markers around construction zones to guide small boats, canoes, and ferries safely. Ensure these aids align with the Traffic Management Plan to maintain safe navigation. • Limit access to construction zones strictly to authorized personnel. Enforce safe distances between boats and construction sites, using physical barriers or signage to keep unauthorized vessels away from heavy machinery and construction activities. • Relocate the Gendema ferry, creating a clearly marked alternative crossing route away from the bridge alignment. Where necessary, provide additional crossing options, such as barges, to ensure river users maintain safe access during construction. • Continued ferry operations at Manowa, Tomparie, and Mattru. Maintain regular ferry services at these sites, where construction does not interfere with ferry routes. Establish safe, marked boat crossings upstream or downstream to minimize construction interaction. • Conduct hydrographic surveys to establish safe, hazard-free alternative routes for boats and canoes, taking river depth and flow patterns into account. Regularly monitor these routes, making adjustments as needed based on evolving construction or river conditions. • Require all construction personnel working over water to wear personal flotation devices (PFDs) or life jackets. Equip work areas with essential safety supplies, such as throw ropes, whistles, flashlights, and first aid kits, to enhance safety over water. • Implement real-time communication systems, such as signage and local announcements, to inform boat operators of navigation restrictions, construction activities, and potential hazards. Regularly update local communities on river access changes and alternative routes. • Engage with boat and ferry operators regularly to communicate construction schedules and potential navigation risks. Use local notices and broadcasts to keep communities informed of any restrictions or detours affecting river traffic. • Follow all local navigation regulations and coordinate with relevant authorities to ensure safe passage for boats and ferries around construction areas. • Regularly review and update the contractor's Traffic Management Plan as construction progresses, with revisions approved by the monitoring consultant to ensure safety compliance. • Require contractors to implement an emergency response plan covering potential river accidents and hazardous material spills. Train construction personnel on safe navigation, emergency response, and environmental protection procedures. • Maintain a dedicated emergency response team with ready access to rescue equipment, including life rafts, throw ropes, and rescue buoys, stationed at construction sites for immediate response.	Contractor(s) through its Project Manager

No.	Potential E&S Risks and Impacts	Project Period	Mitigation Measures	Responsible Entity
			• Conduct emergency response drills with both the rescue team and boat operators, practicing rescue techniques, communication protocols, and safe evacuation methods. • Monitor weather and river conditions continuously. Prepare to suspend boat crossings during adverse conditions, such as high water levels or strong currents, to ensure the safety of boat operators and passengers. • The contractor's Safety Officer should oversee strict compliance with safety guidelines for river traffic, manage access control near construction zones, and ensure all personnel are equipped with appropriate safety gear and trained in emergency procedures.	
18	Impact on borrow pits and quarry sites	Construction	• Apply soil stabilization measures such as silt fences, sediment barriers, or erosion control mats around borrow pits and access roads to prevent soil loss. Where feasible, plant fast-growing grasses or native vegetation around pit perimeters and along access roads to stabilize soil and reduce erosion. • Install fences or barriers around deep pits to prevent unauthorized access, especially in areas frequented by residents or animals. Clearly label areas with warning signs to inform of potential hazards. Ensure proper drainage to prevent water accumulation. Where standing water cannot be avoided, consider safe mosquito control measures to limit insect breeding and reduce disease risk. • Spray water on access roads and active areas of borrow pits during dry conditions to control dust levels, particularly near populated areas. Enforce reduced vehicle speeds on unpaved access roads to minimize dust generation. Consider creating designated routes that reduce dust exposure to nearby communities. • Begin land rehabilitation as soon as sections of the borrow pits are no longer in use. Re-contour pits to blend with the natural landscape, creating gradual slopes where feasible. Spread stockpiled topsoil over disturbed areas in a 10 cm layer to promote natural regrowth. Water to encourage seed germination and monitor for sufficient growth. If natural regrowth is insufficient after two months, hydro-seed with a mix of indigenous grass species. Apply fertilizer as needed to support plant establishment and stabilize the landscape.	Contractor(s) through its Project Manager
19	Impact of labor influx	Construction	• Provision of adequate healthcare facilities (first aid) within construction sites. • Training of all construction workers in basic sanitation and healthcare issues, general health and safety matters, and the specific potential hazards of their work. • Personal protection equipment for workers, such as safety boots, helmets, gloves, protective clothing, goggles and ear protection must be provided. • Clean drinking water facilities for all workers must be provided. • Adequate protection to the general public, including safety barriers and marking of hazardous areas.	Contractor(s) through its Project Manager

No.	Potential E&S Risks and Impacts	Project Period	Mitigation Measures	Responsible Entity
			• Ensure safe access across the construction site. • Adequate drainage throughout the camp to ensure that disease vectors such as stagnant water bodies and puddles do not form. • Septic tanks and garbage bins are to be set up in the construction site, which will be periodically cleared by the contractors to prevent outbreaks of diseases. • Where feasible the contractor will arrange the temporary integration of waste collection from work sites into existing waste collection systems and disposal facilities of nearby communities. • The implementation of a local content policy places preference on the recruitment of a qualified workforce from local communities in the proposed bridge locations, wherever possible, for construction and decommissioning. This will minimize the need for the immigration of workers from elsewhere. • Contractors will conduct thorough cultural induction briefings with all their employees on topics such as the sexual norms of the communities. Contractors will also carry out regular meetings with representatives of the local community throughout the construction, decommissioning of facilities, and commissioning of the bridges. Community relations' (Social Safeguards Specialist) will be appointed by the contractors to liaise with the communities throughout the life of the proposed Subproject. This person will be responsible for community briefings, and dissemination of information by various media. These meetings will keep the community fully informed of the process and will give local people an opportunity to register any complaints or concerns. • Encouraged and developed sustainable income generation opportunities for women with the assistance of local councils. If these measures are taken, the risk of prostitution will be significantly minimized.	
20	Impact on cultural heritage and physical cultural resources	Construction	• Relocate the affected female secret society (Sande Bush) in accordance with laws and local traditional norms and in consultation with the local people during resettlement and or compensation. • Relocate the graveyard before excavation works. • Identify and set aside a plot of land for re-burying the exhumed bodies. • Compensations for the land and funds for rituals and reburial should be done. • Perform burials in consultation with the traditional rulers. • Involve the local community and relevant stakeholders in the decision-making process to ensure their concerns and perspectives are considered. Engage in open dialogue and collaborate with heritage experts, community leaders, and cultural organizations to develop mutually beneficial solutions and preserve cultural heritage.	Contractor(s) through its Project Manager

No.	Potential E&S Risks and Impacts	Project Period	Mitigation Measures	Responsible Entity
			Utilize the chance finds procedures for discoveries of physical cultural resources during construction of Subproject activities.	
21	Impact on access to public service	Construction	- Provision of additional health facilities. - Provision of health services on-site with CHO-trained medical personnel, or Nurses to treat all workers, which will avoid new demands on health services by out-of-area workers. However, cases beyond the capacity of the clinic to treat will be referred to the District Hospital or Freetown hospitals for more specialist care. - Avoid and minimize environmental effects that have the potential to affect health including dust, noise, and any effects that may negatively affect livelihood resources, such as contamination of the rivers or farmlands. - Contractors may include vaccination programs for preventable diseases, HIV/AIDS education and awareness campaigns, and COVID-19 sensitization. - Encourage staff to cooperate with the health system through Voluntary, Counselling and Testing (VCT) centers and improving care and treatment programs. - Map high-risk areas where sexual transactions occur and support intensive education and disease prevention program. - Repeated awareness campaign targeting management, sub-contractors, locals near Subproject facilities, and risk groups (commercial sex workers, truck drivers, police and military forces, young adults).	Contractor(s) through its Project Manager
22	Impact on community networks and social structures	Construction	- Collaborate with CBOs and other stakeholders to support programs that include empowerment of women and girls, gender-based violence prevention programs (workshops), and skills training for men and women. - Support the equitable representation of women in project-related decision-making committees. - The grievance mechanism will allow communities to raise concerns over perceived cultural insensitivities or conflicts.	Contractor(s) through its Project Manager
23	Impact on water resources and soil	Operation	- Adopt overall vehicle inspection and maintenance standards at local level, and if possible at a national level so that worn out vehicle parts, oil, and fuel are not used. - Adequacy of vehicles transporting hazardous materials should be checked at their origins. - Appropriate traffic signs should be erected to inform and warn vehicles about the road/bridge they are using. - Awareness/education should be given to drivers engaged in transportation of hazardous materials. - Vehicles maintenance on the approach roads and bridges should be prohibited.	Ministry of transport and aviation; Sierra Leone roads authority; Ministry of water resources

No.	Potential E&S Risks and Impacts	Project Period	Mitigation Measures	Responsible Entity
24	Impact on air quality	Operation	• Adopt tighter fuel and vehicle emission standards. • Strengthen vehicle emission inspections and enforcement against grossly emitting vehicles. • Promote better vehicle maintenance practices. • Consider planting trees by the side of the approach roads as they have a filtering effect.	Ministry of transport and aviation; Sierra Leone roads authority; Ministry of water resources
25	Community health and safety risks	Operation	• Vehicles should be serviced regularly and adequately, at local and national level. • Strengthen vehicle emission inspections and enforcement against grossly emitting vehicles. • Trees should be planted along approach road sides as they have a filtering effect. • Provide traffic calming structures such as humps and rumble strips on the approach roads to reduce the speed of approach vehicles. • Provide road safety education programs or awareness campaigns in local schools and also in public gathering locations to create awareness among the local community on traffic risks and measures. • The local traffic police should enforce speed restriction measures on the approach roads. • Put traffic signs on the approach roads using local languages to minimize accident and death of pedestrians and motorists. • Strengthen the capacity building of local traffic police for management of traffic and road safety risks.	Ministry of transport and aviation; Sierra Leone roads authority; Ministry of water resources

10.4 PROGRESSIVE REHABILITATION AND CLOSURE PLAN

From the details provided in this ESMP study, the Subproject will adopt the following guidelines in the implementation of its Progressive Rehabilitation and Closure Plan. These guidelines will be used as a baseline for all environmental, occupational health, and safety issues and the concerns that might arise from the implementation of the plan. This will serve as the fundamental guiding principle on all decisions relating to the future decommissioning of the Subproject's ancillary facilities. Furthermore, these principles will be used throughout the development of the proposed bridges.

- ❖ **Accountability** – from its Environmental Policy, SCADeP will ensure that each employee complies with laws and regulations relating to the protection of the environment and general safety. Frequent reviews will be conducted into the activities of all contractors and Subcontractors to check awareness level and compliance with the company's position on progressive rehabilitation. This not being the case, prompt corrective measures will be implemented to mitigate or rehabilitate the areas of concern. Through all phases of the Subproject (commissioning to decommissioning), regular training of employees will be provided on environmental, Occupational Health, and safety issues as they emerge.
 - ❖ **Commitment** – SCADeP, through its consultant or Contractors will ensure that the awareness of the entire management and staff is raised in a way that will reflect compliance at all levels. Contractors should make every effort to be seen to be committed to Environmental and occupational health and Safety best practices.
 - ❖ **Regulatory and Legislative Compliance** – as indicated in the section that reviewed the relevant regulatory and legal framework, SCADeP will ensure that all contractors and employees involved in its daily operations comply with the laws and guidelines relating to the sustainable use of the environment in Sierra Leone.
 - ❖ **Operational Risk Management** – SCADeP (Consultants) will ensure that potential environmental risks associated with the design or operation of the machinery and equipment that will be used in the proposed bridge construction Subproject are regularly assessed, and the necessary corrective actions are taken when necessary, with room for progressive rehabilitation and continuous improvement. This will prevent and minimize negative impacts on the environment and other associated concerns.
 - ❖ **Monitor, Audit, and Review** – SCADeP will maintain continuous assessment, monitoring, and audit programmes in its rehabilitation programs to promote systems review that will optimize improvement. The objective of this programme should be to provide the PCU with adequate data on areas that have already been rehabilitated or that are outstanding. This will also be carried out to appraise the effectiveness of the various reclamation programs.
- Contractors will ensure that the following installations/structures are completely dismantled and leveled:
 - Plants of all kinds;
 - Works yard; and installations therein
 - Refueling system.
 - Roads connecting communities will be retained for public use.
 - Buildings, structures, or objects on the camp/office sites will be completely removed (unless new uses of the building have been agreed with the community or relevant authority) and the site will be fully rehabilitated. Should the above not be applicable, the campsite will be rehabilitated through the removal of all facilities, waste, and any other features constructed or established during construction. Areas without vegetation/grass or where soils have been compacted due to traffic will be sacrificed or ripped and if necessary, ensure adequate and effective regrowth of vegetation.

10.5 ENVIRONMENTAL AND SOCIAL MONITORING PLAN (ESMP)

The Environmental monitoring program is to ensure curtailment of mitigation measures will be covered, they produce the desired results or are abandoned or changed if they do not give conclusive results. This program has the following parts:

- Monitoring during the design and construction period,
- Monitoring during the construction/decommissioning period and
- Monitoring during the operation of the highway.

Environmental measures of conventional order (Personnel Security, leveling quarries, and waste management) to be inserted in the specifications of works will be made by the contractor. In essence, the implementation of the environmental and social management of the Subproject will be provided by the construction companies, contracted for the bridge construction works. In addition, some players will conduct specific measures (reforesting certain areas affected by the appropriate species, information, awareness, etc.): Individual consultants and NGOs about the information and awareness activities; Water and Forest Service regarding afforestation/tree planting and control of fraudulent logging and poaching. The performance will be based on the schedules established for each type of work. The control of the implementation will be mainly carried out by consultants (having in their team an environmental expert), with the support of some players, especially the police about speed limit; the hydraulic services regarding the use of local water sources; and operation and career management. Both SCADeP and EPA-SL will conduct the supervision and monitoring of the Subproject whenever appropriate.

As part of the environmental monitoring equipment, SCADeP PCU and consultant company will be equipped with portable, lightweight, hand-held monitors (onsite sound/ noise, air and water quality monitoring during construction phase for an ad hoc noise, air and water quality measurement. These robust and reliable portable meters provide instantaneous results which can be used to monitor the contractors' performance and quickly address deficiencies. The results can also be used to resolve complaints resulting from noise, air and water quality aspects on the impacted communities.

The consultant company, which will have an EHS expert in its team, a technician, or an engineer with environmental training, will do the regular monitoring. The research department must record in writing (sheets of compliance or non-compliance) orders to the environmental services, advancement, and implementation according to the standards. The Engineer must also call the engineer in charge of the environment from the transport development agency if any particular environmental problem occurs. Supervision will be made:

- From periodic checks either by construction records or through field visits,
- From the minutes of the affected communities and relevant technical services, and
- At the time of acceptance.

In case of non-compliance or non-application of environmental measures, the engineer in charge of the environment concerning mission control initiates the process of formal notice to be sent to the company.

10.6 DETAILS OF ENVIRONMENTAL AND SOCIAL MONITORING PLAN

An E&S Monitoring Plan provides a delivery mechanism to address the adverse E&S impacts of a Subproject during its execution, to enhance project benefits, and to introduce standard good practices to be adopted for all Subproject works. An E&S monitoring plan is important as it provides useful information and helps to assist in detecting the development of any unwanted environmental situation and thus provides opportunities for adopting appropriate control measures and defining the responsibilities of the project proponents, contractors, and environmental monitors and provides means of effectively communicating environmental issues among them.

Define monitoring mechanisms and identify monitoring parameters. Evaluate the performance and effectiveness of mitigation measures proposed in the Environment Social Management Plan (ESMP)

and suggest improvements in the management plan, if required, identify training requirements at various levels. It aims to ensure that the enhancement and mitigation measures proposed are used during the phase of reconstruction and development of the Bridges across the seven years.

10.7 MONITORING CRITERIA

Monitoring criteria are:

- Hygiene and sanitation at the campsite
- The level of maintenance of equipment and trucks (service record);
- The use of gloves, mufflers, hats, etc. for the protection of personnel
- The realization of defense works and restoration of soils, water conservation and
- Soil particularly at sensitive points in slope collapse
- The rate of setting up temporary signs
- The level of watering the earth's embankments
- The level of implementation of other enhancement and mitigation measures to negative impacts.

10.8 MONITORING INDICATORS

Impact indicators to be monitored include:

- The number of claws and erosion gullies around the campsite, borrowings, and quarries of storage sites,
- Turbidity and colour changes of rivers of waters. Analyses will be conducted with an approved laboratory (water service).
- The number of consultations for waterborne disease in health centers in neighbouring regions per quarter (health service);
- The number of visits for respiratory illness, cough, and bronchitis in health centres per quarter (health service);
- The number of jobs created for local workers
- Changes in the number of accidents due to traffic disruption during construction
- The number of signs in place
- The number of awareness signs in place
- The number of consultations with the political, administrative, and local communities.
- The analysis of these indicators is the major input of monitoring reports and the base alternative suggestions for the cancellation of ineffective measures.

10.9 ENVIRONMENTAL AND SOCIAL MONITORING PROGRAMME

E&S monitoring is a part of the environmental and social management plan. It mainly comprises air quality, noise and vibration levels, water quality, and soil quality and sampling will be carried out at all the operational locations under the Subproject like the borrow areas, quarry sites construction sites, labour settlements, and village areas. A special emphasis would be given to the noise and air quality level measurement at the schools and eco-sensitive areas such as Marsh Lands which are considered to be sensitive locations. There are some human settlements and (eco-sensitive) Marshland areas adjoining the road corridor. Air quality monitoring is carried out for Particulate Matter, Sulphur Dioxide, Volatile Organic Compounds, Carbon monoxide, and Oxides of Nitrogen. These parameters will be measured at the respective locations indicated in the tabular form along the corridor. Ambient air quality will be monitored during the construction phase of the Subproject for two years. The monitoring will be carried out during the dry season. The air quality monitoring will be carried out for 24 hours with collection. The sampling will be done throughout the dry season thus collecting four days for sampling in a month. The monitoring will be carried out at the crusher unit, quarry area, batch mixing plant, labour settlement, and villages.

Water, grab sampling is used for the collection of water samples in case of surface waters. The surface waters are generally collected from the rivers flowing in the Subproject area. Two samples will be collected one from the upstream and the other from the downstream of the rivers. All the rivers will be monitored during the entire construction period. Groundwater samples will be collected randomly from the villages adjoining the corridor. The drinking water samples from the labor camps and the treated

wastewater from the construction yard will be regularly tested to assess the efficiency of the treatment facility provided by the contractor. Odour, conductivity, pH, dissolved oxygen, and temperature will be measured at the site and the other parameters like the biochemical oxygen demand, total dissolved solids, total suspended solids, oil and grease, chlorides, sulfates, total nitrogen, total phosphate, and coli forms will be analyzed in the laboratory. Water samples were collected twice a year during the pre-monsoon period and the other one during the post-monsoon season. Wet chemical methods will be used for the analysis of the parameters.

Soil samples will be collected from the agricultural soils and the construction/excavation areas. For soil sample, is collected from all four diagonal corners of agricultural land and one sample is collected from the center of all five samples are mixed homogeneously (generally one acre of land is considered while sampling), and the mixture is tested for organic matter, potassium, nitrogen, phosphate, and sulfate. Generally, soil samples are collected from a depth of one foot at each identified location. Soil samples are mainly collected during the dry season only. The samples are collected once a year. Soil samples are analyzed using wet chemical methods and gravimetric procedures. Noise levels along with vibration will be measured using an integrated noise monitor. The noise and vibration levels are monitored during the construction phase of the Subproject and it is monitored once in a quarter, which makes four times in a year. Moreover, noise monitoring will be done at the Subproject site on regular basis using handheld device.

10.10 ROLE OF THE CONTRACTOR AND THE ENGINEER

The contractor should be undertaking the major role of ensuring the mitigation measures in the ESMP are followed to the details. In the actual period of rehabilitation of the road, the contractor should undertake regular monitoring of all the activities occurring in the Subproject site to ensure compliance with the ESMP. The contractor will bear all the costs related to monitoring activities during the construction or reconstruction phase of the road. The Engineer (supervision consultant) will supervise the construction works and ensure that EHS issues are managed as per the ESMP. The Contractor and Supervision consultant must have a full-time Environment and Social Staff in place. The Engineer will guide the reporting process, to whom, and frequency of reports. The Engineer will supervise the contractor and ensure the ESMP is implemented daily, and the monitoring report must be available and shared as per the monitoring frequency.

10.11 BUDGET

The proposed Capital Cost estimated for the implementation of the Environmental and Social Management and Monitoring Plan is presented in the below Table. They present planned investment in the environmental and social safeguard mechanisms that will support the entire stretch of the construction. This will enhance the full implementation of environmental compliance regimes, and also track progressive rehabilitation of damaged areas like borrow-pits, quarries, spoils disposal, management of overburden and topsoil, prevention of siltation in nearby streams and rivers, sediment traps, etc.

Table 51: Proposed Monitoring Parameters, Schedule and Budget

No	Component	Monitoring Activity	Monitoring Indicator	Estimated Cost (USD)	Monitoring Frequency	Responsibility	Stage
1	Air Quality	Site inspection with the photo documentation Air quality testing	Air quality parameters: PM10, PM2.5, SO2, NOx, CO, Ozone, and HC Compliance with dust abatement measures	30,000	Inspection: Daily and ad hoc at sensitive locations Weekly Testing: Once prior to the start of construction works to establish the baseline within the Subproject boundaries	E&S Officer of the Contractor	Construction
2	Noise	Site inspection measuring the level of noise	Compliance with the time limitations; Switching off the equipment not in use; Use of protective gear	20,000	Daily and ad hoc at sensitive locations Weekly	E&S Officer of the Contractor	Construction
3	Water Resources	· Site inspection with photo documentation; · Water testing	Inspection: debris accumulation in water drainage areas; Alteration of water courses; Signs of spillage of hazardous materials Water testing: pH, Turbidity, Electrical Conductivity (EC), Color, Total Suspended Solids (TSS), Total Dissolved Solids (TDS), Chemical Oxygen Demand (COD), Biological Oxygen Demand (BOD), oil and grease	50,000	Inspection: · Bi-weekly during the rainy season, and after sporadic rains · Once a month during the dry periods Water testing: in case of accidental spillage of hazardous materials	E&S Officer of the Contractor	Construction
4	Soil	· Site inspection with photo documentation; · Soil testing	Inspection: signs of soil erosion, evidence of spills of fuel and lubricants	50,000	Inspection: monthly; Soil testing in case of accidental spills	E&S Officer of the Contractor	Construction

No	Component	Monitoring Activity	Monitoring Indicator	Estimated Cost (USD)	Monitoring Frequency	Responsibility	Stage
			Soil testing: on case by case basis pH, temperature, organic content, poly-aromatic hydrocarbons (PAHs); Fecal coliforms and Total coliforms				
5	Solid and Hazardous waste	· Site inspections · Maintaining a record of type, quantity, and disposal location of solid and liquid waste generation;	·Storage conditions of hazardous materials; ·Disposal at designated sites	50,000	Daily Inspection: Upon occurrence	E&S Officer of the Contractor	Construction
6	Traffic	Site inspections	Site surveillance for the presence of fencing/barriers and warning signs, and traffic speed limitations	10,000	Daily	Resident Engineer and E&S Officer of the Contractor	Construction
7	Flora and Fauna	Site inspections	Cutting of reeds and other aquatic vegetation; ·Evidence of burning of wood; ·Evidence of vehicles moving beyond designated areas; ·Site restoration after work completion	50,000	Weekly	Environmental Officer and E&S Officer of the Contractor	Construction
8	Topography and surface drainage	Inspection and photo evidence	§Location of storage areas; §Ceasing construction activities during rainy events; §Records of waste disposal.	50,000	Inspection: Weekly	Resident Engineer and E&S Officer of the Contractor	Construction

No	Component	Monitoring Activity	Monitoring Indicator	Estimated Cost (USD)	Monitoring Frequency	Responsibility	Stage
9	Handling Complaints	· Maintaining records of filed complaints and responses	· Time of response to the complaint; · Number of complaints	10,000	As they occur	E&S Officer of the Contractor	Construction
10	Health and Safety	· Inspection and photo evidence · Maintaining records of injuries and accidents with cause and location	· Provision and use of personal protective equipment to workers · Installing construction and warning signs	50,000	Inspection: Daily	E&S Officer of the Contractor	Construction
	TOTAL			370,000			
No	Component	Monitoring Activity	Monitoring Indicator	Estimated Cost (USD)	Monitoring Frequency	Responsibility	Stage
1	Air Quality	Air quality monitoring	· Air quality parameters: PM10, PM2.5, SO2, NOx, CO, Ozone, and HC	Testing paid by the Operating and Maintenance Authority	Monthly during the dry season	SLRA (Environment & Social Services Department)	Operational
2	Noise	Noise level monitoring	Ensure the noise levels are within acceptable limits	No additional cost	During maintenance and repairs	SLRA (Environment & Social Services Department)	Operational
3	Water Resources	· Surveillance; · Water testing	· Ensure the drainage channels and culverts are clear of debris · Water quality testing: pH, Turbidity, Electrical Conductivity (EC), Color, Total Suspended Solids (TSS), Total Dissolved Solids (TDS), Chemical Oxygen Demand (COD), Biological Oxygen Demand (BOD), Oil and grease	Testing paid by the Operating and Maintenance Authority	Surveillance: · Before starting the work in order to get a baseline information · Bi-weekly during the rainy season · Monthly during the dry season Water testing: in the case of accidental spills of hazardous materials	SLRA (Environment & Social Services Department)	Operational
4	Soil	· Surveillance; · Soil testing	· Ensure the drainage channels and culverts are clear of debris	Testing paid by the Operating and	Surveillance: · Bi-weekly during the rainy season	SLRA (Environment & Social Services Department)	Operational

No	Component	Monitoring Activity	Monitoring Indicator	Estimated Cost (USD)	Monitoring Frequency	Responsibility	Stage
			Soil testing: pH, temperature, organic content, poly-aromatic hydrocarbons (PAHs)	Maintenance Authority	- Monthly during the dry season - Soil testing: in the case of accidental spills of hazardous materials		
5	Solid and Hazardous waste	- Surveillance; - Maintaining records of quantities of waste and location of its disposal	Waste is disposed of at designated areas	No additional cost	Monthly	SLRA (Environment & Social Services Department)	Operational
6	Traffic and access	Surveillance	Presence of warning signs at maintenance site	No additional cost	During maintenance and repair works	SLRA (Environment & Social Services Department)	Operational
7	Flora and Fauna	Surveillance	- Condition of the manholes and ditches; - Level of re-vegetation; - Absence of ponds	No additional cost	Surveillance: - Bi-weekly during the rainy season - Monthly during the dry season	SLRA (Environment & Social Services Department)	Operational
8	Topography and surface drainage	Surveillance	Disposal of debris during maintenance and repairs	No additional cost	Monthly	SLRA (Environment & Social Services Department)	Operational
9	Handling Complaints	Record keeping on received complaints	Number of complaints and responses	No additional cost	Quarterly	SLRA (Environment & Social Services Department)	Operational
10	Public health and safety	Surveillance; Maintaining records of quantities of waste and location of its disposal	- Adequate warning about scheduled maintenance works; - Timely and adequate disposal of waste	No additional cost	Monthly	SLRA (Environment & Social Services Department)	Operational

10.12 PUNITIVE MEASURES & FINES

Over and above the statutory fines, which may be applicable, the client/ Consultant shall be authorized to impose spot fines on the Contractor for failure to comply with environmental specifications contained in the EMP, including but not limited to the transgressions detailed below.

- Littering on site
- Lighting of illegal fires on site
- Persistent or unrepaired oil leaks. Any persons, vehicles, or equipment related to the operations found within the designated “no-go” areas.
- Openings in fences are used to delineate the site.
- Excess dust, or excess noise and/or vibration emanating from the site.
- Possession or use of intoxicating substances on site. Any vehicles being driven more than the designated speed limits.
- Unauthorized removal and/or damage to fauna, flora, or heritage objects on site.
- Causing illegal pollution incidents.
- Hazardous chemical/ oil spills.
- Unauthorized damage to sensitive environments.
- Unauthorized damage to cultural, historical, or heritage sites.
- Unauthorized removal/damage to indigenous trees and other vegetation.
- The causing of unnecessary or unreasonable erosion.
- Unauthorized explosions or explosions that exceed prescribed time limits and periods.

A list of transgressions, along with the appropriate fines has been included in the Bid document. Such fines will be issued in addition to any remedial costs, which may be incurred by the Concessionaire as a result of non-compliance with the Environmental Specifications and /or legal obligations. The fine shall be payable within 3 (three) days of the delivery of the written notice of the fine. A checklist is prepared for the proper implementation of mitigation measures impacts. The engineers, inspectors, and environmentalists should carry this checklist and it should be duly filled.

11 ANNEXES

11.1 APPENDIX 1 CONSULTATIONS AND ENGAGEMENTS WITH KEY STAKEHOLDERS AT THE CABLE FERRY CROSSING POINTS

The Consultancy Team for the ESIA Study and Mariswe/ICS Engineers held stakeholder consultations and engagements with the community people in the four cable ferry crossing points of Gendema, Manowa, Mattru Jong, and Tomparie to inform them about the Four Bridges Subproject and the Government's intention to construct four modern bridges at the four crossing points to enhance connectivity and for easy movement of goods and services, especially for agricultural produces. A total of eighty-six (86) people participated in the various consultations to inform them about the environmental and social impact assessment studies to be undertaken before the construction of the bridges. The matrix below provides the total number and composition of participants.

No	Cable Ferry Crossing Points	Number of Participants	Composition of Participants
1.	Gendema	23	Hon. PC of Sumbaru Chiefdom, Town Chief of Garwama, Chief Leader, Councillor, Youth Leader and Community members, Community Business people, ESIA Consultants, and MariSwe/ICS Engineers.
2.	Manowa	18	The Hon. PC of Upper Bambara Chiefdom, Youth Leader and community members, Manowa Ferry Head, Fishermen, Chief of Manowa, ESIA Consultants and MariSwe/ICS Engineers,
3.	Mattru Jong	20	Hon. MP of Constituency 92, Bonthe District Council Chairman, Town Chief of Mattru, Chairman of Sand Miners, Youth leader and Commercial Bike Riders, Community members, Students, Petty Traders and Farmers. ESIA Consultants and MariSwe/ICS Engineers,
4.	Tomparie	25	Town Chief and Elders, Timber businessmen and businesswomen, Teachers, Students, Yo Village leaders, Youth leaders and Commercial Bike Riders, ESIA Consultants and MariSwe/ICS Engineers,

11.2 APPENDIX 2: PUBLIC CONSULTATION AND STAKEHOLDER ENGAGEMENT MINUTES FOR MATTRU JONG-SENEHUN CROSSING

MATTRU JONG-SENEHUN CROSSING

AGENDA

1. Registration of Attendees
2. Opening Prayers
3. Introduction of Chairperson
4. Declaration of Purpose
5. Welcome Address
6. Statements
7. AOB
8. Closing Prayers

ATTENDANCE: As recorded in the attendance **Registers of Participants**

OPENING PRAYERS

The Chairman asked all the participants and attendees to observe individual prayers in their different faiths and beliefs.

INTRODUCTION OF CHAIRPERSON

Mr. Dauda M. Kamara introduced the chairperson of the meeting, Mr. Fuad Yusuf Bangura.

DECLARATION OF PURPOSE

The meeting was declared open, and the purpose was well explained by the Chairman. He introduced the Four Bridges Subproject to the Community people, he explained to them the intention of the

Government to convert the traditional cable ferry at the Matru Jong crossing point into a modern engineered bridge that will connect Bonthe District and Moyamba District. He referred to the engagement done earlier in December by SLRA, SCADEP, and the Consultant (MARISWE/ICS) in which meetings and a brief about the project were given. He further informed them that though the project in itself would bring along some environmental, social, and economic implications as well as benefits, he maintained that the visit was to do Environmental and Social Impact Assessment and Resettlement Action Plan (RAP) studies for the Subproject before the commencement of construction. He went on to say that, the purpose of the visit and meeting was as follows;

- To have an engagement with the community people
- To determine and measure properties likely to be affected and measure them for valuation.
- Note the details of Project Affected Persons PAPs
- Administer questionnaires across different communities that are likely to be affected by the bridge Subproject.
- To find a suitable way of minimizing the effects of the Subproject on the communities.
- To study the environmental baseline of the Subproject area.

WELCOME ADDRESS

The Chairman of Bonthe District, Moses Jude Porobyn, welcomed the visiting team stating that he was happy to finally see the project on course. He said that has been the desire of the people to see the bridge being constructed. He mentioned that the Matru Jong crossing is a strategic crossing point and that the decision of the government to replace the traditional cable ferry is a laudable one. He welcomed the team and assured them of his full support at any point his input was needed.

STATEMENTS

Morie Shaka (Chairman of the sand miners (san-san) unit at the crossing point) expressed his gratitude to the Government for considering their crossing point for a bridge. On behalf of the youths welcomed the team to the district and assured the consultants of their full support. He added that they have been supporting other teams that have been at the crossing for different field investigations making special reference to the topographic survey team. Being one of the PAPs, he said that they as a community are willing to sacrifice anything in their power to see the project to completion.

Honourable Alice J Kumabeh welcomed the team and informed the meeting that she was happy about the commencement of the project. She said that most of their children have abandoned school because of the money they used to get from crossing people by boat. She said such development will not only aid connection but also help their children concentrate on their education and make it easy for children and children to go to school across communities and also for pregnant women to access hospitals and ambulance services. She said that she was happy because her constituency stands to benefit from one of the many things she advocated for in parliament. She assured the environmental team of their support.

Mr. Saidu Bah Socioeconomic Specialist also encouraged the community people to open up and give the data and information needed. This he said was to enable the project to gain full knowledge of the project area, as it will help to provide information to government and other development agencies. He requested the cooperation of the people in the various consultations, including focus group discussions, interviews, and questionnaires. He also added that they shall be working with the District's ESO to train enumerators who will be sent to nearby towns and villages to get some data regarding various aspects relating to their livelihood, living conditions, housing, health, education, etc.

Madam Rebecca Nyukeh (PAP), Petty Trader, and Farmer ask about compensation for the potential people who will be affected by the project. Especially for her, as she is a tenant-at-will in a community land close to the bank of the Jong River.

In his response, Mr. Fuad Yusuf Bangura informed Madam Rebecca that she is qualified for compensation and that the RAP will place her under a category that will be communicated to her and her benefits or compensation will be made clear to her before any demolition or removal of her property.

AOB

The Chairman asked Mr. Paul Banister to help the team identify competent people to be trained as enumerators who will administer the questionnaires.

CLOSING PRAYERS

They ended with silent individual prayers

11.3 APPENDIX 3: PUBLIC CONSULTATION AND STAKEHOLDER ENGAGEMENT MINUTES FOR GENDEMA-GARWAMA CROSSING

GENDEMA-GARWAMA CROSSING

AGENDA

1. Registration of Attendees
2. Opening Prayers
3. Introduction of Chairperson
4. Declaration of Purpose
5. Welcome Address
6. Statements
7. AOB
8. Closing Prayers

ATTENDANCE: As recorded in the attendance

OPENING PRAYERS

The Chairman asked all the participants and attendees to observe individual prayers in their different faiths and beliefs.

INTRODUCTION OF CHAIRPERSON

Mr. Saidu Bah introduced the chairperson of the meeting; Mr. Fuad Yusuf Bangura.

DECLARATION OF PURPOSE

The meeting was declared open and the purpose was explained by the Chairman. He introduced the Four Bridges project to the participants; he explained to them the intention of the Government to construct an engineered bridge at the cable ferry crossing point at Gendema/Gawarma to enhance connectivity and for easy movement of goods and services, especially for agricultural produce. He referred to the engagement done earlier in December by SLRA, SCADEP, and the Consultant, in which a brief about the project was given. He further informed them about the potential adverse environmental, social, and economic implications that might result from the commissioning of the said project and the many benefits the community and people stand to gain from the construction and operation of these bridges. He also informed the participants that the team was in the locality to primarily collect baseline data for the ESIA and RAP of the upcoming project. He went on to summarize the purpose of the visit and meeting as follows;

- To have an engagement with the community people
- To determine and measure properties likely to be affected and measure them for valuation.
- Note the details of Project Affected Persons PAPs
- Administer questionnaires across different communities that are likely to be affected by the bridge project.
- To find a suitable way of minimizing the effects of the project on the communities.
- To study the environmental baseline of the project area.

WELCOME ADDRESS

The Hon. Paramount Chief Madam Mamie Gamanga of Simbaru Chiefdom welcomed the Team of Consultants from MARISWE/ICS to her chiefdom and expressed how delighted she was to receive such a team. She further commented that she has been hearing about the bridge for a long time, but no physical sign of implementing it has ever been taken. Now that it is taking a new dimension, she

commended the Government of Sierra Leone for listening to the cries of her chiefdom. This she said has been one of the most difficult issues the chiefdom is faced with, especially during the rainy season when goods are stuck, pregnant women and school-going kids are unable to access hospitals and schools across the other end of the river. She prayed that the project become a success and assured the consultants of her full support in the conduct of their research and also during the construction phase of the project. She then handed the team over to councilor Bockarie M. Momudu, the Ward Councillor, whom she delegated with the duties of assisting the team in the course of the studies.

Town Chief, Mr. Daniel Lavalay welcomed the visiting team stating that he is very happy to hear such great news. He said that the construction of the Gendema Bridge has been the desire of the people of Simbaru Chiefdom, Boajibu Gendema, and Gawarma towns. Citing that, since he was a child, he has heard the news of a bridge for over 40 years, and to an extent that he hardly ever believed that it would indeed be constructed. Notwithstanding the pessimism he had about the bridge, he has gained new optimism and belief in the consistent strides made by the Government to make the bridge a reality. He mentioned that the Gendema cable ferry is very strategic in the trade and connectivity of towns and settlements between Kenema and Tonkolili Districts, which are two different districts and regions (North and East).

STATEMENTS

Bockarie M. Momudu (Councillor, Ward 54 at the Crossing Location) with excitement thanked the Paramount Chief and Town Chief for the honour and recognition and welcomed the team of consultants to his ward, particularly for the reason the team is visiting his ward, and for which purpose he is very happy and for which he is very pleased. He raised the following concerns on behalf of his people:

- He asked whether the current ferry would be operational during the construction of the bridge.
- He also asked what would happen to the livelihood of those presently operating the cable ferry and the boat owners and operators who cross passengers with boats when the bridge has been constructed.

In response, Mr. Fuad Yusuf Bangura thanked the councilor for such brilliant concerns raised. He responded as follows:

He said in the event of construction, the current ferry will have to be relocated and shall be in good working order. He added that because the bridge alignment follows the existing road, relocation of the ferry will be done before the commencement of the construction works.

Regarding the status of the ferry and boat operators, he said the World Bank being the funding agency of the project will look into the potential loss of their livelihood and as a result, the project will compensate PAPs accordingly and livelihood restoration programs will be implemented.

Mr. Michael Jusu added that hearing about the bridge construction is the greatest news to him. He said they have had incidents of maternal mortality and drowning of passengers across the river, and even though the cable ferry operates well with the help of SLRA, it does not operate round the clock and sometimes bad weather (high tide) makes it very hard to be operated in the rainy season. Hence, the construction of this bridge would save the community from a lot of these problems which have persisted since time immemorial.

Gbessay Sengah, the youth Leader of Garwama Town said they as youths a very happy to hear about such development. He asked whether the youth would have the opportunity to gain employment.

Mr. Bangura responded by thanking Mr. Jusu for acknowledging the necessity of the bridge and the good work of the SLRA to maintain the cable ferry amidst difficult circumstances. Concerning the question Mr. Gbessay Sengah, added that the bridge construction would bring unlimited economic and job opportunities to the community. However, the youths stand to gain more in the proposed project. He advised the youths to be open-minded and supportive of the construction and its associated activities.

AOB

Mr. Bangura reiterated the need for the communities to be frank and cooperative with enumerators and other field workers, as this will mark an opportunity to also obtain more information about their living conditions, education, etc., which can be used for future planning and development.

CLOSING PRAYERS

The meeting ended with prayers.

11.4 APPENDIX 4: PUBLIC CONSULTATION AND STAKEHOLDER ENGAGEMENT MINUTES FOR MANOWA-PENDEMBU CROSSING

MANOWA-PENDEMBU CROSSING

AGENDA

1. Registration of Attendees
2. Opening Prayers
3. Introduction of Chairperson
4. Declaration of Purpose
5. Welcome Address
6. Statements
7. AOB
8. Closing Prayers

ATTENDANCE: As recorded in the attendance

OPENING PRAYERS

The Chairman asked all the participants and attendees to observe individual prayers in their different faiths and beliefs.

INTRODUCTION OF CHAIRPERSON

Mr. David Sam introduced the chairperson of the meeting; Mr. Fuad Yusuf Bangura.

DECLARATION OF PURPOSE

The meeting was declared open and the purpose was explained by the Chairman. He introduced the Four Bridges project to the participants; he explained to them the intention of the Government to construct an engineered bridge at the cable ferry crossing point at Manowa/Pendembu to enhance connectivity and for easy movement of goods and services, especially for agricultural produce. He referred to the engagement done earlier in December by SLRA, SCADEP, and the Consultant, in which a brief about the project was given. He further informed them about the potential adverse environmental, social, and economic implications that might result from the commissioning of the said project and the many benefits the community and people stand to gain from the construction and operation of these bridges. He also informed the participants that the team was in the locality to primarily collect baseline data for the ESIA and RAP of the upcoming Subproject. He went on to summarize the purpose of the visit and meeting as follows;

- To have an engagement with the community people
- To determine and measure properties likely to be affected and measure them for valuation.
- Note the details of Project Affected Persons PAPs
- Administer questionnaires across different communities that are likely to be affected by the bridge project.
- To find a suitable way of minimizing the effects of the project on the communities.
- To study the environmental baseline of the project area.

WELCOME ADDRESS

The Hon. Paramount Chief, Hon. Cyril Foray Gondor II of Upper Bambara Chiefdom, PCMP for Kailahun District welcomed the visiting team and said he is happy to see the project on course in his lifetime. He said that the bridge construction has been the desire of his people for the longest time, and it has impeded a lot of development aspirations for his chiefdom. He mentioned that the Manowa/Pendembu crossing is a strategic crossing point as it will reduce the travel time and wear and tear of vehicles that at the moment go through a very long and treacherous road along Tondola (Bunubu). This has not only affected the overall development of the chiefdom; it has equally affected the economy and welfare of the people therein. Hence, he cannot over-emphasize the importance of the proposed bridge. However, he further recalled that the importance of a bridge at the Manowa/Pendembu Crossing was particularly felt during the Ebola crisis. During this time ambulances from the north and Kono needed to use that route to Kailahun and vice versa rather than going through Tondola, which is

quite long. He said several studies have been done regarding the bridge construction, but this one looks like a reality and for which he pledged his full support.

STATEMENTS

Musa Kamara (Youth leader), expressed his gratitude to the government for considering their crossing point for development. He welcomed the team on behalf of the youths of the Chiefdom and assured them of their unflinching support. He added that they have been supporting other teams who have been at the crossing for different field investigations making special reference to the topographic survey team. He also appealed that the Contractors consider employing the youths in the community during the construction phase.

In response, Mr. Bangura thanked the Chief and the Youth leader for such a warm welcome. He assured the youth leader that the project would bring job and skills training opportunities. He maintained that they as youths need to be ready to learn new skills and be law abiding and that the skills that will be transferred to them will remain with them even after the construction and will give them an everlasting livelihood.

Tamba Nabieu (Manowa Ferry Head) said he is happy to hear that the government intends to construct the bridge. He was however worried about losing his livelihood, as he has been getting his income through the operation of the ferry and boats in the crossing. Furthermore, he was also concerned about the livelihood of his colleagues who operate the ferry and boats. He requested clarifications on livelihood restoration packages for operators.

In response, Mr. Saidu Bah assured Mr. Tamba Nabieu to put his fears to rest, as the RAP will collect relevant data on the PAPs and provide for livelihood restoration and compensation programs.

James Keifala (Fisher Man) asked the following questions:

- What will be done to the fishermen during construction the water will get dirty, and fish may be driven away. As a result, they will automatically lose their livelihood.
- He also asked to know how people would be crossing the river during the construction.

In response, Mr. Bangura informed Mr. Keifala and other fishermen that all those whose livelihood may be affected including the fishermen during and after the Subproject shall be duly compensated. However, the ESIA will provide very concise mitigation procedures to deal with the impact on water quality.

Regarding the river crossing during high tides of the rainy season, he said that the cable ferry will be kept in good working order and that even the current crossing point will be operational because the alignment does not exactly follow the existing route.

Mr. Saidu Bah Socioeconomic Specialist, added by encouraging the community and various stakeholders to give their fullest cooperation to the enumerators and other field technicians as they will be moving across their localities to solicit different types of information; ranging from environment, socioeconomic, health, agricultural productivity, etc. He further requested the Youth Leader and Paramount Chief to recommend competent people who will be trained as enumerators to collect data alongside the supervisors and Team Leaders.

AOB

Hon. PC. Cyril Foray Gondor II thanked the Team once more and encouraged them to be in touch with him for any assistance that the Team may require. He further expressed his thanks to the team and the Government of Sierra Leone for selecting the Pendembu/Manowa crossing as he hopes the community will work together with the project to get the best results.

CLOSING PRAYERS

The meeting ended with prayers

11.5 APPENDIX 5: CONSULTATION AND STAKEHOLDER ENGAGEMENT MINUTES FOR THE KAMAKWIE-TOMPARI CROSSING

KAMAKWIE-TOMPARI CROSSING

AGENDA

1. Registration of Attendees
2. Opening Prayers
3. Introduction of Chairperson
4. Declaration of Purpose
5. Welcome Address
6. Statements
7. AOB
8. Closing Prayers

ATTENDANCE: As per the attendance register

OPENING PRAYERS

The Chairman asked all the participants and attendees to observe individual prayers in their different faiths and beliefs.

INTRODUCTION OF CHAIRPERSON

The chairperson of the meeting, Mr. Dauda M. Kamara was introduced by Mr. Alpha Bah.

DECLARATION OF PURPOSE

The meeting was declared open and the purpose was well explained by the Chairman. He introduced the Four Bridges project to the Community people; he explained to them the intention of the Government to convert the ferry crossing at the Tomparie crossing point into a modern bridge for connectivity and for easy movement of goods and services, especially for agricultural goods. He referred to the engagement done earlier in December by SLRA, SCADEP, and the Consultant where a brief about the project was given. He further informed them that the project in itself would bring along some environmental, social, and economic implications. He said that the visit was to do an Environmental and Social Impact Assessment of the project before the construction. He went on to say that, the purpose of the visit and meeting was as follows;

- To have an engagement with the community people
- To determine and measure properties likely to be affected and measure them for valuation.
- Note the details of Project Affected Persons PAPs
- Administer questionnaires across different communities that are likely to be affected by the bridge project.
- To find a suitable way of minimizing the effects of the project on the communities.
- To study the environmental baseline of the project area.

WELCOME ADDRESS

Mr. Kamanda Conteh, Town Chief of Tompari, welcomed the visiting team and said he is very happy to see the project at this commencing stage. He said that Tomparie has been there since 1964. He said the people have desired to see the bridge being constructed. He mentioned that the Tomparie crossing is a strategic crossing point, referring to the presidential entourage that recently crossed at that point. He said they had to spend a lot of time to cross since they had a lot of vehicles. He went further to state that the decision of the government to construct a modern bridge is a welcoming one. He welcomed the team and assured them of his full support at any point his input was needed.

STATEMENTS

Amadu Kargbo, one of the village elders said he was happy to hear such great news. He further thanked the government for considering the Tompari crossing point for a modern bridge. He welcomed the team once again asked them to feel at home and asked questions if they needed any clarification during their studies.

Councillor Benjamin Roy Kargbo also welcomed the team and asked about the starting time of the Project. He also asked whether people would be able to cross at the crossing point during construction.

In response, Mr. Dauda M. Kamara, responded as below:

The project has already started with the ongoing studies, the actual start of construction, which they see, as the start of the project, will commence at an agreed date by the government after the design and procurement phase of the project.

On the activeness of the crossing point during construction, he said that the ferry and boats would be operational throughout the construction, as the alignment would probably not pass through the existing route. He further informed them that in the event that the existing route will have to be followed, a temporary crossing point will be identified and the boats and ferry relocated.

Mr. Alpha Bah from the environmental team encouraged the community people to open up and give them the information needed. He said they would be engaging them on environmental and social issues through focus group discussions and questionnaires. He also added that they have already trained some set of enumerators who have been dispatched to the surrounding villages to administer questionnaires.

AOB

The Chairman informed the community people that another visit would be done to note the properties affected and make measurements when the final alignment is ready.

He also informed them that a team of enumerators had been trained in Kamakwe who would be administering questionnaires in the surrounding villages, he pleaded with them to give the right information to the enumerators.

CLOSING PRAYERS

The meeting ended with prayers and adjourned

11.6 APPENDIX 6: SOCIOECONOMIC SURVEY INSTRUMENT

QUESTIONNAIRE FOR THE SOCIO-ECONOMIC BASELINE SURVEY OF THE PROPOSED FOUR (4) BRIDGES PROJECT AT VARIOUS FERRY CROSSINGS IN SIERRA LEONE

Bridge:

Date:

District:

INTRODUCTION

I am..... from International Consulting Services (ICS), a private consulting firm hired by Smallholder Commercialization for Agribusiness Development (SCADeP). I am collecting baseline data for the development of the Socio-economic component in the Environmental and Social Impact Assessment study for the construction of bridges at various ferry crossings in Sierra Leone. We hope that your responses/recommendations will help us better understand and provide the desired information that will enhance the sustainability of the proposed project and the use of our natural resources. While your participation is deeply appreciated, rest assured that your responses will be treated with the utmost confidentiality they deserve.

Can we start the interview? Yes ☐ No ☐

Start Time..... End Time.....

Town/Village..... Section Chiefdom..... District.....

Distance to proposed bridge location.....km/Miles

Section A – Socio-Economic and Demographic Characteristics of Respondents

1. Gender: Male ☐ Female ☐
2. Age (in years): 18 – 35 ☐ 36 – 52 ☐ 53 - 69 ☐ 70 and above ☐
3. Household Size: 3-5 ☐ 6-10 ☐ 10 and above ☐
4. Marital status: Married ☐ Divorced ☐ Widow ☐ Widower ☐ Single ☐
5. Religion: Christianity ☐ Islam ☐ Traditional ☐ Other (Specify).....
6. Education: Never been to School ☐ Primary School ☐ Junior Secondary School ☐ Senior Secondary School ☐ University ☐ Arabi/Islamic ☐
7. Livelihood: what do you do for a living? Labour (casual) ☐ Subsistence Farming ☐ Artisanal Mining ☐ Petty trading ☐ Paid Employment ☐ Fishing ☐
8. Do you have any school-age children out of school? Yes ☐ No ☐
9. If yes, how many?
10. If yes, why are they not going to school? Lack of finance ☐ Distance of school ☐ Non-availability of schools in the community ☐ puts pressure on home ☐
11. What is the main economy for running the household?

Section B - Social Facilities

1. Are there schools in this community? Yes ☐ No ☐

2. If yes, which type of school? Primary ☐ Secondary ☐ Both ☐
3. How many of these Schools exist in s exist in our community?
.....
4. If No, what is the distance to the nearest locality where the school is/are found.....km
5. Type of toilet facility used by households: Pit latrine ☐ Bush (open defecation) ☐
Flush (modern) ☐
6. Do you have access to drinking water? Yes ☐ No ☐
7. The main source of drinking water: SALWAO ☐ Spring/Stream ☐
Community Well/Borehole ☐ Private Well/Borehole ☐
8. Distance to the source of drinking water.....km
9. Do you own or rent a house in the locality? Yes ☐ No ☐
10. How much rent do you pay?
11. Type of house: Corrugated iron sheaths ‘pan-body’ ☐ Mud dressed with concrete ☐
Wooden ☐ Concrete (finished/unfinished) ☐
12. Roof type: Corrugated Iron Sheaths ☐ Thatched Roof ☐ Plastic Roof ☐
13. Window type: Steele casement ☐ Aluminum ☐ Wood ☐
14. Main source of Energy: Solar National grid ☐ Rechargeable lights ☐ kerosene ☐
15. What is the main source of energy this household uses for cooking? Gas ☐ Charcoal ☐
Firewood ☐
16. What is the common means of transportation to and from this village/town? Motor bikes ☐
Vehicles and light vans ☐
17. Is the ferry the only means of getting to the other villages/towns? Yes ☐ No ☐
18. If no, what other alternatives do you have? Road ☐ Foot bridges ☐ Other.....
19. Are the alternative routes safe and motorable for either bikes or vehicular traffic?
Yes ☐ No ☐
20. Do you have access to telecommunications networks and devices (mobile, internet, or radio station)?
Yes ☐ No ☐

Section C - Health Services

1. Do you have a health clinic/PHU/Hospital in your village/Town? Yes ☐ No ☐
2. If yes, how many?
3. What is the distance to the nearest health facility? Km

4. **Common Ailments/sickness in this community**.....
.....
5. **Household preferred mode of treatment:** Hospital ☐ Traditional ☐ Other.....
6. **Major challenges in accessing medical treatment:** Lack of healthcare facilities ☐
Non-availability of drugs/equipment ☐ non-availability of trained and qualified health
Personnel ☐ Distance ☐ Financial ☐
7. **Are children and under-five vaccinated?** Yes ☐ No ☐
8. **Is infant and maternal mortality high in this community?** Yes ☐ No ☐
9. **What are the reasons for this?** Poor Healthcare facilities ☐ non-availability of
emergency (ambulance) services ☐ Poor Service delivery at hospitals and clinics ☐
10. **Do you know about Covid-19 (Corona)?** Yes ☐ No ☐
11. **How can Covid -19 (coronavirus) be prevented?**
i. iii.
ii. iv.
12. **Are you aware of family planning?** Yes ☐ No ☐
13. **Are you aware of HIV/AIDS?** Yes ☐ No ☐

Section D - Gender-Based Violence

1. **Do you know about gender-based violence?** Yes ☐ No ☐
2. **Have you ever experienced gender-based violence?** Yes ☐ No ☐
3. **If yes, where did you report?** NGO ☐ CBO ☐ FSU(Police) ☐ I did not report ☐
4. **Were you satisfied with the outcome of your report/complaint?** Yes ☐ No ☐

Section E - Household Income and Expenditure

The main source of income	Primary	Mean monthly	Secondary	Mean Monthly

HOUSEHOLD EXPENDITURE

Expenditure item	Daily	Mean monthly	Annual

Section F - Access to Credit

1. Do you have access to credit? Yes ☐ No ☐
2. Type of credit available: Micro-credit ☐ Bank loan ☐ Private lending ☐

Section G - Food Production and Security

1. What are the major food items that are produced in this community?
- i. iii.
ii. iv.
2. Do you have enough food to eat throughout the year? Yes ☐ No ☐
3. Has food production increased in the last five years? Yes ☐ No ☐
4. What is responsible for the increase or decrease?
- i. iii.
ii. iv.
5. What recommendations can you make to increase food production in this community?
- i. iii.
ii. iv.
iii.
6. What are the major crops grown or cultivated by this household in the last 12 months?
- | CROP | ACREAGE |
|------|---------|
| | |
7. Do you have livestock? Yes ☐ No ☐
8. If YES,
- | Type of livestock | Number |
|-------------------|--------|
| | |
9. What manures do you use on your farms (agriculture)?
- i. iii.
ii. iv.
10. What Pesticides do you use on your crops?
- i. iii.
ii. iv.

Section H - Land Ownership and Rights
☐

1. Do you own land? Yes ☐ No ☐
2. If yes, what is the type of land tenure system or ownership?
 - i.
 - ii.
 - iii.
 - iv.
3. Do you have access to arable land for cultivation? Yes ☐ No ☐
4. Do women have access to land? Yes ☐ No ☐
5. What challenges do women face in accessing land in this community?
 - i.
 - ii.
 - iii.
 - iv.
6. How can this be improved?
 - i.
 - ii.
 - iii.
 - iv.
7. If YES, describe the likely impact of the project
 - i.
 - ii.
 - iii.
 - iv.

Section I - Community Needs and Development Priorities

1. In terms of priorities, what are the three [3] most important development priorities of this community?
 - 1st
 - 2nd
 - 3rd
2. What contributions would you like to make to enhance the realization of your aspirations in (2) above?
 - i.
 - ii.
 - iii.

Section J – Indigenous tribes/People

1. How long has your family lived in this settlement? My ancestors were born here ☐
 My grandfather/mother migrated (before independence) ☐ My Parents migrated ☐
2. If you are not an indigene, what brought you/your parents here? Trade ☐ Mining ☐
 Work/job ☐ Traditional medicine ☐ Civil War ☐ Education ☐ Marriage ☐

Section K - Impacts from the bridge works

1. Do you know about the upcoming bridge works? Yes ☐ No ☐
2. If yes, how did you find out?
3. Do you support the construction of the bridge? Yes ☐ No ☐
4. If yes, why? If no, why?

5. How often do you use the ferry? Daily ☐ Weekly ☐ Monthly ☐ Annually ☐
Never ☐

6. What do you use the ferry for?

7. Is the ferry the only means of getting to the other villages/towns? Yes ☐ No ☐

8. If no, what other alternatives do you have? Road ☐ Foot Bridges ☐ Other.....

9. Are the alternative routes safe and motorable for either bikes or vehicular traffic?

Yes ☐ No ☐

8. Is there any work/employment by household members that will lead to the loss of land by the proposed bridge project in your area? Yes ☐ No ☐

9.

10. Is there any work/employment by household members that will lead to the loss of land by the proposed bridge project in your area? Yes ☐ No ☐

11. If YES, describe the likely impact of the project

i. iii.
ii. iv.

3. What benefits do you envisage from the proposed bridge project in your locality?

i. iii.
ii. iv.

4. What problems do you envisage from the proposed project in your area?

i.
ii.
iii.

5. What benefits do you envisage from the proposed bridge project in your locality?

i. iii.
ii. iv.

6. What suggestions can you make to mitigate their impacts?

i.
ii.
iii.
iv.

Thank you!

Supervisor.....
Date.....

Signature.....

11.7 APPENDIX 7: RANDOM PICTURES OF COMMUNITY ENGAGEMENTS AND FIELD DATA COLLECTION





Location: GRAND

No.	
1.	Atahaj
2.	Sailor
3.	Moham
4.	David
5.	Musa
6.	Mary
7.	Shirika
8.	Miche
9.	Davis
10.	Alusi

11.	David Sanyu	community leader	074-86-66-57	
12.	Mohamed Kessie			
13.	Moses J. pubin	Booth District Council chairman		
14.	Hon. Ali J. Kumbaleh	MP. const- 92		
15.	Abu Jalloh	Commercial bank member		
16.	Asduraahman Kangbo			
17.	Fuad Yusif Bangura	Environmental & Safeguards-ICS	076-609-151	
18.	David M. Kamara	GIS and remote sensing	080-80-82-00	
19.	Alpha Bah	socioeconomist	076-911-677	
20.	Saidu Bah	Environmental	076-717-417	
21.				
22.				
23.				

11.8 APPENDIX 8: ATTENDANCE LIST

7 BRIDGES - ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT STUDIES

COMMUNITY ENGAGEMENT

Attendance Register

Location: MAWLA CROSSINGDate: 06/03/2021

No.	NAME	INSTITUTION	CONTACT NO.	SIGNATURE
1.	Musa Kamara	Youth leader	076-16-22-22	
2.	Denis Loise	community youth		
3.	James Keifala	community member	075-34-66-30	
4.	Mohamed Mustapha			
5.	Kandi J. Musa		084-94-72-27	
6.	Mustapha Kamara	Engineer-ICS	076-91-09-49	
7.	Daouda K. Sami	Engineer-ICS	076-47-88-74	
8.	Mustapha Kamara			
9.	Morison Musa			
10.	Aminata Brinco			
11.	Papick Mawo			

06/03/2021

11.	Saidu Sanyu	community leader		
12.	Abu Krewa			
13.	David Kamara	GIS specialist	080-80-82-00	
14.	Alpha Bah	socio-economist	076-911-677	
15.	Saidu Bah	Environmental	076-717-417	
16.	Fuad Yusif Bangura	Environmental and Safeguards-ICS	076-609-151	
17.	Henry Kumbaleh Sanyu	Chief-Mawla	076-717-417	
18.				
19.				
20.				
21.				
22.				
23.				

7 BRIDGES – ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT STUDIES

COMMUNITY ENGAGEMENT

Attendance Register

Location: TOMPARI CROSSING

Date: 07/04/2021

No.	NAME	INSTITUTION	CONTACT NO.	SIGNATURE
1.	Mustapha Kamara	Engineer - ICS	076-91-09-49	
2.	David B. Sam		076-47-85-74	
3.	Richard Tamba	Teacher	033-379158	
4.	Saidu A. Kamara	student		
5.	Faty B. Kamara	Businesswoman		
6.	Abu Saidu	commercial trader		
7.	Lamin M. Bangura			
8.	Adolphus King	Businesswoman		
9.	Bai-Kanteh Sesay	commercial trader		
10.	Abu Saidu			

07/04/2021

11.	Veronica Sierra	Businesswoman	076-41-71-32	
12.	Mintaka Baihara	commercial trader		
13.	Abu Saidu	Businesswoman		
14.	Alice George	Businesswoman		
15.	Richard Amara	commercial trader		
16.	Enthanghina J.			
17.	Konkora Fula			
18.	Abu Saidu			
19.	Tugo Yusif Bangura	Businesswoman / social supporter - ICS	076-607-157	
20.	Alana Bai	Businesswoman	076-911 677	
21.	Kamara center	Town chief's office		
22.	Abulrahman Kany	elder		
23.	Saidu Bai	Businesswoman	076-717 412	

24.	Joseph Kamara			
25.	Mintaka Baihara			

11.9 APPENDIX 9. CONTINUED STAKEHOLDER ENGAGEMENT AT KAMAKWIE-TOMPARI CROSSING

MINUTES FOR RAP COMMUNITY ENGAGEMENT IN TOMPARIE VILLAGE 1 FOR THE TOMPARIE CROSSING	
PROJECT: 4 Bridges	
DATE: 28th August, 2021	
VENUE: Tomparie Village 1.	
CHAIRMAN; Dauda M. Kamara	

ATTENDANCE

28/08/2021

No.	NAME	POSITION	CONTACT NO.
14.	Masalleh Bangura	11	—
15.	Molai Mansaray	11	—
16.	Fuad Yusif Bangura	Environmental & Safety specialist	ICS-076-609151
17.	David M. Kama	GIS/remote sensing	088-808300
18.	David B. Sam	Engineer - ICS	076-475874
19.	Mustapha Karama	Engineer - ICS	080-028439
20.			
21.			
22.			
23.			
24.			
25.			
26.			
27.			
28.			
29.			
30.			

Topic/Issues	Discussion	Action by:
Opening Prayer and declaration of purpose	Everyone prayed in their various faith and beliefs. The meeting was then declared open and the purpose well explained by the Chairman as follows: The Chairman said that the Tomparie bridge project was no longer new to the community, as several engagements and studies have been done already. He said in addition to the Environmental and Social Impact Assessment that was done in April 2021, the Environmental team had also come to do a RAP assessment based on the approach road alignment. He informed them that the alignment passes through some plantations from the Kamakwe end and also affected a few houses. On the Kambia end, he said several houses will be affected. He added that the Engineers who were on the visiting team would do a tour through the plantation and also measure the affected houses and take note of the respective owners.	
Welcome Address	The youth leader of Tomparie Village welcomed the team and assured them of their usual support as a community. He said they were happy and in anticipation of the project. He availed himself to join the team and help them identify house owners since most of them were gone for the weekly market day.	
Statements	Mariatu Bangura, one of the victims said though she was happy with the project, she was also depressed a bit about her house because she was too old to work and build another house to stay. David K. Sam encouraged her to be calm. He said that before the construction, the Government will compensate all victims and give them time before commencement. Aruna Rogers, the town speaker, asked to know about what the government would be doing regarding their plantation.	
AOB	None.	
CLOSURE	The meeting ended with prayers and adjourned.	

11.10 APPENDIX 10. BORROW PITS AND QUARRIES COORDINATES FOR THE FOUR BRIDGES

BORROW PITS AND QUARRY COORDINATES				
Bridge Locations	Quarry Locations		Borrow Pit Locations	
	Eastings	Nothings	Eastings	Nothings
GENDEMA - GARWAMA CROSSING - ZONE 29P	239666.058	912105.691	241969.533	913704.39
	239675.909	912134.197	241958.43	913795.88
	239683.01	912135.183	242034.88	913678.96
			242061.97	913748.89
BORROW PITS AND QUARRY COORDINATES				
Bridge Locations	Quarry Locations		Borrow Pit Locations	
	Eastings	Nothings	Eastings	Nothings
MATTRU JONG – SENEHUN CROSSING 28N	Senahun End			
			809580.88	843654.04
			809602.02	843664.41
			809584.75	843690.78
			809560.45	843680.43
	Mattru End			

	807715	845736	816375.52	843462.55
BORROW PITS AND QUARRY COORDINATES				
Bridge Locations	Quarry Locations		Borrow Pit Locations	
	Eastings	Nothings	Eastings	Nothings
MANOWA – PENDEMBU CROSSING 29P	307101.07	905090.23	308498.61	903014.55
	307365.93	904926.65	308495.23	902877.4
			308712.26	903034.33
			308681.81	902912.16
BORROW PITS AND QUARRY COORDINATES				
Bridge Locations	Quarry Locations		Borrow Pit Locations	
	Eastings	Nothings	Eastings	Nothings
KAMAKWEI TOMPARI 28P	783478.21	1060461.5	790259.43	1050998.2
	783620	1060199.24	790398.64	1051149.56
			790473.08	1051041.06
			790335	1050955.14

11.11 APPENDIX 11. AIR QUALITY DATA LOG FOR THE FOUR BRIDGES

Bridge Location: *Manowa Crossing / Pendembu*
Date: *28/03*

AIR QUALITY DATA LOG

No.	Air Quality Parameter	Morning	Evening	X-Coordinate	Y-Coordinate	Remarks
1	NO (ppm)	0.3	0.3			
2	NO ₂ (ppm)	3.0	2.9	810561	84372.5	
3	CO (ppm)	0.0	0.0			
4	PM ₁₀ (ppm)	0.0	0.0			
5	O ₃ (ppm)	0.0	0.0			
6	CH ₄ (ppm)	0.0	0.0			
7	SO ₂ (ppm)	3.4	0.0			
8	SO ₄ (ppm)	0.0	0.0			
9	H ₂ S (ppm)	0.3	0.0			
10	VOC (ppm)	0.0	0.4			
11	PM _{2.5} (ppm) <i>µg/m³</i>	12.1	0.0			
12	PM ₁₀ (ppm) <i>µg/m³</i>	17.7	16.7			

RH 51 48

Bridge Location: *Manowa Crossing / Mica*
Date: *02/4*

AIR QUALITY DATA LOG

No.	Air Quality Parameter	Morning	Evening	X-Coordinate	Y-Coordinate	Remarks
1	NO (ppm)	0.2	0.2			
2	NO ₂ (ppm)	3.0	2.7	812060	841670	
3	CO (ppm)	0.0	0.0			
4	PM ₁₀ (ppm)	0.0	0.0			
5	O ₃ (ppm)	0.0	0.0			
6	CH ₄ (ppm)	0.0	0.0			
7	SO ₂ (ppm)	3.4	0.0			
8	SO ₄ (ppm)	0.0	0.0			
9	H ₂ S (ppm)	0.4	0.3			
10	VOC (ppm)	0.0	0.0			
11	PM _{2.5} (ppm) <i>µg/m³</i>	18.4	11.5			
12	PM ₁₀ (ppm) <i>µg/m³</i>	12.7	26.2			

RH 36 37

Bridge Location: *Manowa Crossing / Mica*
Date: *02/4*

AIR QUALITY DATA LOG

No.	Air Quality Parameter	Morning	Evening	X-Coordinate	Y-Coordinate	Remarks
1	NO (ppm)	0.3	0.3			
2	NO ₂ (ppm)	3.0	2.9	810561	84372.5	
3	CO (ppm)	0.0	0.0			
4	PM ₁₀ (ppm)	0.0	0.0			
5	O ₃ (ppm)	0.0	0.0			
6	CH ₄ (ppm)	0.0	0.0			
7	SO ₂ (ppm)	3.4	0.0			
8	SO ₄ (ppm)	0.0	0.0			
9	H ₂ S (ppm)	0.3	0.0			
10	VOC (ppm)	0.0	0.4			
11	PM _{2.5} (ppm) <i>µg/m³</i>	12.1	0.0			
12	PM ₁₀ (ppm) <i>µg/m³</i>	17.7	16.7			

RH 50 57

Project Location: Manila City - Manila East Side

Date: 10/10/2017

AIR QUALITY DATA LOG

No.	Air Quality Parameter	Monitoring	Sampling	X-Coordinate	Y-Coordinate	Remarks
1	NO ₂ (ppm)	0.7	0.9	108688	902813	
2	NO _x (ppm)	0.7	0.9			
3	CO (ppm)	0.0	0.0			
4	PM ₁₀ (ppm)	0.0	0.0			
5	SO ₂ (ppm)	0.0	0.0			
6	CH ₄ (ppm)	0.0	0.0			
7	CO ₂ (ppm)	324	334			
8	SO ₂ (ppm)	0.0	0.0			
9	NO ₂ (ppm)	0.0	0.0			
10	NO _x (ppm)	0.0	0.0			
11	PM ₁₀ (ppm)	11.4	11.4			
12	PM _{2.5} (ppm)	18.9	27.6			

RH = 41 48

Project Location: Manila City - Manila East Side

Date: 10/10/2017

AIR QUALITY DATA LOG

No.	Air Quality Parameter	Monitoring	Sampling	X-Coordinate	Y-Coordinate	Remarks
1	NO ₂ (ppm)	0.5	0.5	108688	902813	
2	NO _x (ppm)	0.5	0.5			
3	CO (ppm)	0.0	0.0			
4	PM ₁₀ (ppm)	0.0	0.0			
5	SO ₂ (ppm)	0.0	0.0			
6	CH ₄ (ppm)	0.0	0.0			
7	CO ₂ (ppm)	324	334			
8	SO ₂ (ppm)	0.0	0.0			
9	NO ₂ (ppm)	0.0	0.0			
10	NO _x (ppm)	0.0	0.0			
11	PM ₁₀ (ppm)	11.4	11.4			
12	PM _{2.5} (ppm)	18.9	27.6			

RH = 40 47

Project Location: Manila City - Manila East Side

Date: 10/10/2017

AIR QUALITY DATA LOG

No.	Air Quality Parameter	Monitoring	Sampling	X-Coordinate	Y-Coordinate	Remarks
1	NO ₂ (ppm)	0.0	0.0	108688	902813	
2	NO _x (ppm)	0.0	0.0			
3	CO (ppm)	0.0	0.0			
4	PM ₁₀ (ppm)	0.0	0.0			
5	SO ₂ (ppm)	0.0	0.0			
6	CH ₄ (ppm)	0.0	0.0			
7	CO ₂ (ppm)	324	334			
8	SO ₂ (ppm)	0.0	0.0			
9	NO ₂ (ppm)	0.0	0.0			
10	NO _x (ppm)	0.0	0.0			
11	PM ₁₀ (ppm)	11.4	11.4			
12	PM _{2.5} (ppm)	18.9	27.6			

RH = 77 50.0

Project Location: Manila City - Manila East Side

Date: 10/10/2017

AIR QUALITY DATA LOG

No.	Air Quality Parameter	Monitoring	Sampling	X-Coordinate	Y-Coordinate	Remarks
1	NO ₂ (ppm)	0.0	0.0	108688	902813	
2	NO _x (ppm)	0.0	0.0			
3	CO (ppm)	0.0	0.0			
4	PM ₁₀ (ppm)	0.0	0.0			
5	SO ₂ (ppm)	0.0	0.0			
6	CH ₄ (ppm)	0.0	0.0			
7	CO ₂ (ppm)	324	334			
8	SO ₂ (ppm)	0.0	0.0			
9	NO ₂ (ppm)	0.0	0.0			
10	NO _x (ppm)	0.0	0.0			
11	PM ₁₀ (ppm)	11.4	11.4			
12	PM _{2.5} (ppm)	18.9	27.6			

RH = 36 59

Project Location: Manila City - Manila East Side

Date: 10/10/2017

AIR QUALITY DATA LOG

No.	Air Quality Parameter	Monitoring	Sampling	X-Coordinate	Y-Coordinate	Remarks
1	NO ₂ (ppm)	0.0	0.0	108688	902813	
2	NO _x (ppm)	0.0	0.0			
3	CO (ppm)	0.0	0.0			
4	PM ₁₀ (ppm)	0.0	0.0			
5	SO ₂ (ppm)	0.0	0.0			
6	CH ₄ (ppm)	0.0	0.0			
7	CO ₂ (ppm)	324	334			
8	SO ₂ (ppm)	0.0	0.0			
9	NO ₂ (ppm)	0.0	0.0			
10	NO _x (ppm)	0.0	0.0			
11	PM ₁₀ (ppm)	11.4	11.4			
12	PM _{2.5} (ppm)	18.9	27.6			

RH = 40 50

Project Location: Manila City - Manila East Side

Date: 10/10/2017

AIR QUALITY DATA LOG

No.	Air Quality Parameter	Monitoring	Sampling	X-Coordinate	Y-Coordinate	Remarks
1	NO ₂ (ppm)	0.0	0.0	108688	902813	
2	NO _x (ppm)	0.0	0.0			
3	CO (ppm)	0.0	0.0			
4	PM ₁₀ (ppm)	0.0	0.0			
5	SO ₂ (ppm)	0.0	0.0			
6	CH ₄ (ppm)	0.0	0.0			
7	CO ₂ (ppm)	324	334			
8	SO ₂ (ppm)	0.0	0.0			
9	NO ₂ (ppm)	0.0	0.0			
10	NO _x (ppm)	0.0	0.0			
11	PM ₁₀ (ppm)	11.4	11.4			
12	PM _{2.5} (ppm)	18.9	27.6			

RH = 36 57

Project Location: Manila City - Manila East Side

Date: 10/10/2017

AIR QUALITY DATA LOG

No.	Air Quality Parameter	Monitoring	Sampling	X-Coordinate	Y-Coordinate	Remarks
1	NO ₂ (ppm)	0.0	0.0	108688	902813	
2	NO _x (ppm)	0.0	0.0			
3	CO (ppm)	0.0	0.0			
4	PM ₁₀ (ppm)	0.0	0.0			
5	SO ₂ (ppm)	0.0	0.0			
6	CH ₄ (ppm)	0.0	0.0			
7	CO ₂ (ppm)	324	334			
8	SO ₂ (ppm)	0.0	0.0			
9	NO ₂ (ppm)	0.0	0.0			
10	NO _x (ppm)	0.0	0.0			
11	PM ₁₀ (ppm)	11.4	11.4			
12	PM _{2.5} (ppm)	18.9	27.6			

RH = 41 53

AIR QUALITY DATA LOG
 Village Location: *Matru - Senehun*
 Date: *12/05/2018*

No	Air Quality Parameter	Measuring	Reading	X-Coordinate	Y-Coordinate	Remarks
1	NO ₂ (ppm)	0.6	0.7	33591	89973	
2	NO (ppm)	4.1	4.4			
3	CO (ppm)	0.0	0.0			
4	PM ₁₀ (ppm)	0.0	0.0			
5	O ₂ (ppm)	0.0	0.0			
6	CH ₄ (ppm)	0.0	0.0			
7	CO ₂ (ppm)	326	366			
8	SO ₂ (ppm)	0.0	0.0			
9	H ₂ S (ppm)	0.2	0.3			
10	VOC (ppm)	0.0	0.0			
11	PM _{2.5} (ppm)	19.2	10.6			
12	PM ₁₀ (ppm)	26.7	28.3			
	RH	44	50			

AIR QUALITY DATA LOG
 Village Location: *Matru - Senehun*
 Date: *12/05/2018*

No	Air Quality Parameter	Measuring	Reading	X-Coordinate	Y-Coordinate	Remarks
1	NO ₂ (ppm)	0.6	0.7	33591	89973	
2	NO (ppm)	4.1	4.4			
3	CO (ppm)	0.0	0.0			
4	PM ₁₀ (ppm)	0.0	0.0			
5	O ₂ (ppm)	0.0	0.0			
6	CH ₄ (ppm)	0.0	0.0			
7	CO ₂ (ppm)	326	366			
8	SO ₂ (ppm)	0.0	0.0			
9	H ₂ S (ppm)	0.2	0.3			
10	VOC (ppm)	0.0	0.0			
11	PM _{2.5} (ppm)	19.2	10.6			
12	PM ₁₀ (ppm)	26.7	28.3			
	RH	44	50			

AIR QUALITY DATA LOG
 Village Location: *Matru - Senehun*
 Date: *12/05/2018*

No	Air Quality Parameter	Measuring	Reading	X-Coordinate	Y-Coordinate	Remarks
1	NO ₂ (ppm)	0.6	0.7	33591	89973	
2	NO (ppm)	4.1	4.4			
3	CO (ppm)	0.0	0.0			
4	PM ₁₀ (ppm)	0.0	0.0			
5	O ₂ (ppm)	0.0	0.0			
6	CH ₄ (ppm)	0.0	0.0			
7	CO ₂ (ppm)	326	366			
8	SO ₂ (ppm)	0.0	0.0			
9	H ₂ S (ppm)	0.2	0.3			
10	VOC (ppm)	0.0	0.0			
11	PM _{2.5} (ppm)	19.2	10.6			
12	PM ₁₀ (ppm)	26.7	28.3			
	RH	44	50			

AIR QUALITY DATA LOG
 Village Location: *Matru - Senehun*
 Date: *12/05/2018*

No	Air Quality Parameter	Measuring	Reading	X-Coordinate	Y-Coordinate	Remarks
1	NO ₂ (ppm)	0.6	0.7	33591	89973	
2	NO (ppm)	4.1	4.4			
3	CO (ppm)	0.0	0.0			
4	PM ₁₀ (ppm)	0.0	0.0			
5	O ₂ (ppm)	0.0	0.0			
6	CH ₄ (ppm)	0.0	0.0			
7	CO ₂ (ppm)	326	366			
8	SO ₂ (ppm)	0.0	0.0			
9	H ₂ S (ppm)	0.2	0.3			
10	VOC (ppm)	0.0	0.0			
11	PM _{2.5} (ppm)	19.2	10.6			
12	PM ₁₀ (ppm)	26.7	28.3			
	RH	44	50			

11.12 APPENDIX 12. RANDOM PHOTOS OF AIR QUALITY MONITORING

MATRU-SENEHUN CROSSING



GENDEMA-GARWAMA CROSSING



MANOWA-PENDEMBU CROSSING



KAMAKWIE-TOMPARI CROSSING



11.13 APPENDIX 13: GROUND WATER QUALITY

NATIONAL WATER QUALITY LABORATORY

TEL 077-547-020/079-317-532
MINISTRY OF WATER RESOURCES
TOWER HILL
FREETOWN

Water Quality Monitoring Report Sheet

Water Authority:..... International Consulting Services

District:..... Bontho Chiefdom:..... Jong..... Town:..... Senchun Date:..... 28th /02/2023.....

Sample: WS/lot2/mat1..... Location:..... Matru..... Type of Source:..... Hand-dug Well. Time: 12:35.....

GPS

N-0842330

E-0.810457

Parameters	Measured Values	WHO recommended Permissible Limits
1. Water Temperature (°C)	28.9	No. Value
2. pH	6.9	6.5 – 8.5
3. Turbidity (NTU)	0	<5.0
4. Conductivity (µS/Cm)	215	<450 µS
5. TDS (ppm)	107.5	<248ppm
6. Salinity (ppt)	-	<0.4
7. Residual Chlorine (mg/l)	0.00	0.3-0.5 after 30min. disinfection
8. Aluminum (mg/l)	0.03	<0.2
9. Ammonia (mg/l)	0.13	No. Value
10. Bromine (mg/l)	-	No. Value
11. Calcium Hardness (mg/l)	77	<250
12. Copper (mg/l)	0.22	<1.0
13. Fluoride (mg/l)	1.75	<1.5
14. Iron (mg/l)	0.05	<0.3
15. Magnesium (mg/l)	0.02	<200
16. Manganese (mg/l)	0.77	<0.4
17. Molybdenum (mg/l)	0.01	0.25
18. Nitrite (mg/l)	0.08	3.0
19. Nitrate (mg/l)	12	<10
20. Potassium (mg/l)	7.4	<6.0
21. Phosphate (mg/l)	1.7	<2.0
22. Silica (mg/l)	0.02	<15
23. Sulphate (mg/l)	0	<400

NATIONAL WATER QUALITY LABORATORY

TEL 077-547-020/079-317-532
MINISTRY OF WATER RESOURCES
TOWER HILL
FREETOWN

Water Quality Monitoring Report Sheet

Water Authority:..... International Consulting Services.....

District:..... Bontho Chiefdom:..... Jong..... Town:..... Senchun Date:..... 28th /02/2021.....

Sample: WS/lot2/mat2..... Location:..... Matru..... Type of Source:..... Hand-dug well.

Time: 12:51.....

GPS

N-0842634

E-0810211

Parameters	Measured Values	WHO recommended Permissible Limits
1. Water Temperature (°C)	29.0	No. Value
2. pH	6.8	6.5 – 8.5
3. Turbidity (NTU)	0	<5.0
4. Conductivity (µS/Cm)	46	<450 µS
5. TDS (ppm)	23	<248ppm
6. Salinity (ppt)	-	<0.4
7. Residual Chlorine (mg/l)	0.00	0.3-0.5 after 30min. disinfection
8. Aluminum (mg/l)	0.03	<0.2
9. Ammonia (mg/l)	0.14	No. Value
10. Bromine (mg/l)	-	No. Value
11. Calcium Hardness (mg/l)	2.0	<250
12. Copper (mg/l)	0.20	<1.0
13. Fluoride (mg/l)	2	<1.5
14. Iron (mg/l)	0.06	<0.3
15. Magnesium (mg/l)	0.01	<200
16. Manganese (mg/l)	3.33	<0.4
17. Molybdenum (mg/l)	0.0	0.25
18. Nitrite (mg/l)	0.03	3.0
19. Nitrate (mg/l)	12	<10
20. Potassium (mg/l)	1.0	<6.0
21. Phosphate (mg/l)	0.5	<2.0
22. Silica (mg/l)	0.00	<15

22. Silica (mg/l)	0.00	<15
23. Sulphate (mg/l)	0	<400
24. Sulphide (mg/l)	0.0	<0.5
25. Sulphite (mg/l)	0.0	No. Value
26. Chloride (mg/l)	8	<250
27. Arsenic	0.00	0.01
28. Chromium	0.09	<0.05
29. Bicarbonate (mg/l)	0.00	No. Value
30. Zinc (mg/l)	0.0	<5.0
31. E. Coli	Nil	Zero
32. Faecal Coliforms	50	Zero
33. Non - Faecal Coliforms	Nil	10
34. Vibrio-parahaemolyticus	-	Zero
35. Salmonella sp.	-	Zero

RECOMMENDATIONS:- The physicochemical analysis of this source indicate that all the parameters are within the WHO recommended standard for good drinking water, except for ammonia, Fluoride manganese, and chromium which are above their WHO limits.

Bacteriologically, the source is polluted with faecal bacteria. However, chlorination process is necessary with a free chlorine content of 0.3mg/l – 0.5mg/l which is the WHO guideline for Potable Water.

Signed:..... Edward Toby.....

(Supervisor)

Date:.....

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NATIONAL WATER QUALITY LABORATORY

TEL 077-547-020/079-317-532
MINISTRY OF WATER RESOURCES
TOWER HILL
FREETOWN

Water Quality Monitoring Report Sheet

Water Authority:..... International Consulting Services.....

District:....Bontho.. Chiefdom:....Jong.... Town:....Matru..... Date:.... 28th /02/2023.....

Sample:.. WS/lot2/mat03...Location:Matru..... Type: of Source:....Hand-dug well.. Time:....1:38..
GPS
N-0842369
E-0810782

Parameters	Measured Values	WHO recommended Permissible Limits
1. Water Temperature (°C)	29.2	No. Value
2. pH	7.3	6.5 – 8.5
3. Turbidity (NTU)	0	<5.0
4. Conductivity (µS/cm)	172	<450 µS
5. TDS (ppm)	86	<248
6. Salinity (ppt)	-	<0.4
7. Residual Chlorine (mg/l)	0.00	0.3-0.5 after 30min. disinfection
8. Aluminum (mg/l)	0.04	<0.2
9. Ammonia (mg/l)	0.33	No. Value
10. Bromine (mg/l)	-	No. value
11. Calcium Hardness (mg/l)	40	<250
12. Copper (mg/l)	0.27	<1.0
13. Fluoride (mg/l)	2	<1.5
14. Iron (mg/l)	0.04	<0.3
15. Magnesium (mg/l)	0.00	<200
16. Manganese (mg/l)	1.36	<0.4
17. Molybdenum (mg/l)	0.00	0.25
18. Nitrite (mg/l)	0.04	3.0
19. Nitrate (mg/l)	6.0	<10
20. Potassium (mg/l)	1.0	<6.0
21. Phosphate (mg/l)	1.2	<20

24. Sulphate (mg/l)	0.0	<0.5
25. Sulphate (mg/l)	0.1	No. Value
26. Chloride (mg/l)	4	<250
27. Arsenic	0.00	0.01
28. Chromium	0.06	<0.05
29. Bicarbonate (mg/l)	0.00	No. Value
30. Zinc (mg/l)	0.0	<5.0
31. B. Coll	801	Zero
32. Faecal Coliforms	101	Zero
33. Non – Faecal Coliforms	NH	10
34. Vibrio-parahaemolyticus	-	Zero
35. Salmonella sp.	-	Zero

RECOMMENDATIONS: The physicochemical analysis of this source indicate that all the parameters are within the WHO recommended standard for good drinking water, except for ammonia, fluoride, manganese, nitrate, potassium, sulphate and chromium which are above their WHO limits.

Bacteriologically, the source is polluted with faecal bacteria. However, chlorination process is necessary with a free chlorine content of 0.3mg/l – 0.5mg/l which is the WHO guideline for Potable Water.

Signed:....Edward Toly.....

(Supervisor)

Date:....28/02/2023.....

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NATIONAL WATER QUALITY LABORATORY

TEL 077-547-020/079-317-532

MINISTRY OF WATER RESOURCES

TOWER HILL

FREETOWN

Water Quality Monitoring Report Sheet

Water Authority:..... International Consulting Services

District:..Bonthe... Chiefdom:....Jong..... Town:..Matru... Date:.. 28th/02/2023.....

Sample:.. WS/lot2/mat04... Location:..Matru... Type: of Source:..Hand-dug well..... Time:..1:44.....
GPS

N-0842431

E-0.810725

	Parameters	Measured Values	WHO recommended Permissible Limits
1.	Water Temperature (°C)	29.2	No. Value
2.	pH	6.8	6.5 – 8.5
3.	Turbidity (NTU)	0	<5.0
4.	Conductivity (µS/Cm)	31	<450 µS
5.	TDS (ppm)	15.5	<248
6.	Salinity (ppt)	-	<0.4
7.	Residual Chlorine (mg/l)	0.00	0.3-0.5 after 30min. disinfection
8.	Aluminum (mg/l)	0.03	<0.2
9.	Ammonia (mg/l)	0.18	No. Value
10.	Bromine (mg/l)	-	No. value
11.	Calcium Hardness (mg/l)	1.5	<250
12.	Copper (mg/l)	0.00	<1.0
13.	Fluoride (mg/l)	2	<1.5
14.	Iron (mg/l)	0.03	<0.3
15.	Magnesium (mg/l)	0.0	<200
16.	Manganese (mg/l)	2.01	<0.4
17.	Molybdenum (mg/l)	0.00	0.25
18.	Nitrite (mg/l)	0.02	3.0
19.	Nitrate (mg/l)	6.0	<10
20.	Potassium (mg/l)	1.0	<6.0
21.	Phosphate (mg/l)	1.7	<20
22.	Silica (mg/l)	0.00	<15
23.	Sulphate (mg/l)	0	<400

24.	Sulphide (mg/l)	0.0	<0.5
25.	Sulphite (mg/l)	0.1	No. Value
26.	Chloride (mg/l)	1	<250
27.	Arsenic	0.00	0.01
28.	Chromium	0.05	<0.05
29.	Bicarbonate (mg/l)	0	No. Value
30.	Zinc (mg/l)	0.0	<5.0
31.	E. Coli	Nil	Zero
32.	Faecal Coliforms	Nil	Zero
33.	Non – Faecal Coliforms	5	10
34.	Vibro-parahaemolyticus	-	Zero
35.	Salmonella sp.	-	Zero

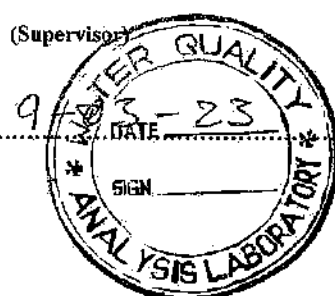
RECOMMENDATIONS:- The physicochemical analysis of this source indicate that all the parameters are within the WHO recommended standard for good drinking water, except for ammonia, fluoride, manganese and sulphite which are above their WHO limits.

Bacteriologically, the source is free from faecal bacteria. However, chlorination process is necessary with a free chlorine content of 0.3mg/l – 0.5mg/l which is the WHO guideline for Potable Water.

Signed:...Edward Toby.....

(Supervisory)

Date:.....



NATIONAL WATER QUALITY LABORATORY

TEL 077-547-020/079-317-532

MINISTRY OF WATER RESOURCES

TOWER HILL

FREETOWN

Water Quality Monitoring Report Sheet

Water Authority:..... International Consulting Services

District:.. Bonthe... Chiefdom:..Jong.... Town:..Matru... Date:.. 28th /02/2023.....

Sample:.. WS/lot2/mat05... Location:..Matru... Type: of Source:..hand-dug well.. Time:.....

GPS

N-0842325

E-0.810958

	Parameters	Measured Values	WHO recommended Permissible Limits
1.	Water Temperature (°C)	29.3	No. Value
2.	pH	6.8	6.5 – 8.5
3.	Turbidity (NTU)	0	<5.0
4.	Conductivity (µS/Cm)	34	<450 µS
5.	TDS (ppm)	17	<248
6.	Salinity (ppt)	-	<0.4
7.	Residual Chlorine (mg/l)	0.00	0.3-0.5 after 30min. disinfection
8.	Aluminum (mg/l)	0.02	<0.2
9.	Ammonia (mg/l)	0.10	No. Value
10.	Bromine (mg/l)	-	No. value
11.	Calcium Hardness (mg/l)	1.0	<250
12.	Copper (mg/l)	0.00	<1.0
13.	Fluoride (mg/l)	2	<1.5
14.	Iron (mg/l)	0.00	<0.3
15.	Magnesium (mg/l)	0.00	<200
16.	Manganese (mg/l)	1.58	<0.4
17.	Molybdenum (mg/l)	0.00	0.25
18.	Nitrite (mg/l)	0.02	3.0
19.	Nitrate (mg/l)	4.0	<10
20.	Potassium (mg/l)	0.7	<6.0
21.	Phosphate (mg/l)	0.5	<20
22.	Silica (mg/l)	0.01	<15
23.	Sulphate (mg/l)	0.00	<400

24.	Sulphide (mg/l)	0.0	<0.5
25.	Sulphite (mg/l)	0.3	No. Value
26.	Chloride (mg/l)	0	<250
27.	Arsenic	0.00	0.01
28.	Chromium	0.02	<0.05
29.	Bicarbonate (mg/l)	0	No. Value
30.	Zinc (mg/l)	0.0	<5.0
31.	E. Coli	Nil	Zero
32.	Faecal Coliforms	90	Zero
33.	Non – Faecal Coliforms	Nil	10
34.	Vibro-parahaemolyticus	-	Zero
35.	Salmonella sp.	-	Zero

RECOMMENDATIONS:- The physicochemical analysis of this source indicate that all the parameters are within the WHO recommended standard for good drinking water, except for ammonia, fluoride, manganese, and sulphite which are above their WHO limits.

Bacteriologically, the source is polluted with faecal bacteria. However, chlorination process is necessary with a free chlorine content of 0.3mg/l – 0.5mg/l which is the WHO guideline for Potable Water.

Signed:....Edward Toby.....

(Supervisor)

Date:.....



NATIONAL WATER QUALITY LABORATORY**TEL 077-547-020/079-317-532****MINISTRY OF WATER RESOURCES****TOWER HILL****FREETOWN****Water Quality Monitoring Report Sheet**

Water Authority:..... International Consulting Services

District:..Bonthe.. Chiefdom:..Jong.... Town:..Matru... Date:.. 28th/02/2023.....

Sample:.. WS/lot2/mat06...Location:..Matru..... Type: of Source:..Hand-dug well.. Time:2:07.....

Parameters		Measured Values	WHO recommended Permissible Limits
1.	Water Temperature (°C)	29.1	No. Value
2.	pH	6.7	6.5 – 8.5
3.	Turbidity (NTU)	0	<5.0
4.	Conductivity (µS/Cm)	25	<450 µS
5.	TDS (ppm)	12.5	<248
6.	Salinity (ppt)	-	<0.4
7.	Residual Chlorine (mg/l)	0.00	0.3-0.5 after 30min. disinfection
8.	Aluminum (mg/l)	0.01	<0.2
9.	Ammonia (mg/l)	0.06	No. Value
10.	Bromine (mg/l)	-	No. value
11.	Calcium Hardness (mg/l)	1.1	<250
12.	Copper (mg/l)	0.17	<1.0
13.	Fluoride (mg/l)	1.92	<1.5
14.	Iron (mg/l)	0.03	<0.3
15.	Magnesium (mg/l)	0.0	<200
16.	Manganese (mg/l)	1.22	<0.4
17.	Molybdenum (mg/l)	0.01	0.25
18.	Nitrite (mg/l)	0.00	3.0
19.	Nitrate (mg/l)	4.0	<10
20.	Potassium (mg/l)	0.6	<6.0
21.	Phosphate (mg/l)	2.6	<20
22.	Silica (mg/l)	0.0	<15
23.	Sulphate (mg/l)	0	<400
24.	Sulphide (mg/l)	0.0	<0.5
25.	Sulphite (mg/l)	0.0	No. Value
26.	Chloride (mg/l)	0.0	<250
27.	Arsenic	0.00	0.01

28.	Chromium	0.05	<0.05
29.	Bicarbonate (mg/l)	0	No. Value
30.	Zinc (mg/l)	0.0	<5.0
31.	E. Coli	Nil	Zero
32.	Faecal Coliforms	101	Zero
33.	Non - Faecal Coliforms	Nil	10
34.	Vibro-parahaemolyticus	-	Zero
35.	Salmonella sp.	-	Zero

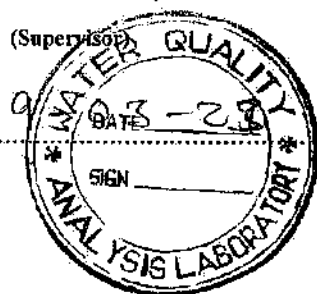
RECOMMENDATIONS:- The physicochemical analysis of this source indicate that all the parameters are within the WHO recommended standard for good drinking water, except for ammonia, fluoride and manganese which are above their WHO limits.

Bacteriologically, the source is polluted with faecal bacteria. However, chlorination process is necessary with a free chlorine content of 0.3mg/l – 0.5mg/l which is the WHO guideline for Potable Water.

Signed:...Edward Toby.....

(Supervisor)

Date:.....



NATIONAL WATER QUALITY LABORATORY

TEL 077-547-020/079-317-532
MINISTRY OF WATER RESOURCES
TOWER HILL
FREETOWN

Water Quality Monitoring Report Sheet

Water Authority:..... International Consulting Services

District: Kenema... Chiefdom:..... Town:.. Gawama.. Date:.. 1st /03/2023,.....

Sample: WS/Lot3/Gen1... Location:.. Gendema... Type: of Source:.. Hand-dug well..... Time:.. 1:20pm.....
 GPS
 N:0910662
 E:0241747

	Parameters	Measured Values	WHO recommended Permissible Limits
1.	Water Temperature (°C)	28.9	No. Value
2.	pH	6.8	6.5 – 8.5
3.	Turbidity (NTU)	0	<5.0
4.	Conductivity (µS/Cm)	68	<450 µS
5.	TDS (ppm)	34	<248
6.	Salinity (ppt)	-	<0.4
7.	Residual Chlorine (mg/l)	0.00	0.3-0.5 after 30min. disinfection
8.	Aluminum (mg/l)	0.01	<0.2
9.	Ammonia (mg/l)	0.25	No. Value
10.	Bromine (mg/l)	-	No. value
11.	Calcium Hardness (mg/l)	6.2	<250
12.	Copper (mg/l)	0.31	<1.0
13.	Fluoride (mg/l)	0.07	<1.5
14.	Iron (mg/l)	0.01	<0.3
15.	Magnesium (mg/l)	0.0	<200
16.	Manganese (mg/l)	0.20	<0.4
17.	Molybdenum (mg/l)	0.00	0.25
18.	Nitrite (mg/l)	0.11	3.0
19.	Nitrate (mg/l)	12	<10
20.	Potassium (mg/l)	0.8	<6.0
21.	Phosphate (mg/l)	0.0	<20
22.	Silica (mg/l)	0.00	<15
23.	Sulphate (mg/l)	7.6	<400

24.	Sulphide (mg/l)	0.00	<0.5
25.	Sulphite (mg/l)	0.1	No. Value
26.	Chloride (mg/l)	3	<250
27.	Arsenic	0.00	0.01
28.	Chromium	0.13	<0.05
29.	Bicarbonate (mg/l)	0	No. Value
30.	Zinc (mg/l)	0.00	<5.0
31.	E. Coli	Nil	Zero
32.	Faecal Coliforms	60	Zero
33.	Non - Faecal Coliforms	Nil	10
34.	Vibro-parahaemolyticus	-	Zero
35.	Salmonella sp.	-	Zero

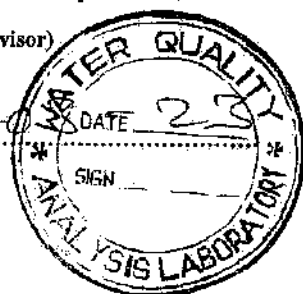
RECOMMENDATIONS:- The physicochemical analysis of this source indicate that all the parameters are within the WHO recommended standard for good drinking water, except for ammonia, sulphite and chromium which are above their WHO limits.

Bacteriologically, the source is polluted with faecal bacteria. However, chlorination process is necessary with a free chlorine content of 0.3mg/l – 0.5mg/l which is the WHO guideline for Potable Water.

Signed: ...Edward Toby.....

(Supervisor)

Date:.....



NATIONAL WATER QUALITY LABORATORY

TEL 077-547-020/079-317-532

MINISTRY OF WATER RESOURCES

TOWER HILL

FREETOWN

Water Quality Monitoring Report Sheet

Water Authority:..... International Consulting Services

District: Kenema.. Chiefdom:..... Town:.. Garwama:.. 1st /03/2023.....

Sample:..... WS/Lot3/Gen2... Location:.. Gendema... Type: of Source:.. Hand-dug well....

Time:.. 1:27pm.....

GPS

N-0910684

E-0241783

	Parameters	Measured Values	WHO recommended Permissible Limits
1.	Water Temperature (°C)	29.1	No. Value
2.	pH	7.0	6.5 – 8.5
3.	Turbidity (NTU)	0	<5.0
4.	Conductivity (µS/Cm)	101	<450 µS
5.	TDS (ppm)	50.5	<248
6.	Salinity (ppt)	-	<0.4
7.	Residual Chlorine (mg/l)	0.00	0.3-0.5 after 30min. disinfection
8.	Aluminum (mg/l)	0.03	<0.2
9.	Ammonia (mg/l)	0.07	No. Value
10.	Bromine (mg/l)	-	No. value
11.	Calcium Hardness (mg/l)	9.0	<250
12.	Copper (mg/l)	0.16	<1.0
13.	Fluoride (mg/l)	2	<1.5
14.	Iron (mg/l)	0.01	<0.3
15.	Magnesium (mg/l)	0.0	<200
16.	Manganese (mg/l)	0.60	<0.4
17.	Molybdenum (mg/l)	0.00	0.25
18.	Nitrite (mg/l)	0.04	3.0
19.	Nitrate (mg/l)	2.0	<10
20.	Potassium (mg/l)	0.7	<6.0
21.	Phosphate (mg/l)	1.4	<20
22.	Silica (mg/l)	0.00	<15
23.	Sulphate (mg/l)	6.3	<400
24.	Sulphide (mg/l)	0.00	<0.5

25.	Sulphite (mg/l)	0.1	No. Value
26.	Chloride (mg/l)	4	<250
27.	Arsenic	0.00	0.01
28.	Chromium	0.09	<0.05
29.	Bicarbonate (mg/l)	0	No. Value
30.	Zinc (mg/l)	0.00	<5.0
31.	E. Coli	Nil	Zero
32.	Faecal Coliforms	45	Zero
33.	Non – Faecal Coliforms	Nil	10
34.	Vibro-parahaemolyticus	-	Zero
35.	Salmonella sp.	-	Zero

RECOMMENDATIONS:- The physicochemical analysis of this source indicate that all the parameters are within the WHO recommended standard for good drinking water, except for ammonia, fluoride, manganese and sulphite which are above their WHO limits.

Bacteriologically, the source is polluted with faecal bacteria. However, chlorination process is necessary with a free chlorine content of 0.3mg/l – 0.5mg/l which is the WHO guideline for Potable Water.

Signed:...Edward Toby.....

(Supervisor)

Date:.....



NATIONAL WATER QUALITY LABORATORY

TEL 077-547-020/079-317-532

MINISTRY OF WATER RESOURCES

TOWER HILL

FREETOWN

Water Quality Monitoring Report Sheet

Water Authority:..... International Consulting Services

District:.. Kenema.. Chiefdom:..... Town:..Garwama.. Date:.... 1st /03/2023.....

Sample:..... WS/Lot3/Gen3... Location:..Gendema... Type: of Source:...Hand-dug well... Time:..1:31pm....

GPS

N-0910645

E-0241803

	Parameters	Measured Values	WHO recommended Permissible Limits
1.	Water Temperature (°C)	29.3	No. Value
2.	pH	6.8	6.5 – 8.5
3.	Turbidity (NTU)	0	<5.0
4.	Conductivity (µS/Cm)	41	<450 µS
5.	TDS (ppm)	20.5	<248
6.	Salinity (ppt)	-	<0.4
7.	Residual Chlorine (mg/l)	0.00	0.3-0.5 after 30min. disinfection
8.	Aluminum (mg/l)	0.04	<0.2
9.	Ammonia (mg/l)	0.51	No. Value
10.	Bromine (mg/l)	-	No. value
11.	Calcium Hardness (mg/l)	1.9	<250
12.	Copper (mg/l)	0.31	<1.0
13.	Fluoride (mg/l)	2	<1.5
14.	Iron (mg/l)	0.01	<0.3
15.	Magnesium (mg/l)	0.0	<200
16.	Manganese (mg/l)	0.07	<0.4
17.	Molybdenum (mg/l)	0.00	0.25
18.	Nitrite (mg/l)	0.02	3.0
19.	Nitrate (mg/l)	2.0	<10
20.	Potassium (mg/l)	0.7	<6.0
21.	Phosphate (mg/l)	0.2	<20
22.	Silica (mg/l)	0.01	<15
23.	Sulphate (mg/l)	0.00	<400

24.	Sulphide (mg/l)	0.00	<0.5
25.	Sulphite (mg/l)	0.2	No. Value
26.	Chloride (mg/l)	1	<250
27.	Arsenic	0.00	0.01
28.	Chromium	0.13	<0.05
29.	Bicarbonate (mg/l)	0	No. Value
30.	Zinc (mg/l)	0.00	<5.0
31.	E. Coli	Nil	Zero
32.	Faecal Coliforms	101	Zero
33.	Non - Faecal Coliforms	Nil	10
34.	Vibro-parahaemolyticus	-	Zero
35.	Salmonella sp.	-	Zero

RECOMMENDATIONS:- The physicochemical analysis of this source indicate that all the parameters are within the WHO recommended standard for good drinking water, except for ammonia, fluoride, sulphite and chromium which are above their WHO limits.

Bacteriologically, the source is polluted with faecal bacteria. However, chlorination process is necessary with a free chlorine content of 0.3mg/l – 0.5mg/l which is the WHO guideline for Potable Water.

Signed:...Edward Toby.....

(Supervisor)

Date:.....



NATIONAL WATER QUALITY LABORATORY**TEL 077-547-020/079-317-532****MINISTRY OF WATER RESOURCES****TOWER HILL****FREETOWN****Water Quality Monitoring Report Sheet**

Water Authority:..... International Consulting Services

District:.. Kenema.. Chiefdom:..... Town:..Garwama.. Date:.. 1st /03/2023.....

Sample:..... WS/Lot3/Gen4... Location:..Gendema... Type: of Source:..Hand-dug well..... Time:..3:20pm.....

GPS

N-0910487

E-0242110

Parameters		Measured Values	WHO recommended Permissible Limits
1.	Water Temperature (°C)	29.3	No. Value
2.	pH	6.8	6.5 – 8.5
3.	Turbidity (NTU)	0	<5.0
4.	Conductivity (µS/Cm)	51	<450 µS
5.	TDS (ppm)	25.5	<248
6.	Salinity (ppt)	-	<0.4
7.	Residual Chlorine (mg/l)	0.00	0.3-0.5 after 30min. disinfection
8.	Aluminum (mg/l)	0.03	<0.2
9.	Ammonia (mg/l)	0.06	No. Value
10.	Bromine (mg/l)	-	No. value
11.	Calcium Hardness (mg/l)	2.4	<250
12.	Copper (mg/l)	0.26	<1.0
13.	Fluoride (mg/l)	21	<1.5
14.	Iron (mg/l)	0.01	<0.3
15.	Magnesium (mg/l)	0.0	<200
16.	Manganese (mg/l)	0.16	<0.4
17.	Molybdenum (mg/l)	0.00	0.25
18.	Nitrite (mg/l)	0.03	3.0
19.	Nitrate (mg/l)	4	<10
20.	Potassium (mg/l)	0.9	<6.0
21.	Phosphate (mg/l)	3.9	<20
22.	Silica (mg/l)	0.01	<15
23.	Sulphate (mg/l)	5.8	<400

24.	Sulphide (mg/l)	0.00	<0.5
25.	Sulphite (mg/l)	0.2	No. Value
26.	Chloride (mg/l)	1	<250
27.	Arsenic	0.00	0.01
28.	Chromium	0.07	<0.05
29.	Bicarbonate (mg/l)	0	No. Value
30.	Zinc (mg/l)	0.00	<5.0
31.	E. Coli	Nil	Zero
32.	Faecal Coliforms	101	Zero
33.	Non – Faecal Coliforms	Nil	10
34.	Vibro-parahaemolyticus	-	Zero
35.	Salmonella sp.	-	Zero

RECOMMENDATIONS:- The physicochemical analysis of this source indicate that all the parameters are within the WHO recommended standard for good drinking water, except for ammonia, fluoride, and sulphite which are above their WHO limits.

Bacteriologically, the source is polluted with faecal bacteria. However, chlorination process is necessary with a free chlorine content of 0.3mg/l – 0.5mg/l which is the WHO guideline for Potable Water.

Signed:....Edward Toby.....

(Supervisor)

Date:.....



NATIONAL WATER QUALITY LABORATORY

TEL 077-547-020/079-317-532

MINISTRY OF WATER RESOURCES

TOWER HILL

FREETOWN

Water Quality Monitoring Report Sheet

Water Authority:..... International Consulting Services		
District: Kenema.. Chiefdom:..... Town:..Gendema.. Date:.... 1 st /03/2023.....		
Sample:..... WS/Lot3/Gen5... Location:..Gendema... Type: of Source: ...Hand-dug well.... Time:..2:09pm... GPS N-0910831 E-0241478		
Parameters	Measured Values	WHO recommended Permissible Limits
1. Water Temperature (°C)	29.3	No. Value
2. pH	6.7	6.5 – 8.5
3. Turbidity (NTU)	0	<5.0
4. Conductivity (µS/Cm)	143	<450 µS
5. TDS (ppm)	71.5	<248
6. Salinity (ppt)	-	<0.4
7. Residual Chlorine (mg/l)	0.00	0.3-0.5 after 30min. disinfection
8. Aluminum (mg/l)	0.01	<0.2
9. Ammonia (mg/l)	0.02	No. Value
10. Bromine (mg/l)	-	No. value
11. Calcium Hardness (mg/l)	6.6	<250
12. Copper (mg/l)	0.24	<1.0
13. Fluoride (mg/l)	1.93	<1.5
14. Iron (mg/l)	0.01	<0.3
15. Magnesium (mg/l)	0.01	<200
16. Manganese (mg/l)	0.17	<0.4
17. Molybdenum (mg/l)	0.00	0.25
18. Nitrite (mg/l)	0.06	3.0
19. Nitrate (mg/l)	6	<10
20. Potassium (mg/l)	3.2	<6.0
21. Phosphate (mg/l)	0.5	<20
22. Silica (mg/l)	0.02	<15
23. Sulphate (mg/l)	7.1	<400

24.	Sulphide (mg/l)	0.00	<0.5
25.	Sulphite (mg/l)	0.3	No. Value
26.	Chloride (mg/l)	2	<250
27.	Arsenic	0.00	0.01
28.	Chromium	0.07	<0.05
29.	Bicarbonate (mg/l)	0	No. Value
30.	Zinc (mg/l)	0.30	<5.0
31.	E. Coli	Nil	Zero
32.	Faecal Coliforms	60	Zero
33.	Non – Faecal Coliforms	Nil	10
34.	Vibro-parahaemolyticus	-	Zero
35.	Salmonella sp.	-	Zero

RECOMMENDATIONS:- The physicochemical analysis of this source indicate that all the parameters are within the WHO recommended standard for good drinking water, except for ammonia, fluoride, sulphite and chromium which are above their WHO limits.

Bacteriologically, the source is polluted with faecal bacteria. However, chlorination process is necessary with a free chlorine content of 0.3mg/l – 0.5mg/l which is the WHO guideline for Potable Water.

Signed:...Edward Toby.....

(Supervisor)

Date:.....



NATIONAL WATER QUALITY LABORATORY

TEL 077-547-020/079-317-532

MINISTRY OF WATER RESOURCES

TOWER HILL

FREETOWN

Water Quality Monitoring Report Sheet

Water Authority:..... International Consulting Services

District: Kenema.. Chiefdom:..... Town:..Gendema.. Date:.. 1st /03/2023.....

Sample:.. WS/Lot3/Gen6... Location:..Gendema... Type of Source:..Hand-dug well.... Time:..2:18pm...

GPS

N-0910790

E-0241385

	Parameters	Measured Values	WHO recommended Permissible Limits
1.	Water Temperature (°C)	29.0	No. Value
2.	pH	6.3	6.5 – 8.5
3.	Turbidity (NTU)	0	<5.0
4.	Conductivity (µS/Cm)	190	<450 µS
5.	TDS (ppm)	95	<248
6.	Salinity (ppt)	-	<0.4
7.	Residual Chlorine (mg/l)	0.01	0.3-0.5 after 30min. disinfection
8.	Aluminum (mg/l)	0.02	<0.2
9.	Ammonia (mg/l)	0.03	No. Value
10.	Bromine (mg/l)	-	No. value
11.	Calcium Hardness (mg/l)	9.0	<250
12.	Copper (mg/l)	0.52	<1.0
13.	Fluoride (mg/l)	2.2	<1.5
14.	Iron (mg/l)	0.01	<0.3
15.	Magnesium (mg/l)	0.00	<200
16.	Manganese (mg/l)	0.00	<0.4
17.	Molybdenum (mg/l)	0.01	0.25
18.	Nitrite (mg/l)	0.09	3.0
19.	Nitrate (mg/l)	12	<10
20.	Potassium (mg/l)	5.4	<6.0
21.	Phosphate (mg/l)	5.9	<20
22.	Silica (mg/l)	0.08	<15
23.	Sulphate (mg/l)	0	<400

24.	Sulphide (mg/l)	0.00	<0.5
25.	Sulphite (mg/l)	0.1	No. Value
26.	Chloride (mg/l)	5	<250
27.	Arsenic	0.00	0.01
28.	Chromium	0.16	<0.05
29.	Bicarbonate (mg/l)	0	No. Value
30.	Zinc (mg/l)	0.75	<5.0
31.	E. Coli	Nil	Zero
32.	Faecal Coliforms	101	Zero
33.	Non - Faecal Coliforms	Nil	10
34.	Vibro-parahaemolyticus	-	Zero
35.	Salmonella sp.	-	Zero

RECOMMENDATIONS:- The physicochemical analysis of this source indicate that all the parameters are within the WHO recommended standard for good drinking water, except for pH is low shows acidity, ammonia, fluoride, nitrate, sulphite and chromium are above their WHO limits.

Bacteriologically, the source is polluted with faecal bacteria. However, chlorination process is necessary with a free chlorine content of 0.3mg/l – 0.5mg/l which is the WHO guideline for Potable Water.

Signed:....Edward Toby.....

(Supervisor)

Date:.....



NATIONAL WATER QUALITY LABORATORY**TEL 077-547-020/079-317-532****MINISTRY OF WATER RESOURCES****TOWER HILL****FREETOWN****Water Quality Monitoring Report Sheet**

Water Authority:..... International Consulting Services

District: Kenema.. Chiefdom:..... Town:..Gendema.. Date:.. 1st /03/2023.....

Sample:..WS/Lot3/Gen07...Location:..Gendema... Type: of Source:..Hand-dug well.... Time:..2:30pm...

GPS

N-0910664

E-0241468

Parameters		Measured Values	WHO recommended Permissible Limits
1.	Water Temperature (°C)	29.2	No. Value
2.	pH	6.8	6.5 – 8.5
3.	Turbidity (NTU)	0	<5.0
4.	Conductivity (µS/Cm)	142	<450 µS
5.	TDS (ppm)	71	<248
6.	Salinity (ppt)	-	<0.4
7.	Residual Chlorine (mg/l)	0.00	0.3-0.5 after 30min. disinfection
8.	Aluminum (mg/l)	0.13	<0.2
9.	Ammonia (mg/l)	0.03	No. Value
10.	Bromine (mg/l)	-	No. value
11.	Calcium Hardness (mg/l)	6.7	<250
12.	Copper (mg/l)	0.23	<1.0
13.	Fluoride (mg/l)	2.5	<1.5
14.	Iron (mg/l)	0.0	<0.3
15.	Magnesium (mg/l)	0.04	<200
16.	Manganese (mg/l)	0.04	<0.4
17.	Molybdenum (mg/l)	0.01	0.25
18.	Nitrite (mg/l)	0.07	3.0
19.	Nitrate (mg/l)	8	<10
20.	Potassium (mg/l)	1.0	<6.0
21.	Phosphate (mg/l)	0.2	<20
22.	Silica (mg/l)	0.08	<15
23.	Sulphate (mg/l)	8.4	<400

24.	Sulphide (mg/l)	0.00	<0.5
25.	Sulphite (mg/l)	0.4	No. Value
26.	Chloride (mg/l)	6	<250
27.	Arsenic	0.00	0.01
28.	Chromium	0.11	<0.05
29.	Bicarbonate (mg/l)	0	No. Value
30.	Zinc (mg/l)	1.28	<5.0
31.	E. Coli	Nil	Zero
32.	Faecal Coliforms	40	Zero
33.	Non - Faecal Coliforms	Nil	10
34.	Vibro-parahaemolyticus	-	Zero
35.	Salmonella sp.	-	Zero

RECOMMENDATIONS:- The physicochemical analysis of this source indicate that all the parameters are within the WHO recommended standard for good drinking water, except for ammonia, fluoride, sulphite and chromium which are above their WHO limits.

Bacteriologically, the source is polluted with faecal bacteria. However, chlorination process is necessary with a free chlorine content of 0.3mg/l – 0.5mg/l which is the WHO guideline for Potable Water.

Signed:....Edward Toby.....

(Supervisor)

Date:.....



NATIONAL WATER QUALITY LABORATORY

TEL 077-547-020/079-317-532

MINISTRY OF WATER RESOURCES

TOWER HILL

FREETOWN

Water Quality Monitoring Report Sheet

Water Authority:..... International Consulting Services			
District: Kenema.. Chiefdom:..... Town:..Gendema.. Date:.... 1 st /03/2023.....			
Sample:.....WS/Lot3/Gen8...Location:..Gendema... Type: of Source:....Hand-dug well.... Time:2:40pm... CPS N-0910820 E-0241260			
No.	Parameters	Measured Values	WHO recommended Permissible Limits
1.	Water Temperature (°C)	29.1	No. Value
2.	pH	6.9	6.5 – 8.5
3.	Turbidity (NTU)	0	<5.0
4.	Conductivity (µS/Cm)	127	<450 µS
5.	TDS (ppm)	63.5	<248
6.	Salinity (ppt)	-	<0.4
7.	Residual Chlorine (mg/l)	0.01	0.3-0.5 after 30min. disinfection
8.	Aluminium (mg/l)	0.02	<0.2
9.	Ammonia (mg/l)	0.04	No. Value
10.	Bromine (mg/l)	-	No. value
11.	Calcium Hardness (mg/l)	6.0	<250
12.	Copper (mg/l)	0.29	<1.0
13.	Fluoride (mg/l)	2.2	<1.5
14.	Iron (mg/l)	0.01	<0.3
15.	Magnesium (mg/l)	0.05	<200
16.	Manganese (mg/l)	0.00	<0.4
17.	Molybdenum (mg/l)	0.00	0.25
18.	Nitrite (mg/l)	0.03	3.0
19.	Nitrate (mg/l)	2	<10
20.	Potassium (mg/l)	5.6	<6.0
21.	Phosphate (mg/l)	0.1	<20

22.	Silica (mg/l)	0.02	<15
23.	Sulphate (mg/l)	0.00	<400
24.	Sulphide (mg/l)	0.00	<0.5
25.	Sulphite (mg/l)	0.3	No. Value
26.	Chloride (mg/l)	4	<250
27.	Arsenic	0.00	0.01
28.	Chromium	0.03	<0.05
29.	Bicarbonate (mg/l)	9	No. Value
30.	Zinc (mg/l)	1.83	<5.0
31.	E. Coli	Nil	Zero
32.	Faecal Coliforms	101	Zero
33.	Non - Faecal Coliforms	Nil	10
34.	Vibro-parahaemolyticus	-	Zero
35.	Salmonella sp.	-	Zero

RECOMMENDATIONS:- The physicochemical analysis of this source indicate that all the parameters are within the WHO recommended standard for good drinking water, except for ammonia, fluoride, and sulphite which are above their WHO limits.

Bacteriologically, the source is polluted with faecal bacteria. However, chlorination process is necessary with a free chlorine content of 0.3mg/l – 0.5mg/l which is the WHO guideline for Potable Water.

Signed:..Edward Toby.....

(Supervisor)

Date:.....



NATIONAL WATER QUALITY LABORATORY

TEL 077-547-020/079-317-532

MINISTRY OF WATER RESOURCES

TOWER HILL

FREETOWN

Water Quality Monitoring Report Sheet

Water Authority:..... International Consulting Services			
District: Kenema.. Chiefdom:..... Town:..Gendema.. Date:.... 1 st /03/2023			
Sample:..... WS/Lot3/Gen09... Location:..Gendema... Type: of Source:.... Hand-dug well.... Time:..2:46pm... GPS N-0910821 E-0241233			
	Parameters	Measured Values	WHO recommended Permissible Limits
1.	Water Temperature (°C)	29.2	No. Value
2.	pH	6.9	6.5 – 8.5
3.	Turbidity (NTU)	0	<5.0
4.	Conductivity (µS/Cm)	42	<450 µS
5.	TDS (ppm)	21	<248
6.	Salinity (ppt)	-	<0.4
7.	Residual Chlorine (mg/l)	0.00	0.3-0.5 after 30min. disinfection
8.	Aluminium (mg/l)	0.01	<0.2
9.	Ammonia (mg/l)	0.09	No. Value
10.	Bromine (mg/l)	-	No. value
11.	Calcium Hardness (mg/l)	1.5	<250
12.	Copper (mg/l)	0.10	<1.0
13.	Fluoride (mg/l)	2.5	<1.5
14.	Iron (mg/l)	0.02	<0.3
15.	Magnesium (mg/l)	0.00	<200
16.	Manganese (mg/l)	0.06	<0.4
17.	Molybdenum (mg/l)	0.00	0.25
18.	Nitrite (mg/l)	0.05	3.0
19.	Nitrate (mg/l)	4	<10
20.	Potassium (mg/l)	1.4	<6.0
21.	Phosphate (mg/l)	0.2	<20
22.	Silica (mg/l)	0.00	<15
23.	Sulphate (mg/l)	6.6	<400
24.	Sulphide (mg/l)	0.00	<0.5
25.	Sulphite (mg/l)	3.5	No. Value

26.	Chloride (mg/l)	0	<250
27.	Arsenic	0.00	0.01
28.	Chromium	0.09	<0.05
29.	Bicarbonate (mg/l)	0	No. Value
30.	Zinc (mg/l)	0.00	<5.0
31.	E. Coli	Nil	Zero
32.	Faecal Coliforms	60	Zero
33.	Non - Faecal Coliforms	Nil	10
34.	Vibro-parahaemolyticus	-	Zero
35.	Salmonella sp.	-	Zero

RECOMMENDATIONS:- The physicochemical analysis of this source indicate that all the parameters are within the WHO recommended standard for good drinking water, except for ammonia, fluoride, sulphite and chromium which are above their WHO limits.

Bacteriologically, the source is polluted with faecal bacteria. However, chlorination process is necessary with a free chlorine content of 0.3mg/l – 0.5mg/l which is the WHO guideline for Potable Water.

Signed: ...Edward Toby.....

(Supervisor)

Date:



NATIONAL WATER QUALITY LABORATORY**TEL 077-547-020/079-317-532****MINISTRY OF WATER RESOURCES****TOWER HILL****FREETOWN****Water Quality Monitoring Report Sheet**

Water Authority:..... International Consulting Services

District:..Kenema.. Chiefdom:..... Town:..Gandema.. Date:.... 1st /03/2023.....

Sample:..... WS/Lot3/Gen10....Location:..Gandema... Type: of Source:..Hand-dug well.....

Time:..2:50pm.....

GPS

N-0910814

E-0241195

Parameters		Measured Values	WHO recommended Permissible Limits
1.	Water Temperature (°C)	29.3	No. Value
2.	pH	6.8	6.5 – 8.5
3.	Turbidity (NTU)	0	<5.0
4.	Conductivity (µS/Cm)	72	<450 µS
5.	TDS (ppm)	36	<248
6.	Salinity (ppt)	-	<0.4
7.	Residual Chlorine (mg/l)	0.01	0.3-0.5 after 30min. disinfection
8.	Aluminum (mg/l)	0.01	<0.2
9.	Ammonia (mg/l)	0.02	No. Value
10.	Bromine (mg/l)	-	No. value
11.	Calcium Hardness (mg/l)	3.0	<250
12.	Copper (mg/l)	0.25	<1.0
13.	Fluoride (mg/l)	2	<1.5
14.	Iron (mg/l)	0.02	<0.3
15.	Magnesium (mg/l)	0.01	<200
16.	Manganese (mg/l)	0.03	<0.4
17.	Molybdenum (mg/l)	0.00	0.25
18.	Nitrite (mg/l)	0.06	3.0
19.	Nitrate (mg/l)	6	<10
20.	Potassium (mg/l)	6.0	<6.0
21.	Phosphate (mg/l)	0.4	<20
22.	Silica (mg/l)	0.01	<15

23.	Sulphate (mg/l)	15	<400
24.	Sulphide (mg/l)	0.00	<0.5
25.	Sulphite (mg/l)	0.3	No. Value
26.	Chloride (mg/l)	1	<250
27.	Arsenic	0.00	0.01
28.	Chromium	0.03	<0.05
29.	Bicarbonate (mg/l)	0	No. Value
30.	Zinc (mg/l)	0.00	<5.0
31.	E. Coli	Nil	Zero
32.	Faecal Coliforms	101	Zero
33.	Non – Faecal Coliforms	Nil	10
34.	Vibro-parahaemolyticus	-	Zero
35.	Salmonella sp.	-	Zero

RECOMMENDATIONS:- The physicochemical analysis of this source indicate that all the parameters are within the WHO recommended standard for good drinking water, except for ammonia, fluoride, and sulphite which are above their WHO limits.

Bacteriologically, the source is polluted with faecal bacteria. However, chlorination process is necessary with a free chlorine content of 0.3mg/l – 0.5mg/l which is the WHO guideline for Potable Water.

Signed:..Edward Toby.....

(Supervisor)

Date:.....



NATIONAL WATER QUALITY LABORATORY**TEL 077-547-020/079-317-532****MINISTRY OF WATER RESOURCES****TOWER HILL****FREETOWN****Water Quality Monitoring Report Sheet**

Water Authority:..... International Consulting Services

District: Kallahun... Chiefdom:..... Town:..Kpolu.. Date:.. 2nd /03/2023.....

Sample:.. WS/lot4/mau01... Location:..Manowa... Type: of Source:..Hand-dug well..... Time:..1:06pm.....

GPS

N-0902060

E-0309113

	Parameters	Measured Values	WHO recommended Permissible Limits
1.	Water Temperature (°C)	29.3	No. Value
2.	pH	6.7	6.5 – 8.5
3.	Turbidity (NTU)	0	<5.0
4.	Conductivity (µS/Cm)	43	<450 µS
5.	TDS (ppm)	21.5	<248
6.	Salinity (ppt)	-	<0.4
7.	Residual Chlorine (mg/l)	0.00	0.3-0.5 after 30min. disinfection
8.	Aluminum (mg/l)	0.05	<0.2
9.	Ammonia (mg/l)	0.64	No. Value
10.	Bromine (mg/l)	-	No. value
11.	Calcium Hardness (mg/l)	1.9	<250
12.	Copper (mg/l)	0.16	<1.0
13.	Fluoride (mg/l)	2	<1.5
14.	Iron (mg/l)	0.10	<0.3
15.	Magnesium (mg/l)	0.0	<200
16.	Manganese (mg/l)	0.00	<0.4
17.	Molybdenum (mg/l)	0.00	0.25
18.	Nitrite (mg/l)	0.05	3.0
19.	Nitrate (mg/l)	6.0	<10
20.	Potassium (mg/l)	1.4	<6.0
21.	Phosphate (mg/l)	0.7	<20
22.	Silica (mg/l)	0.00	<15
23.	Sulphate (mg/l)	1.0	<400
24.	Sulphide (mg/l)	0.00	<0.5
25.	Sulphite (mg/l)	0.1	No. Value

26.	Chloride (mg/l)	0	<250
27.	Arsenic	0.00	0.01
28.	Chromium	0.03	<0.05
29.	Bicarbonate (mg/l)	0	No. Value
30.	Zinc (mg/l)	1.44	<5.0
31.	E. Coli	Nil	Zero
32.	Faecal Coliforms	101	Zero
33.	Non – Faecal Coliforms	Nil	10
34.	Vibro-parahaemolyticus	-	Zero
35.	Salmonella sp.	-	Zero

RECOMMENDATIONS:- The physicochemical analysis of this source indicate that all the parameters are within the WHO recommended standard for good drinking water, except for ammonia, fluoride, and sulphite which are above their WHO limits.

Bacteriologically, the source is polluted with faecal bacteria. However, chlorination process is necessary with a free chlorine content of 0.3mg/l – 0.5mg/l which is the WHO guideline for Potable Water.

Signed:...Edward Toby.....

(Supervisor)

Date:.....



NATIONAL WATER QUALITY LABORATORY**TEL 077-547-020/079-317-532****MINISTRY OF WATER RESOURCES****TOWER HILL****FREETOWN****Water Quality Monitoring Report Sheet**

Water Authority:..... International Consulting Services

District:.. Karene.. Chiefdom:.. Tanibaka..... Town:.. Tompare... Date:.. 3rd /03/2023.....

Sample:.. WS/lot1/tom01... Location:.. Tompare..... Type: of Source:.. Hand-dug well. Time:.. 3:05pm.....

GPS

N-1049545

E-0786170

Parameters		Measured Values	WHO recommended Permissible Limits
1.	Water Temperature (°C)	29.4	No. Value
2.	pH	8.1	6.5 – 8.5
3.	Turbidity (NTU)	754	<5.0
4.	Conductivity (µS/Cm)	150	<450 µS
5.	TDS (ppm)	75	<248
6.	Salinity (ppt)	-	<0.4
7.	Residual Chlorine (mg/l)	0.00	0.3-0.5 after 30min. disinfection
8.	Aluminum (mg/l)	0.3	<0.2
9.	Ammonia (mg/l)	2	No. Value
10.	Bromine (mg/l)	-	No. value
11.	Calcium Hardness (mg/l)	15	<250
12.	Copper (mg/l)	2	<1.0
13.	Fluoride (mg/l)	1.20	<1.5
14.	Iron (mg/l)	2	<0.3
15.	Magnesium (mg/l)	2.2	<200
16.	Manganese (mg/l)	5	<0.4
17.	Molybdenum (mg/l)	0.25	0.25
18.	Nitrite (mg/l)	0.03	3.0
19.	Nitrate (mg/l)	8.0	<10
20.	Potassium (mg/l)	10.1	<6.0
21.	Phosphate (mg/l)	7.2	<20
22.	Silica (mg/l)	1.5	<15
23.	Sulphate (mg/l)	7.5	<400

24.	Sulphide (mg/l)	0.01	<0.5
25.	Sulphite (mg/l)	5	No. Value
26.	Chloride (mg/l)	5	<250
27.	Arsenic	0.00	0.01
28.	Chromium	2	<0.05
29.	Bicarbonate (mg/l)	0	No. Value
30.	Zinc (mg/l)	2.16	<5.0
31.	E. Coli	Nil	Zero
32.	Faecal Coliforms	80	Zero
33.	Non - Faecal Coliforms	Nil	10
34.	Vibro-parahaemolyticus	"	Zero
35.	Salmonella sp.	"	Zero

RECOMMENDATIONS:- The physicochemical analysis of this source indicate that all the parameters are within the WHO recommended standard for good drinking water, except for turbidity, aluminium, ammonia, copper, iron, manganese, potassium, sulphite, and chromium, which are above their WHO limits.

bacteriologically, the source is polluted with faecal bacteria. However, chlorination process is necessary with a free chlorine content of 0.3mg/l – 0.5mg/l which is the WHO guideline for Potable Water.

Signed:..Edward Toby.....

(Supervisor)

Date:.....



NATIONAL WATER QUALITY LABORATORY**TEL 077-547-020/079-317-532****MINISTRY OF WATER RESOURCES****TOWER HILL****FREETOWN****Water Quality Monitoring Report Sheet**

Water Authority:..... International Consulting Services

District:..Karene.. Chiefdom:.. Tambaka.... Town:..Tompare... Date:..3rd /03/2023.....

Sample:.. WS/dot1/tom2.... Location:..Tompare... Type: of Source:..Hand-dug well.. Time:..3:18pm.....

GPS

N-1049574

E-0785855

	Parameters	Measured Values	WHO recommended Permissible Limits
1.	Water Temperature (°C)	29.2	No. Value
2.	pH	6.6	6.5 – 8.5
3.	Turbidity (NTU)	0	<5.0
4.	Conductivity (µS/Cm)	50	<450 µS
5.	TDS (ppm)	25	<248ppm
6.	Salinity (ppt)	-	<0.4
7.	Residual Chlorine (mg/l)	0.00	0.3-0.5 after 30min. disinfection
8.	Aluminum (mg/l)	0.01	<0.2
9.	Ammonia (mg/l)	0.10	No. Value
10.	Bromine (mg/l)	-	No. value
11.	Calcium Hardness (mg/l)	2.7	<250
12.	Copper (mg/l)	0.16	<1.0
13.	Fluoride (mg/l)	1.85	<1.5
14.	Iron (mg/l)	0.03	<0.3
15.	Magnesium (mg/l)	0.0	<200
16.	Manganese (mg/l)	0.0	<0.4
17.	Molybdenum (mg/l)	0.00	0.25
18.	Nitrite (mg/l)	0.07	3.0
19.	Nitrate (mg/l)	8.0	<10
20.	Potassium (mg/l)	1.0	<6.0
21.	Phosphate (mg/l)	1.2	<20
22.	Silica (mg/l)	0.0	<15
23.	Sulphate (mg/l)	1.4	<400

24.	Sulphide (mg/l)	0.0	<0.5
25.	Sulphite (mg/l)	0.2	No. Value
26.	Chloride (mg/l)	0	<250
27.	Arsenic	0.00	0.01
28.	Chromium	0.09	<0.05
29.	Bicarbonate (mg/l)	0	No. Value
30.	Zinc (mg/l)	0.0	<5.0
31.	E. Coli	Nil	Zero
32.	Faecal Coliforms	30	Zero
33.	Non – Faecal Coliforms	Nil	10
34.	Vibro-parahaemolyticus	-	Zero
35.	Salmonella sp.	-	Zero

RECOMMENDATIONS:- The physicochemical analysis of this source indicate that all the parameters are within the WHO recommended standard for good drinking water, except for ammonia, fluoride, sulphite and chromium, which are above their WHO limits.

Bacteriologically, the source is polluted with faecal bacteria. However, chlorination process is necessary with a free chlorine content of 0.3mg/l – 0.5mg/l which is the WHO guideline for Potable Water.

Signed:....Edward Toby.....

(Supervisor)

Date:.....



NATIONAL WATER QUALITY LABORATORY**TEL 077-547-020/079-317-532****MINISTRY OF WATER RESOURCES****TOWER HILL****FREETOWN****Water Quality Monitoring Report Sheet**

Water Authority:..... International Consulting Services

District:.. Karene... Chiefdom:.. Tambaka.... Town:.. Tompare Date:.. 3rd /03/2023.....

Sample:.. WS/lot1/tom3... Location:.. Tompare... Type: of Source:.. Hand-dug well..... Time: 3:24pm.....

GPS

N-1049635

E-0785834

Parameters		Measured Values	WHO recommended Permissible Limits
1.	Water Temperature (°C)	29.2	No. Value
2.	pH	6.7	6.5 – 8.5
3.	Turbidity (NTU)	0	<5.0
4.	Conductivity (µS/Cm)	20	<450 µS
5.	TDS (ppm)	10	<248
6.	Salinity (ppt)	-	<0.4
7.	Residual Chlorine (mg/l)	0.00	0.3-0.5 after 30min. disinfection
8.	Aluminum (mg/l)	0.02	<0.2
9.	Ammonia (mg/l)	0.20	No. Value
10.	Bromine (mg/l)	-	No. value
11.	Calcium Hardness (mg/l)	1	<250
12.	Copper (mg/l)	0.00	<1.0
13.	Fluoride (mg/l)	2	<1.5
14.	Iron (mg/l)	0.08	<0.3
15.	Magnesium (mg/l)	0.0	<200
16.	Manganese (mg/l)	0.02	<0.4
17.	Molybdenum (mg/l)	0.00	0.25
18.	Nitrite (mg/l)	0.10	3.0
19.	Nitrate (mg/l)	4.0	<10
20.	Potassium (mg/l)	1.3	<6.0
21.	Phosphate (mg/l)	0.1	<20

22.	Silica (mg/l)	0.00	<15
23.	Sulphate (mg/l)	1.1	<400
24.	Sulphide (mg/l)	0.00	<0.5
25.	Sulphite (mg/l)	0.2	No. Value
26.	Chloride (mg/l)	0	<250
27.	Arsenic	0.00	0.01
28.	Chromium	0.08	<0.05
29.	Bicarbonate (mg/l)	0	No. Value
30.	Zinc (mg/l)	0.00	<5.0
31.	E. Coli	Nil	Zero
32.	Faecal Coliforms	60	Zero
33.	Non – Faecal Coliforms	Nil	10
34.	Vibro-parahaemolyticus	-	Zero
35.	Salmonella sp.	-	Zero

RECOMMENDATIONS:- The physicochemical analysis of this source indicate that all the parameters are within the WHO recommended standard for good drinking water, except for ammonia, fluoride, sulphite and chromium which are above their WHO limits.

Bacteriologically, the source is polluted with faecal bacteria. However, chlorination process is necessary with a free chlorine content of 0.3mg/l – 0.5mg/l which is the WHO guideline for Potable Water.

Signed:...Edward Toby.....

(Supervisor)

Date:.....



NATIONAL WATER QUALITY LABORATORY

TEL 077-547-020/079-317-532

MINISTRY OF WATER RESOURCES

TOWER HILL

FREETOWN

Water Quality Monitoring Report Sheet

Water Authority:..... International Consulting Services

District:.. Karene... Chiefdom:.. Tambaka.... Town:.. Tompare.. Date:.. 3rd /03/2023.....

Sample:.. WS/lot1/tom04...Location:..Tompare... Type: of Source:..Hand-dug well.. Time:..3:31pm..

GPS

N-1049593

E-0785790

	Parameters	Measured Values	WHO recommended Permissible Limits
1.	Water Temperature (°C)	29.3	No. Value
2.	pH	6.8	6.5 – 8.5
3.	Turbidity (NTU)	0	<5.0
4.	Conductivity (µS/Cm)	20	<450 µS
5.	TDS (ppm)	10	<248
6.	Salinity (ppt)	-	<0.4
7.	Residual Chlorine (mg/l)	0.00	0.3-0.5 after 30min. disinfection
8.	Aluminum (mg/l)	0.01	<0.2
9.	Ammonia (mg/l)	0.00	No. Value
10.	Bromine (mg/l)	-	No. value
11.	Calcium Hardness (mg/l)	2	<250
12.	Copper (mg/l)	0.00	<1.0
13.	Fluoride (mg/l)	2	<1.5
14.	Iron (mg/l)	0.11	<0.3
15.	Magnesium (mg/l)	0.0	<200
16.	Manganese (mg/l)	0.00	<0.4
17.	Molybdenum (mg/l)	0.00	0.25
18.	Nitrite (mg/l)	0.04	3.0
19.	Nitrate (mg/l)	4.0	<10
20.	Potassium (mg/l)	0.9	<6.0
21.	Phosphate (mg/l)	1.4	<20
22.	Silica (mg/l)	0.00	<15
23.	Sulphate (mg/l)	0.00	<400
24.	Sulphide (mg/l)	0.00	<0.5
25.	Sulphite (mg/l)	0.2	No. Value

26.	Chloride (mg/l)	0	<250
27.	Arsenic	0.00	0.01
28.	Chromium	0.08	<0.05
29.	Bicarbonate (mg/l)	0	No. Value
30.	Zinc (mg/l)	0.00	<5.0
31.	E. Coli	Nil	Zero
32.	Faecal Coliforms	40	Zero
33.	Non – Faecal Coliforms	Nil	10
34.	Vibro-parahaemolyticus	-	Zero
35.	Salmonella sp.	-	Zero

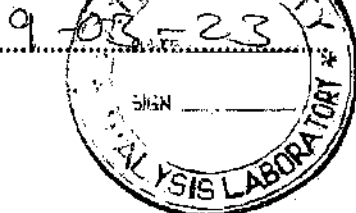
RECOMMENDATIONS:- The physicochemical analysis of this source indicate that all the parameters are within the WHO recommended standard for good drinking water, except for fluoride, sulphite and chromium which are above their WHO limits.

Bacteriologically, the source is polluted with faecal bacteria. However, chlorination process is necessary with a free chlorine content of 0.3mg/l – 0.5mg/l which is the WHO guideline for Potable Water.

Signed:...Edward Toby.....

(Supervisor)

Date:.....



NATIONAL WATER QUALITY LABORATORY**TEL 077-547-020/079-317-532****MINISTRY OF WATER RESOURCES****TOWER HILL****FREETOWN****Water Quality Monitoring Report Sheet**

Water Authority:..... International Consulting Services

District: Karene... Chiefdom:.... Tambaka.... Town:.. Tompare Date:.. 3rd /03/2023.....Sample:.. WS/lot1/tom5... Location:.. Tompare... Type: of Source:.. Hand-dug well... Time: 4:10pm...
GPS

N-1049417

E-0787274

	Parameters	Measured Values	WHO recommended Permissible Limits
1.	Water Temperature (°C)	29.3	No. Value
2.	pH	7.0	6.5 – 8.5
3.	Turbidity (NTU)	0	<5.0
4.	Conductivity (µS/Cm)	130	<450 µS
5.	TDS (ppm)	65	<248
6.	Salinity (ppt)	-	<0.4
7.	Residual Chlorine (mg/l)	0.00	0.3-0.5 after 30min. disinfection
8.	Aluminum (mg/l)	0.03	<0.2
9.	Ammonia (mg/l)	0.05	No. Value
10.	Bromine (mg/l)	-	No. value
11.	Calcium Hardness (mg/l)	6.0	<250
12.	Copper (mg/l)	0.22	<1.0
13.	Fluoride (mg/l)	2	<1.5
14.	Iron (mg/l)	0.05	<0.3
15.	Magnesium (mg/l)	0.0	<200
16.	Manganese (mg/l)	0.00	<0.4
17.	Molybdenum (mg/l)	0.00	0.25
18.	Nitrite (mg/l)	0.07	3.0
19.	Nitrate (mg/l)	4.0	<10
20.	Potassium (mg/l)	1.7	<6.0
21.	Phosphate (mg/l)	0.8	<20
22.	Silica (mg/l)	0.00	<15
23.	Sulphate (mg/l)	1.1	<400

24.	Sulphide (mg/l)	0.00	<0.5
25.	Sulphite (mg/l)	0.1	No. Value
26.	Chloride (mg/l)	0	<250
27.	Arsenic	0.00	0.01
28.	Chromium	0.06	<0.05
29.	Bicarbonate (mg/l)	0	No. Value
30.	Zinc (mg/l)	0.00	<5.0
31.	E. Coli	Nil	Zero
32.	Faecal Coliforms	80	Zero
33.	Non – Faecal Coliforms	Nil	10
34.	Vibro-parahaemolyticus	-	Zero
35.	Salmonella sp.	-	Zero

RECOMMENDATIONS:- The physicochemical analysis of this source indicate that all the parameters are within the WHO recommended standard for good drinking water, except for ammonia, fluoride, sulphite and chromium which are above their WHO limits.

Bacteriologically, the source is polluted with faecal bacteria. However, chlorination process is necessary with a free chlorine content of 0.3mg/l – 0.5mg/l which is the WHO guideline for Potable Water.

Signed:...Edward Toby.....

(Supervisor)

Date:.....



11.14 APPENDIX 14. ENVIRONMENTAL, HEALTH, AND SAFETY (EHS) GUIDELINES

GENERAL EHS GUIDELINES FOR NOISE, WATER AND AIR QUALITY

Table 1.7.1- Noise Level Guidelines ⁵⁴		
Receptor	One Hour L _{Aeq} (dBA)	
	Daytime 07:00 - 22:00	Nighttime 22:00 - 07:00
Residential; institutional; educational ⁵⁵	55	45
Industrial; commercial	70	70

Table 1.1.1: WHO Ambient Air Quality Guidelines ^{7, 8}		
	Averaging Period	Guideline value in µg/m ³
Sulfur dioxide (SO ₂)	24-hour	125 (Interim target-1) 50 (Interim target-2) 20 (guideline)
	10 minute	500 (guideline)
Nitrogen dioxide (NO ₂)	1-year	40 (guideline)
	1-hour	200 (guideline)
Particulate Matter PM ₁₀	1-year	70 (Interim target-1) 50 (Interim target-2) 30 (Interim target-3) 20 (guideline)
	24-hour	150 (Interim target-1) 100 (Interim target-2) 75 (Interim target-3) 50 (guideline)
Particulate Matter PM _{2.5}	1-year	35 (Interim target-1) 25 (Interim target-2) 15 (Interim target-3) 10 (guideline)
	24-hour	75 (Interim target-1) 50 (Interim target-2) 37.5 (Interim target-3) 25 (guideline)
Ozone	8-hour daily maximum	160 (Interim target-1) 100 (guideline)

Table 1.3.1 Indicative Values for Treated Sanitary Sewage Discharges ^a		
Pollutants	Units	Guideline Value
pH	pH	6 – 9
BOD	mg/l	30
COD	mg/l	125
Total nitrogen	mg/l	10
Total phosphorus	mg/l	2
Oil and grease	mg/l	10
Total suspended solids	mg/l	50
Total coliform bacteria	MPN ^b / 100 ml	400 ^a
Notes: ^a Not applicable to centralized, municipal, wastewater treatment systems which are included in EHS Guidelines for Water and Sanitation. ^b MPN = Most Probable Number		

11.15 APPENDIX 15. RANDOM PHOTOS OF COMMON TYPE OF FISH CATCH

Gendema-Garwama Crossing



Manowa-Pendembu Crossing



Tompari-Kamakwe Crossing



11.16 APPENDIX 16. RANDOM PHOTOS OF THE WELLS SAMPLED FOR GROUND WATER ANALYSIS

Matru-Senehun Crossing



Gendema-Garwama Crossing







Manowa-Pendembu Crossing



Tompari-Kamakwe Crossing



11.17 APPENDIX 17 EPA -SL EIA SCREENING FORM

APPLICATION FORM FOR THE ACQUISITION OF AN ENVIRONMENTAL IMPACT ASSESSMENT (EIA) LICENSE

1. NAME of Institution/Company... SCADEP, Smallholder Commercialisation and Agribusiness Development Project

2. TYPE OF BUSINESS... Government project under MAF

3. BUSINESS REGISTRATION NO... N/A

4. CONTACT ADDRESS... 1E SCAD DRIVE, OFF SHIR ROAD
E-MAIL OR TEL NO... 078 82 4210 / csaubesh@gmail.com

5. NATIONALITY... Sierra Leone

6. PROPOSED DEVELOPMENT (ATTACH PROPOSAL)... Bridge Construction

7. PROPOSED LOCATION (INCLUDE RELEVANT MAP)... 6 districts in Sierra Leone

8. COST OF PROPOSAL... 130 million

9. ESTIMATED DURATION FOR DEVELOPMENT ACTIVITIES... 36 months

10. STATE THE IMPACT OF ACTIVITIES ON THE FOLLOWING: TICK THE APPROPRIATE COLUMNS

	POSITIVE	NEGATIVE
a) SUBSTANTIAL IMPACT ON ECOSYSTEM OF THE LOCALITY		☒
b) SOCIAL	☒	
c) AESTHETIC	☒	
d) SCIENTIFIC	☒	
e) HISTORICAL	☒	
f) STATE OTHER IMPORTANT ENVIRONMENTAL PARAMETERS	<u>landscape</u> ☒ <u>Economic</u> ☒	<u>soil quality</u> ☒ <u>noise level</u> ☒

Signed: _____

EXECUTIVE CHAIRPERSON



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ANNEX 2: EIA Screening Form

Serial No. _____

ENVIRONMENTAL IMPACT ASSESSMENT SCREENING FORM

Please type or print clearly, completing this form in its entirety. You may provide additional information on a separate sheet of paper if necessary. Kindly note that the information you are to provide is required by the National Environment Protection Agency Act of 2008 as amended in 2010 for the issuance of an EIA License. Section 15 (2).

SECTION 1:

INFORMATION ON THE CONTACT PERSON

Name

Mr Sulaiman Sesay

Institutional Affiliation

Ministry of Agriculture and Forestry

Business Title/position

Project Coordinator

Business Address:

1E SCAD DRIVE, OFF SHIR ROAD

Telephone

078 82 4210 Email: csaubesh@gmail.com

SECTION 2:

DESCRIPTION OF THE INDUSTRY/ FACTORY/COMPANY/PROJECT AND OR PROPOSED PROJECT

Name Construction of 7no. Bridges in Sierra Leone

Date operations started

November 2020 (Design + formulation phase)

Location of establishment and/or project

6 districts in Sierra Leone

Location of proposed project (if any-----)

attached in proposal
(Attach a map or maps, covering the proposed site and surrounding 5 km radius)

Land Area



Current Land use (Describe how the land is being used at present)

Existing farm crossing points

Describe any possible Alternative Site (s) None/details in proposal

Describe other types of industries or facilities (including health centers and schools), which are located within 100 metres of the site, or are proposed to be located near the facility. Indicate the proximity of the industrial, factory or project site and/or proposed site to residential areas, national parks or areas of ecological, historical or cultural importance.

Details in the project proposal

Indicate whether adequate infrastructure exists at the location and/or proposed location and whether old or new building, roads, electricity and water lines, or drainage systems exist at the location and/or proposed site.

Details in the proposal

SECTION 3: EMPLOYEES AND LABOURERS

Number of people employed: Not applicable at present

Employees and Labourers	Duration Operation
FULL - TIME	
PART - TIME	



Indicate whether you have or plan to construct housing/sanitation facilities for temporary or permanent workers.

During construction stage

SECTION 4: DESCRIPTION OF INDUSTRIAL PROCESS

Briefly describe the type and nature of industrial processes at the installation and/or proposed installation.

State the type and quantity of energy used (including the origin of the energy i.e. public utility, on site generator, wood, solar, wind etc).

Type (s)	Quantity	Period (per day/week etc).
N/A		

Estimate the quantity of water used for the following:

Use (s) of water	Quantity	Period	Source
Construction	to be determined	Construction	local stream/rivers
Domestic	✓	✓	✓

List the type and quantity of raw material (s) used per year in the production process (including soil, sand, cement, aggregates, wood, animals etc). Identify the source (s) of raw material (s).

Type	Quantity	SOURCE
Cement	to be determined	local market
aggregate	✓	Quarry
soil	✓	local market

List all of the chemical (s) used in the production process or expected to be used for any aspect of the production process (A separate list may be attached with more detailed information).

Name/Type	Description	Quantity



SECTION 5:

PRODUCTS

Briefly state the nature of the product (s) or output of the facility and or proposed facility, and the expected quantities on a quarterly or annual basis. Indicate the use and or intended use of the product (s).

NAME	DESCRIPTION OF OUTPUT USES
Local network	transport connectivity improve access to markets

SECTION 6: BY PRODUCTS, WASTE MANAGEMENT AND DISPOSAL

Specify the nature of each waste or by-product and the quantity generated or to be generated.

Type	Description	Quantity in 1g per weeks/
Solid (Bulk)	Domestic + Construction	to be determined
Solid particulate		
Liquid	Wastewater + waste oil	✓
Gaseous		
Other		

State the method of disposal or management of waste (e.g. dump site, burning, bury etc).

Type of waste	Method of disposal/management
Construction	Designated approved sites / Recycling
Domestic	

Indicate sources of noise pollution, the type/quality of noise (i.e. machinery/repetitive pounding etc).

Source of Noise	Type of Noise
Equipment	Construction
Activities	Construction + operations



SECTION 7:

ENVIRONMENTAL IMPACTS

Please indicate environmental impact(s) that may occur as a result of the factory/industrial process and or the process of proposed project. Infrastructure project with temporary environmental impacts.

Nature of impact	Y/N	Brief description of the anticipated impacts
Air quality	Y	Construction generate air pollution
Drainage	Y	Wastewater from construction + workers
Landscape	N	—
Forest cover	N	—
Vegetation	Y	Removal of vegetation for the road approach
Human Population	Y	The project will benefit the local population
Animal Population	N	—
Soil quantity	N	—
Soil Erosion	Y	Increased runoff during construction
Water quality	Y	Temporary water pollution during construction
Tranquility/Noise	Y	Equipment and vehicles
Special Habitants	N	—
Other	—	—



SECTION 8: PROPOSED MITIGATION MEASURES

Indicate the measure (s) employed to mitigate against damage likely to be caused by the factory/industrial process and/or proposed project to human and/or the environment.

Briefly describe these measures

NO	LIKELY DAMAGE TO	MITIGATION MEASURES
1	Air Quality	controlling speed limits etc
2	Drainage	use of existing water course
3	Landscape	
4	Forest Cover	
5	Vegetation	uprooted vegetation will be replanted
6	Human Population	sensitization & local employment
7	Animal Population	
8	Soil Quality	
9	Soil Erosion	stabilization & check dams
10	Water Quality	proper abstraction methods
11	Tranquillity/Noise	maintenance equipment speed
12	Special Habitats	calm water
13	Others	

State any and all experience you have with implementing the above mentioned mitigation measure (s). If you do not have prior experience, what skill (s) do you possess to implement these mitigation measures (s)?

A dedicated and experienced team of Environmental Specialists and engineers from ICS consultants and SCAEP will ensure compliance, implementation of ESMs and regular health and environmental safety standards.

What staff training is provided or will be provided to ensure compliance with World Bank Environmental and Social Safeguards training & workshop before and during construction.

Stamp: ENVIRONMENTAL PROTECTION AGENCY, SIERRA LEONE, DATE 17/12/20

SECTION 9: TESTIMONY

Confirm that the information provided herein is accurate to the best of my knowledge.

I will also endeavor to provide additional information and facilitate a site visit if required.

For Official Use Only

Reviewed by: _____ Date: _____

Classified A B C

Reasons for the Classification:

Stamp: ENVIRONMENTAL PROTECTION AGENCY, SIERRA LEONE, DATE 17/12/20

Approved by Executive Chairperson: _____ Date: _____

11.18 TERMS OF REFERENCE FOR THE FISHERIES MANAGEMENT PLAN (FMP)

1. Introduction

This Fisheries Management Plan (FMP) is essential for mitigating potential impacts on local fisheries from construction activities associated with the project. The FMP shall be prepared prior to the contractor's mobilization on-site, ensuring that measures to protect fisheries resources are ready for immediate implementation upon commencement of construction. This ToR outlines the scope, objectives, and requirements for the development of the FMP, aligning it with the Fisheries and Aquaculture Act, 2018, and Fisheries and Aquaculture Regulations, 2019. Oversight from the Environmental Protection Agency (EPA) is also incorporated where relevant, in accordance with the EPA Act of 2022.

2. Objectives

The objectives of the FMP are to:

- Minimize adverse impacts on local fish populations and aquatic habitats due to construction activities.
- Ensure sustainable fisheries practices in the project area, in compliance with Sierra Leone's fisheries regulations.
- Engage local communities and stakeholders to incorporate traditional knowledge and gain social acceptance of the FMP.
- Define responsibilities and implementation strategies to facilitate smooth integration of fisheries management during project construction.

3. Scope of Work

The scope of the FMP development includes:

- **Assessment of Current Fisheries Status:** Conduct baseline studies to document current fish populations, key habitats, and fishing practices within the project area, aligned with the Fisheries and Aquaculture Act, 2018.
- **Impact Assessment:** Evaluate potential construction impacts on fisheries resources, including water quality degradation, habitat disruption, and barriers to fish movement. In areas where environmental quality may be affected such as water pollution and sedimentation the EPA Act of 2022 may provide regulatory oversight.
- **Mitigation Measures:** Develop specific mitigation measures for protecting fish populations, such as buffer zones, sediment control, regulated working hours, and fish-friendly structures (e.g., fish ladders, silt curtains), in line with the Fisheries and Aquaculture Regulations, 2019. The EPA's oversight may extend to sediment control and buffer zones as they relate to broader environmental protection standards.
- **Monitoring Plan:** Establish a plan for ongoing monitoring of fisheries resources to track and mitigate impacts throughout construction, per the National Biodiversity Strategy and Action Plan (NBSAP) guidelines. If the monitoring program includes water quality testing, EPA standards may apply.
- **Community and Stakeholder Engagement:** Facilitate meetings with local communities, fishers, and the Fisheries Department to incorporate local insights and build community support, as required under the Local Government Act of 2004 for community engagement in public projects.

4. Stakeholder Engagement Requirements

- **Local Communities:** Engage with local communities through consultations and feedback sessions to understand fishing practices, seasonal fishing cycles, and the cultural significance of fishery resources.
- **Fisheries Department:** Collaborate with the Ministry of Fisheries and Marine Resources to ensure that the FMP complies with the Fisheries and Aquaculture Act, 2018 and aligns with regional conservation objectives.
- **Non-Governmental Organizations (NGOs):** If applicable, consult with relevant NGOs involved in fishery protection and aquatic conservation to incorporate best practices.
- **Consultant Team:** The consultant preparing the FMP should engage an interdisciplinary team including environmental scientists, fisheries experts, and social specialists to ensure a comprehensive plan.

5. Contractor Responsibilities

- **Implementation:** Implement the FMP as soon as construction begins, ensuring that all mitigation measures are in place and that the contractor adheres to established guidelines under the Fisheries and Aquaculture Act, 2018.
- **Monitoring and Reporting:** Regularly monitor and report on the effectiveness of the FMP to ensure compliance with outlined mitigation measures and timely adjustments where necessary. Reports involving water quality, sediment control, or pollution management should be shared with the EPA if required.
- **Capacity Building:** Train on-site staff in best practices for fishery protection, including protocols for minimizing habitat disruption and handling fish species, with input from both the Fisheries Department and EPA on areas that overlap.
- **Emergency Response:** Develop and follow response procedures for any unexpected events that may impact fisheries, such as spills or unplanned habitat disturbances, following EPA standards for pollution control and containment where applicable.

6. Deliverables

- **Baseline Fisheries Assessment Report:** Provide a comprehensive report on existing fisheries conditions in the project area.
- **Draft and Final Fisheries Management Plan:** Submit a draft FMP for review and incorporate feedback before submitting the final plan.

- **Monitoring Reports:** Submit regular monitoring reports to track progress and document any adjustments made to the FMP.
- **Stakeholder Engagement Summary:** Document consultations and engagements conducted with local communities, the Fisheries Department, and other stakeholders, including feedback incorporated into the FMP.

7. Compliance and Standards

The FMP shall comply with:

- The **Fisheries and Aquaculture Act, 2018**, governing sustainable fisheries practices and conservation measures.
- The **Fisheries and Aquaculture Regulations, 2019**, which provide guidelines for managing and protecting aquatic resources.
- The **EPA Act of 2022**, which provides standards for pollution control, sediment management, and environmental quality monitoring as it may relate to fisheries management.
- The **National Biodiversity Strategy and Action Plan (NBSAP)**, guiding the protection of biodiversity, including aquatic habitats.
- Additional guidelines as specified by the Ministry of Fisheries and Marine Resources (MFMR) and EPA requirements relevant to environmental protection in water bodies.

8. Timeline

- **Preparation Phase:** The FMP, including all baseline assessments and consultations, shall be completed and approved prior to the contractor's mobilization on-site.
- **Implementation Phase:** The contractor shall implement the FMP from the start of construction, continuing through to the completion of all project-related activities.
- **Review and Adjustment:** Regularly review and adjust the FMP based on monitoring data and stakeholder feedback to ensure continued relevance and effectiveness.

9. Budget Considerations

- **Cost Allocation:** The cost of implementing the FMP shall be included in the contractor's bid, with a clear breakdown of cost for assessments, stakeholder consultations, and monitoring activities.
- **Contingency Budget:** Allow for a contingency budget to address unforeseen impacts or additional mitigation measures that may arise during construction.

11.19 ANNEX 11.19. CHANCE FINDS PROCEDURES

This Annex describes the Chance Finds Procedures to be followed by SCADeP- No.4 Bridges Construction Subproject, outlining the procedures in case of potential cultural heritage discoveries occur during the construction activities associated with the Subproject.

The Chance Finds Procedures is developed in alignment with international good practice, including the World Bank's Physical Cultural Resources OP/BP 4.11, and also complies with Sierra Leone requirements on Monuments and Relics Ordinance, 1946. In 1962, this Ordinance was upgraded into an Act.

This Chance Finds Procedures therefore intends to provide SCADeP and its contractors with an appropriate response in accordance with the relevant national legislation and international good practice. As such, all contracts for civil works will include this Chance Find Procedure.

In order for the Chance Finds Procedures to be effective, the site manager must ensure that all personnel on the proposed development site understand the Chance Finds Procedures and the importance of adhering to it if cultural heritage resources are encountered. In addition, training or induction should be provided on cultural heritage resources that might potentially be found on sites.

Cultural heritage encompasses tangible and intangible heritage which may be recognized and valued at a local, regional, national or global level. *Tangible cultural heritage*, which includes movable or immovable objects, sites, structures, groups of structures, and natural features and landscapes that have

archaeological, paleontological, historical, architectural, religious, aesthetic, or other cultural significance. Tangible cultural heritage may be located in urban or rural settings and may be above or below land or under the water. *Intangible cultural heritage*, which includes practices, representations, expressions, knowledge, skills—as well as the instruments, objects, artefacts and cultural spaces associated therewith— that communities and groups recognize as part of their cultural heritage, as transmitted from generation to generation and constantly recreated by them in response to their environment, their interaction with nature and their history.

In the event that during construction, sites, resources or artifacts of cultural value are found, the following procedures for identification, protection from theft, and treatment of discovered artifacts should be followed and included in standard bidding documents. These procedures take into account requirements related to Chance Finding under national legislation including Monuments and Relics Ordinance, 1946.

- Halt the construction activities around the chance find to avoid any (or further) damage.
- Report the discovery to Supervising Engineer/ Consultant (or equivalent entity) immediately.
- Delineate and fence the discovered site or area and provide a buffer zone around all sides of the find.
- Secure the site to prevent any damage or loss of removable objects. In cases of removable antiquities or sensitive remains, a guard will be arranged until Monuments and Relics Commission and/ or responsible local authorities or the District Department of Tourism and Culture, can take over.
- Forbid any removal of the objects by the workers or other parties.
- Note and photograph the type of archaeological materials you think you have encountered, their location (GPS) and if possible, the depth below the surface the find occurred.
- Notify the Monuments and Relics Commission and/or responsible local authorities immediately.
- The Monuments and Relics Commission and/or responsible local authorities would be in charge of evaluation /inspection of the significance or importance of the chance finds and advise on appropriate subsequent procedures.
- Decisions on how to handle the finding shall be taken by Monuments and Relics Commission and/or responsible authority.
- Implementation for the Monuments and Relics Commission and/or responsible authority's decision concerning the management of the finding shall be communicated in writing.
- Construction work at the site could resume only after permission is given from Monuments and Relics Commission and/or responsible local authorities concerning safeguard of the heritage.
- SCADep and its contractors are responsible for cooperating with Monuments and Relics Commission and/or responsible local authorities to monitor all construction activities and ensure that the adequate preservation actions are taken and hence the heritage sites protected.
- In addition, contractors, supervising engineer/ consultant are obliged to declare the chance find discovery at the earliest possible date to SCADep PCU.

12 LIST OF REFERENCES

1. Beanlands, G.E and Duinker, P.N, 1983. An ecological framework for environmental impact assessment
2. Biodiversity Strategic Action Plan, 2017-2026
3. Child Act, 2007
4. Conservation And Wildlife Policy, 2010
5. Constitution of Sierra Leone, 1991
6. Deighton, F.C. (1957). Vernacular Botanical Vocabulary for Sierra Leone. Crown Agents for Overseas Governments and Administrations, London.
7. National Lands Policy, 2015
8. Disaster Risk Policy 2018
9. Explosives Ordinance, 1955
10. Fisheries Act, 2007
11. Hawthorne, W. & C. Jongkind (2006). Woody Plants of Western African Forests. Kew Publishing. p1023.
12. Hutchinson, J. & J.M. Dalziel (1954–1972). Flora of West Tropical Africa, vols. I, part 1 & 2; II; III, part 1 & 2. Crown Agents for Overseas Governments and Administrations, London.
13. Integrated Transport Policy, Strategy and Investment Plan, 2013
14. IUCN (2009). IUCN Red List of Threatened Species. Version 2009.2. Consulted December 2012.
15. Local Government Act 2004 and the Amendment Act, 2017
16. National Disaster Management Agency Act, 2020
17. National Environmental Policy (NEP), 2013
18. National Protected Area Authority and Conservation Trust Fund Amendment Act, 2022
19. National Water Resource Management Agency Act, 2017
20. Road Maintenance Fund Administration Act, 2010
21. Road Transport Authority Act (1996), and the Roads Safety Authority Act, 2016
22. Road Traffic Act, 2007
23. Sierra Leone Environment Protection Agency (SLEPA) Act, 2022
24. Sierra Leone Roads Authority (Amendment) Act, 2010
25. Sierra Leone Meteorological Agency Weather Reports, 2022
26. The Hydrology of Sierra Leone, 2017
27. World Bank Safeguard Policies