RURAL ELECTRIFICATION AGENCY
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AFRICAN DEVELOPMENT BANK GROUP

DRAFT FINAL REPORT

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) FOR SOLAR-POWERED RENEWABLE ENERGY SOLUTIONS

UNDER THE

PROPOSED NIGERIA ELECTRIFICATION PROJECT (DESERT TO POWER) PHASE II BY THE RURAL ELECTRIFICATION AGENCY (REA)

AT

FEDERAL UNIVERSITY OF AGRICULTURE, BASSAM BIRI, BAYELSA STATE

DRAFT FINAL REPORT

JULY 2026

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LIST OF ACRONYMS AND ABBREVIATIONS

AfDB	African Development Bank
APPI	Area of Potential Project Influence
ARAP	Abbreviated Resettlement Action Plan
ASTM	American Society for Testing and Materials
BMP	Biodiversity Management Plan
BOD	Biochemical Oxygen Demand
BOS	Balance of System
COPE	Care of the People Programme
CWD	Coarse Woody Debris
DRG	Debt Relief Gains
EA	Environmental Assessment
ECN	Energy Commission of Nigeria
EEP	Energizing Education Programme
EIA	Environmental Impact Assessment
EIS	Environmental Impact Statement
EMF	Electromagnetic Field
EMS	Environmental Management System
EPC	Engineering, Procurement and Construction
ERSED	Erosion and Sediment Control
ESCP	Erosion and Sediment Control Plan
ESIA	Environmental and Social Impact Assessment
ESMP	Environmental and Social Management Plan
FEPA	Federal Environmental Protection Agency
FGN	Federal Government of Nigeria
FMEnv	Federal Ministry of Environment
GPS	Global Positioning System
GRM	Grievance Redress Mechanism
HSE	Health, Safety, and Environment
HT	High Tension
LGA	Local Government Area
LT	Low Tension
NACOP	National Council on Power
NEEAP	National Energy Efficiency Action Plan
NEP	Nigeria Electrification Project
NEPP	National Electric Power Policy
NERC	Nigerian Electricity Regulatory Commission
NESREA	National Environmental Standards and Regulations Enforcement Agency
NIMET	Nigerian Meteorological Agency
NML	Noise Management Level
NUC	National Universities Commission
O&M	Operations and Maintenance
OHS	Occupational Health and Safety
PAPs	Project Affected Persons
PCT	Plant Community Type
PESCP	Progressive Erosion and Sediment Control Plan
PMP	Project Management Plan
POCR	Pre-Operation Compliance Report

REA	Rural Electrification Agency
TCN	Transmission Company of Nigeria
TCP	Traffic Control Plan
TMP	Traffic Management Plan
TWA	Time-Weighted Average

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EXECUTIVE SUMMARY

ES 01: Overview of the Project

The Federal Government of Nigeria (FGN), through the Rural Electrification Agency (REA), is implementing the Nigeria Electrification Project (NEP) Phase II – Desert-to-Power with financial support from the African Development Bank (AfDB). The Project forms part of the Energizing Education Programme (EEP), an initiative designed to provide reliable, sustainable, and climate-resilient electricity to Federal Universities and their affiliated Teaching Hospitals across Nigeria. The programme aligns with Nigeria's national development priorities, renewable energy targets, and climate change commitments under the Paris Agreement.

The proposed development consists of a 2.5 MW ground-mounted solar photovoltaic (PV) power plant integrated with a lithium-ion battery energy storage system to ensure power reliability and load balancing. The system will include PV modules, inverters, transformers, battery banks, mounting structures, internal distribution networks, and balance-of-system components necessary for efficient power generation and evacuation.

The selected site is located within the institutional boundaries of the Federal University of Agriculture, Bassim Biri, and is free from ecologically sensitive habitats, cultural heritage resources, and existing physical structures that would require displacement or resettlement. The site selection process considered accessibility, proximity to existing electrical infrastructure, topography, environmental sensitivity, and security considerations.

The project lifecycle includes site preparation and civil works, installation of solar arrays and associated infrastructure, system commissioning, long-term operation and maintenance, and eventual decommissioning at the end of the plant's operational lifespan, estimated at approximately 25 years.

ES 0: Institutional And Legal Framework for the Implementation of the Project

Institutions	Roles and Responsibilities
Federal Government of Nigeria (FGN)	Provides overall policy direction and oversight; ensures alignment with national development objectives; approves relevant national policies; facilitates inter-ministerial coordination and funding support.
Federal Ministry of Power (FMP)	Provides sector policy guidance; oversees implementation of power-sector initiatives; coordinates renewable energy programmes; ensures compliance with national power-sector regulations and standards; supervises agencies under its mandate, including REA and NERC.

Institutions	Roles and Responsibilities
Transmission Company of Nigeria (TCN)	Provides technical guidance on grid infrastructure and integration where applicable; ensures compatibility with national transmission systems; supports system planning and operational coordination.
Federal Ministry of Environment (FMEnv)	Reviews and approves the ESIA and Environmental and Social Management Plans (ESMPs); issues environmental permits and certificates; monitors compliance with environmental regulations; oversees implementation of mitigation measures throughout the project lifecycle.
Nigerian Electricity Regulatory Commission (NERC)	Regulates electricity generation, distribution, and supply; issues required licenses and permits where applicable; ensures compliance with electricity market regulations, technical standards, and mini-grid regulations.
National Environmental Standards and Regulations Enforcement Agency (NESREA)	Enforces national environmental regulations; monitors pollution control, waste management, battery disposal, and environmental performance; ensures compliance with environmental standards during construction and operation phases.
National Universities Commission (NUC)	Facilitates coordination between the project and beneficiary universities; ensures alignment with higher education development objectives; supports project implementation within tertiary institutions.
State Ministry of Lands	Facilitates land acquisition and allocation processes where required; verifies land ownership and occupancy rights; assists in compensation and resettlement matters if applicable.
State Ministry of Environment / State Environmental Protection Agencies (SEPAs)	Collaborate with FMEnv in environmental monitoring and compliance; participate in inspections and stakeholder engagement; address state-level environmental concerns arising from project activities.
Local Government Authority (LGA)	Supports community engagement and stakeholder consultations; facilitates local approvals and coordination; assists in grievance resolution; monitors local impacts and promotes community participation.
Rural Electrification Agency (REA)	Acts as the primary implementing agency for the Energizing Education Programme; coordinates project execution, procurement, supervision, monitoring, and reporting; ensures delivery of project objectives and compliance with donor requirements.
Federal Ministry of Women Affairs and Social Development	Promotes gender inclusion, social safeguards, and protection of vulnerable groups; supports implementation of gender action plans and prevention of gender-based violence (GBV).

Key National Policies

- National Policy on the Environment (2016) promotes sustainable development, conservation of natural resources, and environmental awareness.
- National Climate Change Policy (2021–2030) supports low-carbon, climate-resilient development.
- National Electric Power Policy (2001) initiated reforms that led to power-sector privatization and creation of NERC.
- National Energy Policy (2013) and National Energy Efficiency Action Plan (2015–2030) promote energy efficiency and conservation.

Legal Requirements

The project is governed by several important laws, including:

ES02: Legal Requirements

Law / Regulation	Year Enacted
Land Use Act	1978
Labour Act	1974
Factories Act	2004
Environmental Impact Assessment (EIA) Act	1992
Electric Power Sector Reform (EPSR) Act	2005
National Environmental Standards and Regulations Enforcement Agency (NESREA) Act	2007
Nigerian Electricity Regulatory Commission (NERC) Regulations	2005–Present (various regulations issued under the EPSR Act)
Climate Change Act	2021
Employees' Compensation Act (replacing the Workers' Compensation Act)	2010
Petroleum Industry Act (PIA) *(relevant for gas-fired power projects)*	2021
Electricity Act *(repealed and replaced key provisions of the EPSR Act)*	2023
National Environmental (Air Quality Control) Regulations	2014
National Environmental (Noise Standards and Control) Regulations	2009
National Environmental (Sanitation and Waste Control) Regulations	2009
Harmful Waste (Special Criminal Provisions) Act	1988
Nigerian Urban and Regional Planning Act	1992

African Development Bank (AfDB) Applicable Safeguards Instruments

The proposed activities under for the Desert to Power Phase II have been screened against the requirements of the African Development Bank (AfDB) Integrated Safeguards System (ISS). Based on the nature and scale of the anticipated activities, the following Operational Safeguards (OS) are triggered.

Operational Safeguard 1 (OS1): Assessment and Management of Environmental and Social Risks and Impacts. This is the foundational safeguard dictating how borrowers identify, avoid, and mitigate E&S risks. It requires an Environmental and Social Impact Assessment (ESIA) to categorize the project (e.g., moderate-risk Category 2 as this case of this proposed project) before it is financed.

Operational Safeguard 2 (OS2): Labour and Working Conditions is applicable because project implementation will require a substantial workforce during the construction phase. The OS will be triggered due to the envisaged use direct, contracted, primary-supply, or community workers, which might create occupational health and safety/labour risks.

Operational Safeguard 3 (OS3): Pollution Prevention and Control, Greenhouse Gases, Hazardous Materials and Resource Efficiency is triggered because the proposed solar power project will involve construction, installation, operation, maintenance, and eventual decommissioning activities that may generate pollution risks if not properly managed. Although the project is expected to contribute positively to greenhouse gas reduction by generating renewable energy, its construction and operational phases may involve the use, storage, and handling of fuels, lubricants, transformer oils, paints, solvents, cleaning agents, batteries, electrical equipment, and other potentially hazardous materials.

During construction, pollution risks may arise from site clearing, earthworks, movement of vehicles and machinery, temporary fuel storage, equipment maintenance, concrete works, dust generation, noise, and construction waste. Poor handling of fuels and lubricants could result in spills and soil or groundwater contamination. Improper disposal of packaging materials, scrap metals, cable offcuts, used oil, oily rags, batteries, and damaged solar components could also create environmental and human health risks.

Operational Safeguard 4 (OS4): Community Health, Safety and Security require projects to identify, assess, and manage risks to the health, safety, and security of affected communities throughout the project lifecycle. The safeguard covers risks associated with construction activities, hazardous materials, traffic, communicable diseases, security personnel, emergency situations, and gender-based violence (GBV), sexual exploitation and abuse (SEA), and sexual harassment (SH). It requires the implementation of appropriate mitigation measures, emergency preparedness, stakeholder engagement, and grievance redress mechanisms to protect community wellbeing. The proposed project will comply with OS4 by implementing community health and safety measures, traffic and emergency response plans, security management procedures, and GBV/SEA/SH risk mitigation measures throughout project implementation.

Operational Safeguard 5 (OS5): Land Acquisition, Restrictions on Access to Land and Land Use, and Involuntary Resettlement. OS5 is considered applicable on a precautionary basis because the Project requires approximately five hectares of University land and seasonal farming has been reported around the Project area. Although no permanent residential structures or formal acquisition of privately owned land is

anticipated, temporary, customary or informal use of the land may result in economic displacement if access to crops, farming plots or livelihood resources is restricted.

Operational Safeguard 6 (OS6): Biodiversity Conservation (Protects Habitats and Sustainable Natural Resources)**:** Biodiversity Conservation was triggered because the proposed project will utilize about 5 hectares of land, requiring vegetation clearance. The site is within existing university land and contains no critical habitats or protected biodiversity areas. However, some plant species may be lost during clearing. Therefore, the cleared species will be documented, and a Biodiversity Management Plan will be developed to guide mitigation, replanting, habitat protection, and sustainable natural resource management.

Operational Safeguard 10 (OS10): Stakeholder Engagement and Information Disclosure**:** Triggered for projects requiring stakeholder identification, consultation, disclosure, grievance mechanisms, or ongoing engagement; in practice, it is broadly applicable across AfDB projects. OS10 is triggered because projects can create environmental and social risks that communities, workers, government agencies, civil society groups, private users, vulnerable groups, and other interested parties need to understand and comment on. It is not only about holding one public meeting; it requires an ongoing process of engagement before approval, during design, construction, operation, and sometimes closure.

ES 02: Project Justification

Federal Universities in Nigeria continue to experience significant electricity supply challenges due to unreliable grid power and limited generation capacity. At present, the University relies heavily on diesel-powered generators to supplement an inadequate grid supply. This dependence results in high operational costs, frequent service interruptions, elevated greenhouse gas emissions, and increased maintenance burdens.

The proposed solar-hybrid power plant is intended to provide a reliable, uninterrupted electricity supply to the University, thereby supporting academic activities, research and development, administrative functions, and campus security. The Project also aims to reduce diesel consumption, lower recurrent energy expenditure, and significantly decrease carbon emissions associated with fossil fuel use. In addition, the inclusion of a renewable energy training centre within the project scope will strengthen institutional capacity and promote knowledge transfer in solar energy technologies. The Project directly contributes to Nigeria's Nationally Determined Contributions (NDCs) by promoting low-carbon energy generation and advancing the transition toward renewable energy solutions.

Approximately five (5) hectares of land within the Federal University of Agriculture, Bassam Biri (FUAB) campus, have been designated by the University authorities for the proposed Project. The preferred site is situated about 104 metres from the University's Administrative Building. The selection of this site was guided by several key considerations, including: (i) the absence of rocky outcrops that could hinder the installation of solar panels; (ii) the lack of ecologically sensitive areas or cultural heritage resources within and around the site; (iii) good accessibility through the existing internal road network; (iv) the feasibility of achieving a direct connection to the existing switchyard; and (v) enhanced security within the campus environment.

Other potential locations within the University campus were evaluated but subsequently discounted due to various constraints. These included the presence of existing physical structures and agricultural crops that could result in displacement or relocation, limited accessibility, and technical limitations such as unfavorable topography for solar panel installation.

ES 03: **Project Description**

The Federal University of Agriculture, Bassambiri (FUAB), is a newly established federal institution of higher education, sited across a main campus spanning 80.7 hectares on Nembe–Ogidiama Road and a second campus spanning 163 hectares on Okoroba–Atubo Road, both located in Bassambiri, within the Nembe Local Government Area of Bayelsa State, in the core of the Niger Delta region of southern Nigeria. The university was created by an act of the Federal Government in 2023 to expand access to tertiary education in agriculture and related disciplines and to connect teaching and research to the region's rich agricultural, marine, and environmental resources. Bassambiri lies in a riverine and estuarine landscape characteristic of Bayelsa State, offering strategic proximity to key towns such as Nembe and the state capital, Yenagoa, and broader links to urban centres including Port Harcourt and Warri. The location embeds the university within an environment where agricultural innovation, sustainable resource management, and community engagement are central to both learning and practical application. Academic activities are planned to commence with a strong focus on hands-on and research-driven programmes that align with national goals for agricultural development and regional economic growth.

PV technology consists mainly of PV cells and PV panels/modules. A PV cell is a basic device that converts sunlight into electricity through the photoelectric effect, while a PV panel is an assembly of interconnected PV cells mounted in a protective frame. These panels are designed to generate direct current electricity at specified voltages, and several panels can be connected together to form larger PV arrays.

The proposed PV panels will have consistent electrical and design characteristics within each string and sub-array. Panels connected in the same string will be of the same type, manufacturer, voltage rating, and orientation, including the same azimuth and tilt angle. The structural components supporting the panels will also be corrosion-resistant to ensure durability.

The solar power plant will include several supporting components in addition to the PV panels. These include fixed mounting structures made of galvanized steel or aluminum, secured into the ground using driven piles or screw systems. Inverters will be used to convert the DC electricity produced by the panels into AC electricity suitable for use by the local network or grid. The inverters will include safety and monitoring features such as anti-islanding protection and string current monitoring.

The plant will also include lithium-ion batteries for energy storage, although their final number and capacity have not yet been determined. Backup diesel generators will be installed to recharge the batteries during periods of poor weather, especially during the rainy season. A diesel storage tank with bunding and a concrete base will be provided to support safe fuel storage.

Other electrical components will include combiner boxes, underground power evacuation cables, and low- and medium-voltage switchgear cabinets. Combiner boxes will combine power from several solar strings and provide overcurrent and overvoltage protection. Switchgear cabinets will house circuit breakers, fuses,

disconnect switches, and surge protectors to control, protect, and isolate electrical systems during plant operation. The proposed Project is planned to be operational by the fourth quarter (Q4) of 2028.

ES 04 Environmental Baseline Description

The baseline conditions of the project area were established through stakeholder consultations, review of relevant literature, and field studies. Environmental data collection adopted a multidisciplinary approach and was carried out in accordance with applicable regulatory requirements and good international industry practice. The process included a desktop review of existing information; design and development of the field sampling strategy; confirmation of sampling locations; pre-mobilization activities, including job hazard analysis, equipment calibration, materials checks, and field mobilization; community consultations; dry-season sample collection, supplemented with secondary wet-season data; sample handling, documentation, preservation, and storage; demobilization from the field; and transfer of sample custody to the laboratory for analysis.

Air Quality and Noise Levels

The ambient air quality and noise results indicate that conditions within the project area are generally within applicable FMEnv limits and are broadly comparable with, or better than, those reported in the TCN ESHIA 2019 study. Noise levels ranged from 58.3 to 68.9 dB(A), with a mean of 65.21 dB(A), which is below the FMEnv 8-hour limit of 90 dB(A). Although the mean value is slightly higher than the 58.5 dB(A) reported in the TCN ESHIA 2019, it remains within acceptable regulatory limits and is comparable to the control value of 69.1 dB(A), suggesting influence from normal background activities.

Gaseous pollutants, including SOx, NOx, VOC, CO, and H_2S, were not detected, indicating good baseline air quality with no significant existing contamination from combustion, industrial, or other emission sources. Suspended particulate matter ranged from 28 to 31 µg/m³, well below the FMEnv limit of 250 µg/m³ and lower than the TCN ESHIA 2019 value of 63 µg/m³, indicating low dust levels. Ozone levels were higher than the control value, possibly due to local photochemical conditions, while CO_2 values were comparable to background levels. Meteorological conditions showed temperatures of 29.0 to 30.1°C, relative humidity of 70.1 to 78.1%, and low wind speeds, indicating calm conditions during sampling.

Groundwater Quality

The water quality results show that most physicochemical parameters were within the WHO/FMEnv recommended limits. The pH ranged from 6.5 to 6.85, indicating near-neutral conditions, while temperature values of 27.18°C to 28.60°C suggest normal ambient water conditions with no indication of thermal pollution. Electrical conductivity, total dissolved solids, turbidity, dissolved oxygen, biological oxygen demand, chemical oxygen demand, and total suspended solids were generally low, indicating limited dissolved ions, low suspended particles, and minimal organic or chemical pollution.

Nutrient levels were also within the stated limits, with nitrate, sulphate, and phosphate concentrations below WHO/FMEnv guideline values, suggesting no significant nutrient enrichment. Most heavy metals, including nickel, lead, copper, chromium, zinc, cadmium, barium, cobalt, arsenic, and mercury, were either not detected or recorded at very low concentrations. Total hydrocarbons were also below detection level, indicating no significant contamination from petroleum sources or toxic metals. The measured cations,

including potassium, sodium, magnesium, and calcium, were generally low, suggesting that the water is not highly mineralized and is unlikely to present hardness or salinity concerns.

However, iron exceeded the WHO/FMEnv limit of 0.3 mg/l, with values ranging from 0.021 to 1.015 mg/l and a mean of 0.518 mg/l. Elevated iron may affect the taste, colour, and acceptability of the water and may cause staining. The microbiological results also indicate concern, as coliform counts ranged from 6 to 7 against the required limit of 0, although E. coli was absent. Overall, while the water is acceptable for many physicochemical parameters, the elevated iron level and presence of coliform bacteria mean it is not fully compliant with WHO/FMEnv standards and should be treated before domestic or drinking use.

Surface Water Quality

The pH ranged from 7.3 to 8.7, indicating slightly alkaline but acceptable conditions, while temperature values of 29.2°C to 29.6°C were below the 40°C limit and showed no evidence of thermal pollution. Electrical conductivity, total dissolved solids, turbidity, dissolved oxygen, total suspended solids, biological oxygen demand, and chemical oxygen demand were generally low to moderate, suggesting low ionic concentration, clear water, limited suspended particles, and no excessive organic or chemical pollution. Total hydrocarbons were not detected, indicating no obvious hydrocarbon contamination.

Nutrient concentrations were low and within applicable limits, with nitrate, sulphate, phosphate, and ammonium showing no indication of significant nutrient enrichment. Most heavy metals, including nickel, lead, copper, chromium, zinc, cadmium, barium, cobalt, arsenic, and mercury, were not detected, while iron was below the WHO/FMEnv limit, indicating no significant toxic metal contamination. Cation levels were generally low, although sodium was relatively higher than the other cations and may require monitoring depending on intended use. However, microbiological quality remains the main concern, as coliform counts ranged from 2 to 8 against the WHO recommended limit of 0. Although E. coli was absent, the presence of coliform bacteria indicates that the water does not meet drinking water safety standards and should be treated before domestic or potable use.

Sediment Quality

The sediment results indicate generally stable baseline conditions across the study area when compared with the control. Sediment temperature ranged from 27.2 to 28.8°C, while electrical conductivity, total organic carbon, clay, silt, sand, nitrate, total nitrogen, magnesium, potassium, HUB, and coliform levels were not significantly different from the control values. The sediment texture was dominated by sand, with lower proportions of silt and clay, indicating a largely sandy sediment composition. Organic carbon and nutrient levels were generally low to moderate, suggesting limited organic accumulation and no major nutrient enrichment.

However, some parameters showed notable differences. Sediment pH was slightly acidic, ranging from 6.14 to 6.27, and was significantly lower than both the control and previous ESHIA results. Extractable nitrate and sulphate were higher than values reported in the previous ESHIA study, indicating possible changes in nutrient-related conditions. Calcium and total iron were significantly lower than the control, with total iron also lower than previous ESHIA values. Overall, the sediment quality appears generally acceptable, although the observed differences in pH, nitrate, sulphate, calcium, and iron should be considered during future monitoring.

Soil Quality

The topsoil and subsoil results indicate generally stable soil conditions within the study area. Soil pH ranged from slightly acidic to slightly alkaline and was not significantly different from the control or previous ESHIA results. Electrical conductivity and temperature were also not significantly different from the control, suggesting normal soil conditions, although EC values were significantly higher than those reported in the previous ESHIA study. Nutrients such as nitrate, ammonia, phosphate, and chloride were generally within background levels, with nitrate significantly lower than the previous ESHIA results, while phosphate showed no significant difference from the earlier study.

Soil physical properties showed moderate variability between locations. Total organic carbon in both topsoil and subsoil was significantly lower than the control, while moisture content and porosity were not significantly different from control values. The soil texture showed lower sand content and higher clay content compared with the previous ESHIA study, while silt was not significantly different. This indicates that the soils in the study area are generally finer-textured and more clay-rich than those previously reported. Polynuclear aromatic hydrocarbons were detected only at low concentrations, suggesting limited hydrocarbon-related contamination.

The measured exchangeable cations and metals were generally within acceptable levels. Magnesium, potassium, sodium, nickel, iron, and lead were not significantly different from control values, although magnesium, iron, lead, and zinc were higher than previous ESHIA values. Copper and chromium were significantly higher than the control but remained within FMEnv permissible limits, while cadmium was also within the FMEnv limit despite being higher than the previous ESHIA study. Zinc was significantly lower than the control but higher than previous ESHIA results. Overall, the soil quality appears generally acceptable, but continued monitoring is recommended for metals such as copper, chromium, cadmium, iron, lead, and zinc due to their variation from control and previous baseline values.

Biodiversity Studies

Vegetation within the Project footprint consists largely of secondary growth and previously disturbed land. No endangered species or critical habitats were identified within the designated project area. The broader ecological setting reflects typical Niger Delta flora and fauna, though the site itself does not represent a sensitive biodiversity hotspot. The vegetation data suggests that species diversity remains relatively stable throughout the year, while seasonal influences primarily affect abundance, growth, regeneration, and biomass of herbaceous and understory species rather than the composition of dominant tree species. The dominance of Poaceae and the persistence of high-RIV tree species indicate a plant community well adapted to seasonal flooding and continuously moist environmental conditions characteristic of brackish water forests.

Socio-economic

Socio-economically, the communities surrounding the Project site are largely dependent on livelihood activities such as fishing, small-scale agriculture, and petty trading. These activities provide income, food, and local economic exchange for households in the area. Fishing is particularly important for communities located close to water bodies, while small-scale farming and trading support household subsistence and informal commercial activities. The presence of these livelihood systems indicates that the local economy

is predominantly informal and resource-based, with community members relying on natural resources and small enterprises for daily sustenance.

The Project site is located entirely within university-owned land, which significantly reduces the likelihood of land-related conflicts or livelihood disruption. Since the proposed development does not require acquisition of land from surrounding communities or private individuals, no physical displacement, economic displacement, or involuntary resettlement of Project Affected Persons is anticipated. This means that residential structures, farms, fishing areas, markets, and other livelihood assets outside the university land are not expected to be directly affected by the Project footprint.

ES05: **Assessment of Potential Environmental and Social Impacts and Mitigation Measures**

The ESIA identified and evaluated potential impacts associated with the construction, operation, and decommissioning phases of the Project. During construction, potential impacts include temporary vegetation clearance, soil disturbance, dust generation, noise emissions, and occupational health and safety risks. These impacts are expected to be localized, short-term, and reversible.

During operation, potential impacts relate primarily to battery management, waste handling, minor electromagnetic field exposure, and routine maintenance activities. The lithium-ion battery system presents manageable risks provided appropriate handling, storage, and disposal procedures are implemented. No significant long-term adverse environmental impacts are anticipated.

The decommissioning phase may involve dismantling PV panels and battery systems, which will require environmentally sound waste management practices and site restoration measures. The overall impact assessment concluded that the Project's adverse impacts are limited in scope, site-specific, and capable of effective mitigation.

Table ES03: Matrix of Potential and Associated Impacts and Mitigation Measures

Project Phase	Activity	Key Impacts	Significance	Key Mitigation Measures	Residual Impact
Pre-Construction	Site Selection / Land Take	Loss of land	Moderate	Work with the university to acquire only the appropriate land size required for the project.	Minor
	Site Clearing and Preparation	Vegetation loss, fauna disturbance, soil erosion, dust generation, noise, and worker injuries	Minor	Minimize vegetation clearing, implement a biodiversity management plan, apply erosion control measures, suppress dust, and provide PPE and safety training.	Negligible
	Mobilization of Equipment and Materials	Air emissions and noise from vehicles and machinery	Minor	Maintain vehicles and equipment, optimize logistics, enforce speed limits, and use low-sulfur fuels where available.	Negligible
Construction	Movement of Equipment, Personnel, and Materials	Dust, air emissions, traffic congestion, road safety risks, and accidents	Minor	Implement a traffic management plan, suppress dust, maintain vehicles, train drivers, and provide adequate signage.	Negligible
	Civil and Electrical Works	Noise, soil erosion, habitat disturbance, and potential groundwater impacts	Minor–Moderate	Implement erosion control measures, provide adequate drainage, control vegetation clearing, and apply biodiversity management measures.	Negligible–Minor
	Workforce Activities	Gender discrimination, GBV risks,	Moderate	Implement a Gender Action Plan, enforce a Code of Conduct, conduct awareness campaigns, apply an OHS management	Minor

Project Phase	Activity	Key Impacts	Significance	Key Mitigation Measures	Residual Impact
		spread of STDs, and worker injuries		system, and establish a grievance mechanism.	
	Waste Generation and Disposal	Soil and groundwater contamination	Minor	Segregate waste, prevent spills, treat wastewater where required, and use licensed waste disposal contractors.	Negligible
Commissioning	Plant Testing	Noise, worker injury, electrocution risks, and public safety concerns	Minor–Moderate	Apply electrical safety procedures, use certified personnel, provide PPE, restrict access, and install warning signage.	Negligible–Minor
Operation	Power Generation and Distribution	Workplace discrimination, GBV risks, electric shock, and occupational hazards	Minor–Moderate	Implement an OHS system, Gender Action Plan, worker training, grievance redress mechanism, and fair labour practices.	Negligible–Minor
	Routine Maintenance	Soil contamination from batteries and equipment, and groundwater use	Minor	Implement a hazardous waste management plan, use certified waste disposal contractors, and apply water conservation measures.	Negligible
	Maintenance Activities	Worker injuries and electrocution during maintenance	Minor	Apply lock-out/tag-out procedures, provide PPE, ensure supervision, and conduct competency-based training.	Negligible
Decommissioning	Dismantling of Plant and Equipment	Dust, noise, worker injuries, and electrocution	Minor–Moderate	Suppress dust, control noise, provide PPE, apply lock-out/tag-out procedures, and use trained personnel.	Negligible–Minor

Project Phase	Activity	Key Impacts	Significance	Key Mitigation Measures	Residual Impact
	Removal of Foundations and Civil Works	Soil disturbance, erosion, and potential groundwater contamination	Minor	Implement erosion control measures, prevent spills, reinstate topsoil, and rehabilitate disturbed areas.	Negligible
	Waste Management and Disposal	Soil and groundwater contamination, and increased burden on waste facilities	Moderate	Implement a waste management plan, prioritize recycling, use licensed waste contractors, and securely store hazardous waste.	Minor
	Transportation of Decommissioned Materials	Air emissions, traffic congestion, accidents, and road damage	Minor	Implement a traffic management plan, optimize routes, use trained drivers, and repair any project-related road damage.	Negligible
	Site Restoration and Rehabilitation	Temporary habitat loss and loss of employment after closure	Minor–Moderate	Re-vegetate disturbed areas, conduct ecological monitoring, restore habitats, and support livelihood restoration and skills training.	Negligible–Minor

ES 06 Environmental and Social Management Plan

The purpose of the Environmental and Social Management Plan (ESMP) is to ensure that Environmental and Social impacts identified during the ESIA process are effectively addressed during the construction, operation and closure of the project. The ESMP specifies the mitigation and management measures to which the Proponent is committed and shows how the Project will mobilize organizational capacity and resources to implement these measures. The ESMP will be a living document and will continue to develop during the design and construction phases to enable continuous improvement of the Project's environmental performance.

The specific objectives of the ESMP are to:

- Promote Environmental and social management and communicate the aims and goals of the ESMP.
- Ensure that all workers, subcontractors, and others involved in the Project meet legal and regulatory requirements about environmental management, including financial implications.
- Incorporate environmental and social management into Project design and operating procedures.
- Serve as an action plan for environmental and social management for the project;
- Provide a framework for implementing project environmental and social commitments (i.e. mitigation measures identified in the ESIA).

The Rural Electrification Agency Project Management Unit (REA-PMU) will oversee and coordinate the implementation of the Environmental and Social Management Plan (ESMP) throughout the entire project lifecycle. Compliance with the prescribed mitigation measures during the construction phase will be the responsibility of the Engineering, Procurement, and Construction (EPC) contractor. During the operational phase, adherence to the ESMP requirements will be ensured by the Operations and Maintenance (O&M) contractor.

REA shall identify that plan, monitor, and record training needs for personnel whose work may have a significant adverse impact on the environmental or social conditions. Employees at each relevant phase of the project must be aware of the potential environmental impacts of their activities and the occupational hazards associated with the work, as well as their roles and responsibilities in achieving conformance with the management documented in this report. Training in the university community on general environmental awareness and ESMP mitigation measures about community health, safety, and security should also be provided.

The Estimated Cost of ESMP

The summary of the cost estimate required to effectively and efficiently implement the recommended mitigation measures and management plans required to address the potential and associated impacts of the proposed project. The total cost of implementing the ESMP is estimated at US**$ 86,690** million. Breakdown is provided in the table below;

ES 04: Cost of ESMP

S/N	ESMP Activities	Cost (US Dollars)
1.	Pre-construction phase	9,200
	Construction phase	19,490

	Operational phase	14,400
	Commissioning Phase	5,900
2	Cost of monitoring and mitigation	13,100
3.	Capacity building	12,500
4	Stakeholder Engagement/GRM	12,100
	TOTAL	86,690

ES07: Remediation Plan After Decommissioning/ Closure

Decommissioning refers to the dismantling and removal of project assets at the end of their operational life. The proposed Solar PV power plant is expected to have an average lifespan of about 25 years, which may be extended through proper maintenance, while the training centre may last 40 years or more. At the decommissioning stage, the Rural Electrification Agency (REA), in collaboration with FUAB, will ensure that the project site is restored to a safe and environmentally acceptable condition. Activities will include removal of PV panels, mounting structures, underground cables, inverters, transformers, batteries, and other associated infrastructure; proper handling and disposal of decommissioning waste; environmental restoration; and assessment of any residual impacts or future land-use restrictions.

Decommissioning will be guided by a formal Decommissioning, Abandonment, and Closure Plan prepared in accordance with the National Guidelines for Decommissioning of Facilities in Nigeria, 2017, and other applicable regulatory requirements. The plan will describe the project components to be decommissioned, the scope and objectives of the process, decommissioning methods, schedule, cost estimates, waste streams, disposal options, and the roles of the decommissioning team. Options such as mothballing, partial decommissioning, or complete site closure will be assessed based on environmental, technical, safety, and cost considerations. The process will also include risk assessment, hazard identification, implementation of an HSE Plan, stakeholder notification, waste management, recycling of suitable components, return of PV panels and equipment to manufacturers where feasible, transportation of spent batteries to approved recycling facilities, and post-closure environmental monitoring.

Before site abandonment, REA will develop procedures for identifying assets to be removed or abandoned, determining reuse or disposal options, mitigating environmental impacts, and rehabilitating the site through measures such as re-vegetation with native species. The abandonment process will include stakeholder notification, physical asset verification, compliance with relevant national and FMEnv regulations, procurement of site close-out permits where required, and preparation of a close-out report. Implementation responsibilities will be shared among the decommissioning contractor, REA-PMU, FUAB Site Manager, FUAB Director of Works and Physical Planning, FMEnv, and the Bayelsa State Ministry of Environment. These parties will supervise contractors, monitor compliance, approve and implement the decommissioning plan, address non-compliance, and ensure that environmental and social management measures are effectively applied throughout closure.

ES08 Stakeholder Engagement and Grievance Redress Mechanism

Consultation plays a vital role in identifying and understanding the environmental and social issues that may arise from a proposed project. Through engagement with affected communities, regulatory authorities, institutions, and other interested parties, valuable local knowledge and concerns are gathered to inform the preparation of the Environmental and Social Impact Assessment (ESIA). This participatory approach helps ensure that potential impacts are properly assessed, appropriate mitigation measures are developed, and the project is aligned with both regulatory requirements and community expectations. Meaningful consultation also enhances transparency, builds trust, and promotes informed decision-making.

The stakeholders were identified based on the direct project beneficiaries, adversely impacted groups, project supporters /proponents, regulatory/ planning,

However, the stakeholders covered are;

- Rural Electricity Agency (REA)
- Federal /State Ministry of Environment (FMEnv)
- Nembe Local Government Area
- Bassam Biri Community

Consultation was limited to Focal Group Discussions and Key Informant information. These approaches were adopted due to the demise of the Chief of the Bassam Biri Community. The study team was only allowed to speak to the Community Development Chairman (CDC) on the proposed project development. Key feedback received during Stakeholder Consultations is presented below;

Table ES05: Stakeholder Feedback on the Proposed Solar Power Plant Development

Stakeholder Group	Consultation Method	Key Contributions / Feedback	Key Concerns Raised	REA Responses
Community Development Chairman (CDC), Bassam Biri Community	Key informant consultation	Welcomed the proposed solar power project and acknowledged its potential to improve electricity supply and support development in the area. Stated that the project could create temporary employment opportunities for local youths during construction and installation.	Concerned about possible disturbance to the community during construction, including noise, dust, traffic movement, and safety risks. Also emphasized the need to respect community interests during employment	Consultation will be continuous with the CDC and community leadership. Local labour will be engaged especially during the construction phase Implement dust, noise, traffic, and safety control measures.
University Management	Key informant consultation /	Supported the project because it would	Raised concerns about funding	The project is funded by the

Stakeholder Group	Consultation Method	Key Contributions / Feedback	Key Concerns Raised	REA Responses
	institutional engagement	improve power reliability, reduce dependence on generators, and enhance teaching, research, administration, and ICT services.	and timeline for the completion of the project	AfDB and the Federal Government of Nigeria. Asked for the cooperation of the school and community for a smooth take off.
Students	Focus group discussion	Welcomed the project as it would improve lighting, internet access, reading conditions, safety, and general campus life. Students noted that reliable electricity would support studying, charging of devices, laboratory work, and online learning.	Some students also raised concerns about whether the project would benefit hostels, classrooms, libraries, and common areas equally.	It will benefit the entire school campus and beyond.

ES 09: Conclusion and Recommendations

The ESIA concludes that the proposed 2.5 MW solar-hybrid power plant at the Federal University of Agriculture, Bassambiri, is environmentally sound, socially acceptable, and economically justified. The Project will deliver significant long-term benefits in terms of energy reliability, cost savings, greenhouse gas reduction, academic advancement, and institutional capacity building.

Potential adverse impacts are limited, localized, and manageable through the implementation of the recommended mitigation measures and the Environmental and Social Management Plan. With proper environmental monitoring, regulatory compliance, and stakeholder engagement, the Project is considered sustainable and aligned with Nigeria's renewable energy transition and climate resilience objectives.

The ESIA study recommends the following:

- Ensure full implementation of the Environmental and Social Management Plan (ESMP) throughout the project lifecycle.
- Conduct regular environmental monitoring for air quality, noise, groundwater, and waste management.
- Maintain continuous stakeholder engagement and effective community communication.
- Prioritize local employment, capacity building, and renewable energy training opportunities.
- Implement strong occupational health and safety measures, including emergency response systems.

- Establish and maintain an efficient Grievance Redress Mechanism (GRM) for the timely resolution of complaints.
- Promote proper waste management, including safe disposal of hazardous and electronic waste.
- Ensure compliance with regulatory requirements through continuous oversight by the Rural Electrification Agency and relevant authorities.

ACKNOWLEDGEMENT

The Rural Electrification Agency is pleased to acknowledge with appreciation the opportunity granted it by the Federal Government of Nigeria and the Federal Ministry of Environment to conduct this Environmental and Social Impact Assessment (ESIA) study for the PV-Based Solar Captive Power Plant in the Federal University of Agriculture, Bassam Biri, Bayelsa State, Nigeria. The contributions of the Environmental Consultant – IAQEL, contracted to execute this ESIA is sincerely acknowledged and commended. We are grateful to the management of the university for supporting this assessment through the provision of relevant information, access, and human capital throughout the period of this assessment.

We also appreciate the support of all our other stakeholders, too many to mention, who actively participated in the ESIA process.

CHAPTER ONE
INTRODUCTION

1.1 Context

The Federal Government of Nigeria (FGN), through the Rural Electrification Agency (REA), is implementing the Nigeria Electrification Project (NEP) Phase II – Desert-to-Power, with financial support from the African Development Bank (AfDB). The project is designed to accelerate Nigeria's electrification drive by deploying sustainable, climate-resilient, off-grid and grid-connected solar renewable energy solutions across selected public institutions. The primary objective of the project is to harness Nigeria's vast solar energy resources to provide clean, reliable, and long-lasting electricity to Federal Universities and their affiliated Teaching Hospitals. Through improved access to a stable power supply, the initiative aims to enhance academic performance, strengthen research activities, and significantly improve healthcare service delivery, thereby contributing to national human capital development and socio-economic growth.

This ESIA has been prepared in strict accordance with the African Development Bank's Integrated Safeguards System (ISS), as well as Nigeria's Environmental Impact Assessment (EIA) Act Cap E12 LFN 2004, the Federal Ministry of Environment (FMEnv) Procedural Guidelines (2017), and the Nigerian Climate Change Act (2021). In addition, the assessments aligned with other relevant national regulations and good international practice, including the IFC Performance Standards, ISO 14001 for Environmental Management Systems, and ISO 45001 for Occupational Health and Safety Management Systems.

1.2 The Proponent

The Rural Electrification Agency (REA) is a Federal Government agency established to expand access to electricity in unserved and underserved rural and peri-urban areas of Nigeria. Operating under the supervision of the Federal Ministry of Power, the REA is mandated to promote, coordinate, and implement rural electrification initiatives using both grid extension and decentralized renewable energy solutions, with a strong emphasis on sustainability and private sector participation.

The Agency plays a central role in Nigeria's transition to clean and renewable energy by deploying off-grid and mini-grid systems, particularly solar-based solutions, to communities, public institutions, and productive users. Through flagship initiatives such as the Nigeria Electrification Project (NEP) and the Energizing Education Programme (EEP), the REA has facilitated improved electricity access for universities, teaching hospitals, markets, and rural communities, thereby supporting economic development, education, healthcare delivery, and job creation.

In carrying out its mandate, the REA works closely with development partners, state governments, private developers, and local communities. The Agency also ensures that all projects comply with national environmental and social regulations and applicable international safeguards, integrating climate resilience, environmental protection, and social inclusion into project planning and implementation. Through these efforts, the REA remains a key institution driving Nigeria's rural electrification and energy access agenda. This NEP is in collaboration with the African Development Bank (AfDB) for development and implementation.

1.3 Study Location

Federal University of Agriculture, Bassambiri is a newly established federal institution of higher education located in Bassambiri, within the Nembe Local Government Area of Bayelsa State, in the core of the Niger Delta region of southern Nigeria. The university was created by an act of the Federal Government in 2023 to expand access to tertiary education in agriculture and related disciplines and to connect teaching and research to the region's rich agricultural, marine, and environmental resources. Bassambiri lies in a riverine and estuarine landscape characteristic of Bayelsa State, offering strategic proximity to key towns such as Nembe and the state capital, Yenagoa, and broader links to urban centres including Port Harcourt and Warri. The location embeds the university within an environment where agricultural innovation, sustainable resource management, and community engagement are central to both learning and practical application. Academic activities are planned to commence with a strong focus on hands-on and research-driven programmes that align with national goals for agricultural development and regional economic growth (See Figure 1.1).

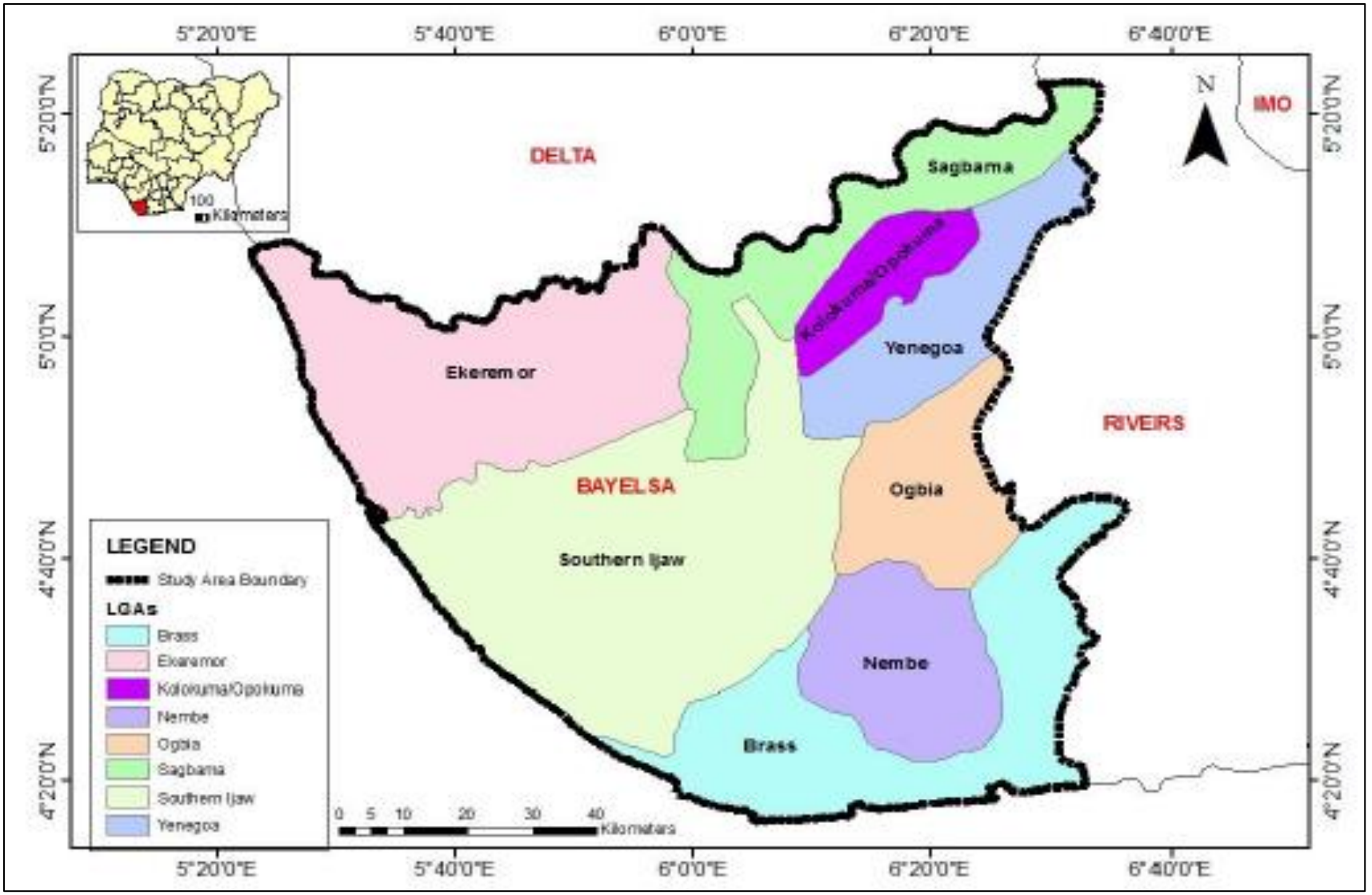

Figure 1.1: Map of Bayelsa State Showing Nembe LGA

1.4 Objectives of the ESIA

The overall objectives of an ESIA are: 1) to avoid or minimize adverse environmental and social effects before they occur; 2) to integrate environmental and social concerns into decision-making.
The specific objectives of this ESIA are to:

- Establish the existing state of the environment and identify sensitive components of the existing environment within the project area and Area of Potential Project Influence (APPI);
- Identify sensitive components of the existing environment within the project area and its environs;
- Assess the scope of the proposed programme, and the likely impacts associated with the same;
- Appraise the project activities and determine any potential negative and positive impacts on the environment;
- Identify existing and expected environmental regulations that will affect the development and advise on standards, consents and targets.
- Contribute to optimization of the project design and planning by identifying those aspects of the construction location and operations, which may cause adverse environmental, social, health and economic effects;
- Identify, where required, the need for development and implementation of a Resettlement Action Plan (RAP) / Livelihood Restoration Plan (LRP).
- Recommend measures during construction, commissioning and operations to avoid and ameliorate these effects and increase beneficial impacts;
- Recommend an environmental management program for the project life cycle, including compliance, monitoring, auditing, and contingency planning; and
- Provide the basis for co-operation and consultation with regulatory and non-regulatory authorities and the public.

This assessment is an important part of the decision-making process to ensure that environmental and social risks have been anticipated, avoided, mitigate, and eventually compensated.

1.5 Scope of the ESIA Study

In line with the Terms of Reference (TOR), the scope of the ESIA study covers the following:

- Description of all actions/activities that will be carried out in the course of the Project development and implementation.
- Review of applicable local and international laws, regulations, standards and industry codes that apply to the proposed Project.
- Desktop review of relevant documents pertaining to the Project and the environment where the Project would be located. These documents include the Nigerian Electrification Project (NEP) environmental and social management framework (ESMF), amongst others.
- Perimeter survey of the Project site, including development of survey maps.
- Field data gathering covering biophysical and socio-economic components of the Project's Area of Influence.

- Consultations with relevant stakeholders including government institutions, project affected persons, University management representatives,
- Laboratory analysis of field samples and data analysis
- Impacts identification and evaluation, and development of appropriate and practicable mitigation measures and EMP.
- Report preparation and disclosure.

1.6. Study Approach/ Methodology

The ESIA methodology adopted a systematic and participatory approach, beginning with a reconnaissance survey to gain an understanding of site-specific conditions and potential environmental and social issues. This was complemented by a comprehensive desktop review of relevant project and programme documents to establish the regulatory, institutional, and technical context for the proposed intervention. A scoping study was conducted in consultation with the beneficiary university authorities and representatives of the host community to capture stakeholder perceptions of the project and to identify key environmental and social concerns. This engagement informed the focus of subsequent studies and ensured that locally relevant issues were adequately addressed. Field data collection was carried out to establish baseline environmental and social conditions at the proposed project sites. This included primary and secondary data gathering on noise levels, air quality, water quality, soil characteristics, ecology, and biodiversity. Samples obtained during field surveys were subjected to laboratory analysis to provide quantitative evidence for baseline conditions and impact prediction.

Based on the baseline data and stakeholder inputs, potential environmental and social risks and impacts associated with the project were identified and assessed. Appropriate mitigation and enhancement measures were then developed to address identified risks. These measures were consolidated into an Environmental and Social Management Plan (ESMP), which outlines specific actions, implementation timelines, and institutional responsibilities for managing impacts throughout the project lifecycle.

The ESIA process concluded with the compilation of the assessment report and the execution of required regulatory procedures, including disclosure of the ESIA report in line with national regulations and international best practice. The Federal Ministry of Environment (FMEnv) developed guidelines to be used by project proponents in conducting EIA, in compliance with the EIA Act. Accordingly, the ESIA process follows the steps sequentially as outlined in the procedural guideline indicated in Figure 1.2.

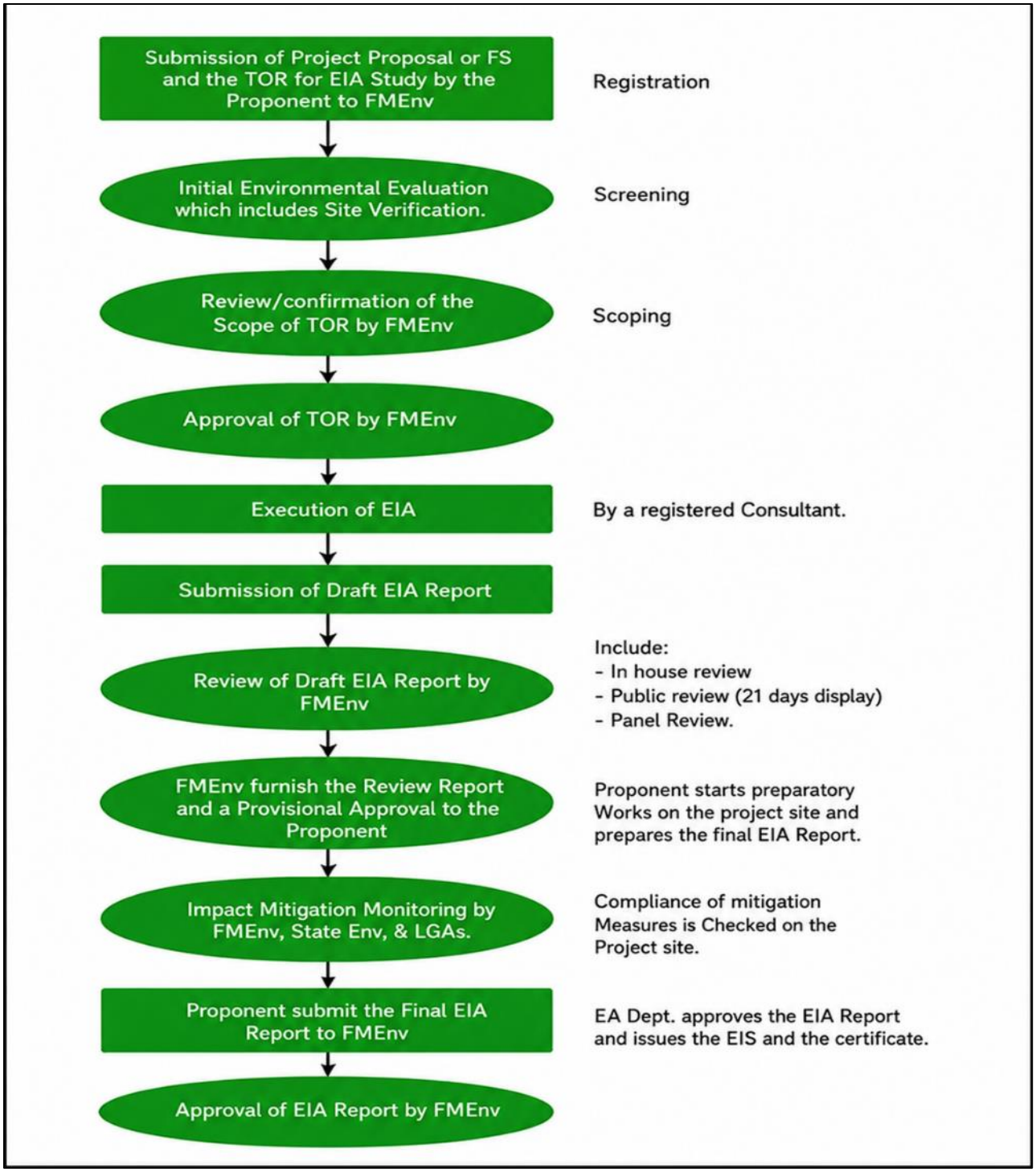

Figure 1.2: Federal Ministry of Environment Environmental Impact Assessment Process
(Source: Environmental assessment department, Federal Ministry of Environment)

1.7 Policy, Legal and Administrative Framework

The proposed Project is part of the Federal Government of Nigeria's Energizing Education Programme, a component of the Nigeria Electrification Project being implemented by the Rural Electrification Agency. Several laws and regulations apply to the energy sector in Nigeria. In addition to the above, several laws, regulations, policies, and instruments have been established to support environmental and social management and the EIA process in Nigeria. This section provides an overview of the relevant statutory regulations, legislation, and guidelines for the proposed Project and the ESIA study. The project shall ensure compliance with the relevant and applicable local and international regulations, policies, and standards throughout its life cycle.

1.7.1 FGN Requirements and Relevant Legislation

The Constitution of the Federal Republic of Nigeria (1999), as the national legal order, recognizes the importance of improving and protecting the environment and makes provision for it. The relevant sections are:

- **Section 20** makes it an objective of the Nigerian State to improve and protect the air, land, water, forest, and wildlife of Nigeria.
- **Section 12** establishes, though impliedly, that international treaties (including environmental treaties) ratified by the National Assembly should be implemented as law in Nigeria; and
- **Sections 33 and 34,** which guarantee fundamental human rights to life and human dignity, respectively, have also been argued to be linked to the need for a healthy and safe environment to give these rights effect.

1.7.2 Policy, Legal, and Institutional Framework

The Policy, Legal, and Institutional Framework guiding the Environmental and Social Impact Assessment (ESIA) for the proposed project at the Federal University of Agriculture, Basaam-Biri is anchored on applicable national policies, laws, and institutional arrangements, as well as relevant international standards. At the national level, the framework is defined by the Federal Ministry of Environment (FMEnv) regulations, including the Environmental Impact Assessment Act Cap E12 LFN 2004, FMEnv Procedural Guidelines (2017), and other sectoral environmental, social, health, and safety regulations. The assessment also aligns with the objectives of the Nigeria Electrification Project and the Rural Electrification Agency's implementation framework. At the international level, the ESIA is guided by the African Development Bank Integrated Safeguards System, alongside international good practice such as the IFC Performance Standards and relevant ISO standards, ensuring that the project complies with both national regulatory requirements and global environmental and social sustainability benchmarks.

1.7.3. Policy Framework

1.7.3.1. National Environmental Policy/ National Policy on the Environment (Revised 2016) The national environmental policy launched by Government in November 1989 revised in 2016, prescribed guidelines for achieving sustainable development in fourteen vital sectors of the nation's economy, namely: Human Population; Land Use and Soil Conservation; Water Resources Management; Forestry, Wildlife and Protected Natural Areas; Marine and Coastal Area Resources; Sanitation and Waste Management; Toxic and Hazardous Substances; Mining and Mineral Resources; Agricultural Chemicals; Energy Production;

Air Pollution; Noise in the Working Environment; Settlements; Recreational Spaces, Green Belts, Monuments, and Cultural Property.

It also contains Nigeria's commitment to ensure that the country's natural and built environment is safeguarded for the use of present and future generations. This commitment demands that efficient resource management and minimization of environmental impacts be the core requirements of all development activities. Accordingly, this Policy seeks to promote good environmental practices through environmental awareness and education. The goal of the National Policy on the Environment is to 'ensure environmental protection and the conservation of natural resources for sustainable development'. Its strategic objective is to coordinate environmental protection and natural resources conservation for sustainable development.

1.7.3.2 Social Protection Policies

Social protection policy has been on the agenda since 2004, when the National Planning Commission, supported by the international community, drafted a social protection strategy. More recently, the National Social Insurance Trust Fund (NSITF) drafted a social security strategy. The social protection policy approached social protection using a life cycle and gender lens, recognizing both economic and social risks, including, for example, job discrimination and harmful traditional practices. The policy was organised around four main themes: social assistance, social insurance, child protection and the labour market.

However, only a few of the instruments of this approach were adopted in the national implementation plan, most notably the provision of specific and limited social assistance, social insurance (such as expanding national health insurance to the informal sector) and labour market programmes (such as developing labour-intensive programmes). Moreover, in practice, programmes to date have been focused largely on conditional cash transfers and two health financing mechanisms driven by the federal government with little inter-sectoral or state-federal coordination. A significant number of actors are involved in funding and implementing social protection, including those from government, donors, international non-governmental organisations and civil society. Federal government-led social protection includes three main programmes:

- the conditional cash transfer in Care of the People (COPE) (funded initially through the debt relief gains (DRG fund) targeted at households with specific social categories (those with children of school-going age that are female-headed or contain members who are elderly, physically challenged, or are fistula or HIV/ AIDS patients).
- the health fee waiver for pregnant women and children under five (financed through the debt relief gains (DRG fund); and
- the community-based health insurance scheme, which was redesigned in 2011 because the previous scheme had design challenges.

Other social assistance programmes are implemented in an ad hoc manner by various government ministries, departments and agencies at state level, and some are funded by international donors. These include conditional cash transfer programmes for girls' education (in three states), child savings accounts, disability grants, health waivers, education support (such as free uniforms) and nutrition support. HIV and AIDS programming at state level also include social protection sub-components (although not as the primary objective), including nutrition, health and education support. Labour market programmes include

Federal and State level youth skills and employment programmes, and Nigeria also has agricultural subsidies/inputs.

1.7.3.3 National Policy on Climate Change/ National Climate Change Policy for Nigeria 2021-2030

Given Nigeria's status as a fossil-fuel dependent economy with a large climate sensitive agricultural sector, the development of a climate change policy and response strategy is critical, as climate change presents a serious threat to poverty eradication and sustainable development in general. One of the key pillars of Vision 20:2020 is investment in low-carbon fuels and renewable energy. Achieving the goal of a low-carbon, high-growth and resilient socio-economic system for equitable and sustainable socio-economic and environmental development faces some challenges, which include stability and sustainability of the enabling environment, adequate institutional and human resource capacity and availability of adequate resources to address mitigation and adaptation initiatives to address climate change. Thus, the Government needs to ensure that economic growth, resource management and climate change mitigation and adaptation can all happen simultaneously if this is to be done effectively (Department of Climate Change 2017).

The National Climate Change Policy for Nigeria 2021-2030 was established to promote a low-carbon, climate-resilient, and gender-responsive sustainable socio-economic development. The revised National Policy on Climate Change was to define a new holistic framework to guide the country's response to the development challenge of climate change.

1.7.3.4 The National Electric Power Policy (NEPP), 2001

In order to ensure a safe, steady, reliable and progressively improved electric power sector in Nigeria, the Electric Power Reform Implementation Committee (EPIC) was inaugurated by the BPE and resulted in Federal Executive Council (FEC) of Nigeria approving the National Electric Power Policy in September 2001, which recommended, amongst others: establishment of the electric power sector regulator and the privatisation of the electric power sector. The National Electric Power Policy (NEPP), 2001 outlines the realization of an adequate and reliable supply of electricity in three phases - the privatization of the state-own utility NEPA and the introduction of the Independent Power Producers (IPPs); increasing the competition between market participants, partial removal of subsidies, and sale of excess power to distribution companies (DISCOs); and the freedom to select suppliers by large consumers and the creation of a fully liberalized and competitive market.

In 2004, the National Integrated Power Project (NIPP) was initiated to boost power supply by the launch of gas-powered stations. The National Electric Power Policy (NEPP) of 2001 resulted in the Electric Power Sector Reform (EPSRA) Act of 2005, establishing the Nigerian Electricity Regulatory Commission (NERC). The EPSRA provided the statutory basis for the privatisation of the power sector.

1.7.3.5 The National Energy Policy (NEP) 2013

The National Energy Policy (NEP) 2013 is a revised version of the NEP 2003, which emphasizes the effective and efficient use of energy and proposes major areas to be considered for energy efficiency and conservation including, amongst others, transportation, services/commercial sector, and energy-efficient building designs.

1.7.3.6 The National Energy Efficiency Action Plans of Nigeria

The first version of the National Energy Efficiency Action Plans (NEEAP) for Nigeria (2015 2030) was approved on July 14, 2016, by the National Council on Power (NACOP). It has been formulated within the framework of United Nations' Sustainable Energy for All (SE4All) and adopted by the Inter-Ministerial Committee on Renewable Energy and Energy Efficiency (ICREEE). The NEEAP includes baseline data and information on energy efficiency activities and programmes in Nigeria, barriers to the development and promotion of energy efficiency in the country and suggested achievable energy efficiency targets, including gender disaggregated indicators, based on national potentials and socio-economic assessments. The implementation of the NEEAP is being monitored by the Federal Ministry of Power.

1.7.4 National Legal Framework

1.7.4.1 The Environmental Impact Assessment Act No. 86, 1992/Environmental Impact Assessment Act Cap E12 LFN 2004

The EIA Act makes it mandatory for any person, authority, corporate body private or public, to conduct EIA before the commencement of any new major development or expansion that may likely have significant effects on the environment. The Act sets out the EIA objectives and the procedures for consideration of EIA of certain public or private projects.

The programme is a minor development, which is expected to have minimum impact on the environment. Hence, the programme is categorized as Category II EIA. The EIA guidelines (procedural and sectoral) issued by the FMEnv derive from this Act and the programme proponents shall conduct their activities in conformance with these guidelines.

1.7.4.2 Electric Power Sector Reform Act 2005

The Electric Power Sector Reform Act No. 6 of 2005 provides for the licensing and the regulation of the generation, transmission, distribution and supply of electricity. Part IV of the Act contains requirements for licensing and stipulates that no person may construct, own or undertake any of the following activities without a license, unless the generating capacity and distribution capacity is below 1 MW and 100 kilowatts (KW), respectively for electricity generation, excluding captive generation, electricity transmission, system operation, electricity distribution and trading in electricity.

1.7.4.3 Energy Commission of Nigeria Act CAP 109 LFN 1990

The Act was promulgated to create the Energy Commission of Nigeria (ECN) with responsibility for coordinating and general surveillance over the systematic development of the various energy resources of Nigeria. Subject to this Act, the ECN is charged with responsibility for the strategic planning and co-ordination of national policies in the field of energy in all its ramifications. The mandates of ECN include statistical analysis of Electricity Generation, Transmission and Distribution.

1.7.4.4 Land Use Act of 1978 and Resettlement Procedures

The Land Use Act (Cap 202, 1990), now Cap L5 Laws of the Federation of Nigeria 2004, is the key legislation that has direct relevance to this project. Relevant sections of these laws that may relate to this project with respect to land ownership and property rights, resettlement, and compensation are summarized in this section.

The Land Use Act is the applicable law regarding ownership, transfer, acquisition and all such dealings on Land. The provisions of the Act vast on every parcel of Land, in every State of the Federation, in the Executive Governor of the State. He holds such parcels of land in trust for the people and government of the State. The Act categorized the land in a State to urban and non-urban or local areas. The administration of the urban land is vested in the Governor, while the latter is vested in the Local Government Councils. At any rate, all land irrespective of the category belongs to the State while individuals only enjoy a right of occupancy as contained in the Certificate of Occupancy, or where the grants are "deemed".

The concept of ownership of land as known in the western context is varied by the Act. The Governor administers the land for the common good and the benefit of all Nigerians. The law makes it lawful for the Governor to grant statutory rights of occupancy for all purposes, grant easements appurtenant to statutory rights of occupancy and to demand rent. The Statutory Rights of Occupancy are for a definite time (the limit is 99 years) and may be granted subject to the terms of any contract made between the state Governor and the Holder.

The Local Government Councils may grant customary rights of Occupancy for agriculture (including grazing and ancillary activities), residential, and other purposes. But the limit of such grants is 500 hectares for agricultural purposes and 5,000 for grazing, except with the consent of the Governor. The local Government, under the Act, is allowed to enter, use, and occupy for public purposes any land within its jurisdiction that does not fall within an area compulsorily acquired by the Government of the Federation or of the relevant State, or subject to any laws relating to minerals or mineral oils.

The State is required to establish an administrative system for the revocation of the rights of occupancy and payment of compensation for the affected parties. So, the Land Use Act provides for the establishment of a Land Use and Allocation Committee in each State that determines disputes as to compensation payable for improvements on the land (Section 2 (2) (c)).

In addition, each Local Government is required to set up a Land Allocation Advisory Committee to advise the Local Government on matters related to the management of land. The holder or occupier of such revoked land is entitled to the value of the unexhausted development as at the date of revocation. (Section 6) (5). Where land subject to customary rights of Occupancy and used for agricultural purposes is revoked under the Land Use Act, the local government can allocate alternative land for the same purposes (section 6) (6).

If Local Government refuses or neglects within a reasonable time to pay compensation to a holder or occupier, the Governor may proceed to effect assessment under section 29 and direct the Local Government to pay the amount of compensation to the holder or occupier. (Section 6) (7).

Where a right of occupancy is revoked on the ground that the land is required by the Local, State or Federal Government for public purposes or for the extraction of building materials, the holder and the occupier shall be entitled to compensation for the value at the date of revocation of their unexhausted improvements. Unexhausted improvement has been defined by the Act as:

> *"anything of any quality permanently attached to the land directly resulting from the expenditure of capital or labour by any occupier or any person acting on his behalf, and increasing the productive capacity the utility or the amenity thereof and includes buildings*

plantations of long-lived crops or trees, fencing walls, roads and irrigation or reclamation works, but does not include the result of ordinary cultivation other than growing produce."

Developed Land is also defined in the generous manner under Section 50(1) as follows: land where there exists any physical improvement in road development services, water, electricity, drainage, building, structure or such improvements that may enhance the value of the land for industrial, agricultural or residential purposes.

It follows from the foregoing that compensation is not payable on vacant land on which there exist no physical improvements resulting from the expenditure on capital or labour. The compensation payable is the estimated value of the unexhausted improvements at the date of revocation.

Payment of such compensation to the holder and the occupier as suggested by the Act may appear confusing, as it raises the following question: Does it refer to the holder in physical occupation of the land or two different parties entitled to compensation, perhaps in equal shares? The correct view appears to follow from the general tenor of the Act.

First, the presumption is more likely to be the owner of such unexhausted improvements. Secondly, the provision of section 6 (5) of the Act, which makes compensation payable to the holder and the occupier according to their respective interests, gives a pre-emptory directive as to who shall be entitled to what.

Again, the Act provides in section 30 that where any dispute arises as to the amount of compensation calculated in accordance with the provisions of section 29, such disputes shall be referred to by the appropriate Land Use and Allocation Committee. It is clear from section 47 (2) of the Act that no further appeal will arise from the decision of such a committee. If this is so, then the provision is not only retrospective but also conflicts with the fundamental principle of natural justice, which requires that a person should not be a judge in his own cause.

The Act must, in making this provision, have proceeded on the basis that the committee is a distinct body quite different from the Governor or the Local Government. It is submitted, however, that it will be difficult to persuade the public that this is so since the members of the committee are all appointees of the Governor.

Where a right of occupancy is revoked for public purposes within the state of the Federation, or on the grounds of the land for the extraction of building materials, the quantum of compensation shall be as follows:

- *In respect of the land, an amount equal to the rent, if any, paid by the occupier during the year in which the right of occupancy was revoked.*
- *In respect of the building, installation or improvements therein, for the amount of the replacement cost of the building, installation or improvements to be assessed based on the prescribed method of assessment as determined by the appropriate officer, less any depreciation, together with interest at the bank rate for delayed payment of compensation. With regards to reclamation works, the quantum of compensation is such cost as may be substantiated by documentary evidence and proof to the satisfaction of the appropriate officer.*
- *In respect of crops on land, the quantum of compensation is an amount equal to the value as prescribed and determined by the appropriate officer.*

Where the right of occupancy revoked is in respect of a part of a larger portion of land, compensation shall be computed in respect of the whole land for an amount equal in rent, if any, paid by the occupier during the year in which the right of occupancy was revoked less a proportionate amount calculated in relation to the area not affected by the revocation; and any interest payable shall be assessed and computed in the like manner.

Where there are any building installation or improvement or crops on the portion revoked, the quantum of compensation shall follow that outlined in paragraph (ii) above, and any interest payable shall be computed in like manner.

1.7.4.5 The Nigerian Urban and Regional Planning Act CAP N138, LFN 2004

The Urban and Regional Planning Act is aimed at overseeing realistic, purposeful planning of the country to avoid overcrowding and poor environmental conditions. In this regard, the following sections are relevant:

- **Section 30 (3)** requires a building plan to be drawn by a registered architect or town planner.
- **Section 39 (7)** establishes that an application for land development would be rejected if such development would harm the environment or constitute a nuisance to the community.
- **Section 59** makes it an offence to disobey a stop-work order. The punishment under this section is a fine not exceeding ₦10,000 (Ten thousand naira) and in the case of a company, a fine not exceeding ₦50,000.
- **Section 72** provides for the preservation and planting of trees for environmental conservation.

1.7.4.6 Harmful Waste (Special Criminal Provisions) ACT CAP H1, LFN 2004

The Harmful Waste Act prohibits, without lawful authority, the carrying, dumping or depositing of harmful waste in the air, land or waters of Nigeria. The following sections are notable:

- **Section 6** provides for a punishment of life imprisonment for offenders as well as the forfeiture of land or anything used to commit the offence.
- **Section 7** makes provision for the punishment accordingly of any conniving, consenting or negligent officer where the offence is committed by a company.
- **Section 12** defines the civil liability of any offender. He would be liable to people who have suffered injury as a result of his offending act.

1.7.4.7 The Endangered Species Act, CAP E9, LFN 2004

This Act focuses on the protection and management of Nigeria's wildlife and some of their species in danger of extinction because of overexploitation. These sections are noteworthy:

- **Section 1** prohibits, except under a valid license, hunting, capture or trade in animal species, either presently or likely, in danger of extinction.

- **Section 5** defines the liability of any offender under this Act.
- **Section 7** provides for regulations to be made necessary for environmental prevention and control as regards the purposes of this Act.

Most of the proposed program locations are on virgin land that serves as wildlife habitats, which will be impacted by the programme. Hence, the programme activities shall be carried out to comply with the relevant provisions.

1.7.4.8 Inland Fisheries Act, Cap I10, LFN 2004

The Inland Fisheries focused on the protection of the water habitat and its species. The following section is relevant:

Section 6 prohibits the taking or destruction of fish by harmful means. This offence is punishable with a fine of ₦3,000 or an imprisonment term of 2 years, or both. One of the integral components of solar hybrid systems is battery storage. During the operational phase of the project, there may be the possibility of battery leakages, which may leach into water bodies for project locations with flowing rivers. The chemical contents of these batteries are toxic to aquatic life (fisheries), which necessitates the relevance of this Act.

1.7.4.9 Cap. N19, Laws of the Federation of Nigeria (LFN) 2004.

The Act provides for the dissolution of both the Antiquities Commission and the Federal Department of Antiquities and to create a National Commission for Museums and Monuments, with the responsibilities to establish and administer national museums, antiquities and monuments, including, antiquities, science and technology, warfare, African, Black and other antiquities, arts and crafts, architecture, natural history and educational services among others. Sections 12 to 18 provide the process/steps for the declaration of antiquities as national monuments, while section 19 deals with the restriction of excavations for the purpose of finding antiquities as well as the issuance of permits and section 20 deals with accidental discoveries. In case of any accidental finding, the Commission shall be notified within seven (7) days.

1.7.4.10 Factories Act, Cap. F1, (LFN) 2004

The Factories Act, Cap. F1, Laws of the Federation of Nigeria 2004 provides for the registration of factories and establishes requirements for the health, safety and welfare of workers and other persons who may be exposed to occupational hazards. Relevant provisions address cleanliness, ventilation, overcrowding, safe access, machinery guarding, lifting equipment, electrical safety, fire precautions, provision and use of personal protective equipment, accident notification and inspection by the competent authority.

The construction, installation, commissioning, operation, maintenance and decommissioning activities under the Project shall comply with all applicable provisions of the Act. The EPC Contractor and O&M Contractor shall implement safe systems of work; maintain plant, tools and machinery in safe condition; provide suitable personal protective equipment; train and supervise workers; maintain emergency and fire-prevention arrangements; and report occupational accidents and dangerous occurrences to the appropriate authority and REA in accordance with applicable legal and contractual requirements.

1.7.4.11 Labour Act, Cap. L1, (LFN) 2004

The objective of the Labour Act, Cap. L1, Laws of the Federation of Nigeria 2004 is to regulate the relationship between employers and workers in Nigeria. The Act provides the legal framework for employment contracts, payment of wages, conditions of service, recruitment, apprenticeship, and the general protection of workers. Another major objective of the Act is to protect workers from unfair labour practices. It ensures that wages are paid in legal tender, prevents unlawful deductions from workers' wages, and regulates the manner in which employers may terminate employment. This helps to promote fairness and accountability in the workplace. The Act also aims to improve working conditions by setting minimum standards for employment. It covers issues such as rest periods, leave, maternity protection, employment of young persons, and other conditions affecting the welfare of workers.

1.7.4.12. National Minimum Wage (Amendment) Act 2024

The National Minimum Wage Act 2019, as amended in 2024, establishes the minimum wage payable to workers in Nigeria. The 2024 amendment increased the national minimum wage to ₦70,000 per month and provides for periodic statutory review. REA shall require the EPC Contractor, O&M Contractor and all subcontractors to pay Project workers not less than the prevailing statutory minimum wage, subject only to lawful exemptions, and to maintain auditable employment contracts, payroll records and evidence of wage payment. Any subsequent statutory revision that becomes effective during Project implementation shall apply from its legally prescribed effective date.

1.7.4.13. Employees' Compensation Act, 2010

The Employees' Compensation Act 2010 establishes a no-fault compensation scheme for employees who suffer occupational injury, disease, disability or death arising out of or in the course of employment. The Act repealed the former Workmen's Compensation Act and established the Employees' Compensation Fund administered by the Nigeria Social Insurance Trust Fund. REA shall require the EPC Contractor, O&M Contractor and all subcontractors to register and make the applicable contributions, promptly notify and document occupational accidents and diseases, support affected workers or dependents in processing valid claims, and maintain measures for occupational injury prevention and return to work.

1.7.4.14 National Environmental Standards & Regulations Enforcement Agency (NESREA) Act, 2007

Administered by the Ministry of Environment, the National Environment Standards and Regulations Enforcement Agency (NESREA) Act of 2007, replaced the Federal Environmental Protection Agency (FEPA) Act. It is the embodiment of laws and regulations focused on the protection and sustainable development of the environment and its natural resources. The following sections are worth noting:

- **Section 7** provides authority to ensure compliance with environmental laws, local and international, on environmental sanitation and pollution prevention and control through monitoring and regulatory measures.
- **Section 8 (1)(K)** empowers the Agency to make and review regulations on air and water quality, effluent limitations, control of harmful substances, and other forms of environmental pollution and sanitation.

- **Section 27** prohibits, without lawful authority, the discharge of hazardous substances into the environment. This offence is punishable under this section, with a fine not exceeding 1,000,000 (One Million Naira) and an imprisonment term of 5 years. In the case of a company, there is an additional fine of ₦50,000 for every day the offence persists.

1.7.4.15 National Environmental Regulations:

Section 34 of the NESREA Act, 2007 empowers the Minister of Environment to make regulations for safe and sustainable environment. In exercise of this power, the minister issued the national environmental regulations covering various environmental components and sectors of development. The regulations relevant to the programme are as follows:

- National Environmental (Battery Control) Regulations, 2024. Official Gazette No. 52, Vol. 111, Government Notice No. 32. Abuja, Nigeria.
- National Environmental (Energy Sector) Regulations, 2014. S.I. 63.
- National Environmental (Electrical/Electronic Sector) Regulations, S. I. No 79, 2022.
- National Environmental (Wetlands, Riverbanks and Lake Shores) Regulations, 2009. S. I. No. 26.
- National Environmental (Sanitation and Wastes Control) Regulations, 2009. S. I. No. 28.
- National Environmental (Watershed, Mountainous, Hilly and Catchment Areas) Regulations, 2009. S. I. No. 27.
- National Environmental (Sanitation and Wastes Control) Regulations, 2009. S. I. No. 28.
- National Environmental (Noise Standards and Control) Regulations, 2009. S. I. No. 35.
- National Environmental (Air Quality Control) Regulations, 2013, S. I. No. 64,
- National Environmental (Soil Erosion and Flood Control) Regulations, 2010. S. I. No. 12.
- National Environmental (Surface and Groundwater Quality Control) Regulations, 2010. S. I. No. 22.
- National Environmental (Control of Vehicular Emissions from Petrol and Diesel Engines) Regulations, 2010. S. I. No. 20.

1.7.4.16. EIA Procedural Guidelines:

This procedure prescribes the steps to be followed in the EIA process from project conception to commissioning and post-commissioning impact mitigation, to ensure that the program is implemented with maximum consideration of environmental factors. This ESIA study will be conducted in compliance with this guideline.

1.7.4.17 EIA Sectorial Guidelines (Infrastructures):

This provides general guidelines for EIA of projects in the infrastructure sectors of Nigeria, with specific details for sub-sectors.

1.7.4.18. FMEnv ESMP Guidelines for Solar Mini-Grid Projects in Nigeria

The ESMP Guidelines for Solar Mini-Grid Projects in Nigeria was developed as an abridged form of the EIA Procedures Guidelines with the aim of simplifying the method of preparing ESMPs for proposed solar

mini-grid projects. The simplified method is to also optimise the mini-grid projects EIA timeline and the cost of development.

1.7.5 International Legislation

The International Conventions, to which Nigeria is a signatory, relevant to this programme are as follows:

- International Covenant on Civil and Political Rights, 1966.
- International Covenant on Economic, Social and Cultural Rights, 1966.
- Convention on International Trade in Endangered Species of Wild Fauna and Flora, 1973.
- Convention on the Conservation of Migratory Species of Wild Animals, 1979.
- Convention on the Elimination of All Forms of Discrimination against Women, 1979.
- Convention on the Rights of the Child, 1989.
- Convention on Biological Diversity, 1992.
- United Nations Framework Convention on Climate Change, 1992.
- Declaration on the Elimination of Violence against Women, 1993.
- United Nations Convention to Combat Desertification, 1994.
- African Convention on the Conservation of Nature and Natural Resources (Revised/Maputo Convention), 2003.
- Protocol to the African Charter on Human and Peoples' Rights on the Rights of Women in Africa (Maputo Protocol), 2003

1.7.6 Institutional Framework

This section highlights the relevant institutions through which the planning and implementation of the program will be affected. Several institutions have been identified and will be involved in the overall implementation of this programme. These include:

- The Federal Government of Nigeria (FGN)
- Federal Ministry of Power
- Transmission Company of Nigeria (TCN)
- Federal Ministry of Environment (FMEnv)
- Nigerian Electricity Regulatory Commission (NERC)
- National Environmental Standards and Regulatory Enforcement Agency (NESREA)
- National University Commission (NUC)

- Relevant State Agencies: State Ministry of Lands, State Ministry of Environment and State Environmental Protection Agencies
- Local Government Authority (LGA)

The responsibilities and roles of each of the institutions are discussed below.

1.7.6.1 The Federal Government of Nigeria

Section 20 of the Constitution of Nigeria makes it an objective of the Nigerian State to improve and protect the air, land, water, forest and wildlife of Nigeria. Sections 33 and 34 which guarantee fundamental human rights to life and human dignity, respectively, can also be linked to the need for a healthy and safe environment to give these rights effect. The Executive Council of the Federation approves all national policies including the National Policy on Environment.

1.7.6.2 Federal Ministry of Environment

The Federal Ministry of Environment is responsible for the overall environmental policy of the country. It has the responsibility for EIA implementation, approval and issuance of certificates. It has developed certain guidelines and regulations to protect the environment and promote sustainable development. It will monitor the implementation of mitigation measures when the project commences. They can also issue directives to the project on specific actions related to the environment in the project area. The Ministry normally involves the states and sometimes local governments in this responsibility depending on the specific activity.

1.7.6.3 The National Environment Standards and Regulations Enforcement Agency (NESREA)

To ensure the embodiment of laws and regulations focused on the protection and sustainable development of the environment and its natural resources are monitored and complied with. NESREA ensures that the operational phase of the solar power system Mini grid project complies with national environmental standards and regulations.

1.7.6.4 The National Universities Commission

The National Universities Commission (the Commission) was established in 1974 by the National Universities Commission Act CAP N81 to advise the Federal and state governments of all aspects of university education and the general development of universities in Nigeria. It is the dynamic regulatory agency acting as a catalyst for positive change and innovation for the delivery of quality university education in Nigeria. It is also the agency for channeling all external aid to the universities in Nigeria; To receive block grants from the Federal Government and allocate them as appropriate

1.7.6.5 The Federal Ministry of Power

The Federal Ministry of Power is the policy-making arm of the Federal Government with the responsibility for the provision of power in the country. The Ministry is guided by the provisions of the Electricity Act No 28 of 1988, the National Electric Power Policy, 2001, the Electric Power Sector Reform Act, 2005, the Roadmap for Power Sector Reform, 2010, and the National Energy Policy, 2013 as described earlier in section 1.6.4. The following parastatals are under the ministry: Energy Commission of Nigeria (ECN)

Nigerian Electricity Regulatory Commission (NERC) Power Holding Company of Nigeria (PHCN) Rural Electrification Agency (REA). The responsibilities of the Federal Ministry of Power are as follows:

- Initiating and formulating broad policies and programmes on the development of the power sector Initiating concessions in the power sector Licensing of electrical contractors and electric generating sets of 1MW capacity and below
- Conducting investigation on electrical accidents and to ensure safety in the electricity industry in Nigeria
- Conducting statutory tests and certification of electric poles (concrete, wooden, steel etc.) and other major electrical materials before they are used on the grid and networks in Nigeria
- Implementing renewable energy programmes/ initiatives (solar, wind, biomass, small hydro etc.) Coordinating activities of the power sector
- Handling policy matters relating to research and development in the power sector
- Promoting the development of hydro power plants through public-private partnership (PPP), participating in bilateral and multilateral relations affecting the power sector
- Facilitating the overall coordination of the activities of the parastatals under their supervision

1.7.6.6 Nigerian Electricity Regulatory Commission (NERC)

The Nigerian Electricity Regulatory Commission (NERC) is an independent regulatory agency. NERC was established in 2005 as part of the economic reform agenda of the Obasanjo administration. The Electric Power Sector Reform Act of 2005 was the legislation that led to the establishment of NERC.
The Commission is required to carry out the following, amongst others:

i. Monitor and regulate the activities of the electricity industry in Nigeria.

ii. Issue licenses to market participants; and

iii. Ensure compliance with market rules and operating guidelines.

In order to create an enabling investment climate for rural electrification projects, NERC established the Mini-Grid Regulation in 2016; regulatory guidelines for mini-grids less than 100 kW and a light-handed regulation for mini-grids between 100 kW und 1 MW.

1.7.6.7 Transmission Company of Nigeria (TCN)

TCN emerged from the defunct National Electric Power Authority (NEPA) as a product of the merger of the Transmission and Operations sectors on April 1, 2004. TCN was incorporated in November 2005. Being one of the 18 unbundled Business Units under the Power Holding Company of Nigeria (PHCN), TCN was issued a transmission License on 1st July 2006. It was subsequently issued two licenses on June 10, 2013, for electricity transmission and system operations.

1.7.6.8 Rural Electrification Agency

The Rural Electrification Agency was set up by Section 88 of the Electric Power Sector Reform Act 2005 as the Implementing Agency of the FGN tasked with the electrification of rural and unserved communities. The mission is to provide access to a reliable electric power supply for rural dwellers irrespective of where they live and what they do, in a way that would allow for a reasonable return on investment through an appropriate tariff that is economically responsive and supportive of the average rural customer.

1.7.6.9 Federal Ministry of Women Affairs and Social Development

Promote actions to achieve the National Gender Policies and a gender budget among policymakers. The goals of the gender policy, among others, include:

- Eliminate cultural/religious gender-based biases and harmful cultural and religious practices which rise to inequalities in gender-role relations in Nigerian society. A culture that is amenable to development must be dynamic.
- Tap the potential of women for development.
- Eliminate all forms of gender-based violence.
- Ensure equal access to women, boys and girls to both formal and informal education. Women's education is a priority because it is the key to gender equity, justice, and poverty reduction, improved skills and technological knowledge, as well as the general socioeconomic development of the nation.

1.7.6.10 State Institutions

Bayelsa State Ministry of Environment

The Ministry of Environment is currently responsible for environmental service matters and resources in the state. Other objectives include initiating formulation, execution, and monitoring of all issues relating to all environmental matters, solid waste management, and mineral resources. A recent law passed established the Bayelsa State Environmental Law 2021.

Bayelsa State Ministry of Women Affairs and Social Development

The ministry seeks to empower women and youth, promote the participation of women in governance, pay attention to women in rural areas, enhance the economic self-reliance of women, create awareness, and campaign against gender-based violence, etc.

Bayelsa State Lands and Survey

This Ministry was created for the purpose of overseeing the Lands resources in the state. They are also charged with the responsibility to plan, devise and implement the state policies on land and its resources.

1.7.7 Funding Agency Requirements

This programme is funded by the African Development Bank (AfDB). Therefore, the AfDB safeguard systems will be integrated in the project cycle as well as other national and international environmental and social protection requirements, in order to comply with the best international practices. Both the main environmental and social requirements that the project needs to comply with are described in the following sections.

The proposed activities under for the Desert to Power Phase II have been screened against the requirements of the African Development Bank (AfDB) Integrated Safeguards System (ISS). Based on the nature and scale of the anticipated activities, the following Operational Safeguards (OS) are triggered.

Operational Safeguard 1 (OS1): Assessment and Management of Environmental and Social Risks and Impacts. This is the foundational safeguard dictating how borrowers identify, avoid, and mitigate E&S

risks. It requires an Environmental and Social Impact Assessment (ESIA) to categorize the project (e.g., moderate-risk Category 2 as this case of this proposed project) before it is financed.

Operational Safeguard 2 (OS2): Labour and Working Conditions is applicable because project implementation will require a substantial workforce during the construction phase. The OS will be triggered due to the envisaged use direct, contracted, primary-supply, or community workers, which might create occupational health and safety/labour risks.

Operational Safeguard 3 (OS3): Pollution Prevention and Control, Greenhouse Gases, Hazardous Materials and Resource Efficiency is triggered because the proposed solar power project will involve construction, installation, operation, maintenance, and eventual decommissioning activities that may generate pollution risks if not properly managed. Although the project is expected to contribute positively to greenhouse gas reduction by generating renewable energy, its construction and operational phases may involve the use, storage, and handling of fuels, lubricants, transformer oils, paints, solvents, cleaning agents, batteries, electrical equipment, and other potentially hazardous materials.

During construction, pollution risks may arise from site clearing, earthworks, movement of vehicles and machinery, temporary fuel storage, equipment maintenance, concrete works, dust generation, noise, and construction waste. Poor handling of fuels and lubricants could result in spills and soil or groundwater contamination. Improper disposal of packaging materials, scrap metals, cable offcuts, used oil, oily rags, batteries, and damaged solar components could also create environmental and human health risks.

Operational Safeguard 4 (OS4): Community Health, Safety and Security requires projects to identify, assess, and manage risks to the health, safety, and security of affected communities throughout the project lifecycle. The safeguard covers risks associated with construction activities, hazardous materials, traffic, communicable diseases, security personnel, emergency situations, and gender-based violence (GBV), sexual exploitation and abuse (SEA), and sexual harassment (SH). It requires the implementation of appropriate mitigation measures, emergency preparedness, stakeholder engagement, and grievance redress mechanisms to protect community wellbeing. The proposed project will comply with OS4 by implementing community health and safety measures, traffic and emergency response plans, security management procedures, and GBV/SEA/SH risk mitigation measures throughout project implementation.

Operational Safeguard 5 (OS5): Land Acquisition, Restrictions on Access to Land and Land Use, and Involuntary Resettlement

OS5 is considered applicable on a precautionary basis because the Project requires approximately five hectares of university land and seasonal farming has been reported around the Project area. Although no permanent residential structures or formal acquisition of privately owned land is anticipated, temporary, customary or informal use of the land may result in economic displacement if access to crops, farming plots or livelihood resources is restricted. Before site handover, REA and FUAB shall undertake and document a land-use verification with university representatives and relevant community representatives. The verification shall include a census of users, an inventory of crops and other affected assets, photographs, georeferenced boundaries, cut-off-date communication and signed records of consultations.

The mitigation hierarchy shall be applied. The final footprint shall be optimised to avoid active cultivation where technically feasible. Where the selected footprint is under seasonal cultivation, current users shall,

where practicable and safe, be permitted to complete the ongoing farming season before possession of the land. FUAB shall identify suitable alternative University land for continued seasonal farming where this is feasible and acceptable to affected users.

Any person whose crops, access or livelihood will be affected shall be compensated at full replacement cost before the impact occurs and shall receive proportionate livelihood-restoration assistance. A site-specific Livelihood Restoration Plan or Resettlement Action Plan, proportionate to the verified impacts, shall be prepared, disclosed, cleared and implemented before civil works commence. Where the verification conclusively demonstrates that the entire footprint is free of users, crops, livelihood activities and access restrictions, the evidence shall be annexed to the ESMP, and the non-displacement conclusion shall be updated accordingly.

Operational Safeguard 6 (OS6): Biodiversity Conservation (Protects Habitats and Sustainable Natural Resources)**:** Biodiversity Conservation was triggered because the proposed project will utilize about 5 hectares of land, requiring vegetation clearance. The site is within existing university land and contains no critical habitats or protected biodiversity areas. However, some plant species may be lost during clearing. Therefore, the cleared species will be documented, and a Biodiversity Management Plan will be developed to guide mitigation, replanting, habitat protection, and sustainable natural resource management.

Operational Safeguard 10 (OS10): Stakeholder Engagement and Information Disclosure**:** Triggered for projects requiring stakeholder identification, consultation, disclosure, grievance mechanisms, or ongoing engagement; in practice, it is broadly applicable across AfDB projects. OS10 is triggered because projects can create environmental and social risks that communities, workers, government agencies, civil society groups, private users, vulnerable groups, and other interested parties need to understand and comment on. It is not only about holding one public meeting; it requires an ongoing process of engagement before approval, during design, construction, operation, and sometimes closure.

The referenced AfDB Operational Safeguards are:

- OS 1: Assessment and Management of E&S Risks and Impacts (Primary framework for risk identification, covering climate and gender).
- OS 2: Labour and Working Conditions (Ensures safe conditions, rights, and prohibits forced/child labor).
- OS 3: Resource Efficiency and Pollution Prevention (Manages energy, water, and pollution).
- OS 4: Community Health, Safety, and Security (Addresses health, safety, and gender-based violence).
- OS 6: Biodiversity Conservation (Protects habitats and sustainable natural resources).
- OS 10: Stakeholder Engagement and Information Disclosure (Ensures transparency and grievance mechanisms

1.8. Report on the ESIA Structure

In line with the FMEnv guidelines, this report is structured as follows:

- Preliminary Sections: containing table of contents, lists of ESIA preparers, Executive Summary, amongst others.

- Chapter One: Introduction containing an overview of the proposed Project, the ESIA objectives and study approach, and applicable legal and administrative framework.
- Chapter Two: Project Location and Justification, containing a rationale for the proposed Project as well as the analysis of Project alternatives and development options.
- Chapter Three: Project Description containing the technical elements of the Project. It concisely describes the proposed Project and its geographic and temporal context, including the Project's associated infrastructure.
- Chapter Four: Description of the Environment. It details the baseline data that is relevant to decisions about the Project location, design, development, and operation.
- Chapter Five: Potential and Associated Impacts. This takes into account all relevant environmental and social risks and impacts of the proposed Project, including cumulative impacts.
- Chapter Six: Mitigation measures for the identified negative environmental and social impacts, as well as the enhancement measures for the identified positive impacts.
- Chapter Seven: is the ESMP. It summarizes the key environmental and social measures and actions, and the timeframe, including responsibility for the implementation of the recommended measures
- Chapter Eight: presents an overview of the remediation/decommissioning plan after Project closure.
- Chapter Nine: describes the stakeholder engagement activities carried out during the ESIA and an overview of the grievance redress mechanism for the Project.
- Chapter Ten: Conclusion and Recommendations

The report also includes references and appendices.

CHAPTER TWO
PROJECT JUSTIFICATION

2.0 General

This chapter presents the justification for the proposed 2.5 MW solar-hybrid power plant and associated infrastructure in the Federal University of Agriculture, Bassam Biri, Bayelsa State, as part of the Federal Government of Nigeria (FGN) proposed Nigeria Electrification Project (Desert to Power) Phase II under the Rural Electrification Agency. It also includes the description of alternatives and development options considered for the proposed Project.

2.1 Need for the Project

Federal Universities in Nigeria continue to be the preferred option for a large proportion of candidates seeking admission into tertiary institutions. Despite this demand, many universities face persistent challenges due to inadequate electricity supply from the national grid. The University currently receives an average of only about two hours of grid-supplied electricity per day. As a result, most universities depend heavily on diesel-powered generators to meet their energy needs, leading to high operational costs, increased maintenance burdens, and adverse environmental impacts. In response to the widespread power supply deficit, the Federal Government of Nigeria (FGN) is implementing the Nigeria Electrification Project (NEP), an innovative initiative aimed at expanding electricity access to off-grid and underserved areas through renewable energy solutions. The project is being implemented by the Rural Electrification Agency (REA) with co-financing from the African Development Bank (AfDB).

A key component of the NEP is the Energizing Education Programme (EEP), which seeks to deliver dedicated, clean, and reliable electricity to Federal Universities and their affiliated Teaching Hospitals nationwide. The current phase of the programme targets seven universities and two affiliated teaching hospitals. Beyond improving energy access, the EEP also supports Nigeria's commitment to climate action by contributing to the country's Nationally Determined Contributions (NDCs) under the Paris Agreement, which aim for a 20–30 percent reduction in carbon emissions by 2030. The proposed project under the NEP is expected to substantially alleviate the power supply challenges currently confronting the University, while generating multiple positive spill-over benefits. Associated infrastructure, including a renewable energy training centre, will enhance capacity building and support professional certification in renewable energy technologies. In addition, the provision of solar-powered street lighting will improve campus security through better illumination, thereby creating a safer and more conducive learning and working environment.

2.2 Value of the Project

The Nigeria Electrification Project (NEP) – including the Desert-to-Power / Energizing Education Programme (EEP) components implemented by the Rural Electrification Agency (REA) – the African Development Bank (AfDB) approved a **sovereign loan facility of approximately US $150 million to the Federal Government of Nigeria. In addition, a US $50 million co-financing loan was provided from the Africa Growing Together Fund (AGTF) (administered by the AfDB) to co-finance the project, bringing the total AfDB-related financing for NEP to about US $200 million.

2.3 Project Benefits

The proposed Project is envisaged to have a range of associated benefits, since the importance of gaining access to reliable and steady power supply cannot be overemphasized. Some of the benefits are a function of the objectives of the Project, while others are a function of the way in which the Project is designed to meet its objectives.

- The potential benefits of the proposed Project include but are not necessarily limited to the following:
- Stimulation of academic and research activities within the University as a result of access to constant and reliable power supply, thereby promoting educational advancement.
- Reduction in fossil fuel consumption by the University, thereby leading to reduction in carbon emissions and improvement in eco-balance. The University's average monthly diesel consumption is 4,749 litres (REA Energy Audit Report, 2019).
- Significant reduction in the cost of power generation by the University through diesel-fuel generators. The University has 9 generators and spends ₦1,163,505 on diesel monthly to self-generate 684 kW of power 14 hours daily (REA Energy Audit Report, 2019). Such savings would be used for other undertakings that will benefit the University.
- Increase in social interactions within the University. There will be enhanced security in the University as a result of more streetlights for illumination which would help keep off opportunistic crimes and gender-based violence.
- Enhancement of learning in renewable energy leading to certification as a result of training centre to be provided as part of the Project.
- Improvement in livelihood enhancing activities within the University.
- Direct and indirect employment opportunities during Project development and operation. The employment opportunities will lead to acquisition of new skills and the introduction of all manners of income generating spill-over effects.
- Increase in local and regional economy through the award of contracts and the purchase of supplies for Project development.
- Increase in financial and technical collaborations between the FGN, the University, REA, African Development Bank, and other relevant Ministries, Departments, and Agencies (MDAs).
- Contributing to the Nigeria's NDC to cut carbon emissions by 20 % to 30 % by the year 2030, under the Paris Agreement.

2.4 Envisaged Sustainability

2.4.1 Technical Sustainability

The Project development shall be handled by a qualified and experienced EPC contractor (to be selected by REA through a competitive process) according to pre-established standards and procedures.

The design and construction phase of the Project shall be overseen by qualified engineers from REA and the Department of Works and Physical Planning in the University. In addition, standard operating manuals and appropriate documentation regarding the operation and maintenance of the Project shall be developed and put in place by the EPC contractor. These documents will be used as the basis for

providing facility-specific training to relevant personnel before starting up to further ensure the technical sustainability of the Project.

Upon completion of the construction phase, an O&M contractor will be engaged to operate and maintain the Project, in conjunction with the team from the University's Works and Physical Planning Department. In addition, adequate capacity building shall be provided for the University personnel who will work with the O&M Contractor for the day-to-day operations of the project in the long run.

2.4.2 Environmental Sustainability

The project aligns with the Federal Government of Nigeria's (FGN) commitment to minimizing greenhouse gas (GHG) emissions as part of its broader climate change mitigation and adaptation agenda. According to the World Resources Institute Climate Analysis Indicators Tool (WRI CAIT), Nigeria's GHG emissions increased by approximately 25 percent between 1990 and 2014, representing an average annual growth of about 1 percent, while Gross Domestic Product (GDP) expanded by about 245 percent over the same period, averaging 5.5 percent annually. Although economic growth outpaced emissions growth, Nigeria's emissions intensity remained high; in 2014, GHG emissions relative to GDP were about 1.6 times the global average, highlighting significant opportunities for improvement (USAID, 2019). Consequently, the promotion and adoption of renewable energy for electricity generation, a critical driver of sustainable development, has become a central policy priority of the FGN.

Furthermore, the establishment of the Rural Electrification Agency Project Management Unit (REA-PMU), which comprises experienced Environmental and Social Safeguards Specialists, provides institutional capacity for effective oversight and environmentally responsible implementation of the project. In addition, the conduct of this ESIA at an early stage of project development, together with the commitment to implement the recommended mitigation measures and the Environmental and Social Management Plan (ESMP), demonstrates a proactive approach to preventing, minimizing, and managing potential environmental and social risks. Collectively, these measures are designed to ensure the long-term environmental sustainability of the project.

2.4.3 Economic Sustainability

The Proposed Nigeria Electrification Project (NEP) Phase II – Desert to Power, implemented by the Rural Electrification Agency (REA) with financing support from the African Development Bank (AfDB), is designed to be economically sustainable in both the short and long term through prudent project design, cost efficiency, and strong institutional arrangements. At the project level, the deployment of this project to the University will significantly reduce dependence on diesel generators, which is the only source of electricity in the university. While initial capital investment in renewable energy infrastructure is relatively high, the long lifespan of solar PV systems and declining technology costs ensure lower levelized cost of electricity (LCOE) over time, making the systems economically competitive and financially viable.

Based on the REA Energy Audit Report (2019), FUAB's baseline diesel consumption was approximately 4,749 litres per month, equivalent to about 56,988 litres per year. Reported diesel expenditure was ₦1,163,505 per month, equivalent to approximately ₦13,962,060 per year at the 2019

cost basis. Based on the current fuel and diesel prices compared to that of 2019, these figures would have at least tripled. These figures exclude generator servicing, lubricants, spare parts, fuel transport, unplanned repairs and the economic cost of outages and downtime. The proposed solar-hybrid system is expected to displace a substantial proportion of this recurrent diesel use and associated cost. The precise savings cannot be finalised at ESIA stage because they depend on the final photovoltaic capacity, battery capacity, verified load profile, expected solar yield, battery round-trip efficiency, system availability and the operating strategy for backup generators.

At completion of front-end engineering and detailed design, REA shall update the energy and financial model using current diesel prices, verified interval load data, final equipment specifications, expected annual energy yield, degradation, O&M expenditure, component-replacement schedules and backup-generator runtime. The updated analysis shall report, at a minimum: annual renewable-energy production; annual diesel displacement; annual operating-cost savings; avoided greenhouse-gas emissions; levelised cost of electricity; net present value; internal rate of return; and simple payback period. During operation, these projections shall be compared annually with metered plant performance and actual fuel consumption. The project also enhances institutional financial sustainability for beneficiary Federal Universities. Reliable and predictable electricity supply reduces recurrent spending on diesel procurement and generator maintenance, allowing institutions to reallocate limited financial resources toward core academic, research, and healthcare functions. Improved power availability also minimizes disruptions to academic calendars and research activities, indirectly strengthening institutional productivity and value for money.

From a macroeconomic perspective, the project supports Nigeria's broader economic sustainability objectives by reducing fossil fuel consumption, lowering foreign exchange expenditure on imported diesel, and contributing to energy security. Local content participation in system installation, operation, and maintenance further stimulates job creation and skills development, supporting local economies and reducing long-term reliance on external technical expertise. The project's financing structure, based on concessional loans and development partner support, enhances affordability and reduces fiscal pressure on the Federal Government. AfDB's involvement ensures robust financial appraisal, risk management, and compliance with international best practice, while the phased implementation approach allows lessons learned to be integrated into subsequent deployments, improving cost efficiency and performance.

In addition, the inclusion of capacity-building components, such as renewable energy training centres and skills transfer to local technicians, strengthens long-term economic sustainability by ensuring that system operation and maintenance can be managed locally at lower cost. This reduces downtime, extends asset life, and protects the value of the investment.

2.4.4 Social Sustainability

Stakeholder consultation was undertaken as an integral part of the ESIA process to ensure that all relevant stakeholders were allowed to contribute to the Project at an early stage of development. This engagement process also helped to establish a strong foundation for building and maintaining positive relationships with stakeholders. The initial stakeholder engagement activities conducted during the ESIA are documented and presented in this report.

To ensure sustained and structured engagement throughout the Project lifecycle, a Stakeholder Engagement Plan (SEP) will be developed and implemented. In addition, the Rural Electrification Agency (REA) has established a Grievance Redress Mechanism (GRM) for the Project. The GRM provides a clear and accessible communication channel through which stakeholders can submit complaints or concerns related to the Project, and it ensures that such grievances are addressed in a timely and effective manner. Comprehensive details of the stakeholder consultations conducted to date for the proposed Project are provided in Chapter 9 of this report.

2.5 Project Alternatives

2.5.1 Alternatives

Approximately five (5) hectares of land within the Federal University of Agriculture, Bassam Biri (FUAB) campus, have been designated by the University authorities for the proposed Project. The preferred site is situated about 104 metres from the University's Administrative Building. The selection of this site was guided by several key considerations, including: (i) the absence of rocky outcrops that could hinder the installation of solar panels; (ii) the lack of ecologically sensitive areas or cultural heritage resources within and around the site; (iii) good accessibility through the existing internal road network; (iv) the feasibility of achieving a direct connection to the existing switchyard; and (v) enhanced security within the campus environment. Other potential locations within the University campus were evaluated but subsequently discounted due to various constraints. These included the presence of existing physical structures and agricultural crops that could result in displacement or relocation, limited accessibility, and technical limitations such as unfavorable topography for solar panel installation.

2.5.2 Alternatives Considered within the Context of the Proposed Solar-Hybrid Power Plant

The power plant to be provided as part of the proposed Project in FUAB has been conceptualized to be a renewable energy source (solar technology) since that is part of the objectives of the EEP initiative (i.e. carbon emission reduction). Thus, this section specifically focuses on the alternatives considered within the proposed solar-hybrid power plant and eliminates discussion on other possible sources of power generation in Nigeria, such as the use of natural gas-fired power plant, coal-fired plant, oil-fuel plant, etc.

Overview

Solar power generation is currently one of the fastest-growing areas in renewable energy. Beyond panel production, it does not emit any significant GHGs. Compared to alternative renewable generation technologies such as wind turbines or biofuel generators, solar energy is produced by converting the sun's radiation – a process void of any smoke, gas, or other chemical by-product, which makes this technology to meet the clean development mechanism of the Kyoto Protocol. This is the main driving force behind all green energy technology, as nations attempt to meet climate change obligations in curbing emissions.

The use of solar energy for the proposed power plant in FUAB will significantly reduce the generation of GHG emissions associated with fossil-fuel power plants. Thus, contribute to Nigeria's NDC on climate change.

Bayelsa State has considerable potential for solar photovoltaic electricity generation despite its humid tropical climate and relatively high rainfall. A study conducted in Ekowe, Southern Ijaw Local Government Area, recorded an average daily solar irradiation of approximately 4.6 kWh/m²/day, equivalent to about 1,679 kWh/m² annually. Using a typical photovoltaic system performance ratio of 75–80%, the state's indicative specific PV output can be estimated as (4.6 \times 365 \times (0.75–0.80)), resulting in an annual electricity yield of approximately 1,260–1,340 kWh per installed kWp. This estimate is consistent with findings from nearby Port Harcourt, where annual PV yields of approximately 1,254–1,267 kWh/kWp have been reported.

Solar Power Technology Alternatives

The solar technologies considered for the proposed power plant in FUAB are:

- Concentrated Solar Power (CSP) Systems
- Photovoltaic (PV) Solar Panels

However, the preferred option for the proposed power plant is the use of PV Solar Panel, since it is highly flexible and requires low installation and maintenance cost in comparison to CSP technology. Water requirement for PV system is also low when compared to CSP system. The comparison between CPS and PV Solar technologies considered for the Project is summarized in Table 2.1.

Table 2.1: Comparison between CSP and PV Solar Technology

Features	CSP Technology	PV Technology
Description	CSP technology uses concentrated radiation from the sun, to heat a liquid substance which is used to generate steam which in turn passes through a steam-turbine to generate electricity. CSP Technology produces electricity through indirect means. Energy output with CSP technology is of AC type.	PV technology uses sunlight through the 'Photovoltaic effect' to generate direct electric current (DC). PV Technology produces electricity through direct means. Energy output with PV technology is of DC type but commonly converted to AC through an inverter.
Applications/Scale	CSP is used for utility-scale power generation, mostly for Grid Connections, and also supports conventional thermal power and desalination plants.	PV technology is suitable for off-grid small and medium-sized applications, and for utility-scale applications
Land requirement	CSP technology is best suited for areas of high direct normal solar radiation. CSP technology requires about 4	PV technology has a wider geographical area of application. PV technology requires about 2 hectares of land per MW of capacity

Features	CSP Technology	PV Technology
	hectares of land per MW of capacity	
Cost	CSP technology has a high installation and maintenance cost compared to PV	PV technology has a low installation and maintenance cost in comparison to CSP
Construction Time	CSP plant construction is technically more complex than PV	Utility-scale PV plants are easier to install and require less time than CSP for Plant construction
Water Requirement	Water requirement is variable depending on the CSP technology option adopted. CSP may utilize wet, dry, and hybrid cooling techniques	Typically requires less water than CSP technology. Water is occasionally required for cleaning dust from the panels.
Design Options	Less flexible in comparison to PV technology. Can be hybridized with fossil fuels like natural gas.	Highly flexible and adaptable to the project specific requirement
Average life span	25 years	25 years
Efficiency	Power production efficiency of CSP technology are as high as 45%	Power production fluctuates with the sunlight's intensity. For practical use this usually requires conversion to certain desired voltages or AC, through the use of inverters.
Environmental Risks	CSP systems have been recorded to pose environmental risks to bird species, which may be killed by the intense heat generated by the concentrated solar radiation that is reflected off the mirrors.	PV systems are generally benign.

PV Panel Alternatives

Solar PV panels are an assembly of photovoltaic cells, also known as solar cells. It is an essential component of a PV system that converts sunlight directly into direct current (DC) electricity. To achieve the required voltage and current, a group of PV panels (also called PV modules) is wired into a large array called a PV array. PV panels can be wired together in series and/or parallel to deliver the voltage and current that a particular system requires.

The types of solar cells that are commonly used in PV technology are:

i) mono-crystalline silicon;
ii) poly-crystalline silicon;
iii) thin film and
iv) bifacial panels.

The typical appearance of each of these PV panels is shown in Plates 2.1 to 2.4. Based on the consideration of cost and efficiency, mono-crystalline silicon; PV panels are envisaged to be used for the proposed Project.

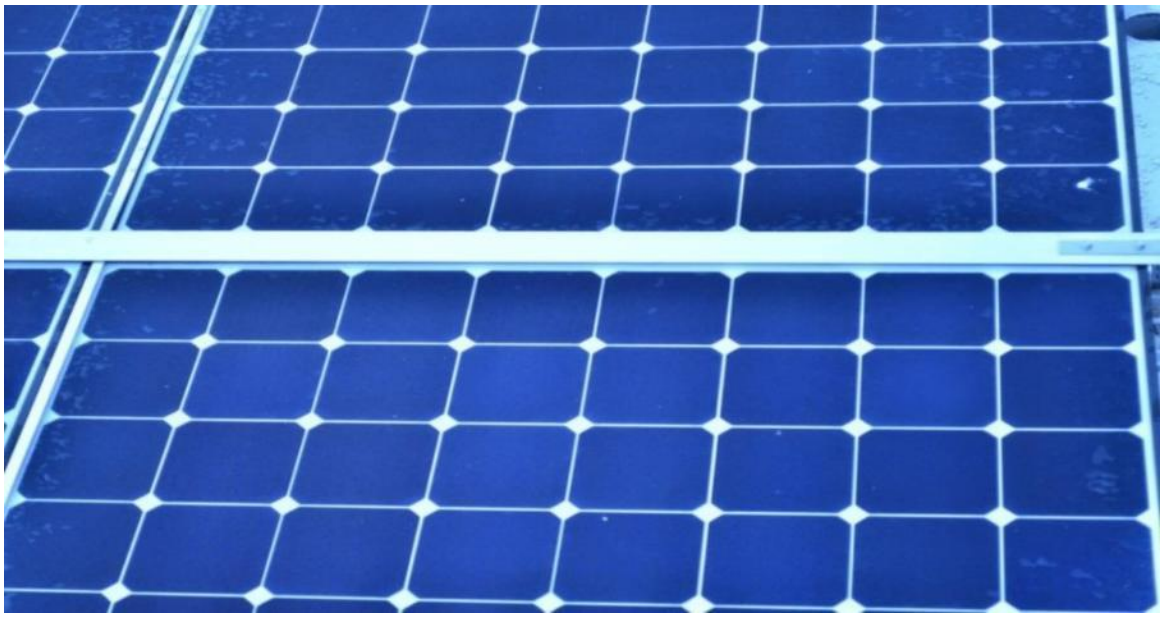

Plate 2.1: Typical appearance of mono-crystalline silicon PV panels

Plate 2.2: Typical Appearance of Polycrystalline Silicon PV panels

Plate 2.3: Typical appearance of Thin-Film Cadet panels

Plate 2.4: Bifacial Solar panels

2.5.4 Battery Types Alternative

The proposed solar-hybrid power plant in FUAB is an off-grid system, which will involve the storage of power. Storage allows the PV array to continue providing power even when the demand is down, instead of having to disconnect and refrain from generating power. The batteries for the proposed power plant would be required to meet the demands of heavy cycling (charging and discharging) and irregular full recharging. There are a variety of battery types fitted for these requirements; however, four (4) of

these batteries are the best available technology for solar power plants. These are: lead-acid, lithium-ion, flow, and nickel-cadmium batteries.

Following careful consideration of factors such as safety, charging cycles, depth of discharge and life span, lithium-ion batteries are envisioned to be used as the preferred battery for the proposed solar power plant. An overview of the battery types considered for the Project is provided below:

Lead-Acid Batteries

These are the oldest and cheapest form of batteries used in solar systems. They are widely used in Solar PV installations due to their wide availability and ability to work in a wide range of conditions. They internally convert hydrogen and oxygen into water and do not require maintenance. However, proper disposal of end-of-life lead-acid batteries is important. The lead-acid battery life is typically 3-10 years.

Lithium-Ion Batteries

Lithium-ion batteries can deliver more cycles in their lifetime than lead-acid. They can be lighter and more self-contained than lead-acid batteries. They are solid and do not require refills or maintenance. The most important benefit lithium-ion provides for solar is its high charge and discharge efficiencies, which help harvest more energy. Lithium-ion batteries also lose less capacity when idle, which is useful in solar installations where energy is only used occasionally. Lithium-ion batteries usually have a longer lifespan when compared to lead-acid batteries, on average of 5 years.

Flow Batteries

The vanadium redox flow battery (VRFB) is the most common technology in this type of battery. In VRFB, the vanadium electrolyte does not degrade over time, so it can last much longer than other technologies. With other technologies, adding more batteries is the only way to increase hours of storage; however, adding more electrolyte (vanadium) can increase battery size in VRFB.

The VRFB has no cycling limitations, and batteries can be charged and discharged completely without impact on their lifespan. They can last up to 20 years. The recycled vanadium in flow batteries is not toxic and can be reused repeatedly for other purposes, such as in making steel. However, the high cost of vanadium and ion-selective membrane within the cell will lead to significant cost implications for the Project.

Nickel-Cadmium Batteries

Nickel cadmium or NiCd batteries are as old as the lead-acid batteries. Though they may not have the energy density (the power) of other technologies, they provide long life and reliability without complex management systems. They are also as cheap as lead-acid batteries. NiCd batteries are rugged batteries with a high life span of up to 20 years. However, the major disadvantage of NiCd batteries is the relatively low energy density and susceptibility to self-discharge. Thus, making NiCd batteries an unreliable alternative for the proposed Project

2.6 Project Options

2.6.1 No Project Option

One of the reasons for the proposed Project in FUAB is that the current demand for electricity in the University significantly exceeds generation/supply and, and that the current power supply through the grid is unreliable and suffers interruptions. If the Project does not go ahead, access to a reliable, safe, and cheaper power supply may be difficult to realize. In addition, the potential benefits associated with the Project would not be realized. Furthermore, the no project option would mean that the University will continue to significantly rely on diesel-fuel generators for self-generation of power, considering the current situation of electricity supply to the University through the grid. This has serious economic implications for the University and would not also be in line with the FGN's efforts in achieving its carbon emission targets. Thus, the No Project option is not considered a viable option to adopt.

2.6.2 Delayed Option

This option implies that the planned Project will be delayed until a much later date. Such an option is usually taken when conditions are unfavorable to project implementation, such as in war situations, or where the stakeholders are deeply resentful of the Project. Also, if the prevailing economic climate is not quite favorable to the Project, then the delayed project option may be feasible. But none of these conditions are applicable. Indeed, both the economic and the political environments are most favorably disposed towards the Project. The implication of the delayed project option will mean that all the preliminary work and associated efforts/costs incurred would have come to nothing. Also, because of inflationary trends, such a delay may result in unanticipated increases in project costs, which may affect the final profit accruable from the Project. The delayed option is considered unviable for the Project.

2.6.3 Go Ahead Option

Allowing the Project to proceed as planned presents significant benefits for the University and its stakeholders. The Project will contribute to improving the quality of education by providing modern infrastructure, facilities, and resources that support effective teaching and learning. It will also strengthen the University's capacity for research and innovation by creating an enabling environment for academic activities, knowledge generation, and technological advancement. Furthermore, the Project will expand opportunities for training, skills development, and professional growth among students, academic staff, and researchers. Enhanced security measures associated with the Project will improve the safety of students, staff, visitors, and University assets, thereby fostering a more conducive environment for academic excellence. Beyond its educational and institutional benefits, the Project is expected to generate substantial socio-economic gains. During the construction and operational phases, it will create direct and indirect employment opportunities for Nigerian professionals, contractors, suppliers, and skilled and semi-skilled craftsmen. These opportunities will contribute to income generation, capacity building, and local economic development within the host community and beyond. The increased demand for goods and services associated with the Project is also likely to stimulate business activities and support local enterprises. Considering these wide-ranging benefits, the implementation of the Project as proposed offers the most practical, beneficial, and sustainable option when compared to the alternatives, ensuring long-term value for the University, its stakeholders, and the wider society.

CHAPTER THREE
PROJECT DESCRIPTION

3.1 Introduction

This chapter presents the technical description of the proposed Project, including the Project location, associated components, power generation and evacuation approach, and development activities. Waste streams associated with the proposed Project over its life cycle and the proposed handling techniques are also discussed.

3.2 Project Location

3.2.1 About FUAB

The Federal University of Agriculture, Bassambiri (FUAB), is a newly established federal institution of higher education, sited across a main campus spanning 80.7 hectares on Nembe–Ogidiama Road located in Bassambiri, within the Nembe Local Government Area of Bayelsa State, in the core of the Niger Delta region of southern Nigeria. The university was created by an act of the Federal Government in 2023 to expand access to tertiary education in agriculture and related disciplines and to connect teaching and research to the region's rich agricultural, marine, and environmental resources. Bassambiri lies in a riverine and estuarine landscape characteristic of Bayelsa State, offering strategic proximity to key towns such as Nembe and the state capital, Yenagoa, and broader links to urban centres including Port Harcourt and Warri. The location embeds the university within an environment where agricultural innovation, sustainable resource management, and community engagement are central to both learning and practical application. Academic activities are planned to commence with a strong focus on hands-on and research-driven programmes that align with national goals for agricultural development and regional economic growth.

3.2.2 Description of the Project Site

Approximately 5 ha of land within the FUAB campus has been allocated for the proposed solar-hybrid power plant and the training centre. The Federal University of Agriculture, Bassambiri (FUAB) is in Bassambiri, within Nembe Local Government Area of Bayelsa State, in the core Niger Delta region of southern Nigeria. The University lies within a predominantly riverine and estuarine environment characterized by low-lying terrain, creeks, mangrove swamps, and freshwater ecosystems typical of Bayelsa State. The FUAB campus is situated within a developing institutional setting, with existing administrative buildings, access roads, and utility infrastructure. Land use within and around the campus is mainly institutional, interspersed with areas of secondary vegetation and previously disturbed land. The surrounding communities engage largely in fishing, small-scale farming, and trading, reflecting the socio-economic profile of the Niger Delta region.

Topographically, the site is generally flat to gently undulating, which is favorable for infrastructure development, including solar photovoltaic installations. The soils are typical of deltaic environments, consisting mainly of sandy to silty deposits with moderate drainage characteristics. The climate of the area is humid tropical, marked by high rainfall, elevated humidity, and relatively uniform temperatures throughout the year, conditions that support dense vegetation growth but also require careful consideration of drainage and flood management in project design. Accessibility to the FUAB campus is accessed through existing road networks connecting Bassambiri to other parts of Nembe LGA and Bayelsa State, with further links to major urban centers such as Yenagoa. Internally, the campus has road access that allows movement of personnel, equipment, and materials to proposed project locations. The proposed project site within FUAB is located in an area free from known ecologically sensitive habitats, cultural heritage sites, or existing physical structures that could result in displacement.

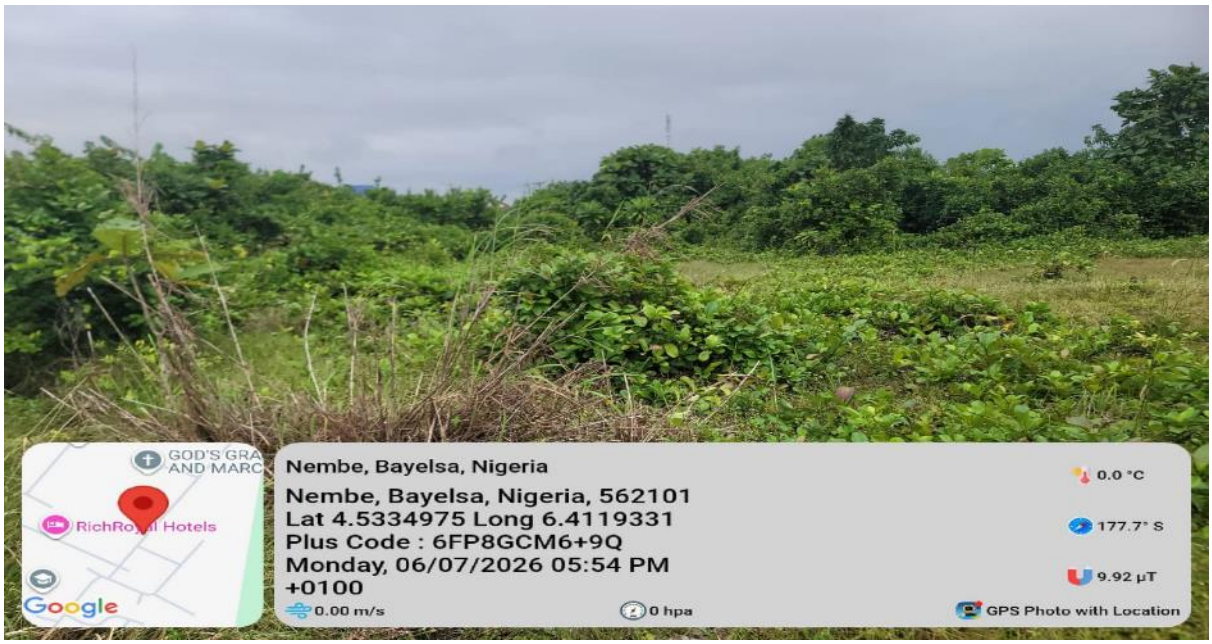

Plate 3.1: Ground View of the Proposed Project Site

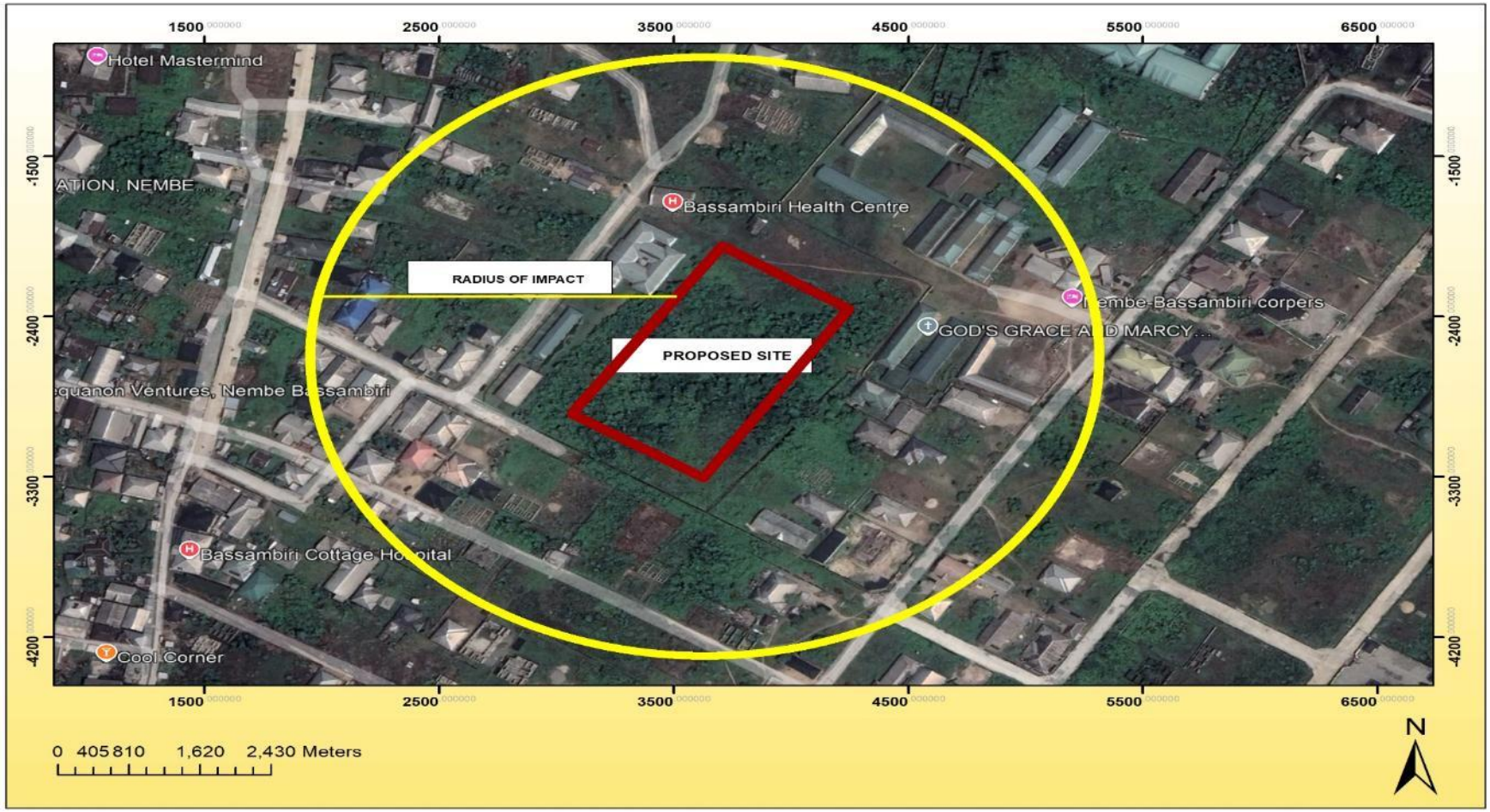

Figure 3.1: Site Aerial Overview

3.3 Project Components

As previously stated, the scope of the EEP includes the provision of an independent power plant, rehabilitation of existing electricity distribution infrastructure, provision of street lighting as well as a renewable energy training centre. However, the Front-End Engineering Design (FEED) for the project is ongoing as at the time of this ESIA study. Therefore, the specifications and number of some of the components to be installed for the proposed project are yet to be finalized. Each of these components as they relate to the FUAB solar hybrid power project are discussed below.

Proposed Solar-Hybrid Power Plant

PV technology is basically comprised of:

PV Cell: This is the basic photovoltaic device, which generates electricity when exposed to solar radiation due to its photo-electric effect. The absorbed solar energy excites electrons inside the cells into a higher state of energy, producing electrical energy. PV cells are commonly constructed from mono- or polycrystalline silicon or thin film technology. Several solar (PV) cells electrically connected to each other and mounted in a single support structure or frame is called a PV panel.

PV panel or module: This is the smallest assembly of interconnected PV cells sold commercially. In the case of crystalline silicon cells, following testing and sorting to match the current and voltage, the cells are interconnected in series and encapsulated between a transparent, anti-reflective front, and a backing material to provide environmental protection to the cells. The panel is then typically mounted in an aluminium frame to provide mechanical strength to the assembly. PV panels are usually designed to supply electricity at a certain voltage, such as a 12 V system. The current produced is directly dependent on the intensity of light reaching the panel. Several PV panels can be wired together to form an array. PV panels and arrays produce Direct Current (DC) electricity.

The PV panels to be installed will have following characteristics:

- All PV panels within a PV string will have equivalent Voc (voltage at open circuit) and Vmpp (voltage at maximum power point) values and will be of the same type, with the same design, from the same manufacturer.
- All PV strings within a PV sub-array connected in parallel will have similar rated electrical characteristics of open circuit voltage and maximum power voltage, and temperature coefficients.
- All PV panels that are electrically in the same string will have the same orientation (azimuth and tilt angle).
- PV structural components will be corrosion-resistant.

Aside from the PV panels, the power plant will typically consist of the following associated components:

Mounting structure: The PV panels will be secured in a fixed structure, made up of galvanized steel or aluminum. The majority of leg structures for the frames will be fixed into the earth. Driven piles and/or screwed system will be used, and the depth of the driven piles is 2 m.

Inverter: An inverter converts the variable DC output of a PV panel into a utility frequency alternating current (AC) that can be used by a local, off-grid electrical network or fed into a commercial electrical grid. Solar inverters are usually designed to have in-built safety features required by PV cells as well as special functions adapted for use with PV arrays, including string current monitoring and anti-islanding protection. The number and specification of inverters to be installed as part of the proposed solar-hybrid power plant are yet to be finalized. The inverters shall, however, be acquired from internationally recognized manufacturers such as WSTech, Ingeteam, Gamesa, Jema, Power Electronics, GPTech, and Helios Systems.

Battery: The number and capacity of lithium-ion batteries to be installed as part of the power plant is yet to be finalized. The batteries would be stored and operated under optimum conditions as specified by the manufacturers.

Backup Generators: Diesel-fuel generating sets (2 – 3 Nos) would be installed at the Project site for recharging the batteries during unfavorable weather conditions (e.g. at the peak of raining season). The capacity of the proposed generators is yet to be finalized. A diesel storage tank with an appropriate bund wall on a concrete floor will also be provided on site.

Combiner Boxes: A combiner box combines the output of several solar strings into one output. Solar combiner boxes also consolidate incoming power into one main feed that distributes to a solar inverter. They are engineered to provide overcurrent and overvoltage protection to enhance inverter protection and reliability.

Underground Cable for Power Evacuation: The power generated from the proposed plant would be evacuated through an 11 kV armored cable. The distance between the Project site and the powerhouse will be approximately 600 m.

Low and Medium Voltage Switchgear Cabinets: Power generation and distribution during plant operation involves the use of various types of circuit breakers and surge protectors, which will be enclosed in low and medium voltage switchgear cabinets. The switch gear cabinets to be installed at the plant site will contain a combination of electrical disconnect switches, fuses and circuit breakers. These components will be used to control, protect and isolate power generation and distribution activities during operation. A typical low-voltage switchgear cabinet is shown in Plate 3.3.

Plate 3.2: A typical low-voltage switchgear cabinet.
Source: bowerselec.co.uk/low-voltage-switchgear, 2018

Rehabilitation of Existing Distribution Infrastructure

The energy audit conducted at FUAB indicates that the major power equipment in the University, such as transformers and the distribution network, is in good condition. In addition, there are high-level interconnection substations in place with an installed distribution capacity of 3,750 kW. Where required, the existing distribution network will be upgraded to accommodate the generated power from the proposed solar-hybrid power plant.

Provision of Street Lighting

As part of the proposed project, Streetlights will be installed (where required) to ensure that different areas within the University campus are well illuminated.

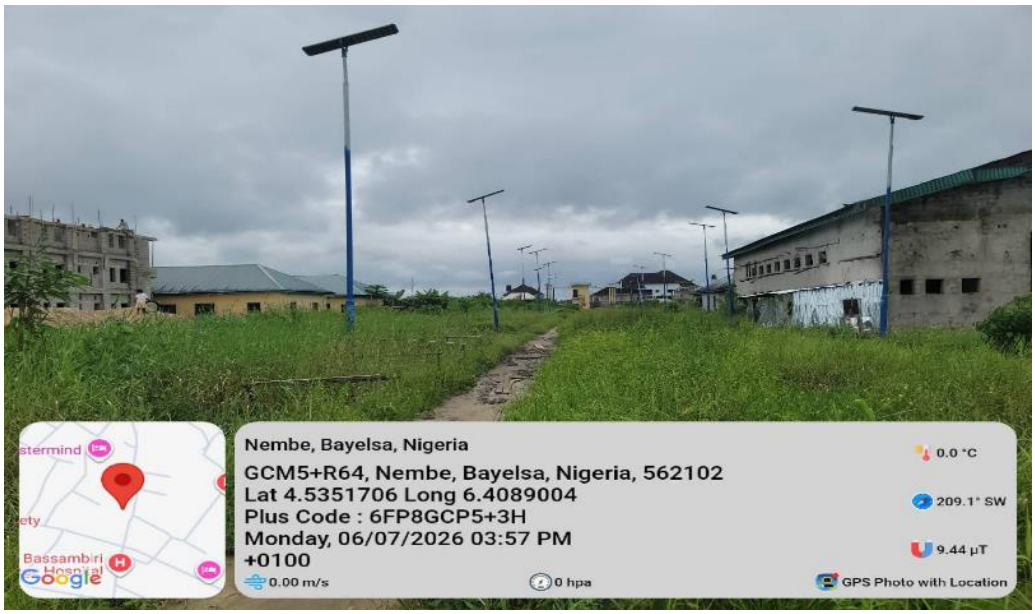

Plate 3.3: Sample of stand-alone and pole-mounted streetlights in the FUAB campus

Renewable Energy Training Centre

Students from the University will be allowed to access the Project site for learning and training purposes. The training center will also include a storage room, a workshop and toilet facilities.

3.4 Engineering Codes and Standards

The Project components shall be designed and installed in compliance with the relevant codes and standards of the British Standard-Europe Norms (BS–EN), the International Electrotechnical Commission (IEC), International Organization for Standardization (ISO), and the Standard Organization of Nigeria (SON). Examples of the relevant codes and standards include ISO 15673:2005 "Guidelines for the simplified design of structural reinforced concrete for buildings" and BS EN 60529:2013 "Degree of Protection by Enclosures (IP Code)", amongst others.

3.5 Project Implementation Phase

3.5.1 Pre-construction Phase Activities

Following the completion of engineering design for the Project and receipt of relevant approvals, the major activities during this phase include site clearing and preparation, and mobilization of equipment, materials and personnel to site. Clearing will involve removal of existing vegetation from the site and preparing a level working surface in readiness for construction activities.

Table 3.1: Construction Equipment and Machinery for a Solar Power Project

S/N	Equipment/Machinery	Primary Use	Estimated Number
1	Excavators (20–30 t)	1	2–3
2	Backhoe Loaders	Light excavation and material handling	2–3
3	Bulldozers	Site clearing, grading, and leveling	1–2
4	Motor Graders	Surface leveling and road preparation	1–2

5	Vibratory Rollers/Compactors	Soil compaction and road construction	1–2
6	Dump Trucks (10–20 t)	Transportation of soil, aggregates, and construction materials	4–8
7	Water Tankers	Dust suppression and water supply	1–3
8	Crane Trucks (25–50 t)	Lifting transformers, inverters, and heavy components	1–2
9	Forklifts	Offloading and handling solar modules and equipment	2–4
10	Pile Driving Machines/Pile Rammers	Installation of mounting structure foundations	2–4
11	Concrete Mixers	Concrete production for foundations and ancillary structures	1–2
12	Concrete Transit Mixers	Delivery of ready-mix concrete	2–4
13	Mobile Generators	Temporary power supply during construction	2–3
14	Cable Pulling Machines	Installation of underground and above-ground cables	1–2
15	Trencher Machines	Cable trench excavation	1–2
16	Pickup Trucks/Utility Vehicles	Personnel movement and supervision	2–3
17	Flatbed Trucks/Trailers	Transport of solar panels, mounting structures, and equipment	3–4
18	Mobile Elevated Work Platforms (MEWP)	Installation and maintenance works at height	1–2
19	Welding Machines	Fabrication and minor structural works	2–4
20	Survey Equipment (GPS, Total Stations, Drones)	Surveying and setting out works	2–3 sets

Construction Phase Activities

The construction phase of the Project will include civil, mechanical and electrical works; installation of PV panels and associated plant facilities; construction of a training centre; installation of streetlights as well as underground armored cable for power evacuation. Also, where required, an upgrade of some of the existing power distribution infrastructure within the University will be carried out.

It is envisaged that approximately 300 people would be required for construction activities. These are divided into low-skilled workers (e.g. construction labour who will make up the majority of workers), semi-skilled workers (drivers, technicians, etc.), and skilled personnel (e.g. engineers and expatriates). Most of the unskilled and semi-skilled workers would be drawn from within the Bassambiri community to enhance the job opportunities associated with the proposed Project. A moderate level of migrant workers may also be associated with the construction phase activities (potential impacts associated with the migrant workers, as well as the proffered mitigation measures, are covered in Chapters 5 and 6). No workers' camp is planned to be established on-site during construction.

Commissioning Phase Activities

The commissioning phase of the proposed Project will include testing and checking individual equipment /system, as well as the associated infrastructure to ensure they have been installed correctly and can be handed over for use.

Operational Phase Activities

The operational phase of the Project will involve power generation and distribution to various sections of the University as well as the preventative, corrective and predictive maintenance of the power plant and associated facilities. In addition, the training centre will be put into use to enhance learning in renewable energy.

The EPC contractor shall develop standard operating procedures (SOPs) for the operation and maintenance of solar panels, inverters, batteries, and other associated components of the Project. If need be, the SOPs shall be further reviewed and updated by the O&M contractor during operation. The day-to-day operations of the plant will involve both regular preventive and corrective maintenance carried out by the O&M Contractor in order to keep the power plant in optimal working condition throughout its operating life. Preventive maintenance follows a routine service schedule aimed at preventing faults from occurring and keeping the power plant operating at its optimum level. The frequency of the preventive maintenance would depend on a number of factors such as the technology selected, environmental conditions of the site, warranty terms and seasonal variances. It contains, for example, activities like PV panel cleaning, inverter service, and checks on structural integrity of the mounting structure.

Corrective maintenance will be carried out in response to failures, for example, the repair / exchange of damaged or faulty equipment. Maintenance will consist mostly of panel / battery replacement and other mechanical and electrical infrastructure repairs. Faulty components will be replaced as soon as the problems are identified. The average life span of the PV power plant is 25 years, which can be extended through regular maintenance. Even after 25 years, the PV panels can still generate up to 90% of the design capacity.

Chapter 8 of this report contains detailed information on the activities associated with the decommissioning of the proposed solar-hybrid power plant and its ancillary facilities (in the event of final decommissioning), including the environmental and social measures to be implemented to address potential impacts of the decommissioning activities.

3.6 Water Use and Supply

One of the key benefits of the power plant (to be provided as part of the proposed Project) in terms of resource use is the generation of electricity using freely available solar energy to produce electricity, reducing the dependence on fossil fuels; thus, reducing carbon emissions.

The use of water for construction activities will be minimal because construction works requiring cement mixing will be few on-site. Water is required mainly during the operational phase of the power plant for periodic cleaning of PV panels to prevent dust build-up (especially during the dry season), since dust can affect their performance by inhibiting the amount of irradiation that reaches the solar cells. The rate of

build-up of dust on the PV panels is dependent on several factors, including soil type, local wind speed and the mounting structure used for the panels.

Manual cleaning of the PV panels with water shall be regulated as much as practicable. During the periods of rainy season, direct cleaning of the PV panels is estimated to occur not more than three times. However, during the dry season (November to April), the frequency of cleaning will depend on the rate of dust accumulation, and it is envisaged to be more than three times due to high dust generation usually experienced in the Northern part of the country.

Based on the review of similar solar power projects, each PV panel would require approximately 5 litres of water per cleaning cycle. This implies that about 33,000 litres of water will be needed for each cleaning cycle. The water required for the cleaning purposes would be obtained from the borehole that will be installed within the Project site. Based on observations noted during the field survey and the estimated quantity of water required for occasional cleaning of the PV panels, water abstraction for the Project is not envisaged to have a significant effect on the existing groundwater aquifer of the Project area as well as the local water use. The recharge of the existing boreholes in the study area is largely due to direct precipitation. During the rainy season, the water reserve of the aquifer in the study area increases; thus, hand dug wells and boreholes yield improve significantly.

3.7 Health and Safety

The EPC Contractor shall engage dedicated personnel competent based on appropriate education, training, and experience to manage and oversee the Health, Safety and Environment (HSE) aspects of the Project. The HSE personnel should ensure that the Project and subcontractors operate in accordance with the applicable regulatory HSE requirements and plans and also monitor the implementation of environmental and social protection measures.

Occupational health and safety (OHS) plans shall be developed and maintained by all contractors involved in the implementation of the proposed Project. The contractors shall provide OHS training that may include hazard awareness, safe work practices and emergency preparedness to ensure they are apprised of the project sites rules of work, personal protection and prevent injury to fellow workers. Worker activities will be managed through appropriate planning and the application of the Permit-to-Work system, Job Hazard/Safety Analysis, Personal Protective Equipment (PPE) requirements and other safety-based protocols.

Also, all contractors, as a component of their contracts, will implement HSE plans which will outline procedures for avoiding health and safety incidents and for emergency medical treatment. Contractors will be required to carry out regular safety inspections to ensure measures to manage potential OHS hazards are implemented.

For example, during the construction phase, a Health and Safety (H&S) risk assessment-based approach will be taken to manage H&S risks to workers. This would involve assessing all the various risks that are involved in each aspect of the job and educating workers on how to manage these risks. The people working around the Project area shall also be warned of the risk involved, i.e. warning signs shall be erected for people to see clearly. In addition, first aid equipment and PPEs for workforce will be provided onsite

throughout the construction activities. All staff, workmen, suppliers and subcontractors working on site shall be informed on the need to ensure their safety and the safety of the people working around them. Every worker will be instructed to always put on PPE whilst on site. Appropriate warning signs will be erected and checked each day. Daily health and safety toolbox meetings among workforce will be ensured. The safety briefings will be conducted by the on-site HSE officers. Smoking, use of alcohol or hard drugs will be strictly forbidden.

3.8 Waste Management

This section discusses the waste streams associated with the proposed Project and the intended management plan.

Overview

It is the goal of REA that the proposed Project is designed, developed and operated in a sustainable manner. Thus, effective waste management practices that comply with the relevant local requirements and international best practices shall be implemented during all phases of the proposed Project. To achieve this, all contractors engaged during the lifecycle of the Project will put in place and comply with a site waste management plan. Waste management principles shall be based on an integrated approach that involves a combination of techniques and programs to manage waste. Source reduction is at the top of the approach, followed by reuse and recycling as preferred options to disposal.

Generally, waste associated with the proposed Project shall be managed using the following prioritized program:

Reduction at Source – The elimination or minimization of waste generation through equipment modifications and installation of pollution abatement equipment.

Reuse – Using an item for its original purpose, or a similar purpose, in its original form. Waste generated from one operation shall be put to use in other operations where they are found useful without compromising standards and safety.

Recycling – conversion of waste materials into reusable objects. This will involve using FMEnv/NESREA approved companies involved in the recycling business using best available technology that meets international standards.

Residue Disposal – disposal of wastes in a government-approved dumpsite.

Associated Waste Streams

The waste streams associated with the proposed Project are discussed as follows:

<u>Pre-construction Phase</u>

The waste streams associated with the pre-construction phase of the Project include cleared vegetation (during site preparation), food waste, and general rubbish. The cleared vegetation (mostly grasses) will be removed from the site and allow biodegrade at a portion of the site while wood from felled trees will be made available to the local community.

Construction Phase

The planned activities during the construction phase include civil, mechanical and electrical works and installation of PV panels and associated components which will be carried out by a number of construction workers. The waste streams associated with the construction activities include excavated soil, general refuse, garbage, inert construction materials, metal scraps, concrete waste, food waste, and used packaging materials. In line with the NEP ESMF, the EPC Contractor shall put in place and comply with a site waste management plan. The plan shall be developed to address all waste streams associated with the construction activities and comply with relevant regulations. The contractor shall comply with the national requirements and building rules on storage of construction materials.

Furthermore, all concrete mixing will be undertaken on impermeable plastic lining to prevent contamination of the surrounding areas. Scrap metals generated during the construction phase will be collected for recycling in blue coloured waste receptacles for non-hazardous waste. Excavated soil generated during the foundation work will be arranged according to the various soil layers for reuse as backfill during landscaping and site rehabilitation. All electronic equipment shall be supplied by credible manufacturers to reduce the risk of generating waste from faulty equipment. All damaged PV panels generated during the installation activities shall be collected in a dedicated container and returned to the manufacturer outside the country for proper recycling, since there is currently no recycling facility in Nigeria that handles PV panels.

Litter collection facilities shall be provided and all solid waste materials that are not identified for reuse or recycling will be placed in appropriate on-site storage containers (black-coloured waste receptacles for food waste, blue-coded bins for paper, and yellow-coded bins for general rubbish) and periodically disposed of (at least once a week throughout the construction period or on the need basis depending on the volume of the waste) at a government-approved dumpsite through a third party waste contractor approved by the Bayelsa State Environmental Sanitation Authority (BESA). It is estimated that approximately 0.225 m^3 of construction debris will be produced per week. Hazardous waste that could be generated during the construction activities includes used oil rags and spent filters from the on-site diesel generator for the power source during construction. Hazardous waste shall be stored in a manner that prevents the commingling or contact between incompatible waste and stored in properly labelled, closed containers prior to evacuation by a third-party waste contractor approved by BESA for treatment and disposal.

Operational Phase

Solid waste generated during the operational phase of the Project will be incorporated into the existing FUAB waste management approach (there is a dedicated site within the University environment where solid wastes are collected for disposal). Approximately 2.25 cm^3 of solid waste (e.g. paper waste, food packaging, etc.) is estimated to be generated per week during the operational phase. In line with NEP ESMF, the University shall be encouraged to prepare e-waste management plans that account for safe end-of-life disposal of equipment from the solar-hybrid power plant. The Extended Producer Responsibility program (EPR) will be implemented for solar panels, inverters, batteries, and other electrical components to be installed for the Project. Damaged or discarded PV panels and inverters will be collected and sent to the manufacturer for recycling in line with the EPR model. Spent, damaged, or expired batteries will also be returned to the manufacturer for recycling. Alternatively, the spent batteries will be recycled by local and accredited battery recycling companies in Nigeria. These batteries shall be stored in red colored waste receptacles before they are transported to the accredited battery recycling companies. The quantity of waste

batteries generated typically depends on several factors such as type, capacity, number of batteries installed, and depth of discharge.

Stormwater and erosion will be managed through a combination of open trenches and ditches. Stormwater shall drain away to the natural environment via gravity. Paved and concreted areas will be sloped to allow for proper drainage.

Sanitary waste (sewage) generated during the facility operation shall be channeled to a septic tank to be installed onsite. The septic tank shall be of reinforced concrete and will be located away from any groundwater source. As at when due, the contents of the septic shall be evacuated by an accredited waste contractor for treatment at a sewage treatment plant approved by the BESA.

Decommissioning

The waste streams associated with the decommissioning phase of the Project would be similar to the construction waste. These will include refuse, e-waste, general rubbish, and demolition of debris. The University shall also be encouraged to prepare e-waste management plan that accounts for safe end-of-life disposal of equipment from solar installations. Wastes will be segregated onsite, and non-reusable / recyclable wastes will be disposed of through an accredited third-party waste contractor. The summary of waste streams associated with the Project is provided in Table 3.2.

Table 3.2: Summary of Waste Streams Associated with the Proposed Project and Handling Techniques

Waste Stream	Sources	Project Phase	Handling Techniques
		Construction (C), Operation (O), Decommissioning (D)	
General rubbish, refuse, and putrescible waste (food waste)	Wood splinter, domestic waste, food packs, used bottles	C, O, D	On-site waste segregation; disposal of non-reusable waste through a third-party waste contractor approved by the BESA
Cleared vegetation	During site clearing and preparation	C	Composting, collection for biomass fuel
Scrap metals	Used tubular and casings, used iron rods	C, O, D	Scrap metals will be collected for recycling
Excavated materials	Foundation works	C, D	Excavated materials generated during foundation works will be used for backfilling. Excess excavated spoil will be stockpiled and reused as part of the materials for the construction of plant buildings.

Damaged/expired PV panels	PV modules	C, O, D	Return to the manufacturer for recycling using the EPR model
Expired inverters	Electrical installation	O, D	Return to the manufacturer for recycling using the EPR model
Damaged/expired Batteries	Power generation	O, D	Return to the manufacturer for recycling using the EPR model
Sanitary waste	Training centre	C, O, D	Periodic evacuation of content of the septic tank

3.9 Project Schedule

The proposed Project is planned to be operational by the fourth quarter (Q4) of 2028. The tentative Project schedule is provided in Table 3.3.

Table 3.3: Tentative Project Schedule

Project Schedule	Timeline											
	2026				2027				2028			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Site allocation												
Energy demand audit												
Front-End Engineering Design												
ESIA study and Approval												
Selection of EPC Contractor and contract signing												
Civil, electrical, and mechanical design												
Procurement (manufacturing and transportation)												
Preconstruction and construction Phase Activities												
Commissioning												
Commencement of operation												

CHAPTER FOUR
ENVIRONMENTAL BASELINE DESCRIPTION

4.1 Preamble

This chapter presents the descriptions of the biophysical, socioeconomic, and health conditions of the environment, which will provide the basis for potential impact identification and appropriate mitigation measures associated with the development of the project.

4.2 Study Approach

The baseline conditions of the project area were established through stakeholder consultations, review of relevant literature, and field studies. Environmental data collection adopted a multidisciplinary approach and was carried out in accordance with applicable regulatory requirements and good international industry practice. The process included a desktop review of existing information; design and development of the field sampling strategy; confirmation of sampling locations; pre-mobilization activities, including job hazard analysis, equipment calibration, materials checks, and field mobilization; community consultations; dry-season sample collection, supplemented with secondary wet-season data; sample handling, documentation, preservation, and storage; demobilization from the field; and transfer of sample custody to the laboratory for analysis. The detailed methodology is provided in Appendix 1.

4.3 Climate and Meteorology

4.3.1 Regional Climate

Niger Delta lies within the humid tropical zone. The climate typifies the humid tropics, characterized by a tropical wet and semi-hot equatorial climate with high solar radiation mainly diffused due to cloud cover and characteristic heavy precipitation, light winds, and low atmospheric pressure. The prevailing (seasonal) wind governs this climate, latitude, apparent movement of the sun across the tropics and relative stability of the Inter-Tropical Discontinuity (ITD) in the area (Ojo, 1977). The two dominating air masses are the drier Tropical Continental from across the Sahara in the North and the humid Tropical Maritime from across the Atlantic Ocean in the South. The wet season is from April to October, and the dry season is from November to March. However, rain can start as early as March and end in November. The months with the highest rainfall are June, July, and September. Climatologically, four seasons are discernible for the region: the early rainy season (March-July), the short dry season (also called August break), the late rainy season (September-November), and dry season (December-February). Clouds during this period are absent, so the temperature is relatively high during the day but low at night. As the overhead sun moves into the Northern hemisphere in March, the influence of the *Harmattan* retreats, and the maritime wind begins to dominate the area once again for the rest of the season.

4.4 Baseline Condition

4.4.1 Air Quality and Noise Levels

The ambient air quality and noise results indicate that the project area is generally within the applicable FMEnv limits and broadly comparable with, or better than, the conditions reported in the TCN ESHIA (Transmission Company of Nigeria Environmental, Social and Health Impact Assessment) 2019 study (a 108km Bayelsa Axes transmission line reconstruction 2019)

Noise levels ranged from 58.3 to 68.9 dB(A), with a mean value of 65.21 dB(A). These values are below the FMEnv 8-hour limit of 90 dB(A). The mean noise level is slightly higher than the 58.5 dB(A) reported in the TCN ESHIA 2019 but remains within acceptable regulatory limits. The control value of 69.1 dB(A) is also comparable to the project area values, suggesting that existing noise conditions are influenced by normal background activities rather than project-related sources.

For gaseous pollutants, SOx, NOx, VOC, CO, and H2S were not detected in the project area, with recorded values of 0 µg/m³. These values are below the applicable FMEnv limits and are also lower than the TCN ESHIA 2019 results, where low concentrations of SOx, VOC, CO, and H2S were reported. This suggests good baseline air quality with no significant existing contamination from combustion, industrial activity, or other emission sources.

Suspended particulate matter (SPM) ranged from 28 to 31 µg/m³, with a mean of 29 µg/m³. This is substantially below the FMEnv limit of 250 µg/m³ and lower than the 63 µg/m³ reported in the TCN ESHIA 2019. The low SPM values indicate limited dust loading in the project area at the time of sampling.
Ozone (O_3) ranged from 35 to 40 µg/m³, with a mean of 37.29 µg/m³. Although no FMEnv limit or TCN ESHIA 2019 comparison value is provided, the measured values are higher than the control value of 10 µg/m³. This may reflect local atmospheric photochemical conditions, although the absence of corresponding NOx and VOC concentrations suggests no major local precursor source was detected during sampling.

Carbon dioxide (CO_2) ranged from 410 to 500 µg/m³, with a mean of 458.29 µg/m³. There is no applicable FMEnv limit for comparison. The mean value is slightly higher than the 411.17 µg/m³ reported in the TCN ESHIA 2019 and comparable to the control value of 455.5 µg/m³, indicating typical ambient background conditions.

Meteorological parameters showed air temperature ranging from 29.0 to 30.1°C, comparable to the TCNESHIA2019 value of 30.52°C. Relative humidity ranged from 70.1 to 78.1%, slightly lower than the 80.43% reported in the TCN ESHIA 2019. Wind speed was relatively low, ranging from 0.3 to 1.1 m/s, compared with 5.06 m/s in the TCN ESHIA 2019, indicating calmer conditions during the current sampling period.

Table 4.1: Air Quality Around the Project Area

Parameters/Unit	Units	Min	Mean	Max	Ctr	TCN EIA 2019	FMENV Limits
							8 h Average
Noise level	d(B) A (day)	58.3	65.21	68.9	69.1	58.5	90
SO_X	µg/m³	0	0	0	0	0.022	26
NO_X	µg/m³	0	0	0	0	0	75-113
SPM	µg/m³	28	29	31	31.5	63	250
VOC	µg/m³	0	0	0	0	0.25	60
CO	µg/m³	0	0	0	0	1.59	11.4
O_3	µg/m³	35	37.29	40	10	NA	NA

CO_2	µg/m^3	410	458.29	500	455.5	411.17	NA
H_2S	µg/m^3	0	0	0	0	0.31	0.01
Air Temperature	°C	29	29.7	30.1	29.9	30.52	NA
Wind Speed	m/s	0.3	0.83	1.1	1.05	5.06	NA
Humidity	%	70.1	71.79	78.1	71.25	80.43	NA

TCN ESHIA,2019 =Transmission Company of Nigeria (TCN) Environmental Social and Health Impact Assessment. [a/b] $T_{cal} > T_{value,}$ difference in mean values of the study area and the control is significant at 0.05 level, $p<0.05$

4.4.2 Groundwater Quality

Physicochemical Parameters

The summary results are shown in Table 4.2, while detailed results are provided in Appendix II.
The results show that the water was generally near neutral, with pH values ranging from 6.5 to 6.85 and a mean of 6.68. This falls within the WHO/FMEnv recommended range of 6.5-9.2, indicating that the water is neither strongly acidic nor alkaline. The temperature ranged from 27.18°C to 28.60°C, with a mean of 27.89°C, which is also below the WHO/FMEnv limit of 40°C. These values suggest normal ambient water conditions and do not indicate thermal pollution.

Electrical conductivity ranged from 166 to 185 µS/cm, with a mean of 175.5 µS/cm. This is below the WHO/FMEnv limit of 250 µS/cm, indicating a relatively low concentration of dissolved ionic substances. Total dissolved solids ranged from 131 to 142 mg/l, with a mean of 136.5 mg/l. Although no limit was provided in the table, the TDS value is low and suggests that the water contains limited dissolved mineral content. Turbidity ranged from 0.7 to 2 NTU, with a mean of 1.35 NTU, which is below the WHO/FMEnv limit of 5 NTU. This indicates that the water is relatively clear and contains low levels of suspended particles.

The dissolved oxygen values ranged from 4.17 to 4.55 mg/l, with a mean of 4.36 mg/l. Although no WHO limit was provided, this level suggests moderate oxygen availability in the water. Biological oxygen demand ranged from 0.451 to 0.556 mg/l, while chemical oxygen demand ranged from 1.155 to 1.161 mg/l. These values are low, indicating limited organic pollution and low levels of chemically oxidizable substances. Total suspended solids were also low, ranging from 0.33 to 0.41 mg/l, suggesting minimal particulate matter in the water.

Nutrient concentrations were within the stated WHO/FMEnv limits. Nitrate ranged from 2.17 to 3.20 mg/l, with a mean of 2.685 mg/l, which is below the limit of 10 mg/l. Sulphate ranged from 25 to 45.01 mg/l, with a mean of 35.01 mg/l, also below the limit of 100 mg/l. Phosphate ranged from 1.27 to 1.41 mg/l, with a mean of 1.34 mg/l, which is below the limit of 5 mg/l. These results indicate that nutrient enrichment is not excessive, although continued monitoring is advisable because elevated nutrients can contribute to eutrophication.

Most heavy metals were either not detected or recorded at very low concentrations. Nickel, lead, copper, chromium, zinc, cadmium, barium, cobalt, arsenic, and mercury were generally below 0.001 mg/l. Lead and copper were within the provided WHO/FMEnv limits of 0.02 mg/l and 1 mg/l, respectively. Total hydrocarbons were also below detection level, less than 0.001 mg/l, which is far below the limit of 0.05

mg/l. This suggests that the water was not significantly contaminated by petroleum hydrocarbons or most toxic metals.

However, iron was a major exception. Iron ranged from 0.021 to 1.015 mg/l, with a mean of 0.518 mg/l. This exceeds the WHO/FMEnv limit of 0.3 mg/l. Elevated iron may affect the taste, colour, and acceptability of the water, and may also cause staining of plumbing fixtures and laundry. The high iron concentration could be due to natural geological sources, corrosion of pipes, runoff, or other local contamination sources.

The cations measured were generally low. Potassium ranged from 0.003 to 0.01 mg/l, with a mean of 0.007 mg/l, far below the limit of 10 mg/l. Sodium, magnesium, and calcium were also present at low concentrations, although no WHO/FMEnv limits were provided for some of them in the table. These low values suggest that the water is not highly mineralized and is unlikely to pose problems related to hardness or salinity.

The microbiological results are the most serious concern. Coliform counts ranged from 6 to 7, with a mean of 6.5, while the WHO/FMEnv limit is 0. This means water does not meet the microbiological standard for safe water. The presence of coliforms indicates possible contamination from faecal matter, surface runoff, sewage intrusion, or poor sanitary conditions around the water source. In contrast, E. coli was absent, which is positive, but the presence of coliforms still shows that the water requires treatment before use.

The water quality is acceptable for many physicochemical parameters when compared with the WHO/FMEnv limits, especially pH, temperature, conductivity, turbidity, nutrients, hydrocarbons, and most heavy metals. However, the exceedance of iron and the presence of coliform bacteria show that the water is not fully compliant with WHO/FMEnv standards. Therefore, the water should be treated before domestic or drinking use, particularly through disinfection to remove microbial contamination and appropriate treatment methods such as aeration, filtration, or oxidation to reduce iron levels.

Table 4.2: Physicochemical Characteristics of the Groundwater around the Project Area

Parameters	Units	Min	Mean	Max	Control	TCN ESHIA 2019	FMENV/ WHO Limits
pH		6.5	6.68	6.85	7.1	6.94	6.5-9.2
Temperature	°C	27.18	27.89	28.6	28.16	27.3	40
Electrical Conductivity E.C.	µs/cm	166	175.5	185	83	35.4	250
Total Dissolved Solids TDS	mg/l	131	136.5	142	143.04	9.24	
Dissolved Oxygen DO	mg/l	4.17	4.36	4.55	5.12	NA	
Total Suspended Solids TSS	mg/l	0.33	0.37	0.41	0.41	NA	
Turbidity	NTU	0.7	1.35	2	0.5	1.22	5
Biological Oxygen Demand BOD	mg/l	0.451	0.504	0.556	0.451	NA	
Chemical Oxygen Demand COD	mg/l	1.155	1.158	1.161	1.161	4.91	
Total Hydrocarbons THC	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	0.05
Nutrient							
Nitrate	mg/l	2.17	2.685	3.2	5.17	0.58	10
Sulphate	mg/l	25	35.01	45.01	65.01	0.16	100
Ammonium	mg/l	<0.001	<0.001	<0.001	<0.001	NA	
Phosphate	mg/l	1.27	1.34	1.41	1.41	0.16	5
Heavy Metals							
Nickel	mg/l	<0.001	<0.001	<0.001	<0.001	NA	
Iron	mg/l	0.021	0.518	1.015	1.015	0.04	0.3
Lead	mg/l	<0.001	<0.001	<0.001	<0.001	NA	0.02
Copper	mg/l	<0.001	<0.001	<0.001	<0.001	NA	1
Chromium	mg/l	<0.001	<0.001	<0.001	<0.001	NA	
Zinc	mg/l	<0.001	<0.001	<0.001	<0.001	0.16	
Cadmium	mg/l	<0.001	<0.001	<0.001	<0.001	NA	
Barium	mg/l	<0.001	<0.001	<0.001	<0.001	NA	
Cobalt	mg/l	<0.001	<0.001	<0.001	<0.001	0.01	
Arsenic	mg/l	<0.001	<0.001	<0.001	<0.001	NA	

Parameters	Units	Min	Mean	Max	Control	TCN ESHIA 2019	FMENV/ WHO Limits
Mercury	mg/l	<0.001	<0.001	<0.001	<0.001	NA	
Cations							
Potassium	mg/l	0.003	0.007	0.01	0.003	0.31	10
Sodium	mg/l	0.215	0.234	0.253	0.215	8.28	
Magnesium	mg/l	0.01	0.011	0.012	0.012	0.22	
Calcium	mg/l	0.022	0.025	0.028	0.022	2.09	
Microbiology							
Coliforms	0	6	6.5	7	3	0	
E. coli	*0*	0	0	0	0	0	

TCN ESHIA,2019 =Transmission Company of Nigeria (TCN) Environmental Social and Health Impact Assessment

4.4.3 Surface Water Quality

Physicochemical Parameters

The summary results are shown in Table 4.3, while detailed results are provided in Appendix II.

The summary results are shown in Table 4.3, while detailed results are provided in Appendix II.
The pH values ranged from 7.3 to 8.7, with a mean value of 7.97. This falls within the WHO/FMEnv recommended range of 6.5-9.2, indicating that the water was slightly alkaline but still within acceptable limits. The temperature ranged from 29.2°C to 29.6°C, with a mean of 29.47°C, which is below the WHO/FMEnv limit of 40°C. This suggests that the water temperature was normal and does not indicate thermal pollution.

Electrical conductivity ranged from 60 to 62 µS/cm, with a mean value of 61.33 µS/cm. This is below the WHO/FMEnv limit of 250 µS/cm, showing that the water had low ionic concentration. Total dissolved solids ranged from 30 to 47 mg/l, with a mean value of 36 mg/l. Although no WHO/FMEnv limit was provided in the table, the low TDS value indicates that the water was not highly mineralized. Turbidity ranged from 0.1 to 1.2 NTU, with a mean value of 0.77 NTU, which is below the WHO/FMEnv limit of 5 NTU. This shows that the water was relatively clear and contained low levels of suspended particles.
Dissolved oxygen ranged from 4.71 to 4.82 mg/l, with a mean value of 4.76 mg/l. Although no WHO/FMEnv limit was provided, the values indicate moderate oxygen availability in the water. Total suspended solids ranged from 4.71 to 7.38 mg/l, with a mean of 6.12 mg/l. These values are relatively low, although no specific limit was provided for comparison. Biological oxygen demand ranged from 2.582 to 3.18 mg/l, with a mean value of 2.831 mg/l, while chemical oxygen demand ranged from 3.952 to 7.03 mg/l, with a mean of 5.382 mg/l. These values suggest some levels of organic and chemical oxygen demand, but they are not excessively high. Total hydrocarbons were not detected, indicating no obvious hydrocarbon pollution in the water.

The nutrient parameters were generally low. Nitrate ranged from 0.107 to 0.247 mg/l, with a mean of 0.167 mg/l, which is well below the WHO/FMEnv limit of 10 mg/l. Sulphate ranged from 38.95 to 51.7 mg/l, with a mean of 44.467 mg/l, also below the WHO/FMEnv limit of 100 mg/l. Phosphate ranged from 0.009 to 0.025 mg/l, with a mean value of 0.015 mg/l, which is far below the WHO/FMEnv limit of 5 mg/l. Ammonium was not detected. These results indicate that nutrient enrichment was low and that the water is not likely to be affected by serious nutrient pollution.

Most heavy metals were not detected in the water samples. Nickel, lead, copper, chromium, zinc, cadmium, barium, cobalt, arsenic, and mercury were all reported as not detected. This suggests that the water was not significantly contaminated by toxic heavy metals. Iron ranged from 0.028 to 0.063 mg/l, with a mean value of 0.048 mg/l. This is below the WHO/FMENV limit of 0.3 mg/l, indicating that iron concentration was within acceptable limits and is unlikely to cause taste, staining, or aesthetic problems.

The concentrations varied among the measured parameters. Potassium ranged from 2.983 to 5.29 mg/l, with a mean of 3.76 mg/l, which is below the WHO/FMEnv limit of 10 mg/l. Sodium ranged from 93.74 to 148.23 mg/l, with a mean of 118.237 mg/l. Although no limit was provided in the table, the sodium concentration is relatively higher than the other cations and may require monitoring, especially if the water is intended for people on sodium-restricted diets. Magnesium

and calcium were low, with mean values of 0.016 mg/l and 1.197 mg/l, respectively, suggesting that the water is soft and not highly mineralized.
The microbiological results are the main area of concern.

Coliform counts ranged from 2 to 8, with a mean value of 4.67. Since the WHO recommended limit for coliforms in drinking water is 0, the presence of coliform bacteria indicates that the water does not meet microbiological safety standards. This may suggest contamination from surface runoff, sewage intrusion, poor sanitation, or exposure of the water source to environmental pollutants. E. coli was absent in the sampled water, which is positive, although the control recorded a value of 2. However, the presence of coliforms alone still indicates that the water requires treatment before domestic or drinking use.

Table 4.3: Physicochemical Characteristics of Surface Water around the Project Area

Parameter	Unit	Min	Mean	Max	Control	TCN ESHIA 2019
pH		7.3	7.97	8.7	8	7.76
Temperature	°C	29.2	29.47	29.6	29.4	26.68
Electrical Conductivity E.C.	µs/cm	60	61.33	62	58.5	0.391
Total Dissolved Solids TDS	mg/l	30	36	47	30	169.2
Dissolved Oxygen DO	mg/l	4.71	4.76	4.82	4.81	2.59
Total Suspended Solids TSS	mg/l	4.71	6.12	7.38	5.58	NA
Turbidity	NTU	0.1	0.77	1.2	1.75	25.71
Biological Oxygen Demand BOD	mg/l	2.582	2.831	3.18	2.5035	3.34
Chemical Oxygen Demand COD	mg/l	3.952	5.382	7.03	4.658	4.01
Total Hydrocarbons THC	mg/l	ND	ND	ND	ND	NA
Nutrient						
Nitrate	mg/l	0.107	0.167	0.247	0.0995	0.181
Sulphate	mg/l	38.95	44.467	51.7	45.005	1.367
Ammonium	mg/l	ND	ND	ND	ND	NA
Phosphate	mg/l	0.009	0.015	0.025	0.0115	5.102
Heavy Metals						
Nickel	mg/l	ND	ND	ND	ND	1.213
Iron	mg/l	0.028	0.048	0.063	0.018	1.314
Lead	mg/l	ND	ND	ND	ND	NA
Copper	mg/l	ND	ND	ND	ND	NA
Chromium	mg/l	ND	ND	ND	ND	0.27
Zinc	mg/l	ND	ND	ND	ND	NA
Cadmium	mg/l	ND	ND	ND	ND	NA
Barium	mg/l	ND	ND	ND	ND	NA
Cobalt	mg/l	ND	ND	ND	ND	NA
Arsenic	mg/l	ND	ND	ND	ND	NA
Mercury	mg/l	ND	ND	ND	ND	NA
Cations						
Potassium	mg/l	2.983	3.76	5.29	3.5065	3.984
Sodium	mg/l	93.74	118.237	148.23	124.747	7.803

Parameter	Unit	Min	Mean	Max	Control	TCN ESHIA 2019
Magnesium	mg/l	0.01	0.016	0.02	0.3195	12.25
Calcium	mg/l	1.017	1.197	1.38	1.525	4.247
Microbiology						
Coliforms		2	4.67	8	11	NA
E.coli		0	0	0	2	NA

TCN ESHIA,2019 =Transmission Company of Nigeria (TCN) Environmental Social and Health Impact Assessment
Control = arithmetic mean of Control 1 and Control 2. Individual station results and coordinates are provided in Appendices I and II.

For Table 4.3, the value presented as "Control" represents the arithmetic mean of results obtained from two reference surface-water stations: Control 1 (4°31′40″N, 6°24′44″E) and Control 2 (4°32′40″N, 6°25′25″E). The stations were located outside the immediate Project footprint and were selected to provide reference conditions for comparison with Project-area sampling stations. Their locations are shown on the sampling-location map in Appendix I.

4.4.4 Sediment Quality

Physicochemical Parameters

The summary results are shown in Table 4.4, while detailed results are provided in Appendix II. The sediment temperature in the study area ranged from 27.2 to 28.8°C, with a mean of 27.97°C. The results were not significantly different from the control value of 28.8°C.

The sediment pH ranged from 6.14 to 6.27, with a mean of 6.19. The results were significantly lower than the control value of 6.27. Compared with previous studies, the new results were significantly lower than the previous ESHIA study. The sediment electrical conductivity ranged from 102.54 to 221.14 µS/cm, with a mean of 142.42 µS/cm. The results were not significantly different from the control value of 221.14 µS/cm.

The sediment TOC ranged from 0.21 to 1.6 g/kg, with a mean of 1.067 g/kg. The results were not significantly different from the control value of 1.6 g/kg. Sediment clay ranged from 0 to 9%, with a mean of 3%. Sediment silt ranged from 0 to 35%, with a mean of 11.667%, while sediment sand ranged from 56 to 100%, with a mean of 85.333%. These results were not significantly different from their respective control values.

Extractable nitrate ranged from 0.28 to 0.58 mg/kg, with a mean of 0.44 mg/kg. The results were not significantly different from the control value of 0.58 mg/kg. However, compared with previous studies, the new results were significantly higher than the previous ESHIA study.

Total nitrogen ranged from 0.43 to 0.81 mg/kg, with a mean of 0.62 mg/kg. The results were not significantly different from the control value of 0.81 mg/kg. Extractable sulphate ranged from 21 to 42 mg/kg, with a mean of 34 mg/kg. The results were significantly higher than the control value of 42 mg/kg. Compared with previous studies, the new results were significantly higher than the previous ESHIA study.

Sediment magnesium ranged from 0 to 13 mg/kg, with a mean of 4.333 mg/kg, while potassium ranged from 12 to 23 mg/kg, with a mean of 16.667 mg/kg. Both parameters were not significantly different from their respective control values. Sediment calcium ranged from 7 to 9 mg/kg, with a mean of 8.333 mg/kg. The results were significantly lower than the control value of 9 mg/kg.

Total iron ranged from 0.12 to 0.43 mg/kg, with a mean of 0.287 mg/kg. The results were significantly lower than the control value of 0.43 mg/kg. Compared with previous studies, the new results were significantly lower than the previous ESHIA study. Sediment HUB ranged from 0 to 1×10^2 cfu/g, with a mean of 0.67×10^2 cfu/g. The results were not significantly different from the control value of 1×10^2 cfu/g. Sediment coliform ranged from 0 to 9 MPN/g, with a mean of 4.3 MPN/g. The results were not significantly different from the control value of 9 MPN/g.

Table 4.4: Physicochemical Characteristics of the Sediment around the Project Area.

Parameter	Units	Method	Min	Mean	Max	Ctr	TCN ESHIA 2019
Temperature	°C	ASTM D 4972	27.2	27.97	28.8	27.75	NA
pH		ASTM D 4972	6.14	6.19	6.27	6.465	7.63
Electrical Conductivity	µS/cm	APHA 2510A	102.54	142.42	221.14	118.98	NA
ORGANICS							
Total Petro Hydrocarbon	mg/kg	USEPA 8015	ND	ND	ND	ND	NA
Total Organic Content	g/kg	BS 1377	0.21	1.067	1.6	0.53	NA
PSD							
Clay	%		ND	3	9	7	NA
Silt	%	ASTM D 422	ND	11.667	35	19	NA
Sand	%		56	85.333	100	74	NA
NUTRIENTS							
External Nitrate	mg/kg	EPA 352.1	0.28	0.44	0.58	0.305	0.188
Total Nitrogen	mg/kg	APHA 4500 N	0.43	0.62	0.81	0.48	NA
External Sulphate	mg/kg	CAEM/APHA 4500-SO_4	21	34	42	17	1.169
External Phosphate	mg/kg	CAEM/APHA 4500-PO_4	ND	0.167	0.5	17.95	3.742
CATIONS							
Magnesium	mg/kg	USEPA 6200	ND	4.333	13	10	NA
Potassium	mg/kg	USEPA 6200	12	16.667	23	20.5	NA
Calcium	mg/kg	USEPA 6200	7	8.333	9	15.5	NA
HEAVY METALS							
Manganese	mg/kg	USEPA 6200	7	8	9	25	1.17
Total Iron	mg/kg	USEPA 6200	0.12	0.287	0.43	0.45	1.288
Zinc	mg/kg	USEPA 6200	ND	ND	ND	ND	1.482
Total Chromium	mg/kg	USEPA 6200	ND	ND	ND	ND	0.22
Lead	mg/kg	USEPA 6200	ND	ND	ND	ND	0.081

Cadmium	mg/kg	USEPA 6200	ND	ND	ND	ND	NA
Mercury	mg/kg	USEPA 6200	ND	ND	ND	ND	NA
Vanadium	mg/kg	USEPA 6200	ND	ND	ND	ND	NA
Nickel	mg/kg	USEPA 6200	ND	ND	ND	ND	0.872
Barium	mg/kg	USEPA 6200	ND	ND	ND	ND	NA
MCB							
THB	X104 cfu/g	*ASTM D 932*	0	0	0	0	NA
HUB	X102 cfu/g	*ASTM D 932*	0	0.67	1	0	NA
THF	X103 cfu/g	ASTM C1338	0	0	0	0	NA
HUF	X102 cfu/g	ASTM C1338	0	0	0	0	NA
Coliform	X MPN/g	*ASTM D 932*	0	4.3	9	0	NA
SRB	x MPN/g	*ASTM D 932*	0	0	0	0	NA

TCN ESHIA = Environmental Impact Assessment was prepared for a Transmission Company of Nigeria (TCN) Power transmission project in 2019.

4.4.5 Soil Quality

Physicochemical Parameters

The summary results are shown in Table 4.5, while detailed results are provided in Appendix II.

The Topsoil and Sub-Soil's pH in the study area ranged from 5.67 to 7.97 and 5.65 to 8.02 respectively. Both Top-soil and Sub-soil results were not significantly different compared with the control of 6.325 and 6.015 respectively. Comparing the results with previous studies, the new results were not significantly different compared with the previous ESHIA study.
The Top-Soil and Sub-Soil's EC in the study area ranged from 98 to 195µS/cm and 113 to 186µS/cm respectively. Both Top-soil and Sub-soil results were not significantly different compared with the control of 167µS/cm and 131.5µS/cm, respectively. Comparing the results with previous studies the new results were significantly higher than the previous ESHIA study.

The Top-Soil and Sub-Soil's Temperature in the study area ranged from 28.4 to 31.8° and 28.2 to 31.4°C respectively. Both Top-soil and Sub-soil results were not significantly different compared with the control of 29.35°C and 28.5°C respectively.

The Top-Soil and Sub-Soil's Nitrate in the study area ranged from 0.38 to 1.03mg/kg and 0.11 to 1mg/kg respectively. Both Top-soil and Sub-soil results were not significantly different compared with the control of 0.895mg/kg and 0.745mg/kg respectively. Comparing the results with previous the new results were significantly lower than the previous ESHIA study.

The Top-Soil and Sub-Soil's Ammonia in the study area ranged from 0.8 to 2.24mg/kg and 0.97 to 4.21mg/kg respectively. Both Top-soil and Sub-soil results were not significantly different compared with the control of 0.985mg/kg and 2.415mg/kg respectively.

The Top-Soil and Sub-Soil's Phosphate in the study area ranged from 0.56 to 2.22mg/kg and 7.23 to 23.21mg/kg respectively. Both Top-soil and Sub-soil results were not significantly different compared with the control of 1.62mg/kg and 7.83mg/kg respectively. Comparing the results with previous, the new results were not significantly different compared with the previous ESHIA study.

The Top-Soil and Sub-Soil's Chloride in the study area ranged from 0.87 to 2.98mg/kg and 0.79 to 6.21mg/kg respectively. Both Top-soil and Sub-soil results were not significantly different compared with the control of 2.06mg/kg and 0.97mg/kg respectively.

The Top-Soil and Sub-Soil's TOC in the study area ranged from 0.63 to 1.05% and 0.69 to 1.11% respectively. Both Top-soil and Sub-soil results were significantly lower than the control of 1.145% and 1.23% respectively.

The Top-Soil and Sub-Soil's Polynuclear Aromatic Hydrocarbon in the study area ranged from 0 to 0.11mg/kg and 0 to 0.09mg/kg respectively.

The Top-Soil and Sub-Soil's Moisture Content in the study area ranged from 6.74 to 8.75% and

6.37 to 9.12% respectively. Both Top-soil and Sub-soil results were not significantly different compared with the control of 8.605% and 9.24% respectively.

The Top-Soil and Sub-Soil's Porosity in the study area ranged from 27.36 to 40.63% and 26.42 to 41.12% respectively. Both Top-soil and Sub-soil results were not significantly different compared with the control of 32.42% and 29.385% respectively.

The Top-Soil and Sub-Soil's Sand in the study area ranged from 6.81 to 33.2% and 5.71 to 33.29% respectively. Both Top-soil and Sub-soil results were not significantly different compared with the control of 26.995% and 24.72% respectively. Comparing the results with previous studies the new results were significantly lower than the previous ESHIA study.

The Top-Soil and Sub-Soil's Silt in the study area ranged from 1.57 to 58.14% and 0.66 to 59.25% respectively. Both Top-soil and Sub-soil results were not significantly different compared with the control of 10.81% and 18.465% respectively. Comparing the results with previous studies the new results were not significantly different compared with the previous ESHIA study.

The Top-Soil and Sub-Soil's Clay in the study area ranged from 24.94 to 91.62% and 28.93 to 93.63% respectively. Both Top-soil and Sub-soil results were not significantly different compared with the control of 62.2% and 56.81% respectively. Comparing the results with previous studies the new results were significantly higher than the previous ESHIA study.

The magnesium concentrations in the topsoil and subsoil were not significantly different from the control values, suggesting that the levels are within the natural background range of the area. However, the concentrations were significantly higher than those reported in the previous ESHIA study, possibly due to temporal changes in environmental conditions, land-use activities, weathering processes, seasonal variations, or differences in sampling and analytical methods.

The Top-Soil and Sub-Soil's Potassium in the study area ranged from 2.43 to 7.16mg/kg and 2.75 to 9.18mg/kg respectively. Both Top-soil and Sub-soil results were not significantly different compared with the control of 4.755mg/kg and 6.08mg/kg respectively.

The Top-Soil and Sub-Soil's Sodium in the study area ranged from 9.1 to 17.69mg/kg and 8.81 to 14.66mg/kg respectively. Both Top-soil and Sub-soil results were not significantly different compared with the control of 12.365mg/kg and 12.525mg/kg respectively.

The copper concentrations in the topsoil and subsoil were significantly higher than the control values but remained within the FMEnv permissible limit. However, the concentrations were significantly lower than those reported in the previous ESHIA study, possibly due to reduced anthropogenic inputs, natural attenuation processes, changes in land-use activities, or differences in sampling locations, periods, and analytical methods between the studies.

The Top-Soil and Sub-Soil's Chromium in the study area ranged from 1.32 to 1.89mg/kg and 1.23 to 1.82mg/kg respectively. Both Top-soil and Sub-soil results were significantly higher than the control of 1.005mg/kg and 1.205mg/kg respectively. This is within the FMEnv limit. Comparing

the results with previous studies the new results were significantly higher than the previous ESHIA study.

The Top-Soil and Sub-Soil's Cadmium in the study area ranged from 0.68 to 1.29mg/kg and 0.62 to 1.32mg/kg respectively. Both Top-soil and Sub-soil results were not significantly different compared with the control of 0.825mg/kg and 0.845mg/kg respectively. This is within the FMEnv limit. Comparing the results with previous studies, the new results were significantly higher than the previous ESHIA study. The Top-Soil and Sub-Soil's Nickel in the study area ranged from 0.69 to 2.39mg/kg and 0.67 to 2.09mg/kg respectively. Both Top-soil and Sub-soil results were not significantly different compared with the control of 0.765mg/kg and 0.72mg/kg respectively. This is within the FMEnv limit. Comparing the results with previous studies the new results were not significantly different compared with the previous ESHIA study.

The Top-Soil and Sub-Soil's Iron in the study area ranged from 97.18 to 299.43mg/kg and 94.62 to 293.12mg/kg respectively. Both Top-soil and Sub-soil results were not significantly different compared with the control of 183.62mg/kg and 184.825mg/kg respectively. This is within the FMEnv limit. Comparing the results with previous studies the new results were significantly higher than the previous ESHIA study.

The Top-Soil and Sub-Soil's Lead in the study area ranged from 0.84 to 1.75mg/kg and 0.89 to 1.94mg/kg respectively. Both Top-soil and Sub-soil results were not significantly different compared with the control of 1.09mg/kg and 0.955mg/kg respectively. Comparing the results with previous studies the new results were significantly higher than the previous ESHIA study. The Topsoil and Sub-Soil's Zinc in the study area ranged from 5.17 to 9.29mg/kg and 5.13 to 9.16mg/kg respectively. Both Top-soil and Sub-soil results were significantly lower than the control of 10.075mg/kg and 8.715mg/kg respectively. Comparing the results with previous studies the new results were significantly higher than the previous ESHIA study.

Table 4.5: Physicochemical Characteristics of Soil Quality around the Project Area

Sample ID			MIN		MEAN		MAX		CTR		TCN ESHIA2019	
Description (Depth)			(0-15cm)	(15-30cm)	(0-15cm)	(15-30cm)	(0-15cm)	(15-30cm)	(0-15cm)	(15-30cm)	(0-15cm)	(15-30cm)
pH		APHA 4500-H+	5.67	5.65	6.69	6.79	7.97	8.02	6.325	6.015	5.9	5.4
EC	µS/cm	APHA 2510 B	98	113	162.76	144.56	195	186	167	131.5	87.84	160.3
Temperature	°C	ASTM E2877	28.4	28.2	30.63	29.99	31.8	31.4	29.35	28.5	NA	NA
Nitrate	mg/kg	APHA 4500-NO_3-E	0.38	0.11	0.63	0.46	1.03	1	0.895	0.745	3.89	5.85
Ammonia	mg/kg	APHA 4500-NH_3C	0.8	0.97	1.13	2.57	2.24	4.21	0.985	2.415	NA	NA
Phosphate	mg/kg	APHA 4500-PE	0.56	7.23	1.14	12.5	2.22	23.21	1.62	7.83	1.8	1.35
Sulphate	mg/kg	EPA375.4 (600/4-79-020)	12.11	0.12	14.04	1.95	16.01	4.31	10.67	1.34	21.83	22.08
Chloride	mg/kg	APHA 4500-Cl-B	0.87	0.79	1.7	3.11	2.98	6.21	2.06	0.97	NS	NS
TOC	%	APHA 2340 A	0.63	0.69	0.87	0.85	1.05	1.11	1.145	1.23	NS	NS
Oil & Grease	mg/kg	API-RP 45	ND	ND	ND	ND	ND	ND	ND	ND	NS	NS
THC	mg/kg	APHA 5210A	ND	ND	ND	ND	ND	ND	ND	ND	NS	NS
TPH	mg/kg	EPA 3580A,3550C,8015C	ND	ND	ND	ND	ND	ND	ND	ND	NS	NS
PAHs	mg/kg	EPA 8270D	ND	ND	0.02	0.01	0.11	0.09	ND	ND	NS	NS
BTEX	mg/kg	EPA 8260B	ND	ND	ND	ND	ND	ND	ND	ND	NS	NS
PSD												NS
Moisture Content	%	ASTM D2216-05	6.74	6.37	7.73	7.64	8.75	9.12	8.605	9.24	NS	NS
Porosity	%		27.36	26.42	32.92	33.84	40.63	41.12	32.42	29.38	NS	NS
Sand	%	APHA 3111B, 311D	6.81	5.71	19.47	23.21	33.2	33.29	26.995	24.72	NS	73.6
Silt	%	APHA 3111B, 311D	1.57	0.66	18.07	21.7	58.14	59.25	10.81	18.46	NS	16.7
Clay	%	APHA 3111B, 311D	24.94	28.93	62.46	55.09	91.62	93.63	62.2	56.81	NS	9.71
CATIONS												
Magnesium	mg/kg	APHA 3111B	22.75	19.09	31.59	29.63	40.62	36.16	27.165	25.26	0.79	0.92
Potassium	mg/kg	APHA 3111B	2.43	2.75	5.33	5.41	7.16	9.18	4.755	6.08	NS	NS
Sodium	mg/kg	APHA 3111B	9.1	8.81	12.25	11.98	17.69	14.66	12.365	12.52	NS	NS
HEAVY METALS												
Copper	mg/kg	APHA 3111B	3.44	3.63	4.19	3.98	4.97	4.51	2	1.825	6.17	8.03
Chromium	mg/kg	APHA 3111B	1.32	1.23	1.53	1.52	1.89	1.82	1.005	1.205	0.72	1.46
Cadmium	mg/kg	APHA 3111B	0.68	0.62	1.03	0.95	1.29	1.32	0.825	0.845	0.56	0.56
Nickel	mg/kg	APHA 3111B	0.69	0.67	1.45	1.31	2.39	2.09	0.765	0.72	0.75	0.98
Arsenic	mg/kg	APHA 3111B	ND	ND	ND	ND	ND	ND	ND	ND	0.27	0.31
Iron	mg/kg	APHA 3111B	97.18	94.62	170.59	160.41	299.43	293.12	183.62	184.8	90.91	118.3
Mercury	mg/kg	APHA 3111B	ND	ND	ND	ND	ND	ND	ND	ND		
Lead	mg/kg	APHA 3111B	0.84	0.89	1.35	1.38	1.75	1.94	1.09	0.955	0.23	0.16
Zinc	mg/kg	APHA 3111B	5.17	5.13	7.05	7.2	9.29	9.16	10.075	8.715	1.11	1.09
Manganese	mg/kg	APHA 3111B	1.3	1.21	1.97	1.99	3.43	3.2	1.83	1.975	5.77	7.99
MCB												
Total Heterotrophic Bacteria	cfu/ml	**MBG3350**	0	0	0	0	0	0	0	0	0	0
Hydrocarbon Utilizing Bacteria	cfu/ml	**MBG3350**	0	0	0	0	0	0	0	0	0	0
Total Heterotrophic Fungi	cfu/ml	**MBG3350**	0	0	0	0	0	0	0	0	0	0
Hydrocarbon Utilizing Fungi	cfu/ml	**MBG3350**	0	0	0	0	0	0	0	0	0	0
E. coli	*MPN/100ml*	**MBG3350**	0	0	1.14	0.14	3	1	1	3	1	1

TCN ESHIA = Environmental Impact Assessment was prepared for a Transmission Company of Nigeria (TCN) Power transmission project in 2019.

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4.4.6 Planktonic and Benthic Fauna

Planktons

According to Thurman (1977), the word plankton was from the Greek word planktons meaning drifters. They usually refer to the large class of microscopic organisms (2-200 micrometre) carried around by the water current in any natural body of water. Biologists have divided plankton into two (2) classes; phytoplankton and zooplankton. The phytoplankton is free-floating organisms of the water body that undergo photosynthesis with the help of chlorophyll and thereby contribute to primary production in their endemic aquatic environment. The zooplankton, on the other hand, is the animal component of the plankton spectrum.

Phytoplankton

Species Composition and Abundance

A checklist of the phytoplankton found within the freshwater habitat around the project area is presented in Table 4.6. They include the Diatoms (Division – Bacillariophyta), Blue-green algae (Division – Cyanophyta), Euglenoids (Division - Euglenophyta) and Chlorophytes (Division – Chlorophyta). This study recorded four (4) major divisions, four (4) classes, seven (7) orders, and twenty (20) species. The dominant group of phytoplankton was the Diatoms, 53.0% (Centrales, 10%, Pennales, 43%), followed by the Blue-green algae, 20.5% (Chroocales, 4.4% Hormogonales, 16.1%) and Chlorophytes (Chlorococales, 10.4%, Zygnematales, 6.3%) and Euglenoids (Euglenales, 12.1%) (Table 4.9, Figure 4-1 and Figure 4-4). The diatoms were the notable group among the phytoplankton identified in the water body. This was similar to previous studies around the project area.

Table 4.6: Checklist and Distribution, Abundance and Diversity of Phytoplanktons in Freshwater habitat around the Project Area.

Phytoplankton Taxa	SW 1	SW 2	SW 3	CTRL 1	CTRL 2
DIVISION – BACILLARIOPHYTA					
CLASS-BACILLARIOPHYCEAE					
ORDER I – CENTRALES					
Aulecoseira granulate	12	0	17	12	11
Cyclotella menighiniana	12	1	4	4	16
Total	**24**	**1**	**21**	**16**	**27**
Order II – PENNALES					
Diatomaelongatum (Lyngb)	1	13	15	7	14
Fragillariaconstruena	8	11	8	7	3
Gomphonemaparvulum	6	11	5	9	16
Melosira sp	9	18	8	5	13
Naviculacuspidata	5	11	5	6	11
Pinnularia major	17	18	0	10	12
Surirellastriatula	7	10	11	2	17
Synedra ulna	3	0	18	13	5
Total	**56**	**92**	**70**	**59**	**91**
DIVISION – CYANOPHYTA					
CLASS – CYANOPHYCEAE					
Order – CHROOCOCALES					
Microcystis aureginosa	7	4	12	2	4
Order – HORMOGONALES					
Lynbyalimnetica	6	15	0	17	18
Oscillatoria borneti	1	6	3	4	4
Oscillatoria curviceps	17	6	5	13	1
Oscillatoria sp	16	0	9	7	3
Total	**40**	**27**	**17**	**41**	**26**
DIVISION - EUGLENOPHYTA					
CLASS - EUGLENOPHYCEAE					

Phytoplankton Taxa	**SW 1**	**SW 2**	**SW 3**	**CTRL 1**	**CTRL 2**
ORDER - EUGLENALES					
Euglena acus	7	1	3	10	9
Phacusacuminatus	10	0	14	7	6
Trachelomonashispida	13	0	15	7	12
Total	**30**	**1**	**32**	**24**	**27**
DIVISION – CHLOROPHYTA					
CLASS – CHLOROPHYCEAE					
ORDER –CHLOROCOCALES					
Scenedesmus obliquus	0	13	3	4	7
Closterium ehrenbergii	10	12	16	16	14
Total	**10**	**25**	**19**	**20**	**21**
ORDER - ZYGNEMATALES					
Gonatozygon monotaenium	16	3	14	11	14
Ecological Indices					
Taxa_S	20	16	19	21	21
Individuals	183	153	185	173	210
Dominance_D	0.06411	0.08189	0.06729	0.05984	0.06018
Shannon_H	2.837	2.588	2.796	2.913	2.893
Simpson_1-D	0.9359	0.9181	0.9327	0.9402	0.9398
Evenness_e^H/S	0.853	0.8315	0.8621	0.8769	0.8594
Menhinick	1.478	1.294	1.397	1.597	1.449
Margalef	3.647	2.982	3.448	3.881	3.74
Equitability_J	0.9469	0.9335	0.9496	0.9568	0.9502
Fisher_alpha	5.72	4.5	5.308	6.26	5.809

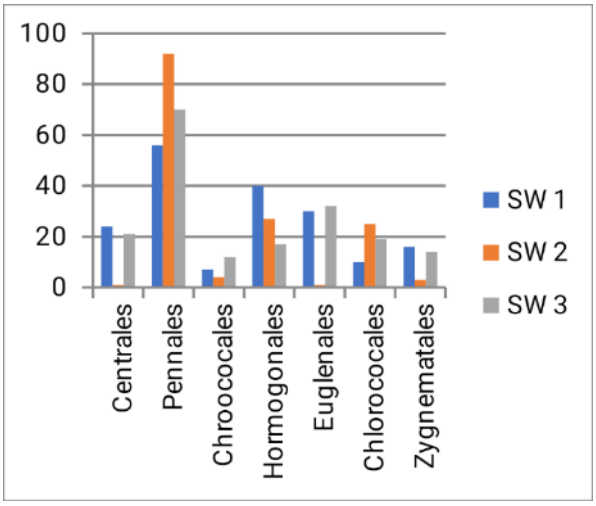

Figure 4-1: Relative Abundance and Distribution of Phytoplankton around the Project Area

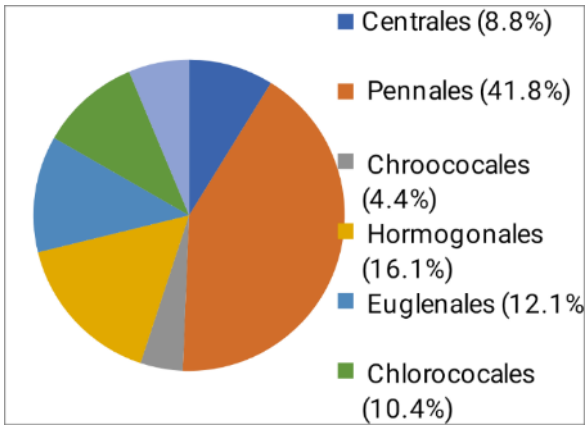

Figure 4-2: Relative Percentage Abundance of Phytoplankton around the Project Area

Distribution and Species Diversity

The spatial distribution of the phytoplankton in the various sampled stations at the project area showed that all the species were moderately dispersed with the highest dominance in Station 2 (Dominance, 0.082). Station 2 had the lowest diversity (Shannon index, 2.588, Simpson index, 0,918) compared with Stations 1 (Shannon index, 2.837, Simpson index, 0,936) and Station 3 (Shannon index, 2.837, Simpson index, 0,933).

The diversity of phytoplankton within the project area was moderate but lower than that recorded at the control stations, likely due to localized environmental conditions such as nutrient fluctuations, turbidity, and anthropogenic disturbances that may affect species distribution and abundance. The increase in diversity indices and corresponding decrease in dominance indicate a more balanced phytoplankton community with greater species richness and evenness, as dominance typically declines with increasing diversity. This pattern is consistent with previous studies conducted in and around the project area, which reported similar phytoplankton community characteristics under the prevailing ecological conditions of the Niger Delta environment

Zooplanktons

Species Composition and Abundance

The project area recorded two (2) phyla, three (3) classes, three (3) orders, and twelve (12) species. The dominant group was the crustacean (Copepoda, 30.4%; and Cladocera, 41.7%) and the crustacean (Copepoda, 31.0%; and Cladocera, 33.0%). The phylum Rotifera has the class Monigonota having 27.9% (Figure 4-9). The checklist of the zooplankton around the project area is presented in Tables 4-10 and 4-11.

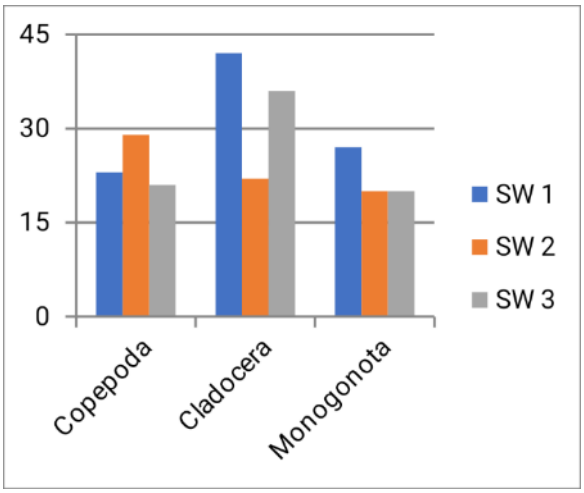

Figure 4-3: Relative Abundance and Distribution of Zooplankton around the Project Area.

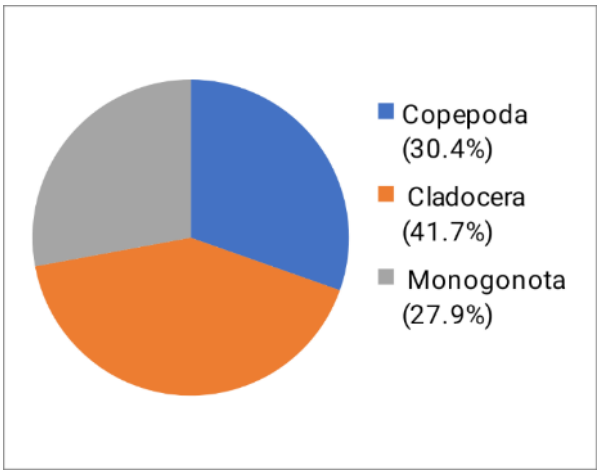

Figure 4-4: Relative Percentage Abundance of Zooplanktons around the Project Area.

Table 4.7: Checklist, Distribution and Diversity of Zooplanktons in Freshwater habitat around the Project Area

Zooplankton Taxa	**SW1**	**SW2**	**SW3**	**CTRL 1**	**CTRL 2**
PHYLUM - CRUSTACEA					
CLASS –COPEPODA					
ORDER - CYCLOPIODA					
Cyclops strenus	18	16	10	13	11
Eucyclopssp	5	13	11	11	7
Total	**23**	**29**	**21**	**24**	**18**
CLASS - CLADOCERA					
ORDER - EUCLADOCERA					
Neutrodiaptonussp	17	11	16	6	16
Bosmina sp	15	4	14	18	5
Diaphiasp	10	7	6	18	10
Total	**42**	**22**	**36**	**42**	**31**
PHYLUM - ROTIFERA					
CLASS - MONOGONOTA					
ORDER - PLOIMA					
Moinaaffins	7	5	15	14	11
Lecanesp	14	6	16	7	8
Keratellasp	6	9	9	12	4
Total	**27**	**20**	**40**	**33**	**23**
Ecological Indices					
Taxa_S	8	8	8	8	8
Individuals	92	71	91	99	72
Dominance_D	0.147	0.1494	0.1433	0.1391	0.1451
Shannon_H	1.987	1.983	1.997	2.02	1.999
Simpson_1-D	0.853	0.8506	0.8567	0.8609	0.8549
Evenness_e^H/S	0.9117	0.9085	0.9211	0.9425	0.9227
Menhinick	0.8341	0.9494	0.8386	0.804	0.9428
Margalef	1.548	1.642	1.552	1.523	1.637
Equitability_J	0.9555	0.9539	0.9605	0.9715	0.9613

Fisher_alpha	2.105	2.315	2.113	2.053	2.303

Table 4.8: Distribution, Abundance and Diversity of Benthic Fauna in Freshwater habitat around the Project Area

BENTHOS TAXA	**SW 1**	**SW 2**	**SW 3**	**CTRL 1**	**CTRL 2**
PHYLUM - MOLLUSCA					
CLASS - GASTROPODA					
Tympanotomusfuscatus	1	1	0	0	2
Neritina glabarata	0	0	0	1	3
Total	**3**	**2**	**2**	**4**	**7**
CLASS - BIVALVA					
Aloidis trigona	1	2	1	0	2
Tellina nymphalis	0	0	1	0	0
Total	**1**	**2**	**2**	**0**	**3**
PHYLUM - ANNELIDA					
CLASS - POLYCHAETA					
Nereis lamellose	0	0	0	1	2
PHYLUM - ARTHROPODA					
CLASS – INSECTA					
Chironomoussp	1	0	0	4	1
Ecological Indices					
Taxa_S	4	3	3	4	7
Individuals	5	4	4	9	13
Dominance_D	0.28	0.375	0.375	0.3333	0.1598
Shannon_H	1.332	1.04	1.04	1.215	1.885
Simpson_1-D	0.72	0.625	0.625	0.6667	0.8402
Evenness_e^H/S	0.9473	0.9428	0.9428	0.8425	0.9408
Menhinick	1.789	1.5	1.5	1.333	1.941
Margalef	1.864	1.443	1.443	1.365	2.339
Equitability_J	0.961	0.9464	0.9464	0.8764	0.9686
Fisher_alpha	9.284	5.453	5.453	2.759	6.182

Species Distribution and Diversity

The spatial distribution of the zooplankton in the various sampled stations showed that all the species were moderately dispersed, with the highest dominance in Station 3 (Dominance, 0.143). The diversity of the zooplankton varies across the sampling stations; Station 1 (Shannon index, 1.987, Simpson index, 0.853, Margalef, 1.548), Station 2 (Shannon index, 1.983, Simpson index, 0.851, Margalef, 1.642) and Station 3 (Shannon index, 1.997, Simpson index, 0,857, Margalef, 1.552). Thus, the diversity of zooplanktons around the project area is moderate but lower than the control stations. This is similar to that reported in previous studies around the project area.

Benthic fauna

Species composition and Abundance

The project area recorded three (3) phyla, four (4) classes, and eight (8) species. The dominant group was the gastropods for dry (gastropoda, 53.8%, bivalve, 38.5%, insect, 18.0%, polychaeta, 4.0%) and wet (gastropoda, 61.0%, bivalve, 19.0%, insect, 7.70%, polychaeta, 0.0%). The checklist of the benthic organisms found within the project area of influence is presented in Figures 4-11 and 4-12.

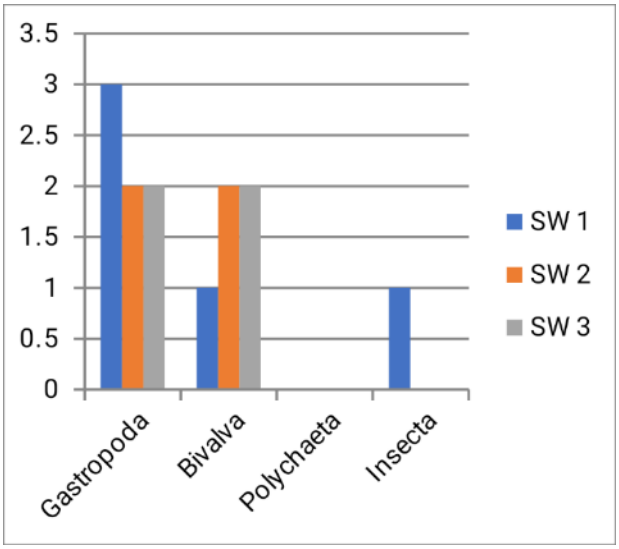

Figure 4.5: Relative Abundance and Distribution of Benthic Fauna around the Project Area.

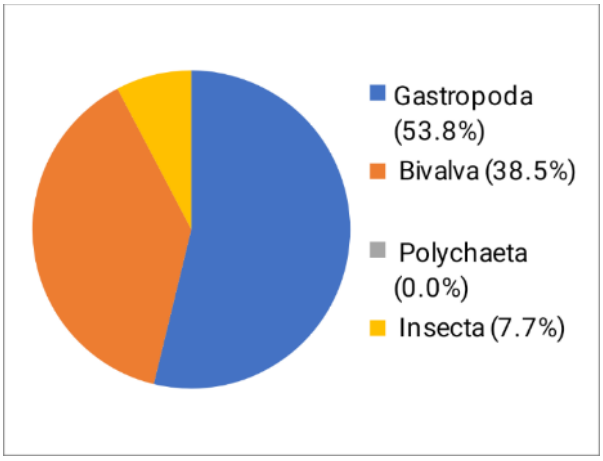

Figure 4.6: Relative Percentage Abundance of Benthos around the Project Area

Species Distribution and Diversity

The spatial distribution of the benthic macroinvertebrates in the various sampled stations in the project area showed that all the species were sparsely dispersed with the highest dominance in Station 2 (Dominance, 0.375) and Station 3 (Dominance, 0.375). The diversity of the benthic macroinvertebrates

varies across the sampling stations; Station 1 (Shannon index, 1.332, Simpson index, 0.720, Margalef, 1864), Station 2 (Shannon index, 1.040, Simpson index, 0.625, Margalef, 1.443) and Station 3 (Shannon index, 1.040, Simpson index, 0,625, Margalef, 1.443). Thus, the diversity of the benthos around the project area is low and lower than the control stations. This is similar to that reported in previous studies around the project area.

4.4.7 Fish and Fisheries

Fisheries Gear and Methods

The fishing gears used by fishermen in the area were bamboo traps (Oparun), cast-nets (obiriki), gill nets (atafo), setnets (Atamu), pole and hooks (Poro), basket traps (Igun/ Ogun), longline (Ewoolokun), Manatee trap (Ipa), Net trap (Keteku) and liftnets (Awo Salapore). A gillnet is like a netting wall hanging vertically in the water by the combined actions of the floats (slippers, raphia) attached to the headline and the lead/ stone sinkers attached at intervals of (1.35 – 2.00) metres to the footrope to sink the net to the waterbed while the floats attached at intervals of (1.1 – 1.95) meters to the headline which allow the heads of the net to float thereby maintaining the vertical opening of the net. These nets are operated day and night throughout the year (rainy and dry season).

Cast nets are conical in shape, and panels vary from 3 to 4 panels. The sinkers are leads with weights ranging from 46.0 – 86.0 g and are attached to the footrope at almost regular intervals. The numbers of sinkers ranged between 71 and 100, depending on the net size. The cast nets are operated for between 3 to 4 hours per trip, either during the day or at night. Both men and women use this net throughout the year.

The longline consists of a mainline with twine ganglions of variable length (0.25 to 0.35m) spaced 1.5 – 3 m apart. The landlines were coiled in a round plastic tub or basket with cork rims for fixing the hooks. Each tub contains between 300 and 500 hooks. The most commonly used hook design in the project area was ‘Mustard’ round bent flattened hooks. It is operated throughout the year, targeting fish species like *Gymnarchus niloticus*, *Sphyreana barracuda, Clarias gariepinus*, etc.

Drum traps are constructed using a small drum covered with wire gauze. It is operated by placing 1or 2 female *Chrysichthys filamentosus*, making a croaking sound to entice the male counterpart. Pole and hook are constructed using poles and hook. It is baited with fish fry, earthworm, and *Batanga lebritonis*. It is operated by pegging them at the lagoon/ creek banks.Net traps are constructed using polyamide and polyethylene in domed shape with the valve of non – return and framed with sticks and canes. The trap is set overnight (5 pm to 6 am). It is either operated by one or two people. The traps are operated four (4) times a week. Lift net is constructed from a mosquito net (0.33mm mesh size) and sticks. It is operated by using light from a lantern and a generator to attack insects which served as bait for *Pellonula afzelluisi*.

Species Composition, Catch Composition and Activities

A total of fifteen fish species belonging to seven families, which include; Bagridae, Cichlidae, Chanidae, Claridae, Citharinidae, Mochokidae, and Phractolaemidae, were caught from the project area. The fishes caught at the project area include fries, juveniles and adult fishes, indicating that there was active breeding occurring in the area where the fishing occurs. Typically fishing often occurs in the freshwater mangrove because such areas are breeding grounds for many species and have submerged structures and vegetation, which create a conducive environment for freshwater fishes to inhabit with minimal risk of drifting. Unfortunately, this area is often the most disturbed by anthropogenic activities.

A notable seasonal influence observed in the study was the higher occurrence and abundance of most fish species during the wet season. This increase is likely associated with enhanced water levels, expanded

breeding and nursery habitats, increased food availability, and improved connectivity between aquatic environments during periods of flooding. Species such as *Tilapia zilli*, *Channa obscura*, *Clarias anguillaris*, and other dominant taxa were reported more frequently during the wet season, reflecting favorable ecological conditions for growth, reproduction, and migration. In contrast, rare species such as *Chrysichthys nigrodigitatus* and *Chrysichthys filamentosus* remained scarce throughout the study period, suggesting either low population densities, restricted habitat preferences, or limited seasonal movements within the project area.

Fish Species and Conservation Concern

The International Union for the Conservation of Nature and Natural Reserve (IUCN2024; presently called the World Conservation Union) evaluates the endangerment of taxa (regardless of trade), placing species of concern into three categories on its so-called Red List, starting with the most imperilled: Not evaluated (NE), least concern (LC), near threaten (NT), critically endangered (CR), endangered (EN), and vulnerable (VU). Using the standard IUCN Red List Categories and Criteria (Version 3.1), The Table 4.9 below listed the fish species observed in the study area and confirmed their IUCN red list status (www.iucnredlist.org). All the fishes identified in the Project area are either not evaluated (NE) or of least concern (LC).

Table 4.9: Fish Species Observed in the Study Area

Common Name	Scientific Name	Habitat	IUCN Status*
African Catfish	*Clarias gariepinus*	Freshwater rivers and creeks	LC
Nile Tilapia	*Oreochromis niloticus*	Freshwater and brackish waters	LC
Bagrid Catfish	*Chrysichthys nigrodigitatus*	Brackish and estuarine waters	LC
Mudskipper	*Periophthalmus papilio*	Mangrove swamps and mudflats	LC
Flathead Grey Mullet	*Mugil cephalus*	Coastal and estuarine waters	LC
West African Ladyfish	*Elops lacerta*	Coastal and estuarine waters	LC
Bonga Shad	*Sardinella maderensis*	Marine and coastal waters	LC
Giant African Threadfin	*Polydactylus quadrifilis*	Coastal waters and estuaries	LC
Silver Catfish	*Chrysichthys auratus*	Freshwater rivers and creeks	LC
Upside-down Catfish	*Synodontis budgetti*	Freshwater rivers	LC
Featherfin Squeaker	*Synodontis eupterus*	Freshwater rivers	LC
African Carp	*Labeo coubie*	Freshwater rivers	LC
Tarpon	*Megalops atlanticus*	Coastal waters and estuaries	LC
Sea Catfish	*Arius* spp.	Estuarine and marine waters	NE/LC
Croaker	*Pseudotolithus* spp.	Coastal and marine waters	LC

The IUCN Red List of Threatened Species. Version 2023-1. **International Union for Conservation of Nature.**

4.4.8 Vegetation Studies

The Vegetation type is reported predominantly freshwater swamp forest. This is a natural habitat with a diversity of plant species in grasses, herbs, shrubs and trees. There were forty-nine (49) plant species belonging to twenty-six (26) families. The families of plants around the project area include; Convolvulaceae, Moraceae, Anacardiaceae, Tapocynaceae, Araceae, Arecaceae, Asteraceae, Cannabaceae, Coataceae, Combretaceae, Commelinaceae, Convolvulaceae, Cyperaceae, Euphorbiaceae, Fabaceae, Irvingiaceae, Lamiaceae, Meliaceae, Mimosoideae, Musaceae, Ochnaceae, Onagraceae, Poaceae, Rubiaceae, Urticaceae, and Zingiberaceae. The family poaceae dominated the forest.

Three distinct canopy layers characterise the forest. The first canopy layer (stratum) consists of large and tall trees reaching 35 - 40m high and above and with crowns up to 20m wide. The floristic composition of this layer is represented by *Alstonia boonei, Erythrophleums uaveolens, Lophira alata, Pausinystelia johimbe, Antiaris africana*, and *Lophira alata.* Species in this stratum mainly possess plank-like buttresses and are visibly raised above other species and scattered throughout the forest. Some have flattened or umbrella-shaped canopies (crowns), which are rarely in lateral contact with each other.

The second stratum is characterised by tree species 20 – 30m high. The stratum is open though occasional contacts of crowns of some species do occur. Characteristic species of this stratum (middle layer) include *Elaeis guineensis, Raphia hookeri, Afromamum spp, Costusafer, Palisota spp Zanthoxylum gilletii, Vernonia conferta, Spondiasmombin, Myrianthus arboreus, and Mussangacercropoides.* Species of this stratum have narrower crowns and are more diverse in floristic composition than the first stratum.

The highest group of plant species with the highest relative important values (RIV) ranging from 3.58 to 4.29 RIV include; *Ipomoea involucrata, Alstonia boonei, Erythrophleum suaveolens, Lophira alata, Pausinystalia johimbe, Antiaris africana and Aframamum meleguata.*

The vegetation data suggest that species diversity remains relatively stable throughout the year, while seasonal influences primarily affect abundance, growth, regeneration, and biomass of herbaceous and understory species rather than the composition of dominant tree species. The dominance of Poaceae and the persistence of high-RIV tree species indicate a plant community well adapted to seasonal flooding.

Table 4.10: Species composition and Relative Importance Value (RIV) of the Herbaceous Flora of the Study Area

S/No.	Species	Family	Type	IUCN Status	RIV
1	*Ipomoea involucrata*	Convolvulaceae	Herb	Not Evaluated	4.298
2	*Alstoniaboonei*	Convolvulaceae	Macrophytes	Not Evaluated	4.003
3	*Erythrophleumsuaveolens*	Fabaceae	Tree	Least Concern	3.901
4	*Lophiraalata*	Ochnaceae	Tree	Vulnerable	3.734
5	*Pausinystaliajohimbe*	Rubiaceae	Tree	Least Concern	3.700
6	*Antiarisafricana*	Moraceae	Tree	Not Evaluated	3.675
7	*Aframamummeleguata*	Zingiberaceae	Herb	Least Concern	3.580
8	*Costusafer*	Coataceae	Herb	Vulnerable	3.475
9	*Palisotahirsuta*	Commelinaceae	Shrub	Not Evaluated	3.420
10	*Zanthoxylum gilletii*	Rutaceae	Tree	Least Concern	3.401
11	*Spondiasmombin*	Anacardiaceae	Tree	Not Evaluated	3.394
12	*Myrianthusarboreus*	Urticaceae	Tree	Not Evaluated	3.345
13	*Musangacercropioides*	Urticaceae	Tree	Not Evaluated	3.293
14	*Ludwigiadecurens*	Onagraceae	Herb	Not Evaluated	3.225
15	*Sporobolus pyramidalis*	Poaceae	Grass	Not Evaluated	2.829
16	*Hyptissuaveolens*	Lamiaceae	Herb	Not Evaluated	2.804
17	*Manihot esculentus*	Euphorbiaceae	Agro-plant	Not Evaluated	2.444
18	*Alchorneacordiflora*	Euphorbiaceae	Tree	Not Evaluated	2.383
19	*Rhynchelytrumrepens*	Poaceae	Grass	Not Evaluated	2.370
20	*Andropogungayanus*	Poaceae	Grass	Not Evaluated	2.264
21	*Commelinadiffusa*	Commelinaceae	Climbers	Not Evaluated	2.009
22	*Alchornelaxiflora*	Euphorbiaceae	Tree	Not Evaluated	1.980
23	*Panicum maximum*	Poaceae	Grass	Not Evaluated	1.868
24	*Panicum laxum*	Poaceae	Grass	Not Evaluated	1.819
25	*Mimosa pudica*	Mimosoideae	Herb	Not Evaluated	1.805
26	*Mariscusalternifolius*	Cyperaceae	Grass	Not Evaluated	1.798
27	*Mariscusligarus*	Cyperaceae	Grass	Not Evaluated	1.788
28	*Carapa procera*	Meliaceae	Herb	Not Evaluated	1.702
29	*Celtis zenkeri*	Cannabaceae	Tree	Least Concern	1.605

S/No.	Species	Family	Type	IUCN Status	RIV
30	*Cocos nucifera*	Arecaceae	Tree	Least Concern	1.582
31	*Dalbergia dendo*	Fabaceae	Shrub	Least Concern	1.389
32	*Funtumiaelastica*	Apocynaceae	Tree	Not Evaluated	1.371
33	*Irvingiagabonensis*	Irvingiaceae	Tree	Least Concern	1.369
34	*Naucleadiderrichii*	Rubiaceae	Herb	Least Concern	1.221
35	*Terminalia superba*	Combretaceae	Tree	Not Evaluated	1.211
36	*Vitex rivularis*	Lamiaceae	Tree	Not Evaluated	1.200
37	*Musa sapientum*	Musaceae	Tree	Least Concern	1.169
38	*Musa paradisiaca*	Musaceae	Tree	Least Concern	1.152
39	*Albizia zygia*	Mimosoideae	Tree	Least Concern	1.113
40	*Dalbergia ecastaphyllum*	Fabaceae	Tree	Least Concern	1.102
41	*Cyperus articulatum*	Onagraceae	Tree	Least Concern	0.811
42	*Mariscusligarus*	Poaceae	Tree	Least Concern	0.799
43	*Palisotabirsuta*	Lamiaceae	Herb	Least Concern	0.747
44	*Raphia hookeri*	Araceae	Tree	Least Concern	0.650
45	*Paspalum spp*	Irvingiaceae	Herb	Not Evaluated	0.611
46	*Assystasiagiganteam*	Rubiaceae	Shrub	Not Evaluated	0.582
47	*Elaeisguineensis*	Arecaceae	Tree	Least Concern	0.518
48	*Vernonia cinerea*	Asteraceae	Herb	Not Evaluated	0.409
49	*Ipomea erecta*	Convolvulaceae	Macrophytes	Not Evaluated	0.375

RIV > 3.5		RIV < 3.5 > 2.0		RIV < 2.0	

4.4.9 Wildlife Studies

Fifty-two species of animals belonging to twenty-one families were observed around the project area. These are composed of arthropoda, mollusca, amphibian, reptilia, aves, and mammalia. These include; 9 species of arthropods, one (1) species of molluscs, three (3) species of amphibians, 24 species of reptiles, 12 species of birds and 14 species of mammals. These are presented in Table 4.13.

Arthropods

The species of arthropods encountered around the project area include *Coliaselecto, Danaus plexippus, Macrotermes sp, Palpaleura lucia, Mantis religiosa, Zonocerus varigatus, Anopheles sp, Simullum sp, and Glossina sp*.

Insects' population is the key to the ecological balance of any ecosystem, particularly the trophic levels. In particular, they forage on terrestrial and aquatic weeds while serving as food (prey) for other carnivorous invertebrates and vertebrates, including birds. In a study conducted in the rainforests of Nigeria, insects in the order Orthoptera, Coleopteran, Odonata, Hemiptera, and Lepidoptera were isolated from three specimens of chameleons (Akani et al., 2001). Others such as mosquitoes, tsetse flies, and black flies constitute health hazards by spreading diseases among the forest-dwelling communities.

Amphibians

The amphibian groups are represented by *Bufo bufo* (Toad) and *Rana sp* (Frog). The Amphibians are the dominant group of aquatic vertebrates other than fish in terms of their numbers and distribution, particularly the frog and toads in the project area. The *Rana sp* (frog) are edible in Nigeria and harvested as wild bushmeat from ponds and waterlogged areas in rural and urban centres. Dried, skinned meat of frogs and fresh frogs have been found useful in feeding catfish and poultry either as raw materials for processed feed or whole as food for catfish. In Nigeria, it is common for fish farmers to supplement the feeding of *Clarias sp and Heterobranchus bidorsalis* in pond culture by feeding them frogs and toads.

Reptiles

The reptiles associated with the study area include *Agama agama* (Lizard) and *Crocodylus niloticus* (Nile crocodile). Although crocodiles were the first group and spent most of their time in the water, the tortoises, monitor lizards, and snakes spend a greater part of their time on land near water. They all, however, contribute to the biological function of the aquatic community. Crocodiles feed on fish, frogs, and toads that inhabit water bodies. Active predation among this group of animals, therefore, contributes to the stabilization of the animal communities. Crocodiles are hunted extensively, even to extinction, for their meat and skins, important foreign exchange-earners. The high demand for crocodile skins, meat and body parts for traditional medicine has contributed to the noticeable decline in their populations in Nigeria. Around the late 1960s, most large bodies of water in Nigeria harboured crocodiles, but now both crocodiles are listed as threatened species in Nigeria (Ebin, 1983, Anon,1986).

Birds

Birds are one of the best-known faunal groups in the world (Tvardikova, 2010). They are ecologically highly diverse and inhabit a wide range of habitats. They are frequently used to indicate the effects of environmental changes (Carignan et al., 2002). Several birds were encountered around the project area. They include *Pycnonotus barbatus, Cecropis domicella, Egretta intermedia, Buteo jamaicensis, Zenaida macroura, Cossyphanivei capilla, Spilopelia senegalensis, Corvus albus, Actitis hypoleucos, Ploceus cuculatus, Spermestes cuculatus,* and *Gallus gallus.*

The presence of feathers in birds has distinguished the class. The advantage of high mobility and their extraordinary hardness made them described as earth's ambassadors as they do not recognize human boundaries except those set by nature (Matthews, 2008). While in many countries, aquatic birds are hunted for sport, in Nigeria, they are predominantly regarded as a source of meat (Ajayi, 1971). Waterfowl and other large birds such as Goliath heron and fish eagles are hunted around the River Niger and Lake Kainji (Okaema et al., 1988). The mangrove swamp forest where the study was conducted is an important habitat for birds for drinking, feeding, resting, sheltering, nesting, rearing of young, foraging and social interaction.

Mammals

Wildlife is important to the national economy both as a source of meat and as a basis for tourism and recreation. In addition, wild animal meat is the main source of cheap protein in most rural communities in Nigeria. Over 80% of the population are rural dwellers who depend on bushmeat, compared with urban dwellers who depend on ruminant meat (Ajayi, 1971). Many species of animals in the mammalian category sighted around the project area include *Capra aegagrus hircus* (goat), *Boa taurus* (cattle), *Cercopithecus mona* (Mona monkey), *Phataginus tricuspis* (White-bellied Pangolin), *Epixerus sp* (Tree squirrels), *Xerus erythropus* (Ground squirrels) and *Cercophitecus nictitans* (Putty nose monkey). These animals were reported in previous studies around the project area.

Table 4.11: Animal Species composition and Abundance of the Project Area

S/N	Common Name	Scientific name	Family	Mode of Detection	IUCN status	Status/Relative Abundance
Arthropoda						
1	Clouded yellow butterfly	*Coliaselecto*	Pieridae	Sighted	LC	Present (++)
2	Monarch butterfly	*Danaus plexippus*	Nymphalidae	Sighted	NE	Present (++)
3	Mound building Termites	*Macrotermessp*	Termitidae	Termitaria	NE	Present (++)
4	Dragonfly	*Palpoleuralucialucia*	Libelulidae	Sighted	LC	Present (++)
5	Grasshopper	*Zonocerus variegatus*	Pyrgomorphidae	Sighted	LC	Present (++)
6	Praying mantis	*Mantis religiosa*	Mantolidea	Sighted	NE	Present (++)
7	Mosquito	*Anopheles sp*	Culicidea	Sighted	NE	Present (++)
8	Blackfly	*Simullumsp*	Simuliidea	Sighted	NE	Common (+++)
9	Tse-tsefly	*Glossina sp*	Glossinidea	Sighted	NE	Common (+++)
Mollusca						
10	African Giant Snail	*Achatina fulica*	Achatinidae	Sighted	LC	Common (+++)
Amphibian						
11	Toad	*Bufo bufo*	Bufonidea	Vocalization	LC	Common (+++)
12	Puddle frog	*Rana sp*	Ranidea	Vocalization	LC	Present (++)
Reptilia						
13	Agama Lizard	*Agama agama*	Agamidae	Sighted	LC	Common (+++)
14	Nile Crocodile	*Crocodylusniloticus*	Crocodylidae	Sighted	LC	Present (++)
15	African Python	*Python sebae*		Testimony		Present (++)
16	Nile Monitor Lizard	*Varanus niloticus*			NE	Present (++)
17	Puff adder	*Bitis aretans*		Testimony	NE	Present (++)
18	Redline snake	*Bothrophthalmuslineatus*		Testimony	NE	Present (++)
19	Spitting cobra	*Naja nigricolis*		Testimony	NE	Present (++)
20	Tortoise	*Kinisysspp*		Sighted	LC	Present (++)
21	Water snake	*Grayiasmythii*	Colubridae	Testimony	LC	Present (++)

S/N	Common Name	Scientific name	Family	Mode of Detection	IUCN status	Status/Relative Abundance
22	West African Dwarf crocodile	*Osteolaemustretraspis*	Crocodylidae	Testimony	LC	Present (++)
23	Gaboon viper	*Bitis gabonica*	Viperidae	Sighted	LC	Present (++)
24	Skink	*Mabuyaaffinis*	Scincidae	Sighted	LC	Present (++)
25	Mud turtle	*Pelusiosniger*	**Pelomedusidae**	Sighted	LC	Present (++)
Birds						
26	Common Bulbul	*Pycnonotus barbatus*	Pycnonotidae	Testimony	LC	Present (++)
27	Swallow	*Cecropisdomicella*	Hirundinidae	Sighted	LC	Present (++)
28	Intermediate egret	*Egretta intermedia H*	Ardeidae	Sighted	LC	Present (++)
29	Hawk	*Buteo jamaicensis W*	accipitridae	Sighted	LC	Present (++)
30	Mourning Dove	*Zenaida macroura L*	Columbidae	Sighted	LC	Present (++)
31	Laughing Dove	*Spilopelia senegalensis*	Columbidae	Sighted	LC	Present (++)
32	Snowy-crowned Robin chat	*Cossyphaniveicapilla*	Muscicapidae	Testimony	LC	Present (++)
33	Pied crew	*Corvus albus*	Corvidae	Sighted	LC	Present (++)
34	Common sandpiper	*Actitis hypoleucos*	Scolopacidae	Sighted	LC	Present (++)
35	Village weaver bird	*Ploceuscuculatus*	Plocidae	Sighted	LC	Present (++)
36	Bronze mannikin	*Spermestescucullata*	Estrildidae	Sighted	LC	Present (++)
37	Domestic fowl	*Gallus gallus L*	Phasianidae	Sighted	D	Present (++)
Mammals						
38	Nigerian Dwarf Goat	*Capra aegrushircus*	Bovidae	Sighted	NE	Present (++)
39	Cattle	*Bos Taurus*	Bovidae	Sighted	D	Present (++)
40	Mona monkey	*Cercopithecus mona*	Cercopithecidae	Sighted	LC	Common (+++)
41	Pangolin	*Phataginustricuspis*	Manidae	Sighted/Rescued	VU	Present (++)
42	Tree squirrels	*Epixerussp*	Sciuridae	Testimony	NE	Present (++)
43	Ground squirrels	*Xerus erythropus*	Sciuridae	Testimony	LC	Present (++)
44	Putty nose monkey	*Cercophitecusnictitans*	Cercopithecidae	Sighted	NE	Present (++)
45	African civet	*Civettictiscivetta*	Viverridae	Sighted	D	Present (++)
46	Bush buck	*Tragelaphus scriptus*	Bovidae	Sighted	LC	Common (+++)

S/N	Common Name	Scientific name	Family	Mode of Detection	IUCN status	Status/Relative Abundance
47	Brush tailed porcupine	*Atherurusafricanaus*	Hystricidae	Sighted	VU	Present (++)
48	Marsh Mongoose	*Trichechus senegalensis*	**Trichechidae** (	Sighted/Rescued	NE	Present (++)
49	Maxwell's duiker	Atilax ,porludinosus	Herpestidae	Testimony	LC	Present (++)
51	Tree hyrax	*Dendrohyrax dorsalis*	Procaviidae	Testimony	NE	Present (++)
52	Water chevrotain	*Hyemoschus aquaticus*	Tragulidae	Sighted	D	Present (++)

Absent; + Present; ++ Common; +++ Abundant; D = Domesticated; NE = Not Evaluated; LC = Least concern; NT = Near Threaten; VU = vulnerable; EN = Endangered; CR = Critically Endangered; EW = Extinct in the Wiild.

4.4.10 Socio-economic and Health Study

This chapter presents the results and analysis of the survey questionnaire conducted as part of the Environmental and Social Impact Assessment (ESIA) for the proposed hybrid solar power plant at Federal University of Agriculture Basaam Biri, Bayelsa State, Nigeria. A total of 40 respondents completed and submitted the questionnaire, providing comprehensive information on socioeconomic and demographic characteristics, health status, standard of living, gender-based violence concerns, environmental and cultural resources, project impact perceptions, and grievance redress mechanisms.

The data collected has been analyzed and presented using various visualization techniques including pie charts and bar charts to facilitate better understanding of the survey findings. The results are organized according to the survey sections: Household Data, Health Status, Standard of Living, Gender-Based Violence/Sexual Exploitation and Abuse, Resources/Cultural Property, Project Activities Impact Evaluation, Grievance Redress Mechanism, and African Development Bank (AfDB).

Household Data, Age Distribution, and Marital Status

This section presents the demographic and socioeconomic characteristics of the respondents, including gender distribution, age groups, marital status, occupation, residential status, ethnic composition, religious affiliation, household relationships, duration of residence, and educational attainment.

The age distribution shows that most respondents (65%) fall within the 18-45 years age bracket, representing 26 individuals. This is followed by 30% in the 46-65 years category (12 respondents), and 5% below 18 years (2 respondents). This distribution indicates a predominantly young to middle-aged population, which is typical for a university community.

The study population showed that 55% of the respondents were married, the single population represented 45%, while no respondent indicated divorce or widowed as their marital status. A significant population of the students was single as expected of undergraduates, while the married population was predominantly staff and business operators within the university community.

Occupation Distribution

The occupational distribution in a university community is highly specialized, dominated by professional, educational, and service-oriented roles, while also featuring a large, temporary, and often part-time student workforce. These communities typically consist of a high concentration of knowledge-based occupations, with a mix of academic, administrative, and support staff, as well as businesses serving the student population.

The occupational distribution of the study population showed that the Civil servants constitute 45% (18 respondents), Students accounted for 35% (14 respondents), while trading and shopkeeping represent 20% (8 respondents). This occupational distribution indicated a mixed occupational distribution typical of a university system. The Civil Servants comprise both academic and non-academic staff of the University, while the students were unemployed.

Residential Status and Household Size

The majority of respondents (55%) are permanent residents, indicating strong community ties and long-term investment in the area. Returnees constitute 35% of the population, while only 10% are non-residents. This residential pattern suggests a stable community with established roots in the area. The household size of a typical family is relative, depending on several factors such as income, level of education, and religious belief. The household size of the respondents varies between 3 and 8 members, with a mean household size of 6 people. This household size is typical of Bassam Biri, Bayelsa State which has an average household size ranging between 6 and 7 people.

4.10. 1 Standard of Living/Socioeconomic Activities

This section analyzes the living conditions, housing characteristics, utility services, income levels, and perceptions about changes in the standard of living among respondents.

Sources of Lighting

All respondents (100%) indicated access to electricity from the national grid, through the existing Distribution Company, although the duration and quality of supply vary due to the Band scheme which specify the number of hours of electricity available to users per day. Alternative lighting sources include torchlight/battery (10%), standalone Solar system (35%) candles (10%), and generators (45%). The reliance on multiple backup sources suggests unreliable electricity supply from the national grid, hence the proposed solar power project will mitigate the power gap within the community. Figure 4.7 shows electricity facility on site.

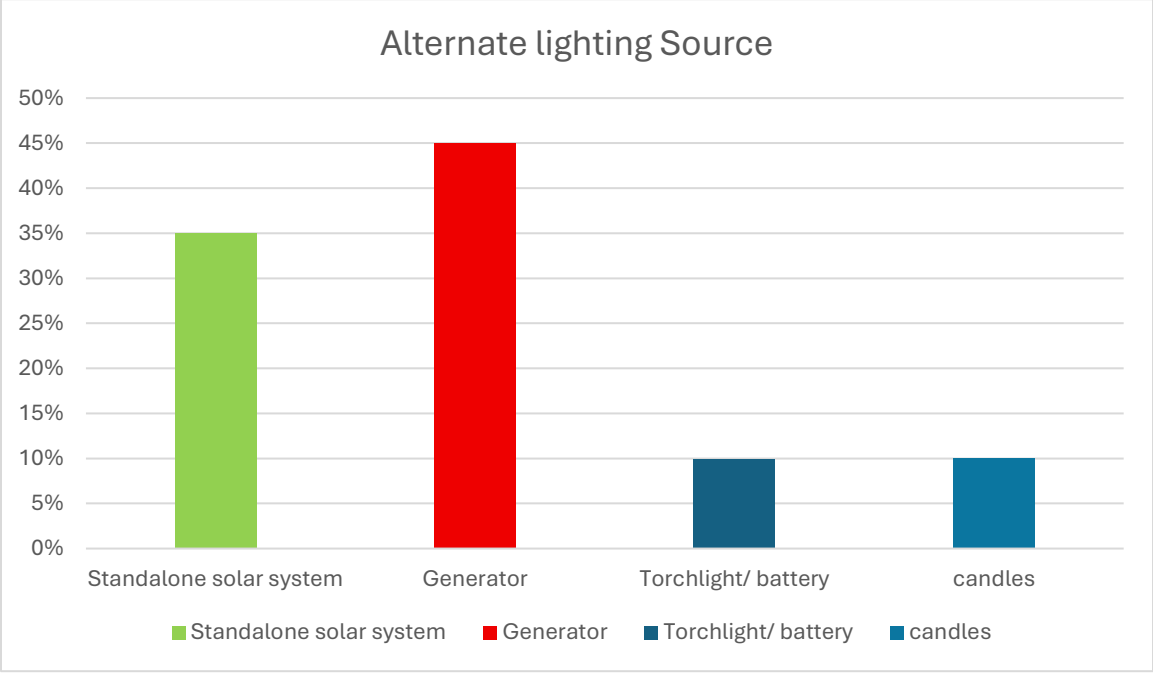

Figure 4.7: Alternative Source of Electricity

Energy Sources for Cooking

The predominant energy for cooking is gas, which represent 45%, kerosene stove represents 25% and firewood represent 10%, Coal represents 15% while electricity users constitute 5%. This heavy reliance on biomass fuels (coal and firewood) indicates significant potential for environmental impact and suggests that improved electricity access could lead to cleaner cooking practices. Figure 4.10 shows firewood for cooking in the study area.

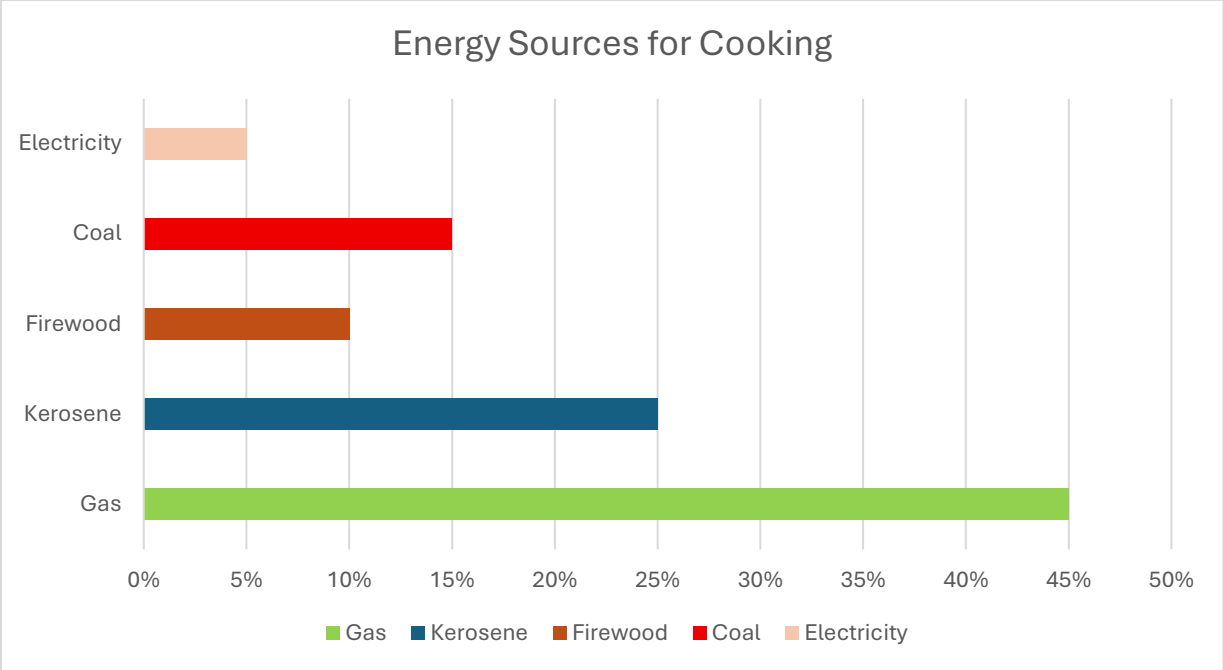

Figure 4.8: Energy Sources for Cooking

Income Distribution

Income distribution measures the spread of income across different groups (households, individuals, or income sources) within an economy, rather than just the average income. Unfortunately, 40% of the respondents refused to disclose their monthly income for personal reasons. However, 20% of the respondents earn a monthly income of 200,000 only, 25% earns less than 150,000 monthly while 15% earn 100,000 and below. Table 4.12 shows the income distribution of the study area.

Table 4.12: Income Distribution of the study Area

S/No	Monthly income	Percentage distribution
1	100,000 and below	15%
2	101,000 – 150,000	25%
3	200,000 and above	20%
4	Non-disclosure	40%

Electricity's Role in Living Standards

Access to reliable and affordable electricity has a multiplier effect in enhancing economic prosperity and improving the standard of living due to lower cost of generating power individually and spurring small and medium-scale businesses. However, 35% percent of respondents reported that their standard of living changed positively due to improved electricity supply, while 65% attribute changes to other factors. This indicates that while electricity is important, it is not the sole determinant of living standards in the community. Figure. 4.8 shows the contribution of electricity supply to the change in the standard of living of respondents in the study area.

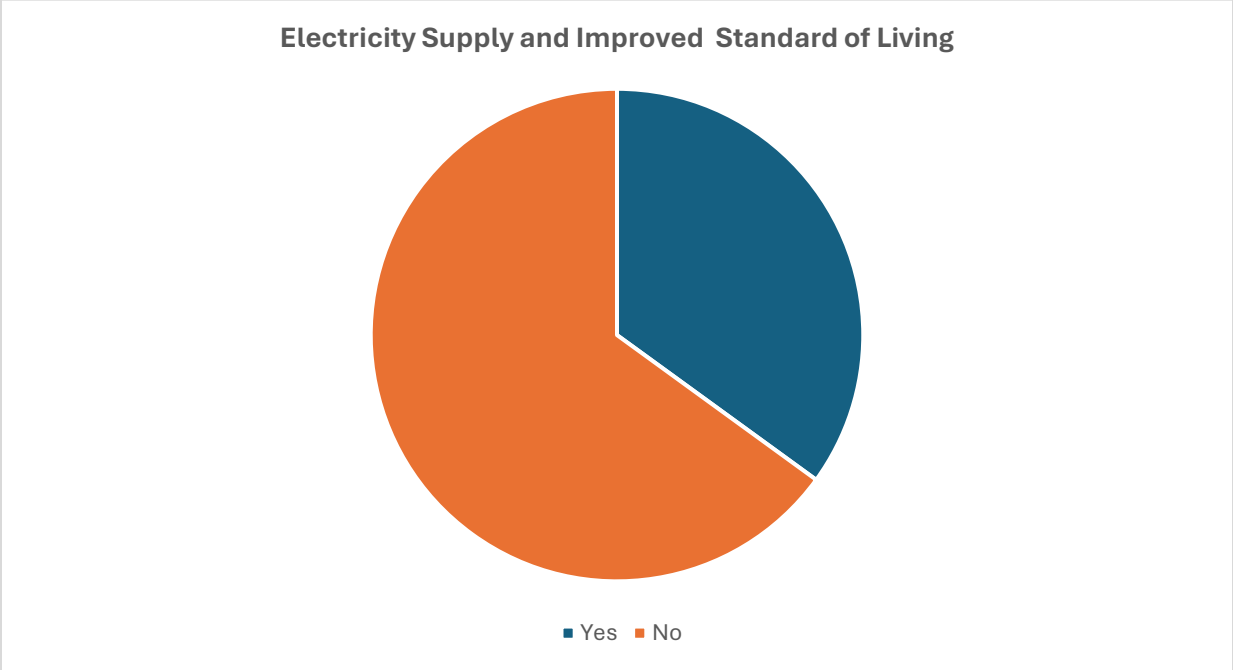

Figure 4.9: Role of Electricity Supply in Improved Living Standards

Gender-Based Violence/Sexual Exploitation and Abuse

This section examines gender-related issues, including restrictions on women's access to services, criminalization of certain acts, safety measures, and gender equity practices in the community.

Gender Equity in the Community

The Nigeria Constitutional Provisions (Section 42): Nigeria's Constitution guarantees freedom from discrimination on the basis of sex, gender, or religion, providing a legal foundation for equality. Nigeria's primary framework for gender equality is the National Gender Policy (2021–2026), which aims to bridge gender gaps, promote women's empowerment, and achieve 35% affirmative action in political and decision-making roles. In the study areas, gender equality is being promoted in line with the University Gender Policy 2024.

When asked how gender equity is ensured, 30% of respondents indicated that Women are elected to public office, 25% indicated that quotas on genders are ensured in the leadership of community-based organizations, while 45% of the respondent indicated that females are given equal opportunity and access to education and employment.

Vulnerable Group

Vulnerable groups are individuals or populations who, due to certain conditions or circumstances, are at a higher risk of harm, discrimination, or exclusion from social, economic, educational, or health opportunities. They often need special protection, support, or attention in policies, institutions, and community programs to ensure fairness and inclusion. At a university level, vulnerable groups were students from extremely poor backgrounds, Female students facing gender-related challenges, international students or minorities, and students with mental health difficulties. Support mechanisms at universities typically include Scholarship or bursary programs, Counseling and health services, and protective policies against harassment or discrimination among others.

The Vulnerable groups within the University community primarily include students living with disabilities (PLWD) facing accessibility challenges, and poor individuals within the university community. Non was sighted in around the university during this study. However, the university has put in place a network of help which includes the University Security Unit, the University Health Centre, and the Dean of Student Affairs' office.

Health Status

This section examines the health management practices, healthcare access patterns, common ailments, and perceptions about potential health impacts of the proposed infrastructure project. An overwhelming majority of respondents (90%) indicated that they attend hospitals or clinics when sick, demonstrating good health-seeking behavior. Only 10% reported buying drugs from nearby chemists without professional consultation. This pattern suggests adequate awareness of the importance of professional medical care and likely indicates reasonable access to healthcare facilities.

Common Ailments and Sicknesses

The most commonly reported ailments are Malaria (45%) and Typhoid fever (30%), which are endemic diseases in Nigeria. High Blood pressure/ Hypertension (10%), Diarrhea affected 10% and 5% of respondents had Eye pain. These disease patterns are typical of tropical regions and do not indicate any unusual health burden that would be exacerbated by the proposed solar power project.

4.10.3 Intervention Project Activities Impact Evaluation

This section evaluates awareness of the proposed solar power project, information sources, potential for community restiveness, expected impacts, and community expectations from the project.

Project Awareness

Project awareness involves educating stakeholders or the public about a project's goals, impact, or existence, crucial for fostering community support, compliance, and successful implementation. Unfortunately, the level of awareness of the proposed intervention was abysmally low, only a handful of persons are aware of the University management team. 10% of respondents indicated awareness of the proposed solar power project, while 90% were not aware. This low awareness level highlights the importance of enhanced stakeholder engagement and communication about the project to ensure community understanding and participation.

Plate: 4.1: Stakeholder Engagement

Potential for Community Restiveness

All respondents (100%) indicated that the proposed infrastructure project will not cause restiveness in the community. This unanimous response reflects strong community acceptance and support for the project, as well as confidence in its implementation approach.

Positive Impacts of the Project

Respondents identified multiple positive impacts expected from the project, including constant power supply, increased productivity and efficiency, enhanced research and academic output for lecturers and students, promotion of economic development and prosperity, and reduction of noise and global warming. No negative impacts were identified by respondents, further demonstrating strong community support.

Community Expectations from the Project

The survey revealed several key expectations from the community. Employment of locals and contracting opportunities during construction was expected by 80% of respondents, capacity building

for maintenance during implementation by 90%, and community input into final engineering design by 20%. Additionally, respondents emphasized the importance of durability, proper maintenance, and adequate security to protect against theft and robbery. The students and staff of the university also welcome the proposed project, trusting that their academic performance will increase as they will have more time to study.

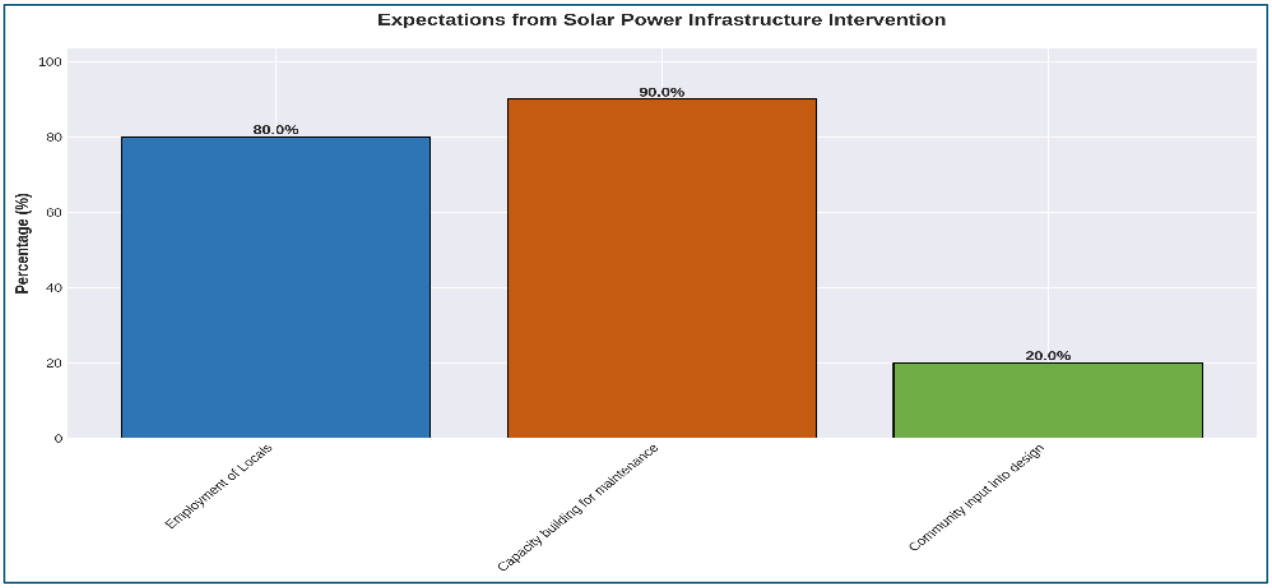

Figure 4:10: Expectations from Solar Power Infrastructure

Grievance Redress Mechanism and Reporting Channels

The University utilizes a structured grievance redress mechanism, primarily managed by the Dean of Student Affairs for student-related issues. Complaints are often settled informally, or through formal investigation involving necessary evidence, with results forwarded to the Vice-Chancellor, who may set up committees for resolution.

When asked where they would report grievances, 75% indicated they would approach the school authority/management, 10% would go to the landlord/ CDA, and 15% would approach the law enforcement agency. This distribution shows that university administration is seen as the primary authority for addressing concerns, which is appropriate given the institutional context.

Satisfaction with Grievance Resolution

The level of satisfaction derived from the grievance resolution mechanism varied in the study area, 80% of respondents indicated that grievances are satisfactorily addressed or resolved by the chosen reporting channels, while 20% objected and were dissatisfied with the outcome of the grievance resolution. However, there are opportunities for improvement in the existing redress mechanism.

Specific Concerns About the Project

Concerns and fears about developmental projects are part of every developmental process. Concerns and fear stem from little knowledge about the project design, its impacts, and scope, among others. However, the beneficiaries of the proposed projects and respondents expressed specific concerns regarding the durability and proper maintenance of the solar power plant. They emphasized the need

for adequate security measures to protect against theft and vandalism. Given that Bassambiri has had many communal clashes with the neighbouring community.

CHAPTER FIVE
ASSOCIATED AND POTENTIAL IMPACTS

5.1 Introduction

The project has overall positive impacts by providing a competitive, cost-effective, pollution-free, and reliable mode of solar power. It will certainly meet the ever-increasing demand for power and bridge the gap between demand and supply of power. However, the proposed project may have some negative impact on the environment during site preparation, construction & operation phases. During the construction phase, the impacts may be regarded as temporary or short-term; while long-term impacts may be observed during the operation stage.

5.2 Impact Assessment Overview

The potential for an Environmental and Social impact exists where an environmental and social aspect has been identified i.e. where a project activity has been determined to have the potential to interact with the biophysical and socio-economic environment.

The assessment process was as follows:

- Identification of the various potential impacts using an interaction matrix to show the relationship/ interaction between the project environmental components and planned project activities.
- A screening of potential impacts associated with each phase of the project is performed using a Risk Assessment Matrix, and
- A detailed evaluation of the individual impact-producing factors that comprise each aspect of the project phases is then performed. The significance of the potential impacts is quantified using the same rationale as for the screening.

The assessment of impact significance is both in qualitative and quantitative terms. Qualitatively, the impact significance is ranked on four (4) widely accepted levels: Major, Moderate, Minor and Negligible. The impact assessment covers the entire life cycle of the Project. i.e.: preconstruction, Construction, operation, and decommissioning.

5.3 Identification of Environmental and Socio-economic Aspects and Impacts

For the purposes of this assessment, a Project activity is a defined action undertaken during the Project lifecycle, such as vegetation clearing, excavation, vehicle movement, equipment testing or waste handling. An environmental or social aspect is an element of that activity that can interact with the receiving environment, such as exhaust emissions, fugitive dust, noise, land occupation, water abstraction or waste generation. An impact is the resulting change in an environmental or social receptor, such as deterioration in ambient air quality, nuisance dust deposition, loss of vegetation, soil or groundwater contamination, disturbance to community access, injury, livelihood loss or improvement in energy access.

All impact matrices shall therefore present the Project activity/aspect separately from the resulting impact. Terms such as “dust”, “emissions”, “noise”, “waste generation”, “security risk” and “testing and commissioning” shall not be presented as impacts without stating the resulting change to the relevant receptor.

Several project activities would be carried out in phases. These planned activities are what would impact on the environmental components positively or negatively. The PV-based power plant project activities are grouped into five phases as follows:

Pre-Construction phase: Involves activities such as award of contract, project design and planning, consultation, recruitment, site preparation and transportation of the utility scale PV based power plant components to site.

Construction phase: It involves activities such as mobilization of workforce and equipment to site, digging, trenching, bulldozing, grading, soil compaction; and installation of temporary camp and power plant components. This phase is usually a short term one.

Commissioning phase: It involves the integrated application of a set of engineering techniques and procedures to check, inspect and test every operational component of the project, from individual functions, such as instruments and equipment, up to complex amalgamations such as modules, subsystems and systems. Operational phase: This is usually 'long term', involving activities from post construction to pre-decommissioning. It commences once the power plant has been commissioned for use. Activities include use of natural resources (water for domestic uses and cleaning of solar modules), plant and equipment operations, and routine maintenance of equipment and plant.

Decommissioning phase: It begins once the power plant use is discontinued or the project life span has come to an end. It should be noted that impacts can occur at any time; during these phases mentioned above i.e. pre-construction, construction and operational phases of the project. Some impacts may, however, occur in some or all phases of the project. To identify environmental and social aspects of the Project, the proposed Project activities were considered in terms of their direct or indirect potential to:

- Interact with the existing natural environment including its physical and biological elements;
- Interact with the existing socio-economic environment; and
- Breach relevant policy, legal and administrative frameworks including national legislation, relevant international legislation/conventions, standards and guidelines, and corporate environmental policy and management systems.

The FMEnv EIA Procedural Guidelines, the AfDB Integrated safeguard systems and ISO 14001 approach among others were used in the impact identification process. The assessment approach generally involved matching the various activities of the different stages of the proposed project (as described in Chapter 3 of this report) with the components of the existing environment. Consequently, the possible changes (and extent of changes) in the environment as a result of the interactions have been identified/ evaluated, hence mitigation measures are proffered in order to reduce, offset or ameliorate such changes. The potential/ associated adverse and beneficial impacts of the proposed power plant project on the existing environment were identified at this stage of the ESIA.

The Risk Assessment Matrix (RAM) has been employed in determining risks posed by the identified potential/associated impacts of the project in order to proffer appropriate mitigation measures. In predicting impacts, the experiential/practical 'worst case scenario's approach has been applied to determine the extreme effects, of project activities on environmental components, while 'consensus of opinions has been used to determine the importance of affected environmental components. The impact evaluation results make up the pedestal for developing the ESMP of the proposed project.

5.3.1 Potential Impact Characterization

The following characteristics were also used to define potential impacts that may be associated with the proposed Project:

- **Negative**: An impact that is considered to represent an adverse change from the baseline or to introduce a new undesirable factor.
- **Positive**: An impact that is considered to represent an improvement to the baseline or to introduce a new desirable factor.
- **Direct**: Impacts that result from the direct interaction between a planned project activity and the receiving bio-physical and socio-cultural environment.
- **Indirect**: Impacts that result from other activities that are encouraged to happen as a consequence of the project.
- **Temporary**: an impact lasting from a few hours up to one month and ending shortly after the relevant activity ceases.
- **Short-term**: an impact lasting more than one month and up to one year, broadly corresponding to discrete mobilisation, construction or commissioning activities.
- **Medium-term**: an impact lasting more than one year and up to five years.
- **Long-term**: an impact lasting more than five years and potentially continuing for a substantial part of the Project's operating life.
- **Permanent**: an irreversible impact or an impact that persists beyond decommissioning and site restoration.
- **On-site**: Impact that is limited to the project site.
- **Local**: Impacts that affect locally important environmental resources or are restricted to a single (local) administrative area or a single community.
- **Regional**: Impacts that affect regionally important environmental resources or are experienced at a regional scale as determined by administrative boundaries.
- **National**: Impacts that affect nationally important environmental resources; affect an area that is nationally protected; or have macroeconomic consequences
- **Reversible**: An impact that the environment can return to its natural state.
- Irreversible: An impact that the environment cannot return to its original state, e.g. the extinction of an animal or plant species
- **Cumulative**: Potential impacts that may result from incremental changes caused by other past, present or reasonably foreseeable actions together with the project. This also includes synergy with other projects/infrastructure in the project area
- Residual: Both environmental and social impacts that will remain after the application of mitigation measures to project impacts during each of the project phases.

5.3.2 Screening and Scoping for Potential Impacts

The first step in identifying impacts associated with the project is the development of an interaction matrix which shows the relationship/ interaction between the project's environmental and social components and planned project activities. A modified version of the Leopold Interaction-matrix technique was employed to screen and scope for the potential impacts of the proposed Project on the environment. The basis for the screening was derived from the following:

- Knowledge of Project activities.
- Detailed information on the environmental and socio-economic setting of the Project's area of influence.
- Consultation with relevant stakeholders.

- Review of other ESIA reports on similar projects/environments.

Table 5.1: Leopold's Environmental and Social Interaction Matrix (Impact Significance Matrix)

Project Phase	Project Activity	Air Quality	Ambient Noise	Soil	Landscape / Topography	Terrestrial Flora	Terrestrial Fauna	Land Use	Population	Utilities Infrastructure	Employment / Income	Gender Issues	Construction Workers (H&S)	Workplace Health & Safety	General Public
Pre-construction Phase	Site selection and confirmation	—	—	—	X	—	—	X	X	X	—	—	—	—	X
	Baseline studies and stakeholder engagement	—	—	—	—	—	—	X	X	—	—	X	—	—	X
	Site clearing and preparation	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	Mobilization of equipment, materials, and workers	X	X	X	X	—	—	X	X	X	X	X	X	X	X
Construction Phase	Excavation, trenching, earthworks, cable laying, foundations, and building works	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	Installation of power plant equipment and associated infrastructure	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	Temporary storage and handling of construction materials	X	X	X	X	—	—	X	X	X	X	X	X	X	X
	Waste generation, handling, and disposal	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Commissioning Phase	Testing, inspection, and commissioning of the power plant and infrastructure	X	X	X	—	—	—	—	X	X	X	X	X	X	X
	Trial operation and performance verification	X	X	X	—	—	—	—	X	X	X	X	X	X	X
Operational Phase	Power generation and distribution to the University	X	X	X	X	—	—	X	X	X	X	X	—	X	X
	Training of operators and maintenance personnel	—	—	—	—	—	—	—	X	X	X	X	—	X	X
	Routine inspection, servicing, and maintenance	X	X	X	X	—	—	X	X	X	X	X	—	X	X
	Operational waste generation, handling, and disposal	X	X	X	X	X	X	X	X	X	X	X	—	X	X
	Environmental, health, and safety monitoring	X	X	X	X	X	X	X	X	X	X	X	—	X	X
Decommissioning Phase	Reduced or discontinued power supply to the University	—	—	—	—	—	—	—	X	X	X	X	—	X	X
	Removal of equipment and reusable materials	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	Demolition of structures and foundations	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	Management of abandoned structures, if any	X	X	X	X	X	X	X	X	X	—	X	—	X	X

Project Phase	Project Activity	Air Quality	Ambient Noise	Soil	Landscape / Topography	Terrestrial Flora	Terrestrial Fauna	Land Use	Population	Utilities Infrastructure	Employment / Income	Gender Issues	Construction Workers (H&S)	Work place Health & Safety	General Public
	Site clean-up, waste disposal, and possible site restoration	x	x	x	x	x	x	x	x	x	x	x	x	x	x

Table 5.2: EEP II Solar Power Plant Impacts Categorization -Project Activities and Associated Potential Impacts Matrix

Project Phase / Activity	Associated & Potential Impacts	Direct	Indirect	Adverse	Beneficial	Reversible	Irreversible	Cumulative	Short Term	Long Term
Pre-construction / Construction Phase	Employment opportunities from recruitment	X			X	X			X	X
	Business opportunities for local contractors	X			X	X			X	
	Skill acquisition and workforce enhancement	X			X		X			X
	Improvement in quality of life (compensation)	X			X		X			X
	Conflicts over employment (quotas, methods)		X	X		X			X	
	Disputes over MoU with project proponents		X	X		X			X	
	Influx of migrant workers & pressure on infrastructure		X	X		X			X	X
	Increase in social vices (theft, prostitution)		X	X		X			X	X
	Loss of vegetation & forest resources	X		X			X		X	
	Incidents of road accidents during mobilization	X		X		X			X	
	Loss of personnel due to kidnapping/ arm robbery/hostage	X		X			X			X
	Noise and vibration from heavy equipment	X		X		X	X			X

Table 5.3: Commissioning and Operational Phases – Potential Impact Matrix

Project Phase / Activity	Associated & Potential Impacts	Direct	Indirect	Adverse	Beneficial	Reversible	Irreversible	Cumulative	Short Term	Long Term
Commissioning Phase	Electrical shock, burns, fire, and worker injury	X		X		X			X	X
	Power reliability, and Operational Readiness.	X			X					X
Operational Phase	Improved quality of life due to enhanced power supply	X			X	X		X		X
	Improvement in air quality (reduced generator emissions)		X		X	X		X		X
	Reduced demand for petrol and diesel for power generation		X		X	X		X		X
	Injuries/fatalities from operational accidents	X		X			X	X	X	X
	Soil/groundwater contamination from oil/fuel spills	X		X		X		X	X	X
	Workplace accidents (cuts, trips, falls)	X		X		X		X	X	
	Skill acquisition for plant operation personnel	X			X	X		X		X

Table 5.4: Decommissioning Phase – Potential Impact Matrix

Project Phase / Activity	Associated & Potential Impacts	Direct	Indirect	Adverse	Beneficial	Reversible	Irreversible	Cumulative	Short Term	Long Term
Decommissioning Phase	Loss of employment and business opportunities	X		X			X			X
	Reduced power supply to the University	X		X		X			X	X
	Injuries from collision with abandoned structures	X		X		X			X	
	Accidents during demolition activities	X		X		X			X	
	Increased dust and vehicular emissions	X		X		X			X	
	Traffic obstruction from movement of vehicles		X	X		X			X	
	Availability of land for alternative uses	X			X	X				X
	Waste generation	X		X		X			X	

5.4 Determination of Impact Significance

The significance of impacts that could occur due to the implementation of the project's activities was established based on three steps, which are:

- Impact Magnitude, which combines the extent, duration, scale, and frequency of an impact
- Value/ Sensitivity/ Fragility and importance of the relevant Receptor.
- Identification of the impact significance, which is the cumulative indicator of both of the above two key variables.

The magnitude of an effect requires quantifying the sources of potential environmental and socio-economic effects from routine and non-routine project activities, such as the extent of land take or predicted change in noise levels. On the other hand, the receptor sensitivity is derived from factors such as:

- Legislative controls.
- Designated status within the land use planning system;
- Number of affected individual receptors;
- Ability of the resource or receptor to absorb change; and
- Public perception about the criticality or sensitivity of the receptors.

The determination of impact significance also entails considering compliance with environmental policies, quality standards and set pollution limits.

5.4.1 Method for Determining Impact Magnitude

Potential negative impacts were assigned Negligible, Low, Medium, and High labels based on their magnitude, while for positive impacts, scores such as high, moderate and low were assigned.

5.4.1.1 Defining Magnitude Levels for Biophysical Impacts

A High Magnitude Impact is considered to affect an entire area, physical system or species at sufficient magnitude to cause a significant measurable numerical increase in measured concentrations or levels (when compared with national or international limits and standards specific to the receptors) or a decline in species abundance beyond which natural process would not return that population or species, to its former level within several generations.

A Medium Magnitude Impact occurs at a sufficient magnitude to cause a measurable numerical increase in measured concentrations or levels and may bring about a change in species abundance but does not threaten the integrity of that population or any population dependent on it. A Low Magnitude Impact affects a specific area, system, aspect (physical), group of localized individuals within a population (biological), and at sufficient magnitude to result in a small increase in measured concentrations or levels over a short time period but does not affect other trophic levels or the population itself, and a localized area.

A Negligible Magnitude Impact results in changes to the environment that may be immeasurable, undetectable or within the range of normal natural variation.

5.4.1.2 Defining Magnitude Levels for Socio-economic Impacts

For socio-economic impacts, the magnitude is based on the perspective of those who would be affected by the impact; this considers the likely perceived importance of the impact, the ability of people to manage and adapt to change caused by the impact and the extent to which a human receptor gains or loses access to, or control over socio-economic resources resulting in a positive or negative effect on their well-being. The event magnitude rankings are shown in Table 5.5.

Table 5.5: Event Magnitude Rankings

Importance Level	Description / Attributes
High	• Highly undesirable outcome (e.g., impairment of endangered or protected habitat/species) • Detrimental and prolonged changes to flora and fauna behavior (breeding, spawning, moulting) • Major reduction or disruption in value, function, or service of impacted resource • Occurs during environmentally sensitive periods • Continuous non-compliance with international best practices • Significant negative impact on livelihoods, income, or living conditions affecting a large population, leading to economic loss and possible protests • Reputational damage and/or revenue loss threatening business viability • Increased public health risk leading to injury or fatality
Medium	• Noticeable negative outcome • Measurable reduction or disruption in value, function, or service of impacted resource • Potential non-compliance with international best practices • Moderate negative impact on livelihoods, income, or living conditions • Temporary business disruption causing minor revenue loss • Increased public health risk is manageable with mitigation measures •
Low	• Imperceptible or minimal outcome • Insignificant change in value, function, or service of impacted resource • Fully compliant; no controls required • Minor, localized, temporary, and reversible nuisance to livelihoods or living conditions • Temporary business disruption without revenue loss or reputational impact • No change in community health status • Minor inconvenience from temporary infrastructure disruption

5.4.2 Determining Receptor Sensitivity

Receptor sensitivity refers to the socio-economic and environmental importance of the receptor, including human dependence on the receptor for food and income. It basically considers the type of receptor (namely, biological/ecological, human, and physical receptors) and the impacts that directly affect people. Vital natural resources are considered more important than indirect impacts.

Where the receptor is physical (for example, soil environment) its current quality, sensitivity to change, and importance (on a local, national and international scale) are considered. Where the receptor is biological (for example, the aquatic environment), its local, regional, national or international importance and its sensitivity to the specific type of impact are considered. Where the receptor is human, the vulnerability of the individual, community or wider societal group is considered. The receptors' sensitivity is categorized as Low, Medium and High and the criteria for ranking the receptor sensitivity are defined in Table 5.6.

Table 5. 6: Receptor Sensitivity Ranking

Sensitivity Level	Description / Attributes
Low	Receptors, including people, businesses, and environmental resources, can easily adapt to change. Impacts are usually temporary, localized, reversible, and affect common or already disturbed environments.
Medium	Receptors have limited ability to adapt. Impacts may affect livelihoods, businesses, soil, vegetation, drainage, or common habitats, and may require mitigation or management for recovery.
High	Receptors are highly vulnerable or environmentally sensitive, with little ability to adapt or recover. Impacts may affect vulnerable groups, marginal livelihoods, protected habitats, sensitive species, water resources, or areas that are difficult to restore.

5.4.3 Significance

Risk Assessment Matrix

Magnitude ↓ / Sensitivity →	Low Sensitivity	Medium Sensitivity	High Sensitivity
High Magnitude	Minor	Moderate	Major
Medium Magnitude	Minor	Moderate	Major
Low Magnitude	Negligible	Minor	Moderate

Negligible Significant impacts are where a resource or receptor will not be affected in any way by a particular activity, or the predicted effect is deemed to be 'negligible' or 'imperceptible' or is indistinguishable from natural background variations. An impact of minor significance is one where an effect will be experienced. Still, the impact severity is sufficiently low (with or without mitigation) and well within accepted standards, and/or the receptor is of low sensitivity/value. An impact of moderate significance is one within accepted limits and standards. Moderate impacts range from a threshold below which the impact is minor, up to a level that might be just short of breaching a permissible limit. Thus, impacts of Negligible, Minor, or Moderate significance are considered as being mitigated as far as practicable and necessary, and therefore, do not require further mitigation. An impact of major significance is one in which acceptable limits or standards may be

exceeded, or a high-magnitude impact occurs to highly valued/sensitive receptors/resources, and for such negative impacts, additional mitigation is required. The impact assessment ranking scale is provided in Table 5.7.

Table 5.7: Impact Assessment Ranking Scale

Receptor Sensitivity	Impact Magnitude
1-low	1-Negligible
2-Medium	2-Low
3-High	3 Medium
	4-High

Impact Significance = Receptor Sensitivity × Impact Magnitude

5.5 Impacts Discussion

5.5.1 Potential Positive Impacts

The proposed Project seeks to provide an independent and reliable power supply to the Academy through solar energy source and thus, improve the quality of education and other services within the institution as there will be longer hours available with better illumination for studying. Ultimately, the activities of the project will contribute to the achievement of Nigeria's carbon emission reduction targets (20% reduction by the year 2030) in fulfilment of the nation's Nationally Determined Contributions (NDC) to climate change. The positive impacts' significance is thus considered **high.**

Within the project area, there will be reduced noise and pollutants from generator sets, and natural habitats and human health will be protected from pollution arising from the use of fossil fuels. The renewable energy training centre constructed during the project implementation will provide capacity development through learning renewable energy technologies and practices in the University and consequently, the certification of trained individuals. The positive impacts' significance is thus considered **moderate.**

The installation of streetlights as part of the proposed Project will improve safety by reducing hazards associated with flammable fuels and candles and enhance security within the school. The positive impacts' significance is thus considered **moderate.**

In addition, the project will improve social cohesion and community development and generate new income as it would stimulate economic activities and offer new opportunities for small businesses in the University premises. The employment opportunities for skilled, semi-skilled, and unskilled labour associated with the project will multiply job creation, especially during construction to facilitate overall socioeconomic development. The positive impacts' significance is thus considered **moderate.**

5.5.2 Potential Negative Impacts

The potential adverse impacts from project activities are grouped into the following subjects and discussed further according to the different applicable phases – Preconstruction, Construction, Operation and Decommissioning phase:

- Land use
- Impacts from equipment, personnel and plant material movement;

- Impact on traffic;
- Impact on air;
- Impacts from noise and vibration;
- Impacts on terrestrial flora and fauna;
- Impact on water resources
- Impacts on waste generation;
- Impact on soil quality;
- Visual/ aesthetic impact;
- Social economic impacts;
- Health impacts; and
- Impacts from workplace hazards.

5.5.3 Preconstruction/ Mobilization Phase

The pre-construction phase of the proposed Project includes the following activities:

- Site selection
- Site clearing and preparation
- Mobilization of equipment, materials and personnel to site

Site Clearing and Preparation

The project site will be cleared of vegetation before construction activities. The site clearing activities would involve the use of earth-moving equipment such as tractors. The potential impacts associated with the site clearing activities are discussed as follows:

Potential Impact on Terrestrial Flora and Fauna

Site clearing activities associated with the proposed Project will lead to loss of terrestrial flora on the Project site. The potential impact on the terrestrial flora is considered to be negative, direct, site specific and largely irreversible. The impact magnitude is considered to be medium considering that not all the land area will be cleared for the Project. However, the sensitivity /importance of the receptor is regarded as low since the Project site is a modified habitat, and none of the plant species identified within the Project site during the baseline survey was found to be endangered or threatened based on the International Union for Conservation of Nature (IUCN)-2024 classification scheme. Also, the local community has no direct or indirect ecosystem services that benefit from the site. Furthermore, there are no protected/conservation areas within the site. The significance of the potential impact of site clearing on the existing terrestrial flora species of the Project site is therefore regarded as minor. While the plant species are unable to avoid the point of impact, most fauna species may be able to migrate away from unfavourable areas. Animals are generally mobile and, in most cases, can move away from a potential threat. The tolerance levels of some animal species are of such nature that surrounding areas will suffice in habitat requirements of species forced to move from areas of impact.

About the clearing of the Project site prior to the construction phase, the potential impact on terrestrial fauna species may include loss of individual or localized population of fauna species or disturbance to avifauna species. This is unlikely to lead to a change in conservation status of the species since none of the fauna species (including avi-fauna) encountered or reported in the project site belongs to the IUCN classification of

threatened animal species which include those classified as critically endangered, endangered or vulnerable. The sensitivity of the fauna species recorded on the Project site is thus regarded as **low**. The impact magnitude is considered to be **low** given that the site clearing activities would cover approximately 5 ha of land allocated for the Project. The potential impact is direct, irreversible, short term and localized. The impact significance is thus considered **minor**.

Potential Impact on Soil

The proposed site clearing and preparation activities could potentially impact on the soil environment of the Project site. The potential effects on soil include degradation due to site preparation e.g. compaction of soil as a result of the movement of earth-moving equipment. Soil degradation is the removal, alteration, or damage to soil and associated soil-forming processes, usually related to human activities. The stripping of vegetation or disturbance to the natural ground level over disturbance areas will negatively affect soil formation, moisture levels, soil density, soil chemistry, and biological activity. Uncontrolled site clearance of vegetation could lead to direct surface soil exposure and hence erosion of soil, which could be significant.

The impact magnitude is considered as **medium** as the extent of soil erosion could be high, especially if the site clearing activities are carried out in the wet season. However, based on the results of laboratory analysis conducted on soil samples from the Project area, the Project site is not considered to be significantly prone to land-based erosion. Thus, the impact and significance of site clearing on soil environment of the study area is considered **minor**.

Potential Impact on Air Quality and Ambient Noise

The pollutants which could impair air quality during site clearing activities are particulate matter in form of dust, and NOx, CO, Total Suspended Particulates (TSP), SOx from combustion engines of the earth-moving equipment that will be used for clearing. Intermittent noise emissions could also occur from the operation of the machinery. The impact magnitude is considered to be low since the activities will be short-term, intermittent, localized and reversible. The site clearing activities will take less than 1 week. The sensitivity of the airshed of the Project area is also regarded as low based on the results of air quality measurements conducted in the area during the field data gathering. The impact significance of site clearing on the ambient air environment of the Project site is considered to be **minor**.

Potential Impact on Workers Safety

Site clearing and preparation are potentially hazardous activities. Accidents may occur, especially when those involved are unskilled. Such accidents may result in loss of man-hours, which may ultimately affect the scheduled date of completion of the Project development, especially if the man-hour losses are high. The site clearing activities will take about 1 week, and the number of workers required will be less than 10. The impact significance is considered to be **minor**.

Mobilization of equipment, materials, and personnel to the site

In executing the proposed project, a great deal of haulage/ movement would be undertaken throughout the phases of the project. Movements would include: transportation of equipment and personnel for construction and operational phases; and movement of plant components to the project site for construction and installation. Anticipated impacts during the mobilization of equipment and personnel to the site will include:

Potential Impact on Air Quality and Ambient Noise

Construction equipment and materials will be moved to the Project site prior to commencement of main construction activities. The potential biophysical impacts associated with the mobilization activities include decrease in ambient air quality of the Project area as a result of emissions from vehicles that will convey materials and equipment to site. It is anticipated that the potential impacts will be similar to those experienced during site clearing activities. The capacity for assimilation of vehicular emissions and dust associated with the mobilization activities in the Project's AoI is considered to be high. The overall impact significance of mobilization activities on the ambient air quality and noise of the Project area is rated **minor**.

Potential Impact on Infrastructure (Road) Regarding safety along the project route, the mobilization activities during the preconstruction phase of the Project could increase the traffic volume in the Project area (and potential for road accident) as a result of movement of vehicles in and out of the Project site. The social aspects of these activities could lead to accidents, traffic congestion and annoyance from other road users in the area. The magnitude of the impact is considered low since the mobilization activities would be within 1 week. The sensitivity of the receptors is judged as medium given that the existing vehicular movement in the University environment is high. The prominent means of transportation are cars, motorcycles/tricycles, and buses/trucks. The impact significance is considered to be **minor**.

Potential Impact on Workers Safety

Mobilization of construction materials will involve offloading of heavy consumables such as cement, gravel, etc. Injuries and accidents may occur especially when those involved are unskilled. It is expected that the potential impacts will be similar to those experienced during site clearing and preparation activities. The impact significance is **minor**. Table 5.8 summarizes the potential impacts associated with the pre-construction phase of the proposed Project.

Table 5. 8: Summary of Potential Negative Impacts Associated with the Pre- Construction Phase of the proposed Project

Activity	Receptor	Associated Impact	Significance
Site Selection/ land	Terrestrial flora and fauna	Loss of land	Moderate
Site clearing and preparation	Terrestrial flora and fauna	• Vegetation loss • Direct impacts on vegetation and soil-dwelling organisms; indirect impacts on fauna species in the immediate surroundings of the Project site	Minor

	Soil	• Loss of topsoil • Soil compaction and degradation • Increased erosion potential • Reduction in structural stability and percolative ability of soil	Minor
	Air Quality and Noise	• Air quality impacts due to emissions from site clearing equipment • Increase in ambient noise levels	Minor
	Workers Safety	• Injuries and accidents to workers during site clearing and preparation.	Minor
Mobilization of construction equipment and materials to site	Air Quality and Noise	• Air quality impacts from vehicular emissions (TSP, NOx, CO, SOx) • Increase in noise levels	Minor
	Infrastructure (road)	• Increase in vehicular movement and traffic including potential for road accident	Minor
	Workers Safety	• Injuries and accidents to workers during loading and offloading of construction materials.	Minor

5.5.4 Construction Phase

The construction phase of the proposed Project will include activities such as civil and electrical works (excavation, trenching, concrete mixing, etc.), installation of PV panels and associated components; construction of a training centre; installation of streetlights, upgrade of existing electricity distribution infrastructure; and waste generation and disposal. The potential environmental and social impacts associated with the construction phase of the proposed Project are assessed and discussed as follows:

Equipment, Personnel and Plant Material Movement

As part of the construction phase, personnel and materials would be transported to site on need basis. Transportation could be from workers or visitors to the site. Vehicles to be deployed for construction purposes would include saloon, SUVs and heavy-duty vehicles (such as trucks, excavators, etc). Movement of vehicles during this phase is important and cannot be avoided as such would impact significantly on the environment as well as on people living within the area in the following ways:

- Vehicular emission of pollutant gases (such as CO, SO2 and NO2) from vehicle exhaust;
- Contribution to global gas warming and ozone layer depletion from pollutant gases emitted from vehicles;
- Increased traffic movement of heavy-duty truck en-route project site;

- Potential accident to personnel and assets from vehicle movement during construction; and
- Dust emission arising from construction activities at the project site.

The impact from equipment, personnel and plant material movement on surrounding receptors is therefore considered to be of moderate significance before mitigation and steps will be taken to minimize the effects.

Civil and Electrical Works, and Installation of Plant Facilities

Potential Impact on Air Quality

At the installation and construction phases of the project, the potential sources of emissions would include dust, particulate matter (PM), and emissions from heavy trucks and earthmoving equipment that will be operated on the project site. Exhaust emissions during material transportation, stockpiling and equipment transfer during construction activities. It is proposed that the construction phase of the project would take up to 12 months. These emissions will be localized to the construction site area and will be short-term, the extent of impact would therefore be **medium,** and its significance is rated **minor.**

Potential Impact on Noise Levels

The primary short-term noise and vibration impacts are associated with construction and decommissioning activities. During construction activities, work equipment will result in increased noise level and vibration in the area, although noise would not cause a major disturbance to its surroundings. The potential source of noise during the construction phase of the Project includes civil work and installation activities, vehicular movement and operation of construction equipment may lead to elevated noise levels beyond the baseline concentration. Noise may cause a major disturbance to fauna species such as birds and mammals in the area.

These would move further into the forest to avoid the disturbance.

The noise levels from construction activities would be intermittent and localized and are not envisaged to result in a maximum increase in background levels of 3 dB(A) at the nearest receptor location. The potential impact magnitude is regarded as low due to the envisaged low extent of its effect. The overall impact significance is considered minor.

Potential Impact on Soil

The proposed construction activities will include excavation, loosening of soil, stockpiling, mixing, filling, etc. These activities can directly impact soil environment negatively contributing to soil degradation and possibly accelerated erosion. Soil environment of the Project site could be impacted in terms of removal of topsoil and soil compaction, reduction in structural stability and percolative ability of soil, loss of soil dwelling organisms resulting from compaction during excavation activities, installation of PV panels, mounting structures, and 11kv underground cable. These activities also have the potential to increase siltation as a result of accelerated erosion. The impact magnitude is considered to be **medium** considering the number of PV panels to be installed and the distance for burial of the proposed underground cable from the Power Plant to the switchyard. The sensitivity of the soil environment in the Project area is regarded **medium** as the soil in the area is prone to erosion especially during the rainy season. Therefore, the impact significance is considered to be **moderate**.

Potential Impact on Terrestrial Flora and Fauna

The project would require the removal of clearing of vegetation to accommodate the power plant and ancillary structures. Increase in human activity, noise level, creation of areas of bare soil would create a resulting effect which would be the altering of the composition and diversity of flora species in the site as well as migration of fauna species that make use of the plants for food and shelter further away into the forest. Also, the disturbance associated with noise and movement of construction equipment and personnel at the Project site may deter bird species from the area and disrupt the breeding of avifauna. It may also lead to increased risk to species such as snakes, rodents and mammals. The sensitivity of the receptor is judged to be **low**. Based on desktop reviews and field observation, the project area is not known as a migratory route for avifauna species. The impact significance is regarded as **minor**.

Potential impact on Gender

During construction activities, women may experience discrimination as most employment and training opportunities may be provided to men, while women will be left with menial jobs. This may result in marginalization thereby reinforcing gender stereotypes and gender pay gaps. In attempts to reduce the gender knowledge gaps, select female students will undergo end-to-end on the-job training and capacity building participating in the full construction activity. Furthermore, there is the possibility that the proposed Project may increase the risk of GBV, as a result of shifting existing power dynamics and financial relationships. This is considered a minor risk as many women in the community are engaged in economic activities.

Potential Impact on Socio-economic and Health

Impacts associated with the construction phase of a project are usually of a short to medium term in nature, but could have long term effects on the surrounding environment. During construction, the proposed Project has the potential to affect the University community and the nearby community.

With regard to the presence of construction workers on site, the manner in which the workers conduct themselves can affect the University environment and local community in terms of disruption of existing structures due to influx of people. The potential behaviour of workers, most especially male construction workers, may lead to an increase in levels of crime and drug and alcohol abuse, and an increase in incidence of casual sexual relations, which may result in increase in sexually transmitted disease (such as HIV/AIDS infections) and unwanted pregnancies. Additional pressure may also be placed on existing social infrastructure. Considering that the proposed number of workers for the construction phase of the Project may be relatively high, the potential risk to social structures is regarded as high. However, given that the majority of the construction workers, especially unskilled labour force would be drawn from the local community, the impact significance is considered to be **moderate**.

Potential Impact on Infrastructure (Road)

It is envisaged that movement of personnel and equipment along the road leading to the University would increase once the project commences. The road is slightly busy during the day and as such may lead to intermittent traffic build up which may not last long with proper coordination. During the installation of street lights around the University campus, traffic flow might be obstructed along the road paths where the street lights will be installed if activities are improperly managed. Construction activities may result in a significant increase in movement of vehicles for the transport of construction materials and equipment increasing the risk of traffic-related accidents. The impact magnitude is considered as **low** due to the minimal number of Project

vehicles and trucks to be used during the construction phase. Therefore, the impact significance is considered **minor**.

Potential Impact on Construction Workers Safety

Construction sites are potentially hazardous place. Occupational accidents may occur especially when those involved are unskilled. Such occupational accidents may result in loss of man-hours which may ultimately affect the schedule date of completion of the Project development especially if the man-hour losses are high. Potential impacts to construction workers include increase in noise level and air emissions from construction activities, injuries, electrical shocks, accident, and denial of rights. The impact significance is considered **moderate**.

Waste Generation and Disposal

Wastes from the project are grouped into solid wastes, liquid (wastewater) and air emissions. Solid wastes would include; wood, metals, food remains, glass, and refuse etc. Liquid wastes include sewage, while gaseous air pollutants (NO_x, SO_x and CO) would be from exhausts of vehicles. It should be noted however that during their normal operation PV systems emit no gaseous or liquid pollutants, and no radioactive substances.

Potential Impact on Soil

The proposed construction activities will lead to the generation of wastes. Improper handling of these wastes or their discharge into the surrounding environment without proper treatment would increase the level of micro-organisms (bacteria, viruses and fungi) that could be pathogenic to staff working in the area. The potential construction wastes to be generated include scrap metals, electrical cables, spent oils, wood/planks, paper waste, leftover sand and gravel, etc. The impact magnitude of the wastes on the soil is considered to be **low**. Thus, the impact significance is considered to be **minor**.

Table 5.9: Potential Negative Impacts Associated with the Construction Phase of the Proposed Project

Activity	Receptor	Associated Impact	Significance
Movement of Equipment, Personnel and Plant Materials	Air Quality	• Vehicular emissions (CO, SO_2, NO_2) from exhaust • Contribution to global warming and ozone layer depletion • Dust emissions from construction activities	Minor
	Social System (Road)	• Increased traffic from heavy-duty trucks en route to the project site	Minor
	Health & Safety	• Risk of accidents involving personnel and assets due to vehicle movement	Minor
Civil and Electrical Works / Installation Activities	Air Quality	• Emissions from construction equipment (SPM, NOx, CO, SOx) • Dust from land clearing and stockpiles	Minor

Activity	Receptor	Associated Impact	Significance
	Ambient Noise	• Increased noise levels from construction activities	Minor
	Soil	• Increased erosion from excavation • Reduced soil stability and permeability due to compaction	Moderate
	Terrestrial Flora and Fauna	• Loss of plant species due to invasive species • Loss of fauna due to human activity and noise	Minor
	Gender	• Potential discrimination against women and GBV risks	Moderate
	Socio-economic & Health	• Influx of people leading to increased risk of sexually transmitted diseases	Moderate
	Infrastructure (Road)	• Road damage, traffic congestion, and safety concerns	Minor
	Construction Workers Safety	• Risk of injury during construction activities	Moderate
	Soil	• Soil contamination from construction waste (solid and liquid)	Minor
Waste Generation and Disposal	Groundwater	• Contamination from liquid construction waste streams	Minor
	Infrastructure (Waste Management Facility)	• Disposal of waste at existing facilities in the project area	Negligible

5.5.5 Commissioning Phase

Once the construction phase of the Solar Power Plant is completed, the Plant will be tested to ensure that it has been installed according to the pre-design and operational requirements.

Potential Impact on Noise

During the Plant commissioning, there could be increase in noise level due to humming noise emission from the Plant components (inverters and batteries), vehicular movement (transportation of commissioning officials), public address system, crowd noise, and other ceremonial activities. The impact significance is however rated **minor**.

Potential Impact on Safety

Also, there is potential for occupational hazards during the Plant testing as a result of any wrong electrical connection. The impact significance is considered to be **moderate** on the workers' health and safety. However, the potential hazard to the public during the commissioning activities could be electrical shocks from exposure to wrong electrical connections. This is considered to have a **minor** impact on the general public.

Potential Impact on infrastructure (road)

The commissioning phase will lead to an influx of guest and officials which will have an impact on the population and infrastructure (road). Due to the short duration of the commissioning phase (1 day), the impacts are considered to be **negligible**. Table 5.10 summarizes the potential negative impacts associated with the commissioning phase of the proposed Project.

Table 5. 10: Potential Impact Associated with the Commissioning Phase of the proposed Project

Activity	Receptor	Associated Impact	Significance
Testing, inspection, and commissioning of the power plant and infrastructure	Ambient Noise	Increase in ambient noise levels during testing activities.	Minor
	Workers	Occupational health and safety hazards, such as injuries, electric shock, burns, fire, or electrocution due to incorrect electrical connections.	Moderate
	Campus Occupants' Safety	Risk of electric shock or electrocution from wrong electrical connections, exposed cables, or poorly isolated energized equipment.	Minor
	Population Influx	Temporary increase in population on campus due to commissioning personnel, contractors, and technical specialists.	Negligible
	Infrastructure / Road	Increased traffic movement and minor risk of road accidents from movement of commissioning equipment and personnel.	Negligible
Trial operation and performance verification	Ambient Noise	Temporary noise and vibration from operating equipment during trial runs and performance checks.	Minor
	Air Quality	Minor temporary emissions may occur during trial operation, depending on the type of power plant and backup systems used.	Minor
	Workers	Occupational health and safety risks during live operation, including electric shock, equipment failure, burns, and injury if procedures are not followed.	Moderate
	Campus Occupants' Safety	Risk of accidental contact with energized equipment or restricted areas during trial operation.	Minor
	Utilities Infrastructure	Verification of power supply reliability and identification of defects before full operation.	Positive

	University / Campus Community	Possible short-term power interruptions or restricted access during performance testing.	Minor
	Workplace Health and Safety	Improved operational readiness, safety awareness, and emergency response through system checks and testing.	Positive

5.5.6 Operational Phase

Power Generation and Distribution

Potential Impact on Noise

The potential sources of noise during the Power Plant operations are inverters and batteries. Typically, the designed noise level from an inverter is approximately 30- 35 dB(A) while that of a battery is 15-20 dB(A). The associated noise levels from the inverters and batteries are not envisaged to result in a maximum increase in background levels of 3 dB(A) at the nearest receptor location offsite. The impact significance is considered to be **negligible**.

Potential Impact on Gender

Women have conventionally been under-represented in the energy sector; they are often marginalized from many power sector employment and training opportunities. There is a potential that this situation may come to play during the operations phase of the Project, as women who experience discrimination may be denied training and employment opportunities. Male and female staff will be trained on the management and maintenance of the facility. Although the number of personnel working at the Project site would be reduced, the likelihood of impacts predicted during the construction phase may exist. Therefore, the impact significance is regarded as **minor.**

Potential Impact on Socio-economic and Health

The potential negative impacts on the socio-economic environment (community health and safety) during the operational phase of the Project are related to visual impact and the generation of electromagnetic field (EMF) radiation.

For visual impact, the Project site is not known to be a tourist route or to have any special scenic characteristics; hence, it has a limited potential for visual impacts on the receiving environment. However, the facility (primarily the PV panels) will be visible during operation.
The impact significance is considered negligible.

Regarding EMF radiation, Solar PV panels, inverters, batteries, and other components that make up solar PV arrays produce extremely low-frequency EMF when generating and transmitting electricity. Thus, the potential impact of EMF radiation from the proposed Solar The power plant on community health and safety is considered to be negligible.

Potential Impact on Occupational Health, Safety, and Welfare of Workers

During the Plant operation, workers may be exposed to occupational health and safety issues (e.g. electrical and field exposure, shock hazards and mechanical injuries), including work-related issues such as

discrimination, denial of rights, unfair treatment, poor working conditions etc. The impact significance is considered to be **moderate** primarily due to the low number of staff (approximately 10) required for operation.

Routine Maintenance, Waste Generation and Disposal

Potential Impact on Soil

Routine maintenance of the Plant will lead to the generation of wastes which can contaminate the soil within the Project site and AoI. The major waste stream will be e-waste generated from spent/damaged components of the Project such as batteries, inverters and PV panels. These wastes will be stored within the Project site according to the manufacturer's instructions. All components to be used for the Project will have buy back agreements with the manufacturers as specified in the Extended Producer Responsibility Program (EPRP). The impact significance is considered to be **minor**.

Potential Impact on Groundwater

Potential impacts may include decrease in amount of groundwater reservoir as a result of water abstraction for cleaning of the PV panels. Cleaning of the PV panels is envisaged to be carried more during the dry season than in the rainy season.

Based on previous experience, each MW of panels would require approximately 5 litres of water per cleaning cycle. The water required for cleaning purposes would be obtained from the boreholes proposed to be dug at the project site. Based on observations noted during the field survey and the estimated quantity of water required for occasional cleaning of the PV panels, water abstraction for the Project is not envisaged to have serious effect on the existing groundwater aquifer of the Project area as well as the local water use. Thus, the impact significance is considered **minor**.

Potential Impact on Occupational Health, and Safety of Workers

During routine maintenance, workers may be exposed to occupational health and safety issues (e.g. electrical and field exposure, shock hazards and mechanical injuries). The impact significance is considered to be **minor** primarily due to the low number of staff (approximately) required for maintenance activities and low frequency of maintenance. Table 5.11 summarizes the potential negative impacts associated with the operational phase of the proposed Project.

Table 5. 11: Potential Negative Impacts Associated with the Operational Phase of the Proposed Project

Activity	Receptor	Associated Impact	Significance
Power Generation and Distribution	Noise	• Noise from batteries and inverters during power generation and evacuation	Negligible
	Gender	• Discrimination against women during employment • GBV (sexual harassment, assault, poor working conditions)	Minor
	Socio-economic (Visual)	• Landscape alterations causing unpleasant visual changes in the area	Negligible

Activity	Receptor	Associated Impact	Significance
	Socio-economic (Health Issues)	• Community health and safety concerns due to electromagnetic field (EMF) radiation	Negligible
	Health, Safety and Welfare of Staff (Plant Operation)	• Electric shock and injuries during plant operation • Work-related issues (discrimination, denial of rights, unfair treatment, poor working conditions)	Moderate
Routine Maintenance	Soil	• Soil contamination from spent batteries and inverters	Minor
	Groundwater	• Groundwater abstraction from the cleaning of PV panels	Minor
Waste Generation and Disposal	Soil & Groundwater	• Soil and groundwater contamination from waste streams	Negligible
	Health, Safety and Welfare of Staff (Maintenance)	• Electric shock and injuries during maintenance activities	Minor

Potential Cumulative Impacts

Cumulative impacts are changes to environmental or social receptors that result from the incremental effects of the proposed Project when combined with the effects of past, existing or reasonably foreseeable developments and activities within an appropriate spatial and temporal boundary. The cumulative assessment focuses on valued environmental and social receptors that may be affected by more than one activity and for which the Project could make a material incremental contribution.

For this ESIA, the spatial boundary includes the Project footprint, the internal access and distribution routes, the wider FUAB campus, nearby sections of the Nembe–Ogidiama Road, adjacent communities and hydrologically connected surface-water and groundwater receptors. The temporal boundary covers construction, commissioning, the operating life of the plant and decommissioning. Relevant receptors include road users and community safety, ambient air quality and noise, drainage and flood pathways, groundwater resources, vegetation and habitat, and authorised waste-management facilities.

At the time of the ESIA, no sufficiently defined major third-party development with a confirmed programme was identified within the immediate area of influence to support a quantitative cumulative model. However, foreseeable interactions may arise from concurrent University construction or utility works, routine campus and community traffic, continued use of backup diesel generators, groundwater abstraction, incremental campus expansion, land use changes around the Project area, high-rainfall/flood conditions and the future accumulation of batteries, photovoltaic modules and other electronic waste.

REA and FUAB shall establish a cumulative-development register before mobilisation and update it at least annually and whenever a new campus or neighbouring development is proposed. Where concurrent activities are identified, the EPC Contractor shall coordinate schedules, traffic routes, drainage design, water use, emergency arrangements and waste disposal with FUAB and the other proponents. Cumulative impacts shall be monitored through the ESMP and corrective measures applied where combined effects approach

regulatory limits, create repeated community disturbance or place material pressure on a shared receptor. The cumulative impact at this period is considered **low.**

Table 5.12: Cumulative-impact screening and management

Receptor / Pathway	Other Existing or Foreseeable Activities	Potential Combined Effect	Pre-Mitigation Significance	Required Management
Traffic and road safety	Routine University/community traffic and any concurrent campus works	Temporary congestion, collision risk and road damage from combined vehicle movements	Minor–Moderate	Coordinated traffic plan, route scheduling, speed control, signage and road-condition monitoring
Air quality and noise	Backup generators, routine traffic and concurrent construction	Localised increase in dust, exhaust emissions, noise and nuisance	Minor	Coordinate high-noise works, dust suppression, equipment maintenance and receptor-based monitoring
Drainage and flooding	New hard standing, campus expansion and high seasonal rainfall	Increased runoff, erosion, ponding or downstream flooding	Moderate	Integrated drainage design, maintain natural flow paths, erosion control and wet-season inspection
Groundwater	Project abstraction plus university/ community boreholes	Incremental drawdown or reduced water availability	Minor pending yield verification	Borehole yield test, abstraction metering, water-efficiency measures and periodic level monitoring
Vegetation and livelihoods	Incremental campus clearing and seasonal land use around or potentially within the footprint	Cumulative vegetation loss and restriction of access to crops/farming plots	Moderate	Footprint optimisation, OS5 verification, compensation/ LRP where triggered and habitat restoration
Waste and e-waste	Routine University waste and future replacement of batteries/PV components	Pressure on authorised facilities and increased contamination risk	Moderate if uncontrolled	Waste inventory, producer take-back, licensed recyclers, secure storage and disposal records

5.6 Risk and Hazard Assessment

Risk assessment refers to the determination of the quantitative or qualitative estimate of risk(s) associated with recognized threats/hazards posed by the project's activities. The assessment of the risks and hazards associated with the proposed project involves:

- Identification of hazards/risks

- Assessing their likelihood of occurrence
- Estimating the consequence/severity of the hazards

5.7. Risk Assessment Methodology

Risk assessment refers to the determination of quantitative and/or qualitative estimates of risks associated with identified hazards arising from project activities. The objective is to systematically identify potential hazards, evaluate their likelihood of occurrence, assess the severity of their potential consequences, and determine appropriate mitigation measures to reduce risks to acceptable levels.

The assessment of risks and hazards associated with the proposed project involves the following key steps:

- Identification of hazards and potential risk sources associated with project activities.
- Assessment of the likelihood or probability of occurrence of each identified hazard.
- Evaluation of the potential consequences or severity of impacts should the hazard occur.
- Determination of the overall risk level through a structured Risk Assessment Matrix (RAM).
- Development of mitigation and control measures to eliminate or reduce identified risks.

Risk Assessment Matrix (RAM) Methodology

The Risk Assessment Matrix (RAM) methodology was adopted to evaluate and rank identified project risks. The methodology combines the likelihood of occurrence of a hazard with the severity of its potential consequences to determine the overall risk rating. This approach enables prioritization of risks and supports the development of appropriate mitigation measures.

The risk rating is determined using the following relationship:

Risk Rating = Likelihood × Consequence (Severity)

Likelihood is assessed based on the probability of a hazard occurring during project implementation, while consequence reflects the potential impact on personnel, equipment, the environment, project schedule, and operational continuity. The resulting risk scores are categorized into Low, Medium, High, or Extreme risk levels, allowing management attention and resources to be directed toward the most significant risks.

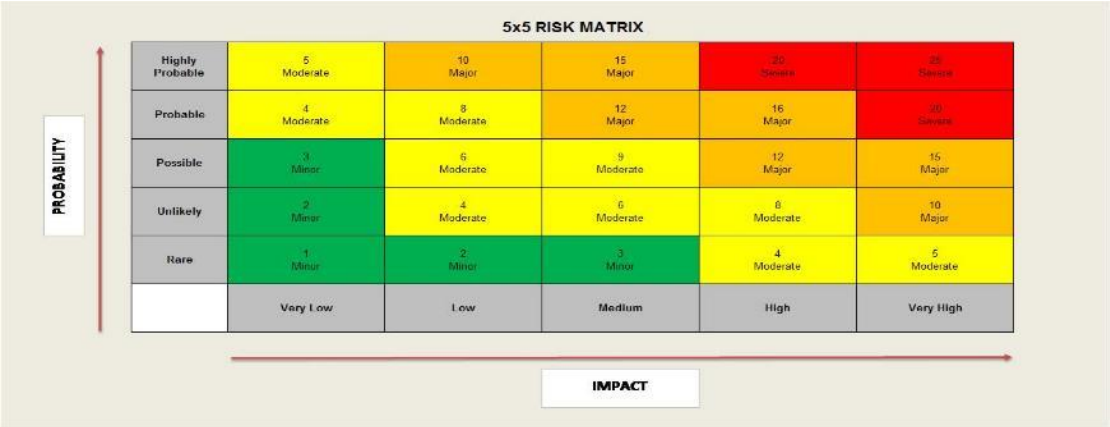

Figure 5.1: Risk Assessment Matrix

Project Specific Risks and Hazards

The potential risks and hazards associated with the proposed project are:

Fire and Explosion

The major risk associated with the operation of the plant is fire and explosion because PV systems are subject to electrical faults like other electrical installations such as short circuits, ground faults and reverse currents. Failures within the plant system could cause hotspots that can ignite nearby combustible materials. Faulty installations or failure with DC/AC inverters can also cause photovoltaic fires. Overcharging, high temperatures and physical stress to Lithium-ion battery cells can cause thermal escape, which commonly leads to the destruction of the battery, fire and even explosions. In addition, deep discharge can also cause battery fires. Any outbreak of uncontrolled fire in the area can escalate to dangerous dimensions, which could be critical. Thus, this hazard is classified as high risk.

Electrocution

Electrocution from direct contact with high-voltage electricity or tools, vehicles, ladders, and other devices that are in contact with high-voltage electricity could occur during the plant operation. This hazard is hardly likely to occur, and it is of minimal severe consequence and is thus classified as moderate risk.

Occupational Hazards

During construction, workers carrying out activities at heights could be exposed to occupational hazards. Electrical accidents may also result in shocks and/or burns, muscle contractions, and traumatic injuries associated with falls after the shock. This hazard is fairly probable although its severity is considered minimal thus it is classified as moderate risk.

5.8. Summary of Anticipated Impacts

These include significant risks such as electric shock and injuries of workers during the construction phase as well as GBV risks and soil degradation. The execution of suitable mitigation measures presented in the next chapter will abate the effect of identified negative impacts/risks to the most minimal level possible and heighten the effects of the identified positive impacts. Table 5.13 is a summary of the general potential site specific environmental and social impacts on the project.

Table 5. 13: Summarised Environmental and Social Impacts of Solar Power Plant

Category	Direct Impacts	Indirect Impacts
Environmental Impacts	- Reduction in noise from generator sets - Protection of natural habitats (reduced deforestation) - Reduced fuel consumption and carbon emissions - Lower greenhouse gas (GHG) emissions - Land use and land-use change - Waste production (including battery waste) - Material production impacts - Localized air, water, and soil pollution - Flood and erosion hazards - Occupational health and safety risks	- Improved safety (reduced exposure to flammable fuels) - Reduced indoor air pollution and improved health - Reduced impacts from fuel production chain - Effects on end-user industries - Improved equity of access to clean energy
Social Impacts	- Longer hours of lighting for studying and productivity - Improved social cohesion and development - Enhanced safety and equitable opportunities for women - Improved access to ICT (radio, TV, mobile, internet) - Access to information and distance education - Temporary land-use or access restrictions	- Reduced household expenditure on fuels (10–15% savings) - Increased savings and investment opportunities - Growth in income-generating activities - Support for small businesses (longer operating hours) - Increased trade and job creation - Improved socioeconomic development

CHAPTER SIX
MITIGATION MEASURES

6.1 Introduction

This chapter presents the mitigation measures proffered for the associated and potential impacts of the proposed solar-based power plant project. A comprehensive risk assessment matrix, as indicated in Figure 6.1, was used to determine the mitigation requirements for each of the impacts identified. The frequency, severity, sensitivity, scale, longevity, political, economic, legal, reputation/ image, and communication/complaints were factors taken into consideration during these assessments.

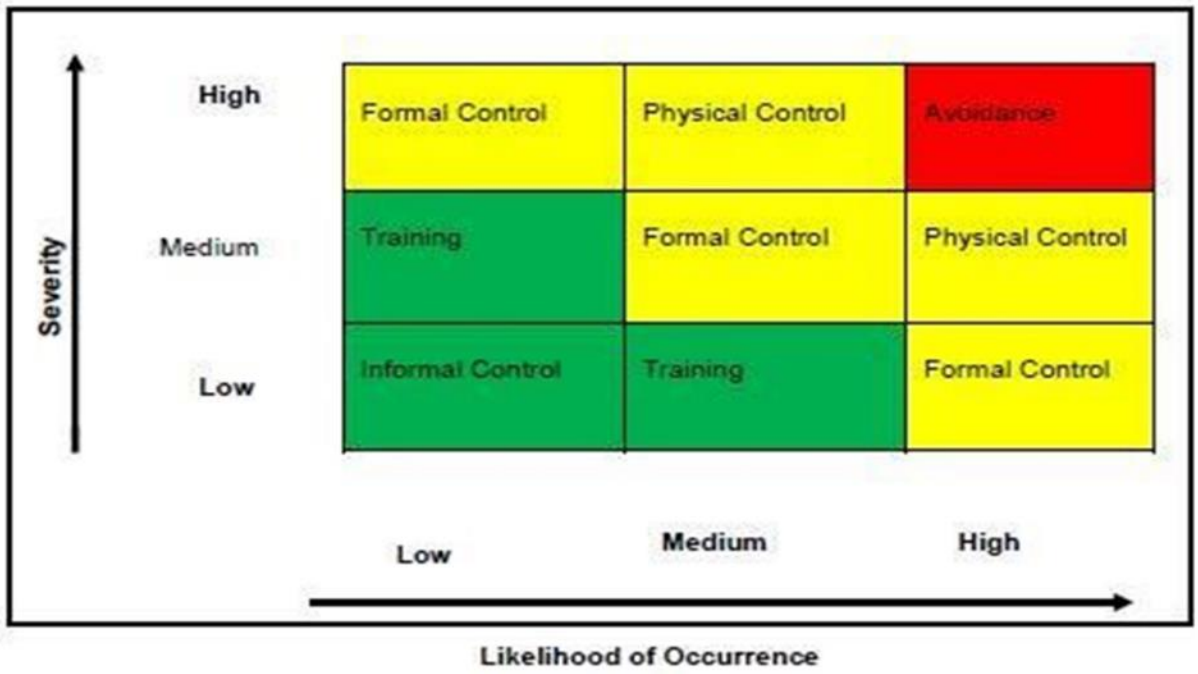

Figure 6. 1: Matrix for Determination of Mitigation Measures
(Source: www.researchgate.net/risk assessment matrix)

Mitigation measures designed to prevent, reduce or control the adverse impacts of the environmental and
social aspects of the proposed project to as low as reasonably practicable were considered and documented in this chapter of the report.

Subsequently, the specific mitigation measures satisfying the mitigation requirement were established, putting the following into consideration:

- Available resources and competencies.
- On-site conditions; and
- Public concerns and technology.

6.2 Mitigation Measures and Approach

Mitigation refers to measures or interventions necessary to avoid, minimize, reduce, or offset adverse impacts. The approach, as indicated in Table 6.1 for selecting appropriate mitigation measures, includes:

- Anticipate and avoid risks and impacts.
- Where avoidance is not possible, minimize or reduce risks and impacts to acceptable levels.
- Once risks and impacts have been minimized or reduced, mitigate.
- Where significant residual impacts remain, compensate or offset them, where technically and financially feasible.

The mitigation measures proposed for the identified environmental and social impacts were developed following the mitigation hierarchy, with priority given to avoiding or preventing adverse impacts wherever possible. Where avoidance was not feasible, practical and cost-effective measures based on best available technology and good industry practice were recommended to minimize or control potential impacts. Rehabilitation, restoration, or compensation measures were considered only as a last resort where residual impacts could not be completely avoided.

The recommended mitigation measures address impacts that may arise during the pre-construction, construction, operation, and decommissioning phases of the Project. These measures include effective environmental management practices, pollution prevention controls, waste management procedures, occupational health and safety measures, and stakeholder engagement initiatives. The implementation of these measures is expected to significantly reduce the magnitude and significance of identified impacts.

Based on the impact assessment, the residual impacts remaining after the application of the proposed mitigation measures are expected to be of negligible to minor significance. Furthermore, no significant long-term environmental or social impacts have been identified that cannot be mitigated to acceptable levels. This demonstrates that the Project can be implemented in an environmentally and socially responsible manner, provided that the recommended mitigation and monitoring measures are effectively applied throughout the Project lifecycle.

Table 6. 1: Summary of Mitigation Approaches for the University Solar Hybrid Power Projects

Project Phase	Mitigation Hierarchy	Approach
Project Design Phase	Avoidance & Minimization	• Micro-siting: changing the layout of project infrastructure to avoid sensitive areas • Re-routing, marking, or burying powerlines to reduce collision risks and barrier effects

Table 6. 1: Summary of Mitigation Approaches for the University Solar Hybrid Power Projects		
Project Phase	Mitigation Hierarchy	Approach
Construction Phase	Avoidance	• Scheduling: adjusting the timing of construction to avoid disturbing biodiversity during sensitive periods
	Minimisation	• Abatement controls to reduce emissions and pollutants (noise, erosion, waste) • Operational controls: exclusion fencing, designated machinery and lay-down areas, minimizing vegetation loss and soil disturbance
	Restoration & Rehabilitation	• Repairing biodiversity damage and ecosystem services • Revegetation of temporary-use and lay-down areas as soon as practicable after construction
Operational Phase	Minimisation	• Physical controls: modifying infrastructure (e.g., solar technology, foundations, fencing, transmission lines) • Abatement controls: wastewater management and water conservation • Operational controls: managing the timing of vegetation control activities
End-of-Life Phase	Avoidance	• Scheduling: timing decommissioning to avoid biodiversity disturbance (e.g., breeding seasons)
	Minimisation	• Abatement controls to reduce emissions and pollutants during decommissioning • Operational controls: exclusion fencing, designated machinery, and lay-down areas
	Restoration & Rehabilitation	• Repairing biodiversity damage and ecosystem services • Revegetation of temporary-use and lay-down areas after decommissioning

Table 6. 2: Mitigation Measures for the Pre-construction Phase of the Proposed Project

Activity	Receptor	Associated Impact	Significance	Mitigation Measures	Residual Impact
Site Selection / Land Take	Terrestrial Flora & Fauna	• Loss of land	Moderate	REA shall; • Work with the university to acquire the appropriate size of land for the project.	Minor
Site Clearing & Preparation	Terrestrial Flora & Fauna	• Loss of biodiversity	Minor	REA shall: • clearing shall be limited to the approved area • species within the designated area will be identified and documented • Biodiversity Management Plant (BMP) and implemented by the EPC contractor	Negligible
	Soil	• Loss of topsoil • Soil compaction and erosion • Reduced soil stability and permeability	Minor	REA shall: • Strip and store topsoil for later reuse (rehabilitation). Restrict the movement of heavy machinery to designated routes • Implement erosion control measures (mulching, silt fences) • Progressive site restoration	Negligible
	Air Quality & Noise	• Emissions from equipment • Increased noise levels	Minor	REA shall: • Regular maintenance of machinery to reduce emissions • Use dust suppression methods (water spraying) • Limit work to daytime hours • Provide noise control measures and PPE (ear protection)	Negligible
	Workers Safety	• Injuries and accidents during site clearing	Minor	REA shall: • Implement Occupational Health & Safety procedures aligned with International	Negligible

Activity	Receptor	Associated Impact	Significance	Mitigation Measures	Residual Impact
				Labour Organization standards • Provide PPE (helmets, gloves, boots) • Conduct safety training and toolbox talks	
Mobilisation of Construction Equipment & Materials	Air Quality & Noise	• Vehicular emissions (TSP, NOx, CO, SOx) • Increased noise levels	Minor	REA shall: • Maintain vehicles regularly to meet emission standards • Optimize logistics to reduce trips • Enforce speed limits and idle-time reduction • Use low-sulfur fuels where possible	Negligible

Table 6.3: Impacts Mitigation Measures for the Construction Phase of the Proposed Project

Activity	Receptor	Associated Impact	Significance	Mitigation Measures	Residual Impact
Movement of Equipment, Personnel & Materials	Air Quality	• Vehicular emissions (CO, SO_2, NO_2) • Dust emissions	Minor	REA shall: • Regular vehicle maintenance and emission checks • Use of low-sulfur fuels and efficient engines • Dust suppression (water spraying, covering trucks) • Limit vehicle idling and enforce speed limits	Negligible
	Social System (Road)	• Increased traffic from heavy-duty trucks	Minor	REA shall: • Implement Traffic Management Plan • Schedule deliveries during off-peak hours • Use designated haulage routes • Community awareness and signage	Negligible
	Health & Safety	• Risk of accidents due to vehicle movement	Minor	REA shall: • Driver training and certification • Speed control and enforcement • Vehicle inspection and maintenance • Use of warning signs and traffic marshals	Negligible
Civil & Electrical Works / Installation	Air Quality	• Emissions from equipment • Dust from land clearing and stockpiles	Minor	REA shall: • Maintain construction equipment regularly • Dust suppression measures (watering, covering materials)	Negligible

Activity	Receptor	Associated Impact	Significance	Mitigation Measures	Residual Impact
				• Limit activities during high winds • Provide PPE (respirators where necessary)	
	Ambient Noise	• Increased noise levels	Minor	REA shall: • Restrict noisy activities to daytime hours • Use well-maintained equipment with silencers • Provide hearing protection to workers • Establish buffer zones near sensitive receptors	Negligible
	Soil	• Erosion from excavation • Soil compaction and reduced permeability	Moderate	REA shall: • Implement erosion and sediment control measures (silt fences, drainage control) • Limit heavy machinery movement to designated areas • Progressive rehabilitation and re-vegetation • Proper site grading and drainage design	Minor
	Terrestrial Flora & Fauna	• Loss of plant species (invasive species risk) • Disturbance to fauna	Minor	REA shall: • Control and monitor invasive species • Minimize vegetation clearing • Restrict worker movement to designated areas	Negligible

Activity	Receptor	Associated Impact	Significance	Mitigation Measures	Residual Impact
				• Implement biodiversity management plan	
	Groundwater	• Depletion from abstraction • Increased sediment load and runoff	Minor	REA shall: • Use water-efficient construction practices • Obtain abstraction permits and monitor usage • Install sediment traps and proper drainage systems • Avoid contamination of water sources	Negligible
	Gender	• Discrimination and GBV risks	Moderate	REA shall: • Develop and implement Gender Action Plan and GBV Action Plan aligned with AfDB ISS • Code of conduct for workers • Awareness training and strict sanctions • Confidential grievance redress mechanism	Minor
	Socio-economic & Health	• Spread of STDs due to influx of workers	Moderate	REA shall: • Community health awareness programs • Provide access to healthcare services and testing • Enforce worker codes of conduct • Collaborate with local health authorities and NGOs	Minor

Activity	Receptor	Associated Impact	Significance	Mitigation Measures	Residual Impact
	Infrastructure (Road)	• Road damage, congestion, safety issues	Minor	REA shall: • Traffic and logistics management plan • Routine road maintenance and repairs • Use appropriate vehicle sizes and loads • Coordination with local authorities	Negligible
	Construction Workers Safety	• Risk of injury during construction	Moderate	REA shall: • Implement Occupational Health & Safety system (aligned with International Labour Organization standards) • PPE provision and enforcement • Safety training, supervision, and emergency preparedness • Regular audits and incident reporting	Minor
	Soil	• Soil contamination from construction waste	Minor	REA shall: • Proper waste segregation and storage • Use lined containment areas for hazardous waste • Spill prevention and response plan • Disposal through licensed contractors	Negligible
Waste Generation & Disposal	Groundwater	• Contamination from liquid waste streams	Minor	REA shall: • Treat wastewater before discharge	Negligible

Activity	Receptor	Associated Impact	Significance	Mitigation Measures	Residual Impact
				• Use impermeable liners for storage areas • Regular inspection of waste systems • Compliance with environmental standards	

Table 6.4: Mitigation Measures for the Commissioning Phase of the proposed Project

Activity	Receptor	Associated Impact	Significance	Mitigation Measures	Residual Impact
Plant Testing	Ambient Noise	• Increase in ambient noise levels during testing activities	Minor	REA shall: • Restrict testing to daytime hours • Use well-maintained equipment with noise suppression features • Notify nearby occupants in advance • Provide hearing protection (PPE) to workers	Negligible
	Workers	• Occupational health and safety hazards (injuries, electrocution due to incorrect connections)	Moderate	REA shall: • Implement strict electrical safety procedures (lockout/tagout systems) • Ensure only certified personnel handle electrical connections • Provide appropriate PPE (insulated gloves, boots) • Conduct pre-commissioning safety checks and supervision • Emergency response and first aid readiness	Minor
	Campus Occupants' Safety	• Risk of electrocution from wrong electrical connections	Minor	REA shall: • Secure and restrict access to testing areas • Install warning signage and physical barriers • Ensure proper grounding and insulation of systems • Supervise all testing activities closely	Negligible

Table 6.5: Mitigation measures for the Operational Phase of the proposed Project

Activity	Receptor	Associated Impact	Significance	Mitigation Measures	Residual Impact
Power Generation & Distribution	Gender	•Discrimination of women during employment • GBV (sexual harassment, assault, poor working conditions)	Minor	REA shall: • Implement Gender Action Plan and GBV prevention measures aligned with AfDB ISS • Enforce equal opportunity employment policy • Worker code of conduct and regular training • Establish confidential grievance redress mechanism	Negligible
	Health, Safety & Welfare of Staff (Plant Operation)	• Electric shock and injuries • Workplace discrimination and unfair treatment	Moderate	REA shall: • Implement Occupational Health & Safety (OHS) system in line with International Labour Organization standards • Install lockout/tagout (LOTO) systems and safety signage • Provide appropriate PPE (insulated gloves, boots, etc.) • Conduct routine safety	Minor

				training and audits • Enforce fair labor practices and worker rights policies	
Routine Maintenance	Soil	• Soil contamination from spent batteries and inverters	Minor	REA shall: • Store hazardous materials in sealed, labeled containers • Implement hazardous waste management plan • Use certified waste handlers for disposal/recycling • Install secondary containment and spill response systems	Negligible
	Groundwater	• Groundwater abstraction from cleaning PV panels	Minor	REA shall: • Use water-efficient or dry-cleaning technologies • Harvest and reuse rainwater where feasible • Monitor abstraction rates and comply with permits • Adopt water conservation measures	Negligible
Waste Generation & Disposal	Health, Safety & Welfare of Staff	• Electric shock and injuries during maintenance	Minor	REA shall: • Enforce electrical isolation	Negligible

	(Maintenance)			procedures (LOTO) • Provide PPE and insulated tools • Conduct competency-based training • Routine inspection and supervision of maintenance work	

Table 6.6: Mitigation Measures for the Decommissioning Phase of the Proposed Project

Activity	Receptor	Associated Impact	Significance	Mitigation Measures	Residual Impact
Dismantling of Plant & Equipment	Air Quality	• Dust emissions from dismantling activities • Emissions from machinery and vehicles	Minor	REA shall: • Apply dust suppression measures (water spraying) • Use well-maintained, low-emission equipment • Cover trucks transporting materials • Limit unnecessary idling of machinery	Negligible
	Ambient Noise	• Increased noise from dismantling activities	Minor	REA shall: • Restrict activities to daytime hours • Use equipment fitted with silencers	Negligible

Activity	Receptor	Associated Impact	Significance	Mitigation Measures	Residual Impact
				• Provide hearing protection (PPE) to workers • Notify nearby communities in advance	
	Workers Safety	• Injuries from equipment dismantling • Risk of electrocution	Moderate	REA shall: • Implement Occupational Health & Safety procedures aligned with International Labour Organization standards • Apply lockout/tagout (LOTO) systems before dismantling • Provide appropriate PPE (helmets, gloves, insulated gear) • Ensure only trained personnel handle electrical components	Minor
Removal of Foundations & Civil Works	Soil	• Soil disturbance, erosion, and compaction	Minor	REA shall: • Minimize excavation footprint • Implement erosion and sediment control measures	Negligible

Activity	Receptor	Associated Impact	Significance	Mitigation Measures	Residual Impact
				• Reuse and reinstate topsoil • Progressive rehabilitation of disturbed areas	
	Groundwater	• Potential contamination from spills and exposed materials	Minor	REA shall: • Proper storage and handling of fuels and chemicals REA shall: • Spill prevention and response plans • Avoid discharge of contaminants into soil and water • Regular inspection of work areas	Negligible
Waste Generation & Disposal	Soil & Groundwater	• Contamination from hazardous and non-hazardous waste	Moderate	REA shall: • Implement comprehensive waste management plan (segregation, recycling, disposal) • Use licensed waste contractors • Store hazardous waste in secure, labeled containers with secondary containment • Comply with national and international	Minor

Activity	Receptor	Associated Impact	Significance	Mitigation Measures	Residual Impact
				waste regulations	
	Infrastructure (Waste Facilities)	• Increased burden on existing waste management systems	Minor	REA shall: • Coordinate with approved waste facilities • Schedule waste transport efficiently • Promote recycling and material recovery (e.g., metals, panels)	Negligible
Transportation of Decommissioned Materials	Air Quality & Noise	• Emissions and noise from haulage vehicles	Minor	REA shall: • Maintain vehicles to reduce emissions • Optimize transport logistics • Enforce speed limits and reduce idling • Use designated transport routes	Negligible
	Infrastructure (Road)	• Traffic congestion and road safety risks	Minor	REA shall: • Implement Traffic Management Plan • Use trained drivers and road signage • Schedule transport during off-peak hours • Repair any road damage caused	Negligible

Activity	Receptor	Associated Impact	Significance	Mitigation Measures	Residual Impact
	Community Health & Safety	• Risk of accidents involving local communities	Minor	REA shall: • Community awareness programs • Install warning signs and barriers • Escort oversized loads where necessary • Enforce strict safety protocols	Negligible
Site Restoration & Rehabilitation	Terrestrial Flora & Fauna	• Loss of habitat prior to restoration	Minor	REA shall: • Re-vegetate using native species • Restore natural habitat conditions • Monitor ecological recovery • Prevent introduction of invasive species	Negligible
	Socio-economic	• Temporary loss of employment after project closure	Moderate	REA shall: • Develop worker transition and livelihood restoration programs • Provide skills training and job placement support • Engage stakeholders early on closure plans	Minor

CHAPTER SEVEN
ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN (ESMP)

7.1 Preamble

This section of the Environmental and Social Management Plan (ESMP) provides a comprehensive framework of mitigation and management measures designed to avoid, minimize, mitigate, or compensate for adverse environmental, occupational health and safety, and social impacts associated with the project. Building on the impact assessment presented in the previous chapter, this section translates identified risks and impacts into actionable mitigation measures and monitoring requirements. It outlines the institutional arrangements for implementation, defines monitoring parameters and schedules, assigns responsibilities, and provides an indicative budget to ensure that environmental and social safeguards are effectively integrated throughout the project lifecycle.

The types of impacts addressed in this section include environmental impacts such as air pollution, noise and vibration, soil erosion, water contamination, biodiversity disturbance, and waste generation; occupational health and safety (OHS) risks such as worker injuries, exposure to hazardous materials, and unsafe working conditions; and social impacts including land use conflicts, community health and safety concerns, labor influx issues, and disruption to local livelihoods. Each identified impact is matched with corresponding mitigation measures that are technically feasible, cost-effective, and aligned with national regulations and international good practice. These measures are designed not only to reduce negative consequences but also to enhance potential positive outcomes where feasible.

Mitigation measures are organized according to project phases such as pre-construction, construction, and operation. During the pre-construction phase, mitigation may include careful site selection, environmental screening, stakeholder consultations, land acquisition planning in compliance with legal frameworks, and development of management plans such as waste management, traffic management, and occupational health and safety plans. During construction, mitigation focuses on controlling dust and emissions, implementing erosion and sediment control, ensuring safe waste disposal, providing personal protective equipment (PPE) to workers, enforcing site safety protocols, managing traffic flow, and minimizing disturbance to nearby communities. In the operational phase, mitigation includes regular maintenance of infrastructure, monitoring emissions and effluents, ensuring safe working conditions, maintaining emergency preparedness plans, and sustaining community engagement mechanisms.

An Environmental Code of Conduct (ECoC) or Environmental and Social Code of Practices forms a key component of the ESMP and will be attached to bidding documents and incorporated into contractor agreements. The Code establishes mandatory standards of behavior and operational procedures for contractors, subcontractors, and workers. It includes provisions on environmental protection, waste management, pollution prevention, occupational health and safety, prohibition of child and forced labor, prevention of gender-based violence and harassment, respect for local communities and cultural heritage, and compliance with applicable laws and regulations. By integrating the Code into contractual documents, the project ensures that environmental and social obligations are legally binding and enforceable.

The Monitoring Plan defines what parameters will be monitored, how frequently monitoring will occur, who will be responsible, and what methods will be used. Environmental parameters may include air

quality indicators (e.g., particulate matter), noise levels, water quality (pH, turbidity, contaminants), waste volumes, and soil stability. Occupational health and safety monitoring may include tracking accident rates, use of PPE, training records, and compliance with safety procedures. Social monitoring may involve tracking grievances received and resolved, stakeholder consultation records, labor conditions, and community health and safety indicators. Monitoring schedules are typically more frequent during construction and may shift to periodic or annual monitoring during operation. The results of monitoring activities will be documented and reviewed regularly to evaluate the effectiveness of mitigation measures and allow for corrective actions when necessary.

Communication and documentation are essential components of effective ESMP implementation. Clear reporting lines will be established among contractors, supervising engineers, project management units, and regulatory authorities. Regular environmental and social monitoring reports will be prepared and submitted to relevant authorities and financing institutions, as applicable. Documentation will include monitoring data, incident reports, corrective actions taken, training records, consultation minutes, and photographic evidence where relevant. Transparent communication with stakeholders will be maintained through public meetings, information boards at project sites, disclosure of monitoring results, and community liaison officers who serve as points of contact for residents.

The cost of implementing the ESMP is estimated through a tentative monitoring and mitigation budget. This budget includes costs associated with environmental monitoring equipment and laboratory testing, training and capacity building, personal protective equipment, waste management systems, stakeholder engagement activities, grievance management mechanisms, and employment of environmental and social specialists. Allocating adequate financial resources ensures that mitigation and monitoring activities are not overlooked during project execution and are treated as integral components of project delivery rather than optional add-ons.

Integration of the ESMP with the overall project framework is achieved through inclusion of specific environmental and social clauses in contract documents, technical specifications, and bills of quantities. Contractors will be contractually obligated to implement mitigation measures, comply with the Environmental Code of Conduct, and cooperate with monitoring activities. Performance indicators related to environmental and social compliance may be included in contractor evaluation criteria. Non-compliance may trigger corrective actions, penalties, or suspension of work as stipulated in the contract. This integration ensures that environmental and social considerations are embedded in project management, procurement, and supervision processes.

A Grievance Resolution Mechanism (GRM) will be established to provide affected individuals and communities with a transparent, accessible, and fair process for raising concerns or complaints related to the project. The GRM will define procedures for submission, registration, acknowledgment, investigation, response, and resolution of grievances within specified timeframes. Multiple entry points, such as suggestion boxes, community meetings, telephone hotlines, or designated grievance officers, will be provided to ensure accessibility. Records of grievances and their resolution status will be maintained and periodically reviewed to identify recurring issues and improve project management practices.

The Stakeholder and Community Engagement Plan outlines strategies for meaningful engagement throughout the pre-construction, construction, and operation phases. During pre-construction, engagement focuses on information disclosure, consultation on project design, identification of community needs, and mobilization of local stakeholders. Community mobilization approaches will

combine social and commercial perspectives by promoting local employment opportunities, supporting local suppliers, and fostering community ownership of project benefits. During construction, engagement activities will include regular updates on project progress, advance notice of potentially disruptive activities, safety awareness campaigns, and continued consultation to address emerging concerns. During operation, engagement will focus on sustaining positive relationships, ensuring long-term benefits, and maintaining open communication channels for feedback and collaboration.

7.2 Objectives of the ESMP

The purpose of the Environmental and Social Management Plan (ESMP) is to ensure that Environmental and Social impacts identified during the ESIA process are effectively addressed during the construction, operation and closure of the project. The ESMP specifies the mitigation and management measures to which the Proponent is committed and shows how the Project will mobilize organizational capacity and resources to implement these measures. The ESMP will be a living document and will continue to develop during the design and construction phases to enable continuous improvement of the Project's environmental performance.

The specific objectives of the ESMP are to:

- Promote Environmental and social management and communicate the aims and goals of the ESMP.
- Ensure that all workers, subcontractors, and others involved in the Project meet legal and regulatory requirements about environmental management, including financial implications
- Incorporate environmental and social management into Project design and operating procedures.
- Serve as an action plan for environmental and social management for the project;
- Provide a framework for implementing project environmental and social commitments (i.e. mitigation measures identified in the ESIA).

7.3 Roles, Responsibilities, and Accountabilities

The Rural Electrification Agency Project Management Unit (REA-PMU) will oversee and coordinate the implementation of the Environmental and Social Management Plan (ESMP) throughout the entire project lifecycle. Compliance with the prescribed mitigation measures during the construction phase will be the responsibility of the Engineering, Procurement, and Construction (EPC) contractor. During the operational phase, adherence to the ESMP requirements will be ensured by the Operations and Maintenance (O&M) contractor. Table 7.10 outlines the specific roles and responsibilities of the various stakeholders involved in the implementation, monitoring, and review of the ESMP.

Table 7. 1: The Roles and Responsibilities of the Stakeholders in the Implementation, Monitoring, and Review of the ESMP

S/N	Stakeholder	Roles and Responsibilities
1	**FUAB Director of Physical Planning:**	**Pre-Construction Phase** • Earmark the areas for the project development from the survey land • Appointing a Site Engineer • Arrange and ensure adequate training is carried out for the Site Engineer • Review the ESMP from the consultant • Ensure the University's commitment to the ESMP implementation • Implement the restoration of livelihood to affected persons before mobilization to the site **Operational Phase** • Supervise the activities of the Site Engineer by reviewing reports on ESMP issues • Suggest ESMP improvements to O&M Contractor and PMU to address noncompliance and upcoming issues
2	**REA-PMU**	**Pre-Construction Phase** • Provide technical support to the University in the final selection of sufficient and suitable land for the construction of a power plant and training centre • Supervise the implementation of the restoration of livelihood to affected persons before mobilization to site • Appointing an EPC contractor • Supervise the activities of the EPC contractor • Review the ESMP from the consultant • Ensure REA's commitment to the ESMP implementation **Construction phase** • Supervise the activities of the EPC contractor by reviewing reports on ESMP issues • Discuss ESMP improvements with FUAB Director of Physical Planning to address non-compliance and upcoming issues • Monitor the implementation of the ESMP • Supervise the activities of the EPC contractor and ensure compliance with ESMP mitigation measures • Report to FUAB Director of Physical Planning on ESMP compliance and noncompliance issues **Operational** • Appointing an O&M Contractor • Supervise the activities of the O&M Contractor by reviewing reports on ESMP issues • Discuss ESMP improvements with the FUAB Director of Physical Planning to address non-compliance and upcoming issues

S/N	Stakeholder	Roles and Responsibilities
3	**MAU Site Engineer**	**Pre-Construction Phase** • Attend adequate training on ESMP implementation • Supervise the activities of the EPC contractor and ensure compliance with ESMP mitigation measures • Report to the FUAB Director of Physical Planning on ESMP compliance and noncompliance issues **Operational phase** • Appointing an O&M Contractor • Supervise the activities of the O&M Contractor by reviewing reports on ESMP issues • Discuss ESMP improvements with the Director of Physical Planning to address non-compliance and upcoming issues
4	**EPC Contractor**	• Familiarize with ESMP requirements • Ensure that all personnel are made aware of the management measures/plans that are to be implemented
		• Report to the REA-PMU, POE and FUAB Site Engineer on ESMP compliance and non-compliance issues • Implement ESMP requirements relevant to the work being undertaken **Construction phase** • Implement ESMP requirements relevant to work being undertaken • Hire a Gender/GBV officer • Report to the REA-PMU, POE and FUAB Site Engineer on ESMP compliance and non-compliance issue
	O&M Contractor	• Implement ESMP requirements relevant to work being undertaken • Hire a Gender/ GBV officer • Report to the REA-PMU, POE and FUAB Site Engineer on ESMP compliance and non-compliance issue
	FMEnv Representatives	• Monitor the implementation of ESMP requirements (impact mitigation monitoring) relevant to work being undertaken • Discuss ESMP improvements with FUAB Director of Physical Planning and REAPMU to address non-compliance and upcoming issues • Operational phase • Monitor the implementation of ESMP requirements (environmental compliance monitoring) relevant to work being undertaken • Discuss ESMP improvements with O&M Contractor, FUAB Director of Physical Planning, and REA-PMU to address non-compliance and upcoming issues
	NESREA Representatives	• Monitor the implementation of ESMP requirements (environmental compliance monitoring) relevant to work being undertaken • Discuss ESMP improvements with O&M Contractor, FUAB Director of Physical Planning, and REA-PMU to address non-compliance and upcoming issues

	Bayelsa State Ministry of Women Affairs and Social Development (GBV/SEA service provider)	• Monitor the implementation of Gender mitigation measures relevant to work being undertaken • Discuss ESMP improvements with the Gender/GBV officer, FUAB Director of Physical Planning, and REA-PMU to address non-compliance and upcoming issues • **Operational** • Monitor the implementation of Gender mitigation measures relevant to work being undertaken • Discuss ESMP improvements with the Gender/GBV officer, FUAB Director of Physical Planning, and REA-PMU to address non-compliance and upcoming issues
	Bayelsa State Ministry of Environment Representatives	• Monitor the implementation of ESMP requirements (impact-mitigation monitoring) relevant to work being undertaken • Discuss ESMP improvements with the Director of Physical Planning and REAPMU to address non-compliance and upcoming issue
	Bayelsa State Ministry of Environment Representatives	• Monitor the implementation of ESMP requirements (impact-mitigation monitoring) relevant to work being undertaken • Discuss ESMP improvements with FUAB • Director of Physical Planning and REA-PMU to address non-compliance and upcoming issues • **Operational** • Monitor the implementation of ESMP requirements (environmental compliance monitoring) relevant to work being undertaken • Discuss ESMP improvements with O&M Contractor, FUAB Director of Physical Planning, and REA-PMU to address non-compliance and upcoming issues
	Safeguards Unit	• **Environmental Aspects** • Analyze potential community/individual sub-projects and their environmental impacts. • Ensure that project activities are implemented in accordance with best practices and guidelines set out in the site specifics;
	Stakeholder	• **Roles and Responsibilities**
		• Identify and liaise with all stakeholders involved in environment-related issues in the project; and • Be responsible for the overall monitoring of mitigation measures and the impacts of the project during implementation. • **Social Aspects** • Develop, coordinate, and ensure the implementation of the social aspects of the ESMP; • Implement the grievance mechanism on the project • Identify and liaise with all stakeholders involved in social-related issues in the project; • Conduct impact evaluation and beneficiaries' assessment; and • Establish partnerships and liaise with organizations, Community-Based Organizations (CBOs) and Civil Society Organizations (CSOs).

	EPC and Works Contractor	• After receiving and committing to the environmental procedures and Management Plans, • Contractors must fully carry out the measures of environmental protection, health, and safety procedures as indicated. • Any changes related to the environment, health, and safety procedures must be referred to PMU for approval • In case of any violations arising from works either detected by Environmental consultants, Safeguard Specialists, or newly arising works proposed by contractors, they must be reported to PMU for further action. • If contractors decide not to follow instructions from PMU, construction activities will be halted until necessary actions are taken. • Contractors must assign at site in charge of the environment, health, and safety procedures. • Compliance with BOQ specification in the procurement of materials and construction • Provide oversight function during construction and decommissioning

7.4 Environmental and Social Management Measures

The recommended environmental and social management measures required to mitigate the identified impacts of the proposed project activities during pre-construction, construction, commissioning, and operation phases are presented in Tables 7.2 to 7.10.

Table 7.2: Environmental Management Plan – Pre-Construction Phase

Summary of Potential Impact	Mitigation Measures	Requirements / Parameters	Frequency	Performance Indicator	Implementation Responsibility	Monitoring Responsibility	Cost (USD)
Vegetation loss; impacts on flora and fauna	Limit clearing strictly to approved project area	Site inspection	Daily	Adherence to demarcated boundaries	EPC Contractor	REA (PMU); POE (Site Engineer)	1,100
	Avoid herbicides; use mechanical clearing only	Inspection	Daily	No herbicide use	EPC Contractor	REA (PMU)	
	Replant trees at 1:10 ratio using locally occurring species	Inspection	Daily	Number of trees replanted	EPC Contractor	REA (PMU)	
	Prohibit bush burning	Inspection	Daily	No evidence of burning	EPC Contractor	REA (PMU)	
	Re-vegetate unused cleared areas	Inspection	Monthly	Revegetated land area	EPC Contractor	REA (PMU)	
	Clearly demarcate approved clearing limits	Inspection	Monthly	No clearing beyond approved corridor	EPC Contractor	REA (PMU)	
	Prohibit hunting or killing of animals; worker sensitization	Inspection	Daily	No hunting incidents	EPC Contractor	REA (PMU)	
Topsoil removal; soil compaction; erosion risk	Restrict soil removal to required areas; stockpile topsoil for restoration	Inspection	Daily	Proper stockpiling and restoration	EPC Contractor	REA (PMU)	500
	Install silt traps to prevent sediment discharge	Inspection	Monthly	Functional silt control systems	EPC Contractor	REA (PMU)	
Air quality and noise impacts from equipment	Maintain machinery for fuel efficiency	Maintenance & fuel records	Daily	Proper maintenance logs	EPC Contractor	REA (PMU)	
	Restrict clearing to daytime (Weekdays 08:00–17:00; Weekends 09:00–13:00)	Inspection	Daily	Compliance with working hours	EPC Contractor	REA (PMU)	

Summary of Potential Impact	Mitigation Measures	Requirements / Parameters	Frequency	Performance Indicator	Implementation Responsibility	Monitoring Responsibility	Cost (USD)
Air & noise impacts during mobilization	Use well-serviced vehicles with minimal emissions	Inspection; Maintenance records	Once before journey	Vehicle compliance	EPC Contractor	REA (PMU); POE	700
	Cover dust-prone materials during transport	Inspection	Before journey	Properly covered loads	EPC Contractor	REA (PMU)	
	Sprinkle site/access roads to suppress dust	Inspection	Daily	Reduced visible dust	EPC Contractor	REA (PMU)	
	Limit onsite speed to 15–20 km/h	Inspection	Daily	Speed compliance	EPC Contractor	REA (PMU)	
	Avoid unnecessary engine idling	Inspection	Daily	Reduced idle time	EPC Contractor	REA (PMU)	

Total Environmental Cost: USD 1,400

Table 7.3: Social Management Plan – Pre-Construction Phase

Summary of Potential Impact	Mitigation Measures	Monitoring Requirements / Parameters	Frequency	Performance Indicator	Implementation Responsibility	Monitoring Responsibility	Cost (USD)
Exposure to infectious diseases (HIV/AIDS, COVID-19)	Implement NCDC safety guidelines	Implementation records	Before mobilization & during clearing	Compliance with NCDC guidelines	EPC Contractor	REA (PMU)	
	Provide hygiene facilities; enforce mask use & infection prevention measures	Facility inspection	Before mobilization & during works	Availability & usage of facilities	EPC Contractor	REA (PMU)	
Worker injuries during loading/offloading	Provide adequate PPE (gloves, shoes, hard hats); enforce usage	PPE availability records	Daily	PPE compliance	EPC Contractor	REA (PMU); POE	3,500
	Prohibit unregistered laborers	Employment records	Once before mobilization	Labour Act compliance	EPC Contractor	REA (PMU)	

Summary of Potential Impact	Mitigation Measures	Monitoring Requirements / Parameters	Frequency	Performance Indicator	Implementation Responsibility	Monitoring Responsibility	Cost (USD)
	Restrict site clearing to daytime	Inspection	Daily	Time log records	EPC Contractor	REA (PMU)	
Increased traffic and road accident risks	Develop and implement Traffic Management Plan (TMP)	TMP records	Daily	TMP benchmarks achieved	EPC Contractor	REA (PMU)	
	Provide signage, barriers, crossing points	Inspection	Before & during mobilization	Adequate safety infrastructure	EPC Contractor	REA (PMU)	
	Assess driver competence; provide training where necessary	Assessment & training records	Once before mobilization	Valid licenses & certificates	EPC Contractor	REA (PMU)	
	Develop incident/accident reporting procedure	Incident forms	Daily	Completed reports	EPC Contractor	REA (PMU)	
	Enforce disciplinary measures for traffic violations	Incident records	Daily	Reduced violations	EPC Contractor	REA (PMU)	

Total Social Cost: USD 5,500

Table 7.4: Environmental Management Plan (Construction Phase)

Summary of Potential Impact	Mitigation Measures	Monitoring Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	Cost (USD)
Air Emissions & Dust (Civil & Electrical Works)	Regular maintenance and servicing of construction equipment	Maintenance records	Monthly during construction	Proper maintenance logs	EPC Contractor	REA-PMU; POE	580
	Routine water sprinkling to suppress dust	Site inspection	Daily during civil works	Reduced visible dust	EPC Contractor	REA-PMU	
	Cover exposed stockpiles to prevent windblown dust	Inspection	Daily	Covered stockpiles	EPC Contractor	REA-PMU	
Increase in Noise Levels	Restrict construction to daytime (08:00–17:00 weekdays; 09:00–13:00 weekends)	Inspection	Daily	Compliance with working hours	EPC Contractor	REA-PMU; POE	760
	Turn off machinery when not in use	Inspection	Daily	Reduced equipment idling	EPC Contractor	REA-PMU	
	Maintain equipment to meet industry noise standards	Maintenance records	Monthly	Compliance with FMEnv noise limits	EPC Contractor	REA-PMU	
	Address noise complaints via GRM	Complaint records	Weekly	Resolved complaints	EPC Contractor	REA-PMU	
	Conduct noise monitoring at sensitive locations	Noise monitoring logs	Monthly	Within FMEnv noise limits	EPC Contractor	REA-PMU	
	Ensure machinery meets noise attenuation standards before deployment	Inspection	Before construction	Compliance certification	EPC Contractor	REA-PMU	
	Cover stockpiles and implement erosion control measures	Inspection	Daily during civil works	No visible erosion	EPC Contractor	POE	

Summary of Potential Impact	Mitigation Measures	Monitoring Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	Cost (USD)
Loss of Flora/Fauna & Introduction of Alien Species	Provide ecological awareness training to workers	Training records	Once before construction	Training certificates	EPC Contractor	REA-PMU; POE	300
	Clean equipment before entering site	Inspection	Daily	Clean equipment	EPC Contractor	REA-PMU	
	Monitor stockpiles for invasive species growth	Monitoring records	Monthly	No invasive species growth	EPC Contractor	REA-PMU	
Traffic & Safety Risks and road and water	Develop and implement Traffic Management Plan (TMP)	TMP implementation records	Daily	TMP benchmarks achieved	EPC Contractor	REA-PMU; POE	1,500
	Enforce speed limits for construction vehicles	Inspection	Daily	Speed compliance	EPC Contractor	REA-PMU	
	Install barriers and traffic signage	Inspection	Before & during construction	Adequate signage installed	EPC Contractor	REA-PMU	
	Assess driver competence and provide training	License & training records	Before construction	Valid licenses and certificates	EPC Contractor	REA-PMU	
	Maintain traffic incident recording procedure	Incident logs	Daily	Completed incident reports	EPC Contractor	REA-PMU	
	Repair or compensate for damaged infrastructure/property	GRM & incident records	As required	Compensation records	EPC Contractor	REA-PMU	
E-Waste Generation	Implement Waste Management Plan (WMP)	WMP records	Weekly	WMP compliance	EPC Contractor	REA-PMU; POE	450
	Train workers on safe e-waste handling	Training records	Before construction	Training certificates	EPC Contractor	REA-PMU	
	Store e-waste appropriately before disposal/recycling	Waste consignment notes	Weekly	Proper storage and disposal	EPC Contractor	REA-PMU	

Summary of Potential Impact	Mitigation Measures	Monitoring Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	Cost (USD)
Soil Contamination (Hazardous Waste)	Store hazardous materials on impervious surfaces with secondary containment	Inspection	Daily	No spills observed	EPC Contractor	REA-PMU; POE	2,400
	Provide spill kits onsite	Inspection	Daily	Spill kits available	EPC Contractor	REA-PMU	
	Train workers on hazardous material handling	Training records	Before construction	Training certificates	EPC Contractor	REA-PMU	
Groundwater Contamination	Implement WMP and hazardous material controls	WMP records	Daily	Compliance with WMP	EPC Contractor	REA-PMU; FMEnv	
	Conduct risk assessment for hazardous materials	Risk assessment report	Before & during construction	Control measures implemented	EPC Contractor	REA-PMU	

Total Environmental Cost (Construction Phase): USD 6,290

Table 7.5: Social Management Plan (Construction Phase)

Summary of Potential Impact	Mitigation Measures	Monitoring Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	Cost (USD)
Employment Discrimination	Ensure fair and open recruitment; prohibit employment under 18	Employment records	Before construction	Labour law compliance	EPC Contractor	REA-PMU; POE	-
Temporary Land Displacement	Manage displacement internally within university	Land reallocation records	Before construction	Proper documentation	University Director (Physical Planning)	REA-PMU; POE	-

Summary of Potential Impact	Mitigation Measures	Monitoring Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	Cost (USD)
GBV / SEA Risks	Implement EEP GBV Action Plan	Implementation records	Before construction	Approved GBV plan	EPC Contractor	REA-PMU; POE; FMEnv	**700**
	Require all workers to sign Code of Conduct	Signed CoC forms	Before construction	Signed records	EPC Contractor	REA-PMU	
	Hire Gender/GBV Officer	Employment records	Before construction	Officer engaged	EPC Contractor	REA-PMU	
	Provide separate male/female facilities & GBV signage	Inspection	Before construction	Adequate facilities	EPC Contractor	REA-PMU	
	Establish GBV-sensitive GRM channels	GRM logs	Monthly	Active reporting system	EPC Contractor	REA-PMU	
	Conduct monthly GBV training	Training attendance logs	Monthly	Attendance records	EPC Contractor	REA-PMU	
	Engage GBV service providers	Engagement records	Before & during construction	Active collaboration	EPC Contractor	REA-PMU	
Labour Influx & STDs Risk	Prioritize local employment; implement Labour Management Plan	Employment records	Before construction	% local workforce	EPC Contractor	REA-PMU; POE	**300**
	Conduct induction & Code of Conduct training	Induction records	Before construction	Attendance records	EPC Contractor	FMEnv; Ministry of Women Affairs	

Summary of Potential Impact	Mitigation Measures	Monitoring Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	Cost (USD)
	Provide awareness on HIV/AIDS, GBV, STDs	Training records	Before construction	Training evidence	EPC Contractor	REA-PMU	
	Restrict public access to construction areas	Inspection	As required	Fencing & signage in place	EPC Contractor	REA-PMU	
	Implement a community grievance mechanism	Grievance logs	Monthly	Resolved grievances	EPC Contractor	REA-PMU	
Worker Health & Safety Risks	Develop & implement Health and Safety Plan	HSE records	Daily	HSE benchmarks achieved	EPC Contractor	REA-PMU; POE	**4,000**
	Conduct daily toolbox talks	Toolbox attendance logs	Daily	Attendance records	EPC Contractor	REA-PMU	
	Engage qualified Safety Officer	Employment record	Before construction	Safety officer appointed	EPC Contractor	REA-PMU	
	Provide and enforce PPE usage	PPE inspection logs	Daily	PPE compliance rate	EPC Contractor	REA-PMU	
	Provide safety & fire-fighting training	Training records	Before & weekly	Training certificates	EPC Contractor	REA-PMU	
	Implement a worker grievance mechanism	Grievance forms	Weekly	Resolved complaints	EPC Contractor	REA-PMU	
Exposure to Infectious	Implement NCDC guidelines	Compliance records	Continuous	Compliance evidence	EPC Contractor	REA-PMU; POE	**500**

Summary of Potential Impact	Mitigation Measures	Monitoring Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	Cost (USD)
Diseases (HIV/AIDS, COVID-19)	Conduct occupational health risk assessment	Risk assessment report	Continuous	Control measures implemented	EPC Contractor	REA-PMU	
	Provide hygiene facilities & infection prevention measures	Inspection	Continuous	Adequate facilities	EPC Contractor	REA-PMU	
	Develop identification & isolation procedures	Policy documents	Continuous	Procedures implemented	EPC Contractor	REA-PMU	

Total Social Cost (Construction Phase): USD 5,200

Table 7.6: Environmental Management Measures – Commissioning Phase

Summary of Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Performance Indicator	Implementation	Monitoring	Cost (USD)
Increase in ambient noise level due to plant testing	Strict compliance with SOPs	SOPs	Once before commissioning	Adherence to measures	EPC Contractor	REA-PMU / POE	500
	Develop SOPs for operational phase	SOPs	Once before commissioning	Adherence to measures	EPC Contractor		
	Install plant components per manufacturer standards	SOPs	Once before commissioning	Adherence to measures	EPC Contractor		
TOTAL							**500**

Table 7.7: Social Management Measures – Commissioning Phase

Summary of Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Performance Indicator	Implementation	Monitoring	Cost (USD)
Occupational health & safety hazards (injuries, electrocution)	Plant testing by experienced personnel	Qualified Engineer	Once before commissioning	Adherence to measures	EPC Contractor	PMU-REA / POE	200
	Provision and use of adequate PPE	Availability of PPE	Once before commissioning	Adherence to measures	EPC Contractor		
	Provision of emergency equipment	Emergency response equipment available	Once before commissioning	Adherence to measures	EPC Contractor		
Wrong electrical connection leading to fire/explosion	Testing by experienced personnel	Qualified Engineer	Once before commissioning	Adherence to measures	EPC Contractor	PMU-REA / POE	-
TOTAL							**200**

Table 7.8: Environmental Management Measures – Operational Phase

Summary of Potential Impact	Mitigation Measures	Monitoring	Frequency	Performance Indicator	Implementation	Monitoring	Cost (USD)
Air emissions from diesel generators	Compliance with SOPs; Regular maintenance	Inspection	Monthly	Adherence to measures	O&M Contractor	PMU-REA / POE / University	1,200
Dust accumulation on solar panels	Cleaning schedule; Regular inspection	Inspection	Monthly	Adherence to measures	O&M Contractor		
Noise from generators & inverters	Maintain inverters; Use soundproof covers; PPE	Inspection	Monthly	Adherence to measures	O&M Contractor		

Summary of Potential Impact	Mitigation Measures	Monitoring	Frequency	Performance Indicator	Implementation	Monitoring	Cost (USD)
Landscape alterations	Shielded, low-level lighting	Inspection	Monthly	Adherence to measures	O&M Contractor		
E-waste generation & disposal	Worker training; Proper storage; Waste tracking	Training records: Waste notes	Continuous	Certificates; Compliance	O&M Contractor	REA-PMU / POE / University	2,000
Soil contamination (fuel, oil, batteries)	EPR compliance; WMP implementation; Proper storage; Spill kits	Consignment notes; Inspection	Quarterly/Yearly	EHS Guidelines compliance	O&M Contractor	REA-PMU / FMEnv / POE	1,200
Electric shock during maintenance	PPE; SOP compliance	PPE availability; SOP review	Quarterly	Adherence to measures	O&M Contractor	REA-PMU / FMEnv	500
Groundwater abstraction	Implementing water management plan	Implementation records	Quarterly	Plan benchmarks met	O&M Contractor	REA-PMU / FMEnv	500
TOTAL							5,400

Table 7.9: Social Management Measures – Operational Phase

Summary of Potential Impact	Mitigation Measures	Monitoring	Frequency	Performance Indicator	Implementation	Monitoring	Cost (USD)
GBV / SEA risks	Implement Gender Action Plan; Training; Code of Conduct; GRM; Separate facilities	Training records; GRM records	Continuous / Monthly	Evidence of implementation	O&M Contractor	REA-PMU / University / POE	2,000
Health, safety & welfare	Medical insurance; Safety signage; SOP compliance; Grievance mechanism	Forms; Inspection	Quarterly / Monthly	Adherence to measures	O&M Contractor	REA-PMU / University / POE	3,000

Exposure to infectious diseases	Implement NCDC guidelines; Hygiene facilities; Risk assessments; Isolation procedures	Implementation records	Continuous	Adherence to measures	O&M Contractor	REA-PMU / University / POE	- -
Electric shock during maintenance	PPE; SOP compliance	PPE availability	Quarterly	Adherence to measures	O&M Contractor	REA-PMU / POE	
TOTAL							5,000

Table 7.10: Environmental Monitoring Programme

Environmental Component	Sampling Location	Parameters	Compliance Standard	Frequency	Responsible Party	Phase	Cost (USD)
Air Quality & Noise	Project site & evacuation route	TSP, CO, NOx, SOx, Noise (dBA)	FMEnv / WHO / AfDB	Monthly	EPC Contractor	Construction	600
Groundwater Quality	University borehole	pH, TDS, DO, BOD, COD, Heavy metals, etc.	FMEnv / WHO / AfDB	Quarterly	EPC & O&M	Construction & Operation	400
Soil	Plant site	pH, TOC, TPH, Heavy metals	NESREA / AfDB	Quarterly	EPC & O&M	Construction & Operation	900
Solid Waste	Operational areas	Waste tracking	FMEnv / NESREA / AfDB	Monthly	EPC & O&M	Construction & Operation	500
Health & Safety	Workers & site	H&S Plan compliance	FMEnv / NESREA / AfDB	Daily / Quarterly	EPC & O&M	Construction & Operation	1,400
Training	Workers	Training records	FMEnv / NESREA / AfDB	Quarterly	EPC & O&M	Construction & Operation	1,200
General Housekeeping	Site areas	Cleanliness	FMEnv / NESREA / AfDB	Daily / Quarterly	EPC & O&M	Construction & Operation	700
Stakeholder Engagement/GRM	Community & agencies	SEP implementation	FMEnv / AfDB	Quarterly	EPC & O&M	Construction & Operation	12,100
TOTAL							20,100

7.5 Additional Management Plans

During the progression of the project, management plans will be expanded to include specific procedures to guide implementation by the relevant project personnel and institutions including contractors and subcontractors. Such documents will be prepared strictly in line with the requirements set out in the relevant international standards and guidelines and other applicable national and local regulations and guidelines. These additional management plans include the following:

- Stakeholder Engagement Plan
- Emergency Preparedness and Response Plan
- Traffic Management Plan
- Waste Management Plan
- Occupational Health and Safety Plan
- Erosion and Sediment Control Management Plan
- Water Conservation Plan
- Vegetation Control Plan

7.6 Environmental Monitoring Program

Monitoring shall be conducted to ensure compliance with regulatory requirements as well as to evaluate the effectiveness of operational controls and other measures intended to mitigate potential impacts. The key components of the environmental monitoring program that will be developed for this project include:

- Comprehensive identification of high-level issues, risks, opportunities and gaps in system and operating practices that can impact ability to achieve the required level of performance;
- Establishment of clear metrics to measure statistically significant performance improvement areas towards goals and targets;
- Establishment of processes to ensure documents and records that are critical to operational excellence are current, controlled and accessible;
- Establishment and maintenance of appropriate processes for regular monitoring of HSE performance as well as conducting regular environmental audits and evaluations to ensure that the system is implemented and maintained and remains effective.

7.7 Training, Awareness, and Capacity Building for Zonal Offices

REA shall identify, plan, monitor, and record training needs for personnel whose work may have a significant adverse impact on the environmental or social conditions. Employees at each relevant phase of the project must be aware of the potential environmental impacts of their activities and the occupational hazards associated with the work, as well as their roles and responsibilities in achieving conformance with the management documented in this report. Thus, a formal training process will be organized for employees on environmental management programs, plans and procedures associated with the project.
All staff employed will be trained in the following:

- General operation of the plant;

- Environmental management.
- Specific job roles and procedures.
- Occupational health and safety; and
- Contingency plans and emergency procedures.

Training will include:

- Induction training on appointments.
- Specialist training (as required for specific job roles); and
- Refresher training as required.

Training in the local community on general environmental awareness and ESMP mitigation measures about community health, safety, and security should also be provided.

7.7.1 ESMP Capacity Building Plan

The various actors involved in the ESMP implementation will need capacity enhancement to ensure adequate understanding of ESMP/OHS/Waste Management/ Code of Conduct requirements, amongst other areas identified. Proposed topics and target audience are outlined in Table 7.11.

Table 7. 11: ESMP Capacity Building Plan

	Training Content	Participants	Delivery	Cost ($)
1.	Specific training on Environmental & Social Mgt.	Environmental & Social Safeguard Officer	PMU Consultant	4000
2.	Training on ESMP Implementation: mitigation, roles & responsibilities	Project Team	PMU Consultant	1000
3.	Training for contractors on ESMP mitigation measures, Code of Conduct, OHS requirements	Contractors' management and workers	PMU Consultant	1000
4.	Training of Contractor Drivers, fleet management, traffic control within MAU etc.	Contractor, contractor drivers, HSE officer, ESO	School of Transport, Security Management	1000
5.	GBV/SEA/SH Prevention and Response Mechanisms	Project team Environmental & Safeguard Officer,	PMU Consultant	2000
6.	Grievance Redress Mechanism	Grievance Redress Committees: project level and management level GRCs	PMU Consultant	12000
			Total	**21,000**

7.8 ESMP Costing

Table 7.12 provides a summary of the cost estimate required to effectively and efficiently implement the recommended mitigation measures and management plans required to address the potential and associated impacts of the proposed project. The total cost of implementing the ESMP is estimated at US**$ 86,690** million. Breakdown is provided in Table 7:12.

Table 7. 12: Cost of ESMP

S/N	ESMP ACTIVITIES	COST (US dollars)
1.	Pre-construction phase	9,200
	Construction phase	19,490
	Operational phase	14,400
	Commissioning Phase	5,900
2	Cost of monitoring and mitigation	13,100
3.	Capacity building	12,500
4	Stakeholder Engagement/GRM	12,100
	TOTAL	86,690

The duration of this estimate is expected to be 24 months, (based on EPC Construction Phase and Handover Protocol).

CHAPTER EIGHT
REMEDIATION PLAN AFTER DECOMMISIONING/ CLOSURE

8.1 Introduction

At the end of a project's useful life, it may become necessary to abandon or decommission the facility if it is no longer economically viable, whether due to depletion of feedstock or the emergence of more competitive technologies. The proposed solar project is anticipated to have an operational lifespan of 25 years. Given the likelihood of significant advancements in technology and changes in environmental policies over this period, it is not feasible to establish a definitive decommissioning plan at this stage. Nevertheless, any future abandonment or decommissioning activities must be carried out in full compliance with applicable Nigerian regulatory requirements.

8.2 Decommissioning Activities

Decommissioning is the process of dismantling and removing all operational assets of a project at the end of its life cycle. The proposed Solar Photovoltaic (PV) power plant is expected to have an average lifespan of 25 years, which may be extended with proper and routine maintenance. The training centre, however, is projected to have a lifespan of 40 years or more. Notably, even after 25 years of operation, the PV panels are expected to retain up to 90% of their original design capacity.

At the decommissioning stage, the Rural Electrification Agency (REA) will ensure that the project sites are restored to a safe and environmentally acceptable condition. The decommissioning process will typically involve the following activities:

- Dismantling and removal of PV panels and all associated infrastructure, including mounting structures, power evacuation cables, inverters, transformers, batteries, and related components.
- Removal of sub-surface installations such as underground cables.
- Proper management and disposal of waste generated during the decommissioning process.
- Restoration of the environment to acceptable baseline conditions, with monitoring carried out in accordance with applicable legislative and regulatory requirements, as well as industry best practices; and
- Evaluation of any residual environmental impacts of the project, including the identification of potential future land-use restrictions, if applicable

8.3 Management of Decommissioning Activities

In the event of decommissioning, the Rural Electrification Agency (REA), in collaboration with the leadership of the FUAB, will ensure that the Project site is restored to a safe and environmentally acceptable condition. A formal decommissioning, abandonment, and closure programme will be implemented to guide the process. Key activities will include, but will not be limited to:

- Removal and return of dismantled PV panels and associated components (including inverters and control systems) to the manufacturers for recycling.
- Transportation of spent batteries to approved recycling facilities; and
- Environmental monitoring of the site following abandonment, as required.

Decommissioning activities will only commence after appropriate consultation with relevant stakeholders, including regulatory authorities. All activities will be conducted in accordance with the applicable provisions of the National Guidelines for Decommissioning of Facilities in Nigeria (2017), issued by the Federal Ministry of Environment (FMEnv).

The decommissioning process will generally involve the following actions:

- Preparation of an updated Decommissioning Plan that reflects the most cost-effective and practicable methods available at the time, in compliance with prevailing legal requirements and industry's best practices. The plan will be submitted to the FMEnv and other relevant regulatory authorities for approval and will include, at a minimum:
    - A description of the site and components to be decommissioned;
    - The scope, objectives, intended end state, and strategy for decommissioning;
    - Detailed activities to be undertaken;
    - A schedule of decommissioning activities;
    - An estimate of decommissioning costs;
    - An estimated inventory of anticipated waste streams and proposed handling and disposal methods; and
    - Details of the decommissioning team, including qualifications, roles, and responsibilities.
- Conduct a comprehensive evaluation of decommissioning options to ensure all feasible alternatives are considered. Options may include mothballing, partial decommissioning, or complete site decommissioning. This evaluation will integrate environmental, technical, safety, and cost considerations to determine the most practicable and environmentally responsible approach.
- Undertaking a risk assessment to ensure that no hazards remain that could pose risks to future site users or the environment. The site will be restored to a safe and environmentally acceptable condition.
- Conducting hazard identification and analysis to address any specific safety concerns associated with decommissioning activities.
- Implementation of a comprehensive Health, Safety, and Environment (HSE) Plan to ensure that all decommissioning activities are carried out in an environmentally sound manner and in full compliance with applicable laws and regulations.

- Issuance of third-party notifications prior to demolition activities, which will be executed in a phased and controlled sequence.
- Assessment of socio-economic implications associated with decommissioning, particularly potential impacts arising from termination of employment at the end of the operational phase. Mitigation measures will include:
    - Ensuring employees are adequately informed about the decommissioning process and its implications well in advance of project closure.
    - Strengthening community capacity to manage opportunities and impacts during and after decommissioning.
    - Providing training to develop local skills relevant to decommissioning and post-decommissioning activities (e.g., equipment dismantling, rehabilitation, and environmental monitoring); and
    - Facilitating the transfer of project-acquired skills to alternative and secondary industries aligned with market demands.
- Development and implementation of an effective Waste Management Plan for decommissioning activities. Redundant structures and equipment will generally be completely dismantled, and suitable components will be returned to manufacturers for recycling. Detailed records of all recyclable materials will be maintained throughout the process.

8.4 Abandonment Plan

Before site abandonment, the Rural Electrification Agency (REA) will develop and implement a standard procedure incorporating the following measures:

- Identification of all components of the power plant to be abandoned and/or removed;
- Determination of appropriate methods for abandonment, dismantling, or potential re-use of plant equipment and materials, where feasible;
- Establishment of processes to mitigate potential environmental impacts associated with the abandonment activities; and
- Implementation of suitable site rehabilitation programmes, including re-vegetation with native plant species, to restore the Project site as close as possible to its original condition.

Should the Project be abandoned, all activities will be undertaken in strict compliance with applicable legislative requirements and best international practices. The decommissioning, abandonment, and/or closure programme will be managed by a competent team comprising representatives from the REA Project Management Unit, the Department of Works and Physical Planning at FUAB, the Federal Ministry of Environment, and the Bayelsa State Ministry of Environment.

The abandonment process will generally involve the following steps:

- Formal notification of all relevant stakeholders.
- Conduct of a Physical Asset Verification (PAV) of the facilities;

- Strict adherence to applicable national and sectoral regulations governing project abandonment to ensure:
    - Proper restoration and rehabilitation of the environment; and
    - Effective management of any residual project impacts in full compliance with extant national and Federal Ministry of Environment (FMEnv) regulations.
- Procurement of a site close-out permit, where required; and
- Preparation and achieving a comprehensive close-out report for future reference.

8.5 Roles, Responsibilities and Accountabilities

The key personnel and institutions with major roles in the implementation and monitoring of environmental and social measures for the Project decommissioning/closure are as follows:

A. Contractor(s) Engaged for Decommissioning Activities

- Implement environmental and social measures and management actions put in place for the decommissioning activities.

B. REA-PMU

- Supervise the activities of the contractor(s) engaged for decommissioning purpose by ensuring that the recommended environmental and social and management actions are implemented.
- Discuss environmental and social management plan improvements with the Director of Works and Physical Planning Department in FUAB to address noncompliance and upcoming issues.

C. FUAB University Site Manager

- Directly monitor the activities of the contractor(s) engaged for decommissioning and ensure compliance with the implementation of environmental and social measures and management actions put in place to address potential impacts and risks associated with the decommissioning activities.
- Report to the Director of Works and Physical Planning Department in FUAB on contractor's performance regarding the implementation of environmental and social measures.

D. Director of Works and Physical Planning Department in FUAB

- Jointly supervise the activities of the contractor(s) engaged for decommissioning
- Suggest environmental and social management plan improvements to REA-PMU to address non-compliance issues and upcoming issues.

E. FMEnv/Bayelsa State Ministry of Environment Representatives

- Approving the decommissioning plan for the Project

- Monitor the implementation of environmental and social measures and management actions documented in the decommissioning plan.
- Discuss environmental and social management plan improvements to REA-PMU to address

CHAPTER NINE
STAKEHOLDER ENGAGEMENT AND GRIEVANCE REDRESS MECHANISM

9.0 General

Consultation plays a vital role in identifying and understanding the environmental and social issues that may arise from a proposed project. Through engagement with affected communities, regulatory authorities, institutions, and other interested parties, valuable local knowledge and concerns are gathered to inform the preparation of the Environmental and Social Impact Assessment (ESIA). This participatory approach helps ensure that potential impacts are properly assessed, appropriate mitigation measures are developed, and the project is aligned with both regulatory requirements and community expectations. Meaningful consultation also enhances transparency, builds trust, and promotes informed decision-making.

To guide this process, a Stakeholder Engagement Plan (SEP) was developed as part of the ESIA preparation. The SEP outlines structured methods for engaging stakeholders throughout the entire Project life cycle, including pre-construction, construction, operation, and eventual decommissioning phases. It defines how stakeholders are identified, how information is disclosed, and how feedback is incorporated into project planning and management. By establishing clear communication channels and engagement strategies, the SEP ensures continuous dialogue, supports effective participation, and strengthens the Project's social sustainability.

The SEP outlines:

- The process for stakeholder identification.
- The methods used for consultation.
- Outcomes of consultations conducted to date; and
- Measures taken to disclose relevant information to stakeholders.

9.1 Stakeholder Engagement

A Stakeholder Engagement Plan (SEP) provides a systematic and organized framework for identifying stakeholders and managing their expectations throughout the life cycle of a project. It ensures that stakeholders, including affected communities, government agencies, institutions, and other interested parties are appropriately informed, consulted, and involved in decision-making processes. By clearly defining engagement strategies, communication methods, and timelines, the SEP helps to minimize misunderstandings, address concerns proactively, and foster transparency and trust between the project proponent and stakeholders.

All consultation activities were properly documented, including relevant data, supporting evidence, participant lists with contact information, and photographic records. Information disclosure complied with the provisions of national regulations, including the EIA Act No. 86 of 1992 (as amended under Cap E12 LFN 2004), as well as the AfDB OS10.

9.2 Objectives of Stakeholder Engagement

Public participation in an ESIA aims to provide adequate and accessible information to potentially affected and interested stakeholders in an objective manner. This enables them to:

- Identify issues of concern;
- Provide suggestions to enhance project benefits; and
- Propose alternatives where appropriate.

The stakeholder engagement process was designed in compliance with Nigerian regulatory requirements and international standards.

Key objectives include:

- Identifying key stakeholders who can influence or be affected by the Project;
- Informing and educating stakeholders about the proposed Project;
- Gathering local knowledge to better understand the environmental and social context.
- Identifying locally important issues;
- Establishing effective communication channels for regular, transparent consultation;
- Providing stakeholders with opportunities to contribute to Project planning;
- Incorporating stakeholder views into mitigation measures and management plans; and
- Establishing a foundation for continuous stakeholder engagement.

9.3 Stakeholder Identification/Mapping and Analysis

The stakeholders were identified based on the direct project beneficiaries, adversely impacted groups, project supporters /proponents, regulatory/ planning,

However, the stakeholders covered are;

- Rural Electricity Agency (REA)
- Federal /State Ministry of Environment (FMEnv)
- Nembe Local Government Area
- Bassam Biri Community

Consultation was limited to Focal Group Discussions and Key Informant information. These approaches were adopted due to the demise of the Chief of the Bassam Biri Community. The study team was only allowed to speak to the Community Development Chairman (CDC) on the proposed project development. Key feedback received during Stakeholder Consultations is presented below;

Table 9.1: Stakeholder Feedback on the Proposed Solar Power Plant Development

Stakeholder Group	Consultation Method	Key Contributions / Feedback	Key Concerns Raised	REA Responses
Community Development Chairman (CDC), Bassam Biri Community	Key informant consultation	Welcomed the proposed solar power project and acknowledged its potential to improve electricity supply and support development in the area. Stated that the project could create temporary employment opportunities for local youths during construction and installation.	Concerned about possible disturbance to the community during construction, including noise, dust, traffic movement, and safety risks. Also emphasized the need to respect community interests during employment	Consultation will be continuous with the CDC and community leadership. Local labour will be engaged especially during the construction phase Implement dust, noise, traffic, and safety control measures.
University Management	Key informant consultation / institutional engagement	Supported the project because it would improve power reliability, reduce dependence on generators, and enhance teaching, research, administration, and ICT services.	Raised concerns about funding and timeline for the completion of the project	The project is funded by the AfDB and the Federal Government of Nigeria. Asked for the cooperation of the school and community for a smooth take off.
Students	Focus group discussion	Welcomed the project as it would improve lighting, internet access, reading conditions, safety, and general campus life. Students noted that reliable electricity would support studying, charging of devices, laboratory work, and online learning.	Some students also raised concerns about whether the project would benefit hostels, classrooms, libraries, and common areas equally.	It will benefit the entire school campus and beyond.

Source: Field work 2026

Plate 9.1: Consultation with FMEnv, BSMEnv, FUAB Rep and the Consultant

Plate 9.2: Consultation with FUAB Rep and the Consultant

Plate 9.3: Consultation with FUAB Student and the Consultant

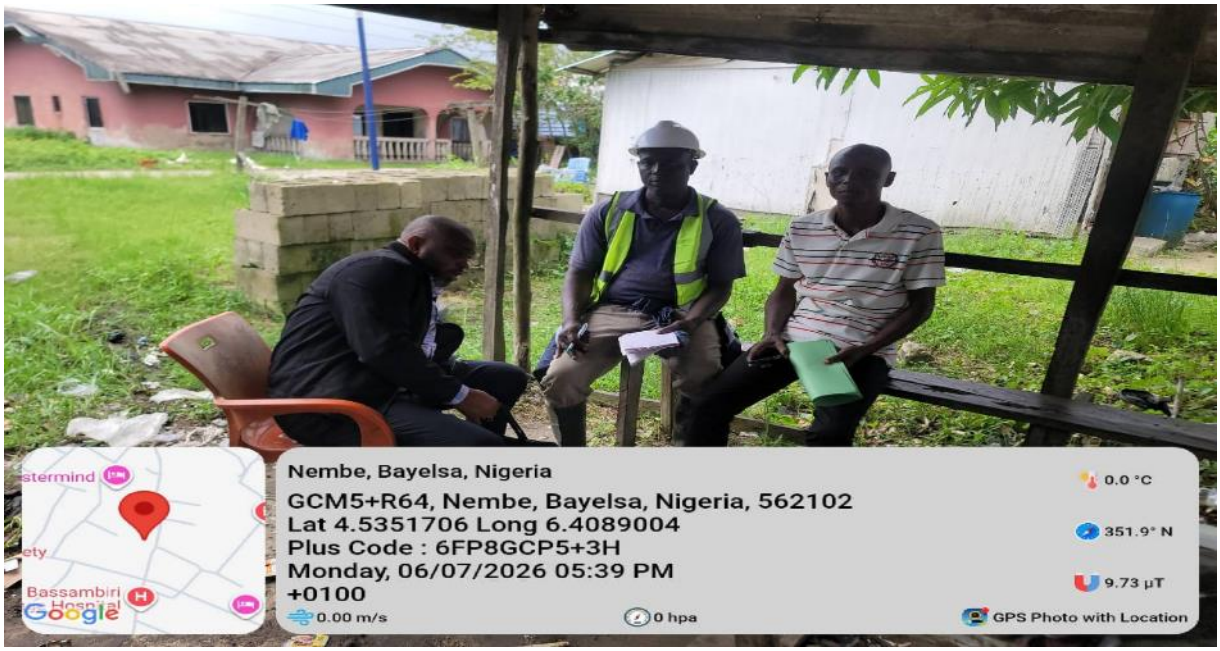

Plate 9.4: Consultation with the CDC leadership and the Consultant

Plate 9.5: Consultation with members of the FUAB Community and the Consultant

9.4 Disclosure and Participation Plan

Information disclosure is essential not only as an engagement activity but also as a prerequisite for meaningful participation. This section outlines the procedures for disclosure and participation under the Environmental and Social Engagement Plan (EEP). Under AfDB OS 10 Operational Safeguards, the Project Proponent must maintain and disclose a documented record of stakeholder engagement, including:

- Stakeholders consulted.
- Summary of feedback received; and
- Explanation of how feedback was addressed or reasons for non-incorporation.

9.4.1 Disclosure Mechanism

Information disclosure may occur through:

1. **Regulatory Disclosure** – Required by relevant authorities (e.g., public hearings under EIA requirements);

2. **Voluntary Disclosure** – Proactive dissemination of project information to stakeholders.

Voluntary disclosure promotes transparency, builds trust, and enhances constructive participation in consultation and grievance resolution processes.

9.4.2 Process for Disclosure of Information

This ESIA will be disclosed for public review in accordance with:

- AfDB disclosure procedures; and
- A 21-day public disclosure period under Nigerian regulatory requirements.

Disclosure materials will be made available at publicly accessible locations, including:

- Environmental Assessment (EA) Department, Federal Ministry of Environment.
- State Ministry of Environment.
- Federal University of Agriculture, Bassim Biri (FUAB);
- Other designated public venues.

Electronic copies will also be published on the AfDB website.
Additional disclosure methods include:

- Press releases and media announcements.
- Notifications to local, regional, and national NGOs.
- Engagement with professional bodies and interested stakeholders.

9.4.3 Timetable for Disclosure

The disclosure process will follow this general timeline:

- Placement of ESIA in public domain (FMEnv and AfDB website) – Dates to be confirmed by REA.
- 21-day disclosure period – Dates to be confirmed by FMEnv;
- Review and response to stakeholder feedback – Dates to be confirmed by FMEnv and REA.

The ESIA will remain publicly accessible throughout the Project life cycle and will be updated periodically. Engagement methods will also be reviewed to ensure continued effectiveness.

9.4.4 Stakeholder Register

A Stakeholder Register will be maintained to document:

- Stakeholders' contact information.
- Dates of engagement.
- Issues raised; and
- Required follow-up actions.

9.5 Grievance Redress Mechanism (GRM)

This section outlines the grievance redress mechanism for general grievances and Gender-Based Violence/Sexual Exploitation and Abuse (GBV/SEA) related grievances, including implementation of a GBV Action Plan. The REA's standard GRM will complement, but not replace, site-specific grievance mechanisms established at the subproject level.
The GRM is a structured framework enabling stakeholders to:

- Raise concerns;
- Log and track complaints; and
- Obtain timely resolution.

The GRM will be communicated to stakeholders and maintained throughout the Project life cycle. A publicly accessible record of grievances and responses will be kept.

9.5.1 GRM Process

The grievance process includes:

1. Provision of grievance procedures to affected persons;
2. Registration of grievances in a Grievance Log;
3. Initial screening through local mechanisms (e.g., community leaders) where appropriate;
4. Review by the Grievance Redress Committee (GRC) within 10 working days;
5. Escalation to the Project Implementation Unit (PIU) if unresolved within 15 working days;
6. Final appeal to a court of competent jurisdiction if required (without administrative or legal fees related to the GRM process).

9.6 Publicizing the GRM

The GRM will be disclosed through:

- Public meetings;
- Group discussions;
- Written materials; and
- Verbal communication.

Disclosure will occur alongside other environmental and social management plans.

9.7 Receiving and Recording Grievances

Grievances may be submitted:

- Verbally (in person or via telephone); or
- In writing, using the prescribed grievance form.

All grievances must be forwarded immediately to the Grievance Officer (GO). A grievance register will be maintained at the Project office and the site camp.

9.7.1 Grievance Register

Each grievance will be recorded in a register and undergo a preliminary assessment to confirm eligibility under the GRM scope.

9.7.2 Acknowledgment of Grievance

An acknowledgment receipt, including case number and response timeline, will be issued upon registration. If a grievance falls outside the GRM scope, the complainant will be notified and referred to an appropriate alternative mechanism.

9.7.3 Site Inspection and Resolution

Where necessary, site inspections will be conducted within 10 days of grievance receipt to verify claims. The personnel responsible will investigate and recommend corrective actions. Resolution responsibilities will depend on grievance type (e.g., compensation, resettlement, environmental impact, worker issues, GBV/SEA).

9.7.4 Resolution, Escalation, and Closure

The Social Safeguard Officer/Manager will determine appropriate corrective actions, which may include:

- Clarification and information disclosure;
- Corrective measures.
- Financial or in-kind compensation.
- Preventive mitigation measures.

A response will be communicated within 10 working days after the investigation.
If unresolved, escalation to the Head of the PMU (NEP) will occur, who will respond within 10 working days. If still unresolved, alternative dispute resolution mechanisms (e.g., mediation centres) may be recommended before judicial recourse.

9.7.5 Update of Records

The grievance register will be updated weekly to reflect the status of each case.
Once resolved and communicated, the grievance will be formally closed in the register. Records will document resolution methods and serve as references for future cases. Recurring grievances will be reported to the Head PMU (NEP) to determine whether project design modifications are required.

CHAPTER TEN
CONCLUSION AND RECOMMENDATIONS

10.1 Conclusion

The Environmental and Social Impact Assessment (ESIA) for the proposed Solar Power Plant at FUAB has been conducted to comply with applicable government policies, regulatory requirements, financier standards, and stakeholder expectations. The assessment ensures that proactive environmental and social considerations are integrated into the project design and planning process from the outset.

The study was undertaken in accordance with Nigeria's regulatory framework for environmental and social management, particularly the Nigerian EIA Act Cap E12 LFN 2004, which mandates Environmental Impact Assessment for projects of this scale with the potential to cause significant environmental impacts. In addition, the ESIA has been prepared in alignment with the African Development Bank's (AfDB) Operational Safeguards to ensure compliance with international best practices.

The ESIA process is intended to provide comprehensive information to support informed decision-making and to promote environmentally sound, socially responsible, and sustainable development. Consultations with relevant stakeholders have been conducted as part of the assessment and will continue throughout the project life cycle. These engagement activities ensured that stakeholder concerns were addressed and that adequate responses were provided to questions regarding the proposed project.

Baseline environmental and social conditions within the study area, including biophysical and socio-economic characteristics, were established through field surveys, sampling, and stakeholder interactions. These findings were complemented by desktop studies, published literature, maps, and other relevant secondary data sources. The baseline data generated during the study will serve as a reference point for future environmental monitoring and performance evaluation.

The assessment evaluated interactions between the existing environmental conditions and the proposed solar power plant activities to identify, characterize, and assess potential impacts. Based on this analysis, appropriate mitigation measures and recommendations were developed in line with industry best practices, available technologies, and Health, Safety, and Environment (HSE) standards to address significant adverse impacts and enhance project sustainability.

An Environmental and Social Management Plan (ESMP) was developed to ensure systematic management of identified impacts and implementation of environmental and social commitments throughout the project's duration. The ESMP includes a monitoring programme designed to track environmental performance and detect any changes resulting from project activities. In this regard, REA will ensure that key parameters such as air quality, noise levels, and groundwater quality are monitored in accordance with Federal Ministry of Environment (FMEnv) and AfDB standards.

In conclusion, it is anticipated that the information and analysis presented in this report provides a sufficient basis for the preparation of the Environmental Impact Statement (EIS) and for securing the necessary regulatory approvals and permits required for the development and operation of the proposed solar power plant.

10.2 Recommendation

The ESIA study recommends the following:

- Ensure full implementation of the Environmental and Social Management Plan (ESMP) throughout the project lifecycle.
- Conduct regular environmental monitoring for air quality, noise, groundwater, and waste management.
- Maintain continuous stakeholder engagement and effective community communication.
- Prioritize local employment, capacity building, and renewable energy training opportunities.
- Implement strong occupational health and safety measures, including emergency response systems.
- Establish and maintain an efficient Grievance Redress Mechanism (GRM) for timely resolution of complaints.
- Promote proper waste management, including safe disposal of hazardous and electronic waste.
- Ensure compliance with regulatory requirements through continuous oversight by the Rural Electrification Agency and relevant authorities.

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Appendix I – Methodology

Study Approach

The baseline status of the project area was obtained through consultations with the relevant stakeholders, a review of relevant literature as well as field studies. Environmental data acquisition involved a multidisciplinary approach and was conducted in line with regulatory requirements and best international practices. This approach includes literature desktop review, designing, and development of field sampling strategy; confirmation of the sampling design and locations, pre-mobilization activities (job hazard analysis, sampling equipment/materials calibrations and checks and mobilization to the field; community consultations, sample collection, handling, documentation, and storage protocols and, demobilization from the field, transfer of sample custody to the laboratory for analysis. A summary of field sampling methods is discussed in the sub-sections below.

Daily Toolbox Meeting

A daily toolbox meeting was held before work to ensure that team members understood the work plan for the day and the security and safety tips. These are geared toward achieving zero incidents during the process of gathering data.

List of Equipment

S/No	Equipment	Serial No	Model No	Range (Sensitivity level)	Calibration Expiration Date	Uses
1	Horiba Water Multimeter	JG5HUYBT	U-5000G	±0.2%	10/03/27	Water insitu measurement
2	Milwaukee Water Multimeter	NA	MW802	±0.2%	10/03/27	Water insitu measurement
3	Kanomax Air Quality	140309086	M2750	±0.3%	10/03/27	Gas analyzer
4	Extech Sound Measurements	140309086	M407732	±0.5%	10/03/27	Sound measurement
5	skymaster multi-parameter	015357	SM 28	±0.2	24/04/27	meteorological parameters
6	Particle counter	1511997161	HHPC MET one	0.001	10/03/27	PM10 and PM 2.5
7	Ven Van Grab /Ekman Grab	NA	NA	NA	NA	Sediment sampling
8	Plankton Nets	NA	NA	NA	NA	Plankton sampling
9	Water sampler	NA	NA	NA	NA	Surface water sampling
Other Materials						
10	60 ML Amber	NA	NA	NA	NA	Organics (soil)
11	250 ML Plastics	NA	NA	NA	NA	Benthos
12	20 ML Vials	NA	NA	NA	NA	BTEX
13	Plastic Zip Locks	NA	NA	NA	NA	Physico-chemicals / PSD
14	120 ML Plastics	NA	NA	NA	NA	Planktons
15	Sterile Plastics	NA	NA	NA	NA	MCB
16	250 ML Plastics	NA	NA	NA	NA	Physico-chemicals
17	250 ML Amber with Teflon cover	NA	NA	NA	NA	Organics (water)
18	250 ML Amber for BOD	NA	NA	NA	NA	BOD
19	120 ML Plastics	NA	NA	NA	NA	Heavy Metals (water)

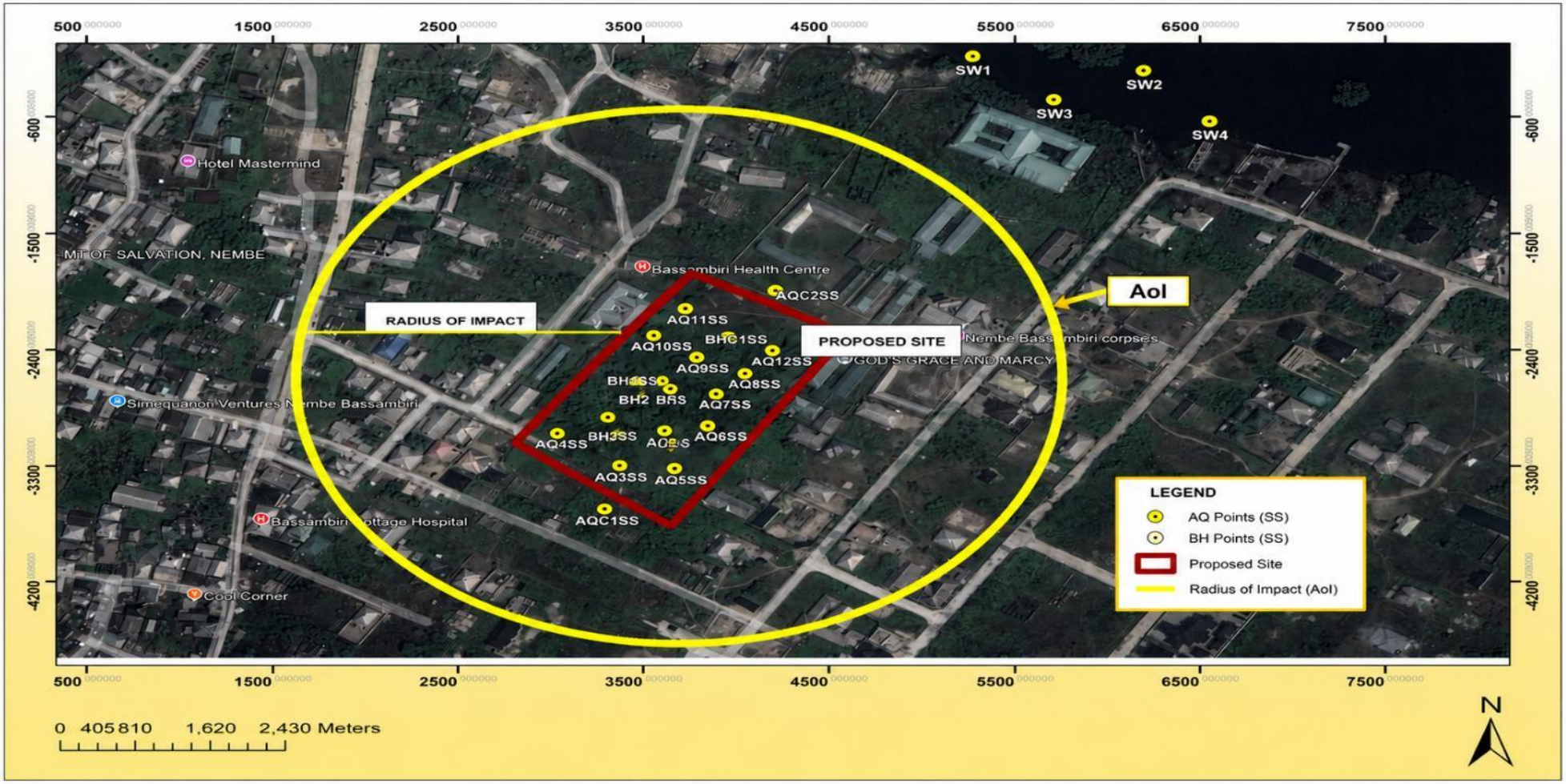
Baseline Data Collection

Data gathering for the biophysical and social components of the project environment was undertaken from 17-18th February 2026 (dry season). The secondary data (wet season) was obtained from existing sources including the following:

- Stakeholders, including government agencies, community chiefs, elders, women, and youths in various communities and community-based organizations (cooperative societies, development committees, etc).
- Local experts and research and academic organizations and
- TCN ESHIA,2019 =Transmission Company of Nigeria (TCN) Environmental Social and Health Impact Assessment

Sampling Design/ Protocol

The sampling maps provide spatial distributions of the sampling points within the study area



Sampling Map

list of Coordinates

Point	Coordinates (DMS)
AQ1	4°32′01″N, 6°25′30″E
AQ2	4°32′05″N, 6°25′10″E
AQ3	4°32′10″N, 6°25′06″E
AQ4	4°32′15″N, 6°25′37″E
AQ5	4°32′25″N, 6°25′60″E
AQ6	4°32′08″N, 6°25′08″E
AQ7	4°32′05″N, 6°25′05″E
AQ8	4°32′10″N, 6°25′01″E
AQ9	4°32′15″N, 6°25′52″E
AQ10	4°32′24″N, 6°25′37″E
AQ11	4°32′25″N, 6°25′09″E
AQ12	4°32′28″N, 6°25′49″E
AQCtrl1	4°31′57″N, 6°24′50″E
AQCtrl2	4°32′35″N, 6°25′15″E
SW1	4°31′55″N, 6°24′55″E
SW2	4°32′05″N, 6°25′05″E
SW3	4°32′15″N, 6°25′10″E
SW4	4°32′25″N, 6°25′15″E
Control 1	4°31′40″N, 6°24′44″E
Control 2	4°32′40″N, 6°25′25″E
BH1	4°32′03″N, 6°25′28″E
BH2	4°31′59″N 6°25′31″E
BH3	4°32′00″N, 6°25′34″E
BHC1 (Control)	4°32′12″N, 6°25′48″E

Field Sampling Equipment and Methods

Meteorology/Air Quality and Noise Measurements

Meteorological elements, namely wind, speed, wind direction, humidity, and temperature were measured during the fieldwork from predetermined locations). Each sampling location was adequately georeferenced with a GPS. Kanomax Gas Meter with Model No.2750 was used for the measurement of the following parameters: Carbon Monoxide (CO), Sulphur Dioxide (SO_2), Nitrogen Dioxide (NO_2), Carbon Dioxide (CO_2), and Hydrogen Sulphide (H_2S). Particulate Meter (PM) with Model No. DT-9880 was used to measure suspended particulate matter (SPM). The Noise levels at each point was measured with an Extech Noise Meter (Model No.407722). The sensor of the noise meter was directed toward the source of noise and the average reading over a period of three minutes was taken to be the Noise level at each point. Plate 4.2 shows air quality and noise measurements being taken during the studies.

Ground Water Sampling

Groundwater samples were collected from 3 existing community boreholes and 1 control point. Groundwater samples were collected using plastic disposable bailers. *In-situ* measurements of pH,

dissolved oxygen (DO), turbidity, salinity, and conductivity were carried out immediately after groundwater sampling, before preservation.
After each in-situ measurement, samples were taken as described below*:*

- General physico-chemical parameters - samples were collected in pre-cleaned 1-litre polyethylene bottles. The bottles were rinsed with some portion of the groundwater before sampling.
- Heavy metals - Samples were collected in pre-cleaned 1 liter polythene bottles and preserved by the addition of 2 ml Analar grade concentrated nitric acid.
- Oil and grease, TPH, and THC - Samples were collected in pre-cleaned 500ml glass bottles and preserved by the addition of 1ml concentrated sulphuric acid (H_2SO_4).
- Microbiology - Samples were collected into 25 ml sterilized vial.
- BOD_5 - Samples were collected in pre-cleaned 300ml amber-colored BOD bottles.

Samples collected were stored in ice chests at 4°C on the field before transportation to the laboratory for further storage at 4°C prior to analysis.

Soil Sampling

Topsoil (0-15cm) and bottom soil (15-30cm) samples were collected from 12 points and 2 controls using a hand auger. Two (2) auger bores were homogenized to form a composite sample. Samples for microbiology were taken in 25 ml sterilized vials. Samples for physico-chemical parameters were collected in pre-cleaned 250ml amber bottles. The samples were properly labeled and preserved in ice chests at 4°C.

Hydrography

A sampling of surface water, sediment and hydrobiology covered the following components:

- Physico-chemistry and microbiology of surface water
- Phytoplankton
- Zooplankton
- Benthos
- Fisheries

Surface Water

At each sampling station, grab samples of surface water were collected; top and bottom at three different time intervals of 5 mins and mixed to form a composite sample.

Samples for laboratory analysis were taken and preserved as follows:
General physicochemical parameters: Samples were collected into 1-liter polyethylene bottles. The bottles were previously washed and rinsed with distilled water and with some portion of the surface water prior to sampling.

- Heavy metals- Samples were collected into 1-liter pre-cleaned polyethylene bottles and preserved by the addition of 2 ml Analar grade concentrated nitric acid.
- Oil and grease and THC- Samples were collected into 1-liter pre-cleaned glass bottles and preserved by the addition of 2 ml concentrated sulfuric acid.
- COD - Samples were collected into pre-cleaned 500 ml glass bottles and fixed with analar grade H_2SO_4
- Microbiology- Samples were collected into 25 ml sterilized glass bottles.
- BOD - Samples were collected into 300 ml amber-colored BOD bottles.

Samples collected were stored at 4°C±2 ice chest on the field before transportation to the laboratory for further storage at 4°C±2. Water temperature was measured *in situ* using a portable thermometer. Hydrogen-ion concentration (pH), electrical conductivity, total dissolved solids (TDS) and turbidity were measured *in situ* using Hanna portable digital meters. Samples for dissolved oxygen (DO) were determined on site by Hanna dissolved oxygen meter.

Plankton Sampling

Zooplankton and Phyto-plankton samples were collected at predetermined locations within Bassim Biri River. The samples were collected by both a horizontal (surface) and a vertical haul for phytoplankton and zooplankton sampling, respectively. For the horizontal haul, the plankton net was dragged on the water surface for about 5-minutes, while for the vertical haul, the net was hauled in from a minimum depth of about 3 meters while the boat remained stationary at each of the sampling stations. The net was thereafter retrieved for the collection of samples for phytoplankton and zooplankton. The plankton samples were poured into 250ml plastic bottles and preserved with the addition of a 10% formalin solution. The bottles were pre-treated by rinsing with distilled water.

Sediment Sampling

Sediment samples were taken from the bottom of surface water using a $0.1m^2$ Van-veen grab A total of 6 sediment samples were collected for physico-chemistry and kept in polythene bags; samples for hydrocarbon and microbiology analyses were kept separately in aluminum foil, preserved in an ice chest and transported to the laboratory for analysis.

Benthos Sampling

Sediment from each station was emptied into a plastic bowl and water was added to disengage the sediment. It was gently stirred and carefully sieved through a 0.5mm mesh sieve**.** The content of the sieve after washing was transferred into a well-labeled 250ml plastic container and 10% formalin was added as a preservative. The preserved samples were kept in boxes for further laboratory analysis and identification.

Vegetation and Wildlife Studies

The vegetation survey was carried out along designated sampling transects/sub-transects. The location of each sampling point was confirmed using GPS. Vegetation was studied in sampling quadrats measuring 20 m x 20 m. For each sampling point, information on habitat, vegetation structure and species was recorded. Habitat data included vegetation description, latitude, longitude, and signs of wildlife. Plant species were categorized into trees (4m or more), shrubs (0.5m to 4m), and herbs (less than 0.5m). Dendrometric parameters recorded included height (m), diameter (cm) and number of trees. A pair of binoculars (Model: Helios Fieldmaster 8x40) was employed to aid in the field identification of trees. Plants were also observed for any disease symptoms/conditions.

Field observations were made at each sampling location for evidence of vertebrate wildlife. Hideouts such as crevices, leaf litters, logs etc. were probed with props to root out any hidden animals. Tree canopies were observed for birds and other arboreal animals such as squirrels and snakes. The indirect count method was employed, particularly for animals that do not readily offer themselves for observation.

Quality Assurance/Quality Control

Standard methods and procedures were strictly adhered to in the course of this study. The quality assurance program covers all aspects of the study, including sample collection, handling, laboratory analysis, data coding, statistical analysis, presenting and communicating results.

Chain of custody procedures including sample handling, transportation, logging and cross-checking in the laboratory were also implemented. Trip blanks were used to assess the quality assurance/quality control of sample preservation, packaging, shipping, and storage.

The following precautions were also observed:

- Samples were collected in bottles that have been thoroughly washed with detergent (nutrient-free) and rinsed thoroughly;
- ✓ All sampling equipment is properly protected and maintained in accordance with manufacturers' manuals;
- ✓ Sampling bottles were adequately labeled with masking tapes and indelible markers to avoid mistaken identity;
- ✓ Only analytical grade (Analar) chemicals were used and where applicable, redistilled.
- ✓ Automated equipment is calibrated prior to field sampling.

Where samples were sent to another laboratory for analysis, a duplicate copy of the samples' information was sent along with the sample to the laboratory, independent of the sample. All movements of the samples were included in the sample record. Basic information was recorded together with the results of the analysis, in a sample registry. With proper, sustained calibration of the instrument and the use of standardized observational procedures, equipment errors were brought to an acceptable minimum.

Sample Handling and Preservation

All the samples collected during the fieldwork were labeled clearly and secured in easily identifiable containers. Each label contained the following Information:

- Date and/or time of sampling
- Sample name and number
- Type of sample
- Type of preservative used if any.

The sampling containers, preservatives used, and holding times for the different parameters of interest for water, benthos, and plankton samples are summarized in Table 2

Table 2: Sample Handling and Preservation Methods used during Field Work

S/N	Parameters	Sample Vol.	Container	Preservative	Holding Time	Container pretreatment
1.	BTEX	15ml	20ml BTEX Vial	5ml of Methanol	10days	Methanol
2.	Metals, Mn, Fe, Cu, Zn, Ag, Ni, Pb, Cd, Cr, Co, Ca, Mg, K, Na	1L	Plastic	Add 2ml Conc HNO_3 & cool 4 °C ± 2◦C	6 months	Rinsed with 1+1 HNO_3
3.	Physico-Chemical, TSS, COD, O/G, Chloride	2L	Plastic	Cool 4 °C ± 2◦C	28 Days	Rinsed with Distilled water
4.	Hydrocarbons, phenols	1.L	Glass (wide mouth, calibrated)	H_2SO_4 to 2ml & cool 4 °C ± 2◦C	28 Days	Rinsed with Solvent
5.	Zoo-/Phyto-plankton	500ml	Wide mouth plastic bottles	10% Formalin (with Rose Bengal)	-	Rinsed with Distilled water
6.	Microbiology, THB, HUB, Coliform, THF & HUF	200ml	Wide mouth plastic bottles	Cool 4 °C ± 2◦C	As soon as possible	Sterilized
7.	Macrobenthos	1.0L	Plastic	10% Formalin (with Rose Bengal)	-	Rinse with distilled water

Laboratory Analysis

After the fieldwork exercises, study samples were transported to Scopex Laboratory, Port Harcourt, Rivers State, Nigeria (accredited by FMENV) for analyses. Samples brought to the laboratory were analyzed using standard analytical methods. The synoptic description of the laboratory methods and procedures employed for the various physical, chemical, and biological parameters, as well as the detection limits of these parameters in water and sediment samples. The summary of standard methods of environmental analysis is presented in Table 3.

Table3: Summary of Laboratory analytical methods used for Water / Sediment Analysis

Parameters	Unit	Method
pH (H2O)		ASTM D 4972
Turbidity	(NTU)	APHA 214
Salinity	$^0/_{00}$	API-RP 45
Total Dissolved Solids	(mg/l)	APHA 209C
Total Solids	(mg/l)	APHA 209D
TSS	(mg/l)	APHA 209D

Parameters	Unit	Method
Electrical conductivity	(µS/cm)	APHA 209
Bicarbonate	(mg/l)	API-RP 45
Alkalinity	(mg/l)	APHA 2320-ALKALINITY-B
Acidity	(mg/L)	APHA 2310 B
Ammonia nitrogen	(mg/l)	EPA 350.2
THC	(mg/l)	APR – RP 45
Nitrite	(mg/l)	EPA 354.1
Chloride	(mg/l)	APHA 4500Cl- B
Sulphate	(mg/l)	EPA 375.4
Total Phosphorous	(mg/l) (mg/kg)	APHA 4500 P0 43-
Calcium	(mg/l) (mg/kg)	APHA 3111
Magnesium	(mg/l) (mg/kg)	APHA 3111/ASTM D 3561
Potassium	(mg/l) (mg/kg)	APHA 3111/ASTM D 3561
Cadmium	(mg/l) (mg/kg)	APHA3111
Chromium	(mg/l) (mg/kg)	APHA3111
Lead	(mg/l) (mg/kg)	APHA 3111
Manganese	(mg/l) (mg/kg)	APHA 3111
Iron	(mg/l) (mg/kg)	APHA 3111
Copper	(mg/l) (mg/kg)	APHA 3111
Zinc	(mg/l) (mg/kg)	APHA 3111
PCB	(mg/l) (mg/kg)	EPA method 625

Plankton and Benthos Analysis

Five (5) drops (using a dropper) of the concentrated sample (10 ml) were investigated at different magnifications (50X, 100X and 400X) using a Wild II binocular microscope with a calibrated eyepiece and the average recorded. The drop count microscope analysis method as described by Onyema (2007) was used to estimate the plankton flora and fauna.

Since each sample drop from the dropper accounts to 0.1 ml, the results of the abundance/occurrence were multiplied accordingly to give the values as numbers of organisms per ml which is the standard unit of measurement. To create a suitable plankton sample mount, a dropper was used to take in at least 1.5ml of the sample after shaking properly. This was then allowed to stand for at least 3 minutes. After which, one or two drops of the concentrated sample from the dropper was then gently dropped on a glass slide (7.5 cm by 2.5 cm) while placed on a flat laboratory table and covered with a glass slide (2cm by 2cm). The mount was then placed on the microscope stage, fitted in and all transects were thoroughly observed for phytoplankton (cells, filaments, colonies) and zooplankton species (e.g. adults and juvenile stages alike). Final data were presented as a number of organisms (cells, filaments, colonies, and whole organism) per ml. Standard methods by Karison, (2010) and Goswami, (2004) were used to aid identification of the species.

Community Structure Analysis

The following diversity indices were used for biological data analysis and the results of these indices are presented in two (2) decimal places.

Species Richness Index (d)

The Species richness index (d) according to Margalef (1951) is a measure of diversity and was used to evaluate the community structure. Species Richness is a measure of the number of different kinds of organisms present in a particular area. This index is also referred to as Margalef index. The equation below was applied.

$$d = \frac{S-1}{\ln N}$$

Where:

d = Species richness index

S = Number of species in a population

N = Total number of individuals in S species.

Menhinick's Index (D)

The Menhinick's Index (D) (Ogbeibu, 2005) is one of several diversity indices used to quantify diversity and hence measure diversity in categorical data. It represents a biological association with a number which gives a measure of its community structure. The equation below was applied.

$$D = \frac{S}{\sqrt{N}}$$

S = Number of species in a population and N = Total number of individuals in S species.

Simpson's Diversity Index (D)

This is a measure of diversity. In ecology, it is often used to quantify the biodiversity of a habitat. It takes into account the number of species present, as well as the abundance of each species.

$$\tilde{D} = 1 - \sum_{i=1}^{S} p_i^2,$$

i = Counts denoting the ith species ranging from 1 – n

Pi = Proportion that the ith species represents in terms of numbers of individuals with respect to the total number of individuals in the sampling space as a whole.

S = Number of species in a population

Shannon and Weiner Diversity Index (H_s)

The Shannon and Weiner diversity index (H_s)is one of several diversity indices used to measure diversity in categorical data. It is simply the Information entropy of the distribution, treating species as symbols and their relative population sizes as the probability (Ogbeibu, 2005). Shannon and Wiener (1963) diversity index is also called Shannon index. The equation below was applied.

$$Hs = \frac{N \log N - \sum P_i \log P_i}{N}$$

Where H_s = Shannon And Wiener Diversity Index

i = Counts denoting the ith species ranging from 1 – n
Pi = Proportion that the ith species represents in terms of numbers of individuals with respect to the total number of individuals in the sampling space as a whole.

Species Equitability or Evenness index (j)

The Species Equitability or Evenness index (j)is one of several diversity indices used to measure diversity in categorical data. Evenness is a measure of the relative abundance of the different species making up the richness of an area (Ogbeibu, 2005).

The equation below was applied.

$$j = \frac{Hs}{Log_2 S}$$

Where j = Equitability index
H_s = Shannon and Weiner index
S = Number of species in a population

Fisheries

The fisheries resources in the Bassim Biri River were assessed with the help of artisanal fishermen who use basket traps and cast nets for their fishing exercise. The fishermen routinely throw cast nets at different sites in the water to obtain a variety of table size fishes for sale and consumption. The crabs and shrimps in the water are fished in the coastal areas using locally fabricated basket traps with fruit snares. Sampling was done using a paddle and motorized wooden boats in the coastal creeks, often in groups of two people per boat. Sampling was usually done early in the morning while fish harvesting, and sales continued from late morning to midday. Occasionally, fish sampling occurs in the morning.

Statistical Analysis

All data generated in this study were subjected to statistical analysis to test for spatial variation and significance difference between data within the proposed project area and control stations using Excel, SPSS version 20.0 and Paleontology Statistical package (PAST version 3.15) as applicable. The statistical calculations reported included descriptive statistics (range, mean, and standard deviation, the coefficient of variation, frequency, and percentages) and a student paired sample t-Test. One level of significance ($p < 0.05$) was considered in the interpretation of the results. The analytical results were also compared with local and international standards where applicable and with data from previous studies within the zone.

Stakeholder Engagement Methodology

The stakeholder engagement process for the Project was designed to ensure that all relevant stakeholders were identified, informed, and provided with opportunities to participate in the Environmental and Social Impact Assessment (ESIA) process. The methodology adopted was guided by the principles of inclusiveness, transparency, accountability, and meaningful participation. Stakeholders were identified based on their potential interest in, influence on, or exposure to the Project's environmental and social impacts. These included representatives of the University management, staff, students, government agencies, regulatory authorities, host communities, local businesses, contractors, and other interested parties.

Stakeholder engagement was carried out through a combination of stakeholder mapping, consultations, interviews, meetings, and field interactions. Information about the Project, including its objectives, scope, anticipated benefits, and potential environmental and social impacts, was communicated to stakeholders in a clear and accessible manner. Consultations were conducted through key informant interviews, focus group discussions, one-on-one meetings, and formal stakeholder meetings to obtain views, concerns, expectations, and recommendations. Stakeholder feedback was documented, analyzed, and incorporated into the impact assessment and project planning process where appropriate.

To ensure effective participation, stakeholders were encouraged to express their opinions freely and raise concerns regarding any aspect of the Project. Particular attention was given to vulnerable groups and individuals who might be disproportionately affected by the Project or have limited access to decision-making processes. The engagement process also provided a platform for discussing mitigation measures, grievance mechanisms, and opportunities for enhancing Project benefits. Records of consultations, attendance lists, issues raised, and responses provided were maintained as part of the ESIA documentation.

Appendix II – Laboratory Data

SCOPEX NIGERIA LIMITED
Environmental Consultancy, Engineering, Contractors and Procurement
PORTHARCOURT OFFICE: #14 Ogbogoro Road, off Choba Road, Port Harcourt.
Tel: +234 (0) 8033100229, +234 (0) 8054971514
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ABUJA OFFICE: Block 57, Flat 18 Mambolo Street, Zone 2, Wuse District, Abuja.
NORTH AMERICA OFFICE: 230 Oak Street, Toronto Ontario M5a 2e2 Canada, Tel: 009147866101 6, 0091141636106314

Our Ref: ROF/LD/A-227/2026

Attention:

Certificate of Analysis for the Environmental Social Impact Assessment (ESIA) for the Proposed REA Solar Power Project

The result herein presents the analytical data for soil, sediment, surface water, and groundwater samples collected and relinquished for laboratory testing under the abovenamed contract. The results are presented in tables. The analysis has been conducted in line with the methods approved by the federal ministry of Environments such as the American Society for Testing and Material (ASTM) and the American Public Health Association (APHA) methods as well as international best practices. A total of 28 soil, 5 Surface water; 5 Sediment and 4 ground water samples were relinquished to the laboratory for analysis. See the chain of custody form attached for details.

The samples were received on the 19th of February 2026 and results were issued on the 5th of March 2023.

Signature:

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Victor Uche

Laboratory Manager

GROUND WATER TEST RESULT

Parameter	Units	BH1	BH2	BH3	Control
pH	–	6.50	6.68	6.85	7.10
Temperature	°C	27.18	27.89	28.60	28.16
Electrical Conductivity (EC)	µS/cm	166.00	175.50	185.00	83.00
Total Dissolved Solids (TDS)	mg/L	131.00	136.50	142.00	143.04
Dissolved Oxygen (DO)	mg/L	4.17	4.36	4.55	5.12
Total Suspended Solids (TSS)	mg/L	0.33	0.37	0.41	0.41
Turbidity	NTU	0.70	1.35	2.00	0.50
Biological Oxygen Demand (BOD)	mg/L	0.451	0.504	0.556	0.451
Chemical Oxygen Demand (COD)	mg/L	1.155	1.158	1.161	1.161
Total Hydrocarbons (THC)	mg/L	<0.001	<0.001	<0.001	<0.001
Nitrate	mg/L	2.17	2.685	3.20	5.17
Sulphate	mg/L	25.00	35.01	45.01	65.01
Ammonium	mg/L	<0.001	<0.001	<0.001	<0.001
Phosphate	mg/L	1.27	1.34	1.41	1.41
Nickel	mg/L	<0.001	<0.001	<0.001	<0.001
Iron	mg/L	0.021	0.518	1.015	1.015
Lead	mg/L	<0.001	<0.001	<0.001	<0.001
Copper	mg/L	<0.001	<0.001	<0.001	<0.001
Chromium	mg/L	<0.001	<0.001	<0.001	<0.001
Zinc	mg/L	<0.001	<0.001	<0.001	<0.001
Cadmium	mg/L	<0.001	<0.001	<0.001	<0.001
Barium	mg/L	<0.001	<0.001	<0.001	<0.001
Cobalt	mg/L	<0.001	<0.001	<0.001	<0.001
Arsenic	mg/L	<0.001	<0.001	<0.001	<0.001
Mercury	mg/L	<0.001	<0.001	<0.001	<0.001
Potassium	mg/L	0.003	0.007	0.010	0.003

Sodium	mg/L	0.215	0.234	0.253	0.215
Magnesium	mg/L	0.010	0.011	0.012	0.012
Calcium	mg/L	0.022	0.025	0.028	0.022
Coliforms (CFU/100 mL)	Count	6	6.5	7	3
E. coli (CFU/100 mL)	Count	0	0	0	0

SURFACE WATER

Parameter	Unit	SW1	SW2	SW3	SW4	Control
pH	–	7.30	7.75	8.12	8.70	8.00
Temperature	°C	29.20	29.35	29.55	29.60	29.40
Electrical Conductivity (EC)	µS/cm	60.0	61.0	62.0	62.0	58.5
Total Dissolved Solids (TDS)	mg/L	30	33	34	47	30
Dissolved Oxygen (DO)	mg/L	4.71	4.74	4.78	4.82	4.81
Total Suspended Solids (TSS)	mg/L	4.71	5.82	6.57	7.38	5.58
Turbidity	NTU	0.10	0.65	1.12	1.20	1.75
Biological Oxygen Demand (BOD)	mg/L	2.582	2.740	2.822	3.180	2.5035
Chemical Oxygen Demand (COD)	mg/L	3.952	4.980	5.566	7.030	4.658
Total Hydrocarbons (THC)	mg/L	ND	ND	ND	ND	ND
Nitrate	mg/L	0.107	0.145	0.169	0.247	0.0995
Sulphate	mg/L	38.95	42.40	44.82	51.70	45.005
Ammonium	mg/L	ND	ND	ND	ND	ND
Phosphate	mg/L	0.009	0.012	0.014	0.025	0.0115
Iron	mg/L	0.028	0.041	0.060	0.063	0.018
Nickel	mg/L	ND	ND	ND	ND	ND
Lead	mg/L	ND	ND	ND	ND	ND
Copper	mg/L	ND	ND	ND	ND	ND
Chromium	mg/L	ND	ND	ND	ND	ND
Zinc	mg/L	ND	ND	ND	ND	ND
Cadmium	mg/L	ND	ND	ND	ND	ND

Barium	mg/L	ND	ND	ND	ND	ND
Cobalt	mg/L	ND	ND	ND	ND	ND
Arsenic	mg/L	ND	ND	ND	ND	ND
Mercury	mg/L	ND	ND	ND	ND	ND
Potassium	mg/L	2.983	3.210	3.557	5.290	3.5065
Sodium	mg/L	93.74	110.00	121.00	148.23	124.747
Magnesium	mg/L	0.010	0.015	0.019	0.020	0.3195
Calcium	mg/L	1.017	1.120	1.271	1.380	1.525
Coliforms	CFU/100 mL	2	4	5	8	11
E. coli	CFU/100 mL	0	0	0	0	2

SEDIMENT

Parameter	**Units**	**SED1**	**SED2**	**SED3**	**SED4**	**SEDC1**
Temperature	°C	27.2	27.8	28.1	28.8	27.75
pH	-	6.14	6.18	6.17	6.27	6.47
Electrical Conductivity	µS/cm	102.54	118.00	128.00	221.14	118.98
Total Petro Hydrocarbon	mg/kg	ND	ND	ND	ND	ND
Total Organic Content	g/kg	0.21	1.20	1.26	1.60	0.53
Clay	%	ND	1	2	9	7
Silt	%	ND	4	8	35	19
Sand	%	100	95	90	56	74
External Nitrate	mg/kg	0.28	0.41	0.49	0.58	0.31
Total Nitrogen	mg/kg	0.43	0.57	0.67	0.81	0.48
External Sulphate	mg/kg	21	32	41	42	17
External Phosphate	mg/kg	ND	0.08	0.09	0.50	0.18
Magnesium	mg/kg	ND	1	3	13	10
Potassium	mg/kg	12	14	18	23	20.5
Calcium	mg/kg	7	8	9	9	15.5
Manganese	mg/kg	7	8	8	9	25
Total Iron	mg/kg	0.12	0.25	0.35	0.43	0.45
Zinc	mg/kg	ND	ND	ND	ND	ND
Total Chromium	mg/kg	ND	ND	ND	ND	ND
Lead	mg/kg	ND	ND	ND	ND	ND

Cadmium	mg/kg	ND	ND	ND	ND	ND
Mercury	mg/kg	ND	ND	ND	ND	ND
Vanadium	mg/kg	ND	ND	ND	ND	ND
Nickel	mg/kg	ND	ND	ND	ND	ND
Barium	mg/kg	ND	ND	ND	ND	ND
THB	$\times 10^4$ cfu/g	0	0	0	0	0

Signature:

---------- **Okeleke Victor Uche**

Laboratory Manager

Physicochemical Properties of Soil

Sample ID	pH 0–15	pH 15–30	EC 0–15 (µS/cm)	EC 15–30 (µS/cm)	Temp 0–15 (°C)	Temp 15–30 (°C)	NO_3 0–15 (mg/kg)	NO_3 15–30 (mg/kg)	NH_3 0–15 (mg/kg)	NH_3 15–30 (mg/kg)	PO_4 0–15 (mg/kg)	PO_4 15–30 (mg/kg)	SO_4 0–15 (mg/kg)	SO_4 15–30 (mg/kg)	Cl 0–15 (mg/kg)	Cl 15–30 (mg/kg)	TOC 0–15 (%)	TOC 15–30 (%)
SS1	5.67	5.65	98	113	28.4	28.2	0.38	0.11	0.80	0.97	0.56	7.23	12.11	0.12	0.87	0.79	0.63	0.69
SS2	5.89	5.92	112	119	28.7	28.5	0.42	0.15	0.86	1.12	0.61	8.10	12.42	0.25	1.01	1.05	0.66	0.72
SS3	6.02	6.10	125	126	29.0	28.8	0.48	0.19	0.92	1.28	0.73	8.95	12.88	0.40	1.14	1.28	0.70	0.75
SS4	6.21	6.28	138	132	29.2	29.0	0.53	0.23	0.98	1.45	0.82	9.82	13.24	0.58	1.27	1.55	0.74	0.78
SS5	6.38	6.52	148	138	29.5	29.3	0.58	0.29	1.04	1.73	0.95	10.66	13.71	0.76	1.42	1.86	0.78	0.81
SS6	6.55	6.73	158	143	30.0	29.7	0.63	0.35	1.10	2.05	1.08	11.48	14.02	0.95	1.58	2.18	0.82	0.84
SS7	6.72	6.85	166	147	30.4	30.0	0.68	0.41	1.18	2.38	1.18	12.32	14.33	1.15	1.74	2.55	0.86	0.87
SS8	6.88	7.02	172	151	30.8	30.2	0.73	0.48	1.25	2.65	1.31	13.15	14.62	1.38	1.92	3.02	0.89	0.90
SS9	7.05	7.23	178	156	31.0	30.5	0.79	0.56	1.36	2.95	1.48	14.28	15.04	1.68	2.12	3.78	0.93	0.94
SS10	7.28	7.42	184	164	31.2	30.8	0.85	0.66	1.52	3.30	1.67	16.40	15.41	2.10	2.36	4.52	0.97	0.98
SS11	7.54	7.71	190	179	31.5	31.1	0.94	0.82	1.86	3.78	1.95	19.85	15.72	3.15	2.64	5.40	1.01	1.03
SS12	7.97	8.02	195	186	31.8	31.4	1.03	1.00	2.24	4.21	2.22	23.21	16.01	4.31	2.98	6.21	1.05	1.11
CTR1	6.33	6.02	167	132	29.35	28.50	0.90	0.75	0.99	2.42	1.62	7.83	10.67	1.34	2.06	0.97	1.15	1.23
CTR2	6.32	6.01	167	131	29.35	28.50	0.89	0.74	0.98	2.41	1.62	7.83	10.67	1.34	2.06	0.97	1.14	1.23

Signature:

---------- **Okeleke Victor Uche**

Laboratory Manager

Particle Size Distribution (PSD)

Sample ID	Mg 0–15	Mg 15–30	K 0–15	K 15–30	Na 0–15	Na 15–30
SS1	22.75	19.09	2.43	2.75	9.10	8.81
SS2	24.81	22.45	2.85	3.12	9.54	9.24
SS3	26.44	24.87	3.18	3.55	10.02	9.76
SS4	28.35	26.53	3.65	4.02	10.55	10.18
SS5	29.72	28.12	4.22	4.56	11.06	10.84

Exchangeable Cations

SS6	31.06	29.47	4.89	5.04	11.78	11.42
SS7	32.44	30.91	5.21	5.28	12.24	11.76
SS8	33.85	31.86	5.54	5.52	12.88	12.08
SS9	35.14	33.22	5.88	5.86	13.52	12.46
SS10	36.48	34.51	6.32	6.32	14.35	13.02
SS11	38.27	35.42	6.81	7.12	15.42	13.86
SS12	40.62	36.16	7.16	9.18	17.69	14.66
CTR1	27.17	25.27	4.76	6.08	12.37	12.52
CTR2	27.16	25.26	4.75	6.08	12.36	12.52

Heavy Metals

Sample ID	Cu	Cu	Cr	Cr	Cd	Cd	Ni	Ni	Fe	Fe	Pb	Pb	Zn	Zn	Mn	Mn
	0–15	15–30	0–15	15–30	0–15	15–30	0–15	15–30	0–15	15–30	0–15	15–30	0–15	15–30	0–15	15–30
SS1	3.44	3.63	1.32	1.23	0.68	0.62	0.69	0.67	97.18	94.62	0.84	0.89	5.17	5.13	1.30	1.21
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
SS12	4.97	4.51	1.89	1.82	1.29	1.32	2.39	2.09	299.43	293.12	1.75	1.94	9.29	9.16	3.43	3.20
CTR1	2.00	1.83	1.01	1.21	0.83	0.85	0.77	0.72	183.62	184.80	1.09	0.96	10.08	8.72	1.83	1.98
CTR2	2.00	1.82	1.00	1.21	0.82	0.85	0.76	0.72	183.62	184.80	1.09	0.95	10.07	8.71	1.83	1.98

Microbiology

Sample ID	THB (cfu/g)	HUB (cfu/g)	THF (cfu/g)	HUF (cfu/g)	*E. coli* (MPN/g)
SS1	0	0	0	0	0
SS2	0	0	0	0	0
SS3	0	0	0	0	0
SS4	0	0	0	0	0
SS5	0	0	0	0	0
SS6	0	0	0	0	0
SS7	0	0	0	0	1
SS8	0	0	0	0	1
SS9	0	0	0	0	1
SS10	0	0	0	0	2
SS11	0	0	0	0	3
SS12	0	0	0	0	1
CTR1	0	0	0	0	1
CTR2	0	0	0	0	0

Soil PSD

Sample ID	Moisture 0–15 (%)	Moisture 15–30 (%)	Porosity 0–15 (%)	Porosity 15–30 (%)	Sand 0–15 (%)	Sand 15–30 (%)	Silt 0–15 (%)	Silt 15–30 (%)	Clay 0–15 (%)	Clay 15–30 (%)
SS1	6.74	6.37	27.36	26.42	6.81	5.71	1.57	0.66	24.94	28.93
SS2	6.91	6.58	28.14	27.75	8.95	8.14	4.22	3.88	30.15	33.74
SS3	7.05	6.81	29.23	29.02	11.34	10.52	8.65	7.84	36.42	39.25
SS4	7.18	7.03	30.45	30.28	13.81	12.95	12.18	11.22	44.26	45.72
SS5	7.34	7.26	31.62	31.74	16.44	15.28	16.57	15.64	53.22	51.38
SS6	7.52	7.48	32.84	33.02	18.96	17.86	20.83	19.85	60.15	56.22

SS7	7.68	7.72	34.15	34.25	21.74	20.48	24.91	23.94	67.42	61.37
SS8	7.86	7.94	35.41	35.88	24.62	23.16	29.37	28.44	73.16	66.45
SS9	8.05	8.18	36.87	37.12	27.81	25.82	36.48	35.25	80.22	72.48
SS10	8.23	8.46	38.14	38.86	30.25	28.36	43.21	42.12	85.64	79.36
SS11	8.51	8.82	39.36	39.95	31.82	30.84	51.08	50.33	88.91	86.45
SS12	8.75	9.12	40.63	41.12	33.20	33.29	58.14	59.25	91.62	93.63
CTR1	8.61	9.24	32.42	29.38	27.00	24.72	10.81	18.46	62.20	56.81
CTR2	8.60	9.24	32.42	29.38	26.99	24.72	10.81	18.46	62.20	56.81

Air /noise Results

Point	Noise dB(A)	SOx	NOx	SPM	VOC	CO	O_3	CO_2	H_2S	Temp °C	Wind m/s	Humidity %
AQ1	58.3	0	0	28.0	0	0	35.0	410.0	0	29.0	0.30	78.1
AQ2	62.5	0	0	28.2	0	0	36.0	430.0	0	29.3	0.55	73.0
AQ3	63.8	0	0	28.4	0	0	36.1	440.0	0	29.4	0.65	72.0
AQ4	64.7	0	0	28.6	0	0	36.5	450.0	0	29.5	0.75	71.8
AQ5	65.2	0	0	28.8	0	0	36.8	455.0	0	29.6	0.80	71.5
AQ6	65.5	0	0	28.9	0	0	37.0	458.0	0	29.7	0.85	71.2
AQ7	65.8	0	0	29.0	0	0	37.2	460.0	0	29.8	0.90	70.9
AQ8	66.2	0	0	29.1	0	0	37.5	465.0	0	29.9	0.95	70.7
AQ9	66.7	0	0	29.2	0	0	37.7	470.0	0	30.0	1.00	70.5
AQ10	67.3	0	0	29.4	0	0	38.0	480.0	0	30.0	1.03	70.3
AQ11	67.6	0	0	29.4	0	0	39.68	481.48	0	30.1	1.08	70.1
AQ12	68.9	0	0	31.0	0	0	40.0	500.0	0	30.1	1.10	71.38
AQC1	60.2	0	0	28.1	0	0	35.4	420.0	0	29.2	0.45	75.0
AQC2	61.5	0	0	28.3	0	0	35.8	425.0	0	29.4	0.50	74.2

Signature:

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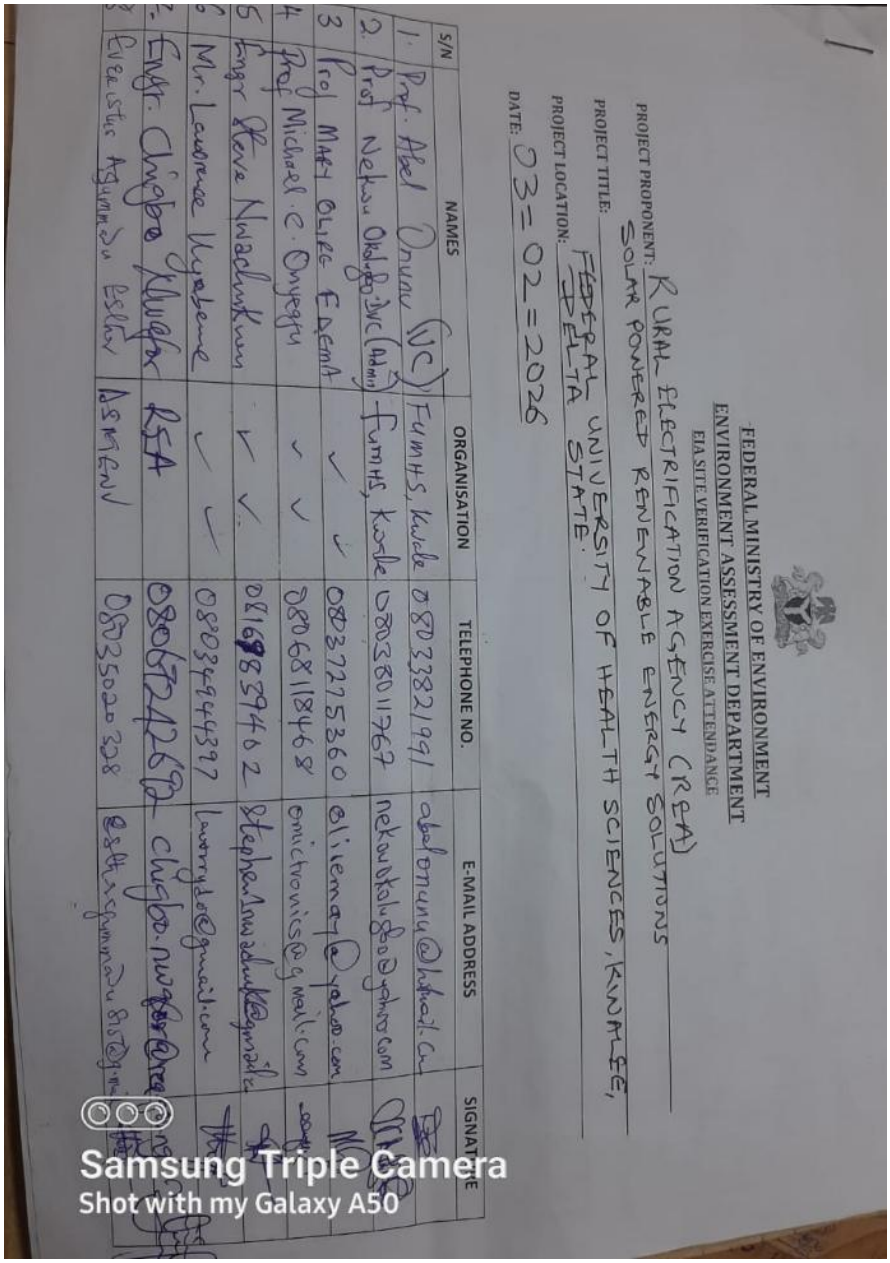
Laboratory Manager

Appendix III- Evident of Consultation



FEDERAL MINISTRY OF ENVIRONMENT
ENVIRONMENT ASSESSMENT DEPARTMENT
EIA SITE VERIFICATION EXERCISE ATTENDANCE

PROJECT PROPONENT: RURAL ELECTRIFICATION AGENCY (REA)
PROJECT TITLE: SOLAR POWERED RENEWABLE ENERGY SOLUTIONS
PROJECT LOCATION: FEDERAL UNIVERSITY OF HEALTH SCIENCES, KWALEE, DELTA STATE.
DATE: 03=02=2026

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Samsung Triple Camera
Shot with my Galaxy A50

FEDERAL MINISTRY OF ENVIRONMENT
ENVIRONMENTAL ASSESSMENT DEPARTMENT
EIA SITE VERIFICATION EXERCISE ATTENDANCE

PROJECT PROPONENT: RURAL ELECTRIFICATION AGENCY [REA]

PROJECT TITLE: SOLAR POWERED RENEWABLE ENERGY SOLUTIONS

PROJECT LOCATION: FEDERAL UNIVERSITY OF AGRICULTURE, BASSAMBIRI, BAYELSA STATE

DATE: 05=02=2026

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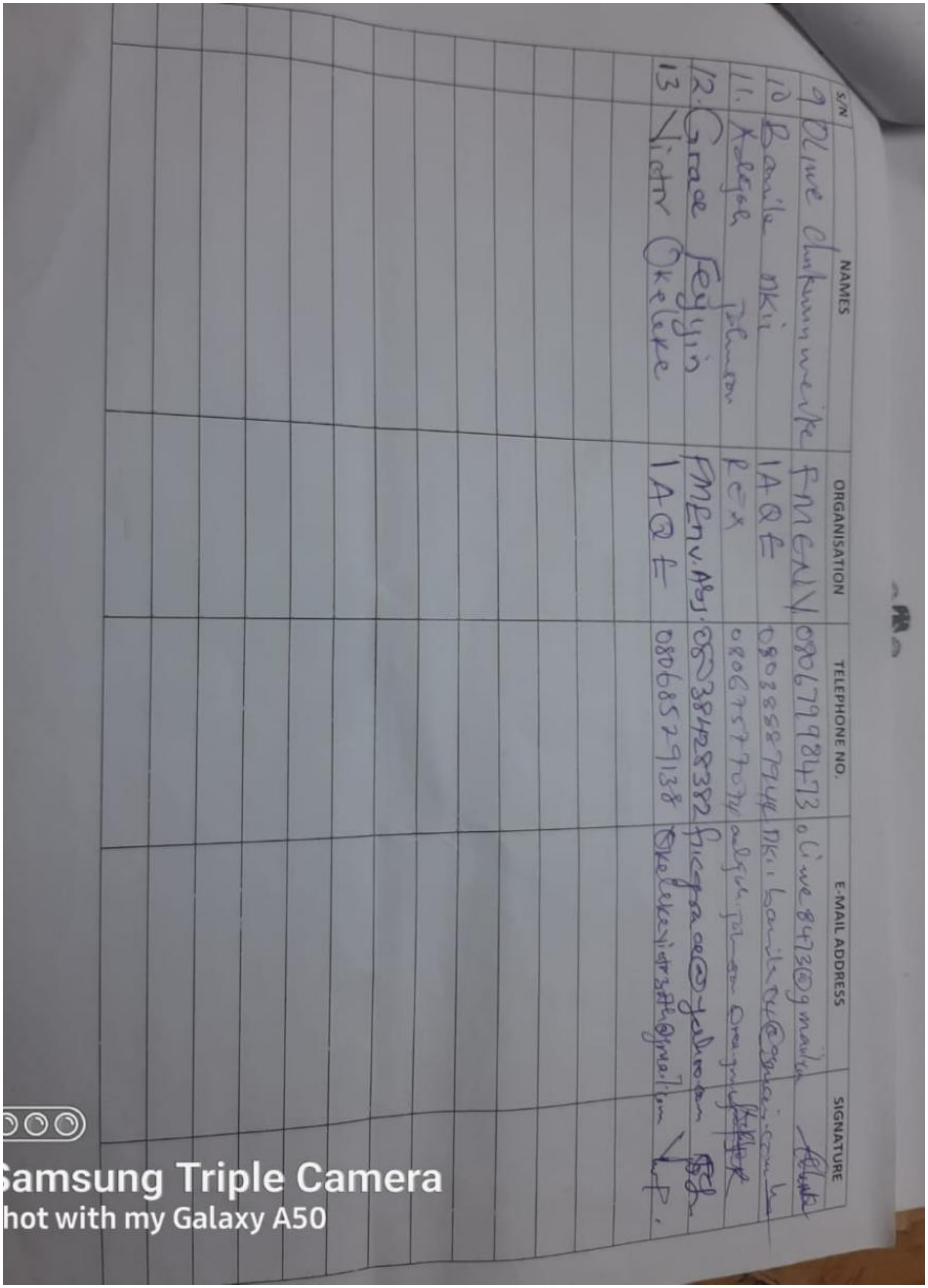
Samsung Triple Camera
Shot with my Galaxy A50



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